APPENDIX A Summary of Approved Regulated Activities

APPENDIX A: Summary of Approved Regulated Activities at Kyalla EP 117 N2 Incorporated into the Shenandoah South E&A Program EMP EP 117 and EP 98 (TAM1)

The following activities arising from the approved regulated activities outlined in the three (3) EMPs below, are incorporated into the ***Shenandoah South E&A Program EMP EP 117 and EP 98 (TAM1)***. Upon approval of this EMP, Tamboran will submit a regulation 14 letter to DEPWS to close-out the EMPs listed in Table A-1, in accordance with the Petroleum (Environment) Regulations 2016.

Table A-1: Approved EMPs and regulated activities incorporated into the *Shenandoah South E&A Program EMP EP 117 and EP 98 (TAM1)*

EMP	Activities approved	Status	Status of activities and transfer/incorporation into the *Shenandoah South E&A Program EMP EP 117 and EP 98 (TAM1)*
Beetaloo Basin Kyalla 117 N2 Civil Construction EP117 (ORI1-1), approved 6 June 2019 EMP Doc # NT-2050-15-MP-34	• Land clearing and establishment of an exploration lease pad, camp pad, soil stockpile area. • Land clearing for construction of access track. • Use of existing approved gravel pits to provide material for improving stability and integrity of the access (SSGP1 and SSGP2 established under ORI-2019). • Clearing and installation of fencing/firebreak, gates and grids.	Completed	• Approved land disturbance for all infrastructure (20.40 ha, including gravel pits SSGP 1 and SSGP2), including 3 Regulation 22 notifications to DEPWS: - Regulation 22 Beetaloo Basin Kyalla, Civil Construction EMP (ORI1-1.1), 11 September 2019: Haul road and helipad increase in surface disturbance 2.10 ha - Regulation 22 Beetaloo Basin Kyalla, Civil Construction EMP (ORI1-1.2), 26 September 2019: Fenceline increase in surface disturbance 0.56 ha - Regulation 22 Beetaloo Basin Kyalla, Civil Construction EMP (ORI1-1.3), 5 June 2023: Tank pad increase in surface disturbance by 0.25 ha - Transfer of gravel pits SSGP1 and SSGP2 installed under ORI-2019, as per Regulation 14 notice dated 22 March 2024: Surface disturbance 8.75 ha • Apart from the Regulation 22 submitted on 5 June 2023 (0.25 ha), all clearing activities approved under this EMP were completed during the 2019/20 dry season. **Transferred activities:** • Ongoing operations; monitoring; maintenance; and rehabilitation of this site are incorporated into the ***Shenandoah E&A Program EMP EP 117 and EP 98 (TAM1)***. • Clearing of 0.25 ha of the lease pad (Reg 22 5 June 2023), is incorporated into the ***Shenandoah E&A Program EMP EP 117 and EP 98 (TAM1).*** • Environmental performance standards and outcomes; ongoing operations; monitoring; maintenance; and rehabilitation (20.40 ha, including SSGP1

EMP	Activities approved	Status	Status of activities and transfer/incorporation into the ***Shenandoah South E&A Program EMP EP 117 and EP 98 (TAM1)***
			and SSGP2) are incorporated into the ***Shenandoah E&A Program EMP EP 117 and EP 98 (TAM1).*** • Ongoing operation, maintenance, monitoring and rehabilitation of gravel pits: SSGP1 and SSGP2 will continue under the S***henandoah E&A Program EMP EP 117 and EP 98 (TAM1)***.
Beetaloo Basin Kyalla drilling hydraulic fracture stimulation and well testing program EP117 N2 EMP (ORI3-2), approved 13 August 2019 EMP Doc # NT-2050-15-MP-025	• Drilling of an exploration well. • Hydraulic fracture stimulation of an exploration well. • Completion and workover maintenance of an exploration well. • Well testing of an exploration well. • Well suspension and decommissioning of an exploration well. • Construction and operation of a temporary camp. • Installation of up to two water extraction bores. • Routine maintenance and monitoring activities. • Any other minor works ancillary of the above.	Completed	• The Kyalla 117 N2-1H well was spudded on 30 November 2019 was shut-in on 22 February 2020. • 2 approved groundwater bores were constructed: - RN041136 20/03/2020 - RN041137 21/03/2020 **Transferred activities:** • The well testing, suspension, maintenance, monitoring and decommissioning of the Kyalla 117 N2-1H well and ancillary activities approved under this EMP will be incorporated into the ***Shenandoah E&A Program EMP EP 117 and EP 98 (TAM1).*** • Ongoing operation, maintenance and monitoring of groundwater bores RN041136 and RN041137 will continue under the S***henandoah E&A Program EMP EP 117 and EP 98 (TAM1)***. • Environmental performance standards and outcomes; ongoing operations; monitoring; maintenance; and rehabilitation are incorporated into the ***Shenandoah E&A Program EMP EP 117 and EP 98 (TAM1)***.
Beetaloo Sub-basin Kyalla 117 N2 Multi-well Drilling, Hydraulic Fracturing and Well Testing Program (ORI6-3), approved 22 February 2021 EMP Doc # NT-2050-MP-038	• Drilling, stimulation and well testing of 2 additional E&A wells – Shenandoah South 1H and Shenandoah South 2H. • Rehabilitation of the site to the standard outlined the *Beetaloo Basin Kyalla 117 N2 Civil Construction EP117* EMP, approved 6 June 2019	Active	• Includes one (1) Regulation 22 notification to DEPWS on 20 June 2023 to amend the target formation (Shenandoah South 1H and Shenandoah South 2H) and incorporate additional drilling chemicals. • Tamboran has drilled Shenandoah South 1H E&A well, which was spudded on 1 August 2023. Stimulation of the well is scheduled to commence on 6 November 2023. • Transfer of groundwater bores RN040895, RN040896 and RN041132 installed under ORI-2019, as per Regulation 14 notice dated 22 March 2024.

EMP	Activities approved	Status	Status of activities and transfer/incorporation into the *Shenandoah South E&A Program EMP EP 117 and EP 98 (TAM1)*
	• Ongoing operation, maintenance and monitoring of groundwater bores RN040895, RN040896 and RN041132, established under ORI-2019		**Transferred activities:** • The drilling, hydraulic fracture stimulation, well testing, suspension, maintenance, monitoring and decommissioning of the Shenandoah South 2H E&A well, will be incorporated into the ***Shenandoah E&A Program EMP EP 117 and EP 98 (TAM1)***. • Ongoing well testing, suspension, maintenance, monitoring and decommissioning of Shenandoah South 1H will be incorporated into the ***Shenandoah E&A Program EMP EP 117 and EP 98 (TAM1).*** • Environmental performance standards and outcomes; ongoing operations; monitoring; maintenance; and rehabilitation, are incorporated into the ***Shenandoah E&A Program EMP EP 117 and EP 98 (TAM1)***. • Ongoing operation, maintenance and monitoring of groundwater bores RN040895, RN040896 and RN041132 will continue under ***Shenandoah E&A Program EMP EP 117 and EP 98 (TAM1)***.

Environmental performance standards and environmental outcomes

Table A-2 to Table A-4 list the environmental outcomes and performance standards described in each EMP. Each table demonstrates where, in the new EMP, the old criteria have been met.

Table A-2: Environmental outcomes and performance standards – *Beetaloo Basin Kyalla 117 N2 Civil Construction EP117 EMP (ORI1-1)* vs *Shenandoah South E&A Program EMP EP 117 and EP 98 (TAM1)*

Beetaloo Basin groundwater monitoring bore installation program – Kyalla 117 EMP				***Shenandoah South E&A Program EMP EP 117 and EP 98 (TAM1)***			
Environmental outcome			**Environmental performance measures**	**Environmental outcome**		**Environmental performance standard**	
1	Soils	• Avoid, minimise and control, soil erosion and discharge of sediment or soil into waterways or established drainage systems • Minimise disturbance of soil, vegetation and drainage during site activities • Minimise the creation of dust.	• Code of Practice for Petroleum Activities in the Northern Territory Part A-Surface. • NT Land Clearing Guidelines. • International Erosion Control Association Best Practice Erosion and Sediment Control (BPESC) standard. • Dangerous goods will be stored, handled, separated and signed as required by the NT Dangerous Goods Act and Flammable and Combustible Liquids Regulations and AS1940.	Land – landforms and terrestrial environmental quality	Ecological function of soils and landforms at the well pad and surrounding area consistent with current (non-petroleum) land use following the activities under this EMP	L-1: L-2 : L-3: L-4: L-5 L-6 L-7	No reportable spills or leaks of flowback, wastewater and chemicals from Tamboran's exploration activities- including gathering. No reportable incidents involving erosion or sediment release beyond the site boundary Stormwater released within the EMP limits. Low point drain releases are within the EMP limits No drift of evaporators that results in visible evidence of water pooling/saturated surfaces Disturbed exploration infrastructure no longer required are rehabilitated back to pre-existing state Disturbed seismic lines are reinstated promptly and rehabilitation implemented to return vegetation cover back to pre-existing state
2	Surface water	• Avoid and or minimise and control any potential contamination caused by the discharge of sediment to waterways or established drainage systems. • Contain all potential contaminants for treatment or disposal. • Minimise the impacts on surface water drainage by preserving drainage system integrity and water quality. • Maintain the natural flow regime of the area to avoid pooling or diversion of water away from wetlands.	• Code of Practice for Petroleum Activities in the Northern Territory Part A-Surface. • NT Land Clearing Guidelines. • International Erosion Control Association Best Practice Erosion and Sediment Control (BPESC) standard.	Water – hydrological processes	• The environmental values of the underlying groundwater resources are maintained with no adverse impacts to users of the resource resulting from Tamboran's exploration activities.	GW-1: GW-2: GW-3: GW-4: GW-5	All aquifers isolated through cement and casing. No reportable spills or leaks of flowback, wastewater and chemicals from Tamboran's exploration activities- including gathering lines No seismic events over Ml 3.5 attributable to Tamboran's activities. No reduction in quality of an impact groundwater monitoring bore that is attributable to Tamboran's activities. Environmental Value) of groundwater in the region. No long term reduction in groundwater level observed in the impact monitoring bore that results in >1 m decline in groundwater water level.
				Water – inland water environmental quality and aquatic ecosystems	• Maintain the quality of surface water and aquatic ecosystems and prevent any adverse impacts from Tamboran's exploration activities.	SW-1: SW-2: SW-3: SW-4:	Stormwater released within the EMP limits with no evidence of wastewater contamination No seismic events over Ml 3.5 attributable to Tamboran's activities. No releases of wastewater (drilling fluid and flowback) off the lease or from gathering lines into surrounding drainage depressions or watercourses No reportable incidents involving erosion or sediment release beyond the site boundary into drainage depression or watercourse (extent of disturbance footprint of a site)
3	Groundwater	• To manage exploration activities to prevent over-extraction of groundwater. • Preserve groundwater quantity for potable and stock supplies.	• NT Water Act.	Water – hydrological processes	• Tamboran's exploration activities do not reduce the environmental values of the underlying groundwater resources (GW-1 – GW-6).	GW-1: GW-2: GW-3: GW-4: GW-5	All aquifers isolated through cement and casing. No reportable spills or leaks of flowback, wastewater and chemicals from Tamboran's exploration activities- including gathering lines No seismic events over Ml 3.5 attributable to Tamboran's activities. No reduction in quality of an impact groundwater monitoring bore that is attributable to Tamboran's activities. Environmental Value) of groundwater in the region. No long term reduction in groundwater level observed in the impact monitoring bore that results in >1 m decline in groundwater water level.

Beetaloo Basin groundwater monitoring bore installation program – Kyalla 117 EMP				*Shenandoah South E&A Program EMP EP 117 and EP 98 (TAM1)*		
Environmental outcome			**Environmental performance measures**	**Environmental outcome**		**Environmental performance standard**
4	Vegetation, flora, fauna and habitat	• Minimise disturbance to flora and fauna. • Minimise disturbance to sensitive areas.	• Code of Practice for Petroleum Activities in the Northern Territory Part A-Surface Activities. • NT Land Clearing Guidelines.	Land – terrestrial ecosystems	Tamboran's activities do not adversely impact surrounding vegetation, significant vegetation communities and listed threatened flora and fauna, with sites rehabilitated back to the current (non-petroleum) land use following the activities under this EMP	EC-1: No releases of wastewater (drilling fluid and flowback) off the lease into the surrounding vegetation. EC-2: No significant (<4 individual deaths per month) impacts to fauna due to wastewater storages . EC-3 – No listed threatened fauna deaths caused by flowback storage. EC-4: No uncontrolled bushfires caused by Tamboran's exploration activities (including civil construction, seismic and E&A activities). EC-5: No WONS (Class A and C) introduced to any Tamboran activity area that is reasonably attributed to exploration activities EC-6 Year-on-year decline in the size and density of all weed infestations introduced because of Tamboran's activities. EC-7: Disturbed seismic lines are reinstated promptly to promote revegetation. EC-8 Disturbed exploration infrastructure no longer required are rehabilitated back to pre-existing condition EC-9 No unauthorised clearing EC-10 Wetlands and riparian vegetation protected from clearing EC-11 Impacts to large trees (>25cm trunk @ 1.3m) minimised during clearing EC12----------No disturbance to grey Falcon nesting sites
				Land – landforms and terrestrial environmental quality	• Ecological function of soils and landforms at the well pad and surrounding area consistent with current (non-petroleum) land use following the activities under this EMP	L-1: No reportable spills or leaks of flowback, wastewater and chemicals from Tamboran's exploration activities- including gathering. L-2 : No reportable incidents involving erosion or sediment release beyond the site boundary L-3: Stormwater released within the EMP limits. L-4: Low point drain releases are within the EMP limits L-5 No drift of evaporators that results in visible evidence of water pooling/saturated surfaces L-6 Disturbed exploration infrastructure no longer required are rehabilitated back to pre-existing state L-7 Disturbed seismic lines are reinstated promptly and rehabilitation implemented to return vegetation cover back to pre-existing state .
5	Weeds (biosecurity)	• Avoid the introduction of weeds • Avoid the spread of existing weeds	• Code of Practice for Petroleum Activities in the Northern Territory Part A-Surface. • NT Land Clearing Guidelines. • Weed Management Planning Guide: Onshore Shale Gas Development Projects.	Land – landforms and terrestrial environmental quality	• Ecological function of soils and landforms at the well pad and surrounding area consistent with current (non-petroleum) land use following the activities under this EMP).	L-1: No reportable spills or leaks of flowback, wastewater and chemicals from Tamboran's exploration activities- including gathering. L-2 : No reportable incidents involving erosion or sediment release beyond the site boundary L-3: Stormwater released within the EMP limits. L-4: Low point drain releases are within the EMP limits L-5 No drift of evaporators that results in visible evidence of water pooling/saturated surfaces L-6 Disturbed exploration infrastructure no longer required are rehabilitated back to pre-existing state L-7 Disturbed seismic lines are reinstated promptly and rehabilitation implemented to return vegetation cover back to pre-existing state
				Land – terrestrial ecosystems	• No significant impact to high valued habitats and listed threatened flora and fauna from Tamboran's exploration activities (EC-1 – EC-9).	EC-1: No releases of wastewater (drilling fluid and flowback) off the lease into the surrounding vegetation. EC-2: No significant (<4 individual deaths per month) impacts to fauna due to wastewater storages . EC-3 – No listed threatened fauna deaths caused by flowback storage.

Beetaloo Basin groundwater monitoring bore installation program – Kyalla 117 EMP				*Shenandoah South E&A Program EMP EP 117 and EP 98 (TAM1)*		
Environmental outcome			**Environmental performance measures**	**Environmental outcome**		**Environmental performance standard**
						EC-4: No uncontrolled bushfires caused by Tamboran's exploration activities (including civil construction, seismic and E&A activities). EC-5: No WONS (Class A and C) introduced to any Tamboran activity area that is reasonably attributed to exploration activities EC-6 Year-on-year decline in the size and density of all weed infestations introduced because of Tamboran's activities. EC-7: Disturbed seismic lines are reinstated promptly to promote revegetation. EC-8 Disturbed exploration infrastructure no longer required are rehabilitated back to pre-existing condition EC-9 No unauthorised clearing EC-10 Wetlands and riparian vegetation protected from clearing EC-11 Impacts to large trees (>25cm trunk @ 1.3m) minimised during clearing EC12----------No disturbance to grey Falcon nesting sites.
6	Waste	• Minimise impacts on soil, surface water, groundwater, sensitive habitat and air quality. • Minimise creation of food sources or habitat for pest species. • Minimise waste generation through reduce, reuse, recycle programs.	• Code of Practice for Petroleum Activities in the Northern Territory Part A-Surface. • NT Waste Management and Pollution Control Act.	Land – landforms and terrestrial environmental quality	• No significant impact to the ecological function and productivity of surrounding soils or distinctive physical landforms resulting from Tamboran's exploration activities (L-1 – L-6).	L-1: No reportable spills or leaks of flowback, wastewater and chemicals from Tamboran's exploration activities- including gathering. L-2 : No reportable incidents involving erosion or sediment release beyond the site boundary L-3: Stormwater released within the EMP limits. L-4: Low point drain releases are within the EMP limits L-5 No drift of evaporators that results in visible evidence of water pooling/saturated surfaces L-6 Disturbed exploration infrastructure no longer required are rehabilitated back to pre-existing state L-7 Disturbed seismic lines are reinstated promptly and rehabilitation implemented to return vegetation cover back to pre-existing state.
				Water – hydrological processes	• The environmental values of the underlying groundwater resources are maintained with no adverse impacts to users of the resource resulting from Tamboran's exploration activities.	GW-1: All aquifers isolated through cement and casing. GW-2: No reportable spills or leaks of flowback, wastewater and chemicals from Tamboran's exploration activities- including gathering lines GW-3: No seismic events over Ml 3.5 attributable to Tamboran's activities. GW-4: No reduction in quality of an impact groundwater monitoring bore that is attributable to Tamboran's activities. Environmental Value) of groundwater in the region. GW-5 No long term reduction in groundwater level observed in the impact monitoring bore that results in >1 m decline in groundwater water level.
				Water – inland water environmental quality and aquatic ecosystems	• Protect the quality of surface water and aquatic ecosystems from any adverse impacts from Tamboran's exploration activities (SW-1 – SW-4).	SW-1: During chemical and wastewater storage activities, no off-site release of contaminants from chemical, hydrocarbon and waste storage. SW-2: No seismic events over Ml 3.5 attributable to Tamboran's activities. SW-3: No reportable spills, including off-site releases of contaminants resulting from Tamboran's exploration activities. SW-4: Erosion and sediment control in place and working effectively.
7	Air quality (dust and emissions)	• Minimise environmental nuisance at sensitive receptors. • Minimise greenhouse gas emissions.	• Code of Practice for Petroleum Activities in the Northern Territory Part A-Surface. • NT Land Clearing Guidelines.	Air – air and atmospheric processes	• No reduction on local air quality and minimisation of greenhouse gas emission generated from Tamboran's exploration activities.	AQ-1: All produced hydrocarbons to be sent to the flare where technically possible (e.g. when pressure is sufficient for the separator to function). AQ-2: All greenhouse gases reporting in accordance with NGERS requirements. AQ-3 – offsets retired in accordance with GGAP

Beetaloo Basin groundwater monitoring bore installation program – Kyalla 117 EMP				*Shenandoah South E&A Program EMP EP 117 and EP 98 (TAM1)*		
Environmental outcome			**Environmental performance measures**	**Environmental outcome**		**Environmental performance standard**
						AQ 4 All leaks detected and repaired in accordance with Code. AQ5 Flare efficiency achieve 98% combustion efficiency
				People – community and economy, and human health	• No adverse impacts to the community resulting from Tamboran's exploration activities (CO-1 – CO-3)	CO-1: All valid community complaints of nuisance investigated and resolved. CO-2: >60% of addressable spend to be from NT businesses. CO-3: All vehicle accidents investigated and reported in accordance with NT Police, Fire and Emergency Services requirements.
8	Lighting, noise, vibration and visual amenity	• Manage activities in accordance with occupational health and safety guidelines for noise, vibration and light exposure. • Minimise nuisance noise and vibration impacts on surrounding communities or exploration workers. • Minimise disruption to fauna and stock.	• Code of Practice for Petroleum Activities in the Northern Territory Part A-Surface. • NT Land Clearing Guidelines.	People – community and economy, and human health	• No adverse impacts to the community resulting from Tamboran's exploration activities (CO-1 – CO-3)	CO-1: All valid community complaints of nuisance investigated and resolved. CO-2: >60% of addressable spend to be from NT businesses. CO-3: All vehicle accidents investigated and reported in accordance with NT Police, Fire and Emergency Services requirements.
9	Bushfire	• Minimise the risk of causing bushfires from Tamboran's activities. • Minimise impacts on environmental habitat and fauna, soil erosion, impacts on stakeholders, impacts on culturally significant sites, public infrastructure and community lands. • Ensure proper health and safety plan for activities. • Prevent accidental fire risk and ensure safe storage of chemicals to prevent fire damage.	• Code of Practice for Petroleum Activities in the Northern Territory Part A-Surface. • NT Land Clearing Guidelines. • NT Bushfire Management Act.	Land – terrestrial ecosystems	Tamboran's activities do not adversely impact surrounding vegetation, significant vegetation communities and listed threatened flora and fauna, with sites rehabilitated back to the current (non-petroleum) land use following the activities under this EMP	EC-6: EC-1: No releases of wastewater (drilling fluid and flowback) off the lease into the surrounding vegetation. EC-2: No significant (<4 individual deaths per month) impacts to fauna due to wastewater storages . EC-3 – No listed threatened fauna deaths caused by flowback storage. EC-4: No uncontrolled bushfires caused by Tamboran's exploration activities (including civil construction, seismic and E&A activities). EC-5: No WONS (Class A and C) introduced to any Tamboran activity area that is reasonably attributed to exploration activities EC-6 Year-on-year decline in the size and density of all weed infestations introduced because of Tamboran's activities. EC-7: Disturbed seismic lines are reinstated promptly to promote revegetation. EC-8 Disturbed exploration infrastructure no longer required are rehabilitated back to pre-existing condition EC-9 No unauthorised clearing EC-10 Wetlands and riparian vegetation protected from clearing EC-11 Impacts to large trees (>25cm trunk @ 1.3m) minimised during clearing EC12----------No disturbance to grey Falcon nesting sites).
				People – cultural heritage	• No significant impact on sacred sites and environmental values because of Tamboran's exploration activities • Protection of culture and heritage	CH-1 – No non-compliances with Native Title Holder Exploration Agreements and AAPA certificate conditions. CH-2 –: Native title holders are actively engaged on Tamboran's work program, including understanding of Tamboran's current and future exploration activities.
				People – community and economy, and human health	• No adverse impacts to the community resulting from Tamboran's exploration activities	CO-1: All valid community complaints of nuisance investigated and resolved. CO-2: >60% of addressable spend to be from NT businesses. CO-3: All vehicle accidents investigated and reported in accordance with NT Police, Fire and Emergency Services requirements.
10	Cultural heritage and sacred sites	• Avoid disturbance or damage to Aboriginal cultural heritage artefacts or sacred • Minimise impacts and disruption to activities of Indigenous stakeholders in culturally significant areas. • Ensure adequate background information and training is provided to	• AAPA Certificates. • NT Bushfire Management Act.	People – cultural heritage	• No significant impact on sacred sites and environmental values because of Tamboran's exploration activities • Protection of culture and heritage (	CH-1 No non-compliances with Native Title Holder Exploration Agreements and AAPA certificate conditions. CH-2 –: Native title holders are actively engaged on Tamboran's work program, including understanding of Tamboran's current and future exploration activities.
				Land – terrestrial ecosystems	Tamboran's activities do not adversely impact surrounding vegetation, significant vegetation communities and listed	EC-1: No releases of wastewater (drilling fluid and flowback) off the lease into the surrounding vegetation. EC-2: No significant (<4 individual deaths per month) impacts to fauna due to wastewater storages .

Beetaloo Basin groundwater monitoring bore installation program – Kyalla 117 EMP				*Shenandoah South E&A Program EMP EP 117 and EP 98 (TAM1)*		
Environmental outcome			**Environmental performance measures**	**Environmental outcome**		**Environmental performance standard**
		employees and contractors working in culturally significant areas. • Ensure that the health and safety of employees, contractors and the community is not compromised through management of cultural and environmental awareness.			threatened flora and fauna, with sites rehabilitated back to the current (non-petroleum) land use following the activities under this EMP	EC-3 – No listed threatened fauna deaths caused by flowback storage. EC-4: No uncontrolled bushfires caused by Tamboran's exploration activities (including civil construction, seismic and E&A activities). EC-5: No WONS (Class A and C) introduced to any Tamboran activity area that is reasonably attributed to exploration activities EC-6 Year-on-year decline in the size and density of all weed infestations introduced because of Tamboran's activities. EC-7: Disturbed seismic lines are reinstated promptly to promote revegetation. EC-8 Disturbed exploration infrastructure no longer required are rehabilitated back to pre-existing condition EC-9 No unauthorised clearing EC-10 Wetlands and riparian vegetation protected from clearing EC-11 Impacts to large trees (>25cm trunk @ 1.3m) minimised during clearing EC-12----------No disturbance to grey Falcon nesting sites
				People – community and economy, and human health	• No adverse impacts to the community resulting from Tamboran's exploration activities	CO-1: All valid community complaints of nuisance investigated and resolved. CO-2: >60% of addressable spend to be from NT businesses. CO-3: All vehicle accidents investigated and reported in accordance with NT Police, Fire and Emergency Services requirements.
11	Community	• Minimise impacts on the local community and services. • Minimise safety risks to the public and other third parties. • Maintain and enhance partnerships with the local community, including using local contractors and maximising opportunities for local employment and training.	• Code of Practice for Petroleum Activities in the Northern Territory Part A-Surface. • NT Land Clearing Guidelines. • DIPL Traffic Management Plan.	People – community and economy, and human health	• No adverse impacts to the community resulting from Tamboran's exploration activities	CO-1: All valid community complaints of nuisance investigated and resolved. CO-2: >60% of addressable spend to be from NT businesses. CO-3: All vehicle accidents investigated and reported in accordance with NT Police, Fire and Emergency Services requirements.

Table A-3: Environmental outcomes and performance standards – *Beetaloo Basin Kyalla drilling hydraulic fracture stimulation and well testing program EP117 N2 EMP (ORI3-2)* vs *Shenandoah South E&A Program EMP EP 117 and EP 98 (TAM1)*

Environmental outcome under the *Beetaloo Basin Kyalla drilling hydraulic fracture stimulation and well testing program EP117 N2 EMP (ORI3-2)*				**Environmental outcome under the *Shenandoah South E&A Program EMP EP 117 and EP 98 (TAM1)***			
Environmental outcome			**Environmental performance standards**	**Environmental outcome**		**Environmental performance standard**	
1	Soils	• Avoid, minimise and control, soil erosion and discharge of sediment or soil into waterways or established drainage systems. • Minimise disturbance of soil, vegetation and drainage during site activities. • Minimise the creation of dust. • Prevent the contamination of soil to maintain the viability of soil resources.	• Code of Practice for Petroleum Activities in the Northern Territory Part A Surface Activities • International Erosion Control Association Best Practice Erosion and Sediment Control (BPESC) standard • NT Dangerous Goods Act and Flammable and Combustible Liquids Regulations and AS1940. • API Guidance Document –HF3, Practices for Mitigating Surface Impacts Associated with Hydraulic Fracturing • Spill Management Plan (Appendix D) • Wastewater Management Plan (Appendix E) • NT Waste Management and Pollution Control Act 1998 • National Environment Protection (Assessment of Site Contamination) Measure	Land – landforms and terrestrial environmental quality	• Ecological function of soils and landforms at the well pad and surrounding area consistent with current (non-petroleum) land use following the activities under this EMP	L-1: L-2 : L-3: L-4: L-5 L-6 L-7	No reportable spills or leaks of flowback, wastewater and chemicals from Tamboran's exploration activities- including gathering. No reportable incidents involving erosion or sediment release beyond the site boundary Stormwater released within the EMP limits. Low point drain releases are within the EMP limits No drift of evaporators that results in visible evidence of water pooling/saturated surfaces Disturbed exploration infrastructure no longer required are rehabilitated back to pre-existing state Disturbed seismic lines are reinstated promptly and rehabilitation implemented to return vegetation cover back to pre-existing state
				Water – hydrological processes	• The environmental values of the underlying groundwater resources are maintained with no adverse impacts to users of the resource resulting from Tamboran's exploration activities.	GW-1: GW-2: GW-3: GW-4: GW-5	All aquifers isolated through cement and casing. No reportable spills or leaks of flowback, wastewater and chemicals from Tamboran's exploration activities- including gathering lines No seismic events over Ml 3.5 attributable to Tamboran's activities. No reduction in quality of an impact groundwater monitoring bore that is attributable to Tamboran's activities. Environmental Value) of groundwater in the region. No long term reduction in groundwater level observed in the impact monitoring bore that results in >1 m decline in groundwater water level.
				Water – inland water environmental quality and aquatic ecosystems	• Maintain the quality of surface water and aquatic ecosystems and prevent any adverse impacts from Tamboran's exploration activities.	SW-1: SW-2: SW-3: SW-4:	Stormwater released within the EMP limits with no evidence of wastewater contamination No seismic events over Ml 3.5 attributable to Tamboran's activities. No releases of wastewater (drilling fluid and flowback) off the lease or from gathering lines into surrounding drainage depressions or watercourses No reportable incidents involving erosion or sediment release beyond the site boundary into drainage depression or watercourse (extent of disturbance footprint of a site)
				Air – air and atmospheric processes	• No significant impact on air quality and no excess greenhouse gas emissions resulting from Tamboran's exploration activities (AQ-1 – AQ-5)	AQ-1: AQ-2: AQ-3 – AQ-5:	Venting to be eliminated as far as reasonably practicable. All greenhouse gases reporting in accordance with NGERS requirements. All leaks detected and repaired in accordance with Code.
2	Surface water	• Avoid and minimise the potential contamination caused by the discharge of sediment or contaminated stormwater to waterways or established drainage systems. • Contain any potential contaminants for treatment or disposal.	• Code of Practice for Petroleum Activities in the Northern Territory Part A- Surface Activities • International Erosion Control Association Best Practice Erosion and Sediment Control (BPESC) standard • Dangerous goods will be stored, handled, separated and signed as required by the NT Dangerous Goods Act and Flammable and Combustible Liquids Regulations and AS1940 • Spill Management Plan • Wastewater Management Plan	Water – hydrological processes	• The environmental values of the underlying groundwater resources are maintained with no adverse impacts to users of the resource resulting from Tamboran's exploration activities.	GW-1: GW-2: GW-3: GW-4: GW-5	All aquifers isolated through cement and casing. No reportable spills or leaks of flowback, wastewater and chemicals from Tamboran's exploration activities- including gathering lines No seismic events over Ml 3.5 attributable to Tamboran's activities. No reduction in quality of an impact groundwater monitoring bore that is attributable to Tamboran's activities. Environmental Value) of groundwater in the region. No long term reduction in groundwater level observed in the impact monitoring bore that results in >1 m decline in groundwater water level.

Environmental outcome under the *Beetaloo Basin Kyalla drilling hydraulic fracture stimulation and well testing program EP117 N2 EMP (ORI3-2)*				Environmental outcome under the *Shenandoah South E&A Program EMP EP 117 and EP 98 (TAM1)*			
Environmental outcome			**Environmental performance standards**	**Environmental outcome**		**Environmental performance standard**	
			• NT Waste Management and Pollution Control Act 1998	Water – inland water environmental quality and aquatic ecosystems	• Maintain the quality of surface water and aquatic ecosystems and prevent any adverse impacts from Tamboran's exploration activities.	SW-1: SW-2: SW-3: SW-4:	Stormwater released within the EMP limits with no evidence of wastewater contamination No seismic events over Ml 3.5 attributable to Tamboran's activities. No releases of wastewater (drilling fluid and flowback) off the lease or from gathering lines into surrounding drainage depressions or watercourses No reportable incidents involving erosion or sediment release beyond the site boundary into drainage depression or watercourse (extent of disturbance footprint of a site)
3	Groundwater	• To manage exploration activities to prevent over-extraction of groundwater. • Preserve groundwater quantity for livestock supplies (the surrounding water use).	• NT Water Act • Code of Practice for Petroleum Activities in the Northern Territory Part A- Surface Activities	Water – hydrological processes	• The environmental values of the underlying groundwater resources are maintained with no adverse impacts to users of the resource resulting from Tamboran's exploration activities.	GW-1: GW-2: GW-3: GW-4: GW-5	All aquifers isolated through cement and casing. No reportable spills or leaks of flowback, wastewater and chemicals from Tamboran's exploration activities- including gathering lines No seismic events over Ml 3.5 attributable to Tamboran's activities. No reduction in quality of an impact groundwater monitoring bore that is attributable to Tamboran's activities. Environmental Value) of groundwater in the region. No long term reduction in groundwater level observed in the impact monitoring bore that results in >1 m decline in groundwater water level.
4	Vegetation, flora, fauna and habitat	• Minimise additional disturbance to flora and fauna. • No disturbance to high conservation areas.	• Code of Practice for Petroleum Activities in the Northern Territory Part A- Surface Activities	Land – landforms and terrestrial environmental quality	• Ecological function of soils and landforms at the well pad and surrounding area consistent with current (non-petroleum) land use following the activities under this EMP	L-1: L-2 : L-3: L-4: L-5 L-6 L-7	No reportable spills or leaks of flowback, wastewater and chemicals from Tamboran's exploration activities- including gathering. No reportable incidents involving erosion or sediment release beyond the site boundary Stormwater released within the EMP limits. Low point drain releases are within the EMP limits No drift of evaporators that results in visible evidence of water pooling/saturated surfaces Disturbed exploration infrastructure no longer required are rehabilitated back to pre-existing state Disturbed seismic lines are reinstated promptly and rehabilitation implemented to return vegetation cover back to pre-existing state
				Land – terrestrial ecosystems	Tamboran's activities do not adversely impact surrounding vegetation, significant vegetation communities and listed threatened flora and fauna, with sites rehabilitated back to the current (non-petroleum) land use following the activities under this EMP	EC-1: EC-2: EC-3 – EC-4: EC-5: EC-6 EC-7: EC-8 EC-9 EC-10 EC-11	No releases of wastewater (drilling fluid and flowback) off the lease into the surrounding vegetation. No significant (<4 individual deaths per month) impacts to fauna due to wastewater storages . No listed threatened fauna deaths caused by flowback storage. No uncontrolled bushfires caused by Tamboran's exploration activities (including civil construction, seismic and E&A activities). No WONS (Class A and C) introduced to any Tamboran activity area that is reasonably attributed to exploration activities Year-on-year decline in the size and density of all weed infestations introduced because of Tamboran's activities. Disturbed seismic lines are reinstated promptly to promote revegetation. Disturbed exploration infrastructure no longer required are rehabilitated back to pre-existing condition No unauthorised clearing Wetlands and riparian vegetation protected from clearing Impacts to large trees (>25cm trunk @ 1.3m) minimised during clearing

Environmental outcome under the *Beetaloo Basin Kyalla drilling hydraulic fracture stimulation and well testing program EP117 N2 EMP (ORI3-2)*				Environmental outcome under the *Shenandoah South E&A Program EMP EP 117 and EP 98 (TAM1)*		
Environmental outcome			**Environmental performance standards**	**Environmental outcome**		**Environmental performance standard**
						EC-12----------No disturbance to grey Falcon nesting sites
5	Weeds (biosecurity)	• Avoid the introduction of weeds. • Avoid the spread of existing weeds.	• Code of Practice for Petroleum Activities in the Northern Territory Part A- Surface Activities • NT Land Clearing Guidelines • Weed Management Planning Guide: Onshore Shale Gas Development Projects	Land – landforms and terrestrial environmental quality	• Ecological function of soils and landforms at the well pad and surrounding area consistent with current (non-petroleum) land use following the activities under this EMP	L-1: No reportable spills or leaks of flowback, wastewater and chemicals from Tamboran's exploration activities- including gathering. L-2 : No reportable incidents involving erosion or sediment release beyond the site boundary L-3: Stormwater released within the EMP limits. L-4: Low point drain releases are within the EMP limits L-5 No drift of evaporators that results in visible evidence of water pooling/saturated surfaces L-6 Disturbed exploration infrastructure no longer required are rehabilitated back to pre-existing state L-7 Disturbed seismic lines are reinstated promptly and rehabilitation implemented to return vegetation cover back to pre-existing state
				Land – terrestrial ecosystems	Tamboran's activities do not adversely impact surrounding vegetation, significant vegetation communities and listed threatened flora and fauna, with sites rehabilitated back to the current (non-petroleum) land use following the activities under this EMP	EC-1: No releases of wastewater (drilling fluid and flowback) off the lease into the surrounding vegetation. EC-2: No significant (<4 individual deaths per month) impacts to fauna due to wastewater storages . EC-3 – No listed threatened fauna deaths caused by flowback storage. EC-4: No uncontrolled bushfires caused by Tamboran's exploration activities (including civil construction, seismic and E&A activities). EC-5: No WONS (Class A and C) introduced to any Tamboran activity area that is reasonably attributed to exploration activities EC-6 Year-on-year decline in the size and density of all weed infestations introduced because of Tamboran's activities. EC-7: Disturbed seismic lines are reinstated promptly to promote revegetation. EC-8 Disturbed exploration infrastructure no longer required are rehabilitated back to pre-existing condition EC-9 No unauthorised clearing EC-10 Wetlands and riparian vegetation protected from clearing EC-11 Impacts to large trees (>25cm trunk @ 1.3m) minimised during clearing EC-12----------No disturbance to grey Falcon nesting sites
6	Waste management	• Minimise impacts on soil, surface water, groundwater, sensitive habitat and air quality. • Minimise creation of food sources or habitat for pest species. • Minimise waste generation through reduce, reuse, recycle programs.	• Code of Practice for Petroleum Activities in the Northern Territory Part A- Surface Activities • Tamboran's Wastewater Management Plan • Tamboran's Spill Management Plan • NT *Waste Management and Pollution Control Act 1998*	Land – landforms and terrestrial environmental quality	• Ecological function of soils and landforms at the well pad and surrounding area consistent with current (non-petroleum) land use following the activities under this EMP	L-1: No reportable spills or leaks of flowback, wastewater and chemicals from Tamboran's exploration activities- including gathering. L-2 : No reportable incidents involving erosion or sediment release beyond the site boundary L-3: Stormwater released within the EMP limits. L-4: Low point drain releases are within the EMP limits L-5 No drift of evaporators that results in visible evidence of water pooling/saturated surfaces L-6 Disturbed exploration infrastructure no longer required are rehabilitated back to pre-existing state L-7 Disturbed seismic lines are reinstated promptly and rehabilitation implemented to return vegetation cover back to pre-existing state
				Water – hydrological processes	• The environmental values of the underlying groundwater resources are maintained with no adverse impacts to users of the resource resulting from Tamboran's exploration activities.	GW-1: All aquifers isolated through cement and casing. GW-2: No reportable spills or leaks of flowback, wastewater and chemicals from Tamboran's exploration activities- including gathering lines

Environmental outcome under the *Beetaloo Basin Kyalla drilling hydraulic fracture stimulation and well testing program EP117 N2 EMP (ORI3-2)*				Environmental outcome under the *Shenandoah South E&A Program EMP EP 117 and EP 98 (TAM1)*		
Environmental outcome			**Environmental performance standards**	**Environmental outcome**		**Environmental performance standard**
						GW-3: No seismic events over Ml 3.5 attributable to Tamboran's activities. GW-4: No reduction in quality of an impact groundwater monitoring bore that is attributable to Tamboran's activities. Environmental Value) of groundwater in the region. GW-5 No long term reduction in groundwater level observed in the impact monitoring bore that results in >1 m decline in groundwater water level.
				Water – inland water environmental quality and aquatic ecosystems	• Maintain the quality of surface water and aquatic ecosystems and prevent any adverse impacts from Tamboran's exploration activities.	SW-1: Stormwater released within the EMP limits with no evidence of wastewater contamination SW-2: No seismic events over Ml 3.5 attributable to Tamboran's activities. SW-3: No releases of wastewater (drilling fluid and flowback) off the lease or from gathering lines into surrounding drainage depressions or watercourses SW-4: No reportable incidents involving erosion or sediment release beyond the site boundary into drainage depression or watercourse (extent of disturbance footprint of a site)
7	Air quality – dust and emissions	• Minimise environmental nuisance at sensitive receptors. • Minimise greenhouse gas emissions.	• Code of Practice for Petroleum Activities in the Northern Territory Part A- Methane Emissions • Code of Practice for Petroleum Activities in the Northern Territory Part B- Well Operations	Air – air and atmospheric processes	• No significant impact on air quality and no excess greenhouse gas emissions resulting from Tamboran's exploration activities (AQ-1 – AQ5)	AQ-1: All produced hydrocarbons to be sent to the flare where technically possible (e.g. when pressure is sufficient for the separator to function). AQ-2: All greenhouse gases reporting in accordance with NGERS requirements. AQ-3 – AQ 4 offsets retired in accordance with GGAP All leaks detected and repaired in accordance with Code. AQ5 Flare efficiency achieve 98% combustion efficiency
8	Lighting, noise, vibration and visual amenity	• Manage activities in accordance with occupational health and safety guidelines for noise, vibration and light exposure. • Minimise nuisance noise and vibration impacts on surrounding communities or exploration workers. • Minimise disruption to fauna and stock.	• Code of Practice for Petroleum Activities in the Northern Territory Part A – Surface Activities	People – community and economy, and human health	• No adverse impacts to the community resulting from Tamboran's exploration activities (CO-1 – CO-3)	CO-1: All valid community complaints of nuisance investigated and resolved. CO-2: >60% of addressable spend to be from NT businesses. CO-3: All vehicle accidents investigated and reported in accordance with NT Police, Fire and Emergency Services requirements.
9	Bushfires	• Minimise the risk of causing bushfires from Tamboran's activities. • Minimise impacts on environmental habitat and fauna, soil erosion, impacts on stakeholders, impacts on culturally significant sites, public infrastructure and community lands. • Ensure proper health and safety plan for activities. • Prevent accidental fire risk and ensure safe storage of chemicals to prevent fire damage.	• Code of Practice for Petroleum Activities in the Northern Territory Part A – Surface Activities • NT Bushfire Management Act • Tamboran's Bushfire Management Plan	Land – terrestrial ecosystems	Tamboran's activities do not adversely impact surrounding vegetation, significant vegetation communities and listed threatened flora and fauna, with sites rehabilitated back to the current (non-petroleum) land use following the activities under this EMP	EC-1: No releases of wastewater (drilling fluid and flowback) off the lease into the surrounding vegetation. EC-2: No significant (<4 individual deaths per month) impacts to fauna due to wastewater storages . EC-3 – No listed threatened fauna deaths caused by flowback storage. EC-4: No uncontrolled bushfires caused by Tamboran's exploration activities (including civil construction, seismic and E&A activities). EC-5: No WONS (Class A and C) introduced to any Tamboran activity area that is reasonably attributed to exploration activities EC-6 Year-on-year decline in the size and density of all weed infestations introduced because of Tamboran's activities. EC-7: Disturbed seismic lines are reinstated promptly to promote revegetation. EC-8 Disturbed exploration infrastructure no longer required are rehabilitated back to pre-existing condition EC-9 No unauthorised clearing EC-10 Wetlands and riparian vegetation protected from clearing

Environmental outcome under the *Beetaloo Basin Kyalla drilling hydraulic fracture stimulation and well testing program EP117 N2 EMP (ORI3-2)*				Environmental outcome under the *Shenandoah South E&A Program EMP EP 117 and EP 98 (TAM1)*		
Environmental outcome			**Environmental performance standards**	**Environmental outcome**		**Environmental performance standard**
						EC-11 Impacts to large trees (>25cm trunk @ 1.3m) minimised during clearing EC-12----------No disturbance to grey Falcon nesting sites
10	Cultural Heritage and Sacred Sites	• Avoid disturbance or damage to Aboriginal cultural heritage artefacts or sacred sites. • Minimise impacts and disruption to activities of indigenous stakeholders in culturally significant areas. • Ensure adequate background information and training is provided to employees and contractors working in culturally significant areas. • Ensure that the health and safety of employees, contractors and the community is not compromised through management of cultural and environmental awareness.	• AAPA Certificates • NT Bushfire Management Act	People – cultural heritage	• No significant impact on sacred sites and environmental values because of Tamboran's exploration activities • Protection of culture and heritage (	CH-1 No non-compliances with Native Title Holder Exploration Agreements and AAPA certificate conditions. CH-2 –: Native title holders are actively engaged on Tamboran's work program, including understanding of Tamboran's current and future exploration activities.
				Land – terrestrial ecosystems	Tamboran's activities do not adversely impact surrounding vegetation, significant vegetation communities and listed threatened flora and fauna, with sites rehabilitated back to the current (non-petroleum) land use following the activities under this EMP	EC-1: No releases of wastewater (drilling fluid and flowback) off the lease into the surrounding vegetation. EC-2: No significant (<4 individual deaths per month) impacts to fauna due to wastewater storages . EC-3 – No listed threatened fauna deaths caused by flowback storage. EC-4: No uncontrolled bushfires caused by Tamboran's exploration activities (including civil construction, seismic and E&A activities). EC-5: No WONS (Class A and C) introduced to any Tamboran activity area that is reasonably attributed to exploration activities EC-6 Year-on-year decline in the size and density of all weed infestations introduced because of Tamboran's activities. EC-7: Disturbed seismic lines are reinstated promptly to promote revegetation. EC-8 Disturbed exploration infrastructure no longer required are rehabilitated back to pre-existing condition EC-9 No unauthorised clearing EC-10 Wetlands and riparian vegetation protected from clearing EC-11 Impacts to large trees (>25cm trunk @ 1.3m) minimised during clearing EC-12----------No disturbance to grey Falcon nesting sites
11	Community	• Minimise impacts on the local community and services. • Minimise safety risks to the public and other third parties. • Maintain and enhance partnerships with the local community, including using local contractors and maximising opportunities for local employment and training.	• Code of Practice for Petroleum Activities in the Northern Territory Part A- Surface Activities • NT Petroleum (Environment) Regulations	People – community and economy, and human health	• No adverse impacts to the community resulting from Tamboran's exploration activities (CO-1 – CO-3)	CO-1: All valid community complaints of nuisance investigated and resolved. CO-2: >60% of addressable spend to be from NT businesses. CO-3: All vehicle accidents investigated and reported in accordance with NT Police, Fire and Emergency Services requirements.

Table A-4: Environmental outcomes and performance standards – *Beetaloo Sub-basin Kyalla 117 N2 Multi-well Drilling, Hydraulic Fracturing and Well Testing Program EMP (ORI6-3*) vs *Shenandoah South E&A Program EMP EP 117 and EP 98 (TAM1)*

Environmental outcome under the *Beetaloo Sub-basin Kyalla 117 N2 Multi-well Drilling, Hydraulic Fracturing and Well Testing Program EMP (ORI6-3)*				**Environmental outcome under the *Shenandoah South E&A Program EMP EP 117 and EP 98 (TAM1)***		
Environmental outcome			**Environmental performance standards**	**Environmental outcome**		**Environmental performance standard**
1	Soils	• No significant impact to the ecological function and productivity of soils surrounding Kyalla 117 N2 as a result of Tamboran's exploration activities.	S-1: No releases of contaminants (chemicals, hydrocarbon, drilling wastewater or flowback wastewater) outside of Tamboran's lease pad. S-2 – S-3: No reportable spills, including wastewater tank/sump overtopping events, resulting from Tamboran's exploration activities. S-4 – S-5: Erosion and sediment control in place and working effectively.	Land – landforms and terrestrial environmental quality	• Ecological function of soils and landforms at the well pad and surrounding area consistent with current (non-petroleum) land use following the activities under this EMP	L-1: No reportable spills or leaks of flowback, wastewater and chemicals from Tamboran's exploration activities- including gathering. L-2 : No reportable incidents involving erosion or sediment release beyond the site boundary L-3: Stormwater released within the EMP limits. L-4: Low point drain releases are within the EMP limits L-5 No drift of evaporators that results in visible evidence of water pooling/saturated surfaces L-6 Disturbed exploration infrastructure no longer required are rehabilitated back to pre-existing state L-7 Disturbed seismic lines are reinstated promptly and rehabilitation implemented to return vegetation cover back to pre-existing state
2	Surface water	• No significant impact on surface water quality as a result of Tamboran's exploration activities.	SW-1: During chemical and wastewater storage activities, no off-site release of contaminants from chemical, hydrocarbon and waste storage. SW-2: No seismic events over Ml 3.5 attributable to Tamboran's activities. SW-3: No reportable spills, including offsite releases of contaminants resulting from Tamboran's exploration activities. SW-4: Erosion and sediment control in place and working effectively.	Water – inland water environmental quality and aquatic ecosystems	• Maintain the quality of surface water and aquatic ecosystems and prevent any adverse impacts from Tamboran's exploration activities.	SW-1: Stormwater released within the EMP limits with no evidence of wastewater contamination SW-2: No seismic events over Ml 3.5 attributable to Tamboran's activities. SW-3: No releases of wastewater (drilling fluid and flowback) off the lease or from gathering lines into surrounding drainage depressions or watercourses SW-4: No reportable incidents involving erosion or sediment release beyond the site boundary into drainage depression or watercourse (extent of disturbance footprint of a site)
3	Groundwater	• Tamboran's exploration activities do not reduce the environmental values of the underlying groundwater resources.	GW-1: All regional aquifers isolated through cement and casing. GW-2: No failure of wastewater tank secondary liner. GW-3: No seismic events over Ml 3.5 attributable to Tamboran's activities. GW-4: No long-term (>12 month) reduction in quality of an impact groundwater monitoring bore that is attributable to Tamboran's activities. A decline is defined as a change in water chemistry that exceeds the ANZECC guidelines for Livestock (the primary Environmental Value) of groundwater in the region. GW-5 – GW-6: No long term (>12 month) reduction in groundwater level observed in the impact monitoring bore that results in >1m decline in groundwater water level.	Water – hydrological processes	• The environmental values of the underlying groundwater resources are maintained with no adverse impacts to users of the resource resulting from Tamboran's exploration activities.	GW-1: All aquifers isolated through cement and casing. GW-2: No reportable spills or leaks of flowback, wastewater and chemicals from Tamboran's exploration activities- including gathering lines GW-3: No seismic events over Ml 3.5 attributable to Tamboran's activities. GW-4: No reduction in quality of an impact groundwater monitoring bore that is attributable to Tamboran's activities. Environmental Value) of groundwater in the region. GW-5 No long term reduction in groundwater level observed in the impact monitoring bore that results in >1 m decline in groundwater water level.
4	Ecology	• No significant impact to high valued habitats and threatened flora and fauna as a result of Tamboran's exploration activities.	EC-1: No releases of wastewater (drilling fluid and flowback) off the lease into the surrounding vegetation. EC-2 – EC-3: <7 individual fauna deaths per week for 2 consecutive weeks caused by flowback water storage. EC-4 – EC-5: <0 threatened fauna deaths caused by flowback storage.	Land – terrestrial ecosystems	Tamboran's activities do not adversely impact surrounding vegetation, significant vegetation communities and listed threatened flora and fauna, with sites rehabilitated back to the current (non-petroleum) land use following the activities under this EMP	EC-1: No releases of wastewater (drilling fluid and flowback) off the lease into the surrounding vegetation. EC-2: No significant (<4 individual deaths per month) impacts to fauna due to wastewater storages . EC-3 – No listed threatened fauna deaths caused by flowback storage. EC-4: No uncontrolled bushfires caused by Tamboran's exploration activities (including civil construction, seismic and E&A activities).

Environmental outcome under the *Beetaloo Sub-basin Kyalla 117 N2 Multi-well Drilling, Hydraulic Fracturing and Well Testing Program EMP (ORI6-3)*					Environmental outcome under the *Shenandoah South E&A Program EMP EP 117 and EP 98 (TAM1)*		
Environmental outcome			**Environmental performance standards**		**Environmental outcome**		**Environmental performance standard**
			EC-6:	No uncontrolled bushfires caused by Tamboran's exploration activities.		•	EC-5: No WONS (Class A and C) introduced to any Tamboran activity area that is reasonably attributed to exploration activities EC-6 Year-on-year decline in the size and density of all weed infestations introduced because of Tamboran's activities. EC-7: Disturbed seismic lines are reinstated promptly to promote revegetation. EC-8 Disturbed exploration infrastructure no longer required are rehabilitated back to pre-existing condition EC-9 No unauthorised clearing EC-10 Wetlands and riparian vegetation protected from clearing EC-11 Impacts to large trees (>25cm trunk @ 1.3m) minimised during clearing EC-12----------No disturbance to grey Falcon nesting sites
			EC-7:	Weed surveys completed on all Tamboran disturbed areas.			
			EC-8:	Year-on-year decline in the size and density of all weed infestations introduced as a result of Tamboran's activities.			
5	Air quality and GHG emissions	• No significant impact on air quality and no excess greenhouse gas emissions as a result of Tamboran's exploration activities.	AQ-1:	Venting to be eliminated as far as reasonably practicable.	Air – air and atmospheric processes	• No significant impact on air quality and no excess greenhouse gas emissions resulting from Tamboran's exploration activities (AQ-1 – AQ5)	AQ-1: All produced hydrocarbons to be sent to the flare where technically possible (e.g. when pressure is sufficient for the separator to function). AQ-2: All greenhouse gases reporting in accordance with NGERS requirements. AQ-3 – offsets retired in accordance with GGAP AQ 4 All leaks detected and repaired in accordance with Code. AQ5 Flare efficiency achieve 98% combustion efficiency
			AQ-2:	All greenhouse gasses reporting in accordance with NGERS requirements.			
			AQ-3 – AQ-5:	All leaks detected and repaired in accordance with code of practice.			
6	Community	• No significant impact on sacred sites and environmental values as a result of Tamboran's exploration activities.	EC-1 – EC-3:	No non-compliances with AAPA certificate conditions.	People – cultural heritage	• No significant impact on sacred sites and environmental values because of Tamboran's exploration activities • Protection of culture and heritage (	CH-1 No non-compliances with Native Title Holder Exploration Agreements and AAPA certificate conditions. CH-2 –: Native title holders are actively engaged on Tamboran's work program, including understanding of Tamboran's current and future exploration activities.

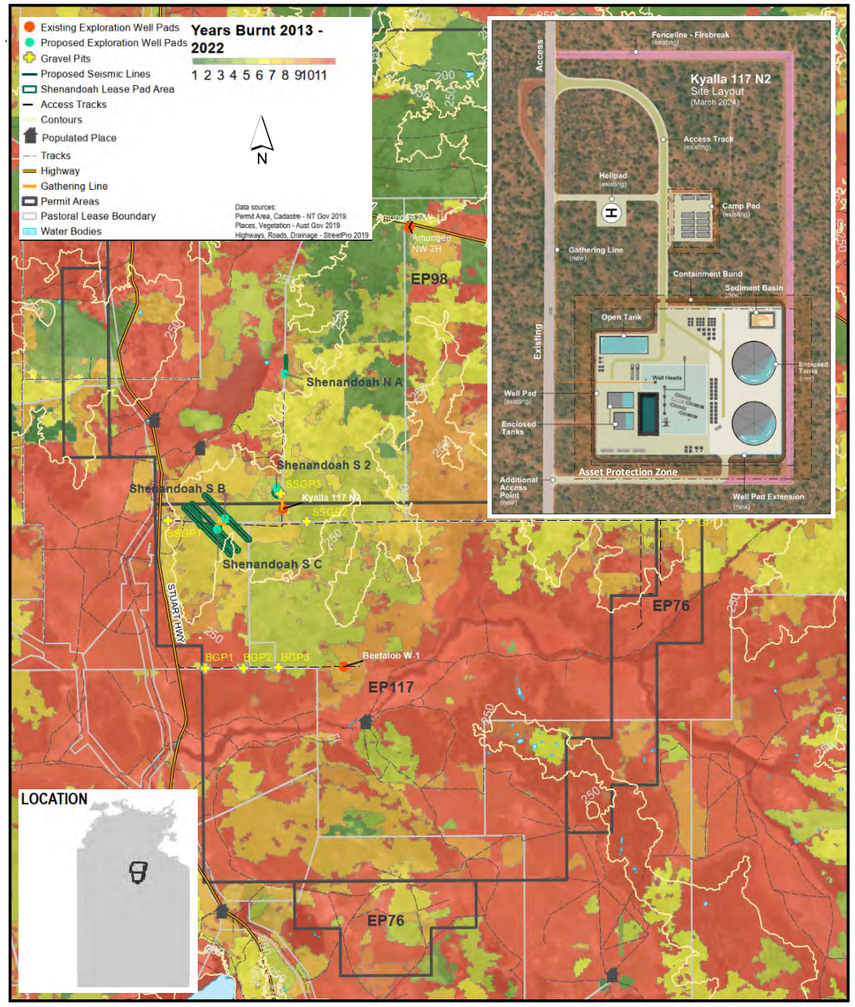
APPENDIX B Bushfire Management Plan

Exploration Permit 117
Bushfire Management Plan
2024 onwards
Kyalla 117 N2 (Rev 1, Mar-2024)

Location of Kyalla 117 N2	
Property and land uses	Gas exploration, cattle grazing, and native title rights and interests recognised by the native title determinations over the land and waters.
Site fire management aim	To reduce the occurrence of, and minimise the impact of bushfires, thereby reducing the threat to life, property, cultural values and the environment.
Site fire management objectives	Mitigate the potential impact of unplanned fires on Tamboran's people, assets and operations and neighbouring land uses.
Fire History (10 years) (NAFI 2024)	Fire scar mapping (2013-2022) indicates the exploration area burns approximately every 4 to 8 years (refer Figure below). Field observations at Kyalla 117 N2 indicates low intensity fire when last burnt.

Fire Management Risks

- Ignitions (humans and lightening) on or off site resulting in harm to workers and loss of equipment.
- Altered landscape fire regimes as result of regulated activities leading to conflict i.e. more or less fire, change in pattern and timing. Noting Kyalla 11 N2 last burnt was over 4 to 8 years ago.
- Bullwaddy and Lancewood vegetation communities occur in areas across the permit and are fire sensitive. Hot fires can reduce habitat quality for flora and fauna species that use these vegetation communities.
- Spread of high fuel load grassy weeds could increase fire intensity, e.g. gamba, grader and buffel grass, adjacent infrastructure areas and access tracks.



The BMP should be read in conjunction with the overarching Environment Management Plan and Emergency Response Plan for Tamboran's operations in the Beetaloo Basin.

Bushfire Officer	Contact Details	Name
	[redacted]	Robert Wear

Neighbours	Contact Details		Name
Beetaloo Station	[redacted]	[redacted]	Scotty & Jane Armstrong
Hayfield/Shenandoah Station	[redacted]	[redacted]	Justin Dyer & Sally Dyer

Stakeholders	Contact Details
National Response Centre	1800 076 251 (24/7 contact line)
Emergency	000 or 112 mobile
Bushfire NT Katherine office (Savanna)	(08) 8973 8871 / BushfiresNT.Katherine@nt.gov.au
Bushfire NT Alice Springs & Tennant Creek office (Barkly)	(08) 8951 9266
NAFI North	https://www.firenorth.org.au/nafi3/
Secure NT (Fire Bans and Alerts)	https://securent.nt.gov.au/alerts
Fire incident map	https://www.pfes.nt.gov.au/incidentmap/

Bushfire Management Actions

Well pad	• Remove and or maintain vegetation within the well pad area and implement erosion and sediment control plan. • Treat emerging vegetation with herbicide. • Hot works are not permitted on total fire ban days without written approval from a fire control officer or fire warden. • When the site is suspended, the well pad can be sufficient to satisfy APZ requirements depending on the level of infrastructure/ assets present.
Fire management break	• A 10 m wide cleared perimeter around well pads and tank pads during operations. • An additional 10 m wide bare earth fire break incorporating a 4 m wide fire access trail during operations.
Fire access trails	• Create and maintain 4 m wide access trail by grading or spraying.
Asset protection zones (APZ)	• Site manager to assess fuel load prior to camp establishment and again at end of wet season if infrastructure is still in place (refer to Fuel Load Criteria). • Establish a 20 m low fuel zone around well pads and well pads during operations (i.e. an area low in combustible material and obstructions). • Monitor for grassy weeds and control where appropriate. • If deemed necessary, conduct controlled burns where other controls are not effective and in consultation with neighbouring properties. • Ensure 4 m wide fire access trail around the perimeter of the asset protection zone is trafficable by firefighting appliances.
Neighbouring property fire management zone	• Fire management planning meeting with neighbouring properties prior to commencing activities and reviewed annually. • Neighbour to advise proponent of planned burns. • Working with pastoralist to assist in responding to fire where it is safe and practicable.

Bushfire Preparedness and Planning

Mandatory for all Severe, Extreme and Catastrophic FDI days

The following must be reviewed daily. If fire alerts are active or presenting with a known fire risk, personnel must execute their contingency plans which need to encompass the following:

- ☐ Procedure on identifying and notifying of a bushfire.
- ☐ Critical equipment to be removed / isolated/ shut down.
- ☐ Safe evacuation routes from site and muster points.
- ☐ Communication methods:
  - ✓ Team channels and / or phone numbers
  - ✓ Area channels and/or phone numbers
- ☐ Closest safe havens.

Monitoring

- ☐ Provide timely advice on changes in level of fire risk as available.
- ☐ Monitor team and area common channels for bushfire early warning.
- ☐ Update changes in work location.

Bushfire First Responder Checklist

The following sequence must be followed by the first person responding to a fire:

1. Danger – Remove yourself and others from danger is safe to do so.

2. Alarm – Raise the alarm either on common radio channel or other agreed process.

3. Gather Information –

- ☐ Location – Direction from known reference points, (e.g. roads and Tamboran's infrastructure such as well pad location).
- ☐ Impacts (actual and potential) – Life, property and the environment.
- ☐ Fire characteristics – Grass or woodlands, flame height, fire front and direction of travel.
- ☐ Weather – Wind strength and direction.
- ☐ Response in progress – What response is underway and by who (Tamboran contractors, pastoralist or Emergency Services).
- ☐ Response required – Tamboran contractors and / or pastoralist and / or emergency services.
- ☐ Access – Safe access and egress routes.

4. Notify Tamboran – Fire Officer/Supervisor

5. Notify Pastoralists – Refer to property contacts

6. Notify Emergency Services—Call 000 or 112 if Tamboran and pastoralist unable to manage situation

7. Respond and Monitor —If safe to do so in consultation with pastoralist and emergency services.

CSIRO Fuel Load Criteria

- ☐ Fuel quantity (tonnes of fuel per ha).
- ☐ Assess vegetation type i.e. grassland, shrubland, scrub, woodland or forest.
- ☐ Fuel size and shape e.g. fine fuel such as grass that burns quick vs course fuel (thick branches/trunks) that burn slowly.
- ☐ Fuel arrangement (i.e. separation of understory to canopy, dense or light understory).
- ☐ Moisture content (strong winds, high temperatures and low humidity will decrease moisture content).



Annual Works Calendar

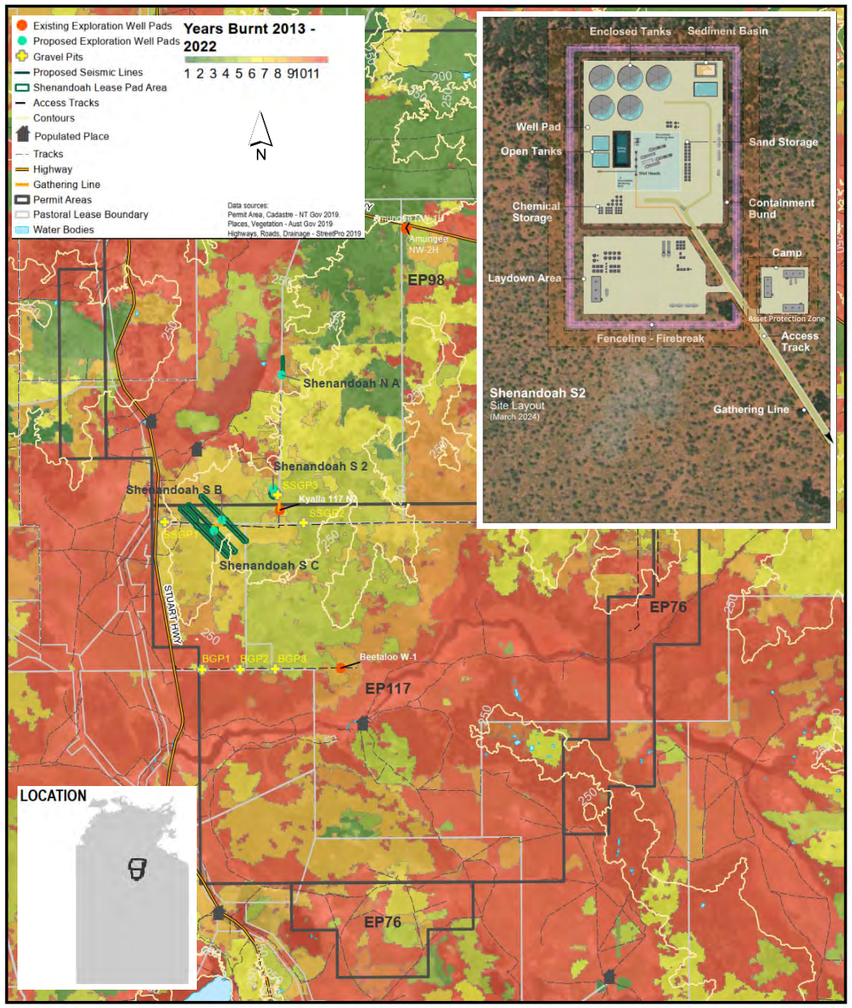
Jan	Low	• No fire management activity	**July**	High	• Manage vegetation onsite (including weeds), fire break and fire access trail • Monitor NAFI, fire danger ratings and fire weather warnings (daily or as required), and visually check horizon for smoke • Liaise with neighbour regarding bushfires
Feb	Low	• No fire management activity	**Aug**	High	• Monitor NAFI, fire danger ratings and fire weather warnings (daily or as required), and visually check horizon for smoke • Liaise with neighbour regarding bushfires
Mar	Low	• Weed survey • Planning meeting with neighbour • Annual fire mapping to monitor changes to fire frequency in the area	**Sep**	High	• Monitor NAFI, fire danger ratings and fire weather warnings (daily or as required), and visually check horizon for smoke • Liaise with neighbour regarding bushfires
Apr	Low	• No fire management activity	**Oct**	High	• Monitor NAFI, fire danger ratings and fire weather warnings (daily or as required), and visually check horizon for smoke • Liaise with neighbour regarding bushfires
May	Low	• No fire management activity • Liaise with neighbour regarding bushfires • Review the preparedness planning requirements	**Nov**	Medium	• Monitor NAFI, fire danger ratings and fire weather warnings (daily or as required), and visually check horizon for smoke • Liaise with neighbour regarding bushfires
Jun	Medium	• Manage vegetation onsite, fire break and fire access trail • Monitor NAFI, fire danger ratings and fire weather warnings • Review the preparedness planning requirements	**Dec**	Low	• No fire management activity • Review the preparedness planning requirements

Exploration Permit 98
Bushfire Management Plan
2024 onwards
Shenandoah South 2 (Rev 1, Mar-2024)

Location of Shenandoah South 2	
Property and land uses	Gas exploration, cattle grazing, and native title rights and interests recognised by the native title determinations over the land and waters.
Site fire management aim	To reduce the occurrence of, and minimise the impact of bushfires, thereby reducing the threat to life, property, cultural values and the environment.
Site fire management objectives	Mitigate the potential impact of unplanned fires on Tamboran's people, assets and operations and neighbouring land uses.
Fire History (10 years) (NAFI 2024)	Fire scar mapping (2013-2022) indicates the exploration area burns approximately every 4 to 8 years (refer Figure below). Field observations in April 2023 indicated a moderate intensity fire when last burnt.

Fire Management Risks

- Ignitions (humans and lightening) on or off site resulting in harm to workers and loss of equipment.
- Altered landscape fire regimes as result of regulated activities leading to conflict i.e. more or less fire, change in pattern and timing. Noting Shenandoah S2 last burnt over 4 to 8 years ago.
- Bullwaddy and Lancewood vegetation communities occur in areas across the permit and are fire sensitive. Hot fires can reduce habitat quality for flora and fauna species that use these vegetation communities.
- Spread of high fuel load grassy weeds could increase fire intensity, e.g. gamba, grader and buffel grass, adjacent infrastructure areas and access tracks.



The BMP should be read in conjunction with the overarching Environment Management Plan and Emergency Response Plan for Tamboran's operations in the Beetaloo Basin.

Bushfire Officer	Contact Details	Name
	[redacted]	Robert Wear

Neighbours	Contact Details		Name
Beetaloo Station	[redacted]	[redacted]	Scotty & Jane Armstrong
Hayfield/Shenandoah Station	[redacted]	[redacted]	Justin Dyer & Sally Dyer

Stakeholders	Contact Details
National Response Centre	1800 076 251 (24/7 contact line)
Emergency	000 or 112 mobile
Bushfire NT Katherine office (Savanna)	(08) 8973 8871 / BushfiresNT.Katherine@nt.gov.au
Bushfire NT Alice Springs & Tennant Creek office (Barkly)	(08) 8951 9266
NAFI North	https://www.firenorth.org.au/nafi3/
Secure NT (Fire Bans and Alerts)	https://securent.nt.gov.au/alerts
Fire incident map	https://www.pfes.nt.gov.au/incidentmap/

Bushfire Management Actions

Well pad	• Remove and or maintain vegetation within the well pad area and implement erosion and sediment control plan. • Treat emerging vegetation with herbicide. • Hot works are not permitted on total fire ban days without written approval from a fire control officer or fire warden. • When the site is suspended, the well pad can be sufficient to satisfy APZ requirements depending on the level of infrastructure/ assets present.
Fire management break	• A 10 m wide cleared perimeter around well pads and tank pads during operations. • An additional 10 m wide bare earth fire break incorporating a 4 m wide fire access trail during operations.
Fire access trails	• Create and maintain 4 m wide access trail by grading or spraying.
Asset protection zones (APZ)	• Site manager to assess fuel load prior to camp establishment and again at end of wet season if infrastructure is still in place (refer to Fuel Load Criteria). • Establish a 20 m low fuel zone around well pads and well pads during operations (i.e. an area low in combustible material and obstructions). • Monitor for grassy weeds and control where appropriate. • If deemed necessary, conduct controlled burns where other controls are not effective and in consultation with neighbouring properties. • Ensure 4 m wide fire access trail around the perimeter of the asset protection zone is trafficable by firefighting appliances.
Neighbouring property fire management zone	• Fire management planning meeting with neighbouring properties prior to commencing activities and reviewed annually. • Neighbour to advise proponent of planned burns. • Working with pastoralist to assist in responding to fire where it is safe and practicable.

Bushfire Preparedness and Planning

Mandatory for all Severe, Extreme and Catastrophic FDI days

The following must be reviewed daily. If fire alerts are active or presenting with a known fire risk, personnel must execute their contingency plans which need to encompass the following:

- ☐ Procedure on identifying and notifying of a bushfire.
- ☐ Critical equipment to be removed / isolated/ shut down.
- ☐ Safe evacuation routes from site and muster points.
- ☐ Communication methods:
  - ✓ Team channels and / or phone numbers
  - ✓ Area channels and/or phone numbers
- ☐ Closest safe havens.

Monitoring

- ☐ Provide timely advice on changes in level of fire risk as available.
- ☐ Monitor team and area common channels for bushfire early warning.
- ☐ Update changes in work location.

Bushfire First Responder Checklist

The following sequence must be followed by the first person responding to a fire:

1. Danger – Remove yourself and others from danger is safe to do so.

2. Alarm – Raise the alarm either on common radio channel or other agreed process.

3. Gather Information –

- ☐ Location – Direction from known reference points, (e.g. roads and Tamboran's infrastructure such as well pad location).
- ☐ Impacts (actual and potential) – Life, property and the environment.
- ☐ Fire characteristics – Grass or woodlands, flame height, fire front and direction of travel.
- ☐ Weather – Wind strength and direction.
- ☐ Response in progress – What response is underway and by who (Tamboran contractors, pastoralist or Emergency Services).
- ☐ Response required – Tamboran contractors and / or pastoralist and / or Emergency Services.
- ☐ Access – Safe access and egress routes.

4. Notify Tamboran – Fire Officer/Supervisor

5. Notify Pastoralists – Refer to property contacts

6. Notify Emergency Services—Call 000 or 112 if Tamboran and pastoralist unable to manage situation

7. Respond and Monitor —If safe to do so in consultation with pastoralist and Emergency Services.

CSIRO Fuel Load Criteria

- ☐ Fuel quantity (tonnes of fuel per ha).
- ☐ Assess vegetation type i.e. grassland, shrubland, scrub, woodland or forest.
- ☐ Fuel size and shape e.g. fine fuel such as grass that burns quick vs course fuel (thick branches/trunks) that burn slowly.
- ☐ Fuel arrangement (i.e. separation of understory to canopy, dense or light understory).
- ☐ Moisture content (strong winds, high temperatures and low humidity will decrease moisture content).



Annual Works Calendar

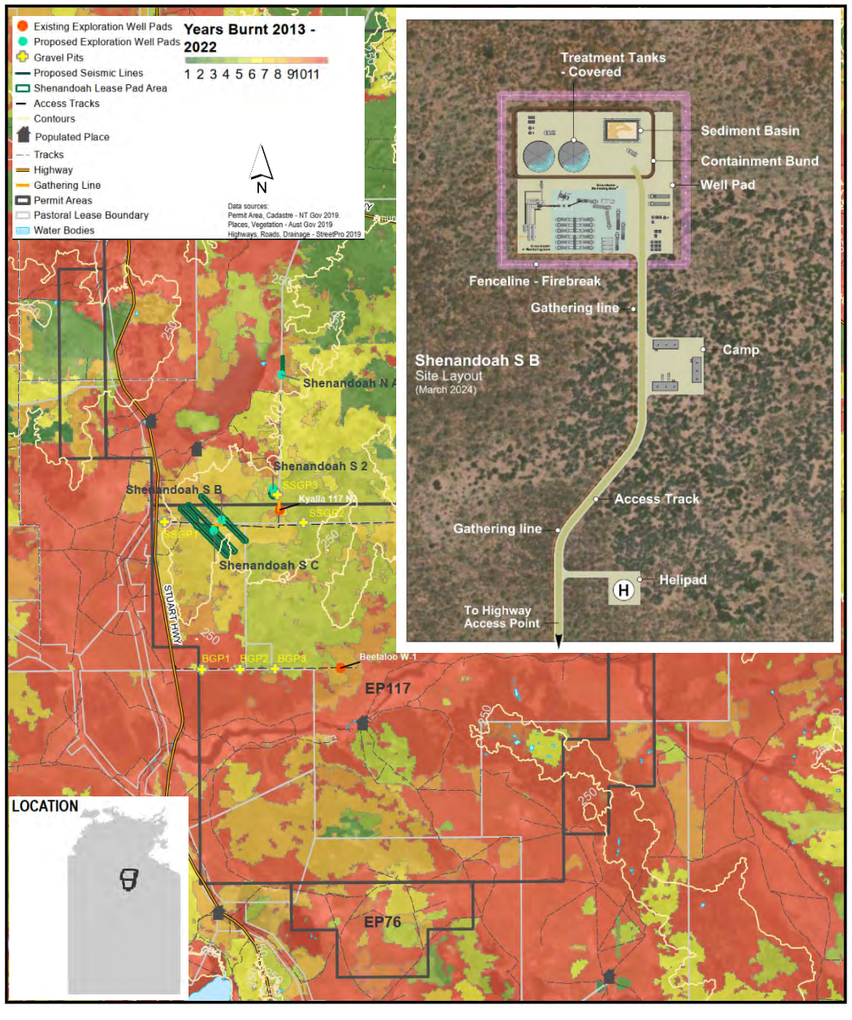
Jan	Low	• No fire management activity	**July**	High	• Manage vegetation onsite (including weeds), fire break and fire access trail • Monitor NAFI, fire danger ratings and fire weather warnings (daily or as required), and visually check horizon for smoke • Liaise with neighbour regarding bushfires
Feb	Low	• No fire management activity	**Aug**	High	• Monitor NAFI, fire danger ratings and fire weather warnings (daily or as required), and visually check horizon for smoke • Liaise with neighbour regarding bushfires
Mar	Low	• Weed survey • Planning meeting with neighbour • Annual fire mapping to monitor changes to fire frequency in the area	**Sep**	High	• Monitor NAFI, fire danger ratings and fire weather warnings (daily or as required), and visually check horizon for smoke • Liaise with neighbour regarding bushfires
Apr	Low	• No fire management activity	**Oct**	High	• Monitor NAFI, fire danger ratings and fire weather warnings (daily or as required), and visually check horizon for smoke • Liaise with neighbour regarding bushfires
May	Low	• No fire management activity • Liaise with neighbour regarding bushfires • Review the preparedness planning requirements	**Nov**	Medium	• Monitor NAFI, fire danger ratings and fire weather warnings (daily or as required), and visually check horizon for smoke • Liaise with neighbour regarding bushfires
Jun	Medium	• Manage vegetation onsite, fire break and fire access trail • Monitor NAFI, fire danger ratings and fire weather warnings • Review the preparedness planning requirements	**Dec**	Low	• No fire management activity • Review the preparedness planning requirements

Exploration Permit 117
Bushfire Management Plan 2024 onwards
Shenandoah South B (Rev 1, Mar-2024)

Location of Shenandoah South B	
Property and land uses	Gas exploration, cattle grazing, and native title rights and interests recognised by the native title determinations over the land and waters.
Site fire management aim	To reduce the occurrence of, and minimise the impact of bushfires, thereby reducing the threat to life, property, cultural values and the environment.
Site fire management objectives	Mitigate the potential impact of unplanned fires on Tamboran's people, assets and operations and neighbouring land uses.
Fire History (10 years) (NAFI 2024)	Fire scar mapping (2013-2022) indicates the exploration area burns approximately every 4 to 8 years (refer Figure below). Field observations in April 2023 indicated a moderate intensity fire when last burnt.

Fire Management Risks

- Ignitions (humans and lightening) on or off site resulting in harm to workers and loss of equipment.
- Altered landscape fire regimes as result of regulated activities leading to conflict i.e. more or less fire, change in pattern and timing. Noting Shenandoah S B last burnt over 4 to 8 years ago.
- Bullwaddy and Lancewood vegetation communities occur in areas across the permit and are fire sensitive. Hot fires can reduce habitat quality for flora and fauna species that use these vegetation communities.
- Spread of high fuel load grassy weeds could increase fire intensity, e.g. gamba, grader and buffel grass, adjacent infrastructure areas and access tracks.



The BMP should be read in conjunction with the overarching Environment Management Plan and Emergency Response Plan for Tamboran's operations in the Beetaloo Basin.

Bushfire Officer	Contact Details	Name
	[redacted]	Robert Wear

Neighbours	Contact Details		Name
Beetaloo Station	[redacted]	[redacted]	Scotty & Jane Armstrong
Hayfield/Shenandoah Station	[redacted]	[redacted]	Justin Dyer & Sally Dyer

Stakeholders	Contact Details
National Response Centre	1800 076 251 (24/7 contact line)
Emergency	000 or 112 mobile
Bushfire NT Katherine office (Savanna)	(08) 8973 8871 / BushfiresNT.Katherine@nt.gov.au
Bushfire NT Alice Springs & Tennant Creek office (Barkly)	(08) 8951 9266
NAFI North	https://www.firenorth.org.au/nafi3/
Secure NT (Fire Bans and Alerts)	https://securent.nt.gov.au/alerts
Fire incident map	https://www.pfes.nt.gov.au/incidentmap/

Bushfire Management Actions

Well pad	• Remove and or maintain vegetation within the well pad area and implement erosion and sediment control plan. • Treat emerging vegetation with herbicide. • Hot works are not permitted on total fire ban days without written approval from a fire control officer or fire warden. • When the site is suspended, the well pad can be sufficient to satisfy APZ requirements depending on the level of infrastructure/ assets present.
Fire management break	• A 10 m wide cleared perimeter around well pads and tank pads during operations. • An additional 10 m wide bare earth fire break incorporating a 4 m wide fire access trail during operations.
Fire access trails	• Create and maintain 4 m wide access trail by grading or spraying.
Asset protection zones (APZ)	• Site manager to assess fuel load prior to camp establishment and again at end of wet season if infrastructure is still in place (refer to Fuel Load Criteria). • Establish a 20 m low fuel zone around well pads and well pads during operations (i.e. an area low in combustible material and obstructions). • Monitor for grassy weeds and control where appropriate. • If deemed necessary, conduct controlled burns where other controls are not effective and in consultation with neighbouring properties. • Ensure 4 m wide fire access trail around the perimeter of the asset protection zone is trafficable by firefighting appliances.
Neighbouring property fire management zone	• Fire management planning meeting with neighbouring properties prior to commencing activities and reviewed annually. • Neighbour to advise proponent of planned burns. • Working with pastoralist to assist in responding to fire where it is safe and practicable.

Bushfire Preparedness and Planning

Mandatory for all Severe, Extreme and Catastrophic FDI days

The following must be reviewed daily. If fire alerts are active or presenting with a known fire risk, personnel must execute their contingency plans which need to encompass the following:

- ☐ Procedure on identifying and notifying of a bushfire.
- ☐ Critical equipment to be removed / isolated/ shut down.
- ☐ Safe evacuation routes from site and muster points.
- ☐ Communication methods:
  - ✓ Team channels and / or phone numbers
  - ✓ Area channels and/or phone numbers
- ☐ Closest safe havens.

Monitoring

- ☐ Provide timely advice on changes in level of fire risk as available.
- ☐ Monitor team and area common channels for bushfire early warning.
- ☐ Update changes in work location.

Bushfire First Responder Checklist

The following sequence must be followed by the first person responding to a fire:

1. Danger – Remove yourself and others from danger is safe to do so.

2. Alarm – Raise the alarm either on common radio channel or other agreed process.

3. Gather Information –

- ☐ Location – Direction from known reference points, (e.g. roads and Tamboran's infrastructure such as well pad location).
- ☐ Impacts (actual and potential) – Life, property and the environment.
- ☐ Fire characteristics – Grass or woodlands, flame height, fire front and direction of travel.
- ☐ Weather – Wind strength and direction.
- ☐ Response in progress – What response is underway and by who (Tamboran contractors, pastoralist or Emergency Services).
- ☐ Response required – Tamboran contractors and / or pastoralist and / or Emergency Services.
- ☐ Access – Safe access and egress routes.

4. Notify Tamboran – Fire Officer/Supervisor

5. Notify Pastoralists – Refer to property contacts

6. Notify Emergency Services—Call 000 or 112 if Tamboran and pastoralist unable to manage situation

7. Respond and Monitor —If safe to do so in consultation with pastoralist and Emergency Services.

CSIRO Fuel Load Criteria

- ☐ Fuel quantity (tonnes of fuel per ha).
- ☐ Assess vegetation type i.e. grassland, shrubland, scrub, woodland or forest.
- ☐ Fuel size and shape e.g. fine fuel such as grass that burns quick vs course fuel (thick branches/trunks) that burn slowly.
- ☐ Fuel arrangement (i.e. separation of understory to canopy, dense or light understory).
- ☐ Moisture content (strong winds, high temperatures and low humidity will decrease moisture content).



Annual Works Calendar

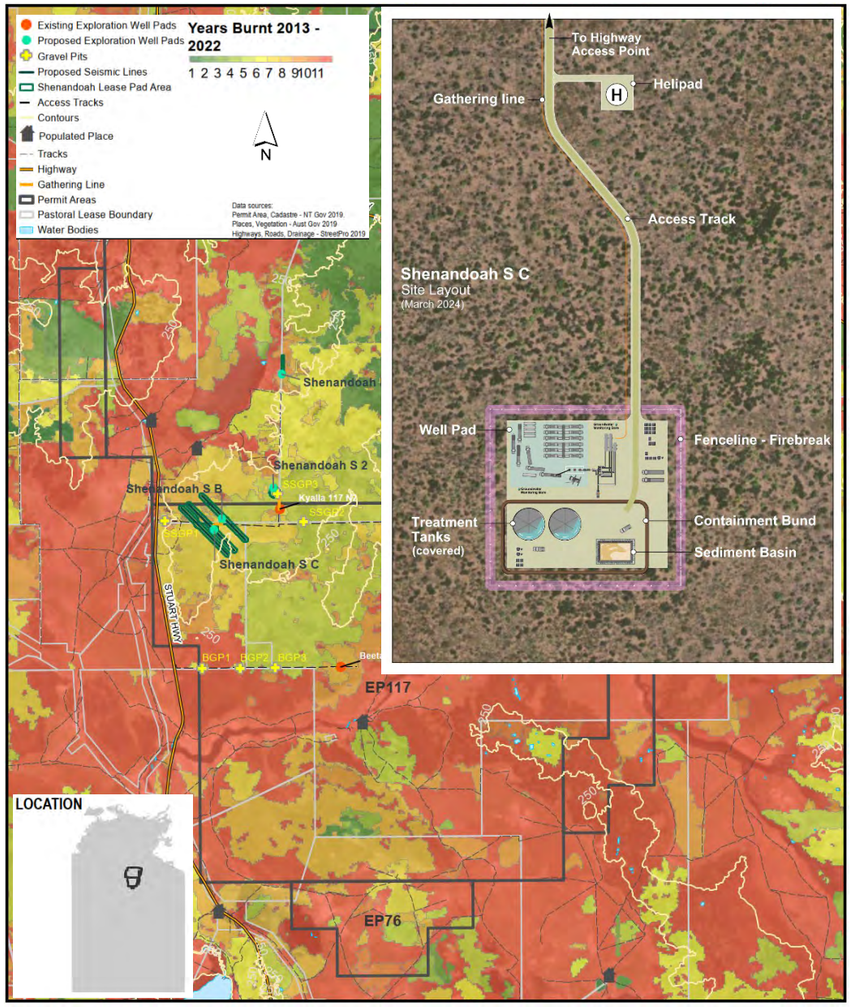
Jan	Low	• No fire management activity	**July**	High	• Manage vegetation onsite (including weeds), fire break and fire access trail • Monitor NAFI, fire danger ratings and fire weather warnings (daily or as required), and visually check horizon for smoke • Liaise with neighbour regarding bushfires
Feb	Low	• No fire management activity	**Aug**	High	• Monitor NAFI, fire danger ratings and fire weather warnings (daily or as required), and visually check horizon for smoke • Liaise with neighbour regarding bushfires
Mar	Low	• Weed survey • Planning meeting with neighbour • Annual fire mapping to monitor changes to fire frequency in the area	**Sep**	High	• Monitor NAFI, fire danger ratings and fire weather warnings (daily or as required), and visually check horizon for smoke • Liaise with neighbour regarding bushfires
Apr	Low	• No fire management activity	**Oct**	High	• Monitor NAFI, fire danger ratings and fire weather warnings (daily or as required), and visually check horizon for smoke • Liaise with neighbour regarding bushfires
May	Low	• No fire management activity • Liaise with neighbour regarding bushfires • Review the preparedness planning requirements	**Nov**	Medium	• Monitor NAFI, fire danger ratings and fire weather warnings (daily or as required), and visually check horizon for smoke • Liaise with neighbour regarding bushfires
Jun	Medium	• Manage vegetation onsite, fire break and fire access trail • Monitor NAFI, fire danger ratings and fire weather warnings • Review the preparedness planning requirements	**Dec**	Low	• No fire management activity • Review the preparedness planning requirements

Exploration Permit 117
Bushfire Management Plan 2024 onwards
Shenandoah South C (Rev 1, Mar-2024)

Location of Shenandoah South C	
Property and land uses	Gas exploration, cattle grazing, and native title rights and interests recognised by the native title determinations over the land and waters.
Site fire management aim	To reduce the occurrence of, and minimise the impact of bushfires, thereby reducing the threat to life, property, cultural values and the environment.
Site fire management objectives	Mitigate the potential impact of unplanned fires on Tamboran's people, assets and operations and neighbouring land uses.
Fire History (10 years) (NAFI 2024)	Fire scar mapping (2013-2022) indicates the exploration area burns approximately every 4 to 8 years (refer Figure below). Field observations in April 2023 indicated a moderate intensity fire when last burnt.

Fire Management Risks

- Ignitions (humans and lightening) on or off site resulting in harm to workers and loss of equipment.
- Altered landscape fire regimes as result of regulated activities leading to conflict i.e. more or less fire, change in pattern and timing. Noting Shenandoah S C last burnt over 4 to 8 years ago.
- Bullwaddy and Lancewood vegetation communities occur in areas across the permit and are fire sensitive. Hot fires can reduce habitat quality for flora and fauna species that use these vegetation communities.
- Spread of high fuel load grassy weeds could increase fire intensity, e.g. gamba, grader and buffel grass, adjacent infrastructure areas and access tracks.



The BMP should be read in conjunction with the overarching Environment Management Plan and Emergency Response Plan for Tamboran's operations in the Beetaloo Basin.

Bushfire Officer	Contact Details	Name
	[redacted]	Robert Wear

Neighbours	Contact Details		Name
Beetaloo Station	[redacted]	[redacted]	Scotty & Jane Armstrong
Hayfield/Shenandoah Station	[redacted]	[redacted]	Justin Dyer & Sally Dyer

Stakeholders	Contact Details
National Response Centre	1800 076 251 (24/7 contact line)
Emergency	000 or 112 mobile
Bushfire NT Katherine office (Savanna)	(08) 8973 8871 / BushfiresNT.Katherine@nt.gov.au
Bushfire NT Alice Springs & Tennant Creek office (Barkly)	(08) 8951 9266
NAFI North	https://www.firenorth.org.au/nafi3/
Secure NT (Fire Bans and Alerts)	https://securent.nt.gov.au/alerts
Fire incident map	https://www.pfes.nt.gov.au/incidentmap/

Bushfire Management Actions

Well pad	• Remove and or maintain vegetation within the well pad area and implement erosion and sediment control plan. • Treat emerging vegetation with herbicide. • Hot works are not permitted on total fire ban days without written approval from a fire control officer or fire warden. • When the site is suspended, the well pad can be sufficient to satisfy APZ requirements depending on the level of infrastructure/ assets present.
Fire management break	• A 10 m wide cleared perimeter around well pads and tank pads during operations. • An additional 10 m wide bare earth fire break incorporating a 4 m wide fire access trail during operations.
Fire access trails	• Create and maintain 4 m wide access trail by grading or spraying.
Asset protection zones (APZ)	• Site manager to assess fuel load prior to camp establishment and again at end of wet season if infrastructure is still in place (refer to Fuel Load Criteria). • Establish a 20 m low fuel zone around well pads and well pads during operations (i.e. an area low in combustible material and obstructions). • Monitor for grassy weeds and control where appropriate. • If deemed necessary, conduct controlled burns where other controls are not effective and in consultation with neighbouring properties. • Ensure 4 m wide fire access trail around the perimeter of the asset protection zone is trafficable by firefighting appliances.
Neighbouring property fire management zone	• Fire management planning meeting with neighbouring properties prior to commencing activities and reviewed annually. • Neighbour to advise proponent of planned burns. • Working with pastoralist to assist in responding to fire where it is safe and practicable.

Bushfire Preparedness and Planning

Mandatory for all Severe, Extreme and Catastrophic FDI days

The following must be reviewed daily. If fire alerts are active or presenting with a known fire risk, personnel must execute their contingency plans which need to encompass the following:

- ☐ Procedure on identifying and notifying of a bushfire.
- ☐ Critical equipment to be removed / isolated/ shut down.
- ☐ Safe evacuation routes from site and muster points.
- ☐ Communication methods:
  - ✓ Team channels and / or phone numbers
  - ✓ Area channels and/or phone numbers
- ☐ Closest safe havens.

Monitoring

- ☐ Provide timely advice on changes in level of fire risk as available.
- ☐ Monitor team and area common channels for bushfire early warning.
- ☐ Update changes in work location.

Bushfire First Responder Checklist

The following sequence must be followed by the first person responding to a fire:

1. Danger – Remove yourself and others from danger is safe to do so.

2. Alarm – Raise the alarm either on common radio channel or other agreed process.

3. Gather Information –

- ☐ Location – Direction from known reference points, (e.g. roads and Tamboran's infrastructure such as well pad location).
- ☐ Impacts (actual and potential) – Life, property and the environment.
- ☐ Fire characteristics – Grass or woodlands, flame height, fire front and direction of travel.
- ☐ Weather – Wind strength and direction.
- ☐ Response in progress – What response is underway and by who (Tamboran contractors, pastoralist or Emergency Services).
- ☐ Response required – Tamboran contractors and / or pastoralist and / or Emergency Services.
- ☐ Access – Safe access and egress routes.

4. Notify Tamboran – Fire Officer/Supervisor

5. Notify Pastoralists – Refer to property contacts

6. Notify Emergency Services—Call 000 or 112 if Tamboran and pastoralist unable to manage situation

7. Respond and Monitor —If safe to do so in consultation with pastoralist and Emergency Services.

CSIRO Fuel Load Criteria

- ☐ Fuel quantity (tonnes of fuel per ha).
- ☐ Assess vegetation type i.e. grassland, shrubland, scrub, woodland or forest.
- ☐ Fuel size and shape e.g. fine fuel such as grass that burns quick vs course fuel (thick branches/trunks) that burn slowly.
- ☐ Fuel arrangement (i.e. separation of understory to canopy, dense or light understory).
- ☐ Moisture content (strong winds, high temperatures and low humidity will decrease moisture content).



Annual Works Calendar

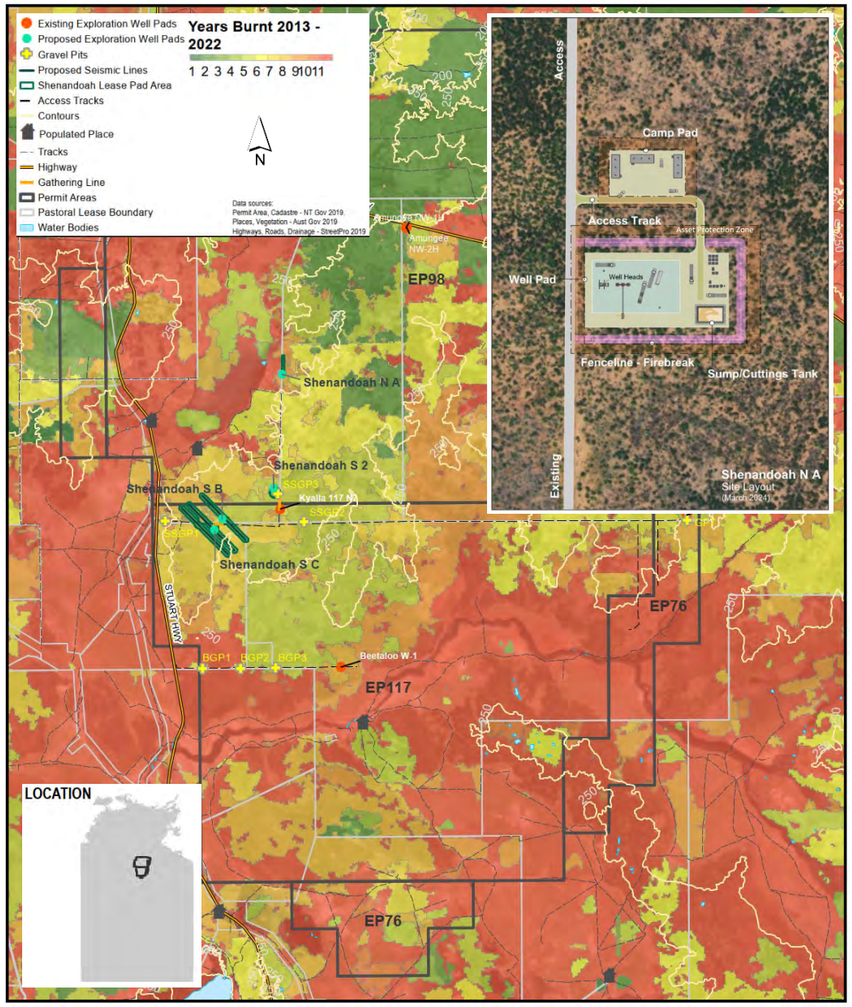
Jan	Low	• No fire management activity	**July**	High	• Manage vegetation onsite (including weeds), fire break and fire access trail • Monitor NAFI, fire danger ratings and fire weather warnings (daily or as required), and visually check horizon for smoke • Liaise with neighbour regarding bushfires
Feb	Low	• No fire management activity	**Aug**	High	• Monitor NAFI, fire danger ratings and fire weather warnings (daily or as required), and visually check horizon for smoke • Liaise with neighbour regarding bushfires
Mar	Low	• Weed survey • Planning meeting with neighbour • Annual fire mapping to monitor changes to fire frequency in the area	**Sept**	High	• Monitor NAFI, fire danger ratings and fire weather warnings (daily or as required), and visually check horizon for smoke • Liaise with neighbour regarding bushfires
Apr	Low	• No fire management activity	**Oct**	High	• Monitor NAFI, fire danger ratings and fire weather warnings (daily or as required), and visually check horizon for smoke • Liaise with neighbour regarding bushfires
May	Low	• No fire management activity • Liaise with neighbour regarding bushfires • Review the preparedness planning requirements	**Nov**	Medium	• Monitor NAFI, fire danger ratings and fire weather warnings (daily or as required), and visually check horizon for smoke • Liaise with neighbour regarding bushfires
Jun	Medium	• Manage vegetation onsite, fire break and fire access trail • Monitor NAFI, fire danger ratings and fire weather warnings • Review the preparedness planning requirements	**Dec**	Low	• No fire management activity • Review the preparedness planning requirements

Exploration Permit 98
Bushfire Management Plan
2024 onwards
Shenandoah North A (Rev 1, Mar-2024)

Location of Shenandoah North A	
Property and land uses	Gas exploration, cattle grazing, and native title rights and interests recognised by the native title determinations over the land and waters.
Site fire management aim	To reduce the occurrence of, and minimise the impact of bushfires, thereby reducing the threat to life, property, cultural values and the environment.
Site fire management objectives	Mitigate the potential impact of unplanned fires on Tamboran's people, assets and operations and neighbouring land uses.
Fire History (10 years) (NAFI 2024)	Fire scar mapping (2013-2022) indicates the exploration area burns rarely every 8 to 10 years (refer Figure below). Field observations in April 2023 indicated a moderate intensity fire when last burnt.

Fire Management Risks

- Ignitions (humans and lightening) on or off site resulting in harm to workers and loss of equipment.
- Potential to impact on known Sacred Site and Restricted Work Area to west of well pad.
- Altered landscape fire regimes as result of regulated activities leading to conflict i.e. more or less fire, change in pattern and timing. Noting Shenandoah N A last burnt over 8 to 10 years ago.
- Bullwaddy and Lancewood vegetation communities occur in areas across the permit and are fire sensitive. Hot fires can reduce habitat quality for flora and fauna species that use these vegetation communities.
- Spread of high fuel load grassy weeds could increase fire intensity, e.g. gamba, grader and buffel grass, adjacent infrastructure areas and access tracks.



The BMP should be read in conjunction with the overarching Environment Management Plan and Emergency Response Plan for Tamboran's operations in the Beetaloo Basin.

Bushfire Officer	Contact Details	Name
	[redacted]	Robert Wear

Neighbours	Contact Details		Name
Amungee Mungee Station	[redacted]	[redacted]	Adrian & Emma Brown
Hayfield/Shenandoah Station	[redacted]	[redacted]	Justin & Sally Dyer

Stakeholders	Contact Details
National Response Centre	1800 076 251 (24/7 contact line)
Emergency	000 or 112 mobile
Bushfire NT Katherine office (Savanna)	(08) 8973 8871 / BushfiresNT.Katherine@nt.gov.au
Bushfire NT Alice Springs & Tennant Creek office (Barkly)	(08) 8951 9266
NAFI North	https://www.firenorth.org.au/nafi3/
Secure NT (Fire Bans and Alerts)	https://securent.nt.gov.au/alerts
Fire incident map	https://www.pfes.nt.gov.au/incidentmap/

Bushfire Management Actions

Well pad	• Remove and or maintain vegetation within the well pad area and implement erosion and sediment control plan. • Treat emerging vegetation with herbicide. • Hot works are not permitted on total fire ban days without written approval from a fire control officer or fire warden. • When the site is suspended, the well pad can be sufficient to satisfy APZ requirements depending on the level of infrastructure/ assets present.
Fire management break	• A 10 m wide cleared perimeter around well pads and tank pads during operations. • An additional 10 m wide bare earth fire break incorporating a 4 m wide fire access trail during operations.
Fire access trails	• Create and maintain 4 m wide access trail by grading or spraying.
Asset protection zones (APZ)	• Site manager to assess fuel load prior to camp establishment and again at end of wet season if infrastructure is still in place (refer to Fuel Load Criteria). • Establish a 20 m low fuel zone around well pads and well pads during operations (i.e. an area low in combustible material and obstructions). • Monitor for grassy weeds and control where appropriate. • If deemed necessary, conduct controlled burns where other controls are not effective and in consultation with neighbouring properties. • Ensure 4 m wide fire access trail around the perimeter of the asset protection zone is trafficable by firefighting appliances.
Neighbouring property fire management zone	• Fire management planning meeting with neighbouring properties prior to commencing activities and reviewed annually. • Neighbour to advise proponent of planned burns. • Working with pastoralist to assist in responding to fire where it is safe and practicable.

Bushfire Preparedness and Planning

Mandatory for all Severe, Extreme and Catastrophic FDI days

The following must be reviewed daily. If fire alerts are active or presenting with a known fire risk, personnel must execute their contingency plans which need to encompass the following:

- ☐ Procedure on identifying and notifying of a bushfire.
- ☐ Critical equipment to be removed / isolated/ shut down.
- ☐ Safe evacuation routes from site and muster points.
- ☐ Communication methods:
  - ✓ Team channels and / or phone numbers
  - ✓ Area channels and/or phone numbers
- ☐ Closest safe havens.

Monitoring

- ☐ Provide timely advice on changes in level of fire risk as available.
- ☐ Monitor team and area common channels for bushfire early warning.
- ☐ Update changes in work location.

Bushfire First Responder Checklist

The following sequence must be followed by the first person responding to a fire:

1. Danger – Remove yourself and others from danger is safe to do so.

2. Alarm – Raise the alarm either on common radio channel or other agreed process.

3. Gather Information –

- ☐ Location – Direction from known reference points, (e.g. roads and Tamboran's infrastructure such as well pad location).
- ☐ Impacts (actual and potential) – Life, property and the environment.
- ☐ Fire characteristics – Grass or woodlands, flame height, fire front and direction of travel.
- ☐ Weather – Wind strength and direction.
- ☐ Response in progress – What response is underway and by who (Tamboran contractors, pastoralist or Emergency Services).
- ☐ Response required – Tamboran contractors and / or pastoralist and / or Emergency Services.
- ☐ Access – Safe access and egress routes.

4. Notify Tamboran – Fire Officer/Supervisor

5. Notify Pastoralists – Refer to property contacts

6. Notify Emergency Services—Call 000 or 112 if Tamboran and pastoralist unable to manage situation

7. Respond and Monitor —If safe to do so in consultation with pastoralist and Emergency Services.

CSIRO Fuel Load Criteria

- ☐ Fuel quantity (tonnes of fuel per ha).
- ☐ Assess vegetation type i.e. grassland, shrubland, scrub, woodland or forest.
- ☐ Fuel size and shape e.g. fine fuel such as grass that burns quick vs course fuel (thick branches/trunks) that burn slowly.
- ☐ Fuel arrangement (i.e. separation of understory to canopy, dense or light understory).
- ☐ Moisture content (strong winds, high temperatures and low humidity will decrease moisture content).



Annual Works Calendar

Jan	Low	• No fire management activity	**July**	High	• Manage vegetation onsite (including weeds), fire break and fire access trail • Monitor NAFI, fire danger ratings and fire weather warnings (daily or as required), and visually check horizon for smoke • Liaise with neighbour regarding bushfires
Feb	Low	• No fire management activity	**Aug**	High	• Monitor NAFI, fire danger ratings and fire weather warnings (daily or as required), and visually check horizon for smoke • Liaise with neighbour regarding bushfires
Mar	Low	• Weed survey • Planning meeting with neighbour • Annual fire mapping to monitor changes to fire frequency in the area	**Sep**	High	• Monitor NAFI, fire danger ratings and fire weather warnings (daily or as required), and visually check horizon for smoke • Liaise with neighbour regarding bushfires
Apr	Low	• No fire management activity	**Oct**	High	• Monitor NAFI, fire danger ratings and fire weather warnings (daily or as required), and visually check horizon for smoke • Liaise with neighbour regarding bushfires
May	Low	• No fire management activity • Liaise with neighbour regarding bushfires • Review the preparedness planning requirements	**Nov**	Medium	• Monitor NAFI, fire danger ratings and fire weather warnings (daily or as required), and visually check horizon for smoke • Liaise with neighbour regarding bushfires
Jun	Medium	• Manage vegetation onsite, fire break and fire access trail • Monitor NAFI, fire danger ratings and fire weather warnings • Review the preparedness planning requirements	**Dec**	Low	• No fire management activity • Review the preparedness planning requirements

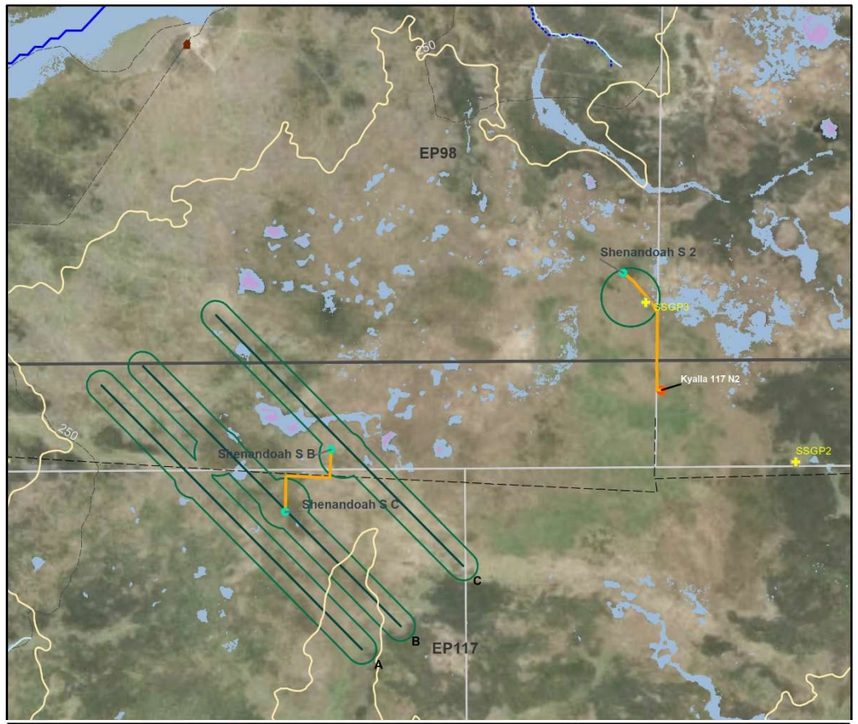
Exploration Permit 98 & 117
Bushfire Management Plan 2024 onwards
Shenandoah South Seismic Program

(Rev 1, Mar-2024)

Location of Shenandoah South Seismic Program	
Property and land uses	Gas exploration, cattle grazing, and native title rights and interests recognised by the native title determinations over the land and waters.
Site Fire Management Aim	To reduce the occurrence of, and minimise the impact of bushfires, thereby reducing the threat to life, property, cultural values and the environment.
Site Fire Management Objectives	Mitigate the potential impact of unplanned fires on Tamboran's people, assets and operations and neighbouring land uses.
Fire History (10 years) (NAFI 2024)	Fire scar mapping (2013-2022) indicates the exploration area burns rarely every 4 to 8 years (refer Figure below). Field observations in April 2023 indicated a low to moderate intensity fire when last burnt.

Fire Management Risks

- Ignitions (humans and lightening) on or off site resulting in harm to workers and loss of equipment.
- Altered landscape fire regimes as result of regulated activities leading to conflict i.e. more or less fire, change in pattern and timing. Noting Shenandoah South Seismic area last burnt over 4 to 8 years ago.
- Bullwaddy and Lancewood vegetation communities occur in areas across the permit and are fire sensitive. Hot fires can reduce habitat quality for both flora and fauna species that use these vegetation communities.
- Flood plain and Palustrine systems occur along Shenandoah South Seismic area that requires protection from accidental fire.
- Spread of high fuel load grassy weeds could increase fire intensity, e.g. gamba, grader and buffel grass, adjacent infrastructure areas and access tracks

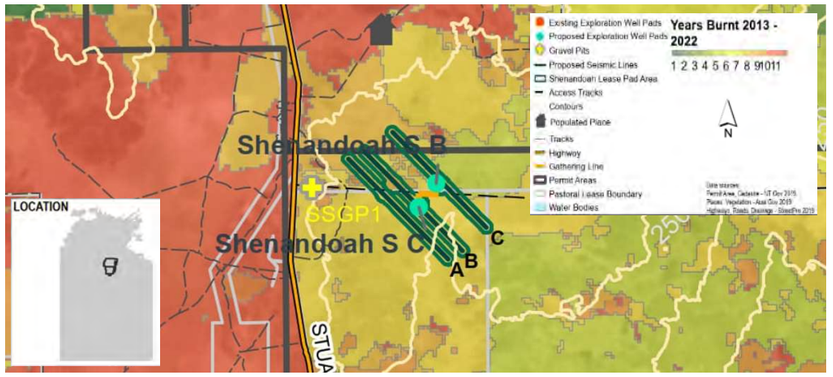


The BMP should be read in conjunction with the overarching Environment Management Plan and Emergency Response Plan for Tamboran's operations in the Beetaloo Basin.

Bushfire Officer	Contact Details	Name
	[redacted]	Robert Wear

Neighbours	Contact Details		Name
Beetaloo Station	[redacted]	[redacted]	Scotty & Jane Armstrong
Hayfield/Shenandoah Station	[redacted]	[redacted]	Justin & Sally Dyer

Stakeholders	Contact Details
National Response Centre	1800 076 251 (24/7 contact line)
Emergency	000 or 112 mobile
Bushfire NT Katherine office (Savanna)	(08) 8973 8871 / BushfiresNT.Katherine@nt.gov.au
Bushfire NT Alice Springs & Tennant Creek office (Barkly)	(08) 8951 9266
NAFI North	https://www.firenorth.org.au/nafi3/
Secure NT (Fire Bans)	https://securent.nt.gov.au/alerts
Fire incident map	https://www.pfes.nt.gov.au/incidentmap/



CSIRO Fuel Load Criteria

- ☐ Fuel quantity (tonnes of fuel per ha).
- ☐ Assess vegetation type i.e. grassland, shrubland, scrub, woodland or forest.
- ☐ Fuel size and shape e.g. fine fuel such as grass that burns quick vs course fuel (thick branches/trunks) that burn slowly.
- ☐ Fuel arrangement (i.e. separation of understory to canopy, dense or light understory).
- ☐ Moisture content (strong winds, high temperatures and low humidity will decrease moisture content).

Bushfire Management Actions

Seismic acquisition, including line preparation	• Adequate fire protection equipment to be provided to prevent fires, the spread of fire, injury to personnel, and to ensure local bushfire and other fire regulations are observed. • Fire extinguishers to be fitted to all vehicles and key Tamboran infrastructure locations. • Site manager to assess fuel load prior to commencement of the seismic program and routinely during line preparation (refer to Fuel Load Criteria). • Line preparation in grassed areas will be flattened to reduce the build-up of fuel within the vehicle's engine bays. Routine inspection of vehicles throughout day.
Neighbouring property fire management zone	• Fire management planning meeting with neighbouring properties prior to commencing activities and reviewed annually (as required). • Neighbour to advise proponent of planned burns. • Working with pastoralist to assist in responding to fire where it is safe and practicable.

Bushfire Preparedness and Planning

Mandatory for all Severe, Extreme and Catastrophic FDI days

The following must be reviewed daily. If fire alerts are active or presenting with a known fire risk, personnel must execute their contingency plans which need to encompass the following:

- ☐ Procedure on identifying and notifying of a bushfire.
- ☐ Critical equipment to be removed / isolated/ shut down.
- ☐ Safe evacuation routes from site and muster points.
- ☐ Communication methods:
  - ✓ Team channels and / or phone numbers
  - ✓ Area channels and/or phone numbers
- ☐ Closest Safe Havens.

Monitoring

- ☐ Provide timely advice on changes in level of fire risk as available.
- ☐ Monitor team and area common channels for bushfire early warning.
- ☐ Update changes in work location.

Bushfire First Responder Checklist

The following sequence must be followed by the first person responding to a fire:

1. Danger – Remove yourself and others from danger is safe to do so.
2. Alarm – Raise the alarm either on common radio channel or other agreed process.
3. Gather Information –

- ☐ Location – Direction from known reference points, (e.g. roads and Tamboran's infrastructure such as lease pad location, gravel pits etc.).
- ☐ Impacts (actual and potential) – Life, property and the environment.
- ☐ Fire characteristics – Grass or woodlands, flame height, fire front and direction of travel.
- ☐ Weather – Wind strength and direction.
- ☐ Response in progress – What response is underway and by who (Tamboran contractors, pastoralist or Emergency Services).
- ☐ Response required – Tamboran contractors and / or pastoralist and / or Emergency Services.
- ☐ Access – Safe access and egress routes.

4. Notify Tamboran – Fire Officer/Supervisor
5. Notify Pastoralists – Refer to Property Contacts
6. Notify Emergency Services—Call 000 or 112 if Tamboran and pastoralist unable to manage situation
7. Respond—If safe to do so in consultation with pastoralist
8. Handover—To pastoralist or Emergency Services as determined.

Annual Works Calendar

Month	Bushfire Risk	Action	Month	Bushfire Risk	Action
Jan	Low	• No fire management activity	Jul	High	• Monitor NAFI, fire danger ratings and fire weather warnings (daily or as required), and visually check horizon for smoke • Liaise with neighbour regarding bushfires
Feb	Low	• No fire management activity	Aug	High	• Monitor NAFI, fire danger ratings and fire weather warnings (daily or as required), and visually check horizon for smoke • Liaise with neighbour regarding bushfires
Mar	Low	• Weed survey • Planning meeting with neighbour • Annual fire mapping to monitor changes to fire frequency in the relevant area	Sep	High	• Monitor NAFI, fire danger ratings and fire weather warnings (daily or as required), and visually check horizon for smoke • Liaise with neighbour regarding bushfires
Apr	Low	• No fire management activity	Oct	High	• Monitor NAFI, fire danger ratings and fire weather warnings (daily or as required), and visually check horizon for smoke • Liaise with neighbour regarding bushfires
May	Low	• No fire management activity • Liaise with neighbour regarding bushfires • Review the preparedness planning requirements	Nov	Medium	• Daily checks of NAFI, fire danger ratings and fire weather warnings and visually • Liaise with neighbour regarding bushfires • Review the preparedness planning requirements
Jun	Medium	• Manage vegetation onsite (including weeds) • Monitor NAFI, fire danger ratings and fire weather warnings • Review the preparedness planning requirements	Dec	Low	• No fire management activity • Review the preparedness planning requirements

APPENDIX C Weed Management Plan

BEETALOO EXPLORATION PROJECT
WEED MANAGEMENT PLAN

Review date: 29/04/2024

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Weed Management Plan

TB2-HSE-MP-11

Review record

REV	DATE	REASON FOR ISSUE	AUTHOR	APPROVER
0	05/10/2018	Issue for release	A Court	M Kernke
1	29/03/2019	Issue for release	A Court	M Kernke
2	20/05/2019	Minor Update	A Court	M Kernke
2.1	10/09/2019	Minor update	M Kernke	M Hanson
2.2	10/09/2019	Minor update to include feedback from Amungee NW-1H EMP review		M Kernke
2.3	25/08/2021	Minor update to content based on DEPWS feedback	M/Kernke	M Kernke
2.4	10/11/2021	Update to include 2021 weed survey	M Kernke	M Kernke
2.5	18/01/2022	Update to include revised RWMP		M Kernke
2.6	27/02/2022	Update to include DEPWs comments	L Pugh	M Kernke
2.7	30/08/2022	Update to refence the *Tennant Creek Weeds Strategy 2021-2026* and Gamba Grass eradication in Zone A	L Pugh	M Kernke
3.0	30/03/2023	Updates to Section 1, 2 and minor edits	L Pugh	L Pugh
3.1	14/04/2023	Edits to figures	L Pugh	L Pugh
3.2	13/03/2024	Addresses regulation 10 and regulation 11 feedback from DEPWS, 29-Feb-2024	L Pugh	L Pugh

Review date: 29/04/2024

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Appendix B Example Weed Data Collection Sheet

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1 Introduction

1.1 Objectives of the Weed Management Plan

This Weed Management Plan (WMP) has been developed to ensure that the risk of weed introduction and spread, resulting from activities associated with Tamboran's exploration activities are mitigated to protect the economic, community, industry and environmental interests of the Northern Territory (NT).

The plan provides an overview of:

- The project context (Section 2).
- Legal requirements in relation to weed management (Section 3).
- The appointment of a dedicated Weed Officer (Section 4).
- Identified risks and proposed mitigation measures and management objectives (Section 5 and 6).
- The weed species that are considered likely or known to occur within the permit area (Section 6 and 7).
- The annual action plan for those species that are known to occur within the permit area (Section 8).
- Control options for species known to occur within the permit area (Section 8).
- The monitoring, notification, recording and reporting requirements for the WMP (Sections 9 – 12).

This plan is supported by appendices that provide guidance on how to identify weed species in the field and collect the necessary data to support the monitoring and reporting requirements of this WMP.

The location of the proposed exploration activities are shown in Figure 1.

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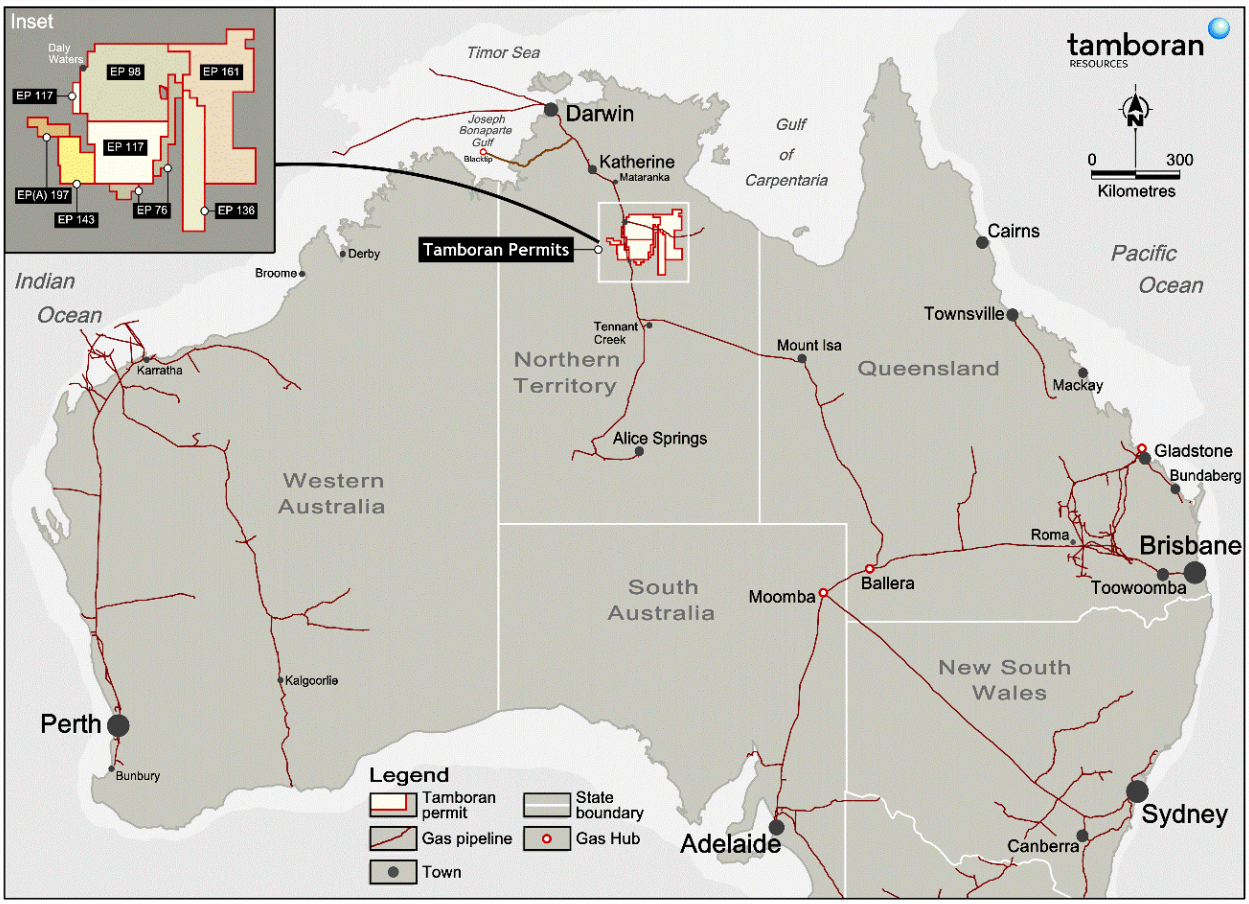


Figure 1 Location of Tamboran exploration permit areas (EPs)

1.2 Intent of the WMP

Weed control is a significant land management issue in the NT. This WMP forms a core component of Tamboran's overarching environmental management strategy and supports the various project Environment Management Plans (EMPs).

The movement of rigs, vehicles, machinery and other materials to, from and within the exploration permit area may result in weeds being moved around the pastoral lease, into the lease from surrounding areas or interstate, depending on where the vehicles and materials are sourced from or returned to.

The focus of this WMP is therefore to ensure that infestations are eradicated, or at the very least that existing weed infestations are controlled such that no further weed species colonise the permit area as a result of Tamboran's activities.

This document is based on the Weed Management Planning Guide - Onshore Shale Gas Development Projects produced by the Department of Environment, Parks and Water Security (DEPWS 2019).

2 Project Context

This plan covers all civil, drilling, stimulation, rehabilitation and routine maintenance/monitoring activities undertaken by Tamboran within its permit areas (Figure 1).

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The primary activities subject to this WMP include but are not limited to:

- Access track construction, use and maintenance
- Gathering line construction, use and maintenance
- Seismic acquisition and line rehabilitation
- Exploration lease pad construction, use and maintenance
- Gravel pit construction and maintenance
- Drilling, stimulating, completing and maintaining petroleum exploration wells
- Routine access, maintenance and monitoring of all exploration areas subject to this plan

3 Legal Requirements

The following section presents the relevant legislation and statutory obligations for the project.

3.1 Petroleum Act and subordinate legal instruments

Petroleum Act 1984, Petroleum (Environment) Regulations 2016 and ***Code of Practice for Petroleum Activities within the Northern Territory***

The *Petroleum Act 1984* provides the legal framework within which persons are encouraged to undertake effective exploration for petroleum and to develop petroleum production so that the optimum value of the resource is returned to the NT. It regulates the exploration for, and production of petroleum, including environmental protection measures which should be employed during exploration and production activities, including protection of parks and reserves and rehabilitation.

In addition, the Act is supported by the Petroleum (Environment) Regulations 2016 (the Regulations).The Regulations require that regulated activities are carried out in a manner consistent with the principles of ecologically sustainable development, and by which the environmental impacts and environmental risks of the activities are identified and reduced to as low as reasonably practical (ALARP) and acceptable levels.

The *Code of Practice for Petroleum Activities in the Northern Territory* (the Code) is a mandatory code of practice for the petroleum industry to ensure that petroleum activities in the NT are managed according to minimum acceptable standards to ensure that risks to the environment can be managed to a level that is ALARP and acceptable.

Under this legal framework, Tamboran is required to submit an EMP prior to any petroleum exploration or production activity.

EMPs must include:

- potential environmental risks or impacts (in this instance relating to the introduction and spread of weeds)
- appropriate environmental outcomes, environmental performance standards and measurement criteria
- appropriate implementation strategy and monitoring, recording and reporting arrangements, and
- demonstrate that there has been an appropriate level of engagement with directly affected stakeholders in developing the plan.

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This WMP is designed to support and implement the requirements of Tamboran's project specific environment management plans.

3.2 NT Weeds Management Act

The aim of the *Weeds Management Act 2001* is *"to protect the Territory's economy, community, industry and environment from the adverse impact of weeds"*.

The purpose of the Act, as defined in section 3, is:

- To prevent the spread of weeds in, into and out of the Territory and to ensure that the management of weeds is an integral component of land management in accordance with the NT Weeds Management Strategy 1996 – 2005 or any other strategy adopted to control weeds in the Territory.
- To ensure there is community consultation in the creation of weed management plans.
- To ensure that there is community responsibility in implementing weed management plans.

The Act[1] identifies declared weeds (those which must be controlled) and provides a framework for weed management. Weeds may be classified according to any of the following purposes:

a) it is necessary to eradicate the plant

b) it is necessary to prevent the growing and spreading of the plant

c) it is necessary to prevent the introduction of the plant into the Territory or a part of the Territory

d) it is necessary to prevent the plant being spread by the actions of persons.

As at 13 October 2023, there are 3 classes of weeds identified on the NT Weed Branch website:

- Class A – to be eradicated
- Class B – growth and spread to be controlled
- Class C* – Not to be introduced into the NT

* All Class A and B weeds are also Class C.

The Act enables the relevant Minister to approve statutory weed management plans. Management obligations in these plans must be adhered to.

There are statutory management plans for 10 high priority weed species in the NT. The WMP must address weeds in accordance with their declaration status and the statutory requirements of any relevant weed management plans.

3.3 Regional Weed Management Strategies

Regional Weed Strategies (RWS) have been developed for areas of the NT, with the Tennant Creek regional weeds strategy 2021 – 2026 and the Katherine regional weeds strategy 2021 – 2026, overlapping Tamboran's Beetaloo exploration tenure. The aim of these regional plans is to assist in prioritising weed management by:

[1] Refer Part 2, section 7(4).

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- identifying the region's priority weeds and associated pathways of spread to inform management priorities
- identifying landscapes that may need prioritised protection from weed impacts like river corridors or sacred Aboriginal sites
- containing information on alert weeds that are not yet found in the region, but could become major issues if they establish.

3.4 Commonwealth Environment Protection Biodiversity Conservation Act

The objectives of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) are, among other things to:

- provide for the protection of the environment, especially those aspects of the environment that are matters of national environmental significance; and
- promote ecologically sustainable development through the conservation and ecologically sustainable use of natural resources; and
- promote the conservation of biodiversity; and
- promote a co-operative approach to the protection and management of the environment involving governments, the community, land holders and indigenous peoples; and
- assist in the co-operative implementation of Australia's international environmental responsibilities.

The EPBC Act provides for the identification and listing of key threatening processes on matters of national environmental significance (MNES). A threatening process is defined as a key threatening process if it threatens or may threaten the survival, abundance or evolutionary development of a native species or ecological community. Key threatening processes include invasive species, such as weeds, which have a major impact on Australia's environment, threatening our unique biodiversity and reducing overall species abundance and diversity (DCCEEW, 2018).

Threat abatement plans (TAP) are developed to address key threatening processes. A TAP has been developed covering 5 listed grass species present within the Northern Territory (DCCEEW, 2012). The TAP covers grasses originally introduced to support pastoralism: gamba grass (*Andropogon gayanus*), para grass (*Urochloa mutica*), olive hymenachne (*Hymenachne amplexicaulis*), mission grass (*Pennisetum polystachion*) and annual mission grass (*Pennisetum pedicellatum*).

The controls in this WMP are designed to align with the Commonwealth TAP.

4 Dedicated Weed Officer

As per recommendation 8.3 of the Scientific Inquiry into Hydraulic Fracturing Stimulation there must be a dedicated Weed Officer for each gas field.

The Weed Officer must have relevant skills and experience and availability to successfully manage weed related issues for the project, including:

- Knowledge of the biology/ecology of local weeds.
- Knowledge of relevant weed management frameworks including NT legislation and plans, the EPBC Act.

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- Understanding of existing weed management arrangements being undertaken by landholders.

The Weed Officer is responsible and accountable for delivery of all weed related requirements of the project in accordance with the WMP and the overarching EMP, including:

- Planning and execution of weed monitoring requirements, including baseline weed assessments and ongoing monitoring both during periods of gas related activities as well as during the target identification period of February to May.
- Facilitate training all workers (including contractors) in weed management requirements, with support from the NT Government Onshore Petroleum Weed Management Officer.
- Oversight of implementation of weed control mechanisms including but not limited to wash-downs and proactive weed control programs.
- Ensuring all reporting requirements are met.
- Act as the designated point of contact for and rapidly responding to any weed related complaints and incidents in accordance with the pre-determined strategies in this WMP and additional strategies as required developed in consultation with the Onshore Petroleum Weed Management Officer and affected landholders.
- Review and update of WMPs to remain effective in communication with relevant landholders and Onshore Petroleum Weed Management Officer in consideration of monitoring results and emerging weed issues for both gas and pastoral operations.

Tamboran has appointed the **Beetaloo Field Manager** as the dedicated Weed Officer of the Beetaloo exploration activities. This role is supported by Tamboran's Approvals and HSE personnel.

5 Baseline Weed Species Information

Baseline and annual weed surveys have been completed across the proposed and existing exploration areas. These surveys indicate the abundance of weeds within the proposed and existing project areas are low.

No weeds were detected within the Shenandoah South E&A program during the December 2022 and April 2023 field survey. *Hyptis suaveolens* (Hyptis), has been identified at the Kalala S1 and Amungee NW site (access tracks, camp pad and lease pad). Hyptis has also recently been observed at the Velkerri 76 S2 site camp pad and irrigation area. Rubber Bush and *Parkinsonia aculeata* (Parkinsonia) have been previously identified along/in proximity to the Beetaloo W access track, with rubber bush also found along the Kyalla 117 N2 access track. Parkinsonia is considered a Weed of National Significance (WoNS), which are weed species that are the focus of national management programs for the purpose of restricting their spread and/or eradicating them from parts of Australia. These species are specifically presented in Table 1 and Section 9.

Gamba Grass (*Andropogon gayanus*) is a Declared Class A (to be eradicated) weed within the Beetaloo Sub-basin.[2] Gamba Grass is grown within the Class A zone on two pastoral leases under strict permit conditions. These pastoral leases are subject to annual audits and regular inspections to ensure it is not spread outside the permitted areas. An active compliance program is in place to ensure eradication is being achieved in Zone A, as per the requirements of the statutory weed management plan for gamba grass (DEPWS 2020).

[2] The Beetaloo lies within the NT Statutory Weed Management Zone Class A (for eradication).

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One incursion of Gamba Grass was treated at Amungee NW1 (EP 98) in 2023, but has not been identified within other Tamboran's exploration permits (e.g. EP 117, EP 98). Tamboran is committed to preventing the spread of Gamba Grass into the project area from known Gamba locations. Gamba grass incursions will continue to be identified, recorded and treated in accordance with the Threat Abatement Advice released by the Commonwealth Government.

Figure 2 illustrates the weeds species confirmed in the region during field surveys, along with other weed species that are known to occur or likely to occur within the wider exploration permit areas. This information is based on.

- Tamboran exploration program weed survey data (2014 onwards – results).
- Mapping data provided by the Weed Management Branch, DEPWS.
- Guidelines for the Management of the Weeds of Beetaloo 2018 (DLRM et al 2018).
- Tennant Creek weeds strategy 2021 – 2026 and Katherine weeds strategy 2021 – 2026.
- Department of Climate Change, Energy, the Environment and Water (DCCEEW) EPBC Act Protected Matters Report database.

Table 3 has been separated into priority weeds, which are broken down into 5 distinct categories:

- Category 1: These species are present in the region and are widely considered feasible to eradicate. They are typically evaluated as very high risk and have isolated and restricted distributions.
- Category 2: These species warrant strategic control across the landscape due to the high impact they have on land managers and on broader economic and environmental values. The key for these species is that outlier populations are practical to eradicate, but there are core infestations that are subject to control and containment. They are typically covered by a statutory weed management plan, the target of a specific program or similar; often they are Weeds of National Significance.
- Category 3: These species have been assessed by the weed risk management system as a medium to high risk (or have not been assessed) and have been identified by stakeholders as posing a threat to the values of the Region. The list is not comprehensive. There are no plans or strategies to manage any one of them as a species across the landscape. They are typically managed on a site basis and to prevent further spread. In some cases there may be local strategies to manage these weeds.
- Category 4: These species are typically evaluated as low risk; however, they do still have local impacts. There are no strategies in place for managing these species at a landscape scale. However, it is important for landholders to implement weed hygiene and other biosecurity measures to prevent the spread of weeds into clean areas, and to control these species where the opportunity arises. Typically, these weeds may become problems around infrastructure, drains and other disturbed areas.
- Category 5: The Weed Management Branch uses a working definition of an 'alert' weed as a species:
    - not yet naturalised in a region
    - with the potential to have a high level of impact should it become established
    - having a reasonable likelihood of arriving in the Region (or of being present undetected).

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It is noted that Parthenium (*Parthenium hysterophorus*) is a major problem in rangelands and cropping areas of Queensland and is estimated to cost farmers and graziers more than $22 million a year in reduced production and increased management costs. Vehicle, machinery and material movements from Queensland into the project area present a risk of spread of Parthenium if not managed correctly (Department of Primary Industry and Resources 2016).

Additional mapped locations of weeds within the Barkly and Katherine RWMS are provided in Figure 3, Figure 4 and Figure 5.

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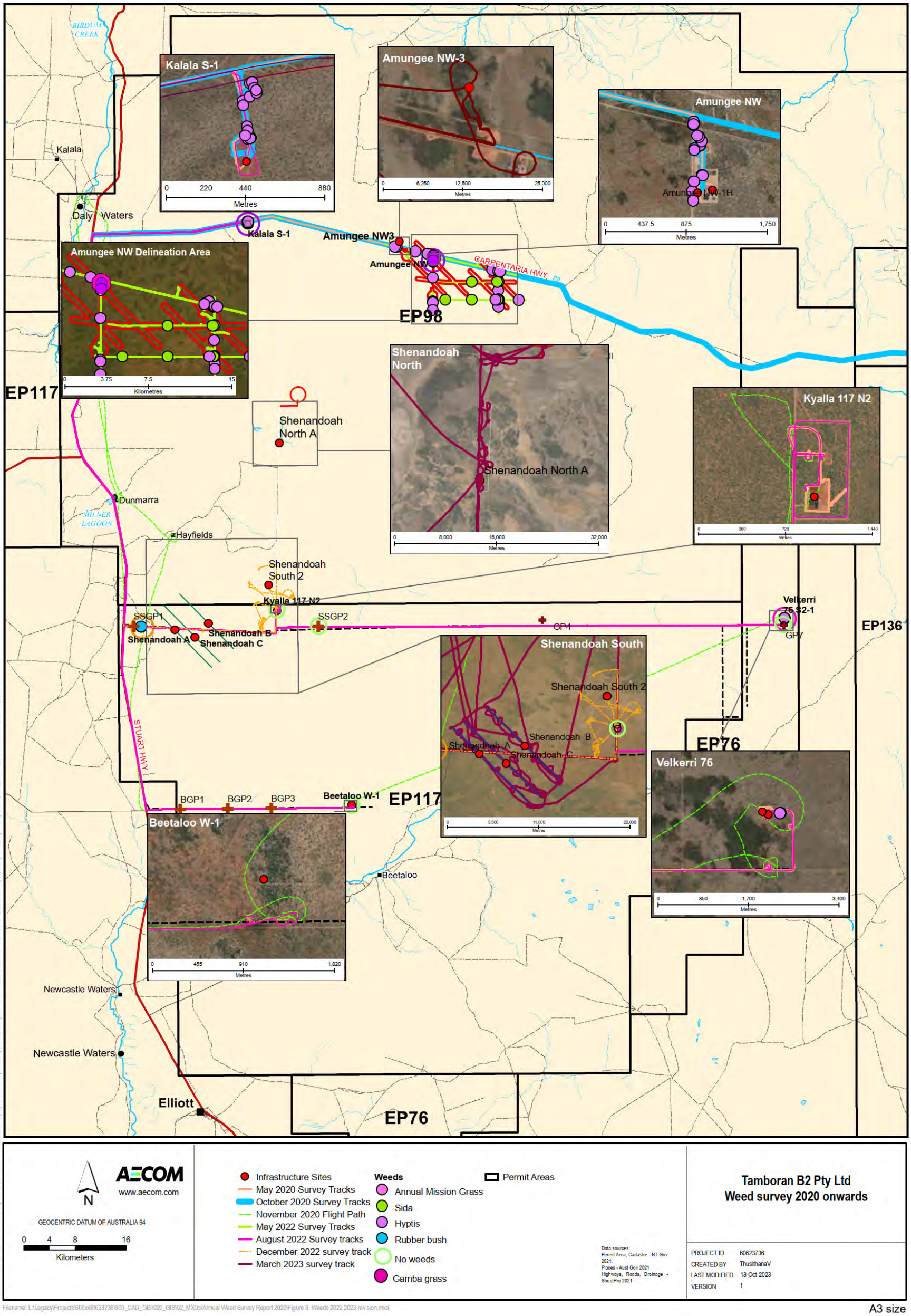


Figure 2 Location of weeds species in EPs

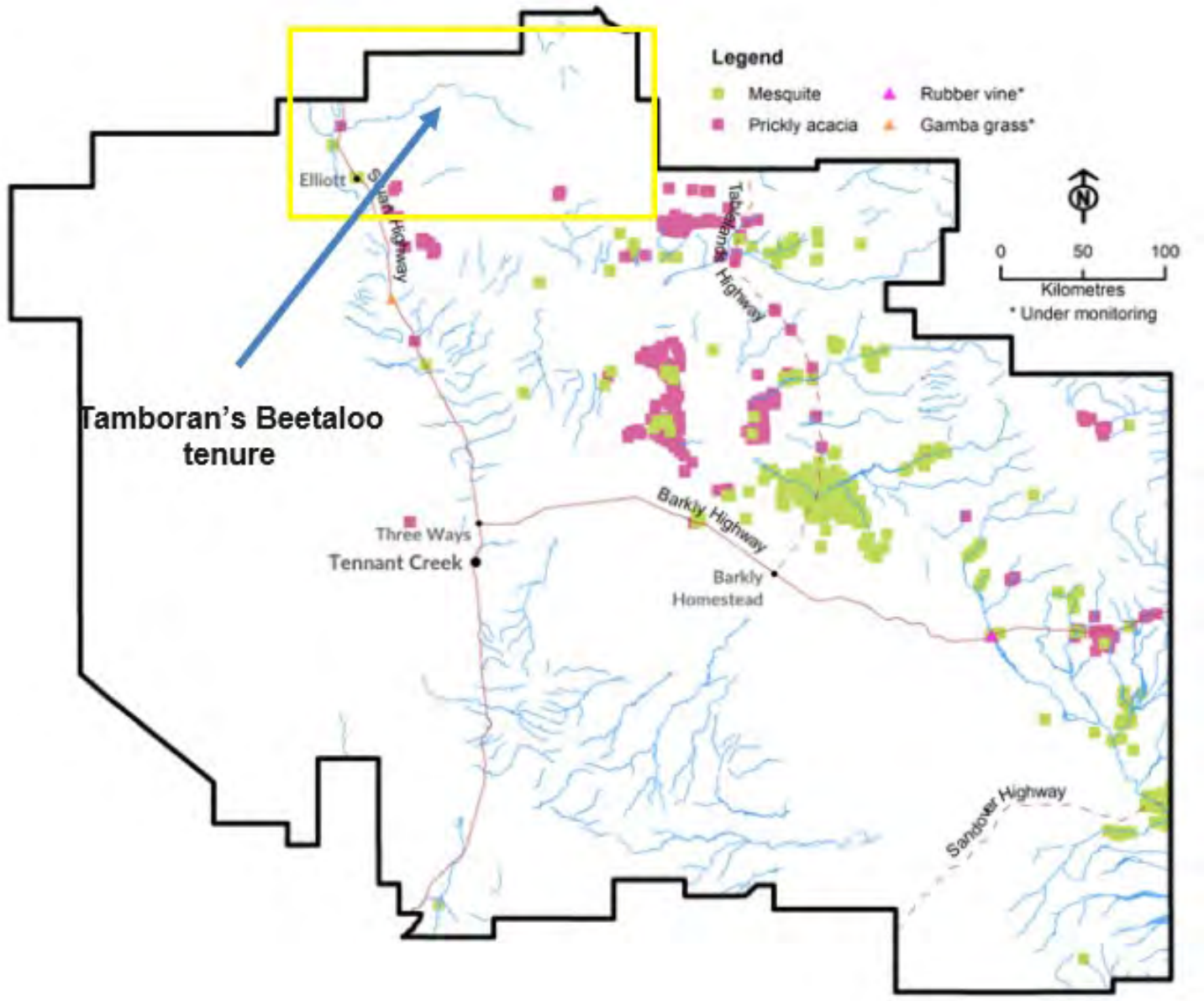


Figure 3 Tennant Creek RWS mapped priority weed for eradication locations (DEPWS 2021)

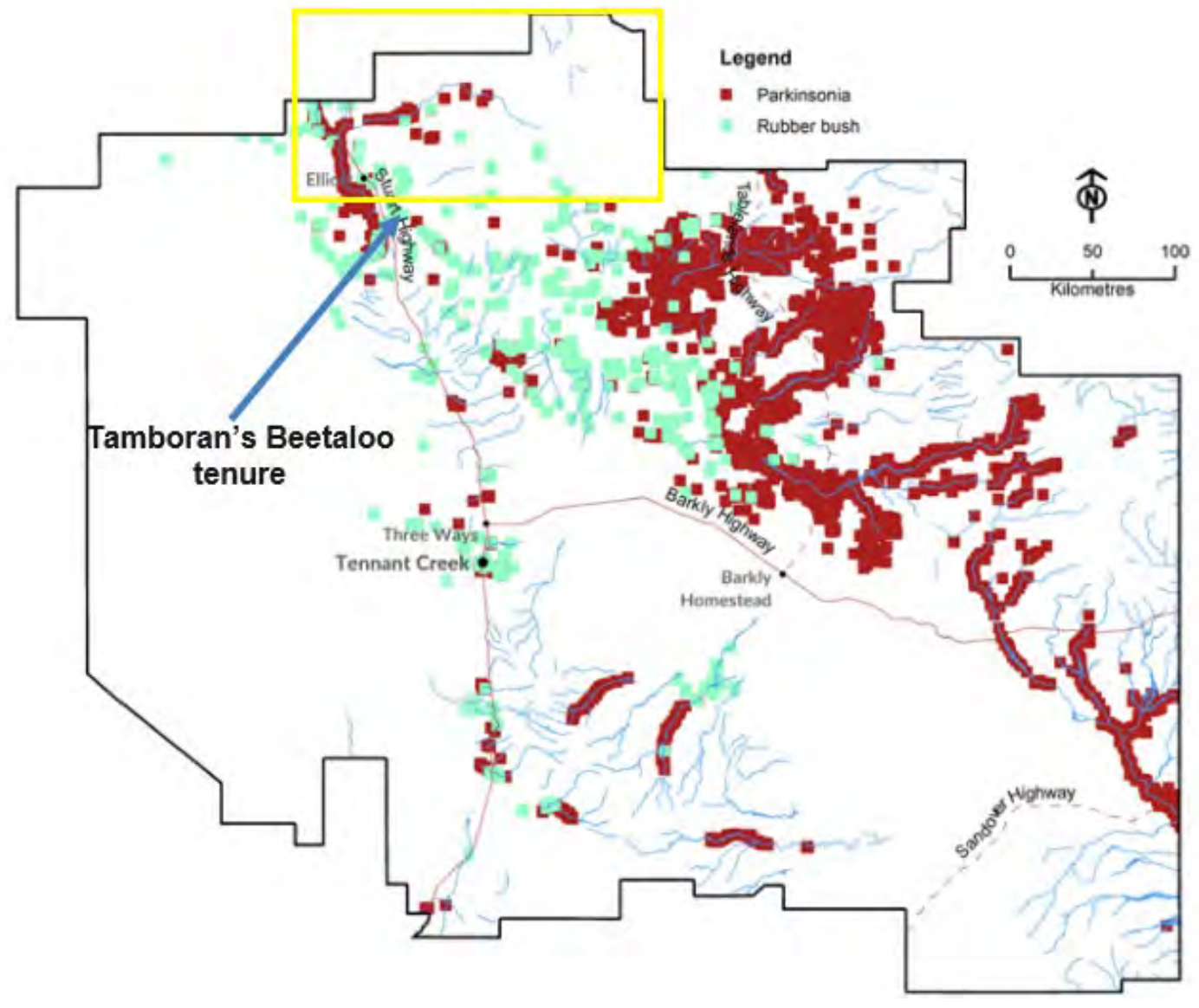
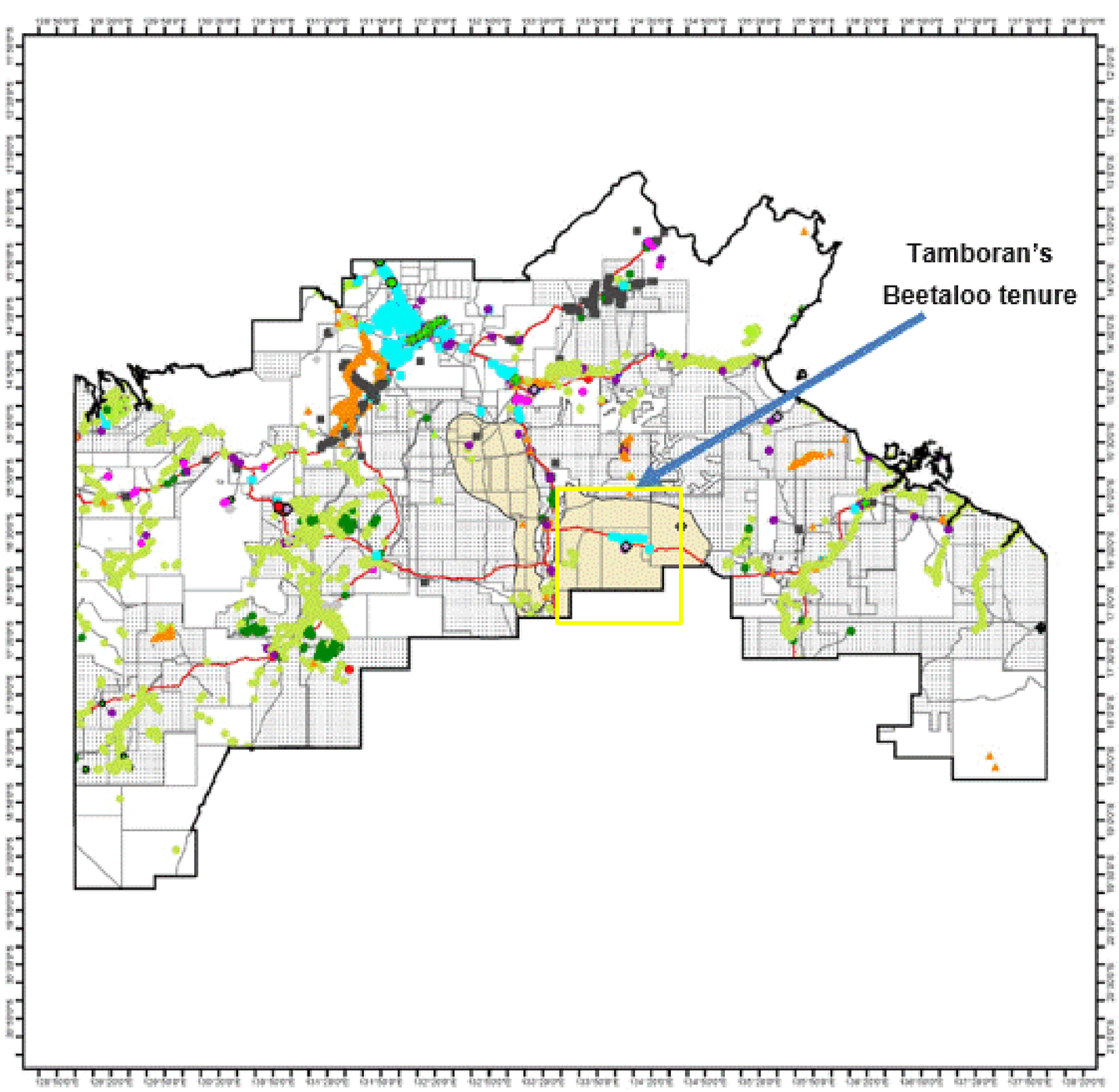


Figure 4 Tennant Creek RWS priority weeds for strategic control (DEPWS 2021)



Katherine Region Priority and Alert Weeds

- Arrowhead
- Athel pine
- Bellyache bush
- Cabomba
- Chinee apple
- Devils claw
- Gamba grass
- Grader grass
- Mesquite
- Mimosa
- Neem
- Parthenium
- Parkinsonia
- Pond apple
- Prickly acacia
- Rats tail grass - Giant
- Rope cactus sp
- Rubber vine
- Rubber vine - Ornamental
- Salvinia
- Siam weed
- Thatch grass
- Water hyacinth
- Water mimosa - plena
- Beetaloo Sub Basin
- Exploration Permit
- NT Cadastre

0 75 150 300 Kilometers

Datum: Geocentric Datum of Australia (GDA94)

CAUTION: The weed infestation information displayed in this area may not be limited to this representation

DATA SOURCE:
Weeds: Weed Management Branch, DENR
Property Infrastructure: Rangelands, DENR
Cadastre/Roads/Placenames:
Dept Lands, Planning and Environment
Drainage: 250K © Commonwealth of Australia (BoM) 2012

For further information, please contact:
Weed Management Branch
Department of Environment, Parks and Water Security (DEPWS)
Goyder Centre, Palmerston NT 0830
Phone: (08) 8999 2355
www.nt.gov.au/weeds

NORTHERN TERRITORY GOVERNMENT

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Map compiled: 13/12/2021

Figure 5 Katherine RWS mapped priority and alert weeds

Table 1 NT listed weeds known or likely to occur within the EPs

Scientific name	Common name	Status*	Category	Data source
Andropogon gayanus	Gamba Grass	Class A/B WoNS	1	Confirmed within exploration lease. High potential introduction through sourcing of equipment from Katherine and Darwin area.
Calotropis procera	Rubber Bush	Class B	2	Mapped in the exploration lease within the Tennant RWS.
Cryptostegia grandiflora	Rubber Vine	Class A	1	Mapped in the exploration lease within the Katherine RWS.
Hyptis suaveolens	Hyptis	Class B	4	Confirmed within exploration lease during previous weed Tamboran surveys.
Jatropha gossypiifolia	Bellyache Bush	Class A/B WoNS	1	Mapped in the exploration lease within the Katherine RWS. Potential introduction through sourcing of equipment from Katherine area.
Parkinsonia aculeata	Parkinsonia	Class B, WoNS	2	Confirmed within exploration lease during previous weed Tamboran surveys and Mapped in the exploration lease within the Katherine RWS. Potential introduction through sourcing of equipment from Katherine area.
Prosopis pallida	Mesquite	Class A, WoNS	1	Mapped in the area surrounding exploration lease within the Katherine and Tennant Creek RWS.
Themeda quadrivalvis	Grader Grass	Class B, WoNs	5	Confirmed within the exploration lease and mapped in the area within the Katherine RWS. High potential introduction through sourcing of equipment from Katherine area.
Parthenium hysterophorus	Parthenium	Class A, WoNS	1/ 5	Confirmed by DEPWS to occur within the exploration lease. Potential introduction through equipment sourced from QLD.
Cryptostegia grandiflora	Rubber vine	Class A, WoNS	1	Alert Species within the Tennant Creek and Katherine RWS.
Chromolaena odorata	Siam Weed	Class A	5	Alert Species Katherine RWS.
Azadirachta indica	Neem	Class B	2	Weed Management Branch – Mapping data
Cenchrus ciliaris	Buffel Grass	Not declared in NT	3	DCCEEW Protected Matters Report
Cenchrus echinatus	Mossman River Grass	Class B	3	DLRM databases (DLRM *et al* 2018)
Datura ferox	Fierce Thornapple	Class A	3	DLRM databases (DLRM *et al* 2018)
Sida acuta	Spinyhead sida	Class B	4	Weed Management Branch – Mapping data

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Scientific name	Common name	Status*	Category	Data source
Sida cordifolia	Flannel Weed	Class B	4	Weed Management Branch – Mapping data DLRM databases (DLRM *et al* 2018)
Sida rhombifolia	Paddy's Lucerne	Class B	4	DLRM databases (DLRM *et al* 2018)
Vachillia nilotica	Prickly Acacia	Class A, WoNS	1	Mapped in the exploration lease within the Katherine RWS.
Xanthium strumarium	Noogoora Burr	Class B	3	Weed Management Branch – Mapping data DLRM databases (DLRM *et al* 2018)
*All Class A and B weeds are also Class C weeds.				

6 Weed Management Mandatory Requirements

6.1 Weed hygiene declarations for vehicles and equipment

e) All vehicles, equipment and loads are to be clean (free of plant matter, seeds, dirt and mud) and have a valid weed hygiene declaration form prior to accessing any pastoralist property

f) Weed hygiene certificates are only to be issued by an authorised inspector that is satisfied that the vehicle is free of plant matter, seeds, dirt, mud animal wastes and any other time that could potentially represent a biosecurity or weeds risk.

g) An authorised inspector is someone who has successfully completed the nationally recognised "AHCBIO201- Inspect and clean machinery for plan, animal and soil material" training course

h) Weed hygiene declarations shall contain:

   a. The identification details of the vehicle or thing inspected.

   b. Odometer reading (where applicable)

   c. Date and location inspected

   d. Name and signature of the authorised inspector issuing the declaration

   e. The organisation with which the inspector issuing the declaration is affiliated

   f. Name and signature of the driver (where applicable)

i) A biosecurity hygiene declaration for a vehicle/equipment remains valid when the vehicle/equipment:

   a. does not travel off sealed/formed roads, or

   b. clean (i.e. free of biosecurity matter including weeds, pests and diseases, and biosecurity carriers) or

   c. is located on the same or adjacent property and has not encountered any areas with weeds. Areas where it is reasonably expected to encounter weeds include the unsealed shoulders of road corridors and known infestation areas as provided in Figure 2.

j) A biosecurity declaration becomes invalid when:

   a. The vehicle or equipment has encountered known areas of weed infestations.

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b. The vehicle or equipment has come from a property that is not adjacent to the property to be accessed.

c. It is not known where the vehicle/ equipment has been previously used.

k) Where a vehicle or piece of equipment arrives at site dirty, they shall be refused entry. The vehicle/ equipment must be directed to the closest washdown facility (Tennant Creek or Katherine), recertified and inspected prior to accessing the site.

6.2 Weed Hygiene Declarations for Loads and Material

1. Weed hygiene declarations are to be utilised to satisfy that a load of materials (including hay, seed, sand, gravel, topsoil) is free of or containing a biosecurity matter and carriers. Anyone who is either the seller, supplier or the driver may issue a Weed Hygiene Declaration for a load providing they have direct knowledge of the product and the status as weed free or containing a biosecurity matter.

2. Weed declarations are not required for loads moved within areas within the same or adjacent properties that have been determined through baseline weed studies as being weed free.

3. Where loads of material cannot be determined to be weed free, they shall be returned to the supplier and an alternative clean source utilised.

6.3 Weed Washdown Facility Requirements

1. Cleaning activities should be undertaken at facilities with effective environmental controls to prevent the spread of biosecurity matter.

2. Wash water, mud/ silt, weed material and other contaminants must be bagged and disposed of at a licenced landfill.

3. Where possible, high pressure water spray should be used. This is the preferred method. If this is impractical, (such as at a site location) the minimum requirement is to use a suitable bar or shovel, brooms/ brushes and compressed air to remove contaminants (dry cleaning).

6.4 Equipment Sourcing and Selection

l) Equipment shall be sourced based on the following prioritisation:

a. Local equipment, particularly civil construction equipment, shall be sourced as a priority.

b. Regional equipment (NT) shale be sourced where no local equipment supplier exists

c. Interstate equipment should be sourced only where local/regional equipment is not available (due to availability or cost constraints). In such cases, additional inspections may be required to ensure vehicles/ equipment are free of weed containing material prior to accessing site.

6.5 Interstate Transport

All vehicles, equipment and loads moved interstate/territory shall be free of weeds and weed containing material (vegetation, seed, grass, soil, mud etc.) prior to entry into the NT.

All vehicles, equipment and loads travelling from interstate shall have a further inspection prior to access to any pastoral property. If required, additional cleaning shall be undertaken to remove any weeds or weed carrying material.

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Where a load/equipment/ vehicle is unclean and is suspected of not being washed prior to entry into the NT, a load must be refused entry into a pastoralist property. The vehicle will require a washdown at an appropriate facility within the state/territory the equipment/vehicle/load originated from.

6.6 Weed Management Awareness

All staff and contractors shall be made aware of their weed management obligations. This shall be undertaken through:

- Building weed prevention and management requirements into contracts and assessed as a part of work readiness reviews and ongoing assurance activities.
- Inclusion of weed management requirements within site inductions and toolbox talks.

7 Weed Introduction and Spread Risk Assessments

As part of the development of the EMP, Tamboran has undertaken an assessment of the risk of introducing or spreading weeds in the project area. This assessment and the corresponding proposed mitigation measures and management objectives are presented in Table 2. Due to the low abundance of weeds within the EPs, management controls will primarily focus on preventing the introduction of weed species through appropriate equipment sourcing cleaning and inspection.

Table 2 Risk of weed introductions and spread, including management controls

Environmental Values	Maintain the integrity of significant ecosystems and agricultural productivity		
Management Objectives	Avoid the introduction of weeds Avoid the spread of existing weeds		
Measures Criteria	No introduction or spread of declared weeds resulting from Tamboran's activities.		
Activity	**Potential Risks**		**Management controls**
	Introduction of new weeds	**Spread of existing weeds**	
Vehicle and equipment movements	Vehicles and equipment sourced from other locations infested with weed species not found in or around Project Area	Traversing of weed infested areas with machinery	• Code of Practice for Petroleum Activities in the NT, Part A Surface Activities. • Activities will adhere to the guidelines within the NT Weed Management Handbook. • Weed management and control measures to be implemented in alignment with existing landholder biosecurity requirements. • All equipment will have certified equipment wash-down completed prior to entry to the field. Wash-down would occur at Contractors deport or a commercial wash facility prior to mobilisation in a manner that prevents pollution of the surrounding environment. • Machinery to be preferentially sourced locally, with machinery sourced from

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Environmental Values	Maintain the integrity of significant ecosystems and agricultural productivity		
Management Objectives	Avoid the introduction of weeds Avoid the spread of existing weeds		
Measures Criteria	No introduction or spread of declared weeds resulting from Tamboran's activities.		
Activity	**Potential Risks**		**Management controls**
	Introduction of new weeds	**Spread of existing weeds**	
			surrounding areas or Queensland being the 2nd and 3rd preferred option respectively. • Weeds will be actively controlled in cleared/ hardstand areas. • Major equipment moves will be planned from weed-free areas to infested areas and not the other way around. • Ensuring all material imported to or between sites is free of weeds.
Construction of access tracks, monitoring bore pads and seismic lines	Importing materials from areas where weeds are present and creating opportunities for weed species to colonise disturbed areas	Traversing of weed infested areas and creating opportunities for weed species to colonise disturbed areas	• Code of Practice for Petroleum Activities in the NT, Part A Surface Activities. • Activities will adhere to the guidelines within the NT Weed Management Handbook. • Weed management and control measures to be implemented in alignment with existing landholder biosecurity requirements. • All equipment will have certified equipment wash-down completed prior to entry to the field. • Ensure field staff, contractors and machinery operators are familiar with hygiene protocols and weed identification. • Machinery to be preferentially sourced locally, with machinery sourced from surrounding areas or Queensland being the 2nd and 3rd preferred option respectively. • Weeds will be actively controlled in cleared/ hardstand areas. • Stabilise disturbed areas.
Drilling, stimulation and well testing	Introduction of weed species not found in or around EP area.	Traversing of weed infested areas with machinery	• Code of Practice for Petroleum Activities in the NT, Part A Surface Activities. • Activities will adhere to the guidelines within the NT Weed Management Handbook.

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Environmental Values	Maintain the integrity of significant ecosystems and agricultural productivity		
Management Objectives	Avoid the introduction of weeds Avoid the spread of existing weeds		
Measures Criteria	No introduction or spread of declared weeds resulting from Tamboran's activities.		
Activity	**Potential Risks**		**Management controls**
	Introduction of new weeds	**Spread of existing weeds**	
			• Weed management and control measures to be implemented in alignment with existing landholder biosecurity requirements. • All equipment will have certified equipment wash-down completed prior to entry to the field. Wash-down would occur at Contractors deport or a commercial wash facility prior to mobilisation in a manner that prevents pollution of the surrounding environment. • Ensure field staff, contractors and machinery operators are familiar with hygiene protocols and weed identification. • Weeds will be actively controlled in cleared/ hardstand areas. • Major equipment moves will be planned from weed-free areas to infested areas and not the other way around. • Drilling and stimulation equipment will be restricted to cleared lease areas. • Ensuring all material imported to or between sites is free of weeds.
Operational / site management	Personnel unable to identify weeds or unaware of weed species present in areas where machinery and equipment is sourced from	Existing weed distribution not known due to insufficient survey effort, surveys conducted at wrong time of year, surveyors not familiar with / unable to identify declared weed species	• Code of Practice for Petroleum Activities in the NT, Part A Surface Activities. • Staff members responsible for preventing, identifying and managing weeds to be appropriately trained. • Weed desktop and field-based surveys to be provided to identify existing weed areas. • Pre-and post-wet (February to May) inspections and periodic audits will be conducted to identify and report weed outbreaks.

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Environmental Values	Maintain the integrity of significant ecosystems and agricultural productivity		
Management Objectives	Avoid the introduction of weeds Avoid the spread of existing weeds		
Measures Criteria	No introduction or spread of declared weeds resulting from Tamboran's activities.		
Activity	**Potential Risks**		**Management controls**
	Introduction of new weeds	**Spread of existing weeds**	
	Insufficient management control to prevent the introduction of weeds	Insufficient management control to prevent the spread of weeds	• Staff members responsible for preventing, identifying and managing weeds to be appropriately trained. • Ensure field staff, contractors and machinery operators are familiar with hygiene protocols and weed identification (Weed identification posters and the NTG Weed Deck will be made available) • Weeds will be actively controlled in cleared/ hardstand areas. • Weed management and control measures to be implemented in alignment with existing landholder biosecurity requirements. • New activities will be planned to address prevention of weed or non-indigenous plant spread.

8 Statutory Weed Management Plans

No statutory weeds have been identified during surveys of the EPs, however the following plans apply to species that have been found / could be potential found in the broader region:

- Weed Management Plan for Athel pine (*Tamarix aphylla*)
- Weed Management Plan for Mesquite (*Prosopis* spp.)
- Weed Management Plan for Prickly Acacia (*Vachella nilotica*)
- Weed Management Plan for Bellyache Bush (*Jatropha gossypiifolia*)
- Weed Management Plan for Neem (*Azadirachta indica*)
- Weed Management Plan for Gamba Grass (*Andropogon gayanus*)
- Weed Management Plan for Grader Grass (*Themeda quadrivalvis*).

The weed management plans establish the legal requirements and management actions to be undertaken by all owners and occupiers of the land on which the declared weed is present in the NT. The aim of each plan is to mitigate the damage caused by the each weed species within specific management areas and zones, through eradication and avoidance of further spread. Conducting land management practices in accordance with the weed management plans will secure compliance with the requirements of the Act.

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9 Annual Action Plan

An action plan for each of the weed species identified in the Project Area is presented in Table 3. Treatment options as contained in the NT Weed Management Handbook are presented in Section 9.1 to Section 9.3.

This section will be undated if new weed species are discovered over the life of the program to ensure that statutory requirements with relation to declaration status and relevant weed management plans are addressed (refer to Section 8).

As part of the Annual Weed Management Action Plan, Tamboran also commits to undertaking finer detailed weed mapping of all permit areas, lease pads, access tracks and gravel pits, as well as any other areas disturbed as part of the activity.

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Table 3 Annual weed management action plan

Management objective	Avoid the introduction of weeds Avoid the spread of existing weeds			
Weed species	**Survey time(s)**	**Treatment time(s)**	**Control options**	**Where located**
Hyptis *Hyptis suaveolens*	6 monthly: pre and post-wet season	• Preferred Dec – Mar • Also Nov and April	Refer to section 9.1.	Beetaloo access track Access track to Amungee NW Kalala S1 site Velkerri 76 S2 camp pad
Parkinsonia *Parkinsonia aculeata*	6 monthly: pre and post wet season	• Preferred Mar – May • Also all year round	Refer to section 9.2.	Beetaloo access track
Rubber Bush *Calotropis procera*	6 monthly: pre and post wet season	• Preferred October – March • April - July	Refer to section 9.3.	Proximity to the Beetaloo access track Kyalla 117 N2 access track and Stuart Highway intersection

9.1 Hyptis (*Hyptis suaveolens*) Treatment Options

Table 4 includes herbicide and non-chemical treatment options for Hyptis (*Hyptis suaveolens*) (NT Government 2015).

Table 4 Hyptis (*Hyptis suaveolens*) treatment options

Weed Species	Hyptis *(Hyptis suaveolens)*		
Control Methods	**Chemical and concentration**	**Rates**	**Weed growth stage, method and comments**
Herbicides	**2, 4-D amine 625 g/L** Various trade names	320 mL / 100 L	**Seedling or adult (individuals or infestation):** Foliar spray – apply when actively growing.
	Glyphosate 360 g/L Various trade names and formulations	15 mL / 1 L	**Seedling or adult (individuals or infestation):** Foliar spray – apply when actively growing.
Non-chemical applications	• Manually remove all plant material; slash to encourage competition from desirable species.		

Source: Northern Territory Weed Management Handbook (NT Government 2021)

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9.2 Parkinsonia (*Parkinsonia aculeata*) Treatment Options

Table 5 includes herbicide and non-chemical treatment options for Parkinsonia (Parkinsonia aculeata) (NT Government 2015).

Table 5 Parkinsonia *(Parkinsonia aculeata)* treatment options

Weed Species	Parkinsonia *(Parkinsonia aculeata)*		
Control Methods	**Chemical and concentration**	**Rate**	**Weed growth stage, method and comments**
Herbicides	**Aminopyralid 8 g/L + Triclopyr 300 g/L + Picloram 100 g/L** Grazon™ Extra	350 mL / 100 L or 3 L / ha	**Seedling (individuals and infestation)** Foliar spray – avoid spraying if plants are stressed or bearing pods – Uptake Spraying Oil required Foliar spray – plants up to 2 m or 2 years old - Uptake Spraying Oil required.
	Triclopyr 240 g/L + Picloram 120 g/L Access™	1 L / 60 L (diesel) 1 L / 60 L (diesel)	**Seedling or adult (individuals or infestation)** Basal bark < 5 cm stem diameter Cut stump > 5 cm stem diameter
	Tebuthiuron 200 g/kg	1.5 g / m^2	**Seedling or adult (individuals or infestation)** Granulated herbicide - ground applied Do not use within 30 m of desirable trees or apply to continuous area > 0.5 ha. Do not use if fire is eminent. Apply when there is soil moisture or prior to rain.
Non-chemical applications	• Blade-ploughing, stick-raking, bulldozing and chaining can be effective if the root layer is removed from the soil. • Cultivation of pasture or native vegetation after mechanical control will help to prevent re-sprouting and seedling establishment. • Fire destroys seed in the soil surface and can be used as a follow-up to remove seedlings after other control efforts. • Fire may also be used to manage mature trees. Hand grubbing for single plants or small outbreaks, ensure removal of the root system. • Biocontrol options are available with Uu establishing slowly in some areas.		

Source: Northern Territory Weed Management Handbook (Northern Territory Government 2021).

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9.3 Rubber bush (*Calotropis procera*) Treatment Options

Table 6 includes herbicide and non-chemical treatment options for rubber bush *(Calotropis procera) (*NT Government, 2015).

Table 6 Rubber bush (*Calotropis procera*) treatment options

Weed Species	Rubber bush *(Calotropis procera)*		
Control Methods	**Chemical and concentration**	**Rate**	**Weed growth stage, method and comments**
Herbicides	**Triclopyr 300 g/L + Picloram 100 g/L** **Conqueror®** **+ Aminopyralid 8 g/L** Grazon™ Extra	750 mL / 100 L (water) 500-750mL / 100 L (water)	**Seedling (individuals or infestation):** Foliar spray. Check label for recommended adjuvant product. More effective on plants <2m as thorough coverage on all leaves is required
	Triclopyr 240 g/L + Picloram 120 g/L Access™	 1 L / 60 L (diesel) 1 L / 10 L (diesel) 1 L / 60 L (diesel)	**Adult (individuals and infestation):** Basal bark < 5cm stem diameter. Spray all stems. Spray to point of runoff. Thin Line up to 5cm stem diameter. Cut stump > 5cm stem diameter.
	Tebuthiuron (200g/kg) Graslan Pending registration. Please check with Weed Management Branch for status confirmation.	1.5 – 2 g/m^2	**Seedling or adult:** Application to black clay soils in conjunction with seasonal rainfall. Spread granules according to density of the infestation.
	Fluroxypyr (333g/L) Starane™ Advanced	3 L / 100 L (diesel)	**Adult:** Cut stump method for plants up to 10cm diameter and 3m high.
Non-chemical applications	This plant is difficult to eradicate as the deep roots survive almost any treatment. Maintenance of a dense pasture sward will assist in preventing invasion.		

Source: Northern Territory Weed Management Handbook (NT Government, 2021)

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10 Notification Procedure

The Onshore Petroleum Weed Management Officer at the Weed Management Branch of the DEPWS should be notified within 48 hours of the discovery of a new weed species in the EP.

Initial notification may be verbal, with follow-up written notification provided within seven working days. The notification should include a preliminary species identification and location information. The Regional Weed Officer will advise what further action is required.

It is noted that some species spread rapidly so immediate action may be required to control spread. For example, as stated above Parthenium (*Parthenium hysterophorus*) is a Class A (to be eradicated) and Class C (not to be introduced) weed in the Northern Territory as well as being classified as a Weed of National Significance. Early detection is crucial in not allowing this species to spread in the Northern Territory (Department of Primary Industry and Resources 2016).

In addition, it is noted that under the Weeds Management Act that:

> *'The owner and occupier of land must… within 14 days after becoming aware of a declared weed that has not previously been, or known to have been, present on the land, notify an officer of the presence of the declared weed'.*

All weed outbreak incidents will be reported in Tamboran's incident reporting system and corrective action initiated.

11 Recording

Records of weed inspections will be maintained by Tamboran.

Data on weed distribution will be maintained within Tamboran's GIS and provided to the Weeds Officer at DEPWS as part of the annual report on performance against the Weed Management Plan, or as requested. Data will be collected as per the requirements of the NT *Weed Data Collection Manual - Section One Technical Data Description* (Weed Management Branch, 2015). Data will be recorded as per the guidelines provided in Appendix A, using the data sheet provided in Appendix B (Weed Management Branch, 2015).

The NT *Weed ID Deck* (NT Government, 2021) will be referenced to assist with identification of species that have been identified as likely or known to occur in the EP.

Field data will be submitted directly to the Weed Management Branch in a shapefile format or as an Excel spreadsheet, including incidental identification of weeds and following completion of field surveys.

12 Reporting

All weed outbreak incidents will be reported in Tamboran's incident reporting system and corrective action initiated.

A report on the performance against this Weed Management Plan will be submitted to DEPWS on an annual basis. At a minimum, this should include:

a. Details of activities implemented to address weed spread and introduction risks (e.g. vehicle wash down/ blow down locations, examples of track construction from working from weed free areas into weed infested areas to reduce spread).

b. Details of survey and monitoring events, including dates, personnel, maps and track data.

c. Submission of all weed data collected.

d. Overview of weed control events and success rates (weed control should be captured in detail through the data collection process and submitted as a component of (a)).

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13 References

Department of Climate Change, Energy, the Environment and Water. 2018. *Key threatening processes under the EPBC Act*. http://www.environment.gov.au/biodiversity/threatened/key-threatening-processes, accessed 14 September 2018.

Department of Environment, Parks and Water Security. 2020. Weed Management Plan. Gamba Grass 2020-2030. https://nt.gov.au/__data/assets/pdf_file/0006/954789/weed-management-plan-for-gamba-grass-2020-2030.PDF.

Department of Environment, Parks and Water Security. 2021. Katherine regional weeds strategy 2021 – 2026. https://depws.nt.gov.au/__data/assets/pdf_file/0006/269286/Katherine-Regional-Weeds-Strategy-2021-2026.pdf.

Department of Environment, Parks and Water Security. 2021. Tennant Creek Regional Weeds Strategy 2021-2026. https://depws.nt.gov.au/__data/assets/pdf_file/0006/258099/tennant-creek-regional-weeds-strategy.pdf, accessed 18 January 2022.

Department of Environment, Parks and Water Security. 2021. Weed Management Act: Compliance Policy, December 2021. https://nt.gov.au/__data/assets/pdf_file/0011/668387/weeds-management-act-compliance-policy.pdf, accessed 30 August 2022.

Department of Land Resource Management and Charles Darwin University. 2018, Guidelines for the Management of the Weeds of Beetaloo 2018.

Department of Natural Resources and Environment. 2019. Weed Management Planning Guide - Onshore Petroleum Projects, June 2019. https://denr.nt.gov.au/__data/assets/pdf_file/0006/708558/weed-management-planning-guide-onshore-petroleum-projects.pdf.

Department of Primary Industry and Resources. 2016. Partheneum found in the NT. https://dpir.nt.gov.au/news/2016/december/parthenium-found-in-the-nt accessed 14 September 2018.

Northern Territory Government. 2000. Information Sheet Gamba Grass. http://www.drytropics.org.au/weeds_gamba_control.htm, accessed 29 March 2019.

Northern Territory Government. 2021. Northern Territory Weed Management Handbook. https://nt.gov.au/__data/assets/pdf_file/0004/233833/nt-weed-management-handbook.pdf.

Northern Territory of Australia. 2021. Northern Territory Weed ID Deck. https://depws.nt.gov.au/__data/assets/pdf_file/0012/257988/2021-weed-id-desk.pdf.

Northern Territory Government. 2018. A – Z List of Weeds in the Northern Territory. https://nt.gov.au/environment/weeds/weeds-in-the-nt/A-Z-list-of-weeds-in-the-NT, accessed 13 September 2018.

Scientific Inquiry into Hydraulic Fracturing in the Northern Territory. 2018. Scientific Inquiry into Hydraulic Fracturing in the Northern Territory – Final Report.

Weed Management Branch, Northern Territory Government. 2015. Northern Territory Weed Data Collection Manual - Section One Technical Data Description. https://nt.gov.au/__data/assets/pdf_file/0007/233854/nt-weed-data-collection-manual-section-1.pdf.

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APPENDIX A Weed Data Collection Methodology

Field data collection for weed infestations: The following is a guide to efficiently evaluating and recording a weed site in the field. Each record must identify the person or organisation taking the record, as well as the details explained below.

How to record weed area as a point record

1. Record the species

When a weed is sighted, move to the area and confirm identification of the weed. If you cannot positively identify the weed record it as "Unknown weed" and take a sample or photograph, do not try to guess. If more than one weed species is present, then repeat the process with separate records for each species.

2. Assess the size of the weed patch

Look across the area of weeds to the furthest weed plant and decide the diameter. Decide if the area is best fits in a circle of either 20, 50 or 100 m. If it is a single plant or small patch you would choose 20 m. The size 100 m extends about as far as you can see on the ground, if the weeds extend out of sight you will need to make another point further on. You may place overlapping circle areas to reflect different densities.

3. Assess the density of weeds within the circle

Decide how much of the area is covered by weeds. Assign a score from 2 to 5 based on the percentage table below. It will be useful (if possible) to move into the centre of the weed circle. Consider the whole circle size chosen in step 2 deciding on the density score. Area covered should be determined by a 'projected canopy' method.

Density categories

1 = Absent, no weeds of this species in this area.

2 = < 1%, Very few, not many weeds – e.g. single plant, perhaps with seedlings.

3 = 1 -10%, More than one or two isolated plants but not a lot – e.g. a few small plants.

4 = 11-50%, A lot, up to half the area covered – e.g. a tree, dense patches of weeds.

5 = > 50%, Dominant cover is weed, more than half covered – e.g. thickets, monocultures.

4. Record the location

Take the GPS location (ideally) from the centre of the circle. If weed seeds may be spread or it is difficult to access the centre, it is acceptable to take the reading from the location as close to the centre as practical.

5. Record the treatment

Record the method you apply a treatment to the weeds, or record 'No Treatment'. Choose from the list of treatment methods – e.g. no treatment, unknown, treated, foliar spray etc.

How to record weed area as a line (polyline) record

1. Record the species

When a weed is sighted, move to the area and confirm identification of the weed. If you cannot positively identify the weed record it as “Unknown weed” and take a sample or photograph, do not try to guess. If more than one weed species is present, then repeat the process with separate records for each species.

2. Assess the ‘best fit’ width in metres of the linear weed area

Look along the area of weeds to the furthest weed plant and decide a width that best sums up the width of the infestation from values of 5, 20, 50 or 100 m. If the width is too variable, you may need to make more than one line or consider recording as points or as a polygon.

3. Assess the density of weeds within the line

For the area of the line, being from start to finish at the designated width, decide the area covered by weeds. Assign a score from 2 to 5 based on the percentage table below. Consider the whole line area when deciding on the density score. Area covered should be determined by a ‘projected canopy’ method.

Density categories

1 = Absent, no weeds of this species in this area.

2 = < 1%, Very few, not many weeds – e.g. single plant, perhaps with seedlings.

3 = 1 -10%, More than one or two isolated plants but not a lot – e.g. a few small plants.

4 = 11-50%, A lot, up to half the area covered – e.g. a tree, dense patches of weeds.

5 = > 50%, Dominant cover is weed, more than half covered – e.g. thickets, monocultures.

4. Record the location

Start the GPS track, or line sketch from one end of the linear weed area. Walk or sketch a line as best fit through the middle of the linear weed area and finish at the end point.

5. Record the treatment

Record the method you apply a treatment to the weeds, or record ‘No Treatment’. Choose from the list of treatment methods – e.g. no treatment, unknown, treated, foliar spray etc.

How to record weed area as a polygon record

1. Record the species

When a weed is sighted, move to the area and confirm identification of the weed. If you cannot positively identify the weed record it as “Unknown weed” and take a sample or photograph, do not try to guess. If more than one weed species is present, then repeat the process with separate records for each species.

2. Assess the extent of the weed area an ensure it can be practically enclosed

Polygons are good for clearly delineated areas of weeds; you should be able to walk around the edge of the weed area with confidence. Ensure the defined area of weed at a similar density can be delineated before attempting to create the area, you may need more than one polygon. If the area is poorly defined, then the point method may be a more useful.

3. Assess the density of weeds within the polygon

Assess the area covered by weeds for density, you may need to move to several vantage points to get a clear picture. Assign a score from 2 to 5 based on the percentage table below. Consider the whole area within the polygon when deciding on the density score. Area covered should be determined by a ‘projected canopy’ method.

Density categories

1 = Absent, no weeds of this species in this area.

2 = < 1%, Very few, not many weeds – e.g. single plant, perhaps with seedlings.

3 = 1 -10%, More than one or two isolated plants but not a lot – e.g. a few small plants.

4 = 11-50%, A lot, up to half the area covered – e.g. a tree, dense patches of weeds.

5 = > 50%, Dominant cover is weed, more than half covered – e.g. thickets, monocultures.

4. Record the location

Start the GPS track, or polygon sketch from one point of the polygon weed area. It is useful to start from a landmark or flagging tape. Create the polygon edge line by walk a path or sketching along the outer edge of the weed area until you return to the start point. If using a GPS track to create the polygon, ensure that you cross your start point so as to close the polygon.

5. Record the treatment

Record the method you apply a treatment to the weeds in the area, or record ‘No Treatment’. Choose from the list of treatment methods– e.g. no treatment, unknown, treated, foliar spray etc.

Appendix B Example Weed Data Collection Sheet

tamboran
RESOURCES

Weed Management Plan

TB2-HSE-MP-11

RECORDER:					PROJECT:							LOCALITY:		
ORG_NAME:					GPS NAME/MODEL:							RECORDING METHOD:		
SITE_ID	DATE_REC	LAT_G94	LONG_G94	WEED_NAME	SIZE_DIA_M	DENS_CAT	SEEDLINGS	JUVENILES	ADULTS	SEED_PRES	PAST_TREAT	TREATMENT	HERBICIDE	COMMENTS

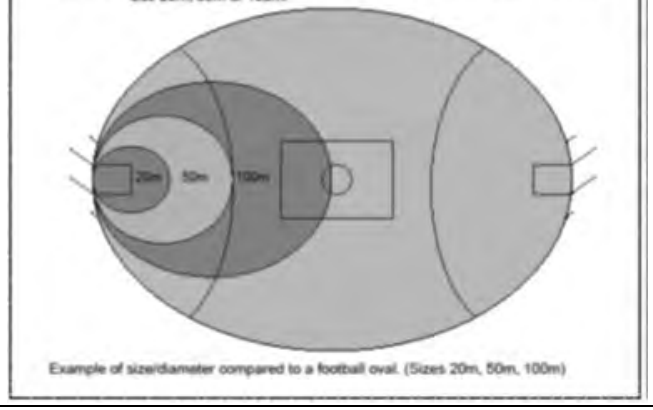
Notes:

Treatment method
Control method applied today as per below.
If none, record 'No treatment'

- Foliar spray
- Residual application
- Basal bark
- Cut stump
- Stem injection
- Aerial spray
- Slashed or cut
- Hand pull

Herbicide	The active ingredient(s) of the herbicide applied today (if any)
GPS waypt	Waypoint ID as entered in the GPS
Weed name	Common name or scientific name for the weed recorded
S (y/n)	Seedlings: Are seedlings visible?
J (y/n)	Juveniles: Are juvenile plants visible?
A (y/n)	Adults: Are there adult plants, or seeds, or evidence of past seeding present?
Seed (y/n)	Seeds: Are seeds visible today? Or plants with seeds or pods?
Treat (y/n)	Treatment: Did you apply treatment to this site?
Comment	Record any notes for yourself here.

Size dia m Size/diameter of the area you are recording information about (in metres). Use 20m, 50m or 100m.



Example of size/diameter compared to a football oval. (Sizes 20m, 50m, 100m)

Dens cat Density of weeds in the assessed area using categories described below

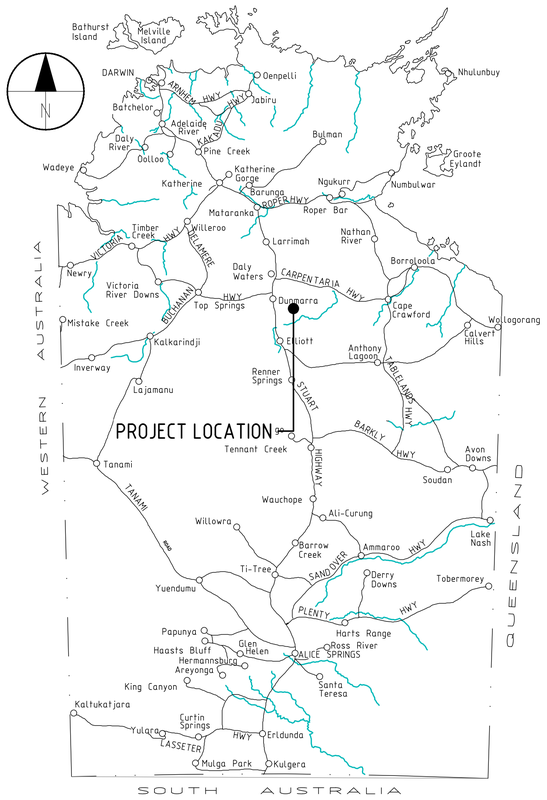
1 = No weeds (absent)	2 = Single plant or very few (<1%)	3 = A few plants (1-10%)
4 = Many weeds, up to half (11 – 50%)	5 = Mostly weeds, more than 50%	6 = Density not assessed

Density category (Dens cat) examples



(Source: Northern Territory Weed Data Collection Manual - Section One Technical Data Description)

APPENDIX D Engineering drawings, layouts and specifications



LOCALITY MAP

SCALE 0 100 150 200 250 300 Kilometers



LOCALITY PLAN

SCALE (km) 0 2 4 6 8 10 1:200,000 (A1)

DRAWING SCHEDULE

CIVIL	
DRAWING NUMBER	DESCRIPTION
60623736-KYALLA-N2-001	LOCALITY MAP, LOCALITY PLAN, DRAWING SCHEDULE, GENERAL NOTES
60623736-KYALLA-N2-002	DRILL PAD, ACCOMODATION CAMP AND WATER TANK GENERAL ARRANGEMENT PLAN
STANDARD DRAWINGS	
-	-

LEGEND

EXISTING

- PIPELINE
- FENCE
- PRINCIPAL ROAD
- UNSEALED TRACK
- WATERCOURSE

GENERAL NOTES

1. ALL DIMENSIONS ARE IN METRES UNLESS NOTED OTHERWISE.
2. ALL WORKS TO BE CARRIED OUT IN ACCORDANCE WITH THE APPROVED MANAGEMENT PLAN REQUIREMENTS.
3. NO CONSTRUCTION WORKS ARE TO BE CARRIED OUT OUTSIDE THE APPROVED WORK CORRIDOR BOUNDARIES.
4. CONSTRUCTION FACILITY AREA LOCATIONS TO BE APPROVED BY THE SUPERINTENDENT PRIOR TO WORKS COMMENCING.
5. THE CONTRACTOR IS TO LIAISE WITH SERVICE PROVIDERS AND THE RELEVANT AUTHORITIES TO ENSURE ALL CONSTRUCTION WORKS ARE CARRIED OUT IN ACCORDANCE WITH SERVICE PROVIDERS AND RELEVANT AUTHORITIES REQUIREMENTS.
6. NO SERVICES WERE PRESENT OR PROVIDED BY DBYD AT THE TIME OF DESIGN AND ARE THEREFORE NOT SHOWN, HOWEVER THE CONTRACTOR IS RESPONSIBLE FOR CONDUCTING A SEARCH PRIOR TO WORKS BEING CARRIED OUT. ANY DAMAGE TO EXISTING SERVICES IS TO BE RE-INSTATED AT THE CONTRACTORS EXPENSE.
7. SIGNAGE TO BE INSTALLED PRIOR TO ROAD USE.

DRAWING NO.	REFERENCE DRAWING TITLE	REV	DATE	REVISION DESCRIPTION
		0	24.10.23	INITIAL ISSUE

NOT TO BE USED FOR CONSTRUCTION

DRAWING IN PROGRESS | DATE: 27/10/2023

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DRAWING OFFICE: NEWCASTLE
PROJECT APPROVALS - OTHERS

tamboran RESOURCES

Tamboran Resources Ltd
ABN 28 135 299 062
100 Barangaroo Ave,
Barangaroo NSW,2000
Ph: (02) 9977 6522

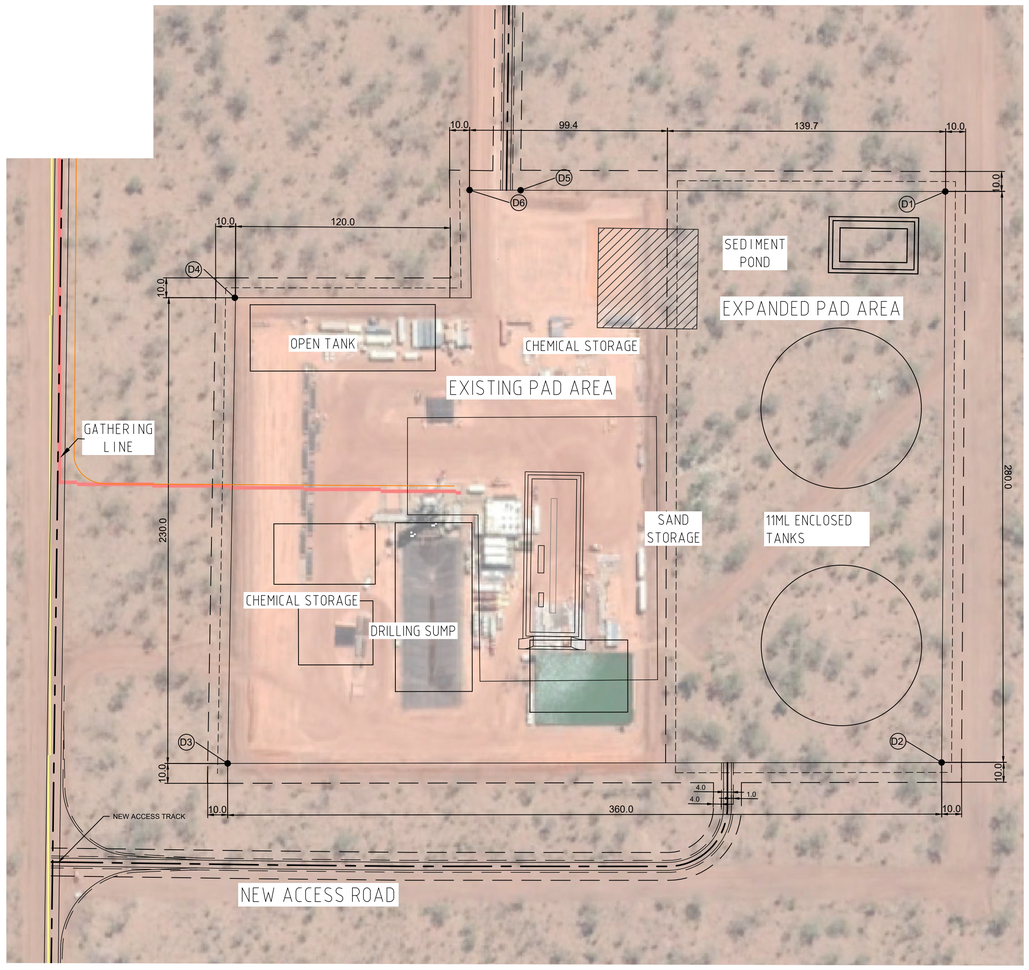
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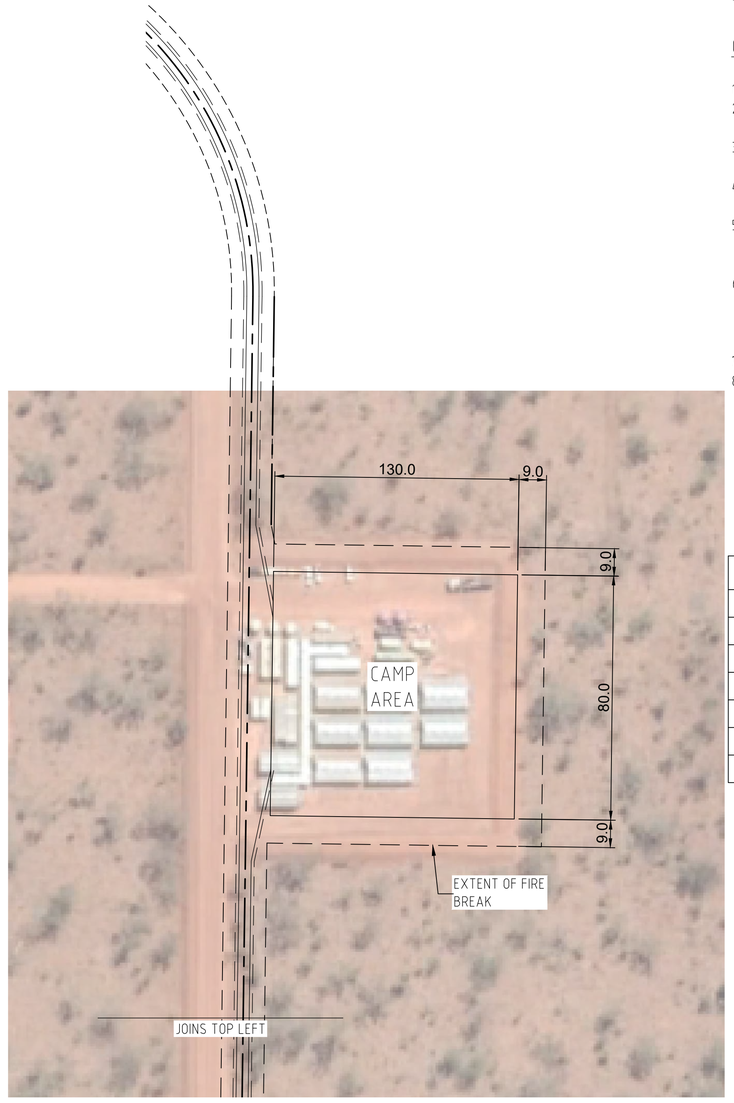
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ORIGIN DRAFT SUPER.	JJ	24.10.2023
ORIGIN PROJECT APPROVAL	JJ	24.10.2023

TITLE: SHENANDOAH SOUTH E&A PROGRAM
KYALLA N2
LOCALITY MAP, LOCALITY PLAN, DRAWING SCHEDULE, GENERAL NOTES

PROJECT NO.
MOD NO.
SCALE: AS NOTED
DRAWING NO.: 60623736-KYALLA-N2-001
REVISION: 0
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LEGEND

- ACCESS ROAD CENTRELINE
- EDGE OF PAVEMENT
- EDGE OF SHOULDER
- EXTENT OF CLEARING (EXTENT OF FIREBREAK)
- STORAGE BERM

GENERAL NOTES

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7. SIGNAGE TO BE INSTALLED PRIOR TO ROAD USE.
8. CONTAINMENT BUND HEIGHT APPROX 1.75m AROUND PERIMETER OF EXPANDED LEASE PAD AREA TO CONTAIN 110% OF ENCLOSED TANK VOLUME

SETOUT TABLE - LEASE PAD AREA

NO.	E	N
D1	356566.934	8137684.006
D2	356566.934	8137409.006
D3	356301.946	8137410.667
D4	356304.853	8137620.647
D5	356406.892	8137619.234
D6	356407.791	8137684.006

DRAWING NO.	REFERENCE DRAWING TITLE	REV	DATE	REVISION DESCRIPTION

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DRAWING OFFICE NEWCASTLE
PROJECT APPROVALS - OTHERS

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Ph: (02) 9977 6522

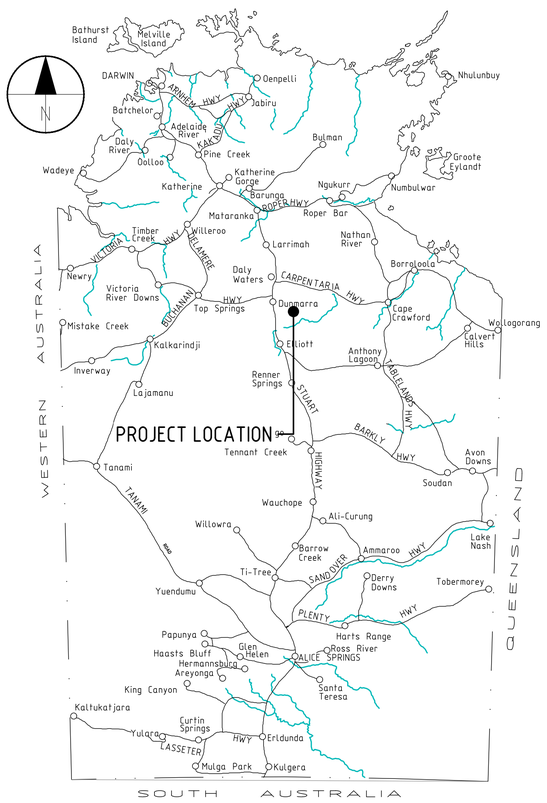
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DWG CHECK	JJ	25.10.23
DESIGN	NM	25.10.23
ENG DES CHECK	JJ	25.10.23
DRAFT. SUPER.	JJ	25.10.23
PROJECT APPROVAL	JJ	25.10.23

TITLE
SHENANDOAH SOUTH E & A PROGRAM
KYALLA 117 N2
DRILLING PADS
DESIGN DETAIL

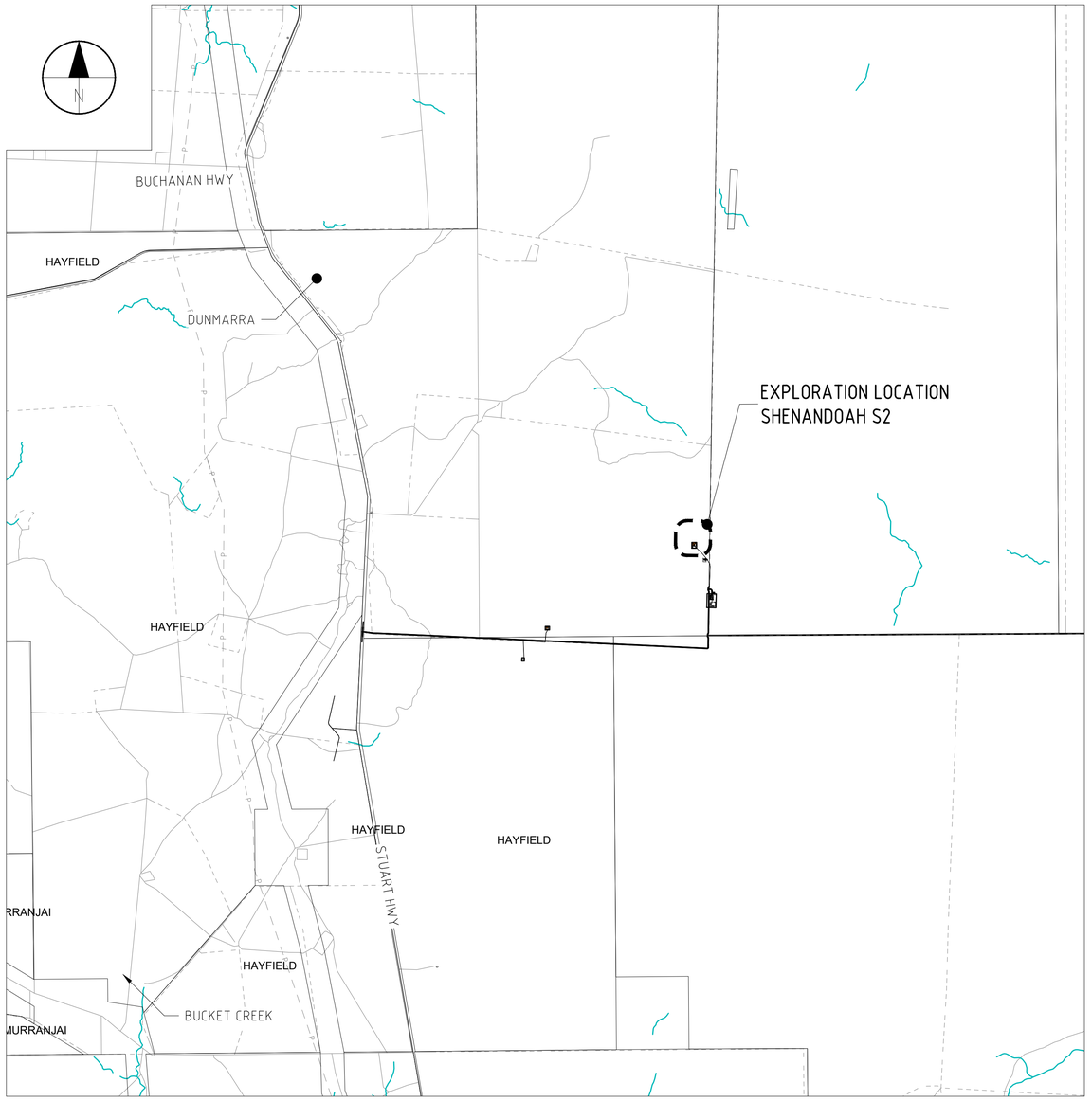
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LOCALITY MAP

SCALE 0 100 150 200 250 300 Kilometers



LOCALITY PLAN

SCALE (km) 0 2 4 6 8 10 1:200,000 (A1)

DRAWING SCHEDULE

CIVIL	
DRAWING NUMBER	DESCRIPTION
60623736-SHENANDOAH-S2-001	LOCALITY MAP, LOCALITY PLAN, DRAWING SCHEDULE, GENERAL NOTES
60623736-SHENANDOAH-S2-002	DRILL PAD, ACCOMODATION CAMP AND WATER TANK GENERAL ARRANGEMENT PLAN
STANDARD DRAWINGS	
-	

LEGEND

EXISTING

- PIPELINE
- FENCE
- PRINCIPAL ROAD
- UNSEALED TRACK
- WATERCOURSE

GENERAL NOTES

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DRAWING NO.	REFERENCE DRAWING TITLE	REV	DATE	REVISION DESCRIPTION
		0	24.10.23	INITIAL ISSUE

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DRAWING OFFICE: NEWCASTLE
PROJECT APPROVALS - OTHERS

tamboran RESOURCES

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ABN 28 135 299 062
100 Barangaroo Ave,
Barangaroo NSW,2000
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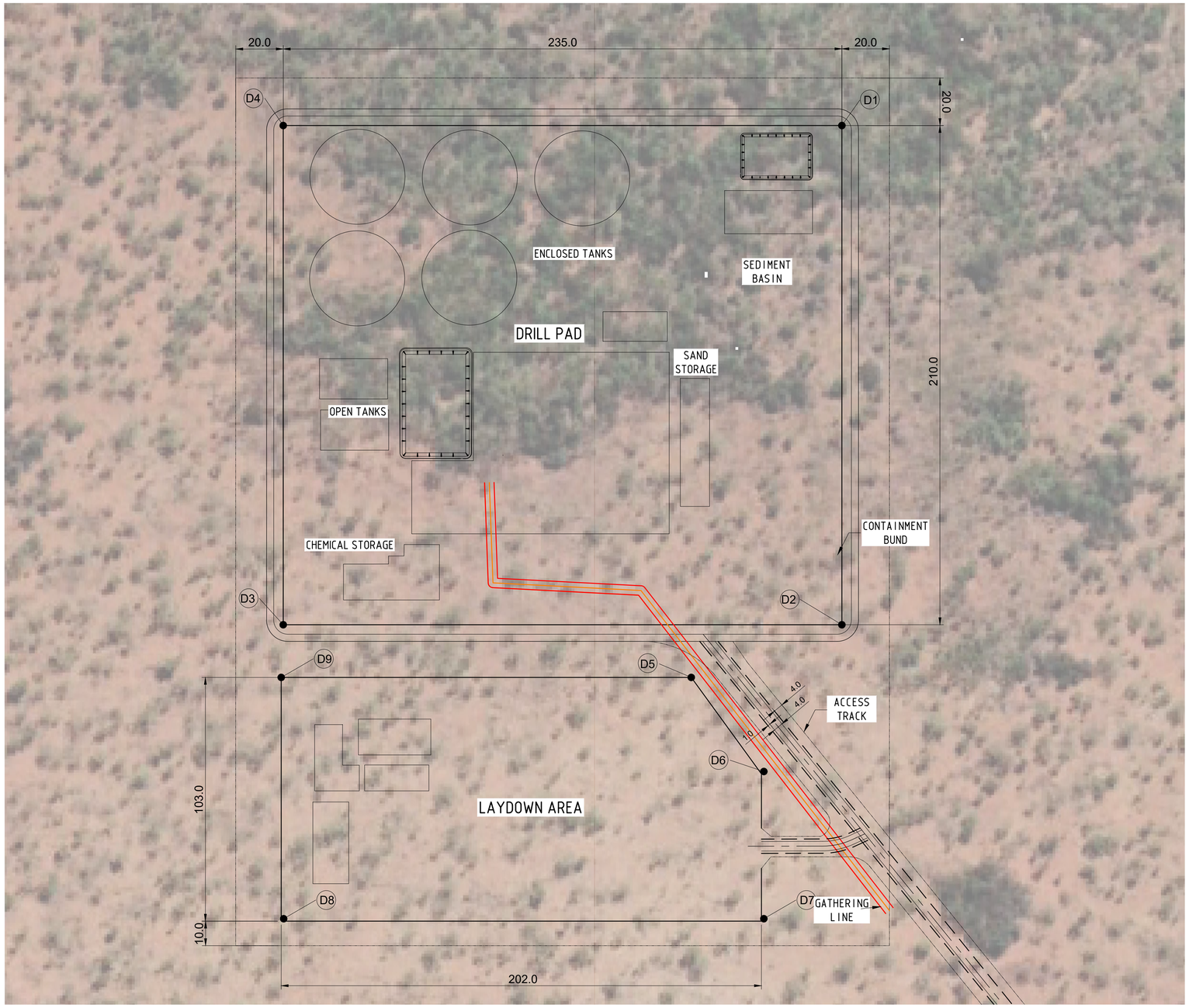
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DWG CHECK	JJ	24.10.2023
DESIGN	NM	24.10.2023
ENG DES CHECK	JJ	24.10.2023
ORIGIN DRAFT SUPER.	JJ	24.10.2023
ORIGIN PROJECT APPROVAL	JJ	24.10.2023

TITLE: SHENANDOAH SOUTH E&A PROGRAM
SHENANDOAH S2
LOCALITY MAP, LOCALITY PLAN, DRAWING SCHEDULE, GENERAL NOTES

PROJECT NO.
MOD NO.
SCALE: AS NOTED
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LEGEND

- ACCESS ROAD CENTRELINE
- EDGE OF PAVEMENT
- EDGE OF SHOULDER
- EXTENT OF CLEARING (EXTENT OF FIREBREAK)

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7. SIGNAGE TO BE INSTALLED PRIOR TO ROAD USE.
8. CONTAINMENT BUND HEIGHT APPROX 1.0m AROUND PERIMETER OF EXPANDED DRILL PAD AREA TO CONTAIN 110% OF ENCLOSED TANK VOLUME

SETOUT TABLE - LEASE PAD AREA		
NO.	E	N
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D2	994962.615	8136140.884
D3	994727.615	8136118.733
D4	994727.615	8136350.884
D5	994899.262	8136118.733
D6	994928.767	8136078.122
D7	994928.767	8136016.204
D8	994726.767	8136016.204
D9	994726.767	8136118.733

DRAWING NO.	REFERENCE DRAWING TITLE	REV	DATE	REVISION DESCRIPTION

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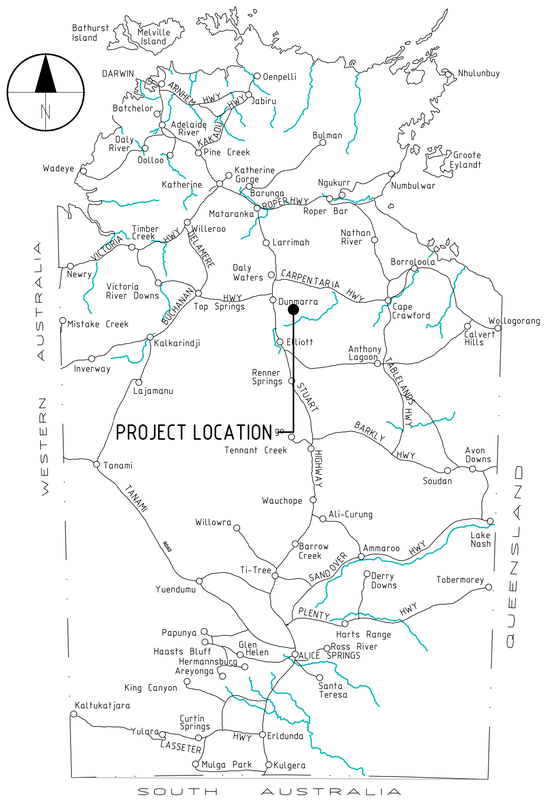
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DESIGN	NM	25.10.23
ENG DES CHECK	JJ	25.10.23
DRAFT SUPER.	JJ	25.10.23
PROJECT APPROVAL	JJ	25.10.23

TITLE
SHENANDOAH E&A PROGRAM
SHENANDOAH SOUTH 2
LEASE PAD LAYOUT
DESIGN DETAIL - CONCEPTUAL

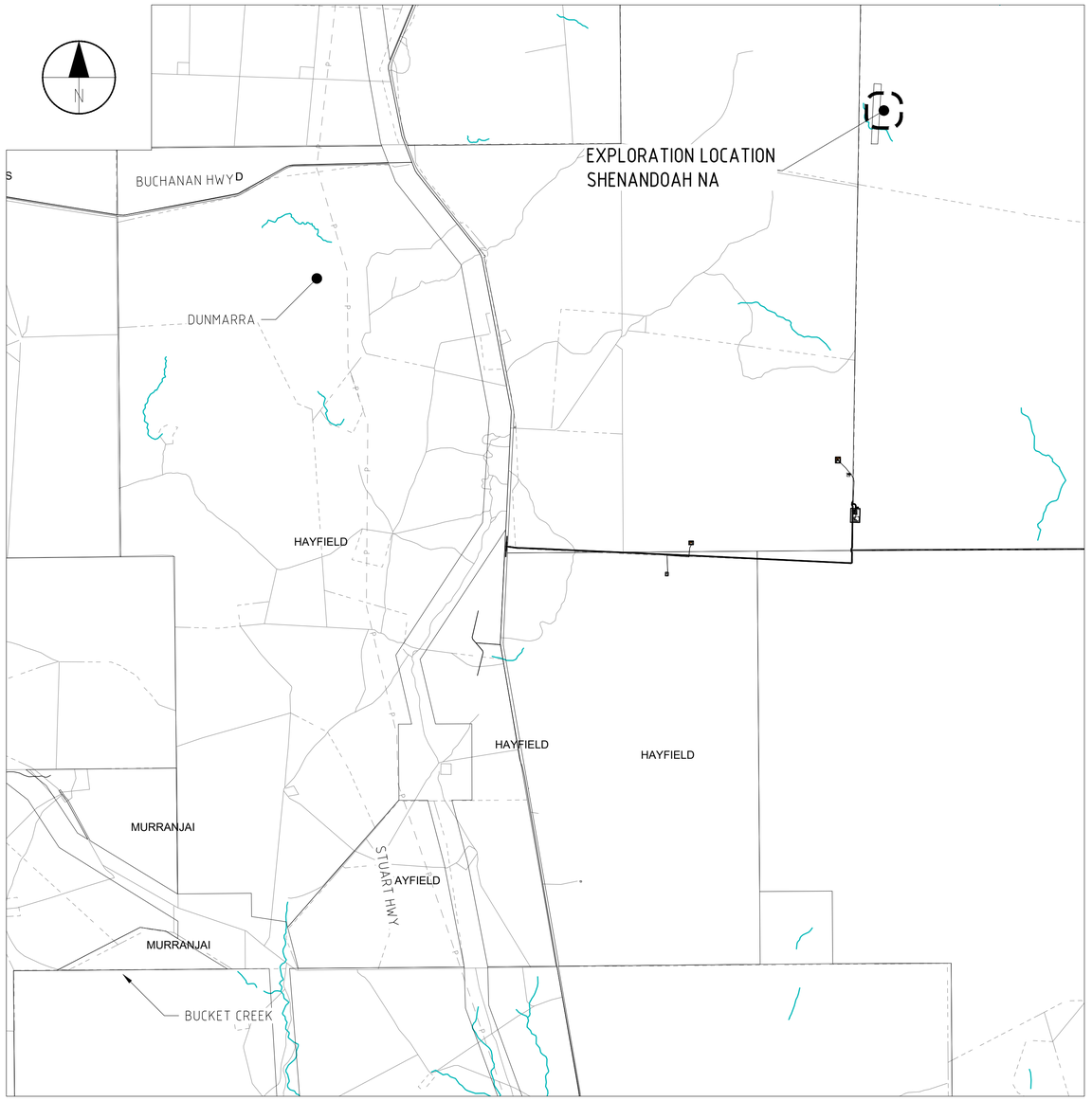
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LOCALITY MAP

SCALE 0 100 150 200 250 300 Kilometers



LOCALITY PLAN

SCALE (km) 0 2 4 6 8 10 1:200,000 (A1)

DRAWING SCHEDULE

CIVIL	
DRAWING NUMBER	DESCRIPTION
60623736-SHENANDOAH-NA-001	LOCALITY MAP, LOCALITY PLAN, DRAWING SCHEDULE, GENERAL NOTES
60623736-SHENANDOAH-NA-002	DRILL PAD, ACCOMODATION CAMP AND WATER TANK GENERAL ARRANGEMENT PLAN
STANDARD DRAWINGS	
- -	

LEGEND

EXISTING

- PIPELINE
- FENCE
- PRINCIPAL ROAD
- UNSEALED TRACK
- WATERCOURSE

GENERAL NOTES

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2. ALL WORKS TO BE CARRIED OUT IN ACCORDANCE WITH THE APPROVED MANAGEMENT PLAN REQUIREMENTS.
3. NO CONSTRUCTION WORKS ARE TO BE CARRIED OUT OUTSIDE THE APPROVED WORK CORRIDOR BOUNDARIES.
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7. SIGNAGE TO BE INSTALLED PRIOR TO ROAD USE.

DRAWING NO.	REFERENCE DRAWING TITLE	REV	DATE	REVISION DESCRIPTION
		0	24.10.23	INITIAL ISSUE

NOT TO BE USED FOR CONSTRUCTION

DRAWING IN PROGRESS | DATE: 27/10/2023

PREPARED FOR ORIGIN BY:

AECOM Australia Pty Ltd
A.B.N 20 093 846 925
www.aecom.com

PROJECT 60623736 SHENANDOAH E & A PROGRAM | DRAWING OFFICE NEWCASTLE

PROJECT APPROVALS - OTHERS

tamboran RESOURCES

Tamboran Resources Ltd
ABN 28 135 299 062
100 Barangaroo Ave,
Barangaroo NSW,2000
Ph: (02) 9977 6522

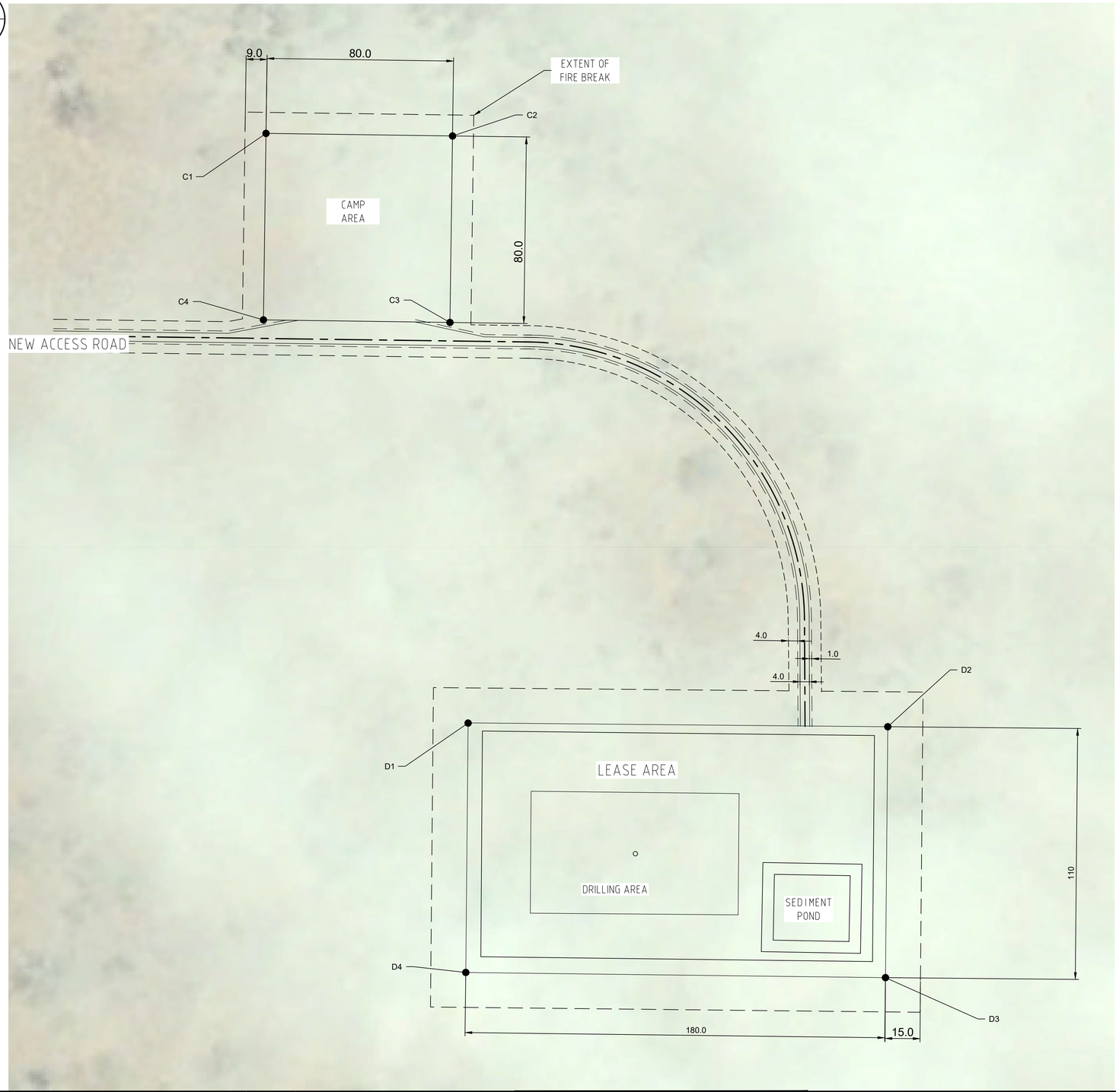
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	DWG CHECK	JJ	24.10.2023
	DESIGN	NM	24.10.2023
	ENG DES CHECK	JJ	24.10.2023
	DRAFT. SUPER.	JJ	24.10.2023
	PROJECT APPROVAL	JJ	24.10.2023

TITLE: SHENANDOAH SOUTH E&A PROGRAM
SHENANDOAH NORTH A
LOCALITY MAP, LOCALITY PLAN, DRAWING SCHEDULE, GENERAL NOTES

PROJECT NO.	DRAWING NO.	REVISION
MOD NO.	60623736-SHENANDOAH-NA-001	0
SCALE: AS NOTED	CADFILE: 60623736 Shenandoah NA-001.dwg	A1

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Ref \A1_OE_LBT.DWG



LEGEND

- ACCESS ROAD CENTRELINE
- EDGE OF PAVEMENT
- EDGE OF SHOULDER
- EXTENT OF CLEARING (EXTENT OF FIREBREAK)
- STORAGE BERM

GENERAL NOTES

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8. CONTAINMENT BUND HEIGHT APPROX 1.75m AROUND PERIMETER OF EXPANDED LEASE PAD AREA TO CONTAIN 110% OF ENCLOSED TANK VOLUME

SETOUT TABLE - LEASE PAD AREA		
NO.	E	N
D1	358269.473	8165236.375
D2	358449.466	8165234.804
D3	358448.476	8165127.175
D4	358268.489	8165129.402

SETOUT TABLE - CAMP AREA		
NO.	E	N
C1	358182.805	8165489.317
C2	358262.798	8165488.209
C3	358261.690	8165408.217
C4	358181.698	8165409.324

DRAWING NO.	REFERENCE DRAWING TITLE	REV	DATE	REVISION DESCRIPTION

NOT TO BE USED FOR CONSTRUCTION

DRAWING IN PROGRESS | DATE: 27/10/2023

PREPARED FOR ORIGIN BY:

AECOM Australia Pty Ltd
A.B.N 20 093 846 925
www.aecom.com

PROJECT: 60623736 SHENANDOAH E & A PROGRAM
DRAWING OFFICE: NEWCASTLE
PROJECT APPROVALS - OTHERS

tamboran RESOURCES

Tamboran Resources Ltd
ABN 28 135 299 062
100 Barangaroo Ave,
Barangaroo NSW,2000
Ph: (02) 9977 6522

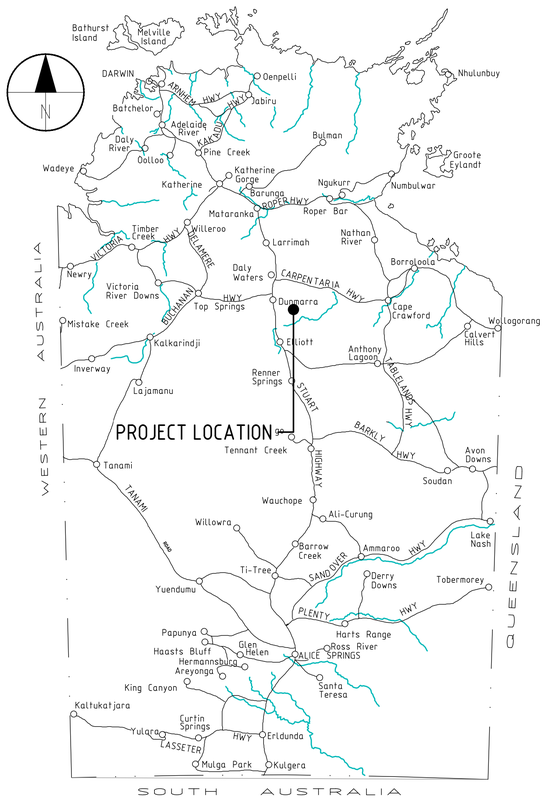
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DWG CHECK	JJ	25.10.23
DESIGN	NM	25.10.23
ENG DES CHECK	JJ	25.10.23
DRAFT. SUPER.	JJ	25.10.23
PROJECT APPROVAL	JJ	25.10.23

TITLE
SHENANDOAH SOUTH E & A PROGRAM
SHENANDOAH NORTH A
DRILLING PADS
DESIGN DETAIL

PROJECT NO.
MOD NO.
DRAWING NO. 60623736-SHENANDOAH-NA-002
REVISION 0
SCALE 1:250 @ A1
CADFILE 60623736_Shenandoah NA-002.dwg
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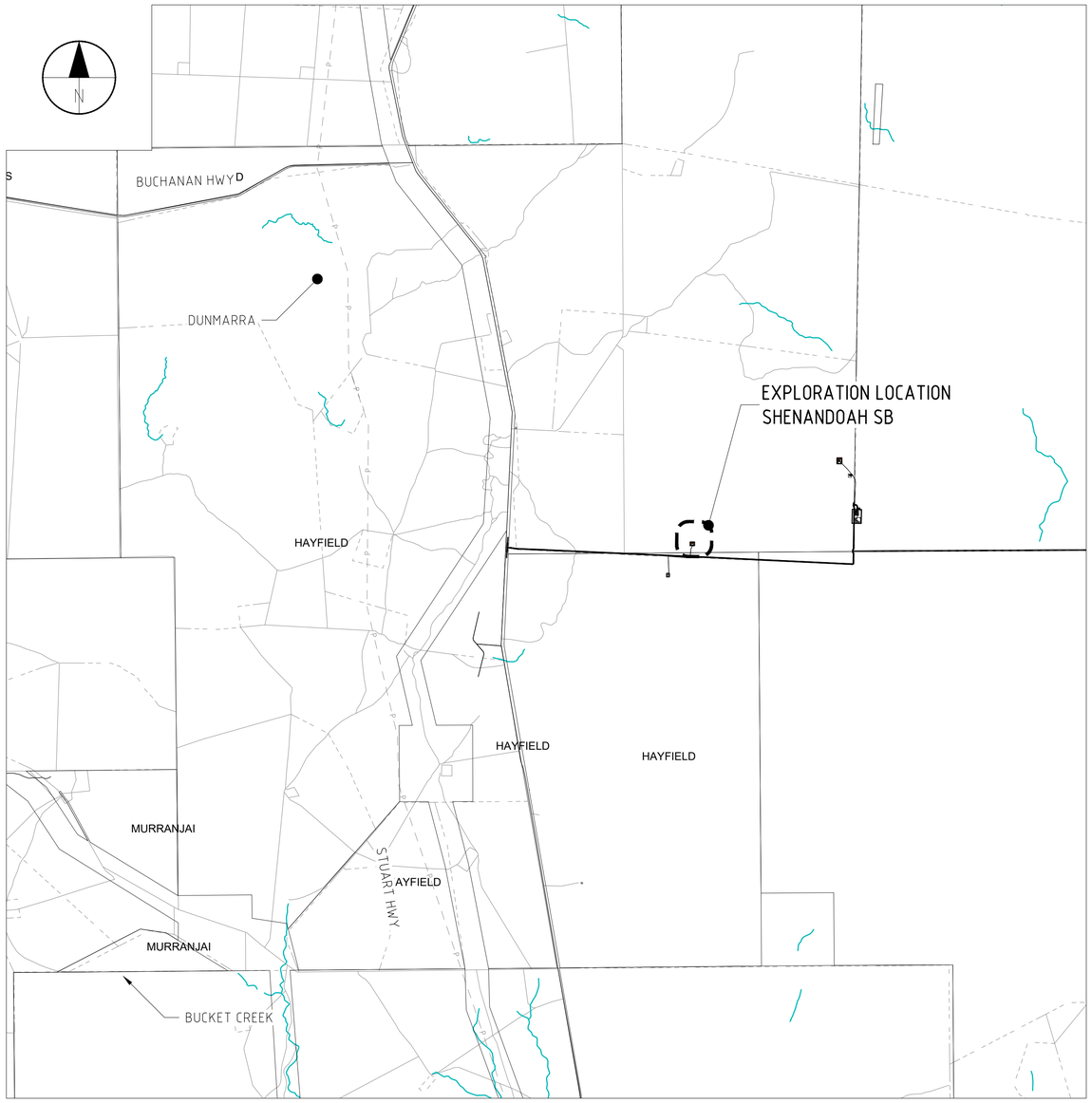
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LOCALITY MAP

0 100 150 200 250 300

SCALE Kilometers



LOCALITY PLAN

0 2 4 6 8 10

SCALE (km) 1:200,000 (A1)

DRAWING SCHEDULE

CIVIL	
DRAWING NUMBER	DESCRIPTION
60623736-SHENANDOAH-SB-001	LOCALITY MAP, LOCALITY PLAN, DRAWING SCHEDULE, GENERAL NOTES
60623736-SHENANDOAH-SB-002	DRILL PAD, ACCOMODATION CAMP AND WATER TANK GENERAL ARRANGEMENT PLAN
STANDARD DRAWINGS	
-	-

LEGEND

EXISTING

- PIPELINE
- FENCE
- PRINCIPAL ROAD
- UNSEALED TRACK
- WATERCOURSE

GENERAL NOTES

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DRAWING NO.	REFERENCE DRAWING TITLE	REV	DATE	REVISION DESCRIPTION
		0	24.10.23	INITIAL ISSUE

NOT TO BE USED FOR CONSTRUCTION

DRAWING IN PROGRESS | DATE: 27/10/2023

PREPARED FOR ORIGIN BY:

AECOM Australia Pty Ltd
A.B.N 20 093 846 925
www.aecom.com

PROJECT 60623736 SHENANDOAH E & A PROGRAM | DRAWING OFFICE NEWCASTLE

PROJECT APPROVALS - OTHERS

tamboran RESOURCES

Tamboran Resources Ltd
ABN 28 135 299 062
100 Barangaroo Ave,
Barangaroo NSW,2000
Ph: (02) 9977 6522

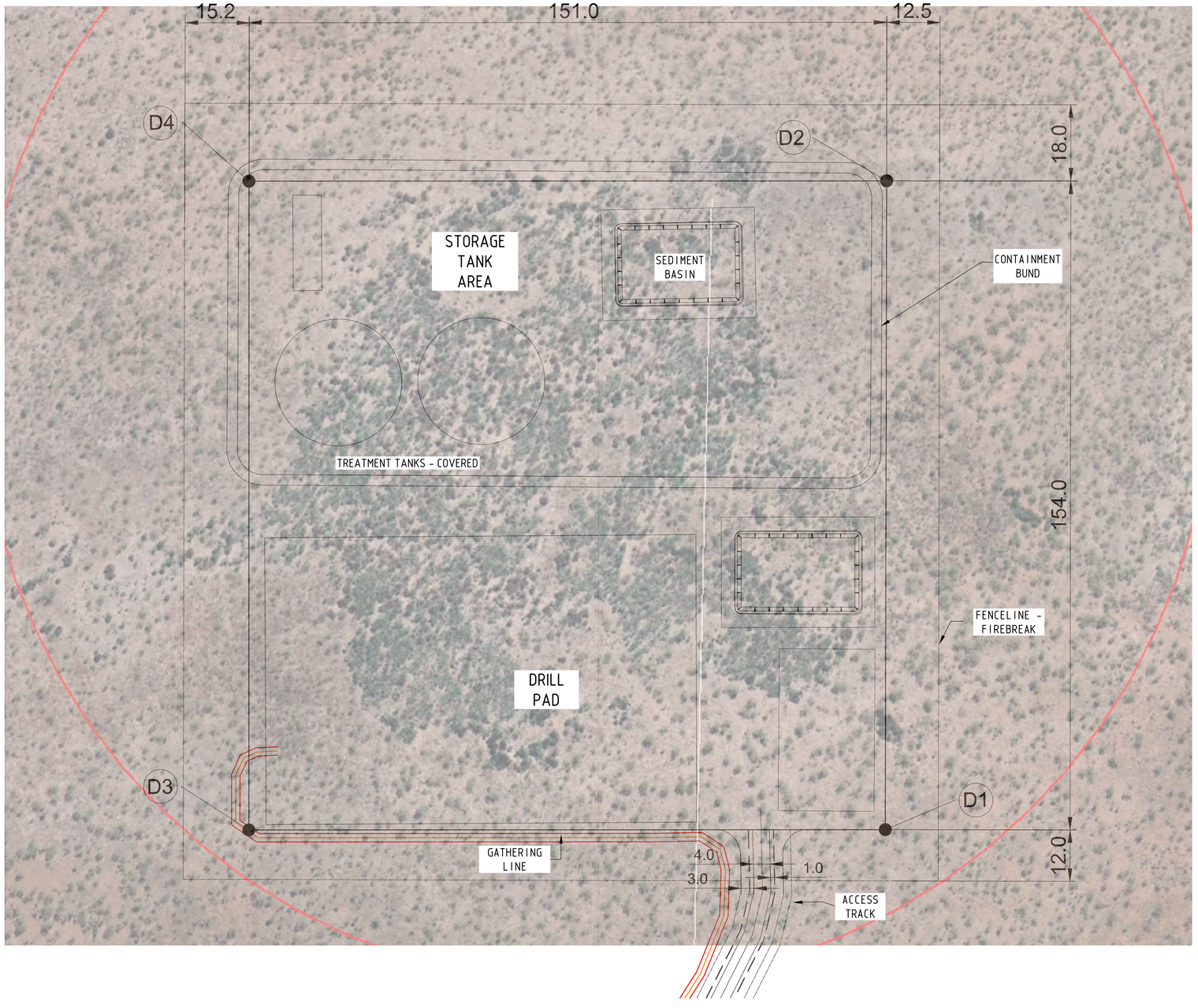
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ORIGIN		BY	DATE
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	DWG CHECK	JJ	24.10.2023
	DESIGN	NM	24.10.2023
	ENG DES CHECK	JJ	24.10.2023
	DRAFT. SUPER.	JJ	24.10.2023
	PROJECT APPROVAL	JJ	24.10.2023

TITLE: SHENANDOAH SOUTH E&A PROGRAM
SHENANDOAH SOUTH B
LOCALITY MAP, LOCALITY PLAN, DRAWING SCHEDULE, GENERAL NOTES

PROJECT NO.	DRAWING NO.	REVISION
	60623736-SHENANDOAH-SB-1-001	0
MOD NO.		
SCALE: AS NOTED	CADFILE: 60623736 Shenandoah SB-1-001.dwg	A1

Plot: 27 Oct 2023 - 2:30pm \\NA.AECOMNET.COM\LFS\APAC\DARWIN-AUD\WIP\LEGACY\PROJECTS\606X\60667354_SWEETPEA_DRILLING_STIM\900_CAD_GIS\910_CAD\10-REFERENCES_SHENANDOAH SB\60623736 SHENANDOAH SB-1-001.DWG McKenna, Nathan
Ref \A1_UE_LBT.DWG



LEGEND

- ACCESS ROAD CENTRELINE
- EDGE OF PAVEMENT
- EDGE OF SHOULDER
- EXTENT OF CLEARING (EXTENT OF FIREBREAK)

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8. CONTAINMENT BUND HEIGHT APPROX 1.75m AROUND PERIMETER OF EXPANDED DRILL PAD AREA TO CONTAIN 110% OF ENCLOSED TANK VOLUME

SETOUT TABLE - LEASE PAD AREA		
NO.	E	N
D1	984714.096	8130400.092
D2	984716.944	8130553.563
D3	984563.49	8130402.492
D4	984566.1	8130555.994

DRAWING NO.	REFERENCE DRAWING TITLE	REV	DATE	REVISION DESCRIPTION

NOT TO BE USED FOR CONSTRUCTION

DRAWING IN PROGRESS | DATE: 27/10/2023

PREPARED FOR ORIGIN BY:

AECOM Australia Pty Ltd
A.B.N 20 093 846 925
www.aecom.com

PROJECT 60623736 SHENDOAH E & A PROGRAM | DRAWING OFFICE NEWCASTLE

PROJECT APPROVALS - OTHERS

tamboran RESOURCES

Tamboran Resources Ltd
ABN 28 135 299 062
100 Barangaroo Ave,
Barangaroo NSW,2000
Ph: (02) 9977 6522

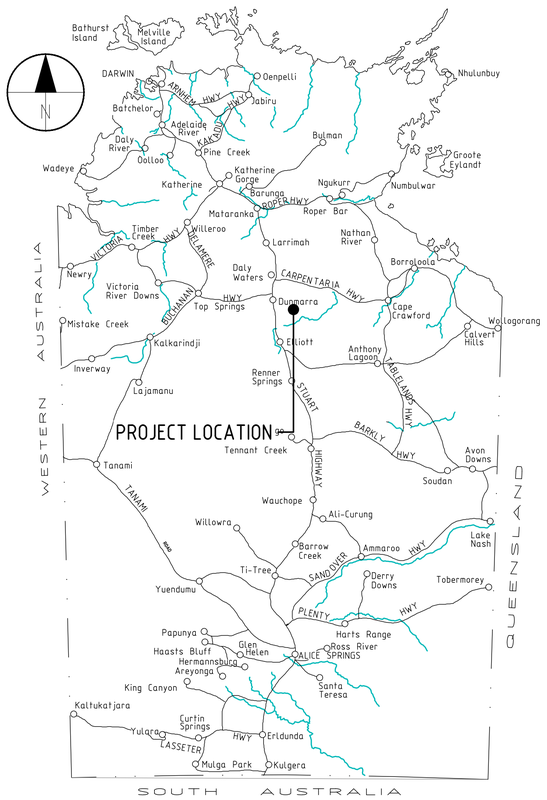
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	DESIGN	NM	25.10.23
	ENG DES CHECK	JJ	25.10.23
	DRAFT. SUPER.	JJ	25.10.23
	PROJECT APPROVAL	JJ	25.10.23

TITLE
SHENANDOAH SOUTH E&A PROGRAM
SHENANDOAH SOUTH B
DRILLING PADS
LEASE PAD LAYOUT

PROJECT NO.
MOD NO.
SCALE 1:250 @ A1
DRAWING NO. 60623736-SHENANDOAH SB-002
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REVISION 0
A1

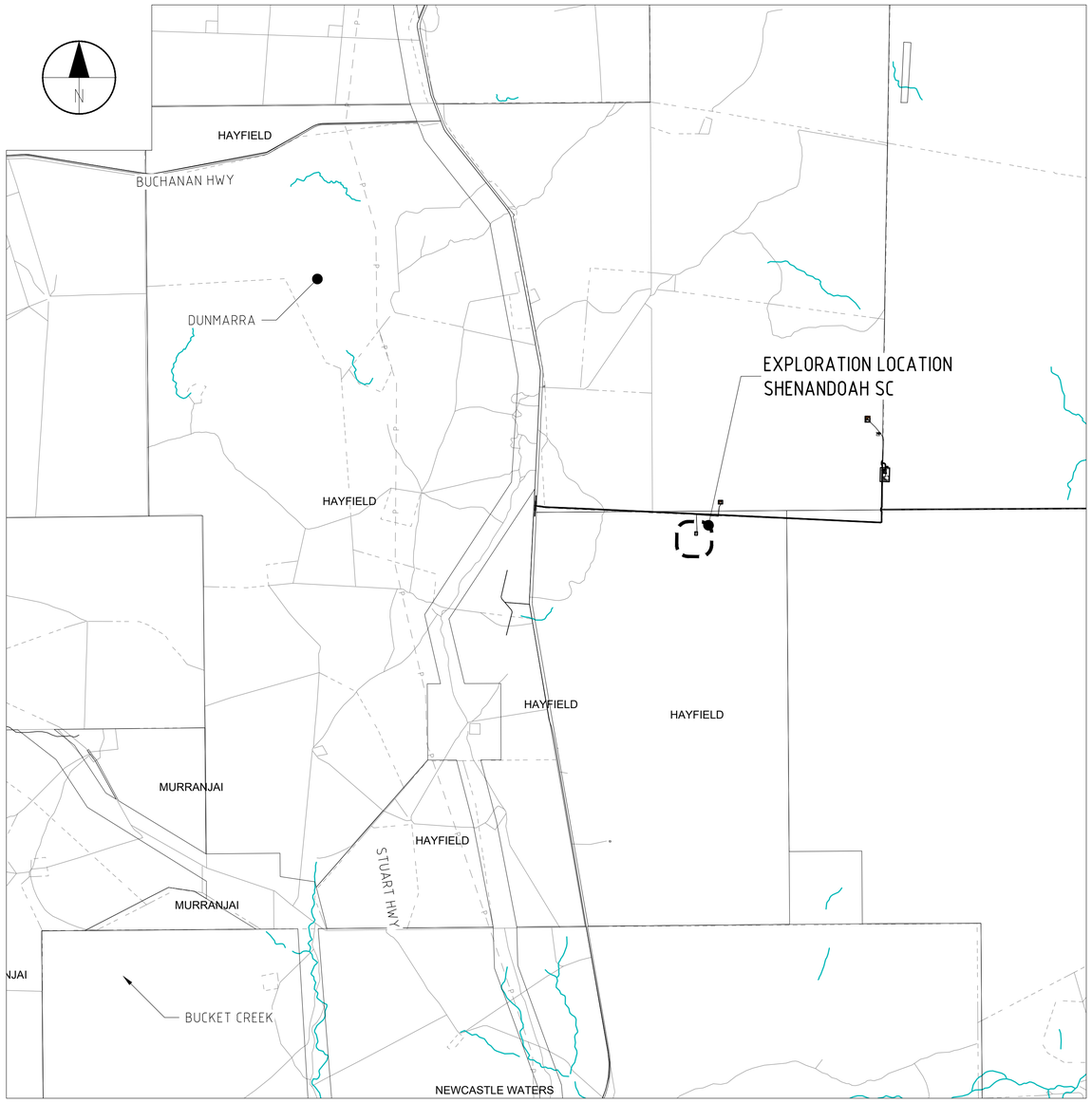
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LOCALITY MAP

0 100 150 200 250 300

SCALE Kilometers



LOCALITY PLAN

0 2 4 6 8 10

SCALE (km) 1:200,000 (A1)

DRAWING SCHEDULE

CIVIL	
DRAWING NUMBER	DESCRIPTION
NT-2050-20-DH-0001	LOCALITY MAP, LOCALITY PLAN, DRAWING SCHEDULE, GENERAL NOTES
NT-2050-20-DH-0002	DRILL PAD, ACCOMODATION CAMP AND WATER TANK GENERAL ARRANGEMENT PLAN
STANDARD DRAWINGS	
-	-

LEGEND

EXISTING

- PIPELINE
- FENCE
- PRINCIPAL ROAD
- UNSEALED TRACK
- WATERCOURSE

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		0	24.10.23	INITIAL ISSUE

NOT TO BE USED FOR CONSTRUCTION

DRAWING IN PROGRESS | DATE: 27/10/2023

PREPARED FOR ORIGIN BY:

AECOM

AECOM Australia Pty Ltd
A.B.N 20 093 846 925
www.aecom.com

PROJECT: 60623736 SHENANDOAH E & A PROGRAM
DRAWING OFFICE: NEWCASTLE
PROJECT APPROVALS - OTHERS

tamboran RESOURCES

Tamboran Resources Ltd
ABN 28 135 299 062
100 Barangaroo Ave,
Barangaroo NSW,2000
Ph: (02) 9977 6522

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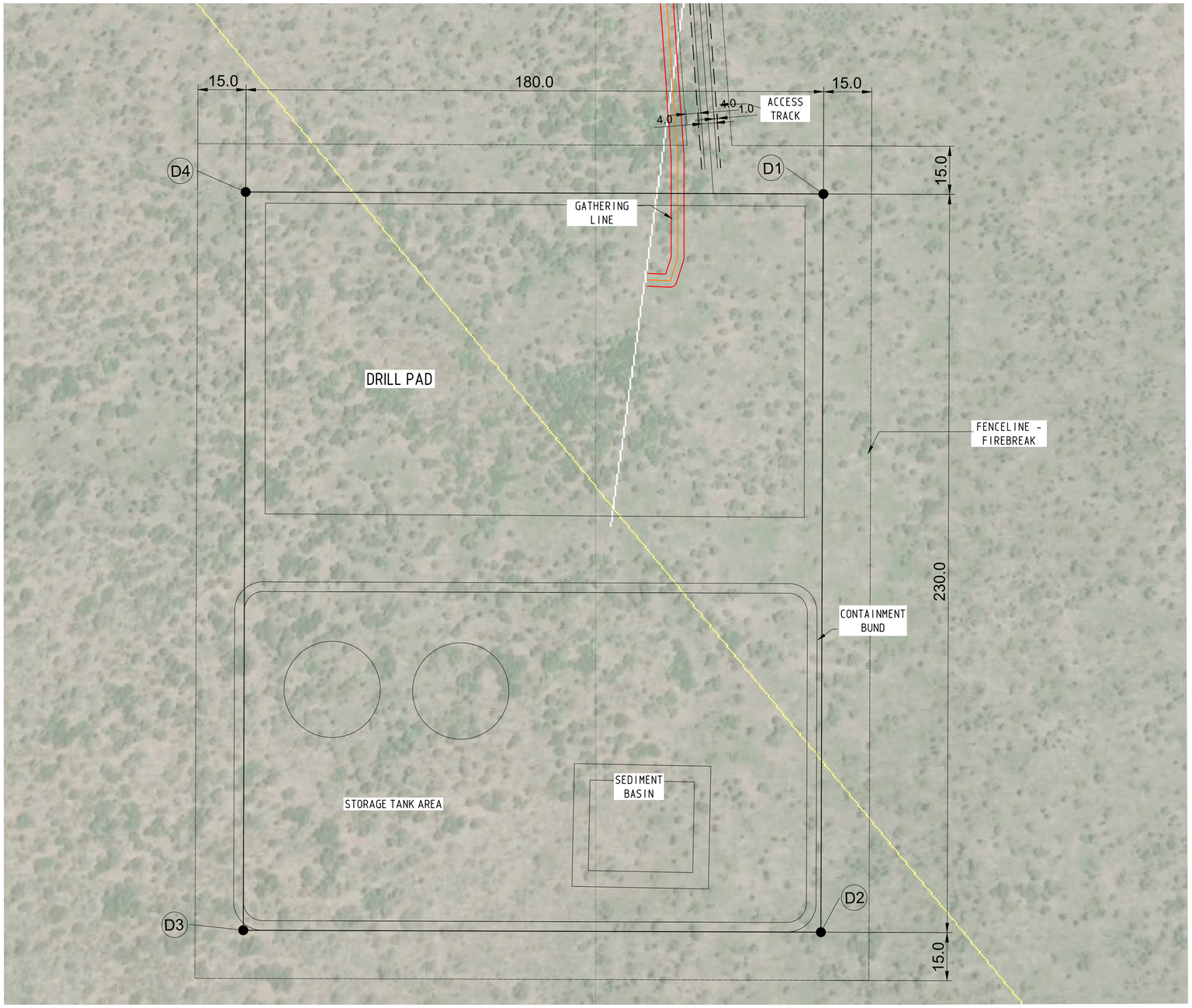
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	ENG DES CHECK	JJ	24.10.2023
	DRAFT. SUPER.	JJ	24.10.2023
	PROJECT APPROVAL	JJ	24.10.2023

TITLE: SHENANDOAH SOUTH E&A PROGRAM
SHENANDOAH SOUTH C
LOCALITY MAP, LOCALITY PLAN, DRAWING SCHEDULE, GENERAL NOTES

PROJECT NO.
DRAWING NO. 60623736-SHENANDOAH-SC-1-001
REVISION 0
MOD NO.
SCALE AS NOTED
CADFILE 60623736 Shenandoah SC-1-001.dwg
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Xref \A1_OF_LR1DWG



LEGEND

- ACCESS ROAD CENTRELINE
- EDGE OF PAVEMENT
- EDGE OF SHOULDER
- EXTENT OF CLEARING (EXTENT OF FIREBREAK)

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SETOUT TABLE - LEASE PAD AREA		
NO.	E	N
D1	982880.533	8128432.973
D2	983060.42	8128203.117
D3	982880.533	8128209.483
D4	982888.667	8128439.339

DRAWING NO.	REFERENCE DRAWING TITLE	REV	DATE	REVISION DESCRIPTION

NOT TO BE USED FOR CONSTRUCTION

DRAWING IN PROGRESS | DATE: 27/10/2023

PREPARED FOR ORIGIN BY:

AECOM Australia Pty Ltd
A.B.N 20 093 846 925
www.aecom.com

PROJECT: 60623736 SHENANDOAH E & A PROGRAM
DRAWING OFFICE: NEWASTLE
PROJECT APPROVALS - OTHERS

tamboran

Tamboran Resources Ltd
ABN 28 135 299 062
100 Barangaroo Ave,
Barangaroo NSW,2000
Ph: (02) 9977 6522

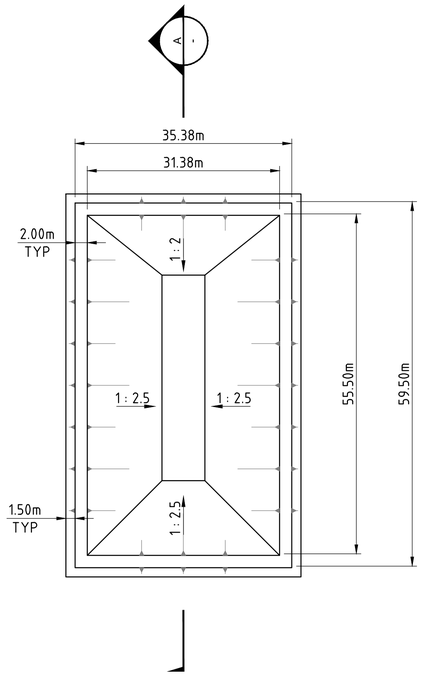
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	PROJECT APPROVAL	JJ	25.10.23

TITLE: SHENANDOAH SOUTH E&A PROGRAM
SHENANDOAH SOUTH C
LEASE PAD
DESIGN DETAIL - CONCEPTUAL

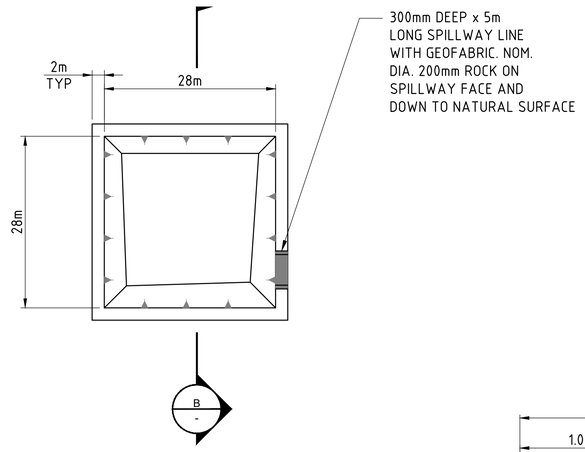
PROJECT NO.
MOD NO.
SCALE: 1:250 @ A1
DRAWING NO.: 60623736-SHENANDOAH SC-002
REVISION: 0
CADFILE: 60623736 Shenandoah-SC-002.dwg
A1

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PLAN - MUD SUMP

Scale N.T.S.



PLAN - SECONDARY CONTAINMENT

Scale N.T.S.

NOTES:

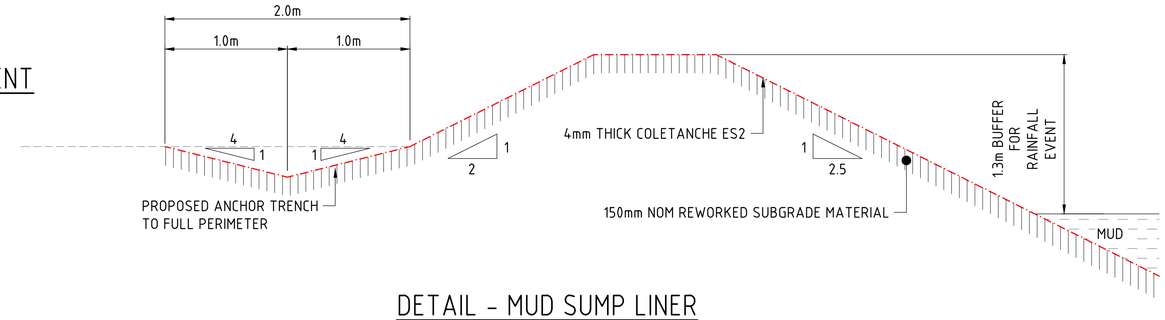
1. ALL UNITS ARE IN METRES (m) UNLESS NOTED OTHERWISE.
2. GROUND CONDITIONS AND SUITABLE MATERIALS TO BE CONFIRMED ON SITE BY SUPERINTENDENT.
3. REFER TO SPECIFICATION FOR COMPACTION REQUIREMENTS.
4. REFER TO SPECIFICATION FOR GENERAL REQUIREMENTS.
5. THE CONTRACTOR IS TO NOTIFY THE ORIGIN SUPERVISOR IF AREAS OF SOFT GROUND ARE ENCOUNTERED OR IF THE SPECIFICATION CANNOT BE ACHIEVED.
6. REFER TO DRAWING NT-2050-20-DA-0022 FOR SETOUT DETAILS OF MUD SUMP.
7. FAUNA LADDERS TO BE INSTALLED TO MUD SUMP.
8. CONTRACTOR TO PROVIDE CATTLE PANELS FOR FENCING AROUND SUMP WHERE DEPTH IS GREATER THAN 1.5m.
9. CATTLE PANEL FENCING TO BE INSTALLED AROUND MUD SUMP AND SEDIMENT BASIN INCLUDING CRITTER FENCING.
10. MUD SUMP VEHICLE OFFLOAD AREA TO BE COMPACTED TO 200 KPa

CERTIFICATION

DISCIPLINE	CERTIFIER	RPEQ No.
CIVIL	J.JENTZ	5583

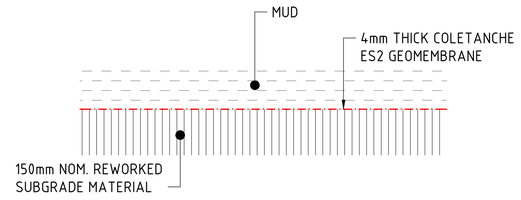
NOTES:

1. GEOSYNTHETICS ARE DRAWN EXAGGERATED FOR CLARITY.



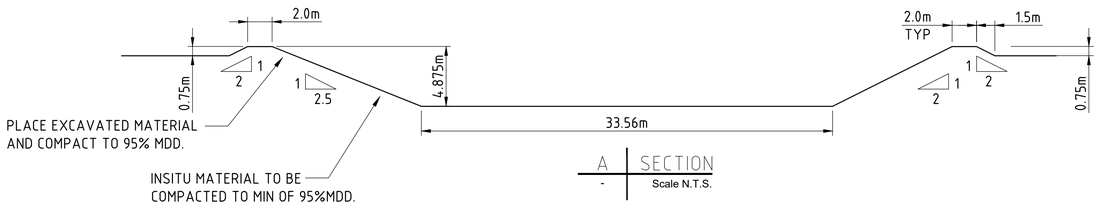
DETAIL - MUD SUMP LINER

Scale N.T.S.



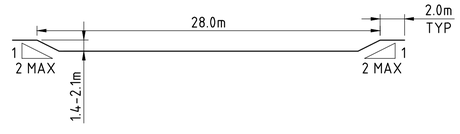
DETAIL - BASE LINER

Scale N.T.S.



A SECTION

Scale N.T.S.



B SECTION

Scale N.T.S.

ISSUED FOR CONSTRUCTION

DRAWING NO.	REFERENCE DRAWING TITLE	REV	DATE	REVISION DESCRIPTION	DRAWN	DWG CHECK	DESIGN	ENG DES CHECK	QE DRAFT SUPER	QE PROJECT APPROVAL
		3	04.10.19	REISSUED FOR CONSTRUCTION	CD	PM	CD	JJ		
		2	25.09.19	LAYOUT UPDATES FOR REVIEW	CD	PM	CD	JJ		
		1	24.05.19	REISSUED FOR CONSTRUCTION	CD	PM	CD	JJ	MR	MR
NT-2050-20-DA-0023	GENERAL ARRANGEMENT PLAN	0	24.04.19	ISSUED FOR CONSTRUCTION	CRD	PCM	PCM	JMJ		

APPROVALS

PREPARED FOR ORIGIN BY:

AECOM

AECOM Australia Pty Ltd
A.B.N 20 093 846 925
www.aecom.com

PROJECT: BEETALOO EXPLORATION
DRAWING OFFICE: DARWIN
PROJECT APPROVALS - OTHERS

tamboran RESOURCES

Tamboran B2 Pty Ltd
ABN 42 105 431 525
110-112 The Corso
Manly NSW 2095
E: tamboran.contact@tamboran.com

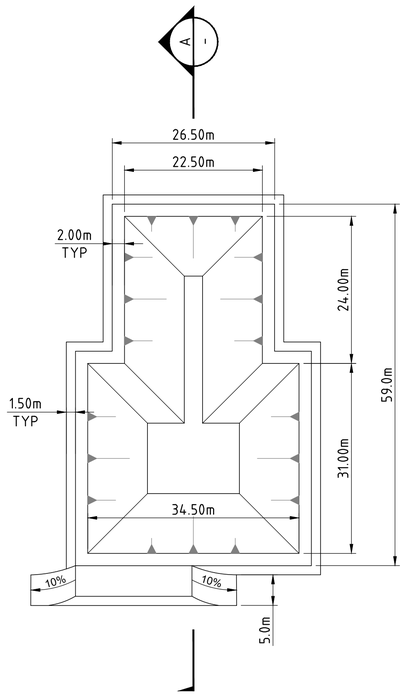
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ORIGIN		BY	DATE
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	DWG CHECK	PM	23.04.2019
	DESIGN	CD	23.04.2019
	ENG DES CHECK	JJ	23.04.2019
	DRAFT. SUPER.	MR	30.05.2019
	PROJECT APPROVAL	MR	30.05.2019

TITLE: BEETALOO EXPLORATION DRILL CAMPAIGN
MUD SUMP DETAILS

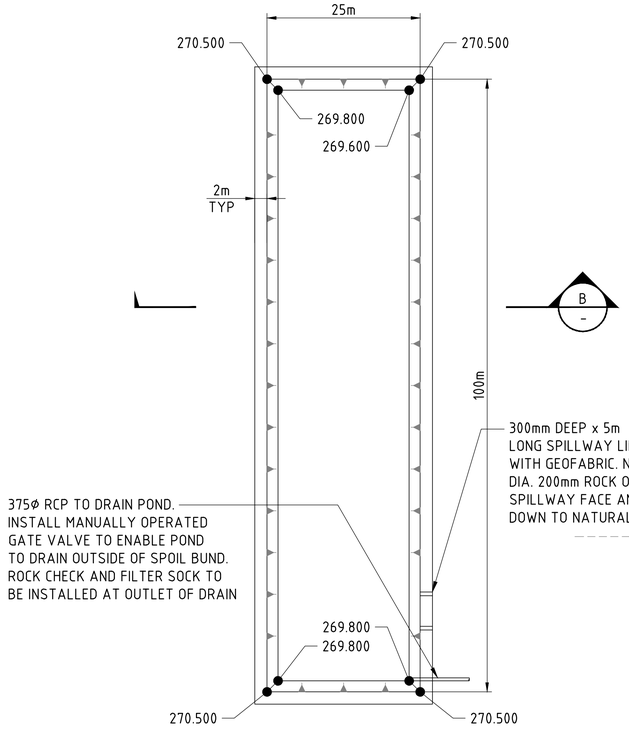
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A1

Mon, 28 Oct 2019 - 10:47am P:\604X\604-805&845 CAD\20-SHEETS\VELKERRI 76 S2-1\NT-2050-20-DD-0031.DWG Dudley, Calvin



PLAN - MUD SUMP

Scale N.T.S.



PLAN - SECONDARY CONTAINMENT

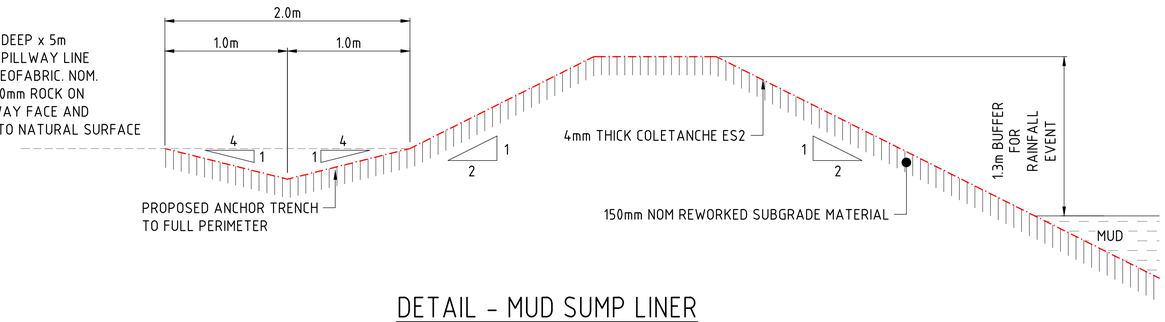
Scale N.T.S.

NOTES:

1. ALL UNITS ARE IN MILLIMETRES (mm) UNLESS NOTED OTHERWISE.
2. GROUND CONDITIONS AND SUITABLE MATERIALS TO BE CONFIRMED ON SITE BY SUPERINTENDENT.
3. REFER TO SPECIFICATION FOR COMPACTION REQUIREMENTS.
4. REFER TO SPECIFICATION FOR GENERAL REQUIREMENTS.
5. THE CONTRACTOR IS TO NOTIFY THE ORIGIN SUPERVISOR IF AREAS OF SOFT GROUND ARE ENCOUNTERED OR IF THE SPECIFICATION CANNOT BE ACHIEVED.
6. REFER TO DRAWING NT-2050-20-DA-0023 FOR SETOUT DETAILS OF MUD SUMP.
7. FAUNA LADDERS TO BE INSTALLED TO MUD SUMP.
8. CONTRACTOR TO PROVIDE CATTLE PANELS FOR FENCING AROUND SUMP WHERE DEPTH IS GREATER THAN 1.5m.
9. FENCE OR BARRICADE TO BE INSTALLED AT SUMP LOAD OUT LOCATION TO ENSURE VEHICLES DO NOT COMPROMISE SUMP WALL/ENTER SUM.
10. MUD SUMP VEHICLE OFFLOAD AREA TO BE COMPACTED TO 200 KPa

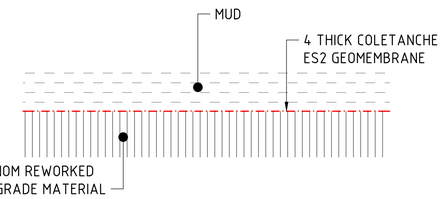
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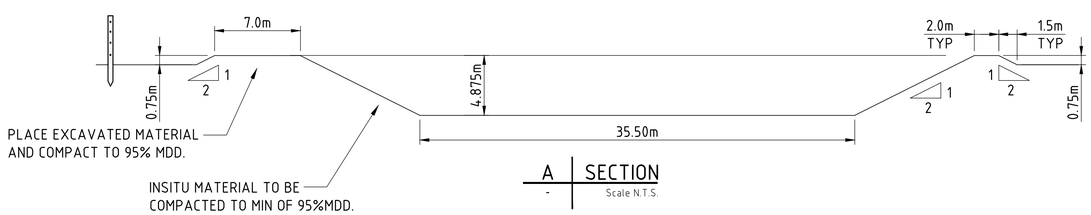
DETAIL - MUD SUMP LINER

Scale N.T.S.

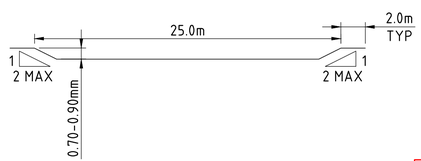


DETAIL - BASE LINER

Scale N.T.S.



A | SECTION
- | Scale N.T.S.



B | SECTION
- | Scale N.T.S.

ISSUED FOR CONSTRUCTION

DRAWING NO.	REFERENCE DRAWING TITLE	REV	DATE	REVISION DESCRIPTION	DRAWN	DWG CHECK	DESIGN	ENG DES CHECK	QE DRAFT SUPER	QE PROJECT APPROVAL
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NT-2050-20-DA-0022	GENERAL ARRANGEMENT PLAN	0	11.04.19	ISSUED FOR CONSTRUCTION	CRD	PCM	PCM	JMJ		

APPROVALS

PREPARED FOR ORIGIN BY:

AECOM Australia Pty Ltd
A.B.N 20 093 846 925
www.aecom.com

PROJECT: BEETALOO EXPLORATION
DRAWING OFFICE: DARWIN
PROJECT APPROVALS - OTHERS

tamboran RESOURCES

Tamboran B2 Pty Ltd
ABN 42 105 431 525
110-112 The Corso
Manly NSW 2095
E: tamboran.contact@tamboran.com

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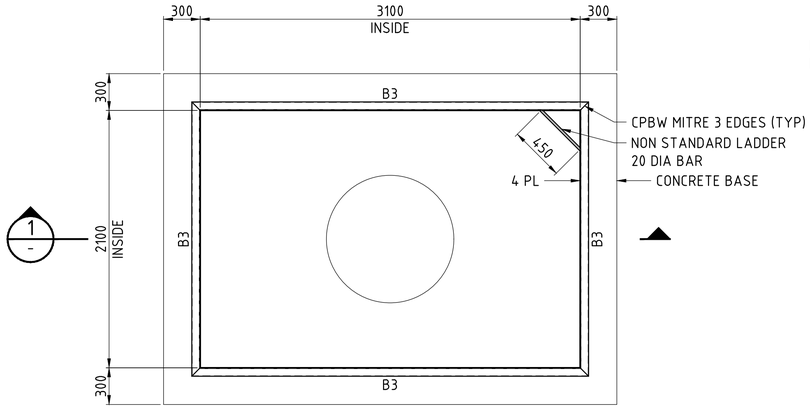
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DESIGN	PCM	20.03.2019
ENG DES CHECK	JMJ	20.03.2019
QE DRAFT SUPER		
QE PROJECT APPROVAL		

TITLE: BEETALOO EXPLORATION DRILL CAMPAIGN

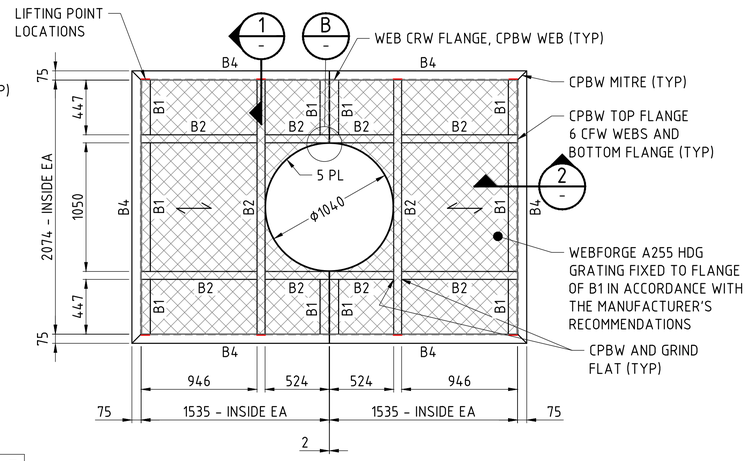
MUD SUMP DETAILS

PROJECT NO.
MOD NO.
SCALE: 1:1000 @ A1
DRAWING NO.: NT-2050-20-DD-0031
REVISION: 1
CADFILE: NT-2050-20-DD-0031.dwg
A1

Thu, 18 Apr 2019 - 1:51pm P:\604X\604805AR\5 CAD\20-SHEETS\VELKERRI 76 S2-1\NT-2050-20-DD-0031.DWG Dudley, Calvin

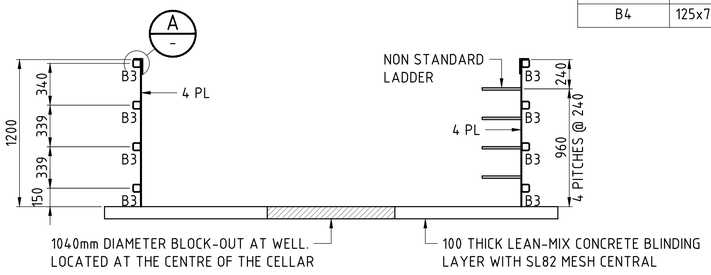


CELLAR PLAN
SCALE 1:25



CELLAR COVER PLAN
SCALE 1:25
GRATING SPAN DIRECTION

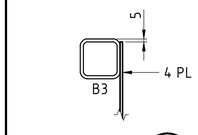
MEMBER SCHEDULE	
MARK	SIZE
B1	75x8 EA
B2	65x4 SHS
B3	65x4 SHS
B4	125x75x8 UA



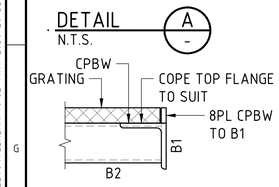
1040mm DIAMETER BLOCK-OUT AT WELL. LOCATED AT THE CENTRE OF THE CELLAR

100 THICK LEAN-MIX CONCRETE BLINDING LAYER WITH SL82 MESH CENTRAL

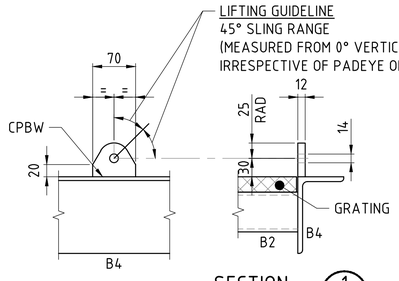
SECTION 1
SCALE 1:25



DETAIL A
N.T.S.

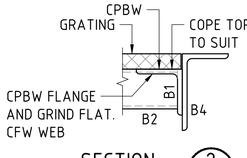


DETAIL B
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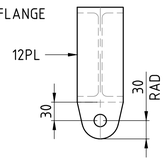


LIFTING POINT
N.T.S.

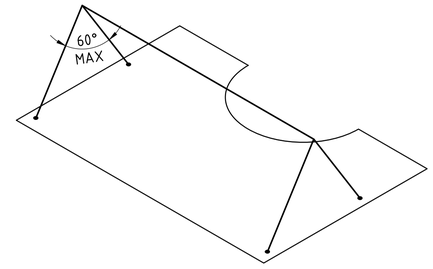
SECTION 1
N.T.S.



SECTION 2
N.T.S.

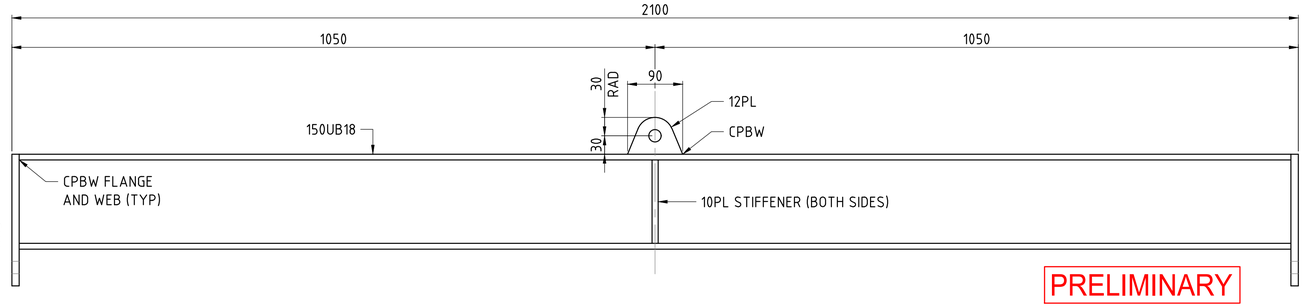


END ELEVATION LIFTING BEAM
N.T.S.



LIFTING DIAGRAM

LIFTING NOTES
- DESIGN ASSUMES A DYNAMIC IMPACT FACTOR Kd=1.2 AND FACTOR OF SAFETY (FOS) OF 3.0
- SLING ANGLE MUST BE 60 DEGREES MAXIMUM AT THE HOOK.
- LIFTING BEAM SHALL HAVE WWL200kg STAMPED INTO FLANGE



LIFTING BEAM
N.T.S.

GENERAL NOTES
- THE FOOTINGS HAVE BEEN DESIGNED FOR A SAFE BEARING PRESSURE OF 50 kPa.
- THE FOOTING DEPTH SHALL BE CHECKED BY THE SUPERINTENDENT AFTER EXCAVATION, AND THE DEPTH MAY BE VARIED FROM THAT DETAILED ON THE DRAWINGS DEPENDING ON THE EXACT LOCATION OF THE LOAD BEARING STRATA.
- FILL UNDER BUILDING FLOOR SLABS: GRANULAR MATERIAL COMPACTED TO A DRY DENSITY RATIO NOT LESS THAN 98% (STANDARD COMPACTION).
- FILL UNDER PAVEMENT SLABS: GRANULAR MATERIAL TO A MIN. THICKNESS OF 50mm UNO ALL FILL AND TOP 150mm OF SUBGRADE COMPACTED TO A DRY DENSITY RATIO NOT LESS THAN 98% (STANDARD COMPACTION).
- DESIGN LIVE LOADS HAVE BEEN CALCULATED IN ACCORDANCE WITH A.S. 1170 PART 1 & A.S. 1657.
- DESIGN LIVE LOAD SURCHARGE ON SOIL 5 kPa
- THESE DRAWINGS SHALL BE READ IN CONJUNCTION WITH THE ARCHITECTS AND OTHER ENGINEERS DRAWINGS, AND ALL DIMENSIONS AND DETAILS SHALL BE CHECKED WITH THEIR DRAWINGS AND ON SITE.
- TRADE NAMES HAVE BEEN USED ONLY TO ESTABLISH A BASIC REQUIREMENT AND ANY SATISFACTORY EQUIVALENT MAY BE SUBMITTED FOR REVIEW.
- ALL DIMENSIONS OF EXISTING STRUCTURES SHALL BE CHECKED PRIOR TO FABRICATION AND ERECTION.
- DURING CONSTRUCTION THE CONTRACTOR SHALL BE RESPONSIBLE FOR MAINTAINING THE STRUCTURE AND EXCAVATIONS IN A STABLE CONDITION, AND ENSURING NO PART SHALL BE OVERSTRESSED UNDER CONSTRUCTION ACTIVITY.

CONCRETE NOTES
- CONCRETE, CONCRETE WORK, AND STEEL REINFORCEMENT SHALL CONFORM TO A.S. 3600, CONCRETE STRUCTURES.
- THE PROPORTION OF FLY ASH SHALL BE 25% BY WEIGHT OF THE TOTAL COMBINED WEIGHT OF FLY ASH AND CEMENT.
- MAXIMUM SLUMP OF CONCRETE = 80±15mm UNO.
- MAXIMUM NOMINAL SIZE OF AGGREGATE = 20mm.
- PLACE 2.N12 REINFORCING BARS X 1000 LONG IN TOP REINF. LAYER DIAGONALLY ACROSS ALL RE-ENTRANT CORNERS AND OPENINGS.
- REINFORCEMENT SHOWN ON DRAWINGS IS REPRESENTED DIAGRAMMATICALLY AND NOT NECESSARILY IN TRUE PROJECTION.
- ALL REINFORCEMENT HOOKS AND COGS SHALL BE STANDARD UNLESS SHOWN OR NOTED OTHERWISE ON THE DRAWINGS.
- ALL REINFORCING STEEL SHALL BE ACRS (AUSTRALIAN CERTIFICATION AUTHORITY FOR REINFORCING AND STRUCTURAL STEEL) CERTIFIED.

STEELWORK NOTES
- ALL STEELWORK SHALL CONFORM TO A.S. 4100, STEEL STRUCTURES.
- STEEL GRADES: 300 UNO. SHS - 350. PLATES - 250.
- FABRICATION SHALL BE CARRIED OUT BY WELDERS WHO ARE QUALIFIED IN ACCORDANCE WITH THE REQUIREMENTS OF A.S./NZS 1554.1.
- THE BOLTING PROCEDURE ADOPTED UNLESS NOTED OTHERWISE IS 8.8/S IN ACCORDANCE WITH THE AUSTRALIAN INSTITUTE OF STEEL CONSTRUCTION - MANUAL OF STANDARDISED STRUCTURAL CONNECTIONS.
- ALL BOLTS OR FASTENERS SHALL BE MARKED WITH THE MANUFACTURERS BRAND, AND COMPLY WITH THE FOLLOWING :
  - BOLTS DENOTED 4.6/S ARE COMMERCIAL BOLTS OF STRENGTH GRADE 4.6 TO A.S. 1111 - SNUG TIGHT.
  - BOLTS DENOTED 8.8/S, 8.8/TF, OR 8.8/TB ARE HIGH STRENGTH STRUCTURAL BOLTS OF STRENGTH GRADE 8.8 TO A.S. 1252.
- BOLTS SHALL BE M20 8.8/S UNO.
- GRADE 8.8 BOLTS SHALL NOT BE WELDED, INCLUDING TACK WELDS FOR CAGING.
- PLATES IN STRUCTURAL STEEL CONNECTIONS SHALL BE 10mm THICK UNO
- MINIMUM CONNECTIONS SHALL BE 10Pl. 2/M20 8.8/S BOLTS UNO.
- ALL BOLTS (INCLUDING MASONRY ANCHORS) SHALL BE HOT DIPPED GALVANISED.
- ALL WELDS SHALL BE 6 CFW UNLESS NOTED OTHERWISE.
- ALL WELDS SHALL BE CATEGORY S.P. AS SPECIFIED IN A.S. 1554, UNO.
- ELECTRODES SHALL BE B-G49X OR B-T49X UNO.
- ALL RHS AND CHS MEMBERS SHALL HAVE 5 PL. SEAL PLATES AT ENDS UNO.
- PROTECTIVE COATING SHALL BE EITHER
  - ALL STEELWORK SSHALL BE BLAST CLEANED TO CLASS 2½ AS SPECIFIED IN AS 1627.4 WITH SURFACE ROUGHNESS OF 75 MICRONS
  - 2 COATS OF IMMERSION GRADE EPOXY TO DRY FILM THICKNESS 400 MICRONS (EACH COAT).

  OR
  - HOT DIP GALVANISED TO AS4680
- SHOP DRAWINGS SHALL BE SUBMITTED BEFORE COMMENCEMENT OF FABRICATION. GRADE OF SANDBLASTING, PAINT BRAND, TYPE, FILM THICKNESS AND WELD CATEGORY SHALL BE NOTED ON THESE DRAWINGS.
- ALL MEMBER CENTROIDS AT CONNECTIONS SHALL INTERSECT AT A POINT UNO GAUGE LINES MAY BE USED IN LIEU OF CENTROIDS FOR BOLTED END CONNECTIONS OF ANGLES.
- ALL STRUCTURAL STEEL SHALL BE ACRS (AUSTRALASIAN CERTIFICATION AUTHORITY FOR REINFORCING AND STRUCTURAL STEEL) CERTIFIED.

PRELIMINARY

NOT FOR CONSTRUCTION

DRAWING NO.	REFERENCE DRAWING TITLE	REV	DATE	REVISION DESCRIPTION	DRAWN	DWG CHECK	DESIGN	ENG DES CHECK	OE DRAFT SUPER APPROVAL	OE PROJECT APPROVAL
-	-	A	21.03.2019	PRELIMINARY ISSUE	-	-	-	-	-	-
-	-									
-	-									

PROJECT APPROVALS - OTHERS

PREPARED FOR ORIGIN BY:

AECOM Australia Pty Ltd
A.B.N 20 093 846 925
www.aecom.com

PROJECT: BEETALOO EXPLORATION
DRAWING OFFICE: DARWIN

tamboran RESOURCES

Tamboran B2 Pty Ltd
ABN 42 105 431 525
110-112 The Corso
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E: tamboran.contact@tamboran.com

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ORIGIN

	BY	DATE
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DWG CHECK	-	- . - . -
DESIGN	-	- . - . -
ENG DES CHECK	-	- . - . -
DRAFT SUPER	-	- . - . -
PROJECT APPROVAL	-	- . - . -

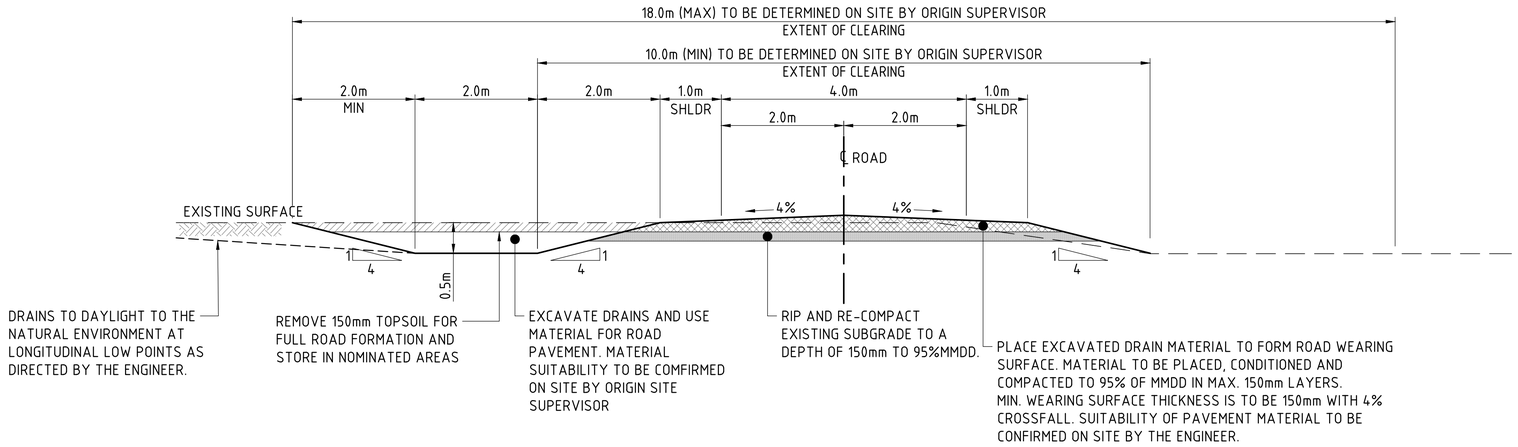
TITLE: BEETALOO EXPLORATION DRILL CAMPAIGN

DRILLING CELLAR DETAILS

PROJECT NO.
MOD NO.
SCALE: 1:25 @ A1
CADFILE: NT-2050-20-DD-0027.dwg

DRAWING NO.: NT-2050-20-DD-0027
REVISION: A
A1

Thu, 18 Apr 2019 - 1:51pm P:\60LXX\60L80548\5 CAD\20-SHEETS\VELKERRI 16.52-1\NT-2050-20-DD-0027.DWG Dudley, Calvin



TYPICAL CROSS SECTION - ACCESS ROAD

SCALE (m) 0 0.2 0.4 0.6 0.8 1.0 1:20 (A1)

NOTES:

1. ALL UNITS ARE IN MILLIMETRES (mm) UNLESS NOTED OTHERWISE.
2. ENSURE THAT TABLE DRAINS ARE FREE DRAINING.
3. GROUND CONDITIONS AND SUITABLE MATERIALS TO BE CONFIRMED ON SITE BY SUPERINTENDENT.
4. CLEARED VEGETATION TO BE STORED ALONGSIDE NEW ROAD FOR FUTURE REHABILITATION.
5. REFER TO SPECIFICATION FOR COMPACTION REQUIREMENTS.
6. STRIPPED TOPSOIL TO BE STORED IN BERMS ALONGSIDE ROAD.
7. REFER TO SPECIFICATION FOR GENERAL REQUIREMENTS.
8. THE CONTRACTOR IS TO NOTIFY THE ORIGIN SUPERVISOR IF AREAS OF SOFT GROUND ARE ENCOUNTERED OR IF THE SPECIFICATION CANNOT BE ACHIEVED.
9. CLEAR, STRIP 150mm TOPSOIL AND STOCKPILE IN NOMINATED BUFFER ZONE TO ESTABLISH BORROW PITS.
10. THIS DRAWING MAY BE USED FOR TEMPORARY ACCESS APPLICATION TO NT ROADS.
11. TYPICAL CROSS SECTION DESIGNED IN ACCORDANCE WITH NORTHERN TERRITORY STANDARD DRAWING C(S)3003.

ISSUED FOR CONSTRUCTION

DRAWING NO.	REFERENCE DRAWING TITLE	REV	DATE	REVISION DESCRIPTION	DRAWN	DWG CHECK	DESIGN	ENG DES CHECK	OE DRAFT SUPER	OE PROJECT APPROVAL
		2	16.04.19	REISSUED FOR CONSTRUCTION	CRD	PCM	PCM	JMJ		
		1	11.04.19	REISSUED FOR CONSTRUCTION	CRD	PCM	PCM	JMJ		
NT-2050-20-DA-0023	GENERAL ARRANGEMENT PLAN	0	20.03.19	ISSUED FOR CONSTRUCTION	CRD	PCM	PCM	JMJ		

APPROVALS

PREPARED FOR ORIGIN BY:

AECOM

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A.B.N 20 093 846 925
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PROJECT: BEETALOO EXPLORATION
DRAWING OFFICE: DARWIN
PROJECT APPROVALS - OTHERS

tamboran RESOURCES

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ABN 42 105 431 525
110 - 112 The Corso
Manly NSW 2095
E: tamboran.contact@tamboran.com

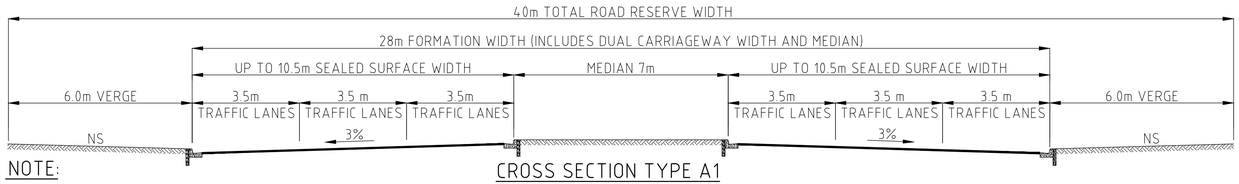
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ORIGIN		BY	DATE
	DRAWN	CRD	20.03.2019
	DWG CHECK	PCM	20.03.2019
	DESIGN	PCM	20.03.2019
	ENG DES CHECK	JMJ	20.03.2019
	DRAFT. SUPER.		
	PROJECT APPROVAL		

TITLE: BEETALOO EXPLORATION DRILL CAMPAIGN
DESIGN DETAILS

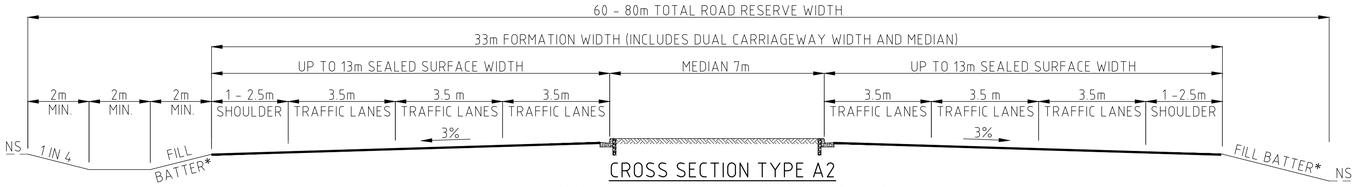
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MOD NO.
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DRAWING NO.: NT-2050-20-DD-0023
REVISION: 0
CADFILE: NT-2050-20-DD-0023.dwg
A1

Thu, 18 Apr 2019 - 1:50pm P:\604-XX\604-805\8\5 CAD\20-SHEETS\VELKERRI 76 S2-1\NT-2050-20-DD-0023.DWG Dudley, Calvin



NOTE:
KERB SIDE LANE TO BE MINIMUM 5.0m WIDE DURING STAGE CONSTRUCTION

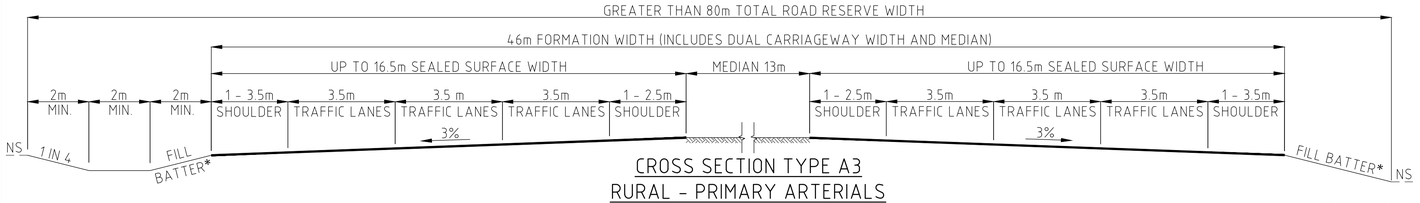
CROSS SECTION TYPE A1
URBAN - PRIMARY ARTERIALS



NOTE:
TOTAL ROAD RESERVE WIDTH 60 - 80m TO ALLOW FOR SIDE DRAINS AND POSSIBLE SERVICES.
SHOULDERS TO BE SEALED, MINIMUM 1.0m.

CROSS SECTION TYPE A2
SEMI-URBAN - PRIMARY ARTERIALS

*REFER NOTE 3



CROSS SECTION TYPE A3
RURAL - PRIMARY ARTERIALS

*REFER NOTE 3

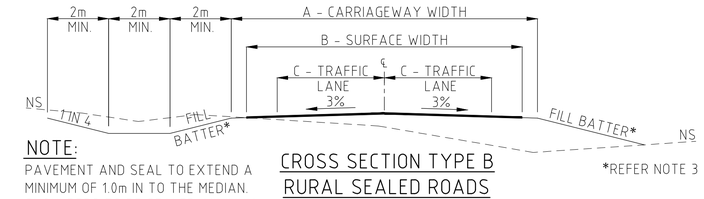
URBAN ENVIRONMENT

TYPICAL CROSS SECTIONS - URBAN ENVIRONMENT

ROAD CLASSIFICATION	AUSTROAD CLASS	TYPE CROSS SECTION	FORMATION (DUAL CARRIAGEWAY)	TRAFFIC LANES		SEAL WIDTH (m)	COMMENTS
				WIDTH (m)	SURFACE		
URBAN - PRIMARY ARTERIALS:							
URBAN	CLASS 6	TYPE A1	28.0	UP TO 3 x 3.5	SEALED	UP TO 10.5 EACH WAY	KERB SIDE LANE TO BE MINIMUM 5.0m WIDE DURING STAGE CONSTRUCTION. TOTAL ROAD RESERVE WIDTH 40m
SEMI - URBAN	CLASS 6	TYPE A2	33.0	UP TO 3 x 3.5 EACH WAY	SEALED	UP TO 13.0 EACH WAY (INC.FULL WIDTH SHOULDER SEAL	SHOULDER TO BE SEALED MINIMUM 1.0m. TOTAL ROAD RESERVE WIDTH 60 -80m TO ALLOW FOR SIDE DRAINS AND POSSIBLE SERVICES.
RURAL	CLASS 6	TYPE A3	46.0	UP TO 3 x 3.5 EACH WAY	SEALED	UP TO 16.5 EACH WAY (INC.FULL WIDTH SHOULDER SEAL)	SHOULDER TO BE SEALED MINIMUM OF 1.0m.

URBAN ENVIRONMENT NOTES:
1. REFER TO LOCAL GOVERNMENT GUIDELINES FOR URBAN SUB ARTERIALS (6000-12000 VPD), URBAN DISTRIBUTOR (LESS THAN 6000 VPD) AND URBAN COLLECTOR (LESS THAN 3000 VPD) ROADS.
2. REFER TO DEPARTMENT GUIDELINES FOR URBAN LOCAL AND URBAN SUBDIVISION REQUIREMENTS.

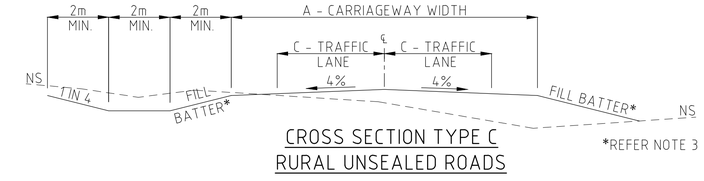
GENERAL NOTES:
1. REFER TO STANDARD DRAWING CS3002 FOR TYPICAL CROSS SECTIONS FOR SUBDIVISIONAL DEVELOPMENTS IN UNINCORPORATED AREAS (SHEET 1 of 2).



NOTE:
PAVEMENT AND SEAL TO EXTEND A MINIMUM OF 1.0m IN TO THE MEDIAN. SHOULDERS TO BE SEALED, MINIMUM 1.0m.

CROSS SECTION TYPE B
RURAL SEALED ROADS

*REFER NOTE 3



CROSS SECTION TYPE C
RURAL UNSEALED ROADS

*REFER NOTE 3

RURAL ENVIRONMENT

TYPICAL CROSS SECTIONS - RURAL ENVIRONMENT

			A	C		B	
ROAD CLASSIFICATION	AUSTROAD CLASS	TYPE CROSS SECTION	CARRIAGE WAY WIDTH (m) (INCLUDING MEDIAN)	TRAFFIC LANES		SEAL/ GRAVEL WIDTH (m)	COMMENTS
				WIDTH (m)	SURFACE		
RURAL - NATIONAL HIGHWAY	CLASS 1	TYPE B	11.0	2 x 3.5	SEALED	9.0	NATIONAL STANDARDS UNDER REVIEW. SEAL WIDTH MAY BE INCREASED TO 9.0m DEPENDING ON LOCAL ISSUES
RURAL ARTERIAL	CLASS 3	TYPE B	10.0	2 x 3.5	SEALED	9.0	> 1000 VPD - 20 YEAR PROJECTED VOLUMES, SEE NOTE 1
RURAL SECONDARY ROADS	CLASS 4	TYPE B	9.0	2 x 3.0	SEALED	8.0	< 500 VPD - 20 YEAR PROJECTED VOLUMES, SEE NOTE 1
RURAL SECONDARY ROADS	CLASS 4	TYPE C	9.0	2 x 3.0	GRAVELLED	6.0	SEE NOTE 2
RURAL - LOCAL	CLASS 5	TYPE B	9.0	2 x 3.0	SEALED	8.0	FOR UNSEALED ROADS A 9.0m CARRIAGEWAY MAY BE APPROPRIATE IF FUTURE SEALING IS FORESEEABLE. SEE NOTE 2.
		TYPE C	8.0	2 x 3.0	GRAVELLED	6.0	
RURAL - SUBDIVISIONS	REFER TO CS3002						REFER TO DEVELOPMENT GUIDELINES BY THE TRANSPORT INFRASTRUCTURE PLANNING DIVISION.
PASTORAL ACCESS ROADS							
PASTORAL 1	CLASS 5	TYPE C	4.0	1 x 4.0	FORMED	-	SINGLE USER ACCESS
PASTORAL 2	CLASS 5	TYPE C	6.0	1 x 6.0	FORMED	-	MULTI USER ACCESS FOR UP TO 3 PROPERTIES
PASTORAL 3	CLASS 5	TYPE C	8.0	2 x 3.0	GRAVELLED	6.0	PROVIDES ACCESS TO GREATER THAN 3 PROPERTIES

RURAL ENVIRONMENT NOTES:
1. FOR PREDICATED FUTURE VOLUMES OF 500 - 1000 VPD THE STANDARD WILL DEPEND ON TRAFFIC MIX (NUMBERS OF ROAD TRAINS/CARAVANS/BUSES) AND TOPOGRAPHY AND WILL BE ASSESSED ON A CASE BY CASE BASIS. SEAL WIDTHS MAY ALSO BE INCREASED DEPENDING ON LOCAL ISSUES SUCH AS SEASONAL VARIATIONS (TOURISM) AND ENVIRONMENT.
2. THE DECISION IN REGARD TO SEALED VERSUS GRAVEL STANDARD FOR A PARTICULAR ROAD WILL DEPEND ON FACTORS SUCH AS PROPOSED USE (I.E HORTICULTURAL), ENVIRONMENT, PREDICTED USE AND THE LIKE AND SHOULD BE REFEREED TO TRANSPORT INFRASTRUCTURE PLANNING DIVISION.
3. PREFERRED FILL BATTER SLOPE 1:6. ABSOLUTE MINIMUM 1:4.

No.	DESCRIPTION	DATE	NAME	DEPT/COMPANY
3	CROSS SECTION TYPE A3 AND TABLE AMENDED	SEP 2021	N.K	EES
2	SEALING DETAIL AMENDED	FEB 2020	S.SHI	EES
1	TABLE DETAILS AMENDED	MAR 2019	S.SHI	EES/ DIPL
0	ISSUED AS A STANDARD DRAWING	SEPT 2017	J.LEESON	EES/DIPL

AMENDMENTS

WARNING

BEWARE OF UNDERGROUND SERVICES.
THE LOCATIONS OF UNDERGROUND SERVICES ARE APPROXIMATE ONLY AND THEIR EXACT POSITION SHOULD BE PROVEN ON SITE. NO GUARANTEE IS GIVEN THAT ALL EXISTING SERVICES ARE SHOWN.

DRAWN J.LEESON	DATE MAR 2017	CHECKED S.HATZI	DATE MAR 2017
DESIGNED J.LEESON	DATE MAR 2017	CHECKED S.HATZI	DATE MAR 2017
DESIGN LEADER S.HATZI	DATE 1/09/2017	DESIGN DIRECTOR S.JACKSON	DATE 1/09/2017

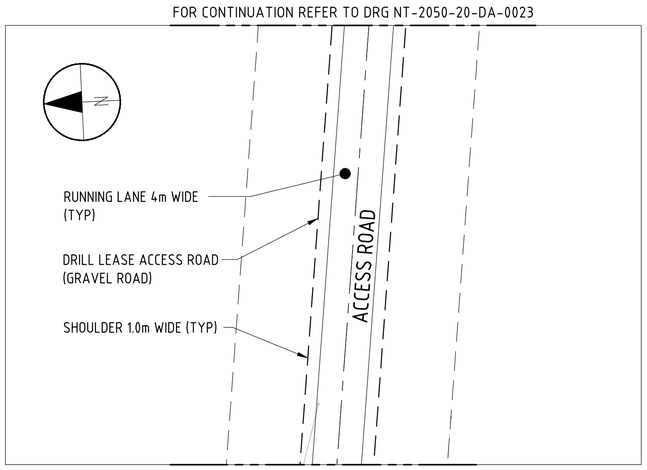
Northern Territory Government

STANDARD DRAWINGS
TYPICAL CROSS SECTIONS

TYPICAL CROSS SECTIONS
FOR URBAN AND RURAL ENVIRONMENTS

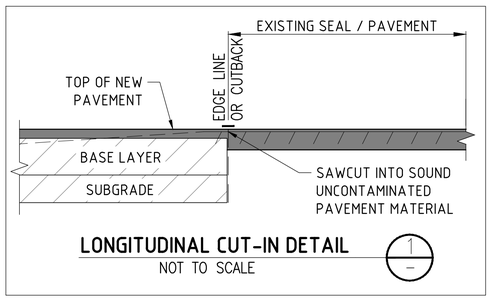
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-	-	2 OF 2	CS3003	3	A1

CS3003_AMED_3 RELEASED 07/09/2021

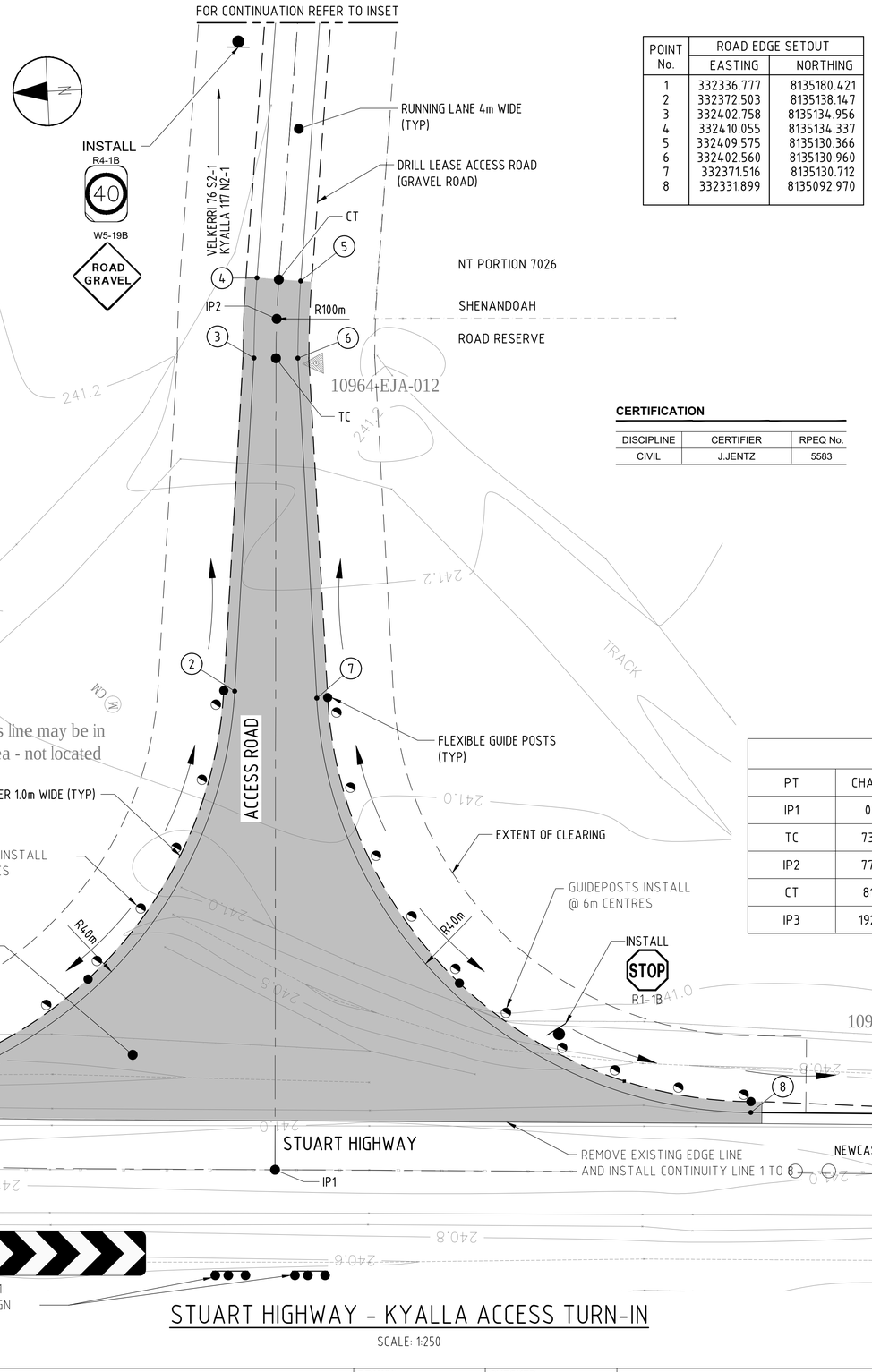


INSET

SCALE (m) 0 2.5 5.0 7.5 10.0 12.5 1:250 (A1)



LONGITUDINAL CUT-IN DETAIL (1)
NOT TO SCALE



STUART HIGHWAY - KYALLA ACCESS TURN-IN

SCALE: 1:250

POINT No.	ROAD EDGE SETOUT	
	EASTING	NORTHING
1	332336.777	8135180.421
2	332372.503	8135138.147
3	332402.758	8135134.956
4	332410.055	8135134.337
5	332409.575	8135130.366
6	332402.560	8135130.960
7	332371.516	8135130.712
8	332331.899	8135092.970

CERTIFICATION

DISCIPLINE	CERTIFIER	RPEQ No.
CIVIL	J.JENTZ	5583

LEGEND

PROPOSED

- ACCESS ROAD CENTERLINE
- EDGE OF PAVEMENT
- EDGE OF SHOULDER
- EXTENT OF CLEARING - (EXTENT OF FIRE BREAK)
- PROPOSED SEALED SHOULDER, PRIME AND SEAL S20E, 14/7mm AGGREGATE. TYPE 2 OR 3 GRAVEL BASE COMPAVETED THICKNESS 200mm TO 100%MMDD
- FLOW DIRECTION OF TABLE DRAIN

NOTES

1. ALL DIMENSIONS ARE IN METRES UNLESS NOTES OTHERWISE.
2. TRAFFIC ROAD SIGNAGE TO COMPLY WITH AS1743 AND NORTHERN TERRITORY GUIDELINES.
3. PAVEMENT SEAL WORKS TO BE CONSTRUCTED TO MEET PERFORMANCE AND DESIGN STANDARDS FOR NORTHERN TERRITORY GOVERNMENT ROADS AND STANDARD SPECIFICATION ROADWORKS v4.2.
4. ACCESS DESIGNED WITH 40m TURNING RADII TO ACCOMMODATE ALL HEAVY VEHICLE MOVEMENTS INCLUDING A-TRIPLE ROAD TRAINS.
5. LOCATION OF ACCESS IS TO BE CONFIRMED BY CONTRACTOR ON SITE.
6. THE CONTRACTOR IS RESPONSIBLE FOR PERMITS REQUIRED FOR CONSTRUCTION IN ROAD RESERVE AND TIE-IN TO EXISTING HIGHWAY.
7. ROAD AREA BETWEEN STUART HIGHWAY AND ROAD RESERVE BOUNDARY TO BE RE-INSTATED/COVERED WHILE ACCESS TRACK NOT IN USE.
8. CONTRACTOR IS RESPONSIBLE TO FIND/LOCATE EXISTING SERVICES. ANY DAMAGE TO EXISTING SERVICES TO BE RE-INSTATED AT THE CONTRACTORS EXPENSE.
9. SIGNAGE TO BE INSTALLED PRIOR TO ROAD USE.
10. ALL WORKS TO BE CARRIED OUT IN ACCORDANCE WITH THE APPROVED MANAGEMENT PLAN REQUIREMENTS.
11. NO CONSTRUCTION WORKS ARE TO BE CARRIED OUT OUTSIDE THE APPROVED WORK CORRIDOR BOUNDARIES.
12. CONSTRUCTION FACILITY AREA LOCATIONS TO BE APPROVED BY THE SUPERINTENDENT PRIOR TO WORKS COMMENCING.
13. NO SERVICES WERE PRESENT OR PROVIDED BY DBYD AT THE TIME OF DESIGN AND ARE THEREFOR NOT SHOWN, HOWEVER THE CONTRACTOR IS RESPONSIBLE FOR CONDUCTING A SEARCH PRIOR TO WORKS BEING CARRIED OUT.
14. THE CONTRACTOR IS TO LIAISE WITH SERVICE PROVIDERS AND THE RELEVANT AUTHORITIES TO ENSURE ALL CONSTRUCTION WORKS ARE CARRIED OUT IN ACCORDANCE WITH SERVICE PROVIDERS AND RELEVANT AUTHORITIES REQUIREMENTS.
15. THIS DRAWING MAY BE USED FOR TEMPORARY ACCESS APPLICATION TO NT ROADS.
16. FINISH SURFACE LEVELS ARE TO FOLLOW EXISTING SURFACE LEVELS AS NEAR AS POSSIBLE AND TO THE GRADES SPECIFIED ON THE DRAWINGS.
17. TABLE DRAINS ARE TO BE CUT ALONG THE LENGTH OF THE ROAD AND ALL ROAD PAVEMENTS ARE TO HAVE A 4% CROSSFALL IN ACCORDANCE WITH THE ROAD CROSS-SECTION DETAILED ON DWG. C-0201.
18. FENCELINE TO BE MAINTAINED AT ALL TIMES.

ACCESS ROAD SETOUT

PT	CHAINAGE	X COORD	Y COORD	BEARING	RADIUS	ARC LENGTH	DEFL. ANGLE
IP1	0.000	332328.748	8135136.549	92°46'54.97"			
TC	73.996	332402.657	8135132.958	92°46'54.97"			
IP2	77.589	332406.247	8135132.784		100.000	7.186	4°07'01.24"
CT	81.182	332409.815	8135132.352	96°53'56.21"			
IP3	192.240	332520.070	8135119.012	96°53'56.21"			

ISSUED FOR CONSTRUCTION

No.	DESCRIPTION	DATE	INIT.	DEPT/COMPANY
2	UPDATED TO INCLUDE SEAL	03.08.23	JG	AECOM
1	REISSUED FOR CONSTRUCTION	24.05.19	PM	AECOM
0	ISSUED FOR CONSTRUCTION	15.05.19	PCM	AECOM

AMENDMENTS Plot Date: 03/08/2023

AECOM Australia Pty Ltd A.B.N. 20 093 846 925

DRAWN J.J DATE:	CHECKED N.M DATE:
DESIGNED N.M DATE:	CHECKED J.J DATE:
DESIGN PROJECT LEADER DATE:	NTG PROJECT MANAGER DATE:

Northern Territory Government

DARWIN REGION
TAMBORAN BEETALOO JV STAGE 4 CIVIL CONSTRUCTION

STUART HIGHWAY - KYALLA ACCESS TURN-IN DETAILS

NTG PROJECT No.	NTG ASSET No.	SHEET No.	NTG DRAWING No.	AMENDMENT	SHEET SIZE
RFD12930	R0045	OF	NT-2050-20-DD-0021	0	A1

Ver. Jan' 2020

PLOTTED ON: 3/Aug/2023 3:31 PM
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FILE LOCATION: \\na.aecomnet.com\fs\APAC\Darwin-AUDWN1\Legacy\Projects\604x\60480548\5. CAD\20-SHEETS\STUART HIGHWAY\NT-2050-20-DD-0021.dwg

Liner and wastewater tank storage specifications for existing and new wastewater tanks

18 Oct 2016	Enviro Liner® 1000 Properties				
Style	**ASTM**	**EL 1020**	**EL 1030**	**EL 1040N**	**EL 1040**
Thickness	D5199	20 mil 0.5 mm	30 mil 0.75 mm	36 mil 0.91 mm	40 mil 1.0 mm
Density (Typical)	D792	0.93	0.93	0.93	0.93
Tensile Strength at Break	D6693	76 ppi 13 N/mm	114 ppi 20 N/mm	136 ppi 24 N/mm	152 ppi 27 N/mm
Elongation	D6693	800%	800%	700%	800%
Tear Resistance	D1004	11 lbs 49 N	16 lbs 70 N	19 lbs 84 N	22 lbs 100 N
Puncture Resistance	D4833	28 lbs 120 N	42 lbs 190 N	54 lbs 240 N	56 lbs 250 N
Carbon Black Content	D6370	≥ 2.0%	≥ 2.0%	2.0%	≥ 2.0%
High Pressure OIT	D5885	400 min	400 min	N/A	400 min
Low Temperature Impact Resistance	D746	-69°F -56°C	-69°F -56°C	-40°F -40°C	-69°F -56°C
Service Temperatures	Max Continuous Use	140°F 60°C	140°F 60°C	140°F 60°C	140°F 60°C

18 Oct 2016	Enviro Liner® 1000 Shop Seam Strengths				
Style	**ASTM D6392**	**Enviro Liner® 1020**	**Enviro Liner® 1030**	**Enviro Liner® 1040N**	**Enviro Liner® 1040**
Heat Bonded Seam Strength	25.4 mm (1") Strip	30 ppi 5.2 N/mm	45 ppi 7.7 N/mm	50 ppi 8.7 N/mm	60 ppi 10.3 N/mm
Peel Adhesion Strength (Wedge Weld)	25.4 mm (1") Strip	25 ppi 4.3 N/mm	38 ppi 6.5 N/mm	45 ppi 7.9 N/mm	50 ppi 8.7 N/mm



FlexiPond Wind Loading

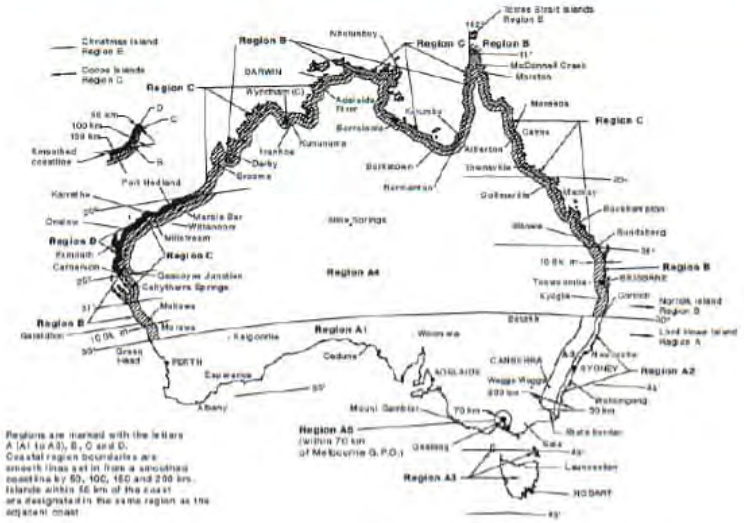
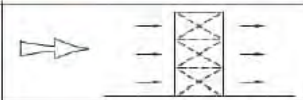


FIGURE 3.1(A) WIND REGIONS



(g) *2 effective surfaces* Lateral pressure on windward and leeward wall.		0.9	1.0 (not an effective surface)
(h) *2 effective surfaces* Lateral pressure on external and internal surfaces		0.9	0.9

Wind Rating as per AS1170.2:2011(R2016)

- Individual panel (or a straight line section of assembled panels)
- Overturning/Sliding rating (e.g. in storage or prior to installation) **rated to a maximum of 100km/hr**

- Fully Assembled (with corner pieces, locking pins and cables)
- **Stable to all wind conditions in all wind regions (includes cyclonic)**

Support Slide: Certified Working Parameters

- Wind Rating as per AS1170.2:2011(R2016), Structural Design Actions Part2 : Wind Actions
  - Individual panel (or a straight line section of assembled panels)
    - Overturning/Sliding rating (e.g. in storage or prior to installation) rated to a maximum of 100km/hr
  - Fully Assembled (with corner pieces, locking pins and cables)
    - Stable to all wind conditions in all wind regions (includes cyclonic)
    - However, recommend minimum 100mm of fluid in tank at shallow end to stop liner from blowing away/tearing

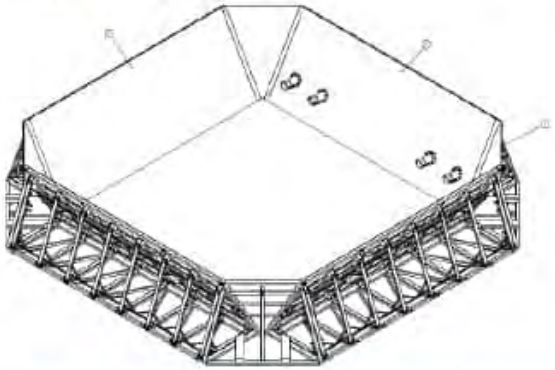
- Hydrostatic Loading as per AS NZS 1170.1-2011(R2016) and AS3990-1993(R2016)
  - Assembled with cables and pins
    - Fluid maximum specific gravity of 1.2 in conjunction with wind loading
    - Structurally able to handle erosion under 70% of the frame (although not recommended as the liner would be removed under the panel by the hydrostatic fluid
    - Cables to be capable of being safely loaded to 160kN

- Installation conditions
  - Site Slope
    - See chart for numbers of panels versus slope
  - Ground Bearing Pressures
    - Uniformly supported panels exert a pressure of 35 kPa beneath the frame members when filled with 1.2 SG fluid
    - The liner exerts a pressure on the ground of 25 kPa when filled with 1.2 SG fluid
    - As a reference – A typical passenger vehicle tyres exert approx. 200kPa on ground
  - Ground/Site Preparation
    - Assessment would be on a site-specific basis
    - Recommended final site preparation of a bedding material of loose sand or fine aggregate to ensure uniform loading under frame members
    - A depth of not less than 100mm would ensure final levelling could be performed during assembly of the panels
    - Alternatively, a ground level tolerance of +/- 16mm should be used to ensure uniform loading under frame members
    - To reduce the likelihood of erosion, it is recommended that a spoon drain or similar be provided around the structure, particularly on the high side or where there is the potential for significant runoff to impact the structure. This would also be site specific.

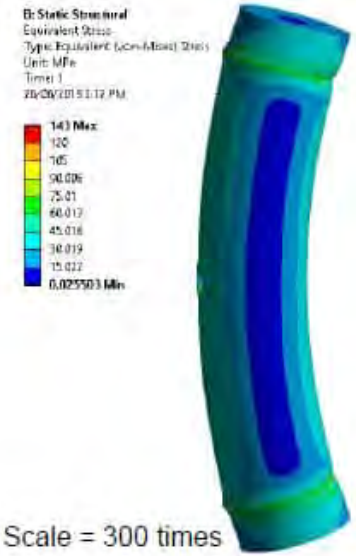
FlexiPond Structural Integrity

FlexiPond is designed and Engineered to AS3990 Mechanical Equipment – Steelwork

Finite Element Analysis (FEA) software used to simulate various load conditions and confirm engineering calculations



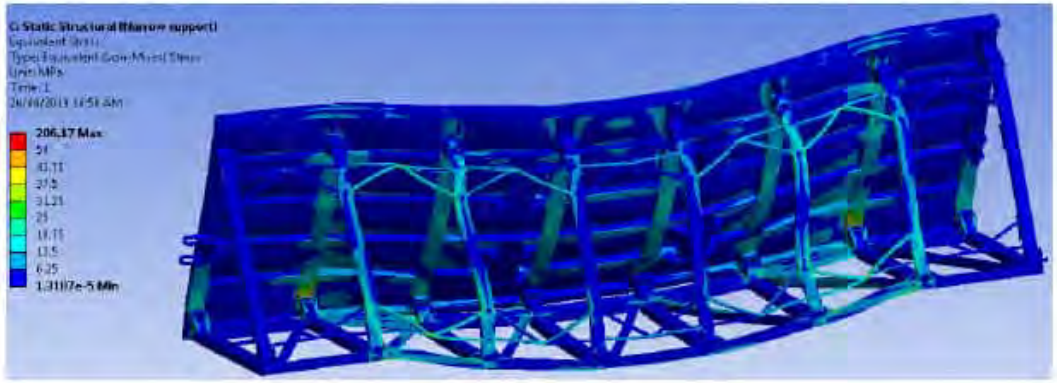




Deformed Scale = 300 times

Structural FEA of Frame Connecting Pin

- Supported in the middle of the pin
- Loaded on either end of the pin



Deformed Scale = 340 times

Structural FEA simulating erosion under 70% of Structure

- Supported on either side by the ground and horizontal cables
- Fluid hydrostatic pressure acting on the panel surface

143, avenue de Verdun
92130 Issy-les-Moulineaux
France
www.coletanche.com

Prepared: 24/02/2020
Cancels and replace 12/06/2018
Code : 1878M01
Manufacture source Courchelettes (59-France)
Technical ref: FT AXTER ES4 ASTM

PRODUCT DATA SHEET

COLETANCHE ES 4

DESCRIPTION

COLETANCHE ES 4 is an SBS elastomeric modified bituminous geomembrane.

USE

Extreme level of mechanical resistance, for use as environmental protection and underground works waterproofing (aggressive materials,reinforced precautions), in particular :
- Railways, directly under ballast,
- Dams,

Product use must be validated by Axter.

APPLICATION METHOD

By torch welding or other similar technique.

STORAGE

Rolls must not be stored directly on the ground. Provide suitable supports (blocks, slides, wooden planks) with a minimum height of 35 cm to be placed under the ends of the mandrel.

COMPOSITION *(indicative)*

Reinforcement (g/m²) :	Glass mat	50
Reinforcement (g/m²) :	Non-woven geotextile	400
Binder (g/m²) :	Elastomeric SBS	5400
Surface finish (g/m²) :	Sand	250
Under surface finish (g/m²) :	Polyester antiroot film	15

CHARACTERISTICS

		STANDARD	UNITS	AVERAGE	Min
Dimensions	Length	-	*m*	55	54
	Width		*m*	5.10	5.01
Thickness (on finished product)		*ASTM D 5199*	mm	5.60	*4.80*
Surface mass		*ASTM D 3776*	kg/m²	6.40	*5.90*
Resistance to tearing	Longitudinal	*ASTM D 4073*	N	1225	*919*
	Cross direction			1025	*769*
Tensile properties : maximum tensile strength	Longitudinal	*ASTM D 7275*	kN/m	35	*29.2*
	Cross direction			30	*23.2*
Tensile properties : elongation	Longitudinal		%	60	*45*
	Cross direction			60	*45*
Static Puncture		*ASTM D 4833*	N	650	*585*
Flexibility at low temperature	Longitudinal	*ASTM D 5147*	°C	-20	-15
	Cross direction			-20	-15
Water permeability (liquid tightness)		*ASTM E 96*	*m/s*	6.10^{-14}	<
Gas permeability (gas tightness)		*ASTM D 1434-82*	*$m^3/(m^2.j.atm)$*	2.10^{-4}	<

NOTE: AXTER COLETANCHE INC. may modify the composition and/or utilisation of its products without prior notice. Consequently orders will be filled according to the latest specification.

LAYFIELD GEOSYNTHETICS

TECHNICAL PAPER

Chemical Resistance Tables

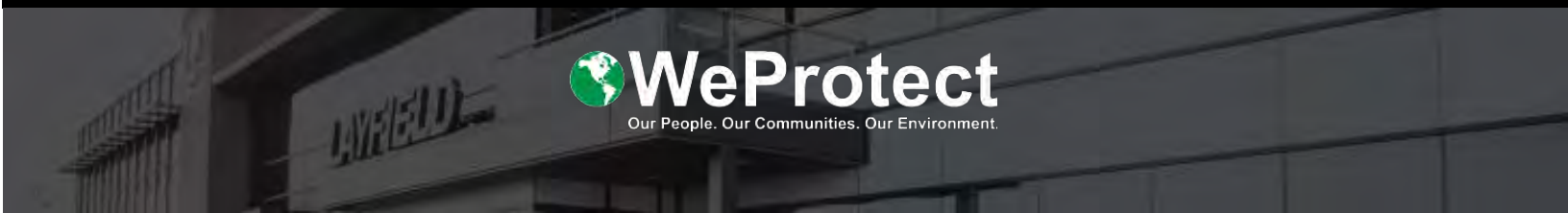
July 2023	Chemical Resistance Ratings
Rev	
A	Fluid has little or no effect
B	Fluid has minor to moderate effect
C	Fluid has severe effect
X	No Data - Likely severe effect
T	No Data - Likely minor effect

July 2023	Geomembrane Material Codes
Rev	
HD	High Density Polyethylene (HDPE)
PV	Polyvinyl Chloride (PVC)
EL	Enviro Liner®
OR	Oil Resistant RPE® (OR RPE®)
PU	Polyurethane
EI	Ethylene Interpolymer Alloy (EIA) (HAZGARD 5000HT)

July 2023

Geomembrane Materials Chemical Resistance Ratings

Material	%	HDPE	PVC	Enviro Liner	Oil Resistant RPE	Polyurethane	Ethylene Interpolymer Alloy (EIA) (HAZGARD 5000 HT)
Acetic Acid	5%	A	A	A	A	A	A
Acetic Acid	50%	A	X	A	B	X	C
Acetic Acid	Gla.	A	C	A	B	X	X
Acetic Anhydride		A	X	C	C	X	X
Acetone		A	C	B	A	C	X
Alkyl Alcohol			C	A		T	T
Alkyl Chloride			C			X	X
Aluminum Chloride		A	B	A	A	T	T
Aluminum Flouride		A	X	A	A	T	T
Aluminum Sulfate		A	A	A	A	T	T
Ammonium Carbonate		A	A	A	A	T	T
Ammonium Chloride		A	A	A	A	T	T
Ammonium Fluoride	20%	A	T	A	A	T	T
Ammonium Hydroxide	30%	A	25	A	A	T	A
Ammonium Nitrate		A	25	A	A	T	T
Ammonium Phosphate		A	T	A	A	T	T
Ammonium Sulphate		A	A	A	A	T	B
Ammonium Sulphide		A	22		A	T	T
Amyl Acetate		B	C	C	C	T	X
Amyl Alcohol		A	T	A	B	T	T
Amyl Chloride		B	T	A	C	T	X
Aniline		A	X	B	C	X	X
Animal Oil		T	B	A	A		A
Antimony Chloride		A	T		A	A	T
Aqua Regia		B	B	C	C	X	X
ASTM Fuel A		T	X		T	A	A
ASTM Fuel B		T	C		T	A	B



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Geomembrane Materials Chemical Resistance Ratings

Material	%	HDPE	PVC	Enviro Liner	Oil Resistant RPE	Polyurethane	Ethylene Interpolymer Alloy (EIA) (HAZGARD 5000 HT)
ASTM Fuel C		T	C		T	B	
ASTM Oil #1		T	T		T	T	T
ASTM Oil #2		T	X		T	T	A
ASTM Oil #3		T	X		T	T	T
Asphalt		A	C	A	A	T	T
Barium Carbonate		A	T	A	A	T	T
Barium Hydroxide		A	T	A	A	T	T
Barium Sulphate		A	T	A	A	T	T
Benzene	<1%	T	T	B	T	T	T
Benzene	25%	T	X	C	T	T	T
Benzene	100	B	X	C	C	T	C
Benzoic Acid		A	T	A	A	T	T
Borax Solutions		A	T	A	A	T	T
Boric Acid		A	T	A	A	T	T
Bromic Acid	10%	A	T		A	X	T
Bromine; Anhydrous		B	X	C	C	X	
Butyl Acetate		B	X	B	B	X	X
Butyl Phenol		A	X		A	X	X
Butyric Acid		A	T	C	C	X	X
Calcuim Bisulphate		A	T	A	A	T	T
Calcium Carbonate		A	A	A	A	T	T
Calcium Chloride		A	A	A	A	T	T
Calcium Hydroxide		A	T	A	A	T	T
Calcium Hypochlorite		A	A	A	A	T	A
Calcium Nitrate	50%	A	T	A	A	T	T
Calcium Sulphate		A	2%	A	A	A	T
Carbon Disulfide		B	X	C	C	X	X
Carbon Tetrachloride		C	C	C	C	C	X
Carbonic Acid		A	T	A	A	T	T
Castor Oil		A	X	A	B	T	T
Chlorine Gas		C	X	X	C	X	T
Chloracetic Acid		A	X	A	A	X	X
Chlorobenzene		B	C	C	C	X	X
Chloroform		C	C	C	C	X	X
Chlorosulfonic Acid		C	C	C	C	X	X
Chrome Alum		A	T		A	T	T
Chromic Acid	30%	A	T	A	B	X	B
Chromium Trioxide		A	T		A	X	
Citric Acid		A	A	A	B	T	T
Copper Chloride		A	T	A	A	T	T
Copper Nitrate		A	T	A	A	T	T
Copper Sulphate		A	T	A	A	T	T
Corn Oil		A	C	A	A	T	A
Cottonseed Oil		A	C	A	B	T	A
Crude Oil		T	C	B		T	T
Cyclohexane		C	X	C	C	T	
Cyclohexanol		A	X	C	A	T	
Cyclohexanol		A	X	C	A	T	
Cyclohexanone		C	C	C	C	X	X

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Geomembrane Materials Chemical Resistance Ratings

Material	%	HDPE	PVC	Enviro Liner	Oil Resistant RPE	Polyurethane	Ethylene Interpolymer Alloy (EIA) (HAZGARD 5000 HT)
Dextrin		A	T	A	A	T	T
Dibutyl Phthalate		B	X	B	B	X	C
Diesel Fuel		A	C	B	A	A	A
Diethyl Ether		B	X	C	B	X	X
Diethyl Keytone		B	X	B	B	X	X
Diethyl Sebacate			X			X	X
Dimethylamine		C	C	C	C	X	X
Dioctyl Phthalate		A	X		A	X	C
Disodium Phosphate		A	T		A	T	T
Epichlorohydrin		A	X		A		
Ethyl Acetate		B	C	B	B		C
Ethyl Alcohol		A	A	A	A		A
Ethyl Bromide		A	X		B		X
Ethyl Chloride		C	X	C	C		X
Ethylene Dichloride		B	X	C	B	X	X
Ethylene Glycol		A	A	A	A	T	A
Ethylene Oxide		A	X	B	A	X	X
Ferric Chloride		A	T	A	A	T	T
Ferric Nitrate		A	T	A	A	T	T
Ferrous Chloride		A	T	A	A	T	T
Ferrous Sulfate		A	T	A	A	T	T
Fluosilicic Acid		A	A	A	A	X	T
Formaldehyde	40%	A	C	A	A	B	
Formic Acid		A	C	A	A	X	
Furfural		B	X	C	B	X	X
Gallic Acid		A	T	A	B	X	
Gasoline	<25 BXT	B	C	B- C	B	A	A
Gasoline	>25 BXT	B	C		B	A	
Glucose		A	T	A	A	T	T
Glycerine		A	X	A	A	T	A
Hexane		B	C	B	B	A	T
Hydraulic Fluid		A	C	B	A	X	A
Hydrazine		A	X	C	A	X	X
Hydrobromic Acid		A	T	A	A	X	T
Hydrochloric Acid	20%	A	A	A	A	X	A
Hydrochloric Acid	37%	A	A	A	A	X	A
Hydrocyanic Acid		A	T	A	A	T	T
Hydrofluoric Acid	20%	A	T	A	A	X	T
Hydrofluoric Acid	75%	A	T	A	A	X	T
Hydrofluosilicic Acid	30%	A	A		A		T
Hydrogen Peroxide	3%	A	A	A	A	A	A
Hydrogen Peroxide	10%	A	A	A	A	T	T
Hydrogen Sulfide		A	A	A	A	T	T
Hydroquinone		A	T	A	A		
Iso Octane		A	X		A	A	T
Iso Octane		A	X		A	A	T
Isopropyl Alcohol	10%	A	T	A	A	A	A
JP-4 Jet Fuel		A	X		A	A	A

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Geomembrane Materials Chemical Resistance Ratings

Material	%	HDPE	PVC	Enviro Liner	Oil Resistant RPE	Polyurethane	Ethylene Interpolymer Alloy (EIA) (HAZGARD 5000 HT)
Jet A		A	X	B	A	T	T
Jet B		A	X		A	T	T
Kerosene		B	A	B	B	A	A
Lactic Acid		A	B	A	A	X	T
Lead Acetate		A	T	A	A	T	T
Linseed Oil		A	X	B	A	T	A
Lubricating Oil		A	C	B	A	T	T
Magnesium Carbonate		A	A	A	A	T	T
Magnesium Chloride		A	T	A	A	T	T
Magnesium Hyroxide		A	T	A	A	T	A
Magnesium Nitrate		A	T	A	A	T	T
Magnesium Sulphate		A	T	A	A	T	T
Malic Acid		A	T		A	T	T
Mercuric Chloride		A	T		A	T	T
Methyl Alcohol		A	T	A	T		A
Methyl Ethyl Keytone		C	C	C	C	C	C
Mineral Oil		A	B	B	B	A	T
Mineral Spirits		A	X	B	A	T	T
Naptha		B	B	B	B	X	T
Napthalene		A	C	C	B	X	X
Nitric Acid	10%	A	B	A	A	X	A
Nitric Acid	50%	A	B	A	A	X	C
Nitric Acid	70%	A	X	B	B	X	X
Nitro Benzene		C	C	C	C	X	X
Oleic Acid		B	T		B	T	T
Oleum	25%	C	X		C	X	
Oxalic Acid		A	A	A	A	T	
Palmatic Acid		A	T		A	T	T
Perchloroethylene	<1%	T	T	B	T	T	T
Perchloroethylene	100	C	X	C	C	C	C
Phenol		A	X	C	A	C	B
Phenol Formaldahyde			C			X	T
Phosphoric Acid	50%	A	A	A	A	C	B
Phosphoric Acid	75%	A	A	A	A	X	X
Phosphorous Yellow			X			X	T
Phosphorous Pentoxide		A	T		A	X	X
Photographic Solutions		A		A	A	T	T
Phthalate Plasticizer		A	X		A	C	C
Pickling Solutions		A		A	A	X	X
Potassium Bicarbonate		A	A	A	A	T	T
Potassium Carbonate		A	A	A	A	T	T
Potassium Chromate	40%	A	T	A	A	T	T
Potassium Cyanide		A	T	A	A	T	T
Potassium Dichromate		40	T	A	A	T	T
Potassium Hydroxide		A	25	A	A	T	T
Potassium Nitrate		A	A	A	A	T	T
Potassium Perchlorate	10%	A	T	A	A	T	T
Potassium Permaganate		20	T	A	A	T	T
Potassium Sulfate		A	T	A	A	A	T

July 2023

Geomembrane Materials Chemical Resistance Ratings

Material	%	HDPE	PVC	Enviro Liner	Oil Resistant RPE	Polyurethane	Ethylene Interpolymer Alloy (EIA) (HAZGARD 5000 HT)
Pyradine		A	X	A	A	X	X
Salt Water		A	A	A	A	A	A
Silicone Grease		A	T	A	A		T
Silver Nitrate		A	X	A	A	T	T
Skydrol Hydraulic Fluid			X	C		C	C
Soap Solutions		B	A	A	B	A	A
Sodium Acetate		A	T	A	A	A	T
Sodium Bicarbonate		A	A	A	A	A	T
Sodium Bisulphite		A	T	A	A	T	T
Sodium Borate		A	T	A	A	T	T
Sodium Carbonate		A	A	A	A	T	T
Sodium Chlorate		A	T	A	A	T	T
Sodium Chloride		A	A	A	A	A	T
Sodium Dichromate	20%	100	T	A	A	T	T
Sodium Ferrocyanide		A	T	A	A	T	T
Sodium Fluoride		A	T	A	A	T	T
Sodium Hydroxide	25%	A	A	A	A	T	A
Sodium Hydroxide	60%	A	X	A	A		A
Sodium Hypochlorite		A	12	A	A	A	A
Sodium Nitrate		A	T	A	A	T	T
Sodium Sulphate		A	A	A	A	T	T
Soybean Oil		A	X		A	T	A
Stannous Chloride		A	T	A	A	T	X
Stearic Acid		A	T	A	B	A	A
Styrene		C	X		C	X	X
Sulphuric Acid	10%	A	A	A	A	X	A
Sulphuric Acid	40%	A	B	A	A	X	
Sulphuric Acid	98%	B	C	B	B	X	C
Tannic Acid		10	T	A	A	X	T
Tataric Acid		A	T	A	A	T	T
Tetrahydrofuran		B	C	C	C	X	X
Toluene	<1%	T	T	B	T	T	T
Toluene	25%	T	X	C	T	T	T
Toluene	100	B	X	C	B	C	C
Transformer Oil		A	C	B	A	T	T
Triethanolamine		A	X		A	B	X
Trisodium Phosphate		A	T	A	A	T	T
Tung Oil			X				T
Turpentine		B	T	C	B	B	T
Urea		A	30	A	A	T	T
Vegetable Oil		A	C	B	A	A	A
Water		A	A	A	A	A	A
Xylene	<1%	T	T	B	T	T	T
Xylene	25%	T	X	C	T	T	T
Xylene	100	C	X	C	C	X	C
Zinc Chloride		A	A	A	A	T	T
Zinc Sulphate		A	T	A	A	T	T

APPENDIX E Chemical Risk Assessment – AECOM 2024

Prepared for
Tamboran B2 Pty Ltd
ABN: 42 105 431 525

AECOM

Beetaloo Exploration and Appraisal Program - Hydraulic Fracturing Chemical Risk Assessment

Beetaloo Sub-basin, NT

25-Mar-2024

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Beetaloo Exploration and Appraisal Program - Hydraulic Fracturing Chemical Risk Assessment

Beetaloo Sub-basin, NT

Client: Tamboran B2 Pty Ltd

ABN: 42 105 431 525

Prepared by

AECOM Australia Pty Ltd
Larrakia Country, Level 3, 9 Cavenagh Street, Darwin NT 0800, GPO Box 3175, Darwin NT 0801, Australia
T +61 8 8942 6200 F +61 8 8942 6299 www.aecom.com
ABN 20 093 846 925

25 March 2024

Job No.: 60623736

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Quality Information

Document	Beetaloo Exploration and Appraisal Program - Hydraulic Fracturing Chemical Risk Assessment
Ref	60623736
Date	25 March 2024
Prepared by	Cindy Cheung, Tiffany Teo
Reviewed by	Mark Chapman

Revision History

Rev	Revision Date	Details	Authorised	
			Name/Position	Signature
A	6 August 2019	Draft	Hayden Seear Project Manager	
0	16-Dec-2019	Final Draft	Hayden Seear Project Manager	
1	18-Mar-2020	Addition of Perfomatrol chemical to drilling fluid	Hayden Seear Project Manager	
2	05-Feb-2022	Addition of chemicals to drilling fluid	Alana Court Project Manager	
3	07-Jul-2022	Minor update to CRA	Alana Court Project Manager	
4	05-Dec-2022	Addition of Newpark chemicals	Alana Court Project Manager	
5	15-June-2023	Addition of packer fluid and lubricant chemicals	Alana Court Project Manager	
6	25-March-2024	Final	Alana Court Project Manager	

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1.0 Background

Chemical risk assessments for the hydraulic fracturing fluid systems were undertaken to assess the potential human health and environmental effects of the chemicals proposed to be used in Tamboran's Exploration and Appraisal Program.

The following fluid systems were assessed:

- Hydraulic fracture stimulation fluids
- Hydraulic fracture chemical tracers
- Drilling fluids
- Packer fluids and lubricants.

A separate assessment was also conducted on the recycled flow back water.

The risk assessment aligns with the *Northern Territory Government, Department of Environment, Parks and Water Security, Environment Management Plan Content Guideline, 2021* (herein referred to as DEPWS 2021) and is in accordance with requirements of the *Petroleum (Environment) Regulations 2016* (herein referred to as the Regulations).

The methods used for this updated chemical risk assessment also follow the guidance provided by the *Department of the Environment and Energy, Exposure Draft - Chemical Risk Assessment Guidance Manual: for chemicals associated with coal seam gas extraction, 2017* (DoEE, 2017) and the methodology adopted for the chemical risk assessment is in general accordance with the following:

- National Industrial Chemicals Notification and Assessment Scheme (NICNAS), National Assessment of Chemicals Associated with Coal Seam Gas Extraction in Australia, 2017 (herein referred to as NICNAS 2017), which includes the approach outlined in the National Chemical Risk Assessment Guidance Manuals published by the National Environmental Protection Council (NEPC)
- enHealth. Environmental Health Risk Assessment, Guidelines for Assessing Human Health Risks from Environmental Hazards, 2012
- National Environment Protection (Assessment of Site Contamination) Measure 1999 (ASC NEPM); Schedule B4, Site-specific health risk assessment methodology, 2013

The chemical risk assessment comprised the following tasks:

- Hazard assessment. An evaluation of the environmental hazard of the chemical additives in the hydraulic fracturing fluid systems, based on their environmental persistence, bioaccumulation and aquatic toxicity properties. Also included was an evaluation of human health effects (i.e. genotoxicity, carcinogenicity, reproductive toxicity, oral toxicity, inhalation toxicity, dermal toxicity, chronic repeated dose toxicity).
- Exposure assessment. The exposure assessment comprised of an evaluation of surface and sub-surface exposure pathways assessment and mass balance calculation to identify the amount of each chemical additive of the hydraulic fracturing fluid system.
- Screening and validation processes via Tier 1 and Tier 2 assessments. Determination of chemicals known to be of low concern, and identification of chemicals for further risk assessment.
    - Tier 1: using published information about each chemical proposed to be used in the hydraulic fracturing fluid systems.
    - Tier 2: A quantitative evaluation of the risks using toxicity values and quantitative estimates of chemical intake to provide an estimate of potential human health risk associated with the hydraulic fracturing activities, based on the identification of complete exposure pathways and hazard identification.

This document has been updated to include chemical risk assessments for two packer fluid recipes sodium bromide (NaBR) and calcium chloride (CaCL2) and lubricants.

2.0 Hydraulic Fracture Chemical Risk Assessment Tier 1 Screen

2.1.1 Outcome of Tier 1 Screen – Stimulation Fluid Recipes

Three Haliburton stimulation fluid recipes (SW, Hybrid and HVFR) and one Schlumberger fluid recipe (SLB HVFR) will be used for the Beetaloo Exploration and Appraisal Program.

Comparison of the chemicals with the assessment criteria as presented in DoEE (2017) and in Appendix C of DEPWS (2021) indicated that 10 chemicals from the Haliburton recipes and 21 chemicals from the Schlumberger recipe were not considered to require a Tier 2 assessment. Some of the chemicals have been assessed under the National Assessment of Chemicals Associated with Coal Seam Gas Extraction in Australia using the adapted IMAP screening process (NICNAS 2017) and were identified to be of low concern because of low hazard. Table 1and Table 2 presents a summary of the chemicals identified to be of low concern to human health for the hydraulic fracture stimulation fluid recipes.

Table 1 Chemicals identified to be of low human health concern (Tier 1) – Haliburton (HAL)Stimulation Fluid Recipes

CAS	Chemical	Reasoning
9003-04-7	Sodium polyacrylate	NICNAS (2017) low concern chemical
25987-30-8	Acrylamide acrylate copolymer	NICNAS (2017) low concern chemical
25987-30-8	Acrylamide, sodium acrylate polymer	NICNAS (2017) low concern chemical
107-21-1	Ethylene glycol	NICNAS (2017) low concern chemical
67-48-1	Choline chloride	NICNAS (2017) low concern chemical
77-92-9	Citric acid	NICNAS (2017) low concern chemical
7681-82-5	Sodium iodide	NICNAS (2017) low concern chemical
9000-30-0	Guar gum	NICNAS (2017) low concern chemical
7757-82-6	Sodium sulfate	NICNAS (2017) low concern chemical
126-96-5	Sodium diacetate	NICNAS (2017) low concern chemical

Based on the Tier 1 screening, most chemicals (24 from SW, 30 from Hybrid and 25 from HVFR) were identified to require a Tier 2 assessment. It is to be noted that none of these chemicals were identified to be persistent and bioaccumulative.

Table 2 Chemicals identified to be of low human health concern (Tier 1) – Schlumberger (SLB) Stimulation Fluid Recipes

CAS	Chemical	Reasoning
7647-01-0	Hydrochloric acid	The risk was classified as low based on chronic data. The substance is not classified as PBT. Management of this chemical is addressed in the EMP to prevent accidental release. OH&S procedures implemented by Tamboran will minimise human health exposure. A Tier 2 assessment is not required.
67-48-1	2-hydroxy-N, N,N-trimethylethanaminium chloride	A Tier 1 Human Health Assessment for this chemical has been conducted by NICNAS which concluded that this chemical was identified as low concern to human health. A Tier 2 assessment is not required.
9000-30-0	Guar gum	A Tier 1 Human Health Assessment for this chemical has been conducted by NICNAS which concluded that this chemical was identified as low concern to human health. A Tier 2 assessment is not required.

CAS	Chemical	Reasoning
107-21-1	Ethylene glycol	A Tier 1 Human Health Assessment for this chemical has been conducted by NICNAS which concluded that this chemical was identified as low concern to human health. A Tier 2 assessment is not required.
129898-01-7	2-Propenoic acid, polymer with sodium phosphinate	A Tier 1 Human Health Assessment for this chemical has been conducted by NICNAS which concluded that this chemical was identified as low concern to human health. A Tier 2 assessment is not required.
25085-02-3	Acrylamide sodium acrylate copolymer	A Tier 1 Human Health Assessment for this chemical has been conducted by NICNAS which concluded that this chemical was identified as low concern to human health. A Tier 2 assessment is not required.
1310-73-2	Sodium hydroxide	The risk was classified as low based on chronic data. The substance is not classified as PBT. Management of this chemical is addressed in the EMP to prevent accidental release. OH&S procedures implemented by Tamboran will minimise human health exposure. A Tier 2 assessment is not required.
31726-34-8	Poly(oxy-1,2-ethanediyl), alphahexyl-omega-hydroxy-	The risk was classified as low based on chronic and acute data. The substance is expected to be readily biodegradable and not bioaccumulative. A Tier 2 assessment is not required.
7647-14-5	Sodium Chloride	The risk was classified as low based on chronic data. The substance is inorganic and ubiquitous in the environment. The exposure concentration is below the respective ecotoxicity values. A Tier 2 assessment is not required.
10043-52-4	Calcium Chloride	The risk was classified as low based on chronic data and acute data. The substance is inorganic and ubiquitous in the environment. The exposure concentration is below the respective ecotoxicity values. A Tier 2 assessment is not required.
25038-72-6	Vinylidene chloride/methylacrylate copolymer	A Tier 1 Human Health Assessment for this chemical has been conducted by NICNAS which concluded that this chemical was identified as low concern to human health. A Tier 2 assessment is not required.
110-17-8	but-2-enedioic acid	The risk was classified as low based on acute data. The substance is expected to be readily biodegradable and not bioaccumulative. A Tier 2 assessment is not required.
111-46-6	Diethylene glycol	The risk was classified as low based on acute data. The substance is expected to be readily biodegradable and not bioaccumulative. A Tier 2 assessment is not required.
7447-40-7	Potassium Chloride	A Tier 1 Human Health Assessment for this chemical has been conducted by NICNAS which concluded that this chemical was identified as low concern to human health. A Tier 2 assessment is not required.
7631-86-9	Non-crystalline silica (impurity)	The risk was classified as low based on acute data. The substance is inorganic and ubiquitous in the environment. The exposure concentration is below the respective ecotoxicity values. A Tier 2 assessment is not required.

CAS	Chemical	Reasoning
14807-96-6	Talc	A Tier 1 Human Health Assessment for this chemical has been conducted by NICNAS which concluded that this chemical was identified as low concern to human health. A Tier 2 assessment is not required.
67-63-0	Propan-2-ol	The risk was classified as low based on chronic and acute data. The substance is expected to be readily biodegradable and not bioaccumulative. A Tier 2 assessment is not required.
67-56-1	Methanol	The risk was classified as low based on chronic data and it is expected to be readily biodegradable and not bioaccummulative. The exposure concentration is below the respective ecotoxicity values. A Tier 2 assessment is not required.
595585-15-2	Diutan	The risk was classified as low based on acute data. The substance is expected to be readily biodegradable and not bioaccumulative. A Tier 2 assessment is not required.
125005-87-0	Diutan gum	The risk was classified as low based on acute data. The substance is expected to be readily biodegradable and not bioaccumulative. A Tier 2 assessment is not required.
9002-84-0	poly(tetrafluoroethylene)	A Tier 1 Human Health Assessment for this chemical has been conducted by NICNAS which concluded that this chemical was identified as low concern to human health. A Tier 2 assessment is not required.

The Tier 1 screening is provided in **Appendix A** to **Appendix D**, and the chemical toxicological profiles are provided in **Appendix G** to **Appendix I**.

2.1.2 Outcome of Tier 1 Screen – Drilling Fluids

Two drilling fluid recipes (Original and Newpark) will be used for the Beetaloo Exploration and Appraisal Program.

2.1.2.1 Outcome of Tier 1 Screen – Original Drilling Fluid Recipe

Comparison of the chemicals with the assessment criteria indicated that 31 chemicals were not considered to require a Tier 2 assessment. 22 chemicals have been assessed by NICNAS (2017) and were identified to be of low concern. In following the IMAP screening process, a further 9 chemicals were also identified to be of low concern to human health and/or the environment.

Table 3 presents a summary of the chemicals identified to be of low concern to human health for the Original drilling fluid recipe.

Table 3 Chemicals identified to be of low human health concern (Tier 1) – Original Drilling Fluids

CAS	Chemical	Reasoning
Not Applicable	Proprietary Chemical	NICNAS (2017) low concern chemical
77-92-9	Citric acid	NICNAS (2017) low concern chemical
9004-32-4	Poly Anionic Cellulose	NICNAS (2017) low concern chemical
7447-40-7	Potassium Chloride	NICNAS (2017) low concern chemical
144-55-8	Sodium Bicarbonate	NICNAS (2017) low concern chemical
7647-14-5	Sodium Chloride	NICNAS (2017) low concern chemical
6381-77-7	Sodium erythorbate	NICNAS (2017) low concern chemical

CAS	Chemical	Reasoning
11138-66-2	Xanthan Gum	NICNAS (2017) low concern chemical
1317-65-3	Calcium Carbonate	NICNAS (2017) low concern chemical
1310-73-2	Sodium hydroxide	Acute toxicity only. No evidence of systemic toxicity. Due to the unavailability of a NOAEL, quantification of risks from repeated exposure is not possible. However, due to dissociation into ions which are subject to homeostatic controls in the human body, systemic effects from repeated exposures to sodium hydroxide are not expected (NICNAS 2017).
1310-58-3	Potassium Hydroxide	Acute toxicity only. No evidence of systemic toxicity. Similar results were reported for sodium hydroxide (NICNAS 2017).
9005-25-8	Starch	NICNAS polymer of low concern (PLC)
12199-37-0	Smectite	No chronic data available. Read across to bentonite which is listed as a NICNAS (2017) low concern chemical.
38193-60-1	Polyacrylamide	NICNAS PLC
1332-58-7	Plagioclase Feldspar/Kaolinite	Listed in US Food and Drug Administration (FDA) Generally Recognized as Safe (GRAS) list and Inert Ingredients Eligible for US Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) 25(b) pesticide products.
Proprietary	Performatrol*	A low weight and stable polymer that is highly biodegradable with low environmental toxicity.
13462-86-7	Barite	NICNAS (2017) low concern chemical
9003-05-8	Partially hydrolysed polyacrylamide	NICNAS (2017) low concern chemical
9004-32-4	Polyanionic cellulose, low viscosity	NICNAS (2017) low concern chemical
7727-43-7	Barium sulphate	NICNAS (2017) low concern chemical
7439-92-1	Lead	Maximum concentration below Australian Drinking Water Guidelines (NHMRC, 2018) and Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG, 2018).
7782-42-5	Graphite	NICNAS (2017) low concern chemical
14807-96-6	Talc	NICNAS (2017) low concern chemical
8042-47-5	Mineral oil	NICNAS (2017) low concern chemical
7440-50-8	Copper	NICNAS (2017) low concern chemical
7440-66-6	Zinc	NICNAS (2017) low concern chemical
1305-78-8	Calcium oxide	NICNAS (2017) low concern chemical
7429-90-5	Aluminium not powder, dust or fume	NICNAS (2017) low concern chemical
1317-38-0	Copper (II) Oxide	NICNAS (2017) low concern chemical
64-02-8	Tetrasodium ethylenediaminetetraacetate	NICNAS (2017) low concern chemical
1305-62-0	Calcium Hydroxide	The risk was classified as low based on acute data. A Tier 1 Environmental Assessment for this chemical has been conducted by NICNAS under the IMAP framework which concluded that it was

CAS	Chemical	Reasoning
		of low concern to the environment and thus required no further assessment.

*CAS number not provided to AECOM, information obtained via chemical manufacturer's SDS

Based on the Tier 1 screening 26 drilling fluid chemicals were identified to require a Tier 2 assessment. It is to be noted that none of these chemicals were identified to be persistent and bioaccumulative.

2.1.3 Outcome of Tier 1 Screen – Newpark Drilling Fluid Recipe

Comparison of the chemicals with the assessment criteria indicated that 42 chemicals were not considered to require a Tier 2 assessment. Eight chemicals have been assessed by NICNAS (2017) and were identified to be of low concern. In following the IMAP screening process, a further 34 chemicals (which were not assessed by NICNAS 2017) were identified to be of low concern to human health.

Table 4 presents a summary of the chemicals identified to be of low concern to human health for the Newpark drilling fluid recipe.

Table 4 Chemicals identified to be of low human health concern (Tier 1) – Newpark Drilling Fluids

CAS	Chemical	Reasoning
Proprietary	Barium Sulphate	NICNAS (2017) low concern chemical
Proprietary	Sodium Chloride	NICNAS (2017) low concern chemical
Proprietary	Citric acid	NICNAS (2017) low concern chemical
Proprietary	Calcium Carbonate (Limestone)	NICNAS (2017) low concern chemical
Proprietary	Disodium Pyrophosphate	NICNAS (2017) low concern chemical
Proprietary	Sodium sulphate	NICNAS (2017) low concern chemical
Proprietary	Sodium erythorbate	NICNAS (2017) low concern chemical
Proprietary	Potassium Chloride	NICNAS (2017) low concern chemical
Proprietary	Oxirane, 2-methyl-, polymer with oxirane, di-(9Z)-9-octadecenoate	NICNAS polymer of low concern (PLC)
Proprietary	Fatty acids, tall-oil	The risk was classified as low based on acute data and it is expected to be readily biodegradable and not bioaccumulative. The exposure concentration is below the respective ecotoxicity values. A Tier 2 assessment is not required.
Proprietary	Poly Anionic Cellulose	The risk was classified as low based on acute data. It is not expected to be readily biodegradable however it is not expected to be bioaccumulative. A Tier 1 Human Health and Environmental Assessment for this chemical has been conducted by NICNAS under the IMAP framework which concluded that it was low concern to human health and the environment and thus required no further assessment.
Proprietary	Acetic acid, ethenyl ester, polymer with ethenol	A Tier 1 Human Health and Environmental Assessment for this chemical has been conducted by NICNAS under the IMAP framework which concluded that it was low concern to human health and the environment and thus required no further assessment.
Proprietary	Crystalline silica, quartz	The risk was classified as low based on acute data. The substance is not classified as PBT. It is noted that the substance is hazardous to human health via

CAS	Chemical	Reasoning
		the inhalation pathways and as such OH&S procedures implemented by Tamboran will minimise human health exposure. Management of this chemical is addressed in the EMP to prevent accidental release. A Tier 2 assessment is not required.
Proprietary	Calcium Chloride	The risk was classified as low based on chronic data and acute data. The substance is inorganic and ubiquitous in the environment. A Tier 2 assessment is not required.
Proprietary	Sodium hydroxide	The risk was classified as low based on chronic data. The substance is not classified as PBT. Management of this chemical is addressed in the EMP to prevent accidental release. OH&S procedures implemented by Tamboran will minimise human health exposure. A Tier 2 assessment is not required.
Proprietary	Calcium carbonate	The risk was classified as low based on acute data. A Tier 1 Human Health and Environmental Assessment for this chemical has been conducted by NICNAS under the IMAP framework which concluded that it was low concern to human health and the environment and thus required no further assessment.
Proprietary	Starch	A Tier 1 Human Health and Environmental Assessment for this chemical has been conducted by NICNAS under the IMAP framework which concluded that it was low concern to human health and the environment and thus required no further assessment.
Proprietary	Xanthan Gum	The risk was classified as low based on acute data, and it is expected to be readily biodegradable and not bioaccumulative. A Tier 1 Human Health and Environmental Assessment for this chemical has been conducted by NICNAS under the IMAP framework which concluded that it was low concern to human health and the environment and thus required no further assessment.
Proprietary	Polyethylene Glycol	The risk was classified as low based on acute data and it is expected to be readily biodegradable and not bioaccumulative. A Tier 2 assessment is not required.
Proprietary	Octan-2-ol	The risk was classified as low based on acute data and it is expected to be readily biodegradable and not bioaccumulative. A Tier 2 assessment is not required.
Proprietary	Organic fibres / Cellulose	A Tier 1 Human Health and Environmental Assessment for this chemical has been conducted by NICNAS under the IMAP framework which concluded that it was low concern to human health and the environment and thus required no further assessment.

CAS	Chemical	Reasoning
Proprietary	Poly(oxy-1,2-ethanediyl), alpha-octyl-omega-hydroxy-	The risk was classified as low based on acute data and it is expected to be readily biodegradable and not bioaccumulative. A Tier 2 assessment is not required.
Proprietary	Starch, carboxymethyl ether, sodium salt	The risk was classified as low based on acute data and it is expected to be readily biodegradable and not bioaccumulative. A Tier 2 assessment is not required.
Proprietary	Methanol	The risk was classified as low based on chronic data and it is expected to be readily biodegradable and not bioaccumulative. The exposure concentration is below the respective ecotoxicity values. A Tier 2 assessment is not required.
Proprietary	Poly(oxy-1,2-ethanediyl), alpha-hydro-omega-hydroxy-, mono(2-(4,5-dihydro-2-nortall-oil alkyl-1H-imidazol-1-yl)ethyl) ethers	The risk was classified as low based on acute data. A Tier 2 assessment is not required.
Proprietary	Acetic acid	The risk was classified as low based on chronic data and it is expected to be readily biodegradable and not bioaccumulative. A Tier 2 assessment is not required.
Proprietary	Magnesium oxide	The risk was classified as low based on acute data. A Tier 1 Human Health and Environmental Assessment for this chemical has been conducted by NICNAS under the IMAP framework which concluded that it was low concern to human health and the environment and thus required no further assessment.
Proprietary	Calcium oxide	A Tier 1 Human Health and Environmental Assessment for this chemical has been conducted by NICNAS under the IMAP framework which concluded that it was low concern to human health and the environment and thus required no further assessment.
Proprietary	Non-crystalline silica (impurity)	The risk was classified as low based on acute data. The substance is inorganic and ubiquitous in the environment. The exposure concentration is below the respective ecotoxicity values. A Tier 2 assessment is not required.
Proprietary	2,2`,2"- Nitrilotriethanol (Triethanolamine)	The risk was classified as low based on chronic data. A Tier 2 assessment is not required.
Proprietary	Ethanamine, N-ethyl-N-hydroxy-	The risk was classified as low based on acute data. A Tier 2 assessment is not required.
Proprietary	Ethanolamine	The risk was classified as low based on chronic data and it is expected to be readily biodegradable and not bioaccumulative. A Tier 2 assessment is not required.
Proprietary	Sodium Glycolate (impurity)	The risk was classified as moderate based on acute data. The substance is expected to be readily biodegradable and not bioaccumulative. The exposure concentration is below the respective ecotoxicity values. A Tier 2 assessment is not required.
Proprietary	Hexanedinitrile, hydrogenated, high-boiling fraction	The risk was classified as low based on acute data and it is expected to be readily biodegradable and not bioaccumulative. A Tier 2 assessment is not required.

CAS	Chemical	Reasoning
Proprietary	Sodium Carbonate	Inorganic substance comprising ions of low ecotoxicological concern. This chemical is not expected to pose an unreasonable risk to the environment provided that ANZECC water quality guidelines for physical and chemical stressors are not exceeded.
Proprietary	Sodium sulphite	A Tier 1 Environmental Assessment for this chemical has been conducted by NICNAS under the IMAP framework which concluded that it was low concern to the environment and thus required no further assessment.
Proprietary	Diethanolamine	The risk was classified as low based on chronic data and it is expected to be readily biodegradable and not bioaccumulative. A Tier 2 assessment is not required.
Proprietary	Methyl alpha-D-glucopyranoside	The risk was classified as low based on acute data and it is expected to be readily biodegradable and not bioaccumulative. The exposure concentration is below the respective ecotoxicity values. A Tier 2 assessment is not required.
Proprietary	1,2,3-Propanetriol, homopolymer	A Tier 1 Human Health and Environmental Assessment for this chemical has been conducted by NICNAS under the IMAP framework which concluded that it was low concern to human health and the environment and thus required no further assessment.
Proprietary	1,2,3-Propanetriol, homopolymer, (Z)-9-octadecenoate	A Tier 1 Human Health and Environmental Assessment for this chemical has been conducted by NICNAS under the IMAP framework which concluded that it was low concern to human health and the environment and thus required no further assessment.
Proprietary	1-Dodecene, dimer	The risk was classified as low based on chronic data. A Tier 2 assessment is not required.
Proprietary	Glycol	Based on information provided in the SDS, this substance is classified as not hazardous. A Tier 2 assessment is not required.

Based on the Tier 1 screening three Newpark recipe drilling fluid chemicals were identified to require a Tier 2 assessment. It is to be noted that none of these chemicals were identified to be toxic *and* persistent *and* bioaccumulative.

Two of the chemicals from the Original drilling fluid recipe and all chemicals from the Newpark Recipe are proprietary. In accordance with s.105 of the *Industrial Chemical Act 2019*, for the proprietary chemicals, the CAS number and name have been redacted from the public submission to protect the intellectual property of chemical manufacturer. Although the proprietary details of the chemical have been redacted in this report, AECOM had access to the chemical name and CAS number and the assessment of risk from the redacted chemical is presented in this report. For the one proprietary chemical (Performatrol), the CAS number was not provided by the chemical manufacturer, however the information in its SDS was utilised to inform this assessment.

The Tier 1 screening is provided in **Appendix E**, the chemical toxicological profiles are provided in **Appendix H** and the Newpark Drilling Fluid SDS are provided in **Appendix J.**

2.1.4 Outcome of Tier 1 Screen – Chemical Tracers

The following chemical tracers may be used for the Beetaloo Exploration and Appraisal Program – CFT, GFT and WFT. The proprietary chemical CAS numbers and names have been redacted from the public submission to protect the intellectual property of chemical manufacturers. Although the proprietary details of the chemicals have been redacted in this report, AECOM had access to the chemical names and CAS numbers (with the exception of Performatrol) and the assessment of risk from the redacted chemicals is presented in this report.
Comparison of the chemicals with the assessment criteria indicated that all chemicals were considered to require a Tier 2 assessment. However, none of these chemicals were identified to be persistent and bioaccumulative.

The Tier 1 screening is provided in **Appendix F**, and the chemical toxicological profiles are provided in **Appendix I**.

2.1.5 Outcome of Tier 1 Screen – Packer Fluid Recipes

Comparison of the chemicals with the assessment criteria indicated that 8 chemicals were not considered to require a Tier 2 assessment. One chemical has been assessed by NICNAS (IMAP) and was identified to be of low concern. In following the IMAP and DEPWS (2021) screening process, a further 9 chemicals (which were not assessed by NICNAS 2017) were identified to be of low concern to human health.

Table 5 presents a summary of the chemicals identified to be of low concern to human health for the two packer fluid recipes (NaBr and CaCL2).

Table 5 Chemicals identified to be of low human health concern (Tier 1) – Packer Fluid Recipes (NaBR and CaCL2)

CAS	Chemical	Reasoning
7647-15-6	Sodium Bromide	A Tier 1 Human Health and Environmental Assessment for this chemical has been conducted by NICNAS under the IMAP framework which concluded that it was low concern to human health and the environment and thus required no further assessment.
111-30-8	Glutaraldehyde	The risk was classified as moderate based on chronic data; however the substance is readily biodegradable and not bioaccumulative. The exposure concentration is several orders of magnitude below the respective ecotoxicity values. A Tier 2 assessment is not required.
67-56-1	Methanol	The risk was classified as low based on chronic data and it is expected to be readily biodegradable and not bioaccumulative. The exposure concentration is below the respective ecotoxicity values. A Tier 2 assessment is not required.
Proprietary	BARACOR W-991 (chemical formulation unknown)	Due to proprietary controls, the chemical name or CAS numbers were not provided to AECOM, and a quantitative assessment could not be completed. However, based on the information provided in the SDS, this product is not classified as hazardous, and a Tier 2 assessment is assumed to be not required.
4719-04-4	Triazine based biocide C572,2',2''-(hexahydro-1,3, 5-triazine-1,3,5-triyl) triethanol	The risk was classified as high based on acute data; however the substance is readily biodegradable and not bioaccumulative. The exposure concentration is below the respective ecotoxicity values. A Tier 2 assessment is not required.

CAS	Chemical	Reasoning
Proprietary	OXYGON (chemical formulation unknown)	Due to proprietary controls, the chemical name or CAS numbers were not provided to AECOM, and a quantitative assessment could not be completed. However, based on the information provided in the SDS, this product is not classified as hazardous, and a Tier 2 assessment is assumed to be not required
10043-52-4	Calcium Chloride	The risk was classified as low based on chronic data and acute data. The substance is inorganic and ubiquitous in the environment. The exposure concentration is below the respective ecotoxicity values. A Tier 2 assessment is not required.
141-43-5	Ethanolamine	The risk was classified as low based on chronic data, and it is expected to be readily biodegradable and not bioaccumulative. The exposure concentration is below the respective ecotoxicity values. A Tier 2 assessment is not required.

Based on the Tier 1 screening one of the packer fluid chemicals were identified to require a Tier 2 assessment. It is to be noted that none of these chemicals were identified to be toxic *and* persistent *and* bioaccumulative.

Two of the products from the Packer fluid recipes are proprietary to protect the intellectual property of chemical manufacturer. Although the proprietary details of the products such as chemical formulation and CAS numbers have not been provided to AECOM, the information in their SDS' was utilised to inform this assessment.

The Tier 1 screening is provided in **Appendix E**, the chemical toxicological profiles are provided in **Appendix I** and the Packer Fluid SDS are provided in **Appendix J.**

2.1.6 Outcome of Tier 1 Screen – Lubricant Recipes

Comparison of the chemicals with the assessment criteria indicated that all 7 chemicals were not considered to require a Tier 2 assessment. One chemical has been assessed by NICNAS (IMAP) and was identified to be of low concern. In following the IMAP and DEPWS (2021) screening process, a further 6 chemicals (which were not assessed by NICNAS 2017) were identified to be of low concern to human health.

Table 6 presents a summary of the chemicals identified to be of low concern to human health for the lubricant recipes.

Table 6 Chemicals identified to be of low human health concern (Tier 1) – Lubricant recipes

CAS	Chemical	Reasoning
143-22-6	Triethylene glycol, monobutyl ether,	A Tier 1 Environmental Assessment for this chemical has been conducted by NICNAS under the IMAP framework which concluded that it was low concern to the environment and thus required no further assessment.
111-76-2	2-Butoxyethanol	The risk was classified as low based on chronic and acute data. The substance is expected to be readily biodegradable and not bioaccumulative. The exposure concentration is below the respective ecotoxicity values. A Tier 2 assessment is not required.

CAS	Chemical	Reasoning
111-42-2	Diethanolamine	The risk was classified as high based on chronic data. However, the substance is expected to be readily biodegradable and not bioaccumulative and the exposure concentration is several orders of magnitude below the respective ecotoxicity values. A Tier 2 assessment is not required.
Proprietary	Fatty Esters (Radiagreen EME)	Due to proprietary controls, the chemical name or CAS numbers were not provided to AECOM, and a quantitative assessment could not be completed. However, based on the information provided in the SDS, this product is not classified as hazardous, and a Tier 2 assessment is assumed to be not required
Proprietary	Fatty Esters (Radiagreen EBL)	Due to proprietary controls, the chemical name or CAS numbers were not provided to AECOM, and a quantitative assessment could not be completed. However, based on the information provided in the SDS, this product is not classified as hazardous, and a Tier 2 assessment is assumed to be not required
100-42-5	Styrene	The risk was classified as high based on acute and chronic data. However, the substance is expected to be readily biodegradable and not bioaccumulative. Due to proprietary controls the chemical concentration was not provided to AECOM, and a quantitative assessment could not be conducted. Based on the information provided in the SDS, this product is classified as hazardous. Management of this chemical is addressed in the EMP to prevent accidental release. OH&S procedures implemented by Tamboran will minimise human health exposure. A Tier 2 assessment is not required
Proprietary	Sulphonated organic polymer (Polydrill)	Due to proprietary controls, limited chemical information was obtained from the supplier. However, based on the information provided in the SDS, this product is not classified as hazardous, and a Tier 2 assessment is assumed to be not required.

Based on the Tier 1 screening none of the lubricant chemicals were identified to require a Tier 2 assessment. It is to be noted that none of these chemicals were identified to be toxic *and* persistent *and* bioaccumulative.

Four of the products from the lubricant recipes are proprietary to protect the intellectual property of chemical manufacturer. Although the proprietary details of the products such as chemical formulation, CAS numbers and concentrations have not been provided to AECOM, the information in their SDS' was utilised to inform this assessment.

The Tier 1 screening is provided in **Appendix K**, the chemical toxicological profiles are provided in **Appendix I** and the Lubricant SDS are provided in **Appendix J.**

3.0 Hydraulic Fracture Chemical Risk Assessment Tier 2 Screen

3.1.1 Tier 2 Screen Methodology

The Tier 2 assessment evaluated the toxicity of the individual chemicals and characterised the cumulative risks of the total fluid mixtures to Workers. The methodology incorporated an assessment of potential exposures to the Workers, with the following identified as the only potentially complete exposure pathways:

- Incidental ingestion and dermal contact of flowback fluid by Workers during the hydraulic stimulation period for a maximum duration of 1 month; and
- Inhalation of mist from the evaporation units at the flowback tank by Workers for a maximum duration of 1 year.

These scenarios are also deemed protective of the following due to the less frequent and short duration of these exposures occurring:

- Worker exposure during a spill (i.e., a coupling breaks on a tank and releases product onto the worker) or leak scenarios.

Based on the risk mitigation measures identified in the NT Government *Scientific Inquiry into Hydraulic Fracturing in the Northern Territory*, the *Code of Practice for Onshore Petroleum Activities* in the Northern Territory and mitigation measures outlined by Tamboran in its EMPs, no potentially complete exposure pathways were identified for hydraulic fracturing chemicals to impact groundwater that is used for beneficial use in the project area. The specific controls implemented by Tamboran focussed on the protection of aquifers follow industry standard practice and include:

- the physical vertical separation distances of 1,400 m between the aquifer and target formation to prevent any migration of stimulation fluid to aquifer units
- the horizontal separation distance between the exploration well and the closest groundwater extraction bores of at least 1 km, as per the Code
- use of double lined wastewater tanks with leak detection
- implementation of spill management plan
- use of enclosed tanks and freeboard requirements
- mandatory secondary containment requirements.

Potential exposures to hydraulic fracturing chemicals at the project area were therefore assessed to be limited to the above ground storage and handling of flowback water. Management of flowback water involves temporary storage in above ground fluid holding tanks for evaporation.

3.1.2 Chemicals of Potential Concern

Exposure point concentrations (EPC) were developed for each of the hydraulic fracturing fluid systems using theoretical calculations, where it was conservatively assumed that 100% of the mass of the chemicals injected into the well will be present in the flowback water.

A summary of the chemicals that require further assessment are presented in Table 7 to Table 14.

Table 7 Chemicals requiring further assessment (Tier 2) – Stimulation Fluid HALSW Recipe (24 chemicals)

CAS	Chemical Name
7647-01-0	Hydrochloric acid
68937-66-6	Alcohols, C6-12, ethoxylated propoxylated
69227-22-1	Alcohols, C10-16, ethoxylated propoxylated
7647-14-5	Sodium Chloride
64-19-7	Acetic acid
81741-28-8	Tributyl tetradecyl phosphonium chloride
25322-68-3	Polyethylene glycol
7631-90-5	Sodium bisulfite
104-55-2	Cinnamaldehyde
111-46-6	Diethylene glycol
67-56-1	Methanol
61788-90-7	Amine oxides, cocoalkyldimethyl
1310-73-2	Sodium hydroxide
100-52-7	Benzaldehyde
64-17-5	Ethanol
64742-47-8	Hydrotreated light petroleum distillate
61791-00-2	Fatty acids, tall-oil, ethoxylated
68155-20-4	Amides, tall-oil fatty, N,N-bis(hydroxyethyl)
71-36-3	Butyl alcohol
68131-39-5	Alcohols, C12-15, ethoxylated
68551-12-2	Alcohols, C12-16, ethoxylated
107-13-1	Acrylonitrile
111-42-2	Diethanolamine
111-30-8	Glutaraldehyde

Table 8 Chemicals requiring further assessment (Tier 2) – Stimulation Fluid HAL Hybrid Recipe (30 chemicals)

CAS	Chemical Name
7647-01-0	Hydrochloric acid
68937-66-6	Alcohols, C6-12, ethoxylated propoxylated
1319-33-1	Ulexite
102-71-6	Triethanol amine
7647-14-5	Sodium Chloride
1310-73-2	Sodium hydroxide
69227-22-1	Alcohols, C10-16, ethoxylated propoxylated
64-19-7	Acetic acid
111-42-2	Diethanolamine

CAS	Chemical Name
81741-28-8	Tributyl tetradecyl phosphonium chloride
7631-90-5	Sodium bisulfite
7758-19-2	Chlorous acid, sodium salt
12008-41-2	Disodium octaborate tetrahydrate
104-55-2	Cinnamaldehyde
25322-68-3	Polyethylene glycol
111-46-6	Diethylene glycol
14808-60-7	Crystalline silica, quartz
67-56-1	Methanol
7775-27-1	Sodium persulfate
61788-90-7	Amine oxides, cocoalkyldimethyl
100-52-7	Benzaldehyde
64-17-5	Ethanol
64742-47-8	Hydrotreated light petroleum distillate
61791-00-2	Fatty acids, tall-oil, ethoxylated
68155-20-4	Amides, tall-oil fatty, N,N-bis(hydroxyethyl)
71-36-3	Butyl alcohol
68131-39-5	Alcohols, C12-15, ethoxylated
68551-12-2	Alcohols, C12-16, ethoxylated
107-13-1	Acrylonitrile
111-30-8	Glutaraldehyde

Table 9 Chemicals requiring further assessment (Tier 2) – Stimulation Fluid HAL HVFR Recipe (25 chemicals)

CAS	Chemical Name
64-19-7	Acetic acid
69227-22-1	Alcohols, C10-16, ethoxylated propoxylated
68131-39-5	Alcohols, C12-15, ethoxylated
68551-12-2	Alcohols, C12-16, ethoxylated
68937-66-6	Alcohols, C6-12, ethoxylated propoxylated
68155-20-4	Amides, tall-oil fatty, N,N-bis(hydroxyethyl)
61788-90-7	Amine oxides, cocoalkyldimethyl
100-52-7	Benzaldehyde
71-36-3	Butyl alcohol
104-55-2	Cinnamaldehyde
111-42-2	Diethanolamine
111-46-6	Diethylene glycol
64-17-5	Ethanol

CAS	Chemical Name
68439-54-3	Ethoxylated branched C13 alcohol
61791-00-2	Fatty acids, tall-oil, ethoxylated
7647-01-0	Hydrochloric acid
64742-47-8	Hydrotreated light petroleum distillate
67-56-1	Methanol
25322-68-3	Polyethylene glycol
1338-43-8	Sobitan, mono-9-octadecenoate, (Z)
7631-90-5	Sodium bisulfite
1310-73-2	Sodium hydroxide
9005-65-6	Sorbitan monooleate polyoxyethylene derivative
81741-28-8	Tributyl tetradecyl phosphonium chloride
10486-00-7	Sodium perborate tetrahydrate

Table 10 Chemicals requiring further assessment (Tier 2) – Stimulation Fluid SLB HVFR Recipe (11 chemicals)

CAS	Chemical Name
1319-33-1	Ulexite
7789-38-0	Sodium bromate
7727-54-0	Diammonium peroxidisulphate
111-30-8	Glutaraldehyde
1303-96-4	Sodium Tetraborate Decahydrate
61789-77-3	Dicoco dimethyl quaternary ammonium chloride
61791-00-2	Fatty acids, tall-oil (CAS propreitary)
68527-49-1	Thiourea, polymer with formaldehyde and 1-phenylethanone
68951-67-7	Aliphatic alcohols, ethoxylated #2 (proprietary CAS)
107-19-7	Prop-2-yn-1-ol
629-73-2	Hexadec-1-ene

Table 11 Chemicals requiring further assessment (Tier 2) – Drilling Fluids- Original Recipe (26 chemicals)

CAS	Chemical Name
78330-21-9	Alcohol, C11-14, ethoxylated
64742-47-8	Distillates, hydrotreated light
68909-77-3	Ethanol, 2,2'-oxybis-, reaction products with ammonia, morpholine derivatives residues
111-30-8	Glutaraldehyde
107-22-2	Glyoxal <1%
67-56-1	Methanol
5064-31-3	Nitrilotriacetic acid, trisodium salt monohydrate
14808-60-7	Quartz/Cristobite

CAS	Chemical Name
497-19-8	Sodium Carbonate
533-74-4	Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione
50-01-1	Guanidine, hydrochloride (1:1)
4719-04-4	Triazine based biocide C572,2',2''-(hexahydro-1,3, 5-triazine-1,3,5-triyl) triethano
10192-30-0	Ammonium hydrogensulfite
68909-77-3	Filming amine Ethanol, 2,2'-oxybis-, reaction products with ammonia, morpholine derivs. Residues
848301-67-7	Distillates (Fischer-Tropsch), C8-26 - Branched and Linear
68990-47-6	Fatty acids, tall-oil, reaction products with diethylenetriamine, maleic anhydride, tetraethylenepentamine and triethylenetetramine
34590-94-8	(2-methoxymethylethoxy)propanol
1120-36-1	1-tetradecene
68155-20-4	Amides, tall oil fatty N,N-bis (hydroxyethyl)
68910-93-0	Fatty acids, tall-oil, reaction products with polyethylenepolyamines
68585-36-4	Phosphoric ester of ethoxylated fatty alcohol
629-73-2	Hexadec-1-ene
64742-52-5	Distillates (petroleum), hydrotreated heavy naphthenic
64742-53-6	Distillates (petroleum), hydrotreated light naphthenic < 3% DMSO
64741-44-2	Distillates (petroleum), straight-run middle
8052-42-4	Bitumen
68457-79-4	Phosphorodithioic acid, mixed o,o-bis(iso-bu and pentyl) esters, zinc salts
4719-04-4	Triazine based biocide C572,2',2''-(hexahydro-1,3, 5-triazine-1,3,5-triyl) triethano
10192-30-0	Ammonium hydrogensulfite
68909-77-3	Filming amine Ethanol, 2,2'-oxybis-, reaction products with ammonia, morpholine derivs. Residues
848301-67-7	Distillates (Fischer-Tropsch), C8-26 - Branched and Linear
68990-47-6	Fatty acids, tall-oil, reaction products with diethylenetriamine, maleic anhydride, tetraethylenepentamine and triethylenetetramine
34590-94-8	(2-methoxymethylethoxy)propanol
1120-36-1	1-tetradecene
68155-20-4	Amides, tall oil fatty N,N-bis (hydroxyethyl)
68910-93-0	Fatty acids, tall-oil, reaction products with polyethylenepolyamines
68585-36-4	Phosphoric ester of ethoxylated fatty alcohol
629-73-2	Hexadec-1-ene
64742-52-5	Distillates (petroleum), hydrotreated heavy naphthenic
64742-53-6	Distillates (petroleum), hydrotreated light naphthenic < 3% DMSO
64741-44-2	Distillates (petroleum), straight-run middle
8052-42-4	Bitumen
68457-79-4	Phosphorodithioic acid, mixed o,o-bis(iso-bu and pentyl) esters, zinc salts

Table 12 Chemicals requiring further assessment (Tier 2) – Newpark Drilling Fluids (3 chemicals)

CAS	Chemical Name
Proprietary	Distillates, hydrotreated light
Proprietary	Ethanol, 2,2'-oxybis-, reaction products with ammonia, morpholine derivatives residues
Proprietary	Glutaraldehyde

Table 13 Chemicals requiring further assessment (Tier 2) – Chemical Tracers (4 chemicals)

CAS	Chemical Name
Proprietary	CFT (one analogue chemical* selected to represent a group of 20 similar chemicals)
Proprietary	GFT (one analogue chemical* selected to represent a group of 15 similar chemicals)
Proprietary	WFT
Proprietary	WFT

*Analogue chemical selected as per guidance from DoEE (2017)

Table 14 Chemicals requiring further assessment (Tier 2) – NaBR Packer Fluid (1 chemical)

CAS	Chemical Name
7681-52-9	Sodium Hypochlorite

3.1.3 Outcome of Tier 2 Screen

For the assessment of the overall potential for adverse human health effects posed by simultaneous exposure to multiple chemicals, the estimated daily intake of the chemicals by inhalation and direct (ingestion and dermal) contact were compared to acceptable risk-based intakes to calculate an individual hazard quotient (HQ) and then summed for all constituents into a hazard index (HI).

Consistent with Australian risk assessment methodologies, if the HI is less than or equal to 1, then no adverse health effects are likely associated with exposures. However, if the total HI is greater than 1, adverse health effects may be possible and therefore the assumptions inherent in the risk characterisation process warrant further evaluation.

3.1.3.1 Stimulation Fluids

A summary of the calculated risks for the workers that are relevant to the assessment of potential exposure to COPCs in stimulation fluids on-site, based on the available data is presented in Table 15 and Table 16.

Table 15 Risk associated with potential exposure to Workers – Haliburton Stimulation Fluids

Receptor and Pathway	Threshold Hazard Index
	100% Mass Return
Worker - Exposure to Stimulation Fluid SW Recipe	
Ingestion of chemicals via incidental contact with flowback water	0.01
Dermal exposure to chemicals via incidental contact with flowback water	0.20
Inhalation of mist from the evaporation units containing flowback water	0.05
Total Risk	**0.3**
Worker - Exposure to Stimulation Fluid Hybrid Recipe	
Ingestion of chemicals via incidental contact with flowback water	0.03

Receptor and Pathway	Threshold Hazard Index
	100% Mass Return
Dermal exposure to chemicals via incidental contact with flowback water	0.08
Inhalation of mist from the evaporation units containing flowback water	0.74
Total Risk	**0.9**
Worker - Exposure to Stimulation Fluid HVFR Recipe	
Ingestion of chemicals via incidental contact with flowback water	0.01
Dermal exposure to chemicals via incidental contact with flowback water	0.22
Inhalation of mist from the evaporation units containing flowback water	0.05
Total Risk	**0.3**

The following can be noted from the table above:

- The calculated risks associated with potential exposure to COPC identified in flowback water, where either SW, Hybrid or HVFR stimulation fluid recipes are used and assuming 100% mass recovery, are below the target 1, hence, risks are considered to be low and acceptable.

Table 16 Risk associated with potential exposure to Workers – Schlumberger Stimulation Fluid

Receptor and Pathway	Threshold Hazard Index
	100% Mass Return
Worker - Exposure to Stimulation Fluid SW Recipe	
Ingestion of chemicals via incidental contact with flowback water	0.12
Dermal exposure to chemicals via incidental contact with flowback water	0.06
Inhalation of mist from the evaporation units containing flowback water	0.67
Total Risk	**0.8**

The following can be noted from the table above:

- The calculated risks associated with potential exposure to COPC identified in flowback water, where the SLB HVFR stimulation fluid recipe is used and assuming 100% mass recovery, is below the target 1, hence, risks are considered to be low and acceptable.

3.1.3.2 Drilling Fluid

A summary of the calculated risks for the workers that are relevant to the assessment of potential exposure to COPCs in the drilling fluid on-site, based on the available data is presented in Table 17 for the Original drilling fluid recipe and Table 18 for the Newpark drilling fluid recipe.

Table 17 Risk associated with potential exposure to Workers – Original Drilling Fluid Recipe

Receptor and Pathway	Threshold Hazard Index
	100% Mass Return
Worker	
Ingestion of chemicals via incidental contact with flowback water	0.004
Dermal exposure to chemicals via incidental contact with flowback water	0.007
Inhalation of mist from the evaporation units containing flowback water	0.2

Receptor and Pathway	Threshold Hazard Index
	100% Mass Return
Total Risk	**0.3**

The following can be noted from the table above:

- The calculated risks associated with potential exposure to COPC identified in flowback water, where Original drilling fluid recipe is used and assuming 100% mass recovery are below the target 1, hence, risks are considered to be low and acceptable.

Table 18 Risk associated with potential exposure to Workers – Newpark Drilling Fluid Recipe

Receptor and Pathway	Threshold Hazard Index
	100% Mass Return
Worker	
Ingestion of chemicals via incidental contact with flowback water	0.03
Dermal exposure to chemicals via incidental contact with flowback water	0.02
Inhalation of mist from the evaporation units containing flowback water	0.18
Total Risk	**0.24**

The following can be noted from the table above:

- The calculated risks associated with potential exposure to COPC identified in flowback water, where Newpark drilling fluid recipe is used and assuming 100% mass recovery are below the target 1, hence, risks are considered to be low and acceptable.

3.1.3.3 Chemical Tracers

A summary of the calculated risks for the workers that are relevant to the assessment of potential exposure to COPCs in the Chemical Tracers on-site, based on the available data is presented in Table 19.

Table 19 Risk associated with potential exposure to Workers – Chemical Tracers

Receptor and Pathway	Threshold Hazard Index
	100% Mass Return
Worker – Exposure to Chemical Tracer CFT Recipe	
Ingestion of chemicals via incidental contact with flowback water	0.0000032
Dermal exposure to chemicals via incidental contact with flowback water	0.000010
Inhalation of mist from the evaporation units containing flowback water	0.000018
Total Risk	**0.00003**
Worker – Exposure to Chemical Tracer GFT Recipe	
Ingestion of chemicals via incidental contact with flowback water	0.0000047
Dermal exposure to chemicals via incidental contact with flowback water	0.0010
Inhalation of mist from the evaporation units containing flowback water	0.000026
Total Risk	**0.001**
Worker – Exposure to Chemical Tracer WFT Recipe	

Receptor and Pathway	Threshold Hazard Index
	100% Mass Return
Ingestion of chemicals via incidental contact with flowback water	0.30
Dermal exposure to chemicals via incidental contact with flowback water	0.012
Inhalation of mist from the evaporation units containing flowback water	-
Total Risk	**0.3**

The following can be noted from the table above:

- The calculated risks associated with potential exposure to COPC identified in flowback water, where either CFT, GFT or WFT chemical tracer recipes are used and assuming 100% mass recovery, are below the target 1, hence, risks are considered to be low and acceptable.

3.1.3.4 Packer Fluid

A summary of the calculated risks for the workers that are relevant to the assessment of potential exposure to COPCs in the Packer Fluid on-site, based on the available data is presented in Table 20.

Table 20 Risk associated with potential exposure to Workers – Chemical Tracers

Receptor and Pathway	Threshold Hazard Index
	100% Mass Return
Worker – Exposure to NaBR Packer Fluid Recipe	
Ingestion of chemicals via incidental contact with flowback water	0.0000052
Dermal exposure to chemicals via incidental contact with flowback water	0.0000000076
Inhalation of mist from the evaporation units containing flowback water	0.000029
Total Risk	**0.00003**

The following can be noted from the table above:

- The calculated risks associated with potential exposure to COPC identified in flowback water, where the NaBR Packer fluid recipe is used and assuming 100% mass recovery, are below the target 1, hence, risks are considered to be low and acceptable.

3.1.3.5 Combination of Hydraulic Fracturing Fluid Systems

A summary of the calculated risks for the workers that are relevant to the assessment of potential exposure to COPCs from combinations of hydraulic fracturing fluid systems on-site, based on the available data is presented in Table 21 and Table 22.

Table 21 Risk associated with potential exposure to Workers – Combination of Haliburton Hydraulic Fracturing Fluid Systems

Receptor	Threshold Hazard Index
	100% Mass Return
Worker	
Exposure to SW + Original Drilling Fluid + Chemical Tracer CFT Recipes + Packer Fluid Recipe	0.5
Exposure to Hybrid + Original Drilling Fluid + Chemical Tracer CFT Recipes + Packer Fluid Recipe	1

Receptor	Threshold Hazard Index
	100% Mass Return
Exposure to HVFR+ Original Drilling Fluid + Chemical Tracer CFT Recipes + Packer Fluid Recipe	0.5
Exposure to SW + Original Drilling Fluid + Chemical Tracer GFT Recipes + Packer Fluid Recipe	0.5
Exposure to Hybrid + Original Drilling Fluid + Chemical Tracer GFT Recipes + Packer Fluid Recipe	1
Exposure to HVFR+ Original Drilling Fluid + Chemical Tracer GFT Recipes + Packer Fluid Recipe	0.5
Exposure to SW + Original Drilling Fluid + Chemical Tracer WFT Recipes + Packer Fluid Recipe	0.8
Exposure to Hybrid + Original Drilling Fluid + Chemical Tracer WFT Recipes + Packer Fluid Recipe	1
Exposure to HVFR+ Original Drilling Fluid + Chemical Tracer WFT Recipes + Packer Fluid Recipe	0.8
Exposure to SW + Newpark Drilling Fluid + Chemical Tracer CFT Recipes + Packer Fluid Recipe	0.5
Exposure to Hybrid + Newpark Drilling Fluid + Chemical Tracer CFT Recipes + Packer Fluid Recipe	1
Exposure to HVFR+ Newpark Drilling Fluid + Chemical Tracer CFT Recipes + Packer Fluid Recipe	0.5
Exposure to SW + Newpark Drilling Fluid + Chemical Tracer GFT Recipes + Packer Fluid Recipe	0.5
Exposure to Hybrid + Newpark Drilling Fluid + Chemical Tracer GFT Recipes + Packer Fluid Recipe	1
Exposure to HVFR+ Newpark Drilling Fluid + Chemical Tracer GFT Recipes + Packer Fluid Recipe	0.5
Exposure to SW + Newpark Drilling Fluid + Chemical Tracer WFT Recipes + Packer Fluid Recipe	0.8
Exposure to Hybrid + Newpark Drilling Fluid + Chemical Tracer WFT Recipes + Packer Fluid Recipe	1
Exposure to HVFR+ Newpark Drilling Fluid + Chemical Tracer WFT Recipes + Packer Fluid Recipe	0.8

The following can be noted from the table above:

- On the basis of the risk evaluation, no unacceptable risk to Workers was identified in all of the possible recipe combinations of Haliburton stimulation fluids, drilling fluids, packer fluid and chemical tracers. It is noted that conservative risk scenarios assessed included regular exposure to the flowback water during the hydraulic stimulation and evaporation phases, with exposures to high theoretical concentrations of COPC in the flowback water. This may result in overestimation of the risk.

Table 22 Risk associated with potential exposure to Workers – Combination of Schlumberger Hydraulic Fracturing Fluid Systems

Receptor	Threshold Hazard Index
	100% Mass Return
Worker	
Exposure to HVFR+ Original Drilling Fluid + Chemical Tracer CFT Recipes + Packer Fluid Recipe	1
Exposure to HVFR+ Original Drilling Fluid + Chemical Tracer GFT Recipes + Packer Fluid Recipe	1
Exposure to HVFR+ Original Drilling Fluid + Chemical Tracer WFT Recipes + Packer Fluid Recipe	1
Exposure to HVFR+ Newpark Drilling Fluid + Chemical Tracer CFT Recipes + Packer Fluid Recipe	1
Exposure to HVFR+ Newpark Drilling Fluid + Chemical Tracer GFT Recipes + Packer Fluid Recipe	1
Exposure to HVFR+ Newpark Drilling Fluid + Chemical Tracer WFT Recipes + Packer Fluid Recipe	1

The following can be noted from the table above:

- On the basis of the risk evaluation, no unacceptable risk to Workers was identified in all of the possible recipe combinations of Schlumberger stimulation fluids, drilling fluids, packer fluid and chemical tracers. It is noted that conservative risk scenarios assessed included regular exposure to the flowback water during the hydraulic stimulation and evaporation phases, with exposures to high theoretical concentrations of COPC in the flowback water. This may result in overestimation of the risk.

It is to be noted that this assessment does not replace the requirement for appropriate occupational health and safety procedures and management plans. Crystalline silica is scheduled by Safe Work Australia as a chemical for which health monitoring may be required.

The Tier 2 assessment is provided in **Appendix A** to **Appendix F** and **Appendix K**, the chemical toxicological profiles are provided in **Appendix G** to **Appendix I**.

3.1.4 Recycled Flowback Fluid Risk Assessment

A separate chemical risk assessment of the recycled flowback fluid is presented in **Appendix L**. The calculated risks associated with a worker's potential exposure to recycled flowback water was below the Non-Threshold target of 1E-05 and Threshold target of 1 respectively. As such, the chronic health risks were considered to be low and acceptable.

4.0 Chemical Transport, Storage and Handling

Tamboran aligns its transport, storage, and handling of hazardous chemicals with WHS Regulations, and the prescribed chemical legislation including all obligations and duties for storage and handling of hazardous chemicals and eliminating risks to workers from potential exposure and the potential requirements for health monitoring.

The following prescribed chemical legislation, as defined by the Petroleum (Environment) Regulations 2016, will be followed as it relates to the transport, storage, and handling of HFS chemicals:

- *Medicines, Poisons and Therapeutic Goods Act 2012 and Medicines, Poisons and Therapeutic Goods Regulations 2014*
- *Dangerous Goods Act 1998*
- *Water Act 1992*
- *Waste Management and Pollution Control Act 1998*
- *Work Health and Safety (National Uniform Legislation) Act 2011*
- *Radiation Protection Act 2004.*

5.0 References

AECOM (2021). *EP136 Beetaloo Sub-Basin, NT – Hydraulic Fracturing Chemical Risk Assessment*, November 2021

AECOM (2022). Well Drilling, Hydraulic Fracture Stimulation and Well Testing Environment Management Plan. EP136 Beetaloo Sub-basin, NT, July 2022

ANZG (2018). Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia. Available at www.waterquality.gov.au/anz-guidelines

DoEE (2017). Department of the Environment and Energy, Exposure Draft - Chemical Risk Assessment Guidance Manual: for chemicals associated with coal seam gas extraction, 2017

enHealth (2012). Environmental Health Risk Assessment, Guidelines for Assessing Human Health Risks from Environmental Hazards, 2012

ASC NEPM (2013). National Environment Protection (Assessment of Site Contamination) Measure 1999; Schedule B4, Site-specific health risk assessment methodology, 2013

NEPC (2009). National Chemical Risk Assessment Guidance Manuals. https://www.nepc.gov.au/projects/chemical-risk-assessment-guidance-manuals

NICNAS (2017). National Industrial Chemicals Notification and Assessment Scheme, National Assessment of Chemicals Associated with Coal Seam Gas Extraction in Australia, 2017

NHMRC (2018). Australian Drinking Water Guidelines 6, 2011, Version 3.5 Updated August 2018. National Water Quality Management

DEPWS (2021). Northern Territory Government, Department of Environment, Parks and Water Security, Environment Management Plan Content Guideline, 2021

Tamboran Petroleum Pty Ltd (2021). *Draft Drilling, Stimulation and Testing Environmental Management Plan*, 2019

Scientific Inquiry into Hydraulic Fracturing in the Northern Territory, Draft Final Report, December 2017.

Appendix A

Chemical Risk Assessment Hydraulic Fracture Stimulation Fluid – HAL Hybrid

Chemical Name	CAS Number	Density (kg/L)	Volume of Chemical (L)	Volume Fraction (%v/v)	Chemical Mass in Fluid (kg)	Mass Fraction (% w/w)	Concentration in Injected Fluid (mg/L)	Parent Compound Purpose	Ecotoxicity[1]	Toxicity[2]	Biodegradation[1,3]	Bioaccummulative[1]	Tier 1 Screening Assessment	Tier 2 Assessment Worker Ingestion Risk	Tier 2 Assessment Worker Dermal Risk	Tier 2 Assessment Worker Aerosol Inhalation Risk	Hazard Quotient	Outcome of Tier 2 Worker Risk Assessment[1]
Hydrochloric acid	7647-01-0	1.152	10,206	0.0392%	11,757	0.0421%	474	Acid	Algae = 0.492 mg/L Daphnia = 0.492 mg/L Fish = 4.92 mg/L Daphnia (chronic) = 62 mg/L	Based on Chronic: Low	N.A.(Inorganic)	N.A. (Inorganic)	Tier 2	NA. Acute toxity only	NA. Acute toxity only	NA. Acute toxity only	NA. Acute toxity only	NA. Acute toxity only
Alcohols, C6-12, ethoxylated propoxylated	68937-66-6	0.94	5,253	0.0202%	4,938	0.0177%	199	Surfactant	LC50 (96h) 0.59 mg/L (Pleuronectes platessa) EC50 (48h) 0.14 mg/L (Daphnia magna) EC50 (96h) 0.7 mg/L (Pseudokirchneriella subapitata) NOEC 4.4 mg/L (Pimephales promelas, juvenile)	Based on Chronic: Moderate	Expected to be readily biodegradable based on similar substances	Not Bio accumulative (Based on an estimated log Kow value of 4.3 – 5.36, and BCF value of 1.1 – 1.8)	Tier 2	1.40E-03	7.78E-05	7.79E-03	9.26E-03	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Ulexite	1319-33-1	1.49	3,476	0.0134%	5,175	0.0185%	209	Crosslinker	Chronic endpoints for Boric acid were available for Daphnia (6 mg/L) and Fish (2.1 mg/L).	Based on Chronic: Moderate	N.A.(Inorganic)	N.A. (Inorganic)	Tier 2	7.63E-03	3.21E-03	4.25E-02	5.33E-02	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Triethanol amine	102-71-6	1.1245	3,309	0.0127%	3,721	0.0133%	150	Crosslinker	Fish: 96h-LC50 of 11,800 mg/ Daphnia: 24h-EC50 of 1,390 mg/l Daphnia: 21 d NOEC of 16 mg/l Algae:96 h EC50 of 910 mg/l	Based on Chronic: Low	Inherently biodegradable	Not Bio accumulative (Based on an estimated log Kow value of -1.0, and BCF value of <3.9)	Tier 2	4.21E-04	9.55E-06	2.35E-03	2.78E-03	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Sodium Chloride	7647-14-5	2.165	2,859	0.0110%	6,189	0.0221%	249	Stabiliser	EC50 = 400 to 30000 mg/L EC50 Fish = 1290 mg/L NOEC = 314 mg/L (Daphnia)	Based on Chronic: Low	N.A.(Inorganic)	N.A. (Inorganic)	Tier 2	Low chronic toxicity, insufficient data to establish toxicity value	Low chronic toxicity, insufficient data to establish toxicity value	Low chronic toxicity, insufficient data to establish toxicity value	Low chronic toxicity, insufficient data to establish toxicity value	Low chronic toxicity, insufficient data to establish toxicity value
Sodium hydroxide	1310-73-2	1.515	2,059	0.0079%	3,119	0.0112%	126	pH buffer	Measured acute endpoints were available for fish (196 mg/L). Measured chronic endpoint were available for Daphnia (240 mg/L)	Based on Chronic: Low	N.A.(Inorganic)	N.A. (Inorganic)	Tier 2	NA. Acute toxicity only (irritant and corrosive), not systemically available in body	NA. Acute toxicity only (irritant and corrosive), not systemically available in body	NA. Acute toxicity only (irritant and corrosive), not systemically available in body	NA. Acute toxicity only (irritant and corrosive), not systemically available in body	NA. Acute toxicity only (irritant and corrosive), not systemically available in body
Alcohols, C10-16, ethoxylated propoxylated	69227-22-1	0.94	1,876	0.0072%	1,763	0.0063%	71	Friction Reducer, Surfactant	LC50 (96h) 0.59 mg/L (Pleuronectes platessa EC50 (48h) 0.14 mg/L (Daphnia magna) ErC50 (48h) 0.7 mg/L (Skeletonema costatum) ErC50 (16.9h) > 10 g/L (Pseudomonas putida)	Based on Acute: Very high	Expected to be readily biodegradable based on similar substances	Not Bio accumulative (Based on an estimated log Kow value of 4.3 – 5.36, and BCF value of 1.1 – 1.8)	Tier 2	4.99E-04	6.59E-02	2.78E-03	6.92E-02	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Acetic acid	64-19-7	1.05	1,558	0.0060%	1,636	0.0059%	66	Acid	Acute endpoints: Fish = 75 mg/L, Daphnia EC50 = 32 mg/L Chronic endpoints: Daphnia = 150 mg/L	Based on Chronic: Low	Readily biodegradable	Not Bio accumulative (Based on log Kow = -0.136)	Tier 2	1.93E-05	4.93E-06	1.07E-04	1.32E-04	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Diethanolamine	111-42-2	1.1	1,459	0.0056%	1,605	0.0057%	65	Breaker Activiator	Fish 96-h LC50 = 1370 mg/l Invertebrates 48-h EC50 = 55 mg/l Pseudokirchneriella subcapitata 96-h ErC50 = 2.2 mg/l Microorganisms 16-h TTC = 16 mg/l Daphnia magna, the NOEC (21 days) was 0.78 mg/l	Based on Chronic: High	Readily biodegradable	Not Bioaccumulative. Based on a measured log Kow of -2.18 and a calculated BCF of 3.16	Tier 2	1.62E-02	3.37E-04	9.04E-02	1.07E-01	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Tributyl tetradecyl phosphonium chloride	81741-28-8	0.95	736	0.0028%	700	0.0025%	28	Biocide	LC50: (96 hour) 0.46 mg/L (Oncorhynchus mykiss) LC50: (96 hour) 0.06 mg/l (Lepomis macrochirus) LC50: (96 hour) 0.58 mg/l (fish) TLM96: 1.6 mg/l (Crangon crangon) TLM48: 0.025 mg/l (Daphnia magna Modelled acute endpoint: Daphnia is 16.788 mg/L Fish is 1059.2530 mg/L	Based on Acute: Very high	Not available, however it has been observed to biodegrade in sediment.	Not bioaccumulative (Based on an estimated log Kow value of 6.26)	Tier 2	NA. Acute toxity only	NA. Acute toxity only	NA. Acute toxity only	NA. Acute toxity only	NA. Acute toxity only
Sodium bisulfite	7631-90-5	2.44	483	0.0019%	1,179	0.0042%	47	Scale Inhibitor	72h-EC50 = 36.8 mg sodium sulfite/L (alga) NOEC of >8.41 mg sodium sulfite/L (Daphnia)	Based on Chronic: Moderate	N.A.(Inorganic)	N.A. (Inorganic)	Tier 2	1.59E-05	3.04E-11	8.85E-05	1.04E-04	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Chlorous acid, sodium salt	7758-19-2	2.47	458	0.0018%	1,131	0.0040%	46	Breaker	LC50 values above 100 mg/l (fish) LC50 48-hour = 0.063 mg/l (daphnia) ECr50 value at 72 h as 1.2 mg/l (algae)	Based on Acute: Very High	No. Not expected to be persistent due to its instability.	No. Based on an estimated log Kow value of 3	Tier 2	4.10E-03	1.56E-08	2.29E-02	2.70E-02	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Disodium octaborate tetrahydrate	12008-41-2	1.874	336	0.0013%	630	0.0023%	25	Crosslinker	Algae: EC10 (3 d) 96.5 mg/L (Pseudokirchneriella subcapitata) Fish: LC50 (96 h) 314.6 mg/L (Pimephales promelas), NOEC (34 d) 25.2 mg/L (Danio rerio) Invertebrates: NOEC (21 d) 42.5 mg/L (Daphnia magna) Microorganism: EC50 (3 h) > 39371 mg/L (activated sludge)	Based on Chronic: Low	N.A.(Inorganic)	N.A. (Inorganic)	Tier 2	9.29E-04	3.90E-04	5.17E-03	6.49E-03	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Cinnamaldehyde	104-55-2	1.048	332	0.0013%	348	0.0012%	14	Corrosion Inhibitor	Danio rerio (Zebrafish) 96 h LC50 = 3.1 mg/L; Daphnia magna (Water flea) 48 h EC50 = 3.86 mg/L; Pseudokirchneriella subcapitata (Green algae) 72 h EC50 = 4.07 mg/L. 72 h NOEC value = 2.0 mg/L Pseudokirchneriella subcapitata (Green algae)	Based on Chronic: Moderate	N.A.(Inorganic)	N.A. (Inorganic)	Tier 2	2.46E-05	5.89E-05	1.37E-04	2.21E-04	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Polyethylene glycol	25322-68-3	1.21	328	0.0013%	397	0.0014%	16	Scale Inhibitor	LC50 = 100 mg/L (fish) LC50 = 1000 mg/L (invertebrates) EC 50 = 15.91 mg/L (algae)	Based on Acute: Moderate	Expected to be readily biodegradable	No based on BCF of 3.2	Tier 2	7.03E-06	6.92E-09	3.92E-05	4.62E-05	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Diethylene glycol	111-46-6	1.12	303	0.0012%	339	0.0012%	14	Corrosion Inhibitor	LC 50 = >100 mg/L (fish, invertebrates, algae)	Based on Acute: Low	Readily biodegradable	No based on the estimated BCF of 3	Tier 2	1.60E-04	3.07E-06	8.91E-04	1.05E-03	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Crystalline silica, quartz	14808-60-7	2.6	235	0.0009%	611	0.0022%	25	Crosslinker	no acute toxicity to fish, Daphnia, or algae, though some physical effects were observed with loading rates of greater than or equal to 10 g/L (OECD 2004). Any harmful effects to aquatic ecosystems are therefore not ecotoxicological in nature. No chronic toxicity data were identified.	Based on Acute: Low	N.A.(Inorganic)	N.A. (Inorganic)	Tier 2	NA. Not toxic via oral exposure as not absorbed via GI tract	NA. Not toxic via dermal exposure.	5.62E-01	5.62E-01	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).

Chemical Name	CAS Number	Density (kg/L)	Volume of Chemical (L)	Volume Fraction (%v/v)	Chemical Mass in Fluid (kg)	Mass Fraction (% w/w)	Concentration in Injected Fluid (mg/L)	Parent Compound Purpose	Ecotoxicity[1]	Toxicity[2]	Biodegradation[1,3]	Bioaccummulative[1]	Tier 1 Screening Assessment	Tier 2 Assessment Worker Ingestion Risk	Tier 2 Assessment Worker Dermal Risk	Tier 2 Assessment Worker Aerosol Inhalation Risk	Hazard Quotient	Outcome of Tier 2 Worker Risk Assessment[1]
Methanol	67-56-1	0.791	125	0.0005%	99	0.0004%	4	Corrosion Inhibitor, Surfactant	LC50s ranged from 15,400 to 29,400 mg/L (fish) 24-hour and 48-hour EC50s were > 10,000 mg/L (Daphnia) 28 days NOEC was 446.7 mg/L (fish) 21 days NOEC was 208 mg/L (invertebrates)	Based on Chronic: Low	Readily biodegradable	No based on the Log Kow of -0.74	Tier 2	3.76E-04	5.52E-05	2.10E-03	2.53E-03	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Sodium persulfate	7775-27-1	1.68	116	0.0004%	194	0.0007%	8	Breaker	LC50 fish = 163 to 771 mg/L. EC50 invertebrates = 133 and 519 mg/L EC50 algae = 116 mg/L	Based on Acute: Low	N.A.(Inorganic)	N.A. (Inorganic)	Tier 2	4.10E-05	1.33E-08	2.29E-04	2.70E-04	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Amine oxides, cocoalkyldimethyl	61788-90-7	0.716	103	0.0004%	74	0.0003%	3	Corrosion Inhibitor	LC50/EC50/ErC50 values: 0.60-32 mg/L for fish 0.50-10.8 mg/L for Daphnia magna 0.010-5.30 mg/L for algae NOEC/ EC20: 0.010-1.72 mg/L for algae 0.28 mg/L for Daphnia 0.31 mg/L for fish	Based on Chronic: Very High	Readily biodegradable	No based on the calculated Log Kow of <2.7 and BCF <87	Tier 2	1.30E-04	6.18E-03	7.27E-04	7.04E-03	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Benzaldehyde	100-52-7	1.0415	47	0.0002%	48	0.0002%	2	Corrosion Inhibitor	Acute LC50 for freshwater fish is 1.07 mg/L, freshwater invertebrates is 16.2 mg/L and EC10 for freshwater algae is 20 mg/L. Chronic NOEC for freshwater fish is 0.12 mg/L.	Based on Chronic: High	Expected to be readily biodegradable	No based on Log Pow of 1.4	Tier 2	2.29E-05	4.03E-05	1.27E-04	1.91E-04	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Ethanol	64-17-5	0.7864	45	0.0002%	35	0.0001%	1	Surfactant	LC50/EC50 > 1000 mg/L (fish, daphnia, algae) NOEC for invertebrates is 9.6 mg/L (10 day reproduction), plants it is 280 mg/L (7 day study)	Based on Chronic: High	Readily biodegradable	No based on calculated logBCF=0.5	Tier 2	2.07E-07	5.11E-08	1.15E-06	1.41E-06	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Hydrotreated light petroleum distillate	64742-47-8	0.8	43	0.0002%	35	0.0001%	1	Friction Reducer, Surfactant	96 hr LL50 was 2 to 5 mg/L (fish) 48 hr EL50 was 1.4 mg/L (daphnia) 21 d NOEL = 0.48 mg/L (daphnia)	Based on Chronic: High	Readily biodegradable	Yes based on calculated log BCF values for constituents that range from 2.78 to 4.06, and calculated BCF values of 598 to 11,430 L/kg wet-weight	Tier 2	4.90E-07	4.41E-04	2.73E-06	4.45E-04	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Fatty acids, tall-oil, ethoxylated	61791-00-2	1.054	23	0.0001%	24	0.0001%	1	Surfactant	96h-LL50 > 100 mg/L (fish) 48h-EL50 = 12.41 mg/L (invertebrates) 72h-EL50 = 39.7 mg/L (algae) 72h-EL10 = 7.08 mg/L (algae)	Based on Acute: High	Readily biodegradable (read across)	No based on low BCF values of < 100 L/kg ww	Tier 2	3.37E-07	3.27E-06	1.88E-06	5.48E-06	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Amides, tall-oil fatty, N,N-bis(hydroxyethyl)	68155-20-4	0.9	22	0.0001%	20	0.0001%	1	Surfactant	LC50 (96h) 6.7 mg/L (Danio rerio) (similar substance) LC50 (21d) = 0.1 mg/L (Daphnia magna) LC50 (48h) = 2.15 mg/L EC50 (72h) 2.2 mg/L (Scendesmus subspicatus) (similar substance)	Based on Chronic: High	Readily biodegradable (read across)	No Log Kow 3	Tier 2	5.67E-06	1.86E-04	3.16E-05	2.23E-04	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Butyl alcohol	71-36-3	0.81	22	0.0001%	18	0.0001%	1	Surfactant	Fish, LC50 (96h) 1376 mg/l Invertebrates, EC50 (48h) 1328 mg/L) Algae, EC50 (96h) 225 mg/L EC10 (17h) Pseudomonas putida = 2476 mg/L Chronic NOECrepro (21d) = 4.1 mg/L for Daphnia magna	Based on Chronic: Moderate	Readily biodegradable	No based on low log Kow values of 1	Tier 2	1.98E-06	2.11E-06	1.10E-05	1.51E-05	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Alcohols, C12-15, ethoxylated	68131-39-5	0.867	20	0.0001%	18	0.0001%	1	Friction Reducer, Surfactant	96 h LC50 Oncorhynchus mykiss was 5 - 7 mg/L Lepomis macrochirus, NOEC (30 days) was 0.11 – 0.33 mg/L. Daphnia magna, EC50 (48 h) was 2.5 mg/L. Daphnia magna, NOEC (21 days) was 0.77 – 1.75 mg/L. Green algae, EC50 (96 h) was 1.4 mg/L. EC50 (3 h) for microorganisms was 140 mg/L.	Based on Chronic: High	Readily biodegradable	No. Based on an estimated log Kow value of 4.3 – 5.36, and BCF value of 1.1 – 1.8, it is not expected to be bioaccumulative.	Tier 2	4.97E-06	3.39E-06	2.77E-05	3.61E-05	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Alcohols, C12-16, ethoxylated	68551-12-2	0.97	20	0.00008%	19	0.00007%	1	Corrosion Inhibitor, Surfactant	96 h LC50 Oncorhynchus mykiss was 5 - 7 mg/L Lepomis macrochirus, NOEC (30 days) was 0.11 – 0.33 mg/L. Daphnia magna, EC50 (48 h) was 2.5 mg/L. Daphnia magna, NOEC (21 days) was 0.77 – 1.75 mg/L. Green algae, EC50 (96 h) was 1.4 mg/L. EC50 (3 h) for microorganisms was 140 mg/L.	Based on Chronic: High	Readily biodegradable	No. Based on an estimated log Kow value of 4.3 – 5.36, and BCF value of 1.1 – 1.8, it is not expected to be bioaccumulative.	Tier 2	5.42E-06	2.24E-03	3.02E-05	2.27E-03	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Acrylonitrile	107-13-1	0.806	2	0.00001%	2	0.00001%	0.1	Surfactant	96h LC50 for freshwater fish = 10 - 20 mg/l 96h LC50 for saltwater fish 8.6 mg/l 48h EC50 for Daphnia = 7.6 mg/l 30d NOEC for fish of 0.17 mg/l	Based on Chronic: High	Biodegradable	No based on the low log Pow (0.00-0.30)	Tier 2	1.11E-04	5.95E-05	6.21E-04	7.92E-04	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Glutaraldehyde	111-30-8	1.05	0	0.0000001%	0	0.00000%	0.001	Biocide	96 h acute Bluegill sunfish LC50 = 11.2 mg/L 48 h acute Oyster larvae LC550 = 2.1 mg/L 96 h acute Green crabs LC50 = 465 mg/L 96 h acute Grass shrimp LC50 = 41 mg/L 48 acute Daphnia magna LC50 = 0.35 mg/L 48 acute Daphnia magna LC50 = 16.3 mg/L 21 d reproduct'n Daphnia magna LOEC = 4.3 mg/L, NOEC = 2.1 mg/L 96 h algal growth inhibition Selenastrum capricornutum ILm = 3.9 mg/L (median inhibitory limit) 96 h algal growth inhibition Scenedesmus subspicatus EC50 = 1.0 mg/L Bacterial inhibition Sewage microbes IC50 = 25-34 mg/L	Based on Chronic: Moderate	Readily biodegradable	No based on the Log Pow of -0.01	Tier 2	7.47E-05	1.12E-05	4.16E-04	5.02E-04	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
																Total Risk	**0.9**	The calculated risks associated with potential exposure to COPC identified in flowback water, where the HYBRID Recipe is used and assuming 100% mass recovery is below the target of 1, respectively. Hence, chronic health risks are considered to be low and acceptable.

Notes
Tier 1 (NICNAS) - Chemical identified as of low concern for human health, as published in the National Assessment of Chemicals Associated with Coal Seam Gas Extraction in Australia (NICNAS 2017).
1 - Please refer to the individual toxicity profiles for further detail.
2 - Toxicity assessed using Commonwealth of Australia 2013 Ecotoxicity Assessment Guidelines (presented as Table 4 in the Northern Territory Government Draft Guideline for the Preparation of an Environment Management Plan under the Petroleum Regulations (2019))
3- Biodegradation assessed as per Northern Territory Government Draft Guideline for the Preparation of an Environment Management Plan under the Petroleum Regulations (2019) and Australian Government Department of Health National Industrial Chemicals Notification and Assessment Scheme (NICNAS)
BCF - Bioconcentration Factor
NA - Not Applicable
MOE - Margin of Exposure
NICNAS 2017 - National Assessment of Chemicals Associated with Coal Seam Gas Extraction in Australia
DOE 2017 - Draft Risk Assessment Guidance Manual: For Chemicals Associated with Coal Seam Gas Extraction, Australian Government, Department of Energy

Toxicity and Dermal Absorption Parameters

C = calculated from chronic value, Ch = chronic value adopted

CAS#	Chemical	Oral/Dermal Exposures				Inhalation Exposures									
		Threshold Chronic TDI or RfD (mg/kg/day)		Dermal Permeability (cm/hr)	Reference	Inhalation Unit Risk $(ug/m^3)^{-1}$	Non-Threshold Slope Factor $(mg/kg/day)^{-1}$		Threshold Chronic TC or RfC (mg/m^3)		NOAEC or LOAEC (mg/m^3)	NOAEL or LOAEL (mg/kg bw/d)	Reference	UF	Reference
	COPC in Hydraulic Fracturing Fluid Injected into Well														
1319-33-1	Boronatrocalcite/Ulexite[A]	0.096	D	9.14E-04	EPI (as boric acid)				0.336	converted from RFD		9.6	NICNAS (2017)	100	NICNAS (2017)
68937-66-6	Alcohols, C6-12, ethoxylated propoxylated[B]	0.5	D	1.21E-04	EPI				1.75	converted from RFD		50	NICNAS (2017)	100	NICNAS (2017)
69227-22-1	Alcohols, C10-16, ethoxylated propoxylated[B]	0.5	D	2.87E-01	EPI				1.75	converted from RFD		50	NICNAS (2017)	100	NICNAS (2017)
64-19-7	Acetic acid	12	D	5.56E-04	EPI				42	converted from RFD		1200	NICNAS (2017)	100	NICNAS (2017)
25322-68-3	Polyethylene glycol	8	D	2.14E-06	EPI				28	converted from RFD		8000	REACH	1000	D
7631-90-5	Sodium bisulfite[C]	10.5	D	4.16E-09	EPI				36.75	converted from RFD		1050	NICNAS (2017)	100	NICNAS (2017)
104-55-2	Cinnamaldehyde	2	D	5.20E-03	EPI				7	converted from RFD		200	NTP (2004); REACH	100	D
67-56-1	Methanol	0.037	D	3.19E-04	EPI				0.13	converted from RFD		3.7	NICNAS (2017)	100	NICNAS (2017)
61788-90-7	Amine oxides, cocoalkyldimethyl	0.08	D	1.03E-01	EPI				0.28	converted from RFD		80	OECD (2001)	1000	D
100-52-7	Benzaldehyde	0.3	D	3.83E-03	EPI				1.05	converted from RFD		300	OECD (2002); REACH; NICNAS	1000	D
64-17-5	Ethanol	24	D	5.38E-04	EPI				84	converted from RFD		2400	NICNAS (2017)	100	NICNAS (2017)
64742-47-8	Hydrotreated light petroleum distillate	10	D	1.96E+00	EPI				35	converted from RFD		1000	NICNAS (2017)	100	NICNAS (2017)
61791-00-2	Fatty acids, tall-oil, ethoxylated	10	D	2.11E-02	EPI				35	converted from RFD		1000	REACH	100	D
68155-20-4	Amides, tall-oil fatty, N,N-bis(hydroxyethyl)	0.5	D	7.14E-02	EPI				1.75	converted from RFD		50	USEPA (2010)	100	D
71-36-3	Butyl alcohol	1.25	D	2.31E-03	EPI				4.375	converted from RFD		125	OECD (2001)/NICNAS	100	D
68131-39-5	Alcohols, C12-15, ethoxylated[B]	0.5	D	1.48E-03	EPI				1.75	converted from RFD		50	NICNAS (2017)	100	NICNAS (2017)
68551-12-2	Alcohols, C12-16, ethoxylated[B]	0.5	D	8.97E-01	EPI				1.75	converted from RFD		50	NICNAS (2017)	100	NICNAS (2017)
107-13-1	Acrylonitrile	0.0025	D	1.16E-03	EPI				0.00875	converted from RFD		0.25	OECD (2005); NICNAS	100	D
111-42-2	Diethanolamine	0.014	D	4.51E-05	EPI				0.049	converted from RFD		14	REACH; OECD (2002); NICNAS	1000	D
111-30-8	Glutaraldehyde	0.04	D	3.25E-04	EPI				0.14	converted from RFD		4	NICNAS (2017)	100	NICNAS (2017)
102-71-6	Triethanol amine	1.25	D	4.93E-05	EPI				4.375	converted from RFD		125	NICNAS (2017)	100	NICNAS (2017)
7758-19-2	Chlorous acid, sodium salt	0.039	D	8.27E-09	EPI				0.1365	converted from RFD		3.9	NICNAS (2017)	100	NICNAS (2017)
12008-41-2	Disodium octaborate tetrahydrate[A]	0.096	D	9.14E-04	EPI (as boric acid)				0.336	converted from RFD		9.6	NICNAS (2017)	100	NICNAS (2017)
7775-27-1	Sodium persulfate	0.67	D	7.05E-07	EPI				2.345	converted from RFD		67	NICNAS (2017)	100	NICNAS (2017)
68439-54-3	Ethoxylated branched C13 alcohol	0.5	D	1.06E-03	EPI				1.75	converted from RFD		50	NICNAS (2017)	100	NICNAS (2017)
1338-43-8	Sobitan, mono-9-octadecenoate, (Z)	25	JECFA	5.02E-02	EPI				87.5	converted from RFD		-	JECFA(1973); US FDA; FSANZ (2018)	-	-
9005-65-6	Sorbitan monooleate polyoxyethylene derivative	10	EFSA	3.54E-09	EPI				35	converted from RFD		-	EFSA (2017)	-	-
111-46-6	2,2''-oxydiethanol (diethylene glycol)	0.3	D	4.17E-05	EPI				1.05	converted from RFD		300	Health Council of the Netherlands (2007); NICNAS	1000	D
7631-90-5	Sodium bisulfate[C]	10.5	D	9.29E-09	EPI				36.75	converted from RFD		1050	NICNAS (2017)	100	NICNAS (2017)
14808-60-7	Crystalline silica, quartz	Not toxic via oral/dermal exposure							0.003	USEPA (2019)		-	-	-	-
10486-00-7	Sodium perborate tetrahydrate	0.05	D	1.81E-06	EPI				0.175	converted from RFD		50	REACH	1000	D

Notes:

A - Read across data from Boric Acid

B - Read across data from Alcohol ethoxylates C6-C12

C - Read across data from Sodium Sulfite

References:

D - Derived (refer to individual Toxicity Profiles)

EFSA - European Food Safety Authority

EPI - USEPA Estimation Programs Interface (EPI) Suite

FSANZ - Food Standards Australia New Zealand

J- JECFA - Joint FAO/WHO Expert Committee on Food Additives

NICNAS - National Industrial Chemicals Notification and Assessment Scheme. Assessed at https://www.nicnas.gov.au/

NICNAS (2017) - Department of the Environment and Energy 2017 , National assessment of chemicals associatedwith coal seam gas extraction in Australia, prepared by the National Industrial ChemicalsNotification and Assessment Scheme

NTP - US Department of Health and Serices National Toxicology Program

OECD - Organisation for Economic Co-operation and Development Screening Information Data Set (SIDS)

REACH - ECHA REACH European Chemicals Agency Database: http://apps.echa.europa.eu

Exposure to Chemicals via Incidental Ingestion of Flowback fluid - Hybrid Recipe

Chronic Exposures

General Data/ Equations	Units	Exposure Calculations (RME) Ingestion of Flowback Water by Workers	
Exposure Parameters			
Exposure Frequency (EF)	days/year	20	Assume work 5 days per week for 1 month during the fraccing period
Exposure Duration (ED)	years	0.083	Maximum duration of the frac. Works will be complete in one month.
Body Weight (BW)	kg	78	Average male and female adults as per enHealth 2012
Averaging Time - NonThreshold (ATc)	days	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (ATn)	days	30.42	USEPA 1989 and CSMS 1996
Ingestion Rate (IRw)	L/day or L/hr	0.005	Assume Incidental ingestion of 5 ml (1 tsp) of water per day during fraccing.
Bioavailability (B)	-	100%	Assume 100% bioavailability via ingestion of chemicals in water.
Intake Factor = IRw*ET*B*EF*ED / BW*AT	L/kg/day	**4.2E-09**	**NonThreshold**
		3.5E-06	**Threshold**

Daily Intake from Water = Concentration in Water x Intake Factor (ref: USEPA 1989)
NonThreshold Risk = Daily Intake from Water for NonThreshold Effects x Slope Factor
Hazard Quotients = (Daily Intake from Water for Threshold Effects/ADI)

Chemical		Toxicity Data				Concentration	Daily Intake		Calculated Risk	
		Non-Threshold Slope Factor	Chronic Threshold TDI	Background Intake (% Chronic TDI)	Chronic TDI Allowable for Assessment (TDI-Background)	in Water	NonThreshold	Threshold	NonThreshold Risk	Chronic Hazard Quotient
		$(mg/kg\text{-}day)^{-1}$	(mg/kg/day)		(mg/kg/day)	(mg/L)	(mg/kg/day)	(mg/kg/day)	(unitless)	(unitless)
68937-66-6	Alcohols, C6-12, ethoxylated propoxylatedB		5.0E-01		5.0E-01	198.94	8.3E-07	7.0E-04	--	1.4E-03
1319-33-1	Boronatrocalcite/UlexiteA		9.6E-02		9.6E-02	208.50	8.7E-07	7.3E-04	--	7.6E-03
102-71-6	Triethanol amine		1.3E+00		1.3E+00	149.92	6.3E-07	5.3E-04	--	4.2E-04
69227-22-1	Alcohols, C10-16, ethoxylated propoxylatedB		5.0E-01		5.0E-01	71.05	3.0E-07	2.5E-04	--	5.0E-04
64-19-7	Acetic acid		1.2E+01		1.2E+01	65.91	2.8E-07	2.3E-04	--	1.9E-05
111-42-2	Diethanolamine		1.4E-02		1.4E-02	64.65	2.7E-07	2.3E-04	--	1.6E-02
7631-90-5	Sodium bisulfiteC		1.1E+01		1.1E+01	47.49	2.0E-07	1.7E-04	--	1.6E-05
7758-19-2	Chlorous acid, sodium salt		3.9E-02		3.9E-02	45.57	1.9E-07	1.6E-04	--	4.1E-03
12008-41-2	Disodium octaborate tetrahydrateA		9.6E-02		9.6E-02	25.38	1.1E-07	8.9E-05	--	9.3E-04
104-55-2	Cinnamaldehyde		2.0E+00		2.0E+00	14.02	5.9E-08	4.9E-05	--	2.5E-05
25322-68-3	Polyethylene glycol		8.0E+00		8.0E+00	16.01	6.7E-08	5.6E-05	--	7.0E-06
111-46-6	2,2"-oxydiethanol (diethylene glycol)		3.0E-01		3.0E-01	13.65	5.7E-08	4.8E-05	--	1.6E-04
67-56-1	Methanol		3.7E-02		3.7E-02	3.98	1.7E-08	1.4E-05	--	3.8E-04
7775-27-1	Sodium persulfate		6.7E-01		6.7E-01	7.82	3.3E-08	2.7E-05	--	4.1E-05
61788-90-7	Amine oxides, cocoalkyldimethyl		8.0E-02		8.0E-02	2.97	1.2E-08	1.0E-05	--	1.3E-04
100-52-7	Benzaldehyde		3.0E-01		3.0E-01	1.95	8.2E-09	6.9E-06	--	2.3E-05
64-17-5	Ethanol		2.4E+01		2.4E+01	1.41	5.9E-09	5.0E-06	--	2.1E-07
64742-47-8	Hydrotreated light petroleum distillate		1.0E+01		1.0E+01	1.39	5.8E-09	4.9E-06	--	4.9E-07
61791-00-2	Fatty acids, tall-oil, ethoxylated		1.0E+01		1.0E+01	0.96	4.0E-09	3.4E-06	--	3.4E-07
68155-20-4	Amides, tall-oil fatty, N,N-bis(hydroxyethyl)		5.0E-01		5.0E-01	0.81	3.4E-09	2.8E-06	--	5.7E-06
71-36-3	Butyl alcohol		1.3E+00		1.3E+00	0.71	3.0E-09	2.5E-06	--	2.0E-06
68131-39-5	Alcohols, C12-15, ethoxylatedB		5.0E-01		5.0E-01	0.71	3.0E-09	2.5E-06	--	5.0E-06
68551-12-2	Alcohols, C12-16, ethoxylatedB		5.0E-01		5.0E-01	0.77	3.2E-09	2.7E-06	--	5.4E-06
107-13-1	Acrylonitrile		2.5E-03		2.5E-03	0.08	3.3E-10	2.8E-07	--	1.1E-04
111-30-8	Glutaraldehyde		4.0E-02		4.0E-02	0.85	3.6E-09	3.0E-06	--	7.5E-05
								Total Risk (mixture)		**3.21E-02**

Note:
This scenario is deemed protective of the following scenarios due to the less frequent and short duration of exposures:
- Worker exposure during a spill (i.e.a couple breaks on a tank and releases product onto the worker) or leak scenarios

Dermal Exposure to Chemicals via Contact with Flow Back Water - Hybrid Recipe

Chronic Exposures

General Data/ Equations	Units	Exposure Calculations (RME) Dermal Contact with Flow Back Water by Workers	
Exposure Parameters			
Exposure Frequency (EF)	days/year	20	Assume work 5 days per week for 1 month during the fraccing period
Exposure Duration (ED)	years	0.083	Maximum duration of the frac. Works will be complete in one month.
Body Weight (BW)	kg	78	Average male and female adults as per enHealth 2012
Averaging Time - NonThreshold (ATc)	days	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (ATn)	days	30.42	USEPA 1989 and CSMS 1996
Surface Area (SAw)	cm^2	2300	Hands and forearms exposed (enHealth 2012) Occupational HSE would require long pants and closed shoes on Australian work sites; forearms conservatively included
Exposure Time (ET)	hr/day	1	Assume contact with flow back water for 1 hours per day
Conversion Factor (CF)	L/cm^3	1.E-03	Conversion of units
Intake Factor = SAw*ET*CF*EF*ED / BW*AT	L-hr/(cm-kg-day)	**1.9E-06** **1.6E-03**	**NonThreshold** **Threshold**

Daily Intake from Water = Concentration in Water x Dermal Permeability x Intake Factor (ref: USEPA 1989, 2004)
NonThreshold Risk = Daily Intake from Water for NonThreshold Effects x Slope Factor
Hazard Quotients = (Daily Intake from Water for Threshold Effects/ADI)

	Chemical	Toxicity Data				Dermal Permeability	Concentration in Water	Daily Intake		Calculated Risk	
		Non-Threshold Slope Factor	Chronic Threshold TDI	Background Intake (% chronic TDI)	Chronic TDI Allowable for Assessment (TDI-Background)			NonThreshold	Threshold	NonThreshold Risk	Chronic Hazard Quotient
		$(mg/kg\text{-}day)^{-1}$	(mg/kg/day)		(mg/kg/day)	(cm/hr)	(mg/L)	(mg/kg/day)	(mg/kg/day)	(unitless)	(unitless)
68937-66-6	Alcohols, C6-12, ethoxylated propoxylatedB		5.0E-01		5.0E-01	1.2E-4	198.94	4.6E-08	3.9E-05	--	7.8E-05
1319-33-1	Boronatrocalcite/UlexiteA		9.6E-02		9.6E-02	9.1E-4	208.50	3.7E-07	3.1E-04	--	3.2E-03
102-71-6	Triethanol amine		1.3E+00		1.3E+00	4.9E-5	149.92	1.4E-08	1.2E-05	--	9.6E-06
69227-22-1	Alcohols, C10-16, ethoxylated propoxylatedB		5.0E-01		5.0E-01	2.9E-1	71.05	3.9E-05	3.3E-02	--	6.6E-02
64-19-7	Acetic acid		1.2E+01		1.2E+01	5.6E-4	65.91	7.0E-08	5.9E-05	--	4.9E-06
111-42-2	Diethanolamine		1.4E-02		1.4E-02	4.5E-5	64.65	5.6E-09	4.7E-06	--	3.4E-04
7631-90-5	Sodium bisulfiteC		1.1E+01		1.1E+01	4.2E-9	47.49	3.8E-13	3.2E-10	--	3.0E-11
7758-19-2	Chlorous acid, sodium salt		3.9E-02		3.9E-02	8.3E-9	45.57	7.2E-13	6.1E-10	--	1.6E-08
12008-41-2	Disodium octaborate tetrahydrateA		9.6E-02		9.6E-02	9.1E-4	25.38	4.5E-08	3.7E-05	--	3.9E-04
104-55-2	Cinnamaldehyde		2.0E+00		2.0E+00	5.2E-3	14.02	1.4E-07	1.2E-04	--	5.9E-05
25322-68-3	Polyethylene glycol		8.0E+00		8.0E+00	2.1E-6	16.01	6.6E-11	5.5E-08	--	6.9E-09
111-46-6	2,2"-oxydiethanol (diethylene glycol)		3.0E-01		3.0E-01	4.2E-5	13.65	1.1E-09	9.2E-07	--	3.1E-06
67-56-1	Methanol		3.7E-02		3.7E-02	3.2E-4	3.98	2.4E-09	2.0E-06	--	5.5E-05
7775-27-1	Sodium persulfate		6.7E-01		6.7E-01	7.1E-7	7.82	1.1E-11	8.9E-09	--	1.3E-08
61788-90-7	Amine oxides, cocoalkyldimethyl		8.0E-02		8.0E-02	1.0E-1	2.97	5.9E-07	4.9E-04	--	6.2E-03
100-52-7	Benzaldehyde		3.0E-01		3.0E-01	3.8E-3	1.95	1.4E-08	1.2E-05	--	4.0E-05
64-17-5	Ethanol		2.4E+01		2.4E+01	5.4E-4	1.41	1.5E-09	1.2E-06	--	5.1E-08
64742-47-8	Hydrotreated light petroleum distillate		1.0E+01		1.0E+01	2.0E+0	1.39	5.3E-06	4.4E-03	--	4.4E-04
61791-00-2	Fatty acids, tall-oil, ethoxylated		1.0E+01		1.0E+01	2.1E-2	0.96	3.9E-08	3.3E-05	--	3.3E-06
68155-20-4	Amides, tall-oil fatty, N,N-bis(hydroxyethyl)		5.0E-01		5.0E-01	7.1E-2	0.81	1.1E-07	9.3E-05	--	1.9E-04
71-36-3	Butyl alcohol		1.3E+00		1.3E+00	2.3E-3	0.71	3.1E-09	2.6E-06	--	2.1E-06
68131-39-5	Alcohols, C12-15, ethoxylatedB		5.0E-01		5.0E-01	1.5E-3	0.71	2.0E-09	1.7E-06	--	3.4E-06
68551-12-2	Alcohols, C12-16, ethoxylatedB		5.0E-01		5.0E-01	9.0E-1	0.77	1.3E-06	1.1E-03	--	2.2E-03
107-13-1	Acrylonitrile		2.5E-03		2.5E-03	1.2E-3	0.08	1.8E-10	1.5E-07	--	5.9E-05
111-30-8	Glutaraldehyde		4.0E-02		4.0E-02	3.3E-4	0.85	5.3E-10	4.5E-07	--	1.1E-05
									Total Risk (mixture)		**7.92E-02**

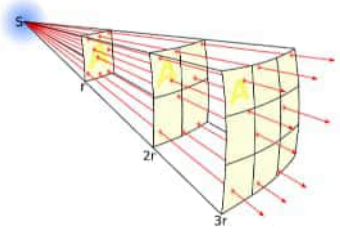
Note:
This scenario is deemed protective of the following scenarios due to the less frequent and short duration of exposures:
- Worker exposure during a spill (i.e.a couple breaks on a tank and releases product onto the worker) or leak scenarios

Aerosol Exposure - Hybrid Recipe

The concentration of COPC in aerosol spray was estimated by calculating the concentration for driftable droplets using a mixed box model in which steady state
An emission factor for driftable aerosol was estimated using the algorithm presented below.

Emission Factor for Driftable Aerosol Algorithm

$$Emission\ Factor_{driftable\ aerosol}\left(\frac{L}{m^3}\right) = \frac{Box\ Centre^2(m) \times \left(\frac{Spray\ Vol\ \left(\frac{L}{hr}\right) \times Aerosol_{driftable}(\%)}{BoxVR\ \left(\frac{m^3}{hr}\right)}\right)}{BoxDistance^2\ (m)}$$



Aerosol Exposure Modelling Notes:

1) The inhalation of chemicals in mist/aerosol resultant from irrigation activities is dependent upon the concentration in water, the amount of water used per unit time, how close a person stands to the spray generation, how long they are in a position of exposure and the extent of spray drift (determined by the size of the water droplets and speed/direction of the wind). These equations are applicable for non-volatile contaminants that are inhaled.
2) These equations calculate the concentration for driftable droplets using a simple well mixed box model in which steady state air concentrations are calculated. The 'Inverse square law' is then applied to approximate the air concentration at a distance from the virtual air box. This law assumes the further away a receptor is from the spray source, the density of the droplets will decrease. The density of the spray droplets is inversely proportional to the square of the distance from the source.

Parameter	Units	Value	Description
Spray box length	m	3	Assume a 'spray box' of 3 m long.
Spray box width	m	3	Assume a 'spray box' of 3 m wide.
Box Centre	m	1.5	Distance to centre of box is 1.5 m.
$Box_{Distance}$	m	2	Distance the irrigation worker is from the 'spray box'. Assumed a distance of 2 m.
$Aerosol_{driftable}$	unitless	0.2	Proportion of aerosol spray that drifts outside the 'spray box' and available for exposure. Assumed 0.2, based on a droplet size of 400 – 500 µm that falls approximately 0.3 m in less than 10 seconds, with a lateral drift of approximately 3.5 m in a 5 km/hr wind (i.e. a light breeze) (Grisso et al. 2013).
Spray Volume	L/hr	1800.0	1800 L/min, irrigation value adopted from NZ MtE (2011) Appendix 5A.
Wind speed	m/hr	9000	Based on windspeed of 2.5 m/sec
BoxVR	m^3/hr	81000.0	Ventilation rate of spray in the 'spray box'. Assumed to be 81,000 m3/hr based on a wind speed of 9000 m/hr, and a 'spray box' dimension of 3 x 3 m.

CAS	Chemical	Concentration in Water	Generation rate of chemical in volume	Driftable Aerosol Emission Factor
		mg/L	mg/hr	L/m^3
68937-66-6	Alcohols, C6-12, ethoxylated propoxyla	198.94	71619.76796	2.500000E-03
1319-33-1	Boronatrocalcite/UlexiteA	208.50	75061.62126	2.500000E-03
102-71-6	Triethanol amine	149.92	53969.54143	2.500000E-03
69227-22-1	Alcohols, C10-16, ethoxylated propoxy	71.05	25578.48856	2.500000E-03
64-19-7	Acetic acid	65.91	23729.05222	2.500000E-03
111-42-2	Diethanolamine	64.65	23274.23026	2.500000E-03
7631-90-5	Sodium bisulfateC	47.49	17096.46645	2.500000E-03
7758-19-2	Chlorous acid, sodium salt	45.57	16404.17744	2.500000E-03
12008-41-2	Disodium octaborate tetrahydrateA	25.38	9138.176627	2.500000E-03
104-55-2	Cinnamaldehyde	14.02	5046.11094	2.500000E-03
25322-68-3	Polyethylene glycol	16.01	5761.962715	2.500000E-03
111-46-6	2,2"-oxydiethanol (diethylene glycol)	13.65	4915.303675	2.500000E-03
67-56-1	Methanol	3.98	1431.585551	2.500000E-03
7775-27-1	Sodium persulfate	7.82	2816.350509	2.500000E-03
61788-90-7	Amine oxides, cocoalkyldimethyl	2.97	1069.713505	2.500000E-03
100-52-7	Benzaldehyde	1.95	703.1990079	2.500000E-03
64-17-5	Ethanol	1.41	508.3231621	2.500000E-03
64742-47-8	Hydrotreated light petroleum distillate	1.39	501.7922025	2.500000E-03
61791-00-2	Fatty acids, tall-oil, ethoxylated	0.96	345.0387202	2.500000E-03
68155-20-4	Amides, tall-oil fatty, N,N-bis(hydroxye	0.81	290.4332727	2.500000E-03
71-36-3	Butyl alcohol	0.71	254.0323025	2.500000E-03
68131-39-5	Alcohols, C12-15, ethoxylatedB	0.71	254.9143591	2.500000E-03
68551-12-2	Alcohols, C12-16, ethoxylatedB	0.77	278.0084294	2.500000E-03
107-13-1	Acrylonitrile	0.08	28.55172359	2.500000E-03
111-30-8	Glutaraldehyde	0.85	306.4351619	2.500000E-03
14808-60-7	Crystalline silica, quartz	24.60	8857.767115	2.500000E-03

Exposure to Chemicals via Inhalation of Mist from the Evaporation Units - Hybrid Recipe

Chronic Exposures

General Data/ Equations	Units	Exposure Calculations (RME) Inhalation of Mist by Workers	
Exposure Parameters			
Exposure Frequency (EF)	days/year	240	Exposure for 5 days per week minus 4 weeks holidays
Exposure Duration (ED)	years	1	Maximum duration that the flowback tank will be on-site
Exposure Time (ET)	hr/day	1	Professional judgement for irrigation exposure. Assume worker to be near tank for 1 hours every working day.
Driftable aerosol emission factor (EMF)	L/m3	2.50E-03	Calculated
Aerosol Inhalation Bioavailability (AAF)	unitless	1.0	Assume 100% bioavailability
Averaging Time - Threshold (AT)	years	1.0	USEPA 1989 and CSMS 1996
$ITF_{inh,w,shwr} = \frac{EmF \times AAF \times ET_{iw} \times EF \times ED}{365\ \frac{days}{year} \times 24\ \frac{hours}{day} \times AT}$			

Daily Intake = Concentration in Water x Intake Factor (ref: USEPA 1989)
Hazard Quotients = (Daily Intake from Water for Threshold Effects/ADI)

CAS	Chemical	Groundwater Concentration	Aerosol Inhalation Bioavailability	Driftable Aerosol Emission Factor	RfC (Background Corrected)	Threshold Intake and Risk Calculations: Adult Exposure Factor (threshold)	Adult Exposure Adjusted Air Concentration (threshold)	Hazard Index (Adult)
		mg/L	(unitless)	(L/m^3)	(mg/m^3)	(L/m^3)	(mg/m^3)	(unitless)
68937-66-6	Alcohols, C6-12, ethoxylated propoxylatedB	1.99E+02	1.00	2.50E-03	1.75E+00	6.85E-05	1.36E-02	7.79E-03
1319-33-1	Boronatrocalcite/UlexiteA	2.09E+02	1.00	2.50E-03	3.36E-01	6.85E-05	1.43E-02	4.25E-02
102-71-6	Triethanol amine	1.50E+02	1.00	2.50E-03	4.38E+00	6.85E-05	1.03E-02	2.35E-03
69227-22-1	Alcohols, C10-16, ethoxylated propoxylatedB	7.11E+01	1.00	2.50E-03	1.75E+00	6.85E-05	4.87E-03	2.78E-03
64-19-7	Acetic acid	6.59E+01	1.00	2.50E-03	4.20E+01	6.85E-05	4.51E-03	1.07E-04
111-42-2	Diethanolamine	6.47E+01	1.00	2.50E-03	4.90E-02	6.85E-05	4.43E-03	9.04E-02
7631-90-5	Sodium bisulfateC	4.75E+01	1.00	2.50E-03	3.68E+01	6.85E-05	3.25E-03	8.85E-05
7758-19-2	Chlorous acid, sodium salt	4.56E+01	1.00	2.50E-03	1.37E-01	6.85E-05	3.12E-03	2.29E-02
12008-41-2	Disodium octaborate tetrahydrateA	2.54E+01	1.00	2.50E-03	3.36E-01	6.85E-05	1.74E-03	5.17E-03
104-55-2	Cinnamaldehyde	1.40E+01	1.00	2.50E-03	7.00E+00	6.85E-05	9.60E-04	1.37E-04
25322-68-3	Polyethylene glycol	1.60E+01	1.00	2.50E-03	2.80E+01	6.85E-05	1.10E-03	3.92E-05
111-46-6	2,2''-oxydiethanol (diethylene glycol)	1.37E+01	1.00	2.50E-03	1.05E+00	6.85E-05	9.35E-04	8.91E-04
67-56-1	Methanol	3.98E+00	1.00	2.50E-03	1.30E-01	6.85E-05	2.72E-04	2.10E-03
7775-27-1	Sodium persulfate	7.82E+00	1.00	2.50E-03	2.35E+00	6.85E-05	5.36E-04	2.29E-04
61788-90-7	Amine oxides, cocoalkyldimethyl	2.97E+00	1.00	2.50E-03	2.80E-01	6.85E-05	2.04E-04	7.27E-04
100-52-7	Benzaldehyde	1.95E+00	1.00	2.50E-03	1.05E+00	6.85E-05	1.34E-04	1.27E-04
64-17-5	Ethanol	1.41E+00	1.00	2.50E-03	8.40E+01	6.85E-05	9.67E-05	1.15E-06
64742-47-8	Hydrotreated light petroleum distillate	1.39E+00	1.00	2.50E-03	3.50E+01	6.85E-05	9.55E-05	2.73E-06
61791-00-2	Fatty acids, tall-oil, ethoxylated	9.58E-01	1.00	2.50E-03	3.50E+01	6.85E-05	6.56E-05	1.88E-06
68155-20-4	Amides, tall-oil fatty, N,N-bis(hydroxyethyl)	8.07E-01	1.00	2.50E-03	1.75E+00	6.85E-05	5.53E-05	3.16E-05
71-36-3	Butyl alcohol	7.06E-01	1.00	2.50E-03	4.38E+00	6.85E-05	4.83E-05	1.10E-05
68131-39-5	Alcohols, C12-15, ethoxylatedB	7.08E-01	1.00	2.50E-03	1.75E+00	6.85E-05	4.85E-05	2.77E-05
68551-12-2	Alcohols, C12-16, ethoxylatedB	7.72E-01	1.00	2.50E-03	1.75E+00	6.85E-05	5.29E-05	3.02E-05
107-13-1	Acrylonitrile	7.93E-02	1.00	2.50E-03	8.75E-03	6.85E-05	5.43E-06	6.21E-04
111-30-8	Glutaraldehyde	8.51E-01	1.00	2.50E-03	1.40E-01	6.85E-05	5.83E-05	4.16E-04
14808-60-7	Crystalline silica, quartz	2.46E+01	1.00	2.50E-03	3.00E-03	6.85E-05	1.69E-03	5.62E-01
							Total Threshold Risk (mixture)	**0.7**

Summary of Risk to Workers - Hybrid Recipe
Exposure fo Target Chemicals - Theoretical Data

Receptor/Exposure Pathway	Calculated HI 100% Mass Return
Use of Stimulation Fluid in Hydraulic Fracturing	
HYBRID Recipe	
Workers	
Ingestion of Chemicals via Incidental Contact with Flowback Water	0.03
Dermal Exposure to Chemicals via Incidental Contact with Flowback Water	0.08
Inhalation of mist from the evaporation units	0.74
Total Risk	**0.85**

Appendix B

Chemical Risk Assessment Hydraulic Fracture Stimulation Fluid – HAL HVFR

Chemical Name	CAS Number	Density (kg/L)	Volume of Chemical (L)	Volume Fraction (%v/v)	Chemical Mass in Fluid (kg)	Mass Fraction (% w/w)	Concentration in Injected Fluid (mg/L)	Parent Compound Purpose	Ecotoxicity[1]	Toxicity[2]	Biodegradation[1,3]	Bioaccummulative[1]	Tier 1 Screening Assessment	Tier 2 Assessment Worker Ingestion Risk	Tier 2 Assessment Worker Dermal Risk	Tier 2 Assessment Worker Aerosol Inhalation Risk	Hazard Quotient	Outcome of Tier 2 Worker Risk Assessment
Acetic acid	64-19-7	1.05	1050.64	0.0032%	1,103	0.0032%	35	Acid	Acute endpoints: Fish = 75 mg/L, Daphnia EC50 = 32 mg/L Chronic endpoints: Daphnia = 150 mg/L	Based on Chronic: Low	Readily biodegradable	Not Bio accumulative (Based on log Kow = -0.136)	Tier 2	1.03E-05	2.63E-06	5.72E-05	7.01E-05	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Acrylamide acrylate copolymer	9003-06-9	0.75	1991.54	0.0061%	1,494	0.0043%	47	Scale Inhibitor	96 hour LC50 for fish = 1 400 mg/L 48 hour EC50 for Daphnia magna = 1 200 mg/L 21 day EC50 for Daphnia magna = 680 mg/L 21 day NOEC for algae = 380 mg/L	Based on Chronic: Low	Polymers are not readily biodegradable, hence they meet the screening criteria for persistence.	Polymers are expected to have very high molecular weights and poor water solubility. They are not expected to be bioavailable.	Tier 1 (NICNAS)	NA	NA	NA	NA	NA
Acrylamide, sodium acrylate polymer	25987-30-8	0.75	19778.02	0.0603%	14,834	0.0424%	472	Corrosion Inhibitor	LC50 (96h) 0.59 mg/L (Pleuronectes platessa) EC50 (48h) 0.14 mg/L (Daphnia magna) EC50 (96h) 0.7 mg/L (Pseudokirchneriella subapitata) NOEC 4.4 mg/L (Pimephales promelas, juvenile)	96 hour LC50 for fish = 1 400 mg/L 48 hour EC50 for Daphnia magna = 1 200 mg/L 21 day EC50 for Daphnia magna = 680 mg/L 21 day NOEC for algae = 380 mg/L	Based on Chronic: Low	Polymers are not readily biodegradable, hence they meet the screening criteria for persistence.	Tier 1 (NICNAS)	NA	NA	NA	NA	NA
Alcohols, C10-16, ethoxylated propoxylated	69227-22-1	0.94	1950.67	0.0059%	1,834	0.0052%	58	Friction Reducer, Surfactant	LC50 (96h) 0.59 mg/L (Pleuronectes platessa EC50 (48h) 0.14 mg/L (Daphnia magna) ErC50 (48h) 0.7 mg/L (Skeletonema costatum) ErC50 (16.9h) > 10 g/L (Pseudomonas putida)	Based on Acute: Very high	Expected to be readily biodegradable based on similar substances	Not Bio accumulative (Based on an estimated log Kow value of 4.3 – 5.36, and BCF value of 1.1 – 1.8)	Tier 2	4.10E-04	5.41E-02	2.28E-03	5.68E-02	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Alcohols, C12-15, ethoxylated	68131-39-5	0.867	1679.39	0.0051%	1,456	0.0042%	46	Friction Reducer, Surfactant	96 h LC50 Oncorhynchus mykiss was 5 - 7 mg/L Lepomis macrochirus, NOEC (30 days) was 0.11 – 0.33 mg/L. Daphnia magna, EC50 (48 h) was 2.5 mg/L. Daphnia magna, NOEC (21 days) was 0.77 – 1.75 mg/L. Green algae, EC50 (96 h) was 1.4 mg/L. EC50 (3 h) for microorganisms was 140 mg/L.	Based on Chronic: High	Readily biodegradable	No. Based on an estimated log Kow value of 4.3 – 5.36, and BCF value of 1.1 – 1.8, it is not expected to be bioaccumulative.	Tier 2	3.25E-04	2.21E-04	1.81E-03	2.36E-03	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Alcohols, C12-16, ethoxylated	68551-12-2	0.97	1.25	0.0000%	1	0.0000%	0	Corrosion Inhibitor, Surfactant	96 h LC50 Oncorhynchus mykiss was 5 - 7 mg/L Lepomis macrochirus, NOEC (30 days) was 0.11 – 0.33 mg/L. Daphnia magna, EC50 (48 h) was 2.5 mg/L. Daphnia magna, NOEC (21 days) was 0.77 – 1.75 mg/L. Green algae, EC50 (96 h) was 1.4 mg/L. EC50 (3 h) for microorganisms was 140 mg/L.	Based on Chronic: High	Readily biodegradable	No. Based on an estimated log Kow value of 4.3 – 5.36, and BCF value of 1.1 – 1.8, it is not expected to be bioaccumulative.	Tier 2	2.70E-07	1.11E-04	1.51E-06	1.13E-04	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Alcohols, C6-12, ethoxylated propoxylated	68937-66-6	0.94	5461.88	0.0166%	5,134	0.0147%	163	Surfactant	LC50 (96h) 0.59 mg/L (Pleuronectes platessa) EC50 (48h) 0.14 mg/L (Daphnia magna) EC50 (96h) 0.7 mg/L (Pseudokirchneriella subapitata) NOEC 4.4 mg/L (Pimephales promelas, juvenile)	Based on Chronic: Moderate	Expected to be readily biodegradable based on similar substances	Not Bio accumulative (Based on an estimated log Kow value of 4.3 – 5.36, and BCF value of 1.1 – 1.8)	Tier 2	1.15E-03	6.38E-05	6.39E-03	7.60E-03	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Amides, tall-oil fatty, N,N-bis(hydroxyethyl)	68155-20-4	0.9	1843.23	0.0056%	1,659	0.0047%	53	Surfactant	LC50 (96h) 6.7 mg/L (Danio rerio) (similar substance) LC50 (21d) = 0.1 mg/L (Daphnia magna) LC50 (48h) = 2.15 mg/L EC50 (72h) 2.2 mg/L (Scendesmus subspicatus) (similar substance)	Based on Chronic: High	Readily biodegradable (read across)	No based on Log Kow of 3	Tier 2	3.71E-04	1.22E-02	2.06E-03	1.46E-02	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Amine oxides, cocoalkyldimethyl	61788-90-7	0.716	6.50	0.0000%	5	0.0000%	0	Corrosion Inhibitor	LC50/EC50/ErC50 values: 0.60-32 mg/L for fish 0.50-10.8 mg/L for Daphnia magna 0.010-5.30 mg/L for algae NOEC/ EC20: 0.010-1.72 mg/L for algae 0.28 mg/L for Daphnia 0.31 mg/L for fish	Based on Chronic: Very High	Readily biodegradable	No based on the calculated Log Kow of <2.7 and BCF <87	Tier 2	6.50E-06	3.08E-04	3.62E-05	3.51E-04	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Benzaldehyde	100-52-7	1.0415	2.94	0.0000%	3	0.0000%	0	Corrosion Inhibitor	Acute LC50 for freshwater fish is 1.07 mg/L, freshwater invertebrates is 16.2 mg/L and EC10 for freshwater algae is 20 mg/L. Chronic NOEC for freshwater fish is 0.12 mg/L.	Based on Chronic: High	Expected to be readily biodegradable	No based on Log Pow of 1.4	Tier 2	1.14E-06	2.01E-06	6.35E-06	9.49E-06	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Butyl alcohol	71-36-3	0.81	1791.35	0.0055%	1,451	0.0041%	46	Surfactant	Fish, LC50 (96h) 1376 mg/l Invertebrates, EC50 (48h) 1328 mg/L) Algae, EC50 (96h) 225 mg/L EC10 (17h) Pseudomonas putida = 2476 mg/L Chronic NOECrepro (21d) = 4.1 mg/L for Daphnia magna	Based on Chronic: Moderate	Readily biodegradable	No based on low log Kow values of 1	Tier 2	1.30E-04	1.38E-04	7.22E-04	9.90E-04	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Choline Chloride	67-48-1	1.1	31430.04	0.0958%	34,573	0.0988%	1099	Clay Stabiliser	96-hour fish LC50 value is >100 mg/L 48-hour in vertebrate EC50 is 349 mg/L 72-hour EC50 to Pseudokirchneriella subcapitata is >1,000 mg/L 21-day Daphnia NOEC value is 30.2 mg/L	Based on Chronic: Low	Choline chloride is readily biodegradable and thus it does not meet the screening criteria for persistence.	Not Bioaccumulative (based on a measured log Kow of -3.77 and a calculated BCF of 0.59)	Tier 1 (NICNAS)	NA	NA	NA	NA	NA
Cinnamaldehyde	104-55-2	1.048	20.95	0.0001%	22	0.0001%	1	Corrosion Inhibitor	Danio rerio (Zebrafish) 96 h LC50 = 3.1 mg/L ; Daphnia magna (Water flea) 48 h EC50 = 3.86 mg/L; Pseudokirchneriella subcapitata (Green algae) 72 h EC50 = 4.07 mg/L. 72 h NOEC value = 2.0 mg/L Pseudokirchneriella subcapitata (Green algae)	Based on Chronic: Moderate	N.A.(Inorganic)	N.A. (Inorganic)	Tier 2	1.23E-06	2.93E-06	6.83E-06	1.10E-05	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Citric acid	77-92-9	1.542	144.39	0.0004%	223	0.0006%	7	Corrosion Inhibitor	LC50/EC50 > 100 mg/L (fish, daphnia, algae) 8 day NOEC = 425 mg/L (algae)	Based on Chronic: Low	Readily biodegradable	No based on low log Kow	Tier 1 (NICNAS)	NA	NA	NA	NA	NA
Diethanolamine	111-42-2	1.1	133.12	0.0004%	146	0.0004%	5	Breaker Activiator	Fish 96-h LC50 = 1370 mg/l Invertebrates 48-h EC50 = 55 mg/l Pseudokirchneriella subcapitata 96-h ErC50 = 2.2 mg/l Microorganisms 16-h TTC = 16 mg/l Daphnia magna, the NOEC (21 days) was 0.78 mg/l	Based on Chronic: High	Readily biodegradable	No. Based on a measured log Kow of -2.18 and a calculated BCF of 3.16	Tier 2	1.17E-03	2.42E-05	6.51E-03	7.70E-03	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).

Chemical Name	CAS Number	Density (kg/L)	Volume of Chemical (L)	Volume Fraction (%v/v)	Chemical Mass in Fluid (kg)	Mass Fraction (% w/w)	Concentration in Injected Fluid (mg/L)	Parent Compound Purpose	Ecotoxicity[1]	Toxicity[2]	Biodegradation[1,3]	Bioaccummulative[1]	Tier 1 Screening Assessment	Tier 2 Assessment Worker Ingestion Risk	Tier 2 Assessment Worker Dermal Risk	Tier 2 Assessment Worker Aerosol Inhalation Risk	Hazard Quotient	Outcome of Tier 2 Worker Risk Assessment
Diethylene glycol	111-46-6	1.12	19.09	0.0001%	21	0.0001%	1	Corrosion Inhibitor	LC 50 = >100 mg/L (fish, invertebrates, algae)	Based on Acute: Low	Readily biodegradable	No based on the estimated BCF of 3	Tier 2	7.96E-06	1.53E-07	4.44E-05	5.25E-05	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Ethanol	64-17-5	0.7864	3692.09	0.0113%	2,903	0.0083%	92	Surfactant	LC50/EC50 > 1000 mg/L (fish, daphnia, algae) NOEC for invertebrates is 9.6 mg/L (10 day reproduction), plants it is 280 mg/L (7 day study)	Based on Chronic: High	Readily biodegradable	No based on calculated logBCF=0.5	Tier 2	1.35E-05	3.34E-06	7.53E-05	9.21E-05	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Ethoxylated branched C13 alcohol	68439-54-3	0.8	1019.49	0.0031%	816	0.0023%	26		96 h LC50 Oncorhynchus mykiss was 5 - 7 mg/L Lepomis macrochirus, NOEC (30 days) was 0.11 – 0.33 mg/L. Daphnia magna, EC50 (48 h) was 2.5 mg/L. Daphnia magna, NOEC (21 days) was 0.77 – 1.75 mg/L. Green algae, EC50 (96 h) was 1.4 mg/L. EC50 (3 h) for microorganisms was 140 mg/L.	Based on Chronic: High	Readily biodegradable	No.	Tier 2	1.82E-04	8.88E-05	1.02E-03	1.29E-03	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Ethylene glycol	107-21-1	1.11	2040.97	0.0062%	2,265	0.0065%	72	Crosslinker	LC50 for fish = 22800 mg/L LC50 for Daphnia =7800 mg/L NOEC for Algae =100 mg/L	Based on Acute: Low	Readily biodegradable	No based on the measured log Kow of -1.36 and a measured BCF of 10	Tier 1 (NICNAS)	NA	NA	NA	NA	NA
Fatty acids, tall-oil, ethoxylated	61791-00-2	1.054	1869.83	0.0057%	1,971	0.0056%	63	Surfactant	96h-LL50 > 100 mg/L (fish) 48h-EL50 = 12.41 mg/L (invertebrates) 72h-EL50 = 39.7 mg/L (algae) 72h-EL10 = 7.08 mg/L (algae)	Based on Acute: High	Readily biodegradable (read across)	No based on low BCF values of < 100 L/kg ww	Tier 2	2.20E-05	2.14E-04	1.23E-04	3.58E-04	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Hydrochloric acid	7647-01-0	1.152	4292.88	0.0131%	4,945	0.0141%	157	Acid	Algae = 0.492 mg/L Daphnia = 0.492 mg/L Fish = 4.92 mg/L Daphnia (chronic) = 62 mg/L	Based on Chronic: Low	N.A.(Inorganic)	N.A. (Inorganic)	Tier 2	Acute Toxicity Only	Acute Toxicity Only	Acute Toxicity Only	Acute Toxicity Only	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Hydrotreated light petroleum distillate	64742-47-8	0.8	18843.51	0.0574%	15,075	0.0431%	479	Friction Reducer, Surfactant	96 hr LL50 was 2 to 5 mg/L (fish) 48 hr EL50 was 1.4 mg/L (daphnia) 21 d NOEL = 0.48 mg/L (daphnia)	Based on Chronic: High	Readily biodegradable	Yes based on calculated log BCF values for constituents that range from 2.78 to 4.06, and calculated BCF values of 598 to 11,430 L/kg wet-weight	Tier 2	1.68E-04	1.52E-01	9.38E-04	1.53E-01	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Methanol	67-56-1	0.791	191.40	0.0006%	151	0.0004%	5	Corrosion Inhibitor, Surfactant	LC50s ranged from 15,400 to 29,400 mg/L (fish) 24-hour and 48-hour EC50s were > 10,000 mg/L (Daphnia) 28 days NOEC was 446.7 mg/L (fish) 21 days NOEC was 208 mg/L (invertebrates)	Based on Chronic: Low	Readily biodegradable	No based on the Log Kow of -0.74	Tier 2	4.55E-04	6.68E-05	2.54E-03	3.06E-03	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Polyethylene glycol	25322-68-3	1.21	341.37	0.0010%	413	0.0012%	13	Scale Inhibitor	LC50 = 100 mg/L (fish) LC50 = 1000 mg/L (invertebrates) EC 50 = 15.91 mg/L (algae)	Based on Acute: Moderate	Expected to be readily biodegradable	No based on BCF of 3.2	Tier 2	5.77E-06	5.68E-09	3.21E-05	3.79E-05	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Sobitan, mono-9-octadecenoate, (Z)	1338-43-8	1.06	1002.94	0.0031%	1,063	0.0030%	34	Surfactant	96 h LC50 for fish = 75 mg/L	Based on Acute: Low	Readily biodegradable	No. Based on a calculated BCF of 2.832 and a BAF of 36.4	Tier 2	4.75E-06	1.10E-04	2.65E-05	1.41E-04	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Sodium bisulfite	7631-90-5	2.44	614.20	0.0019%	1,499	0.0043%	48	Scale Inhibitor	72h-EC50 = 36.8 mg sodium sulfite/L (alga) NOEC of >8.41 mg sodium sulfite/L (Daphnia)	Based on Chronic: Moderate	N.A.(Inorganic)	N.A. (Inorganic)	Tier 2	1.59E-05	3.05E-11	8.88E-05	1.05E-04	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Sodium diacetate	126-96-5	1.01	941.81	0.0029%	951	0.0027%	30	pH buffer	96 h LC 50 for fish = 184.7 mg/L 48h EC 50 for daphnia > 141 mg/L 72 h EC50 for algae = 164 mg/L	Based on Acute: Low	Readily biodegradable	No. Based on a log Kow of -3.72 and a calculated BCF of 3.16	Tier 1 (NICNAS)	NA	NA	NA	NA	NA
Sodium hydroxide	1310-73-2	1.515	1213.57	0.0037%	1,839	0.0053%	58	pH buffer	Measured acute endpoints for fish (196 mg/L). Measured chronic endpoint for Daphnia (240 mg/L)	Based on Chronic: Low	N.A.(Inorganic)	N.A. (Inorganic)	Tier 2	Acute toxicity only (irritant and corrosive), not systemically available in body	Acute toxicity only (irritant and corrosive), not systemically available in body	Acute toxicity only (irritant and corrosive), not systemically available in body	Acute toxicity only (irritant and corrosive), not systemically available in body	Acute toxicity only (irritant and corrosive), not systemically available in body
Sodium iodide	7681-82-5	3.67	0.33	0.0000%	1	0.0000%	0	Corrosion Inhibitor	96 hour LC50 for fish is > 860 mg/l 7 days NOEC for fish is 100 mg/L 48hrs-EC50 for Daphnia magna is 1.27 mg/L NOEC for algae is 66 mg/L	Based on Chronic: Low	N.A.(Inorganic)	N.A.(Inorganic)	Tier 1 (NICNAS)	NA	NA	NA	NA	NA
Sodium polyacrylate	9003-04-7	1.32	3013.30	0.0092%	3,978	0.0114%	126	Gelling Agent	96 hr LC50 for fish is >1000 mg/L NOEC from a chronic early life stage test for the fathead minnow is 56 mg/L 48 hr LC50 for Dapnia magna is >1000 mg/L NOEC for a 21day chronic reproductive test on Daphnia magna is 5.6 mg/L EC10 for Scenedesmus is 180 mg/L	Based on Chronic: Moderate to low	Sodium polyacrylate has limited biodegradation potential and thus meets the screening criteria for persistence.	Bioaccumulation of sodium polyacrylate is unlikely due to the high molecular weight of the polymer.	Tier 1 (NICNAS)	NA	NA	NA	NA	NA
Sorbitan monooleate polyoxyethylene derivative	9005-65-6	1.06	915.65	0.0028%	971	0.0028%	31	Surfactant	EC50 in algae was reported to be 100 mg/L	Based on Acute: Low	Not readily biodegradable	No. Based on a log Kow of -2.03 and a calculated BCF of 3.16	Tier 2	1.08E-05	1.77E-11	6.04E-05	7.12E-05	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Tributyl tetradecyl phosphonium chloride	81741-28-8	0.95	936.32	0.0029%	890	0.0025%	28	Biocide	LC50: (96 hour) 0.46 mg/L (Oncorhynchus mykiss) LC50: (96 hour) 0.06 mg/l (Lepomis macrochirus) LC50: (96 hour) 0.58 mg/l (fish) TLM96: 1.6 mg/l (Crangon crangon) TLM48: 0.025 mg/l (Daphnia magna Modelled acute endpoint: Daphnia is 16.788 mg/L Fish is 1059.2530 mg/L	Based on Acute: Very high	Not available, however it has been observed to biodegrade in sediment.	Not bioaccumulative (Based on an estimated log Kow value of 6.26)	Tier 2	Acute toxicity only	Acute toxicity only	Acute toxicity only	Acute toxicity only	Acute toxicity only
Sodium perborate tetrahydrate	10486-00-7	0.65	3060.09	0.0093%	1,989	0.0057%	63	TBD	96hr LC50 for fish is estimated to be 2610 mg/L 48 hr LC50 for daphnids is estimated to be 1241 mg/L 96 hr EC50 for algae is estimated to be 444 mg/L	Based on Acute: Low	Readily biodegradable (read across)	Not bioaccumulative	Tier 2	4.44E-03	3.70E-06	2.48E-02	2.92E-02	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
																Total Risk	**0.28**	The calculated risks associated with potential exposure to COPC identified in flowback water, where the HVFR Recipe is used and assuming 100% mass recovery is below the target of 1, respectively. Hence, chronic health risks are considered to be low and acceptable.

Notes
Tier 1 (NICNAS) - Chemical identified as of low concern for human health, as published in the National Assessment of Chemicals Associated with Coal Seam Gas Extraction in Australia (NICNAS 2017).
1 - Please refer to the individual toxicity profiles for further detail.
2 - Toxicity assessed using Commonwealth of Australia 2013 Ecotoxicity Assessment Guidelines (presented as Table 4 in the Northern Territory Government Draft Guideline for the Preparation of an Environment Management Plan under the Petroleum Regulations (2019))
3- Biodegradation assessed as per Northern Territory Government Draft Guideline for the Preparation of an Environment Management Plan under the Petroleum Regulations (2019) and Australian Government Department of Health National Industrial Chemicals Notification and Assessment Scheme (NICNAS)
BCF - Bioconcentration Factor
NA - Not Applicable
TBD - To be determined
NICNAS 2017 - National Assessment of Chemicals Associated with Coal Seam Gas Extraction in Australia
DOE 2017 - Draft Risk Assessment Guidance Manual: For Chemicals Associated with Coal Seam Gas Extraction, Australian Government, Department of Energy

Toxicity and Dermal Absorption Parameters

C = calculated from chronic value, Ch = chronic value adopted

CAS#	Chemical	Oral/Dermal Exposures				Inhalation Exposures										
		Threshold Chronic TDI or RfD (mg/kg/day)		Dermal Permeability (cm/hr)	Reference	Inhalation Unit Risk $(ug/m^3)^{-1}$	Non-Threshold Slope Factor $(mg/kg/day)^{-1}$		Threshold Chronic TC or RfC (mg/m^3)		NOAEC or LOAEC (mg/m^3)	NOAEL or LOAEL (mg/kg bw/d)	Reference	UF	Reference
	COPC in Hydraulic Fracturing Fluid Injected into Well															
1319-33-1	Boronatrocalcite/Ulexite[A]	0.096	D	9.14E-04	EPI (as boric acid)				0.336	converted from RFD		9.6	NICNAS (2017)	100	NICNAS (2017)
68937-66-6	Alcohols, C6-12, ethoxylated propoxylated[B]	0.5	D	1.21E-04	EPI				1.75	converted from RFD		50	NICNAS (2017)	100	NICNAS (2017)
69227-22-1	Alcohols, C10-16, ethoxylated propoxylated[B]	0.5	D	2.87E-01	EPI				1.75	converted from RFD		50	NICNAS (2017)	100	NICNAS (2017)
64-19-7	Acetic acid	12	D	5.56E-04	EPI				42	converted from RFD		1200	NICNAS (2017)	100	NICNAS (2017)
25322-68-3	Polyethylene glycol	8	D	2.14E-06	EPI				28	converted from RFD		8000	REACH	1000	D
7631-90-5	Sodium bisulfite[C]	10.5	D	4.16E-09	EPI				36.75	converted from RFD		1050	NICNAS (2017)	100	NICNAS (2017)
104-55-2	Cinnamaldehyde	2	D	5.20E-03	EPI				7	converted from RFD		200	NTP (2004); REACH	100	D
67-56-1	Methanol	0.037	D	3.19E-04	EPI				0.13	converted from RFD		3.7	NICNAS (2017)	100	NICNAS (2017)
61788-90-7	Amine oxides, cocoalkyldimethyl	0.08	D	1.03E-01	EPI				0.28	converted from RFD		80	OECD (2001)	1000	D
100-52-7	Benzaldehyde	0.3	D	3.83E-03	EPI				1.05	converted from RFD		300	OECD (2002); REACH; NICNAS	1000	D
64-17-5	Ethanol	24	D	5.38E-04	EPI				84	converted from RFD		2400	NICNAS (2017)	100	NICNAS (2017)
64742-47-8	Hydrotreated light petroleum distillate	10	D	1.96E+00	EPI				35	converted from RFD		1000	NICNAS (2017)	100	NICNAS (2017)
61791-00-2	Fatty acids, tall-oil, ethoxylated	10	D	2.11E-02	EPI				35	converted from RFD		1000	REACH	100	D
68155-20-4	Amides, tall-oil fatty, N,N-bis(hydroxyethyl)	0.5	D	7.14E-02	EPI				1.75	converted from RFD		50	USEPA (2010)	100	D
71-36-3	Butyl alcohol	1.25	D	2.31E-03	EPI				4.375	converted from RFD		125	OECD (2001)/NICNAS	100	D
68131-39-5	Alcohols, C12-15, ethoxylated[B]	0.5	D	1.48E-03	EPI				1.75	converted from RFD		50	NICNAS (2017)	100	NICNAS (2017)
68551-12-2	Alcohols, C12-16, ethoxylated[B]	0.5	D	8.97E-01	EPI				1.75	converted from RFD		50	NICNAS (2017)	100	NICNAS (2017)
107-13-1	Acrylonitrile	0.0025	D	1.16E-03	EPI				0.00875	converted from RFD		0.25	OECD (2005); NICNAS	100	D
111-42-2	Diethanolamine	0.014	D	4.51E-05	EPI				0.049	converted from RFD		14	REACH; OECD (2002); NICNAS	1000	D
111-30-8	Glutaraldehyde	0.04	D	3.25E-04	EPI				0.14	converted from RFD		4	NICNAS (2017)	100	NICNAS (2017)
102-71-6	Triethanol amine	1.25	D	4.93E-05	EPI				4.375	converted from RFD		125	NICNAS (2017)	100	NICNAS (2017)
7758-19-2	Chlorous acid, sodium salt	0.039	D	8.27E-09	EPI				0.1365	converted from RFD		3.9	NICNAS (2017)	100	NICNAS (2017)
12008-41-2	Disodium octaborate tetrahydrate[A]	0.096	D	9.14E-04	EPI (as boric acid)				0.336	converted from RFD		9.6	NICNAS (2017)	100	NICNAS (2017)
7775-27-1	Sodium persulfate	0.67	D	7.05E-07	EPI				2.345	converted from RFD		67	NICNAS (2017)	100	NICNAS (2017)
68439-54-3	Ethoxylated branched C13 alcohol	0.5	D	1.06E-03	EPI				1.75	converted from RFD		50	NICNAS (2017)	100	NICNAS (2017)
1338-43-8	Sobitan, mono-9-octadecenoate, (Z)	25	JECFA	5.02E-02	EPI				87.5	converted from RFD		-	JECFA(1973); US FDA; FSANZ (2018)	-	-
9005-65-6	Sorbitan monooleate polyoxyethylene derivative	10	EFSA	3.54E-09	EPI				35	converted from RFD		-	EFSA (2017)	-	-
111-46-6	2,2''-oxydiethanol (diethylene glycol)	0.3	D	4.17E-05	EPI				1.05	converted from RFD		300	Health Council of the Netherlands (2007); NICNAS	1000	D
7631-90-5	Sodium bisulfate[C]	10.5	D	9.29E-09	EPI				36.75	converted from RFD		1050	NICNAS (2017)	100	NICNAS (2017)
14808-60-7	Crystalline silica, quartz	Not toxic via oral/dermal exposure							0.003	USEPA (2019)		-	-	-	-
10486-00-7	Sodium perborate tetrahydrate	0.05	D	1.81E-06	EPI				0.175	converted from RFD		50	REACH	1000	D

Notes:

A - Read across data from Boric Acid

B - Read across data from Alcohol ethoxylates C6-C12

C - Read across data from Sodium Sulfite

References:

D - Derived (refer to individual Toxicity Profiles)

EFSA - European Food Safety Authority

EPI - USEPA Estimation Programs Interface (EPI) Suite

FSANZ - Food Standards Australia New Zealand

J- JECFA - Joint FAO/WHO Expert Committee on Food Additives

NICNAS - National Industrial Chemicals Notification and Assessment Scheme. Assessed at https://www.nicnas.gov.au/

NICNAS (2017) - Department of the Environment and Energy 2017 , National assessment of chemicals associatedwith coal seam gas extraction in Australia, prepared by the National Industrial ChemicalsNotification and Assessment Scheme

NTP - US Department of Health and Serices National Toxicology Program

OECD - Organisation for Economic Co-operation and Development Screening Information Data Set (SIDS)

REACH - ECHA REACH European Chemicals Agency Database: http://apps.echa.europa.eu

Exposure to Chemicals via Incidental Ingestion of Flowback fluid - HVFR Recipe

Chronic Exposures

General Data/ Equations	Units	Exposure Calculations (RME) Ingestion of Flowback Water by Workers	
Exposure Parameters			
Exposure Frequency (EF)	days/year	20	Assume work 5 days per week for 1 month during the fraccing period
Exposure Duration (ED)	years	0.083	Maximum duration of the frac. Works will be complete in one month.
Body Weight (BW)	kg	78	Average male and female adults as per enHealth 2012
Averaging Time - NonThreshold (ATc)	days	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (ATn)	days	30.42	USEPA 1989 and CSMS 1996
Ingestion Rate (IRw)	L/day or L/hr	0.005	Assume Incidental ingestion of 5 ml (1 tsp) of water per day during fraccing.
Bioavailability (B)	-	100%	Assume 100% bioavailability via ingestion of chemicals in water.
Intake Factor = IRw*ET*B*EF*ED / BW*AT	L/kg/day	**4.2E-09** **3.5E-06**	**NonThreshold** **Threshold**

Daily Intake from Water = Concentration in Water x Intake Factor (ref: USEPA 1989)
NonThreshold Risk = Daily Intake from Water for NonThreshold Effects x Slope Factor
Hazard Quotients = (Daily Intake from Water for Threshold Effects/ADI)

CAS	Chemical	Toxicity Data				Concentration	Daily Intake		Calculated Risk	
		Non-Threshold Slope Factor	Chronic Threshold TDI	Background Intake (% Chronic TDI)	Chronic TDI Allowable for Assessment (TDI-Background)	in Water	NonThreshold	Threshold	NonThreshold Risk	Chronic Hazard Quotient
		$(mg/kg\text{-}day)^{-1}$	(mg/kg/day)		(mg/kg/day)	(mg/L)	(mg/kg/day)	(mg/kg/day)	(unitless)	(unitless)
64-19-7	Acetic acid		1.2E+01		1.2E+01	35.08	1.5E-07	1.2E-04	--	1.0E-05
69227-22-1	Alcohols, C10-16, ethoxylated propoxylatedB		5.0E-01		5.0E-01	58.31	2.4E-07	2.0E-04	--	4.1E-04
68131-39-5	Alcohols, C12-15, ethoxylatedB		5.0E-01		5.0E-01	46.30	1.9E-07	1.6E-04	--	3.3E-04
68551-12-2	Alcohols, C12-16, ethoxylatedB		5.0E-01		5.0E-01	0.04	1.6E-10	1.4E-07	--	2.7E-07
68937-66-6	Alcohols, C6-12, ethoxylated propoxylatedB		5.0E-01		5.0E-01	163.27	6.8E-07	5.7E-04	--	1.1E-03
68155-20-4	Amides, tall-oil fatty, N,N-bis(hydroxyethyl)		5.0E-01		5.0E-01	52.75	2.2E-07	1.9E-04	--	3.7E-04
61788-90-7	Amine oxides, cocoalkyldimethyl		8.0E-02		8.0E-02	0.15	6.2E-10	5.2E-07	--	6.5E-06
100-52-7	Benzaldehyde		3.0E-01		3.0E-01	0.10	4.1E-10	3.4E-07	--	1.1E-06
71-36-3	Butyl alcohol		1.3E+00		1.3E+00	46.14	1.9E-07	1.6E-04	--	1.3E-04
104-55-2	Cinnamaldehyde		2.0E+00		2.0E+00	0.70	2.9E-09	2.5E-06	--	1.2E-06
111-42-2	Diethanolamine		1.4E-02		1.4E-02	4.66	1.9E-08	1.6E-05	--	1.2E-03
111-46-6	2,2"-oxydiethanol (diethylene glycol)		3.0E-01		3.0E-01	0.68	2.8E-09	2.4E-06	--	8.0E-06
64-17-5	Ethanol		2.4E+01		2.4E+01	92.33	3.9E-07	3.2E-04	--	1.4E-05
61791-00-2	Fatty acids, tall-oil, ethoxylated		1.0E+01		1.0E+01	62.67	2.6E-07	2.2E-04	--	2.2E-05
64742-47-8	Hydrotreated light petroleum distillate		1.0E+01		1.0E+01	479.38	2.0E-06	1.7E-03	--	1.7E-04
67-56-1	Methanol		3.7E-02		3.7E-02	4.81	2.0E-08	1.7E-05	--	4.6E-04
25322-68-3	Polyethylene glycol		8.0E+00		8.0E+00	13.14	5.5E-08	4.6E-05	--	5.8E-06
1338-43-8	Sobitan, mono-9-octadecenoate, (Z)		2.5E+01		2.5E+01	33.81	1.4E-07	1.2E-04	--	4.7E-06
9005-65-6	Sorbitan monooleate polyoxyethylene derivative		1.0E+01		1.0E+01	30.86	1.3E-07	1.1E-04	--	1.1E-05
10486-00-7	Sodium perborate tetrahydrate		5.0E-02		5.0E-02	63.25	2.6E-07	2.2E-04	--	4.4E-03
68439-54-3	Ethoxylated branched C13 alcohol		5.0E-01		5.0E-01	25.94	1.1E-07	9.1E-05	--	1.8E-04
7631-90-5	Sodium bisulfiteC		1.1E+01		1.1E+01	47.66	2.0E-07	1.7E-04	--	1.6E-05
								Total Risk (mixture)		**8.90E-03**

Note:
This scenario is deemed protective of the following scenarios due to the less frequent and short duration of exposures:
- Worker exposure during a spill (i.e.a couple breaks on a tank and releases product onto the worker) or leak scenarios

Dermal Exposure to Chemicals via Contact with Flow Back Water - HVFR Recipe

Chronic Exposures

General Data/ Equations	Units	Exposure Calculations (RME) Dermal Contact with Flow Back Water by Workers	
Exposure Parameters			
Exposure Frequency (EF)	days/year	20	Assume work 5 days per week for 1 month during the fraccing period
Exposure Duration (ED)	years	0.083	Maximum duration of the frac. Works will be complete in one month.
Body Weight (BW)	kg	78	Average male and female adults as per enHealth 2012
Averaging Time - NonThreshold (ATc)	days	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (ATn)	days	30.42	USEPA 1989 and CSMS 1996
Surface Area (SAw)	cm^2	2300	Hands and forearms exposed (enHealth 2012) Occupational HSE would require long pants and closed shoes on Australian work sites; forearms conservatively included
Exposure Time (ET)	hr/day	1	Assume contact with flow back water for 1 hours per day
Conversion Factor (CF)	L/cm^3	1.E-03	Conversion of units
Intake Factor = SAw*ET*CF*EF*ED / BW*AT	L-hr/(cm-kg-day)	**1.9E-06** **1.6E-03**	**NonThreshold** **Threshold**

Daily Intake from Water = Concentration in Water x Dermal Permeability x Intake Factor (ref: USEPA 1989, 2004)
NonThreshold Risk = Daily Intake from Water for NonThreshold Effects x Slope Factor
Hazard Quotients = (Daily Intake from Water for Threshold Effects/ADI)

CAS	Chemical	Toxicity Data				Dermal Permeability	Concentration in Water	Daily Intake		Calculated Risk	
		Non-Threshold Slope Factor	Chronic Threshold TDI	Background Intake (% chronic TDI)	Chronic TDI Allowable for Assessment (TDI-Background)			NonThreshold	Threshold	NonThreshold Risk	Chronic Hazard Quotient
		$(mg/kg\text{-}day)^{-1}$	(mg/kg/day)		(mg/kg/day)	(cm/hr)	(mg/L)	(mg/kg/day)	(mg/kg/day)	(unitless)	(unitless)
64-19-7	Acetic acid		1.2E+01		1.2E+01	5.6E-4	35.08	3.8E-08	3.2E-05	--	2.6E-06
69227-22-1	Alcohols, C10-16, ethoxylated propoxylatedB		5.0E-01		5.0E-01	2.9E-1	58.31	3.2E-05	2.7E-02	--	5.4E-02
68131-39-5	Alcohols, C12-15, ethoxylatedB		5.0E-01		5.0E-01	1.5E-3	46.30	1.3E-07	1.1E-04	--	2.2E-04
68551-12-2	Alcohols, C12-16, ethoxylatedB		5.0E-01		5.0E-01	9.0E-1	0.04	6.6E-08	5.6E-05	--	1.1E-04
68937-66-6	Alcohols, C6-12, ethoxylated propoxylatedB		5.0E-01		5.0E-01	1.2E-4	163.27	3.8E-08	3.2E-05	--	6.4E-05
68155-20-4	Amides, tall-oil fatty, N,N-bis(hydroxyethyl)		5.0E-01		5.0E-01	7.1E-2	52.75	7.2E-06	6.1E-03	--	1.2E-02
61788-90-7	Amine oxides, cocoalkyldimethyl		8.0E-02		8.0E-02	1.0E-1	0.15	2.9E-08	2.5E-05	--	3.1E-04
100-52-7	Benzaldehyde		3.0E-01		3.0E-01	3.8E-3	0.10	7.2E-10	6.0E-07	--	2.0E-06
71-36-3	Butyl alcohol		1.3E+00		1.3E+00	2.3E-3	46.14	2.1E-07	1.7E-04	--	1.4E-04
104-55-2	Cinnamaldehyde		2.0E+00		2.0E+00	5.2E-3	0.70	7.0E-09	5.9E-06	--	2.9E-06
111-42-2	Diethanolamine		1.4E-02		1.4E-02	4.5E-5	4.66	4.0E-10	3.4E-07	--	2.4E-05
111-46-6	2,2"-oxydiethanol (diethylene glycol)		3.0E-01		3.0E-01	4.2E-5	0.68	5.5E-11	4.6E-08	--	1.5E-07
64-17-5	Ethanol		2.4E+01		2.4E+01	5.4E-4	92.33	9.6E-08	8.0E-05	--	3.3E-06
61791-00-2	Fatty acids, tall-oil, ethoxylated		1.0E+01		1.0E+01	2.1E-2	62.67	2.5E-06	2.1E-03	--	2.1E-04
64742-47-8	Hydrotreated light petroleum distillate		1.0E+01		1.0E+01	2.0E+0	479.38	1.8E-03	1.5E+00	--	1.5E-01
67-56-1	Methanol		3.7E-02		3.7E-02	3.2E-4	4.81	3.0E-09	2.5E-06	--	6.7E-05
25322-68-3	Polyethylene glycol		8.0E+00		8.0E+00	2.1E-6	13.14	5.4E-11	4.5E-08	--	5.7E-09
1338-43-8	Sobitan, mono-9-octadecenoate, (Z)		2.5E+01		2.5E+01	5.0E-2	33.81	3.3E-06	2.7E-03	--	1.1E-04
9005-65-6	Sorbitan monooleate polyoxyethylene derivative		1.0E+01		1.0E+01	3.5E-9	30.86	2.1E-13	1.8E-10	--	1.8E-11
10486-00-7	Sodium perborate tetrahydrate		5.0E-02		5.0E-02	1.8E-6	63.25	2.2E-10	1.8E-07	--	3.7E-06
68439-54-3	Ethoxylated branched C13 alcohol		5.0E-01		5.0E-01	1.1E-3	25.94	5.3E-08	4.4E-05	--	8.9E-05
7631-90-5	Sodium bisulfiteC		1.1E+01		1.1E+01	4.2E-9	47.66	3.8E-13	3.2E-10	--	3.1E-11
									Total Risk (mixture)		**2.19E-01**

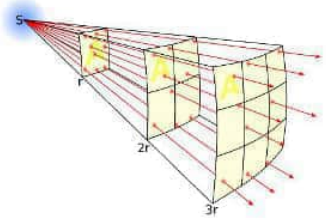
Note:
This scenario is deemed protective of the following scenarios due to the less frequent and short duration of exposures:
- Worker exposure during a spill (i.e.a couple breaks on a tank and releases product onto the worker) or leak scenarios

Aerosol Exposure - HVFR Recipe

The concentration of COPC in aerosol spray was estimated by calculating the concentration for driftable droplets using a mixed box model in which steady state concentrations An emission factor for driftable aerosol was estimated using the algorithm presented below.

Emission Factor for Driftable Aerosol Algorithm

$$Emission\ Factor_{driftable\ aerosol}\left(\frac{L}{m^3}\right) = \frac{Box\ Centre^2(m) \times \left(\frac{Spray\ Vol\ \left(\frac{L}{hr}\right) \times Aerosol_{driftable}(\%)}{BoxVR\ \left(\frac{m^3}{hr}\right)}\right)}{BoxDistance^2\ (m)}$$



Aerosol Exposure Modelling Notes:

1) The inhalation of chemicals in mist/aerosol resultant from irrigation activities is dependent upon the concentration in water, the amount of water used per unit time, how close a person stands to the spray generation, how long they are in a position of exposure and the extent of spray drift (determined by the size of the water droplets and speed/direction of the wind). These equations are applicable for non-volatile contaminants that are inhaled.

2) These equations calculate the concentration for driftable droplets using a simple well mixed box model in which steady state air concentrations are calculated. The 'Inverse square law' is then applied to approximate the air concentration at a distance from the virtual air box. This law assumes the further away a receptor is from the spray source, the density of the droplets will decrease. The density of the spray droplets is inversely proportional to the square of the distance from the source.

Parameter	Units	Value	Description
Spray box length	m	3	Assume a 'spray box' of 3 m long.
Spray box width	m	3	Assume a 'spray box' of 3 m wide.
Box Centre	m	1.5	Distance to centre of box is 1.5 m.
$Box_{Distance}$	m	2	Distance the irrigation worker is from the 'spray box'. Assumed a distance of 2 m.
$Aerosol_{driftable}$	unitless	0.2	Proportion of aerosol spray that drifts outside the 'spray box' and available for exposure. Assumed 0.2, based on a droplet size of 400 – 500 µm that falls approximately 0.3 m in less than 10 seconds, with a lateral drift of approximately 3.5 m in a 5 km/hr wind (i.e. a light breeze) (Grisso et al. 2013).
Spray Volume	L/hr	1800.0	1800 L/min, irrigation value adopted from NZ MtE (2011) Appendix 5A.
Wind speed	m/hr	9000	Based on windspeed of 2.5 m/sec
BoxVR	m^3/hr	81000.0	Ventilation rate of spray in the 'spray box'. Assumed to be 81,000 m3/hr based on a wind speed of 9000 m/hr, and a 'spray box' dimension of 3 x 3 m.

CAS	Chemical	Concentration in Water mg/L	Generation rate of chemical in volume mg/hr	Driftable Aerosol Emission Factor L/m^3
64-19-7	Acetic acid	35.08	12629.04069	2.500000E-03
69227-22-1	Alcohols, C10-16, ethoxylated propoxylated	58.31	20991.25298	2.500000E-03
68131-39-5	Alcohols, C12-15, ethoxylatedB	46.30	16668.49372	2.500000E-03
68551-12-2	Alcohols, C12-16, ethoxylatedB	0.04	13.84454389	2.500000E-03
68937-66-6	Alcohols, C6-12, ethoxylated propoxylatedB	163.27	58775.50834	2.500000E-03
68155-20-4	Amides, tall-oil fatty, N,N-bis(hydroxyethyl)	52.75	18991.02585	2.500000E-03
61788-90-7	Amine oxides, cocoalkyldimethyl	0.15	53.27067097	2.500000E-03
100-52-7	Benzaldehyde	0.10	35.01861274	2.500000E-03
71-36-3	Butyl alcohol	46.14	16610.81728	2.500000E-03
104-55-2	Cinnamaldehyde	0.70	251.2913171	2.500000E-03
111-42-2	Diethanolamine	4.66	1676.321009	2.500000E-03
111-46-6	2,2"-oxydiethanol (diethylene glycol)	0.68	244.7772451	2.500000E-03
64-17-5	Ethanol	92.33	33238.54124	2.500000E-03
61791-00-2	Fatty acids, tall-oil, ethoxylated	62.67	22561.59975	2.500000E-03
64742-47-8	Hydrotreated light petroleum distillate	479.38	172575.2226	2.500000E-03
67-56-1	Methanol	4.81	1733.209245	2.500000E-03
25322-68-3	Polyethylene glycol	13.14	4728.6147	2.500000E-03
1338-43-8	Sobitan, mono-9-octadecenoate, (Z)	33.81	12170.50102	2.500000E-03
9005-65-6	Sorbitan monooleate polyoxyethylene deriv	30.86	11111.21667	2.500000E-03
10486-00-7	Sodium perborate tetrahydrate	63.25	22770.58133	2.500000E-03
68439-54-3	Ethoxylated branched C13 alcohol	25.94	9336.793624	2.500000E-03
7631-90-5	Sodium bisulfiteC	47.66	17156.33574	2.500000E-03

Exposure to Chemicals via Inhalation of Mist from the Evaporation Units - HVFR Recipe

Chronic Exposures

General Data/ Equations	Units	Exposure Calculations (RME) Inhalation of Mist by Workers	
Exposure Parameters			
Exposure Frequency (EF)	days/year	240	Exposure for 5 days per week minus 4 weeks holidays
Exposure Duration (ED)	years	1	Maximum duration that the flowback tank will be on-site
Exposure Time (ET)	hr/day	1	Professional judgement for irrigation exposure. Assume worker to be near tank for 1 hours every working day.
Driftable aerosol emission factor (EMF)	L/m3	2.50E-03	Calculated
Aerosol Inhalation Bioavailability (AAF)	unitless	1.0	Assume 100% bioavailability
Averaging Time - Threshold (AT)	years	1.000	USEPA 1989 and CSMS 1996
$ITF_{inh,w,shwr} = \frac{EmF \times AAF \times ET_{iw} \times EF \times ED}{365\ \frac{days}{year} \times 24\ \frac{hours}{day} \times AT}$			

Daily Intake = Concentration in Water x Intake Factor (ref: USEPA 1989)
Hazard Quotients = (Daily Intake from Water for Threshold Effects/ADI)

CAS	Chemical	Groundwater Concentration	Aerosol Inhalation Bioavailability	Driftable Aerosol Emission Factor	RfC (Background Corrected)	Threshold Intake and Risk Calculations: Adult Exposure Factor (threshold)	Adult Exposure Adjusted Air Concentration (threshold)	Hazard Index (Adult)
		mg/L	(unitless)	(L/m^3)	(mg/m^3)	(L/m^3)	(mg/m^3)	(unitless)
64-19-7	Acetic acid	3.51E+01	1.00	2.50E-03	4.20E+01	6.85E-05	2.40E-03	5.72E-05
69227-22-1	Alcohols, C10-16, ethoxylated propoxylatedB	5.83E+01	1.00	2.50E-03	1.75E+00	6.85E-05	3.99E-03	2.28E-03
68131-39-5	Alcohols, C12-15, ethoxylatedB	4.63E+01	1.00	2.50E-03	1.75E+00	6.85E-05	3.17E-03	1.81E-03
68551-12-2	Alcohols, C12-16, ethoxylatedB	3.85E-02	1.00	2.50E-03	1.75E+00	6.85E-05	2.63E-06	1.51E-06
68937-66-6	Alcohols, C6-12, ethoxylated propoxylatedB	1.63E+02	1.00	2.50E-03	1.75E+00	6.85E-05	1.12E-02	6.39E-03
68155-20-4	Amides, tall-oil fatty, N,N-bis(hydroxyethyl)	5.28E+01	1.00	2.50E-03	1.75E+00	6.85E-05	3.61E-03	2.06E-03
61788-90-7	Amine oxides, cocoalkyldimethyl	1.48E-01	1.00	2.50E-03	2.80E-01	6.85E-05	1.01E-05	3.62E-05
100-52-7	Benzaldehyde	9.73E-02	1.00	2.50E-03	1.05E+00	6.85E-05	6.66E-06	6.35E-06
71-36-3	Butyl alcohol	4.61E+01	1.00	2.50E-03	4.38E+00	6.85E-05	3.16E-03	7.22E-04
104-55-2	Cinnamaldehyde	6.98E-01	1.00	2.50E-03	7.00E+00	6.85E-05	4.78E-05	6.83E-06
111-42-2	Diethanolamine	4.66E+00	1.00	2.50E-03	4.90E-02	6.85E-05	3.19E-04	6.51E-03
111-46-6	2,2''-oxydiethanol (diethylene glycol)	6.80E-01	1.00	2.50E-03	1.05E+00	6.85E-05	4.66E-05	4.44E-05
64-17-5	Ethanol	9.23E+01	1.00	2.50E-03	8.40E+01	6.85E-05	6.32E-03	7.53E-05
61791-00-2	Fatty acids, tall-oil, ethoxylated	6.27E+01	1.00	2.50E-03	3.50E+01	6.85E-05	4.29E-03	1.23E-04
64742-47-8	Hydrotreated light petroleum distillate	4.79E+02	1.00	2.50E-03	3.50E+01	6.85E-05	3.28E-02	9.38E-04
67-56-1	Methanol	4.81E+00	1.00	2.50E-03	1.30E-01	6.85E-05	3.30E-04	2.54E-03
25322-68-3	Polyethylene glycol	1.31E+01	1.00	2.50E-03	2.80E+01	6.85E-05	9.00E-04	3.21E-05
1338-43-8	Sobitan, mono-9-octadecenoate, (Z)	3.38E+01	1.00	2.50E-03	8.75E+01	6.85E-05	2.32E-03	2.65E-05
9005-65-6	Sorbitan monooleate polyoxyethylene derivative	3.09E+01	1.00	2.50E-03	3.50E+01	6.85E-05	2.11E-03	6.04E-05
10486-00-7	Sodium perborate tetrahydrate	6.33E+01	1.00	2.50E-03	1.75E-01	6.85E-05	4.33E-03	2.48E-02
68439-54-3	Ethoxylated branched C13 alcohol	2.59E+01	1.00	2.50E-03	1.75E+00	6.85E-05	1.78E-03	1.02E-03
7631-90-5	Sodium bisulfiteC	4.77E+01	1.00	2.50E-03	3.68E+01	6.85E-05	3.26E-03	8.88E-05
							Total Risk (mixture)	**0.050**

Summary of Risk to Workers - HVFR Recipe
Exposure fo Target Chemicals - Theoretical Data

Receptor/Exposure Pathway	Calculated HI 100% Mass Return
Use of Stimulation Fluid in Hydraulic Fracturing	
HVFR Recipe	
Workers	
Ingestion of Chemicals via Incidental Contact with Flowback Water	0.0089
Dermal Exposure to Chemicals via Incidental Contact with Flowback Water	0.22
Inhalation of mist from the evaporation units	0.050
Total Risk	**0.28**

Appendix C

Chemical Risk Assessment Hydraulic Fracture Stimulation Fluid – HAL SW

Chemical Name	CAS Number	Density (kg/L)	Volume of Chemical (L)	Volume Fraction (%v/v)	Chemical Mass in Fluid (kg)	Mass Fraction (% w/w)	Concentration in Injected Fluid (mg/L)	Parent Compound Purpose	Ecotoxicity[1]	Toxicity[2]	Biodegradation[1,3]	Bioaccummulative[1]	Tier 1 Screening Assessment	Tier 2 Assessment Worker Ingestion Risk	Tier 2 Assessment Worker Dermal Risk	Tier 2 Assessment Worker Aerosol Inhalation Risk	Hazard Quotient	Outcome of Tier 2 Worker Risk Assessment[1]
Choline Chloride	67-48-1	1.1	24720	0.0848%	27192	0.0869%	977	Clay Stabiliser	96-hour fish LC50 value is >100 mg/L 48-hour in vertebrate EC50 is 349 mg/L 72-hour EC50 to Pseudokirchneriella subcapitata is >1,000 mg/L 21-day Daphnia NOEC value is 30.2 mg/L	Based on Chronic: Low	Choline chloride is readily biodegradable and thus it does not meet the screening criteria for persistence.	Not Bioaccumulative (based on a measured log Kow of -3.77 and a calculated BCF of 0.59)	Tier 1 (NICNAS)	NA	NA	NA	NA	NA
Hydrochloric acid	7647-01-0	1.152	23649	0.0811%	27244	0.0871%	979	Acid	Algae (acute) = 0.492 mg/L Daphnia (acute) = 0.492 mg/L Fish (acute) = 4.92 mg/L Daphnia (chronic) = 62 mg/L	Based on Chronic: Low	N.A.(Inorganic)	N.A. (Inorganic)	Tier 2	NA. Acute toxity only	NA. Acute toxity only	NA. Acute toxity only	NA. Acute toxity only	NA. Acute toxity only
Alcohols, C6-12, ethoxylated propoxylated	68937-66-6	0.94	10,206	0.0350%	9,593	0.0307%	345	Surfactant	LC50 (96h) 0.59 mg/L (Pleuronectes platessa) EC50 (48h) 0.14 mg/L (Daphnia magna) EC50 (96h) 0.7 mg/L (Pseudokirchneriella subapitata) NOEC 4.4 mg/L (Pimephales promelas, juvenile)	Based on Chronic: Moderate	Expected to be readily biodegradable based on similar substances	Not Bio accumulative (Based on an estimated log Kow value of 4.3 – 5.36, and BCF value of 1.1 – 1.8)	Tier 2	2.42E-03	1.35E-04	1.35E-02	1.60E-02	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Alcohols, C10-16, ethoxylated propoxylated	69227-22-1	0.94	5,253	0.0180%	4,938	0.0158%	177	Friction Reducer, Surfactant	LC50 (96h) 0.59 mg/L (Pleuronectes platessa EC50 (48h) 0.14 mg/L (Daphnia magna) ErC50 (48h) 0.7 mg/L (Skeletonema costatum) ErC50 (16.9h) > 10 g/L (Pseudomonas putida)	Based on Acute: Very high	Expected to be readily biodegradable based on similar substances	Not Bio accumulative (Based on an estimated log Kow value of 4.3 – 5.36, and BCF value of 1.1 – 1.8)	Tier 2	1.25E-03	1.64E-01	6.94E-03	1.73E-01	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Sodium polyacrylate	9003-04-7	1.32	3723	0.0128%	4914	0.0157%	177		96 hr LC50 for fish is >1000 mg/L NOEC from a chronic early life stage test for the fathead minnow is 56 mg/L 48 hr LC50 for Dapnia magna is >1000 mg/L NOEC for a 21day chronic reproductive test on Daphnia magna is 5.6 mg/L EC10 for Scenedesmus is 180 mg/L	Based on Chronic: Moderate to low	Sodium polyacrylate has limited biodegradation potential and thus meets the screening criteria for persistence.	Bioaccumulation of sodium polyacrylate is unlikely due to the high molecular weight of the polymer.	Tier 1 (NICNAS)	NA	NA	NA	NA	NA
Sodium Chloride	7647-14-5	2.165	3476	0.0119%	7525	0.0241%	270	Stabiliser	EC50 = 400 to 30000 mg/L EC50 Fish = 1290 mg/L NOEC = 314 mg/L (Daphnia)	Based on Chronic: Low	N.A.(Inorganic)	N.A. (Inorganic)	Tier 2	Low chronic toxicity, insufficient data to establish toxicity value	Low chronic toxicity, insufficient data to establish toxicity value	Low chronic toxicity, insufficient data to establish toxicity value	Low chronic toxicity, insufficient data to establish toxicity value	Low chronic toxicity, insufficient data to establish toxicity value
Acrylamide acrylate copolymer	25987-30-8	0.75	3309	0.0113%	2482	0.0079%	89	Scale Inhibitor	96 hour LC50 for fish = 1 400 mg/L 48 hour EC50 for Daphnia magna = 1 200 mg/L 21 day EC50 for Daphnia magna = 680 mg/L 21 day NOEC for algae = 380 mg/L	Based on Chronic: Low	Polymers are not readily biodegradable, hence they meet the screening criteria for persistence.	Polymers are expected to have very high molecular weights and poor water solubility. They are not expected to be bioavailable.	Tier 1 (NICNAS)	NA	NA	NA	NA	NA
Acetic acid	64-19-7	1.05	2859	0.0098%	3002	0.0096%	108	Acid	Acute endpoints: Fish = 75 mg/L, Daphnia EC50 = 32 mg/L Chronic endpoints: Daphnia = 150 mg/L	Based on Chronic: Low	Readily biodegradable	Not Bio accumulative (Based on log Kow = -0.136)	Tier 2	3.16E-05	8.07E-06	1.76E-04	2.15E-04	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Tributyl tetradecyl phosphonium chloride	81741-28-8	0.95	2370	0.0081%	2251	0.0072%	81	Biocide	LC50: (96 hour) 0.46 mg/L (Oncorhynchus mykiss) LC50: (96 hour) 0.06 mg/l (Lepomis macrochirus) LC50: (96 hour) 0.58 mg/l (fish) TLM96: 1.6 mg/l (Crangon crangon) TLM48: 0.025 mg/l (Daphnia magna Modelled acute endpoint: Daphnia is 16.788 mg/L Fish is 1059.2530 mg/L	Based on Acute: Very high	Not available, however it has been observed to biodegrade in sediment.	Not bioaccumulative (Based on an estimated log Kow value of 6.26)	Tier 2	NA. Acute toxity only	NA. Acute toxity only	NA. Acute toxity only	NA. Acute toxity only	NA. Acute toxity only
Polyethylene glycol	25322-68-3	1.21	2059	0.0071%	2491	0.0080%	89	Scale Inhibitor	LC50 = 100 mg/L (fish) LC50 = 1000 mg/L (invertebrates) EC 50 = 15.91 mg/L (algae)	Based on Acute: Moderate	Expected to be readily biodegradable	No based on BCF of 3.2	Tier 2	3.93E-05	3.87E-08	2.19E-04	2.58E-04	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Sodium bisulfite	7631-90-5	1.348	1876	0.0064%	2529	0.0081%	91	Scale Inhibitor	72h-EC50 = 36.8 mg sodium sulfite/L (alga) NOEC of >8.41 mg sodium sulfite/L (Daphnia)	Based on Chronic: Moderate	N.A.(Inorganic)	N.A. (Inorganic)	Tier 2	3.04E-05	5.81E-11	1.69E-04	2.00E-04	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Ethylene glycol	107-21-1	1.11	1558	0.0053%	1729	0.0055%	62	Crosslinker	LC50 for fish = 22800 mg/L LC50 for Daphnia =7800 mg/L NOEC for Algae =100 mg/L	Based on Acute: Low	Readily biodegradable	No based on the measured log Kow of -1.36 and a measured BCF of 10	Tier 1 (NICNAS)	NA	NA	NA	NA	NA
Cinnamaldehyde	104-55-2	1.048	1459	0.0050%	1529	0.0049%	55	Corrosion Inhibitor	Danio rerio (Zebrafish) 96 h LC50 = 3.1 mg/L; Daphnia magna (Water flea) 48 h EC50 = 3.86 mg/L; Pseudokirchneriella subcapitata (Green algae) 72 h EC50 = 4.07 mg/L. 72 h NOEC value = 2.0 mg/L Pseudokirchneriella subcapitata (Green algae)	Based on Chronic: Moderate	N.A.(Inorganic)	N.A. (Inorganic)	Tier 2	9.64E-05	2.31E-04	5.37E-04	8.64E-04	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Diethylene glycol	111-46-6	1.12	736	0.0025%	825	0.0026%	30	Corrosion Inhibitor	LC 50 = >100 mg/L (fish, invertebrates, algae)	Based on Acute: Low	Readily biodegradable	No based on the estimated BCF of 3	Tier 2	3.47E-04	6.65E-06	1.93E-03	2.29E-03	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Methanol	67-56-1	0.791	730	0.0025%	578	0.0018%	21	Corrosion Inhibitor, Surfactant	LC50s ranged from 15,400 to 29,400 mg/L (fish) 24-hour and 48-hour EC50s were > 10,000 mg/L (Daphnia) 28 days NOEC was 446.7 mg/L (fish) 21 days NOEC was 208 mg/L (invertebrates)	Based on Chronic: Low	Readily biodegradable	No based on the Log Kow of -0.74	Tier 2	1.96E-03	2.88E-04	1.09E-02	1.32E-02	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Amine oxides, cocoalkyldimethyl	61788-90-7	0.716	483	0.0017%	346	0.0011%	12	Corrosion Inhibitor	LC50/EC50/ErC50 values: 0.60-32 mg/L for fish 0.50-10.8 mg/L for Daphnia magna 0.010-5.30 mg/L for algae NOEC/ EC20: 0.010-1.72 mg/L for algae 0.28 mg/L for Daphnia 0.31 mg/L for fish	Based on Chronic: Very High	Readily biodegradable	No based on the calculated Log Kow of <2.7 and BCF <87	Tier 2	5.45E-04	2.58E-02	3.04E-03	2.94E-02	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Sodium hydroxide	1310-73-2	1.515	458	0.0016%	694	0.0022%	25	pH buffer	Measured acute endpoints for fish (196 mg/L). Measured chronic endpoint for Daphnia (240 mg/L)	Based on Chronic: Low	N.A.(Inorganic)	N.A. (Inorganic)	Tier 2	NA. Acute toxicity only (irritant and corrosive), not systemically available in body	NA. Acute toxicity only (irritant and corrosive), not systemically available in body	NA. Acute toxicity only (irritant and corrosive), not systemically available in body	NA. Acute toxicity only (irritant and corrosive), not systemically available in body	NA. Acute toxicity only (irritant and corrosive), not systemically available in body
Citric acid	77-92-9	1.542	336	0.0012%	518	0.0017%	19	Corrosion Inhibitor	LC50/EC50 > 100 mg/L (fish, daphnia, algae) 8 day NOEC = 425 mg/L (algae)	Based on Chronic: Low	Readily biodegradable	No based on low log Kow	Tier 1 (NICNAS)	NA	NA	NA	NA	NA
Benzaldehyde	100-52-7	1.0415	332	0.0011%	346	0.0011%	12	Corrosion Inhibitor	Acute LC50 for freshwater fish is 1.07 mg/L, freshwater invertebrates is 16.2 mg/L and EC10 for freshwater algae is 20 mg/L. Chronic NOEC for freshwater fish is 0.12 mg/L.	Based on Chronic: High	Expected to be readily biodegradable	No based on Log Pow of 1.4	Tier 2	1.45E-04	2.56E-04	8.10E-04	1.21E-03	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Ethanol	64-17-5	0.7864	328	0.0011%	258	0.0008%	9	Surfactant	LC50/EC50 > 1000 mg/L (fish, daphnia, algae) NOEC for invertebrates is 9.6 mg/L (10 day reproduction), plants it is 280 mg/L (7 day study)	Based on Chronic: High	Readily biodegradable	No based on calculated logBCF=0.5	Tier 2	1.36E-06	3.36E-07	7.56E-06	9.25E-06	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Hydrotreated light petroleum distillate	64742-47-8	0.8	303	0.0010%	242	0.0008%	9	Friction Reducer, Surfactant	96 hr LL50 was 2 to 5 mg/L (fish) 48 hr EL50 was 1.4 mg/L (daphnia) 21 d NOEL = 0.48 mg/L (daphnia)	Based on Chronic: High	Readily biodegradable	Yes based on calculated log BCF values for constituents that range from 2.78 to 4.06, and calculated BCF values of 598 to 11,430 L/kg wet-weight	Tier 2	3.05E-06	2.75E-03	1.70E-05	2.77E-03	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Fatty acids, tall-oil, ethoxylated	61791-00-2	1.054	235	0.0008%	248	0.0008%	9	Surfactant	96h-LL50 > 100 mg/L (fish) 48h-EL50 = 12.41 mg/L (invertebrates) 72h-EL50 = 39.7 mg/L (algae) 72h-EL10 = 7.08 mg/L (algae)	Based on Acute: High	Readily biodegradable (read across)	No based on low BCF values of < 100 L/kg ww	Tier 2	3.12E-06	3.03E-05	1.74E-05	5.08E-05	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Amides, tall-oil fatty, N,N-bis(hydroxyethyl)	68155-20-4	0.9	125	0.0004%	112	0.0004%	4	Surfactant	LC50 (96h) 6.7 mg/L (Danio rerio) (similar substance) LC50 (21d) = 0.1 mg/L (Daphnia magna) LC50 (48h) = 2.15 mg/L EC50 (72h) 2.2 mg/L (Scendesmus subspicatus) (similar substance)	Based on Chronic: High	Readily biodegradable (read across)	No Log Kow 3	Tier 2	2.83E-05	9.31E-04	1.58E-04	1.12E-03	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).

Chemical Name	CAS Number	Density (kg/L)	Volume of Chemical (L)	Volume Fraction (%v/v)	Chemical Mass in Fluid (kg)	Mass Fraction (% w/w)	Concentration in Injected Fluid (mg/L)	Parent Compound Purpose	Ecotoxicity[1]	Toxicity[2]	Biodegradation[1,3]	Bioaccummulative[1]	Tier 1 Screening Assessment	Tier 2 Assessment Worker Ingestion Risk	Tier 2 Assessment Worker Dermal Risk	Tier 2 Assessment Worker Aerosol Inhalation Risk	Hazard Quotient	Outcome of Tier 2 Worker Risk Assessment[1]
Butyl alcohol	71-36-3	0.81	116	0.0004%	94	0.0003%	3	Surfactant	Fish, LC50 (96h) 1376 mg/l Invertebrates, EC50 (48h) 1328 mg/L) Algae, EC50 (96h) 225 mg/L EC10 (17h) Pseudomonas putida = 2476 mg/L Chronic NOECrepro (21d) = 4.1 mg/L for Daphnia magna	Based on Chronic: Moderate	Readily biodegradable	No based on low log Kow values of 1	Tier 2	9.45E-06	1.00E-05	5.26E-05	7.21E-05	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Alcohols, C12-15, ethoxylated	68131-39-5	0.867	103	0.0004%	89	0.0003%	3	Friction Reducer, Surfactant	96 h LC50 Oncorhynchus mykiss was 5 - 7 mg/L Lepomis macrochirus, NOEC (30 days) was 0.11 – 0.33 mg/L. Daphnia magna, EC50 (48 h) was 2.5 mg/L. Daphnia magna, NOEC (21 days) was 0.77 – 1.75 mg/L. Green algae, EC50 (96 h) was 1.4 mg/L. EC50 (3 h) for microorganisms was 140 mg/L.	Based on Chronic: High	Readily biodegradable	No. Based on an estimated log Kow value of 4.3 – 5.36, and BCF value of 1.1 – 1.8, it is not expected to be bioaccumulative.	Tier 2	2.25E-05	1.53E-05	1.26E-04	1.63E-04	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Alcohols, C12-16, ethoxylated	68551-12-2	0.97	69	0.0002%	67	0.0002%	2	Corrosion Inhibitor, Surfactant	96 h LC50 Oncorhynchus mykiss was 5 - 7 mg/L Lepomis macrochirus, NOEC (30 days) was 0.11 – 0.33 mg/L. Daphnia magna, EC50 (48 h) was 2.5 mg/L. Daphnia magna, NOEC (21 days) was 0.77 – 1.75 mg/L. Green algae, EC50 (96 h) was 1.4 mg/L. EC50 (3 h) for microorganisms was 140 mg/L.	Based on Chronic: High	Readily biodegradable	No. Based on an estimated log Kow value of 4.3 – 5.36, and BCF value of 1.1 – 1.8, it is not expected to be bioaccumulative.	Tier 2	1.68E-05	6.93E-03	9.36E-05	7.04E-03	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Sodium iodide	7681-82-5	3.67	47	0.0002%	171	0.0005%	6	Corrosion Inhibitor	96 hour LC50 for fish is > 860 mg/l 7 days NOEC for fish is 100 mg/L 48hrs-EC50 for Daphnia magna is 1.27 mg/L NOEC for algae is 66 mg/L	Based on Chronic: Low	N.A.(Inorganic)	N.A.(Inorganic)	Tier 1 (NICNAS)	NA	NA	NA	NA	NA
Acrylonitrile	107-13-1	0.806	45	0.0002%	36	0.0001%	1	Surfactant	96h LC50 for freshwater fish = 10 - 20 mg/l 96h LC50 for saltwater fish 8.6 mg/l 48h EC50 for Daphnia = 7.6 mg/l 30d NOEC for fish of 0.17 mg/l	Based on Chronic: High	Biodegradable	No based on the low log Pow (0.00-0.30)	Tier 2	1.81E-03	9.67E-04	1.01E-02	1.29E-02	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Diethanolamine	111-42-2	1.1	43	0.0001%	48	0.0002%	2	Breaker Activator	Fish 96-h LC50 = 1370 mg/l Invertebrates 48-h EC50 = 55 mg/l Pseudokirchneriella subcapitata 96-h ErC50 = 2.2 mg/l Microorganisms 16-h TTC = 16 mg/l Daphnia magna, the NOEC (21 days) was 0.78 mg/l	Based on Chronic: High	Readily biodegradable	No. Based on a measured log Kow of -2.18 and a calculated BCF of 3.16	Tier 2	4.29E-04	8.89E-06	2.39E-03	2.83E-03	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Glutaraldehyde	111-30-8	1.05	23	0.0001%	24	0.0001%	1	Biocide	96 h acute Bluegill sunfish LC50 = 11.2 mg/L 48 h acute Oyster larvae LC550 = 2.1 mg/L 96 h acute Green crabs LC50 = 465 mg/L 96 h acute Grass shrimp LC50 = 41 mg/L 48 acute Daphnia magna LC50 = 0.35 mg/L 48 acute Daphnia magna LC50 = 16.3 mg/L 21 d reproductn Daphnia magna LOEC = 4.3 mg/L, NOEC = 2.1 mg/L 96 h algal growth inhibition Selenastrum capricornutum ILm = 3.9 mg/L (median inhibitory limit) 96 h algal growth inhibition Scenedesmus subspicatus EC50 = 1.0 mg/L Bacterial inhibition Sewage microbes IC50 = 25-34 mg/L	Based on Chronic: Moderate	Readily biodegradable	No based on the Log Pow of -0.01	Tier 2	7.47E-05	1.12E-05	4.16E-04	5.02E-04	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
																Total Risk	**0.26**	The calculated risks associated with potential exposure to COPC identified in flowback water, where the SW Recipe is used and assuming 100% mass recovery is below the target of 1, respectively. Hence, chronic health risks are considered to be low and acceptable.

Notes
Tier 1 (NICNAS) - Chemical identified as of low concern for human health, as published in the National Assessment of Chemicals Associated with Coal Seam Gas Extraction in Australia (NICNAS 2017).
1 - Please refer to the individual toxicity profiles for further detail.
2 - Toxicity assessed using Commonwealth of Australia 2013 Ecotoxicity Assessment Guidelines (presented as Table 4 in the Northern Territory Government Draft Guideline for the Preparation of an Environment Management Plan under the Petroleum Regulations (2019)
3- Biodegradation assessed as per Northern Territory Government Draft Guideline for the Preparation of an Environment Management Plan under the Petroleum Regulations (2019) and Australian Government Department of Health National Industrial Chemicals Notification and Assessment Scheme (NICNAS)
BCF - Bioconcentration Factor
NA - Not Applicable
NICNAS 2017 - National Assessment of Chemicals Associated with Coal Seam Gas Extraction in Australia
DOE 2017 - Draft Risk Assessment Guidance Manual: For Chemicals Associated with Coal Seam Gas Extraction, Australian Government, Department of Energy

Toxicity and Dermal Absorption Parameters

C = calculated from chronic value, Ch = chronic value adopted

CAS#	Chemical	Oral/Dermal Exposures				Inhalation Exposures										
		Threshold Chronic TDI or RfD (mg/kg/day)		Dermal Permeability (cm/hr)	Reference	Inhalation Unit Risk $(ug/m^3)^{-1}$	Non-Threshold Slope Factor $(mg/kg/day)^{-1}$		Threshold Chronic TC or RfC (mg/m^3)		NOAEC or LOAEC (mg/m^3)	NOAEL or LOAEL (mg/kg bw/d)	Reference	UF	Reference
	COPC in Hydraulic Fracturing Fluid Injected into Well															
1319-33-1	Boronatrocalcite/Ulexite[A]	0.096	D	9.14E-04	EPI (as boric acid)				0.336	converted from RFD		9.6	NICNAS (2017)	100	NICNAS (2017)
68937-66-6	Alcohols, C6-12, ethoxylated propoxylated[B]	0.5	D	1.21E-04	EPI				1.75	converted from RFD		50	NICNAS (2017)	100	NICNAS (2017)
69227-22-1	Alcohols, C10-16, ethoxylated propoxylated[B]	0.5	D	2.87E-01	EPI				1.75	converted from RFD		50	NICNAS (2017)	100	NICNAS (2017)
64-19-7	Acetic acid	12	D	5.56E-04	EPI				42	converted from RFD		1200	NICNAS (2017)	100	NICNAS (2017)
25322-68-3	Polyethylene glycol	8	D	2.14E-06	EPI				28	converted from RFD		8000	REACH	1000	D
7631-90-5	Sodium bisulfite[C]	10.5	D	4.16E-09	EPI				36.75	converted from RFD		1050	NICNAS (2017)	100	NICNAS (2017)
104-55-2	Cinnamaldehyde	2	D	5.20E-03	EPI				7	converted from RFD		200	NTP (2004); REACH	100	D
67-56-1	Methanol	0.037	D	3.19E-04	EPI				0.13	converted from RFD		3.7	NICNAS (2017)	100	NICNAS (2017)
61788-90-7	Amine oxides, cocoalkyldimethyl	0.08	D	1.03E-01	EPI				0.28	converted from RFD		80	OECD (2001)	1000	D
100-52-7	Benzaldehyde	0.3	D	3.83E-03	EPI				1.05	converted from RFD		300	OECD (2002); REACH; NICNAS	1000	D
64-17-5	Ethanol	24	D	5.38E-04	EPI				84	converted from RFD		2400	NICNAS (2017)	100	NICNAS (2017)
64742-47-8	Hydrotreated light petroleum distillate	10	D	1.96E+00	EPI				35	converted from RFD		1000	NICNAS (2017)	100	NICNAS (2017)
61791-00-2	Fatty acids, tall-oil, ethoxylated	10	D	2.11E-02	EPI				35	converted from RFD		1000	REACH	100	D
68155-20-4	Amides, tall-oil fatty, N,N-bis(hydroxyethyl)	0.5	D	7.14E-02	EPI				1.75	converted from RFD		50	USEPA (2010)	100	D
71-36-3	Butyl alcohol	1.25	D	2.31E-03	EPI				4.375	converted from RFD		125	OECD (2001)/NICNAS	100	D
68131-39-5	Alcohols, C12-15, ethoxylated[B]	0.5	D	1.48E-03	EPI				1.75	converted from RFD		50	NICNAS (2017)	100	NICNAS (2017)
68551-12-2	Alcohols, C12-16, ethoxylated[B]	0.5	D	8.97E-01	EPI				1.75	converted from RFD		50	NICNAS (2017)	100	NICNAS (2017)
107-13-1	Acrylonitrile	0.0025	D	1.16E-03	EPI				0.00875	converted from RFD		0.25	OECD (2005); NICNAS	100	D
111-42-2	Diethanolamine	0.014	D	4.51E-05	EPI				0.049	converted from RFD		14	REACH; OECD (2002); NICNAS	1000	D
111-30-8	Glutaraldehyde	0.04	D	3.25E-04	EPI				0.14	converted from RFD		4	NICNAS (2017)	100	NICNAS (2017)
102-71-6	Triethanol amine	1.25	D	4.93E-05	EPI				4.375	converted from RFD		125	NICNAS (2017)	100	NICNAS (2017)
7758-19-2	Chlorous acid, sodium salt	0.039	D	8.27E-09	EPI				0.1365	converted from RFD		3.9	NICNAS (2017)	100	NICNAS (2017)
12008-41-2	Disodium octaborate tetrahydrate[A]	0.096	D	9.14E-04	EPI (as boric acid)				0.336	converted from RFD		9.6	NICNAS (2017)	100	NICNAS (2017)
7775-27-1	Sodium persulfate	0.67	D	7.05E-07	EPI				2.345	converted from RFD		67	NICNAS (2017)	100	NICNAS (2017)
68439-54-3	Ethoxylated branched C13 alcohol	0.5	D	1.06E-03	EPI				1.75	converted from RFD		50	NICNAS (2017)	100	NICNAS (2017)
1338-43-8	Sobitan, mono-9-octadecenoate, (Z)	25	JECFA	5.02E-02	EPI				87.5	converted from RFD		-	JECFA(1973); US FDA; FSANZ (2018)	-	-
9005-65-6	Sorbitan monooleate polyoxyethylene derivative	10	EFSA	3.54E-09	EPI				35	converted from RFD		-	EFSA (2017)	-	-
111-46-6	2,2''-oxydiethanol (diethylene glycol)	0.3	D	4.17E-05	EPI				1.05	converted from RFD		300	Health Council of the Netherlands (2007); NICNAS	1000	D
7631-90-5	Sodium bisulfate[C]	10.5	D	9.29E-09	EPI				36.75	converted from RFD		1050	NICNAS (2017)	100	NICNAS (2017)
14808-60-7	Crystalline silica, quartz	Not toxic via oral/dermal exposure							0.003	USEPA (2019)		-	-	-	-
10486-00-7	Sodium perborate tetrahydrate	0.05	D	1.81E-06	EPI				0.175	converted from RFD		50	REACH	1000	D

Notes:

A - Read across data from Boric Acid

B - Read across data from Alcohol ethoxylates C6-C12

C - Read across data from Sodium Sulfite

References:

D - Derived (refer to individual Toxicity Profiles)

EFSA - European Food Safety Authority

EPI - USEPA Estimation Programs Interface (EPI) Suite

FSANZ - Food Standards Australia New Zealand

J- JECFA - Joint FAO/WHO Expert Committee on Food Additives

NICNAS - National Industrial Chemicals Notification and Assessment Scheme. Assessed at https://www.nicnas.gov.au/

NICNAS (2017) - Department of the Environment and Energy 2017 , National assessment of chemicals associatedwith coal seam gas extraction in Australia, prepared by the National Industrial ChemicalsNotification and Assessment Scheme

NTP - US Department of Health and Serices National Toxicology Program

OECD - Organisation for Economic Co-operation and Development Screening Information Data Set (SIDS)

REACH - ECHA REACH European Chemicals Agency Database: http://apps.echa.europa.eu

Exposure to Chemicals via Incidental Ingestion of Flowback fluid - SW Recipe

Chronic Exposures

General Data/ Equations	Units	Exposure Calculations (RME) Ingestion of Flowback Water by Workers	
Exposure Parameters			
Exposure Frequency (EF)	days/year	20	Assume work 5 days per week for 1 month during the fraccing period
Exposure Duration (ED)	years	0.083	Maximum duration of the frac. Works will be complete in one month.
Body Weight (BW)	kg	78	Average male and female adults as per enHealth 2012
Averaging Time - NonThreshold (ATc)	days	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (ATn)	days	30.42	USEPA 1989 and CSMS 1996
Ingestion Rate (IRw)	L/day or L/hr	0.005	Assume Incidental ingestion of 5 ml (1 tsp) of water per day during fraccing.
Bioavailability (B)	-	100%	Assume 100% bioavailability via ingestion of chemicals in water.
Intake Factor = IRw*ET*B*EF*ED / BW*AT	L/kg/day	**4.2E-09**	**NonThreshold**
		3.5E-06	**Threshold**

Daily Intake from Water = Concentration in Water x Intake Factor (ref: USEPA 1989)
NonThreshold Risk = Daily Intake from Water for NonThreshold Effects x Slope Factor
Hazard Quotients = (Daily Intake from Water for Threshold Effects/ADI)

CAS	Chemical	Toxicity Data				Concentration	Daily Intake		Calculated Risk	
		Non-Threshold Slope Factor	Chronic Threshold TDI	Background Intake (% Chronic TDI)	Chronic TDI Allowable for Assessment (TDI-Background)	in Water	NonThreshold	Threshold	NonThreshold Risk	Chronic Hazard Quotient
		$(mg/kg\text{-}day)^{-1}$	(mg/kg/day)		(mg/kg/day)	(mg/L)	(mg/kg/day)	(mg/kg/day)	(unitless)	(unitless)
68937-66-6	Alcohols, C6-12, ethoxylated propoxylatedB		5.0E-01		5.0E-01	344.58	1.4E-06	1.2E-03	--	2.4E-03
69227-22-1	Alcohols, C10-16, ethoxylated propoxylatedB		5.0E-01		5.0E-01	177.36	7.4E-07	6.2E-04	--	1.2E-03
64-19-7	Acetic acid		1.2E+01		1.2E+01	107.82	4.5E-07	3.8E-04	--	3.2E-05
25322-68-3	Polyethylene glycol		8.0E+00		8.0E+00	89.47	3.7E-07	3.1E-04	--	3.9E-05
7631-90-5	Sodium bisulfiteC		1.1E+01		1.1E+01	90.84	3.8E-07	3.2E-04	--	3.0E-05
104-55-2	Cinnamaldehyde		2.0E+00		2.0E+00	54.91	2.3E-07	1.9E-04	--	9.6E-05
111-46-6	2,2"-oxydiethanol (diethylene glycol)		3.0E-01		3.0E-01	29.63	1.2E-07	1.0E-04	--	3.5E-04
67-56-1	Methanol		3.7E-02		3.7E-02	20.75	8.7E-08	7.3E-05	--	2.0E-03
61788-90-7	Amine oxides, cocoalkyldimethyl		8.0E-02		8.0E-02	12.42	5.2E-08	4.4E-05	--	5.5E-04
100-52-7	Benzaldehyde		3.0E-01		3.0E-01	12.42	5.2E-08	4.4E-05	--	1.5E-04
64-17-5	Ethanol		2.4E+01		2.4E+01	9.27	3.9E-08	3.3E-05	--	1.4E-06
64742-47-8	Hydrotreated light petroleum distillate		1.0E+01		1.0E+01	8.69	3.6E-08	3.1E-05	--	3.1E-06
61791-00-2	Fatty acids, tall-oil, ethoxylated		1.0E+01		1.0E+01	8.89	3.7E-08	3.1E-05	--	3.1E-06
68155-20-4	Amides, tall-oil fatty, N,N-bis(hydroxyethyl)		5.0E-01		5.0E-01	4.03	1.7E-08	1.4E-05	--	2.8E-05
71-36-3	Butyl alcohol		1.3E+00		1.3E+00	3.36	1.4E-08	1.2E-05	--	9.4E-06
68131-39-5	Alcohols, C12-15, ethoxylatedB		5.0E-01		5.0E-01	3.21	1.3E-08	1.1E-05	--	2.3E-05
68551-12-2	Alcohols, C12-16, ethoxylatedB		5.0E-01		5.0E-01	2.39	1.0E-08	8.4E-06	--	1.7E-05
107-13-1	Acrylonitrile		2.5E-03		2.5E-03	1.29	5.4E-09	4.5E-06	--	1.8E-03
111-42-2	Diethanolamine		1.4E-02		1.4E-02	1.71	7.1E-09	6.0E-06	--	4.3E-04
111-30-8	Glutaraldehyde		4.0E-02		4.0E-02	0.85	3.6E-09	3.0E-06	--	7.5E-05
								Total Risk (mixture)		**9.19E-03**

Note:
This scenario is deemed protective of the following scenarios due to the less frequent and short duration of exposures:
- Worker exposure during a spill (i.e.a couple breaks on a tank and releases product onto the worker) or leak scenarios

Dermal Exposure to Chemicals via Contact with Flow Back Water - SW Recipe

Chronic Exposures

General Data/ Equations	Units	Exposure Calculations (RME) Dermal Contact with Flow Back Water by Workers	
Exposure Parameters			
Exposure Frequency (EF)	days/year	20	Assume work 5 days per week for 1 month during the fraccing period
Exposure Duration (ED)	years	0.083	Maximum duration of the frac. Works will be complete in one month.
Body Weight (BW)	kg	78	Average male and female adults as per enHealth 2012
Averaging Time - NonThreshold (ATc)	days	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (ATn)	days	30.42	USEPA 1989 and CSMS 1996
Surface Area (SAw)	cm^2	2300	Hands and forearms exposed (enHealth 2012) Occupational HSE would require long pants and closed shoes on Australian work sites; forearms conservatively included
Exposure Time (ET)	hr/day	1	Assume contact with flow back water for 1 hours per day
Conversion Factor (CF)	L/cm^3	1.E-03	Conversion of units
Intake Factor = SAw*ET*CF*EF*ED / BW*AT	L-hr/(cm-kg-day)	**1.9E-06** **1.6E-03**	**NonThreshold** **Threshold**

Daily Intake from Water = Concentration in Water x Dermal Permeability x Intake Factor (ref: USEPA 1989, 2004)
NonThreshold Risk = Daily Intake from Water for NonThreshold Effects x Slope Factor
Hazard Quotients = (Daily Intake from Water for Threshold Effects/ADI)

	Chemical	Toxicity Data				Concentration	Daily Intake		Calculated Risk	
		Non-Threshold Slope Factor	Chronic Threshold TDI	Background Intake (% chronic TDI)	Chronic TDI Allowable for Assessment (TDI-Background)	Dermal Permeability	in Water	NonThreshold	Threshold	NonThreshold Risk	Chronic Hazard Quotient
		$(mg/kg\text{-}day)^{-1}$	(mg/kg/day)		(mg/kg/day)	(cm/hr)	(mg/L)	(mg/kg/day)	(mg/kg/day)	(unitless)	(unitless)
68937-66-6	Alcohols, C6-12, ethoxylated propoxylatedB		5.0E-01		5.0E-01	1.2E-4	344.58	8.0E-08	6.7E-05	--	1.3E-04
69227-22-1	Alcohols, C10-16, ethoxylated propoxylatedB		5.0E-01		5.0E-01	2.9E-1	177.36	9.8E-05	8.2E-02	--	1.6E-01
64-19-7	Acetic acid		1.2E+01		1.2E+01	5.6E-4	107.82	1.2E-07	9.7E-05	--	8.1E-06
25322-68-3	Polyethylene glycol		8.0E+00		8.0E+00	2.1E-6	89.47	3.7E-10	3.1E-07	--	3.9E-08
7631-90-5	Sodium bisulfiteC		1.1E+01		1.1E+01	4.2E-9	90.84	7.3E-13	6.1E-10	--	5.8E-11
104-55-2	Cinnamaldehyde		2.0E+00		2.0E+00	5.2E-3	54.91	5.5E-07	4.6E-04	--	2.3E-04
111-46-6	2,2"-oxydiethanol (diethylene glycol)		3.0E-01		3.0E-01	4.2E-5	29.63	2.4E-09	2.0E-06	--	6.7E-06
67-56-1	Methanol		3.7E-02		3.7E-02	3.2E-4	20.75	1.3E-08	1.1E-05	--	2.9E-04
61788-90-7	Amine oxides, cocoalkyldimethyl		8.0E-02		8.0E-02	1.0E-1	12.42	2.5E-06	2.1E-03	--	2.6E-02
100-52-7	Benzaldehyde		3.0E-01		3.0E-01	3.8E-3	12.42	9.1E-08	7.7E-05	--	2.6E-04
64-17-5	Ethanol		2.4E+01		2.4E+01	5.4E-4	9.27	9.6E-09	8.1E-06	--	3.4E-07
64742-47-8	Hydrotreated light petroleum distillate		1.0E+01		1.0E+01	2.0E+0	8.69	3.3E-05	2.8E-02	--	2.8E-03
61791-00-2	Fatty acids, tall-oil, ethoxylated		1.0E+01		1.0E+01	2.1E-2	8.89	3.6E-07	3.0E-04	--	3.0E-05
68155-20-4	Amides, tall-oil fatty, N,N-bis(hydroxyethyl)		5.0E-01		5.0E-01	7.1E-2	4.03	5.5E-07	4.7E-04	--	9.3E-04
71-36-3	Butyl alcohol		1.3E+00		1.3E+00	2.3E-3	3.36	1.5E-08	1.3E-05	--	1.0E-05
68131-39-5	Alcohols, C12-15, ethoxylatedB		5.0E-01		5.0E-01	1.5E-3	3.21	9.1E-09	7.7E-06	--	1.5E-05
68551-12-2	Alcohols, C12-16, ethoxylatedB		5.0E-01		5.0E-01	9.0E-1	2.39	4.1E-06	3.5E-03	--	6.9E-03
107-13-1	Acrylonitrile		2.5E-03		2.5E-03	1.2E-3	1.29	2.9E-09	2.4E-06	--	9.7E-04
111-42-2	Diethanolamine		1.4E-02		1.4E-02	4.5E-5	1.71	1.5E-10	1.2E-07	--	8.9E-06
111-30-8	Glutaraldehyde		4.0E-02		4.0E-02	3.3E-4	0.85	5.3E-10	4.5E-07	--	1.1E-05
									Total Risk (mixture)		**2.0E-1**

Note:
This scenario is deemed protective of the following scenarios due to the less frequent and short duration of exposures:
- Worker exposure during a spill (i.e.a couple breaks on a tank and releases product onto the worker) or leak scenarios

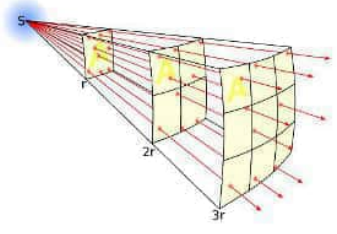
Aerosol Exposure - SW Recipe

The concentration of COPC in aerosol spray was estimated by calculating the concentration for driftable droplets using a mixed box model in which steady state concentrations were calculated. The 'inverse square law' was then applied to approximate the air concentration at a distance from the virtual air box. This law assumes that the density of the spray droplets is inversely proportional to the square of the distance from the source. That is, the further away a receptor is from the spray source, the density of the droplets (and therefore the concentration) will decrease.

An emission factor for driftable aerosol was estimated using the algorithm presented below.

Emission Factor for Driftable Aerosol Algorithm

$$Emission\ Factor_{driftable\ aerosol}\left(\frac{L}{m^3}\right) = \frac{Box\ Centre^2(m) \times \left(\frac{Spray\ Vol\ \left(\frac{L}{hr}\right) \times Aerosol_{driftable}(\%)}{BoxVR\ \left(\frac{m^3}{hr}\right)}\right)}{BoxDistance^2\ (m)}$$



Aerosol Exposure Modelling Notes:

1) The inhalation of chemicals in mist/aerosol resultant from irrigation activities is dependent upon the concentration in water, the amount of water used per unit time, how close a person stands to the spray generation, how long they are in a position of exposure and the extent of spray drift (determined by the size of the water droplets and speed/direction of the wind). These equations are applicable for non-volatile contaminants that are inhaled.
2) These equations calculate the concentration for driftable droplets using a simple well mixed box model in which steady state air concentrations are calculated. The 'Inverse square law' is then applied to approximate the air concentration at a distance from the virtual air box. This law assumes the further away a receptor is from the spray source, the density of the droplets will decrease. The density of the spray droplets is inversely proportional to the square of the distance from the source.

Parameter	Units	Value	Description
Spray box length	m	3	Assume a 'spray box' of 3 m long.
Spray box width	m	3	Assume a 'spray box' of 3 m wide.
Box Centre	m	1.5	Distance to centre of box is 1.5 m.
$Box_{Distance}$	m	2	Distance the irrigation worker is from the 'spray box'. Assumed a distance of 2 m.
$Aerosol_{driftable}$	unitless	0.2	Proportion of aerosol spray that drifts outside the 'spray box' and available for exposure. Assumed 0.2, based on a droplet size of 400 – 500 µm that falls approximately 0.3 m in less than 10 seconds, with a lateral drift of approximately 3.5 m in a 5 km/hr wind (i.e. a light breeze) (Grisso et al. 2013).
Spray Volume	L/hr	1800.0	1800 L/min, irrigation value adopted from NZ MtE (2011) Appendix 5A.
Wind speed	m/hr	9000	Based on windspeed of 2.5 m/sec
BoxVR	m^3/hr	81000.0	Ventilation rate of spray in the 'spray box'. Assumed to be 81,000 m3/hr based on a wind speed of 9000 m/hr, and a 'spray box' dimension of 3 x 3 m.

CAS	Chemical	Concentration in Water	Generation rate of chemical in volume	Driftable Aerosol Emission Factor
		mg/L	mg/hr	L/m^3
68937-66-6	Alcohols, C6-12, ethoxylated propoxylat	344.58	124049.7383	2.500000E-03
69227-22-1	Alcohols, C10-16, ethoxylated propoxyl	177.36	63849.13002	2.500000E-03
64-19-7	Acetic acid	107.82	38815.27443	2.500000E-03
25322-68-3	Polyethylene glycol	89.47	32209.40603	2.500000E-03
7631-90-5	Sodium bisulfiteC	90.84	32700.84622	2.500000E-03
104-55-2	Cinnamaldehyde	54.91	19768.14867	2.500000E-03
111-46-6	2,2"-oxydiethanol (diethylene glycol)	29.63	10665.31447	2.500000E-03
67-56-1	Methanol	20.75	7469.078692	2.500000E-03
61788-90-7	Amine oxides, cocoalkyldimethyl	12.42	4472.513177	2.500000E-03
100-52-7	Benzaldehyde	12.42	4470.713715	2.500000E-03
64-17-5	Ethanol	9.27	3338.494405	2.500000E-03
64742-47-8	Hydrotreated light petroleum distillate	8.69	3130.000401	2.500000E-03
61791-00-2	Fatty acids, tall-oil, ethoxylated	8.89	3201.205801	2.500000E-03
68155-20-4	Amides, tall-oil fatty, N,N-bis(hydroxyetl	4.03	1452.129696	2.500000E-03
71-36-3	Butyl alcohol	3.36	1210.554971	2.500000E-03
68131-39-5	Alcohols, C12-15, ethoxylatedB	3.21	1154.770361	2.500000E-03
68551-12-2	Alcohols, C12-16, ethoxylatedB	2.39	861.0898092	2.500000E-03
107-13-1	Acrylonitrile	1.29	464.4655534	2.500000E-03
111-42-2	Diethanolamine	1.71	615.1041839	2.500000E-03
111-30-8	Glutaraldehyde	0.85	306.4351619	2.500000E-03

Exposure to Chemicals via Inhalation of Mist from the Evaporation Units - SW Recipe

Chronic Exposures

General Data/ Equations	Units	Exposure Calculations (RME) Inhalation of Mist by Workers	
Exposure Parameters			
Exposure Frequency (EF)	days/year	240	Exposure for 5 days per week minus 4 weeks holidays
Exposure Duration (ED)	years	1	Maximum duration that the flowback tank will be on-site
Exposure Time (ET)	hr/day	1	Professional judgement for irrigation exposure. Assume worker to be near tank for 1 hours every working day.
Driftable aerosol emission factor (EMF)	L/m3	2.50E-03	Calculated
Aerosol Inhalation Bioavailability (AAF)	unitless	1.0	Assume 100% bioavailability
Averaging Time - Threshold (AT)	years	1.0	USEPA 1989 and CSMS 1996
$ITF_{inh,w,shwr} = \frac{EmF \times AAF \times ET_{iw} \times EF \times ED}{365\ \frac{days}{year} \times 24\ \frac{hours}{day} \times AT}$			

Daily Intake = Concentration in Water x Intake Factor (ref: USEPA 1989)
Hazard Quotients = (Daily Intake from Aerosol for Threshold Effects/ADI)

CAS	Chemical	Concentration in Water	Aerosol Inhalation Bioavailability	Driftable Aerosol Emission Factor	RfC (Background Corrected)	Threshold Intake and Risk Calculations: Adult Exposure Factor (threshold)	Adult Exposure Adjusted Air Concentration (threshold)	Hazard Quotient (Adult)
		mg/L	(unitless)	(L/m^3)	(mg/m^3)	(L/m^3)	(mg/m^3)	(unitless)
68937-66-6	Alcohols, C6-12, ethoxylated propoxylatedB	3.45E+02	1.00	2.50E-03	1.75E+00	6.85E-05	2.36E-02	1.35E-02
69227-22-1	Alcohols, C10-16, ethoxylated propoxylatedB	1.77E+02	1.00	2.50E-03	1.75E+00	6.85E-05	1.21E-02	6.94E-03
64-19-7	Acetic acid	1.08E+02	1.00	2.50E-03	4.20E+01	6.85E-05	7.38E-03	1.76E-04
25322-68-3	Polyethylene glycol	8.95E+01	1.00	2.50E-03	2.80E+01	6.85E-05	6.13E-03	2.19E-04
7631-90-5	Sodium bisulfiteC	9.08E+01	1.00	2.50E-03	3.68E+01	6.85E-05	6.22E-03	1.69E-04
104-55-2	Cinnamaldehyde	5.49E+01	1.00	2.50E-03	7.00E+00	6.85E-05	3.76E-03	5.37E-04
111-46-6	2,2''-oxydiethanol (diethylene glycol)	2.96E+01	1.00	2.50E-03	1.05E+00	6.85E-05	2.03E-03	1.93E-03
67-56-1	Methanol	2.07E+01	1.00	2.50E-03	1.30E-01	6.85E-05	1.42E-03	1.09E-02
61788-90-7	Amine oxides, cocoalkyldimethyl	1.24E+01	1.00	2.50E-03	2.80E-01	6.85E-05	8.51E-04	3.04E-03
100-52-7	Benzaldehyde	1.24E+01	1.00	2.50E-03	1.05E+00	6.85E-05	8.51E-04	8.10E-04
64-17-5	Ethanol	9.27E+00	1.00	2.50E-03	8.40E+01	6.85E-05	6.35E-04	7.56E-06
64742-47-8	Hydrotreated light petroleum distillate	8.69E+00	1.00	2.50E-03	3.50E+01	6.85E-05	5.96E-04	1.70E-05
61791-00-2	Fatty acids, tall-oil, ethoxylated	8.89E+00	1.00	2.50E-03	3.50E+01	6.85E-05	6.09E-04	1.74E-05
68155-20-4	Amides, tall-oil fatty, N,N-bis(hydroxyethyl)	4.03E+00	1.00	2.50E-03	1.75E+00	6.85E-05	2.76E-04	1.58E-04
71-36-3	Butyl alcohol	3.36E+00	1.00	2.50E-03	4.38E+00	6.85E-05	2.30E-04	5.26E-05
68131-39-5	Alcohols, C12-15, ethoxylatedB	3.21E+00	1.00	2.50E-03	1.75E+00	6.85E-05	2.20E-04	1.26E-04
68551-12-2	Alcohols, C12-16, ethoxylatedB	2.39E+00	1.00	2.50E-03	1.75E+00	6.85E-05	1.64E-04	9.36E-05
107-13-1	Acrylonitrile	1.29E+00	1.00	2.50E-03	8.75E-03	6.85E-05	8.84E-05	1.01E-02
111-42-2	Diethanolamine	1.71E+00	1.00	2.50E-03	4.90E-02	6.85E-05	1.17E-04	2.39E-03
111-30-8	Glutaraldehyde	8.51E-01	1.00	2.50E-03	1.40E-01	6.85E-05	5.83E-05	4.16E-04
							Total Risk (mixture)	**0.05**

Summary of Risk to Workers - SW Recipe
Exposure fo Target Chemicals - Theoretical Data

Receptor/Exposure Pathway	Calculated HI 100% Mass Return
Use of Stimulation Fluid in Hydraulic Fracturing	
SW Recipe	
Workers	
Ingestion of Chemicals via Incidental Contact with Flowback Water	0.01
Dermal Exposure to Chemicals via Incidental Contact with Flowback Water	0.20
Inhalation of mist from the evaporation units	0.05
Total Risk	**0.26**

Appendix D

Chemical Risk Assessment Hydraulic Fracture Stimulation Fluid – SLB Hybrid

SLB HVFR/SW Recipe

Chemical Name	CAS Number	Density (kg/L)	Volume of Chemical (L)	Volume Fraction (%v/v)	Chemical Mass in Fluid (kg)	Mass Fraction (% w/w)	Concentration in Injected Fluid (mg/L)	Ecotoxicity[1]	Toxicity[2]	Biodegradation[1,3]	Bioaccummulative[1]	Tier 1 Screening Assessment	Tier 2 Assessment Worker Ingestion Risk	Tier 2 Assessment Worker Dermal Risk	Tier 2 Assessment Worker Aerosol Inhalation Risk	Hazard Quotient	Outcome of Tier 2 Worker Risk Assessment[1]
Hydrochloric acid	7647-01-0	1.35	17,034	0.001136098	22,996	0.001	1,646	Algae = 0.492 mg/L Daphnia = 0.492 mg/L Fish = 4.92 mg/L Daphnia (chronic) = 62 mg/L	Based on Chronic: Low	N.A.(Inorganic)	N.A. (Inorganic)	Tier 1	NA	NA	NA	NA	NA
2-hydroxy-N,N,N-trimethylethanaminium chloride	67-48-1	1.1	20,782	0.001386039	22,860	0.001	1,636	96-hour fish LC50 value is >100 mg/L 48-hour in vertebrate EC50 is 349 mg/L 72-hour EC50 to Pseudokirchneriella subcapitata is >1,000 mg/L 21-day Daphnia NOEC value is 30.2 mg/L	Based on Chronic: Low	Choline chloride is readily biodegradable and thus it does not meet the screening criteria for persistence.	Not Bioaccumulative (based on a measured log Kow of -3.77 and a calculated BCF of 0.59)	Tier 1 (NICNAS)	NA	NA	NA	NA	NA
Guar gum	9000-30-0	1	10,461	0.00069769	10,461	0.001	749	lowest measured ecotoxicity endpoint for fish was reported to be 218 mg/L.	Based on Acute: Low	Guar gum is a naturally occurring polysaccharide which would be expected to readily biodegrade. Thus, it is not expected to meet the screening criteria for persistence	Not Bioaccumulative based on the molecular weight of guar gum (ranges from 200,000 to 300,000 daltons), and it is also water soluble.	Tier 1 (NICNAS)	NA	NA	NA	NA	NA
Ethylene glycol	107-21-1	1.24	7,893	0.000526442	9,788	0.001	701	LC50 for fish = 22800 mg/L LC50 for Daphnia =7800 mg/L NOEC for Algae =100 mg/L	Based on Acute: Low	Readily biodegradable	No based on the measured log Kow of -1.36 and a measured BCF of 10	Tier 1 (NICNAS)	NA	NA	NA	NA	NA
2-Propenoic acid, polymer with sodium phosphinate	129898-01-7	1.18	5,126	0.00034189	6,049	0.000	433	Aquatic Toxicity Acute Aquatic - Fish -96-hr LC50 Rianbow Trout - >1,000 mg/L -96-hr LC50 Zebra Fish - >1,000 mg/L Acute Aquatic - Invertebrate -24-hr EC50 Daphnia - 320 mg/L -72-hr EC50 - 130 mg/L	Based on acute: Low	The polymer is not readily biodegradable, hence it meets the screening criteria for persistence.	The polymer is expected to have a very high molecular weight and poor water solubility. It is not expected to be bioavailable, hence this polymer does not meet the criteria for bioaccumulation.	Tier 1 (NICNAS)	NA	NA	NA	NA	NA
Ulexite	1319-33-1	1.36	4,157	0.000277258	5,654	0.000	405	Fish toxicity: Rainbow Trout (S.gairdneri) 24 day LC50 = 150.0 mg/B/L 36 day NOEC-LOEC = 0.75-1 mg/B/L Invertebrate toxicity: LC50 to Daphnia magna Straus = 133 mg B/L (48 h). 21-day NOEC-LOEC = 6-13 mg B/L.	Based on Chronic: Moderate	N.A.(Inorganic)	N.A. (Inorganic)	Tier 2	1.48E-02	6.23E-03	8.25E-02	1.04E-01	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Acrylamide sodium acrylate copolymer	25085-02-3	0.8	4,104	0.000273724	3,283	0.000	235	Limited information is available. The polymer is expected to be a low concern for toxicity to aquatic organisms. Due to its poor solubility and high molecular weight, it is not expected to be bioavailable. It does not contain any reactive functional groups.	No data	The polymer is not readily biodegradable, hence it meets the screening criteria for persistence	The polymer is expected to have a very high molecular weight and poor water solubility. It is not expected to be bioavailable, hence this polymer does not meet the criteria for bioaccumulation.	Tier 1 (NICNAS)	NA	NA	NA	NA	NA
Sodium bromate	7789-38-0	3.3	801	5.34218E-05	2,643	0.000	60	Short term toxicity to fish: 1- to 10-d LC50s ranging from 698.0 to 278.6 mg/l BrO3-, respectively for Juvenile spot. Short term toxicity to aquatic algae and cynobacteria: 72h EC50 value was 603.5 (189.3 – n.d.) mg/L for Yield. Short term toxicity to Invertebrates: 24hr LC50 of 112.7 mg/L Daphnia magna 48 hr LC50 of 55.3 mg/L Daphnia magna 72 hr LC50 of 46.8 mg/L Daphnia magna 96hr LC50 46.8 mg/L Daphnia magna 72 hr EC50 of 15954 mg/L for Isochrysis galbana (Haptophyte algae) 24 hr EC50 of 170 mg/L for Crassostrea gigas (Pacific oyster) larvae	Based on acute: Moderate	Not applicable (inorganic salt, ionic species ubiquitous in environment)	Not applicable (inorganic salt, ionic species ubiquitous in environment)	Tier 2	7.02E-02	1.22E-07	3.91E-01	4.62E-01	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Sodium hydroxide	1310-73-2	1.3	1,997	0.000133176	2,596	0.000	186	Measured acute endpoints were available for fish (196 mg/L). Measured chronic endpoint were available for Daphnia (240 mg/L)	Based on Chronic: Low	N.A.(Inorganic)	N.A. (Inorganic)	Tier 1	NA	NA	NA	NA	NA
Diammonium peroxidisulphate	7727-54-0	1.98	1,078	7.18771E-05	2,134	0.000	153	Acute Aquatic - Fish -96-hr LC50 Oncorhynchus - 76.3 mg/L -48-hr EC50 Daphnia magnaL - 120 mg/L -72-hr EC10 Phaedactylum tricornutum - 320 mg/L Acute Aquatic - Invertebrate -Daphnia magna reproduction test - NOEC of 20.8 mg/L	Based on acute: Moderate	No. Not applicable, inorganic salt, ionic species ubiquitous in environment.	No. Not applicable, inorganic salt, ionic species ubiquitous in environment.	Tier 2	2.55E-02	1.18E-02	1.42E-01	1.80E-01	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Poly(oxy-1,2-ethanediyl), alphahexyl-omega-hydroxy-	31726-34-8	1	1,663	0.000110883	1,663	0.000	119	Acute Aquatic - Fish -96-hr LC50 Oncorhynchus mykiss - 1,464 mg/L -96-hr LC50 Pimephales promelas - range from 1,580 mg/L - 2,137 mg/L -96 hr LC50 - Lepomis machrochirus - 1,490 mg/L Acute Aquatic - Invertebrate -48-hr EC50 Daphnia magna - range from - 881 mg/L - 2,650 mg/L Acute Aquatic - Algae and other aquatic plants -72-hr EC50 Pseudokirchneriella subcapitata - 911 mg/L -72-hr EC50 Selenastrum capricornutum - 720 mg/L Chronic Aquatic - Fish -21-day NOEC Brachydanio rerio - > 100 mg/L Chronic Aquatic - Invertebrate - 21-day NOEC Daphnia magna - 100 mg/L	Based on acute and chronic: Low	Readily biodegradable	Based on a log Kow value greater than 3, and a maximum BCF value of under 800 the substance is not bioaccumulative.	Tier 1	NA	NA	NA	NA	NA
Sodium Chloride	7647-14-5	1.18	1,025	6.83678E-05	1,210	0.000	87	EC50 = 400 to 30000 mg/L EC50 Fish = 1290 mg/L NOEC = 314 mg/L (Daphnia)	Based on Chronic: Low	N.A.(Inorganic)	N.A. (Inorganic)	Tier 1	NA	NA	NA	NA	NA
Glutaraldehyde	111-30-8	1.06	1,039	6.9302E-05	1,101	0.000	79	96 h acute Bluegill sunfish LC50 = 11.2 mg/L 48 h acute Oyster larvae LC550 = 2.1 mg/L 96 h acute Green crabs LC50 = 465 mg/L 96 h acute Grass shrimp LC50 = 41 mg/L 48 acute Daphnia magna LC50 = 0.35 mg/L 48 acute Daphnia magna LC50 = 16.3 mg/L 21 d reproduct'n Daphnia magna LOEC = 4.3 mg/L, NOEC = 2.1 mg/L 96 h algal growth inhibition Selenastrum capricornutum ILm = 3.9 mg/L (median inhibitory limit) 96 h algal growth inhibition Scenedesmus subspicatus EC50 = 1.0 mg/L Bacterial inhibition Sewage microbes IC50 = 25-34 mg/L	Based on Chronic: Moderate	Readily biodegradable	No based on the Log Pow of -0.01	Tier 2	6.92E-03	1.04E-03	3.86E-02	4.65E-02	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Sodium Tetraborate Decahydrate	1303-96-4	1.36	460	3.06494E-05	625	0.000	45	Fish toxicity: Rainbow Trout (S.gairdneri) 24 day LC50 = 150.0 mg/B/L 36 day NOEC-LOEC = 0.75-1 mg/B/L Invertebrate toxicity: LC50 to Daphnia magna Straus = 133 mg B/L (48 h). 21-day NOEC-LOEC = 6-13 mg B/L.	Based on Chronic: Moderate	N.A.(Inorganic)	N.A. (Inorganic)	Tier 2	1.64E-03	6.88E-04	9.12E-03	1.14E-02	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Calcium Chloride	10043-52-4	1.18	527	3.5118E-05	621	0.000	44	Acute Toxicity 96-hr LC50 value was 4,630 mg/L in fathead minnow (Pimephales promelas) 48-hr EC50 was 1,062 mg/L for Daphnia magna 72-hr EC50 = >4,000 for fresh water algae 72-hr EC50 = 2,900 mg/L for fresh water algae (biomass) Chronic Toxicity 21-day NOEC = 160 mg/L for Daphnia magna	Based on acute and chronic: Low	Not applicable (inorganic salt, ionic species ubiquitous in environment)	Not applicable (inorganic salt, ionic species ubiquitous in environment)	Tier 1	NA	NA	NA	NA	NA
Vinylidene chloride/methylacrylate copolymer	25038-72-6	2	234	1.55772E-05	467	0.000	33	No data	No data	The polymers are synthetic addition polymers with stable carbon-chain backbones. If released to the environment, the polymers in this group are not expected to undergo rapid degradation	The polymer is expected to have a very high molecular weight and poor water solubility. Therefore, this polymer is considered to be not bioaccumulative	Tier 1 (NICNAS)	NA	NA	NA	NA	NA
but-2-enedioic acid	110-17-8	1.36	109	7.29627E-06	149	0.000	11	Acute Aquatic -96-h LC50 Danio rerio - >100 mg/L -48-h EC50 daphnia magna - >100 mg/L -72-h EC50 Pseudokirchneriella subcapitata - >100 mg/L -48-hr EC50 Daphnia magna - 62,630 mg/L	Based on acute: Low	Fumaric acid is readily biodegradable and as such not persistent in the environment.	Based on the measured log Kow of <3 Fumaric acid is not bioaccumulative.	Tier 1	NA	NA	NA	NA	NA

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Chemical Name	CAS Number	Density (kg/L)	Volume of Chemical (L)	Volume Fraction (%v/v)	Chemical Mass in Fluid (kg)	Mass Fraction (% w/w)	Concentration in Injected Fluid (mg/L)	Ecotoxicity[1]	Toxicity[2]	Biodegradation[1,3]	Bioaccummulative[1]	Tier 1 Screening Assessment	Tier 2 Assessment Worker Ingestion Risk	Tier 2 Assessment Worker Dermal Risk	Tier 2 Assessment Worker Aerosol Inhalation Risk	Hazard Quotient	Outcome of Tier 2 Worker Risk Assessment[1]
Dicoco dimethyl quaternary ammonium chloride	61789-77-3	1	69	4.62013E-06	69	0.000	5.0	Short term toxicity data: Fish Lepomis macrochirus (Bluegill) 96 h LC50 = 1.04 mg/L Invertabrate Daphnia magna (Water flea) 48 h LC50 = 0.16 mg/L Algae Pseudokirchneriella subcapitata (Green algae) 96 h EC50 = 0.46 mg/L Long term toxicity data: Invertebrates Daphnia magna (Water flea) 21 d NOEC = 0.38 mg/L Algae Pseudokirchneriella subcapitata (Green algae) 96 h NOEC = 0.16 mg/L	Based on chronic: High	Not Persistent (Not P). Based on results obtained from biodegradation studies, all chemicals in this group are categorised as Not Persistent.	Not Bioaccumulative (Not B). Based on the available measured bioconcentration data, all chemicals in this group are categorised as Not Bioaccumulative.	Tier 2	1.74E-04	1.43E-02	9.70E-04	1.54E-02	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Diethylene glycol	111-46-6	1.18	55	3.68601E-06	65	0.000	4.7	LC 50 = >100 mg/L (fish, invertebrates, algae)	Based on Acute: Low	Readily biodegradable	No based on the estimated BCF of 3	Tier 1	NA	NA	NA	NA	NA
Potassium Chloride	7447-40-7	1.19	28	1.843E-06	33	0.000	2.4	96 h LC50 in Pimephales promelas = 880 mg/L 48 h LC50 Lepomis macrochirus, Oncorhyncusmykiss and Ictalurus punctatus = 720 - 2010 mg/L 48 h EC50 Daphnia magna and Ceriodaphnia dubia were 660 and 630 mg/L respectively NOEC for Daphnia is 373 mg/L	Based on chronic: Low	N.A.(Inorganic)	N.A. (Inorganic)	Tier 1 (NICNAS)	NA	NA	NA	NA	NA
Non-crystalline silica (impurity)	7631-86-9	1	26	1.74202E-06	26	0.000	1.9	Acute Aquatic -96-h LL0 Danio-rerio - 10,000 mg/L -24-h ECL50 Daphnia magna ->10,000 mg/L -72hr-NOEL (Scenedesmus subspicatus) - 10,000 mg/L	Based on acute: Low	Not applicable, inorganic substance, ubiquitous in environment.	Not applicable, inorganic substance, ubiquitous in environment.	Tier 1	NA	NA	NA	NA	NA
Talc	14807-96-6	2	7	4.79686E-07	14	0.000	1.0	No data	Based on low bioavailability: Low	Not readily biodegradable	Not bioaccumulative	Tier 1 (NICNAS)	NA	NA	NA	NA	NA
Propan-2-ol	67-63-0	1	14	9.34125E-07	14	0.000	1.0	Short term toxicity data: 96-hour LC50 in Pimephales promelas is 9,640 mg/L 24- hour EC50 in Daphnia magna is >10,000 mg/L Long term toxicity data: 16- and 21-day NOEC values of 141 and 30 mg/L, respectively, for the freshwater invertebrate Daphnia magna 7-day toxicity threshold value of 1,800 mg/L for freshwater algae	Based on acute and chronic: Low	Expected to be readily biodegradable.	No. Based on a measured log Kow of 0.05 and a calculated BCF of 1, the substance is not bioaccumulative.	Tier 1	NA	NA	NA	NA	NA
Methanol	67-56-1	0.95	9	6.31165E-07	9	0.000	0.6	LC50s ranged from 15,400 to 29,400 mg/L (fish) 24-hour and 48-hour EC50s were > 10,000 mg/L (Daphnia) 28 days NOEC was 446.7 mg/L (fish) 21 days NOEC was 208 mg/L (invertebrates)	Based on Chronic: Low	Readily biodegradable	Not bioaccumulative based on the Log Kow of -0.74	Tier 1	NA	NA	NA	NA	NA
Diutan	595585-15-2	1.43	5	3.53453E-07	8	0.000	0.5	Acute Aquatic -96-h LC50 freshwater fish > 100 mg/L -48-h EC50 freshwater Daphnia >100 mg/L -72 h EC50 Freshwater algae > 100 mg/L	Based on acute: Low	Diutan expected to readily biodegrade. Thus, it is not expected to meet the screening criteria for persistence	Based on the molecular weight, water solubility and Kow value (log Kow -2.76) the polymer is not expected to bioaccumulate	Tier 1	NA	NA	NA	NA	NA
Diutan gum	125005-87-0	1.4	5	3.53453E-07	7	0.000	0.5	Acute Aquatic -96-h LC50 freshwater fish > 100 mg/L -48-h EC50 freshwater Daphnia >100 mg/L -72 h EC50 Freshwater algae > 100 mg/L	Based on acute: Low	Diutan expected to readily biodegrade. Thus, it is not expected to meet the screening criteria for persistence	Based on the molecular weight, water solubility and Kow value (log Kow -2.76) the polymer is not expected to bioaccumulate	Tier 1	NA	NA	NA	NA	NA
Fatty acids, tall-oil (CAS proprietary)		0.91	7	4.79686E-07	7	0.000	0.5	Acute Aquatic: fish 96h-LL50 > 100 mg/L aquatic invertebrates 48h-EL50 = 12.41 mg/L algae 72h-EL50 = 39.7 mg/L	Based on acute: Moderate	Expected to be readily biodegradable.	No based on estimated BCF values of < 100 L/kg	Tier 2	1.65E-07	1.60E-06	9.17E-07	2.68E-06	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
poly(tetrafluoroethylene)	9002-84-0	2	3	2.01973E-07	6	0.000	0.4	No data	No data	Polymers are not expected to be readily biodegradable.	The polymer is not expected to bioaccumulate because of its poor water solubility and high molecular weight	Tier 1 (NICNAS)	NA	NA	NA	NA	NA
Thiourea, polymer with formaldehyde and 1-phenylethanone	68527-49-1	0.92	5	3.53453E-07	5	0.000	0.3	Fish: LC50 (96h) Morone saxatilis 6.18 mg/L LC50 (6d) embryos of Danio rerio 6.9 mg/L NOEC (28d) Oryzias latipes ≥ 48 mg/L Aquatic invertebrates: EC50 (48h) Daphnia pulex 5.8 mg/L NOEC (21 d) Daphnia magna > 6.4 mg/L Algae: EC50 (72h) Desmodesmus subspicatus 4.89 mg/L	Based on acute: High	Expected to be readily biodegradable.	No. Based on data for formaldehyde, due to the low log Kow (0.35), accumulation in organisms is not to be expected.	Tier 2	1.23E-06	5.64E-07	6.83E-06	8.62E-06	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Aliphatic alcohols, ethoxylated #2 (proprietary CAS)		0.9	5	3.02959E-07	4	0.000	0.3	Toxicity to fish: LC50 (96h) 0.59 mg/L (Pleuronectes platessa) (similar substance) LC50 (96) 1.4 mg/L (Pimephales promelas) (similar substance) NOEC 4.4 mg/L (Pimephales promelas, juvenile) Toxicity to invertebrates: EC50 (48h) 0.14 mg/L (Daphnia magna) (similar substance) EC50 (48h) 0.39 mg/L (Cerodaphnia dubia) (similar substance) Toxicity to algae: EC50 (72h) 0.75 mg/L (Pseudokirchnerella subcapitata) (similar substance) EC50 (96h) 0.7 mg/L (Pseudokirchneriella subapitata) (similar substance) CD10 8 mg/L (Pseudokirchneriella subapitata) EC10 2 mg/L (Brachionus calyciflorus) Toxicity to microorganisms: EC50 (48h) 0.39 mg/L (Cerodaphnia dubia) (similar substance)	Based on Chronic: Moderate	Expected to be readily biodegradable based on similar substances	Not Bioaccumulative (Based on an estimated log Kow value of 4.3 – 5.36, and BCF value of 1.1 – 1.8)	Tier 2	2.06E-06	2.71E-04	1.15E-05	2.85E-04	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Prop-2-yn-1-ol	107-19-7	0.87	2	1.26233E-07	2	0.000	0.1	LC50 (96h) of 1.53 mg/L for fish EC50 (48h) of 3.36 mg/L for invertebrates ErC50 (72h) >100 mg/L for algae	Based on acute: High	No. Expected to be readily biodegradable	No. As the Log KoW -0.35 @ 25 °C 59 (Log Pow < 4.5), it is not expected to be bioaccumulative.	Tier 2	8.28E-05	1.62E-05	4.61E-04	5.60E-04	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Hexadec-1-ene	629-73-2	0.88	1	7.57398E-08	1	0.000	0.1	Short term toxicity 96-hr LC50 > solubility Actual concentration negligible. Fish 96-hr LL0 = 1000 mg/L (nominal) Long term toxicity: NOEC (21 days) 19.4 µg/L (invertebrates)	Based on chronic: Very high	Expected to be readily biodegradable.	Not bioaccumulative	Tier 2	2.51E-06	2.28E-02	1.40E-05	2.28E-02	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
															Total Risk	**8.42E-01**	The calculated risk associated with potential exposure to COPC identified in flowback water, where the SLB HVFR/SW recipe is used and assuming 100% mass recovery is below the target of 1. Hence, chronic health risks are considered to be low and acceptable.

Notes
Tier 1 (NICNAS) - Chemical identified as of low concern for human health, as published in the National Assessment of Chemicals Associated with Coal Seam Gas Extraction in Australia (NICNAS 2017).
1 - Please refer to the individual toxicity profiles for further detail.
2 - Toxicity assessed using NT (2021)
3 - Biodegradation assessed as per NT (2021) and DoEE (2017)
BCF - Bioconcentration Factor
NA - Not Applicable
NICNAS 2017 - National Assessment of Chemicals Associated with Coal Seam Gas Extraction in Australia
DoEE 2017 - Draft Risk Assessment Guidance Manual: For Chemicals Associated with Coal Seam Gas Extraction, Australian Government, Department of Energy
NT 2021 - Northern Territory Government, Department of Environment, Parks and Water Security, Environment Management Plan Content Guideline, 2021

Toxicity and Dermal Absorption Parameters

C = calculated from chronic value, Ch = chronic value adopted

CAS#	Chemical	Oral/Dermal Exposures				Inhalation Exposures					
		Threshold Chronic TDI or RfD (mg/kg/day)		Dermal Permeability (cm/hr)	Reference	Threshold Chronic TC or RfC (mg/m^3)		NOAEL or LOAEL (mg/kg bw/d)	Reference	UF	Reference
	COPC in Hydraulic Fracturing Fluid Injected into Well										
1319-33-1	Boronatrocalcite/Ulexite[A]	0.096	D	9.14E-04	EPI (as boric acid)	0.336	converted from RFD	9.6	NICNAS (2017)	100	NICNAS (2017)
61791-00-2	Fatty acids, tall-oil, ethoxylated	10	D	2.11E-02	EPI	35	converted from RFD	1000	REACH	100	D
111-30-8	Glutaraldehyde	0.04	D	3.25E-04	EPI	0.14	converted from RFD	4	NICNAS (2017)	100	NICNAS (2017)
7789-38-0	Sodium bromate	0.003	A	3.78E-09	EPI	0.0105	converted from RFD	30	NHMRC (2021)	10000	D
61789-77-3	Dicoco dimethyl quaternary ammonium chloride	0.1	D	1.78E-01	EPI	0.350	converted from RFD	100	OECD (1996)	1000	D
629-73-2	Hexadec-1-ene	0.1	D	1.97E+01	EPI	0.350	converted from RFD	100	REACH	1000	D
7727-54-0	Diammonium peroxidisulphate	0.021	D	1.00E-03	EPI	0.074	converted from RFD	2.1	NICNAS (2017)	100	NICNAS (2017)
68951-67-7	Aliphatic alcohols, ethoxylated #2	0.5	D	2.87E-01	EPI	1.75	converted from RFD	50	NICNAS (2017)	100	NICNAS (2017)
1303-96-4	Sodium Tetraborate Decahydrate	0.096	D	9.14E-04	EPI (as boric acid)	0.336	converted from RFD	9.6	NICNAS (2017)	100	NICNAS (2017)
68527-49-1	Thiourea, polymer with formaldehyde and 1-phenylethanone	1	D	1.00E-03	EPI	3.5	converted from RFD	1000	NICNAS, NCBI, REACH	1000	D
107-19-7	Prop-2-yn-1-ol	0.005	D	4.24E-04	EPI	0.0175	converted from RFD	5	REACH, NCBI	1000	D

Notes:

A - Read across data from Boric Acid

#2 - Read across data from Alcohol ethoxylates C6-C12

References:

D - Derived (refer to individual Toxicity Profiles)

NICNAS (2017) - Department of the Environment and Energy 2017 , National assessment of chemicals associatedwith coal seam gas extraction in Australia, prepared by the National Industrial ChemicalsNotification and Assessment Scheme

OECD - Organisation for Economic Co-operation and Development Screening Information Data Set (SIDS)

REACH - ECHA REACH European Chemicals Agency Database: http://apps.echa.europa.eu

Exposure to Chemicals via Incidental Ingestion of Flowback fluid - HVFR/SW Recipe

Chronic Exposures

General Data/ Equations	Units	Exposure Calculations (RME) Ingestion of Flowback Water by Workers	
Exposure Parameters			
Exposure Frequency (EF)	days/year	20	Assume work 5 days per week for 1 month during the fraccing period
Exposure Duration (ED)	years	0.083	Maximum duration of the frac. Works will be complete in one month.
Body Weight (BW)	kg	78	Average male and female adults as per enHealth 2012
Averaging Time - NonThreshold (ATc)	days	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (ATn)	days	30.42	USEPA 1989 and CSMS 1996
Ingestion Rate (IRw)	L/day or L/hr	0.005	Assume Incidental ingestion of 5 ml (1 tsp) of water per day during fraccing.
Bioavailability (B)	-	100%	Assume 100% bioavailability via ingestion of chemicals in water.
Intake Factor = IRw*ET*B*EF*ED / BW*AT	L/kg/day	**4.2E-09** **3.5E-06**	**NonThreshold** **Threshold**

Daily Intake from Water = Concentration in Water x Intake Factor (ref: USEPA 1989)
NonThreshold Risk = Daily Intake from Water for NonThreshold Effects x Slope Factor
Hazard Quotients = (Daily Intake from Water for Threshold Effects/ADI)

Chemical		Toxicity Data				Concentration	Daily Intake		Calculated Risk	
		Non-Threshold Slope Factor	Chronic Threshold TDI	Background Intake (% Chronic TDI)	Chronic TDI Allowable for Assessment (TDI-Background)	in Water	NonThreshold	Threshold	NonThreshold Risk	Chronic Hazard Quotient
		$(mg/kg\text{-}day)^{-1}$	(mg/kg/day)		(mg/kg/day)	(mg/L)	(mg/kg/day)	(mg/kg/day)	(unitless)	(unitless)
1319-33-1	Boronatrocalcite/UlexiteA		9.6E-02		9.6E-02	404.72	1.7E-06	1.4E-03	--	1.5E-02
7789-38-0	Sodium bromate		3.0E-03		3.0E-03	60.00	2.5E-07	2.1E-04	--	7.0E-02
7727-54-0	Diammonium peroxidisulphate		2.1E-02		2.1E-02	152.75	6.4E-07	5.4E-04	--	2.6E-02
111-30-8	Glutaraldehyde		4.0E-02		4.0E-02	78.85	3.3E-07	2.8E-04	--	6.9E-03
1303-96-4	Sodium Tetraborate Decahydrate		9.6E-02		9.6E-02	44.74	1.9E-07	1.6E-04	--	1.6E-03
61789-77-3	Dicoco dimethyl quaternary ammonium chloride		1.0E-01		1.0E-01	4.96	2.1E-08	1.7E-05	--	1.7E-04
61791-00-2	Fatty acids, tall-oil, ethoxylated		1.0E+01		1.0E+01	0.47	2.0E-09	1.6E-06	--	1.6E-07
68527-49-1	Thiourea, polymer with formaldehyde and 1-phenylethanone		1.0E+00		1.0E+00	0.35	1.5E-09	1.2E-06	--	1.2E-06
68951-67-7	Aliphatic alcohols, ethoxylated #2		5.0E-01		5.0E-01	0.29	1.2E-09	1.0E-06	--	2.1E-06
107-19-7	Prop-2-yn-1-ol		5.0E-03		5.0E-03	0.12	4.9E-10	4.1E-07	--	8.3E-05
629-73-2	Hexadec-1-ene		1.0E-01		1.0E-01	0.07	3.0E-10	2.5E-07	--	2.5E-06
								Total Risk (mixture)		**1.19E-01**

Note:
This scenario is deemed protective of the following scenarios due to the less frequent and short duration of exposures:
- Worker exposure during a spill (i.e.a couple breaks on a tank and releases product onto the worker) or leak scenarios

Dermal Exposure to Chemicals via Contact with Flow Back Water - HVFR/SW Recipe

Chronic Exposures

General Data/ Equations	Units	Exposure Calculations (RME) Dermal Contact with Flow Back Water by Workers	
Exposure Parameters			
Exposure Frequency (EF)	days/year	20	Assume work 5 days per week for 1 month during the fraccing period
Exposure Duration (ED)	years	0.083	Maximum duration of the frac. Works will be complete in one month.
Body Weight (BW)	kg	78	Average male and female adults as per enHealth 2012
Averaging Time - NonThreshold (ATc)	days	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (ATn)	days	30.42	USEPA 1989 and CSMS 1996
Surface Area (SAw)	cm^2	2300	Hands and forearms exposed (enHealth 2012) Occupational HSE would require long pants and closed shoes on Australian work sites; forearms conservatively included
Exposure Time (ET)	hr/day	1	Assume contact with flow back water for 1 hours per day
Conversion Factor (CF)	L/cm^3	1.E-03	Conversion of units
Intake Factor = SAw*ET*CF*EF*ED / BW*AT	L-hr/(cm-kg-day)	**1.9E-06** **1.6E-03**	**NonThreshold** **Threshold**

Daily Intake from Water = Concentration in Water x Dermal Permeability x Intake Factor (ref: USEPA 1989, 2004)
NonThreshold Risk = Daily Intake from Water for NonThreshold Effects x Slope Factor
Hazard Quotients = (Daily Intake from Water for Threshold Effects/ADI)

	Chemical	Toxicity Data					Concentration	Daily Intake		Calculated Risk	
		Non-Threshold Slope Factor	Chronic Threshold TDI	Background Intake (% chronic TDI)	Chronic TDI Allowable for Assessment (TDI-Background)	Dermal Permeability	in Water	NonThreshold	Threshold	NonThreshold Risk	Chronic Hazard Quotient
		$(mg/kg\text{-}day)^{-1}$	(mg/kg/day)		(mg/kg/day)	(cm/hr)	(mg/L)	(mg/kg/day)	(mg/kg/day)	(unitless)	(unitless)
1319-33-1	Boronatrocalcite/UlexiteA		9.6E-02		9.6E-02	9.1E-4	404.72	7.1E-07	6.0E-04	--	6.2E-03
7789-38-0	Sodium bromate		3.0E-03		3.0E-03	3.8E-9	60.00	4.4E-13	3.7E-10	--	1.2E-07
7727-54-0	Diammonium peroxidisulphate		2.1E-02		2.1E-02	1.0E-3	152.75	2.9E-07	2.5E-04	--	1.2E-02
111-30-8	Glutaraldehyde		4.0E-02		4.0E-02	3.3E-4	78.85	4.9E-08	4.1E-05	--	1.0E-03
1303-96-4	Sodium Tetraborate Decahydrate		9.6E-02		9.6E-02	9.1E-4	44.74	7.9E-08	6.6E-05	--	6.9E-04
61789-77-3	Dicoco dimethyl quaternary ammonium chloride		1.0E-01		1.0E-01	1.8E-1	4.96	1.7E-06	1.4E-03	--	1.4E-02
61791-00-2	Fatty acids, tall-oil, ethoxylated		1.0E+01		1.0E+01	2.1E-2	0.47	1.9E-08	1.6E-05	--	1.6E-06
68527-49-1	Thiourea, polymer with formaldehyde and 1-phenylethanone		1.0E+00		1.0E+00	1.0E-3	0.35	6.7E-10	5.6E-07	--	5.6E-07
68951-67-7	Aliphatic alcohols, ethoxylated #2		5.0E-01		5.0E-01	2.9E-1	0.29	1.6E-07	1.4E-04	--	2.7E-04
107-19-7	Prop-2-yn-1-ol		5.0E-03		5.0E-03	4.2E-4	0.12	9.6E-11	8.1E-08	--	1.6E-05
629-73-2	Hexadec-1-ene		1.0E-01		1.0E-01	2.0E+1	0.07	2.7E-06	2.3E-03	--	2.3E-02
									Total Risk (mixture)		**5.7E-02**

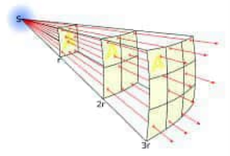
Note:
This scenario is deemed protective of the following scenarios due to the less frequent and short duration of exposures:
- Worker exposure during a spill (i.e.a couple breaks on a tank and releases product onto the worker) or leak scenarios

Aerosol Exposure - HVFR/SW Recipe

The concentration of COPC in aerosol spray was estimated by calculating the concentration for driftable droplets using a mixed box model in which steady state
An emission factor for driftable aerosol was estimated using the algorithm presented below.

Emission Factor for Driftable Aerosol Algorithm

$$Emission\ Factor_{driftable\ aerosol}\left(\frac{L}{m^2}\right) = \frac{Box\ Centre^2(m) \times \left(\frac{Spray\ Vol\ \left(\frac{L}{hr}\right) \times Aerosol_{driftable}(\%)}{BoxVR\ \left(\frac{m^3}{hr}\right)}\right)}{BoxDistance^2\ (m)}$$



Aerosol Exposure Modelling Notes:

1) The inhalation of chemicals in mist/aerosol resultant from irrigation activities is dependent upon the concentration in water, the amount of water used per unit time, how close a person stands to the spray generation, how long they are in a position of exposure and the extent of spray drift (determined by the size of the water droplets and speed/direction of the wind). These equations are applicable for non-volatile contaminants that are inhaled.

2) These equations calculate the concentration for driftable droplets using a simple well mixed box model in which steady state air concentrations are calculated. The 'Inverse square law' is then applied to approximate the air concentration at a distance from the virtual air box. This law assumes the further away a receptor is from the spray source, the density of the droplets will decrease. The density of the spray droplets is inversely proportional to the square of the distance from the source.

Parameter	Units	Value	Description
Spray box length	m	3	Assume a 'spray box' of 3 m long.
Spray box width	m	3	Assume a 'spray box' of 3 m wide.
Box Centre	m	1.5	Distance to centre of box is 1.5 m.
$Box_{Distance}$	m	2	Distance the irrigation worker is from the 'spray box'. Assumed a distance of 2 m.
$Aerosol_{driftable}$	unitless	0.2	Proportion of aerosol spray that drifts outside the 'spray box' and available for exposure. Assumed 0.2, based on a droplet size of 400 – 500 µm that falls approximately 0.3 m in less than 10 seconds, with a lateral drift of approximately 3.5 m in a 5 km/hr wind (i.e. a light breeze) (Grisso et al. 2013).
Spray Volume	L/hr	1800.0	1800 L/min, irrigation value adopted from NZ MtE (2011) Appendix 5A.
Wind speed	m/hr	9000	Based on windspeed of 2.5 m/sec
BoxVR	m^3/hr	81000.0	Ventilation rate of spray in the 'spray box'. Assumed to be 81,000 m3/hr based on a wind speed of 9000 m/hr, and a 'spray box' dimension of 3 x 3 m.

CAS	Chemical	Concentration in Water	Generation rate of chemical in volume	Driftable Aerosol Emission Factor
		mg/L	mg/hr	L/m^3
1319-33-1	Boronatrocalcite/UlexiteA	404.72	145697.8836	2.500000E-03
7789-38-0	Sodium bromate	60.00	21600	2.500000E-03
7727-54-0	Diammonium peroxidisulphate	152.75	54990.23214	2.500000E-03
111-30-8	Glutaraldehyde	78.85	28384.49093	2.500000E-03
1303-96-4	Sodium Tetraborate Decahydrate	44.74	16106.10369	2.500000E-03
61789-77-3	Dicoco dimethyl quaternary ammo	4.96	1785.188109	2.500000E-03
61791-00-2	Fatty acids, tall-oil, ethoxylated	0.47	168.6661334	2.500000E-03
68527-49-1	Thiourea, polymer with formaldehy	0.35	125.6460265	2.500000E-03
68951-67-7	Aliphatic alcohols, ethoxylated #2	0.29	105.3553638	2.500000E-03
107-19-7	Prop-2-yn-1-ol	0.12	42.43479931	2.500000E-03
629-73-2	Hexadec-1-ene	0.07	25.75353337	2.500000E-03

Exposure to Chemicals via Inhalation of Mist from the Evaporation Units - HVFR/SW Recipe

Chronic Exposures

General Data/ Equations	Units	Exposure Calculations (RME) Inhalation of Mist by Workers	
Exposure Parameters			
Exposure Frequency (EF)	days/year	240	Exposure for 5 days per week minus 4 weeks holidays
Exposure Duration (ED)	years	1	Maximum duration that the flowback tank will be on-site
Exposure Time (ET)	hr/day	1	Professional judgement for irrigation exposure. Assume worker to be near tank for 1 hours every working day.
Driftable aerosol emission factor (EMF)	L/m3	2.50E-03	Calculated
Aerosol Inhalation Bioavailability (AAF)	unitless	1.0	Assume 100% bioavailability
Averaging Time - Threshold (AT)	years	1.0	USEPA 1989 and CSMS 1996
$ITF_{inh,w,shwr} = \frac{EmF \times AAF \times ET_{iw} \times EF \times ED}{365\ \frac{days}{year} \times 24\ \frac{hours}{day} \times AT}$			

Daily Intake = Concentration in Water x Intake Factor (ref: USEPA 1989)
Hazard Quotients = (Daily Intake from Water for Threshold Effects/ADI)

CAS	Chemical	Groundwater Concentration	Aerosol Inhalation Bioavailability	Driftable Aerosol Emission Factor	RfC (Background Corrected)	Threshold Intake and Risk Calculations: Adult Exposure Factor (threshold)	Adult Exposure Adjusted Air Concentration (threshold)	Hazard Index (Adult)
		mg/L	(unitless)	(L/m^3)	(mg/m^3)	(L/m^3)	(mg/m^3)	(unitless)
1319-33-1	Boronatrocalcite/UlexiteA	404.72	2.00	2.50E-03	3.36E-01	6.85E-05	2.77E-02	8.3E-02
7789-38-0	Sodium bromate	60.00	3.00	2.50E-03	1.05E-02	6.85E-05	4.11E-03	3.9E-01
7727-54-0	Diammonium peroxidisulphate	152.75	4.00	2.50E-03	7.35E-02	6.85E-05	1.05E-02	1.4E-01
111-30-8	Glutaraldehyde	78.85	6.00	2.50E-03	1.40E-01	6.85E-05	5.40E-03	3.9E-02
1303-96-4	Sodium Tetraborate Decahydrate	44.74	7.00	2.50E-03	3.36E-01	6.85E-05	3.06E-03	9.1E-03
61789-77-3	Dicoco dimethyl quaternary ammonium chloride	4.96	10.00	2.50E-03	3.50E-01	6.85E-05	3.40E-04	9.7E-04
61791-00-2	Fatty acids, tall-oil, ethoxylated	0.47	17.00	2.50E-03	3.50E+01	6.85E-05	3.21E-05	9.2E-07
68527-49-1	Thiourea, polymer with formaldehyde and 1-phenylethanone	0.35	18.00	2.50E-03	3.50E+00	6.85E-05	2.39E-05	6.8E-06
68951-67-7	Aliphatic alcohols, ethoxylated #2	0.29	19.00	2.50E-03	1.75E+00	6.85E-05	2.00E-05	1.1E-05
107-19-7	Prop-2-yn-1-ol	0.12	20.00	2.50E-03	1.75E-02	6.85E-05	8.07E-06	4.6E-04
629-73-2	Hexadec-1-ene	0.07	21.00	2.50E-03	3.50E-01	6.85E-05	4.90E-06	1.4E-05
							Total Threshold Risk (mixture)	**6.65E-01**

Summary of Risk to Workers - HVFR/SW Recipe
Exposure fo Target Chemicals - Theoretical Data

Receptor/Exposure Pathway	Calculated HI 100% Mass Return
Use of Stimulation Fluid in Hydraulic Fracturing	
HYBRID Recipe	
Workers	
Ingestion of Chemicals via Incidental Contact with Flowback Water	0.12
Dermal Exposure to Chemicals via Incidental Contact with Flowback Water	0.06
Inhalation of mist from the evaporation units	0.67
Total Risk	**0.8**

Appendix E

Chemical Risk Assessment – Drilling Fluid

Chemical Name	CAS Number	Concentration in Injected Fluid (mg/L)	Ecotoxicity[1]	Toxicity[2]	Biodegradation[1,3]	Bioaccummulative[1]	Tier 1 Screening Assessment	Tier 2 Assessment Worker Ingestion Risk	Tier 2 Assessment Worker Dermal Risk	Tier 2 Assessment Worker Aerosol Inhalation Risk	Hazard Quotient	Outcome of Tier 2 Worker Risk Assessment[1]
Alcohol, C11-14, ethoxylated	78330-21-9	1.5	96 h LC50, Oncorhynchus mykiss = 5 - 7 mg/L 30 d Lepomis macrochirus, NOEC = 0.11 – 0.33 mg/L. 48 h EC50 Daphnia magna = 2.5 mg/L. 21 d NOEC Daphnia magna = 0.77 – 1.75 mg/L. 96 h EC50 (green algae) = 1.4 mg/L EC50 (3 h) for microorganisms = 140 mg/L	Based on chronic: High	Readily biodegradable	Not bioaccumulative	Tier 2	1.1E-05	6.16E-03	2.9E-07	6.2E-03	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Proprietary	Proprietary	Proprietary	Proprietary	Proprietary	Proprietary	Proprietary	Tier 1 (NICNAS)	NA	NA	NA	NA	NA
Performatrol	Proprietary	Proprietary	Proprietary	Proprietary	Proprietary	Proprietary	Tier 1	NA	NA	NA	NA	NA
Citric Acid, monohydrate	77-92-9	1	96 h LC50 fish = 440 to 1,516 mg/L 24 h EC50 value for invertebrates is 85 mg/L 7 d toxic limit concentration values for algae = 300 to 640 mg/L 8 d freshwater static test for the algae Scenedesmus quadricauda, NOEC = 425 mg/L	Based on chronic: Low	Expected to be readily biodegradable	Not bioaccumulative	Tier 1 (NICNAS)	NA	NA	NA	NA	NA
Distillates, hydrotreated light	64742-47-8	1.5	Lowest acute endpoint for Daphnia = 0.018 mg/L (modelled)	Based on acute: Very high	Readily biodegradable	Yes based on calculated log BCF values for constituents that range from 2.78 to 4.06, and calculated BCF values of 598 to 11,430 L/kg wet-weight	Tier 2	5.3E-07	4.75E-04	2.9E-06	4.8E-04	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Glutaraldehyde	111-30-8	0.3	96 h acute Bluegill sunfish LC50 = 11.2 mg/L 48 h acute Oyster larvae LC550 = 2.1 mg/L 96 h acute Green crabs LC50 = 465 mg/L 96 h acute Grass shrimp LC50 = 41 mg/L 48 acute Daphnia magna LC50 = 0.35 mg/L 48 acute Daphnia magna LC50 = 16.3 mg/L 21 d reproduct'n Daphnia magna LOEC = 4.3 mg/L, NOEC = 2.1 mg/L 96 h algal growth inhibition Selenastrum capricornutum ILm = 3.9 mg/L (median inhibitory limit) 96 h algal growth inhibition Scenedesmus subspicatus EC50 = 1.0 mg/L Bacterial inhibition Sewage microbes IC50 = 25-34 mg/L	Based on chronic: Moderate	Readily biodegradable	No based on the Log Pow of -0.01	Tier 2	2.6E-05	3.94E-06	1.5E-04	1.8E-04	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Glyoxal <1%	107-22-2	2.2	96 h-LC50 fish = 215 mg/L Invertebrates EC50 > 100 mg/L NOEC fish = 119 mg/L (a.i.)	Based on chronic: Low	Expected to be readily biodegradable	Not bioaccumulative	Tier 2	5.8E-05	1.57E-06	3.2E-04	3.8E-04	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Methanol	67-56-1	0.3	Acute LC50s = 15,400 to 29,400 mg/L Invertebrates, chronic NOEC = 32,000 mg/L.	Based on acute: Low	Readily biodegradable	No based on the Log Kow of -0.74	Tier 2	2.8E-05	4.16E-06	1.6E-04	1.9E-04	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Nitrilotriacetic acid, trisodium salt monohydrate	5064-31-3	1	Fish 96 h LC50 = 98 - 487 mg/L Fish NOEC = 54 mg/L Invertebrates NOEC = 9.3 mg/L	Based on chronic: Moderate	Readily biodegradable	No based on the Log Pow of -13.2	Tier 2	3.5E-04	1.83E-12	2.0E-03	2.3E-03	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Plagioclase Feldspar/Kaolinite	1332-58-7	10	Daphnia pulex (water flea) 24- and 48-h LC50 >1.1 g/L P. trilineatum 12-h LC50 = 170 mg/L O. fasciatus 12-h LC50 = 710 mg/L	Based on acute: Low	N.A.(Inorganic)	N.A. (Inorganic)	Tier 1	NA	NA	NA	NA	NA
Poly Anionic Cellulose	9004-32-4	1.5	96 h LC50 for Brachydanio rerio is >2,500 mg/L 48 h LC50 for Daphnia magna is >5,000 mg/L; 96 h EC50 for Selenastrum capricornutum is 500 mg/L	Based on acute: Low	Not readily biodegradable	Not bioaccumulative	Tier 1 (NICNAS)	NA	NA	NA	NA	NA
Potassium Chloride	7447-40-7	18	96 h LC50 in Pimephales promelas = 880 mg/L 48 h LC50 Lepomis macrochirus, Oncorhyncusmykiss and Ictalurus punctatus = 720 - 2010 mg/L	Based on chronic: Low	N.A.(Inorganic)	N.A. (Inorganic)	Tier 1 (NICNAS)	NA	NA	NA	NA	NA
Potassium Hydroxide	1310-58-3	0.3	96-hour fish LC50 value = 80 mg/L 48-hr invertebrate EC50 value = 40 mg/L 120-hr algae EC50 value = 1337 mg/L	Based on acute: Low	N.A.(Inorganic)	N.A. (Inorganic)	Tier 1	NA	NA	NA	NA	NA. Acute toxicity only (irritant and corrosive), not systemically available in body
Quartz/Cristobite	14808-60-7	10	acute data >10 g/L	Based on acute: Low	N.A.(Inorganic)	N.A. (Inorganic)	Tier 2	NA. Not toxic via oral exposure as not absorbed via GI tract	NA. Not toxic via dermal exposure.	2.3E-01	2.3E-01	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Smectite	12199-37-0	10	96 hr Oncorhynchus mykiss (Rainbow Trout) LC50 = 19000 mg/L	Based on acute: Low	N.A.(Inorganic)	N.A. (Inorganic)	Tier 1	NA	NA	NA	NA	NA
Sodium Bicarbonate	144-55-8	0.5	21 d Daphnia NOEC = 576 mg/L	Based on chronic: Low	N.A.(Inorganic)	N.A. (Inorganic)	Tier 1 (NICNAS)	NA	NA	NA	NA	NA
Sodium Carbonate	497-19-8	0.29	96-hour LC50 Bluegill sunfish (Lepomis macrochirus) = 300 mg/L 96-hour LC50 to mosquitofish (Gambusia affinis) = 740 mg/L 48-hour EC50 to the invertebrate Ceriodaphnia cf. dubia = 200 to 227 mg/L	Based on acute: Low	N.A.(Inorganic)	N.A. (Inorganic)	Tier 2	1.1E-05	1.49E-10	5.9E-05	6.9E-05	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Sodium Chloride	7647-14-5	17.61	acute endpoint for Fish = 1290 mg/L NOEC for Daphnia = 314 mg/L	Based on chronic: Low	N.A.(Inorganic)	N.A. (Inorganic)	Tier 1 (NICNAS)	NA	NA	NA	NA	NA
Sodium erythorbate	6381-77-7	0.2	96 h LC50 Fish > 100 mg/L 48 h EC50 Daphnia magna = 84 - 100 mg/L 72 h NOEC alga = 20 mg/L	Based on acute: Low	Not readily biodegradable	Not bioaccumulative	Tier 1 (NICNAS)	NA	NA	NA	NA	NA
Sodium hydroxide	1310-73-2	0.3	Measured acute endpoints for fish = 196 mg/L Measured chronic endpoint for Daphnia = 240 mg/L	Based on acute: Low	N.A.(Inorganic)	N.A. (Inorganic)	Tier 1	NA	NA	NA	NA	NA. Acute toxicity only (irritant and corrosive), not systemically available in body
Starch	9005-25-8	4	Crassostrea virginica 96 h = 1000 mg/L Orthopristis chrysoptera 96 h = 5000 mg/L Bairdiella chrysoura 96 h = 5000 mg/L	Based on acute: Low	Expected to be readily biodegradable	Not bioaccumulative	Tier 1	NA	NA	NA	NA	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	4	Daphnia magna (Water flea), 48 h, static, EC50 = 0.3 mg/L Salmo gairdneri (Rainbow trout), 96 h, static, LC50 = 0.16 mg/L Ankistrodesmus bribaianus (Green alga), 72 h, static, EC50 = 1.08 mg/L Colinus virginianus (Bobwhite quail), 21 d, LD50 = 415 mg/kg bw Colinus virginianus (Bobwhite quail), 25 weeks, NOEL = 100 mg/kg food	Based on acute: Very high	Expected to be readily biodegradable	Not bioaccumulative	Tier 2	2.8E-03	6.53E-04	1.6E-02	1.9E-02	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Xanthan Gum	11138-66-2	1.5	Acute Fish (measured) = 420 mg/L	Based on acute: Low	Expected to be readily biodegradable	Not bioaccumulative	Tier 1 (NICNAS)	NA	NA	NA	NA	NA
Guanidine, hydrochloride (1:1)	50-01-1	7	96-h-LC50 for fish = 690 mg/L NOEC for fish = 181 mg/L EC50 for Daphnia = 70.2 mg/L NOEC for Daphnia = 2.9 mg/L EC50 for algae = 33.5 mg/L NOEC for algae = 6.3 mg/L	Based on chronic: Moderate	Expected to be readily biodegradable	Not bioaccumulative	Tier 2	2.5E-04	4.37E-09	1.4E-06	2.5E-04	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Polyacrylamide	38193-60-1	1.5	LC50 = 357 mg/L (fish) LC50 = 212 mg/L (invertebrates) EC 50 = >1000 mg/L (algae)	Based on acute: Low	Not readily biodegradable	Not bioaccumulative	Tier 1	NA	NA	NA	NA	NA
Calcium Carbonate	1317-65-3	15	96h EC50 for fish >100mg/L 48 h EC50 for Daphnia >100 mg/L 72 h ERC50 for algae >14 mg/L	Based on acute: Low	N.A.(Inorganic)	N.A. (Inorganic)	Tier 1 (NICNAS)	NA	NA	NA	NA	NA
Barite	13462-86-7	0.12	Long-term toxicity data are available for three trophic levels: 33 days NOEC: 1.26 mg/L (Fish) 21 days NOEC: 2.9 mg/L (Invertebrates) 72 hrs NOEC: 1.15 mg/L (Algae)	Based on chronic: Moderate	N.A.(Inorganic)	N.A. (Inorganic)	Tier 1 (NICNAS)	NA	NA	NA	NA	NA
Triazine based biocide C572,2',2''-(hexahydro-1,3, 5-triazine-1,3,5-triyl) triethanol	4719-04-4	0.00101	LC50 for fish 240.04 mg/L LC50 for invertebrates 60.67 mg/L EC50 for freshwater algae: 6.6 mg/L	Based on acute: High	Expected to be readily biodegradable.	Not bioaccumulative	Tier 2	5.5E-08	1.86E-12	3.1E-07	3.6E-07	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Ammonium hydrogensulfite	10192-30-0	0.00071	Algae NOEC/EC10 = 28 mg SO32-/L Invertebrates NOEC/EC10 = ≥8.41 mg SO32-/L Fish NOEC/EC10 = 50 mg SO32-/L	Based on chronic: Low	N.A.(Inorganic)	N.A. (Inorganic)	Tier 2	2.2E-08	6.36E-13	1.2E-07	1.5E-07	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Sulphur Dioxide (Impurity)	7446-09-5	0.00071	Sulfur dioxide is not present as a substance. It is formed during decomposition. Sulphur dioxide is a gaseous substance and does not remain present in the aquatic environment.	NA	NA	NA	NA	NA	NA	NA	NA	NA
Partially hydrolysed polyacrylamide	9003-05-8	0.00117	Fathead minnow LC50: 810 mg/L Rainbow trout LC50: > 100 mg/L Bluegill sunfish LC50: >300 mg/L Daphnia magna LC50: 470 mg/L	Based on acute: Low	Not readily biodegradable	Not bioaccumulative	Tier 1 (NICNAS)	NA	NA	NA	NA	NA
Polyanionic cellulose, low viscosity	9004-32-4	0.00338	Brachydanio rerio 96-hour LC50 >2,500 mg/L Daphnia magna 48-hour EC50 >5,000 mg/L Daphnia magna 48-hour EC50 87.26 mg/L Selenastrum capricornutum 96-hour EC50 500 mg/L	Based on acute: Low	Not readily biodegradable	Not bioaccumulative	Tier 1 (NICNAS)	NA	NA	NA	NA	NA
Barium sulphate	7727-43-7	0.08743	Long-term toxicity data are available for three trophic levels: 33 days NOEC: 1.26 mg/L (Fish) 21 days NOEC: 2.9 mg/L (Invertebrates) 72 hrs NOEC: 1.15 mg/L (Algae)	Based on chronic: Moderate	N.A.(Inorganic)	N.A. (Inorganic)	Tier 1 (NICNAS)	NA	NA	NA	NA	NA
Filming amine Ethanol, 2,2'-oxybis-, reaction products with ammonia, morpholine derivs. Residues	68909-77-3	0.005	LC50 (96 h) for fish: 681.2 mg/L EC50 for daphnids: > 122 mg/L ErC50(72h) for algae: 45 mg/L	Based on acute: Moderate	Not readily biodegradable	Not bioaccumulative	Tier 2	1.8E-08	1.11E-11	9.8E-08	1.2E-07	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Distillates (Fischer-Tropsch), C8-26 - Branched and Linear	848301-67-7	0.0000001	Short-term toxicity: NOEC (48 h): 1000 mg/L (fish) LC50 (7 day): >100000 mg/L (fish) EL50 (72 h): >1000 mg/L (invertebrates) EL50 (48 h): 1000 mg/L (crustaceans) EL50 (72 h): 1000 mg/L (algae) Long-term toxicity: NOEL (33 day): >100 mg/L (fish) NOEL (21 day): <100 mg/L (invertebrates)	Based on acute: Low	Expected to be readily biodegradable.	No. Based on log BCF of 3.17 or BCF of 1479.	Tier 2	1.8E-12	1.10E-09	9.8E-12	1.1E-09	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).

Chemical Name	CAS Number	Concentration in Injected Fluid (mg/L)	Ecotoxicity[1]	Toxicity[2]	Biodegradation[1,3]	Bioaccummulative[1]	Tier 1 Screening Assessment	Tier 2 Assessment Worker Ingestion Risk	Tier 2 Assessment Worker Dermal Risk	Tier 2 Assessment Worker Aerosol Inhalation Risk	Hazard Quotient	Outcome of Tier 2 Worker Risk Assessment[1]
Fatty acids, tall-oil, reaction products with diethylenetriamine, maleic anhydride, tetraethylenepentamine and triethylenetetramine	68990-47-6	0.007	Short term toxicity: LC50 (4 days): 100 mg/L (fish) NOEC (4 days): 100 mg/L (fish) LOEC (4 days): 100 mg/L (fish) IC50 (48 h): 100 mg/L (invertebrates) NOEC (48 h): 100 mg/L (invertebrates)	Based on acute: Low	Not readily biodegradable	Yes. Based on the estimated Log Kow of 11 (Log Kow > 4.2).	Tier 2	2.5E-08	1.14E-08	1.4E-07	1.7E-07	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
(2-methoxymethylethoxy)propanol	34590-94-8	0.007	Short term toxicity data: EC50s/LC50s >1000 mg/l in daphnia (48 hr), fish (96 hr) and algae (7 days). Long term toxicity data: NOEC: 0.5 mg/L (daphnia)	Based on chronic: High	Expected to be readily biodegradable.	Not bioaccumulative. Based on the Log Kow of 0.004 at 25 °C (Log Kow < 4.2).	Tier 2	2.5E-08	1.54E-09	1.4E-07	1.6E-07	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
1-tetradecene	1120-36-1	0.0000001	Short term toxicity: LC50 (4 days): 3.4 µg/L (fish) EC50 (48 h): 2.8 µg/L (invertebrates) EC50 (4 days): 4.5 µg/L (algae)	Based on chronic: Low	Expected to be readily biodegradable.	Yes. Based on the estimated Log Kow of 7.3 (Log Kow > 4.2)	Tier 2	3.5E-12	1.02E-08	2.0E-11	1.0E-08	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Amides, tall oil fatty N,N-bis (hydroxyethyl)	68155-20-4	0.0000001	Based on read across: Daphnia: EC50 (24-hour): 3.3 mg active matter/l Daphnia: 48-hour LC50 = 2.15 and 2.64 mg/l 21 d NOEC = 0.08 mg/L	Based on chronic: Very high	Expected to be readily biodegradable.	Not bioaccumulative. Based on BAF = 108 and log Kow of 3 (estimated)	Tier 2	4.7E-13	1.54E-11	2.6E-12	1.8E-11	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Fatty acids, tall-oil, reaction products with polyethylenepolyamines	68910-93-0	0.0000001	Short term toxicity data: 96h-LL50 > 100 mg/L (fish) 48h-EL50 = 12.41 mg/L (invertebrates) 72h-EL50 = 39.7 mg/L (algae)	Based on acute: Moderate	Expected to be readily biodegradable.	Not bioaccumulative	Tier 2	3.5E-13	1.63E-13	2.0E-12	2.5E-12	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Phosphoric ester of ethoxylated fatty alcohol	68585-36-4	0.0000001	Short term toxicity data: 96h-LL50 > 100 mg/L (fish) 48h-EL50 = 12.41 mg/L (invertebrates) 72h-EL50 = 39.7 mg/L (algae)	Based on acute: Moderate	Expected to be readily biodegradable.	Not bioaccumulative	Tier 2	3.5E-13	1.63E-13	2.0E-12	2.5E-12	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Hexadec-1-ene	629-73-2	0.0000001	Short term toxicity 96-hr LC50 > solubility Actual concentration negligible. Fish 96-hr LL0 = 1000 mg/L (nominal)	Based on chronic: Very high	Expected to be readily biodegradable.	Not bioaccumulative	Tier 2	3.5E-12	3.18E-08	2.0E-11	3.2E-08	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Distillates (petroleum), hydrotreated heavy naphthenic	64742-52-5	0.0000001	Short term toxicity data: LL50 was > 100 mg/L (fish) EL50 was >10,000 mg/L (invertebrates) Long term toxicity data: 21 day NOEL: 10 mg/L (invertebrates)	Based on chronic: Low	Not readily biodegradable	Yes. Calculated BCF for constituents of this substance range between 0.4 and 71100 L/kg	Tier 2	4.4E-13	5.09E-08	2.4E-12	5.1E-08	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Lead	7439-92-1	0.0000001	Short-term toxicity data: LC50 (96 h) 40.8 µg/L (Fish) LC50 (48 h) 26 µg/L (Invertebrates) EC50 (72 h) 20.5 µg/L (algae)	Based on chronic: Very high	N.A.(Inorganic)	N.A. (Inorganic)	Tier 1 (below ADWG and ANZECC)	NA	NA	NA	NA	NA
Graphite	7782-42-5	0.0000001	The short-term toxicity: LC50 > 100 mg/L for the LC50 and NOEC > 100 mg/L (fish) EC50 > 100 mg/L for the EC50 and NOEC > 100 mg/L for the NOEC (daphnids)	Based on acute: Low	N.A.(Inorganic)	N.A. (Inorganic)	Tier 1 (NICNAS)	NA	NA	NA	NA	NA
Talc	14807-96-6	0.0000001	No data	Based on low bioavailability: Low	Not readily biodegradable	Not bioaccumulative	Tier 1 (NICNAS)	NA	NA	NA	NA	NA
Mineral oil	8042-47-5	0.0000001	Rainbow trout 96 hr LL50 (48 h) 100 mg/L	Based on acute: Low	N.A.(UVCB)	No. Not readily biodegradable based on read across study.	Tier 1 (NICNAS)	NA	NA	NA	NA	NA
Copper	7440-50-8	0.0000001	Fish: 2.6 µg/L (Ptylocheilus oregonensis, from 7-day LC50) 131 µg/L (Pimephales promelas, 7-day LC50) Crustaceans: 1.7 µg/L (D. pulex and G. pulex, NOEC, reproduction & mortality) 12.1 µg/L (Hyalella azteca, from 10 to 14-day LC50).	Based on chronic: Very high	N.A. (Inorganic)	N.A. (Inorganic)	Tier 1 (NICNAS)	NA	NA	NA	NA	NA
Zinc	7440-66-6	0.0000001	Fish: 24 µg/L (Oncorhynchus tshawytscha; from LC50) Amphibians: Ambystoma opacum, 180 µg/L (from LOEC) Crustaceans: 5.5 µg/L (C. dubia; from LC50)	Based on acute: Very high	N.A. (Inorganic)	N.A. (Inorganic)	Tier 1 (NICNAS)	NA	NA	NA	NA	NA
Calcium oxide	1305-78-8	0.0000001	Oncorhynchus mykiss 96-hour LC50: 50.6 mg/L Daphnia magna 48-hour EC50: 49.1 mg/L Pseudokirchneriella subcapitata 72 hour EC10: 79.22 mg/L Crangon septemspinosa 14-day: EC10 of 32 mg/L	Based on acute: Moderate	N.A. (Inorganic)	N.A. (Inorganic)	Tier 1 (NICNAS)	NA	NA	NA	NA	NA
Distillates (petroleum), hydrotreated light naphthenic < 3% DM	64742-53-6	0.0000001	Short term toxicity data: LL50 was > 100 mg/L (fish) EL50 was >10,000 mg/L (invertebrates) Long term toxicity data: 21 day NOEL: 10 mg/L (invertebrates)	Based on chronic: Low	Not readily biodegradable	Yes. Calculated BCF for constituents of this substance range between 0.4 and 71100 L/kg	Tier 2	4.4E-13	3.96E-10	2.4E-12	4.0E-10	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Aluminum not powder, dust or fume	7429-90-5	0.0000001	8-day LC50 0.17 mg/L (fish) 8-day LC50 of 2.28 mg/L (amphibian)	Based on chronic: High	N.A. (Inorganic)	N.A. (Inorganic)	Tier 1 (NICNAS)	NA	NA	NA	NA	NA
Distillates (petroleum), straight-run middle	64741-44-2	0.0000001	96h LL50 21 mg/L (fish) NOEL: 0.068 mg/L (fish) 48h EL50 68 mg/L (daphnia) 21 d NOEL: 0.167 mg/L (daphnia) 72 h ErL50: 22 mg/L (algae)	Based on chronic: High	Expected to be readily biodegradable.	Yes. Log Kow values in the range 3.9 to greater than 6.	Tier 2	1.2E-11	7.32E-09	6.5E-11	7.4E-09	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Bitumen	8052-42-4	0.0000001	Short term toxicity: LL50 (4 days): 1 g/L (fish) LL50 (48 h): 1 g/L (invertebrates) EL50 (72 h): 1 g/L (algae) Long term toxicity: LL50 (28 days): 1 g/L (fish)	Based on chronic: Low	Expected to be readily biodegradable.	N.A. (UVCB)	Tier 2	1.8E-12	0.00E+00	9.8E-12	1.2E-11	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Copper (II) Oxide	1317-38-0	0.0000001	Fish: 2.6 µg/L (Ptylocheilus oregonensis, from 7-day LC50) 131 µg/L (Pimephales promelas, 7-day LC50) Crustaceans: 1.7 µg/L (D. pulex and G. pulex, NOEC, reproduction & mortality) 12.1 µg/L (Hyalella azteca, from 10 to 14-day LC50).	Based on chronic: Very high	N.A. (Inorganic)	N.A. (Inorganic)	Tier 1 (NICNAS)	NA	NA	NA	NA	NA
Phosphorodithioic acid, mixed o,o-bis(iso-bu and pentyl) esters	68457-79-4	0.0000001	Short term toxicity: LC50 (4 days): 46 mg/L (fish) LL50 (4 days): 4.5 mg/L (fish) EL50 (48 h): 23 mg/L (invertebrates) EL50 (72 h): 21 mg/L (algae) Long term toxicity: NOEC (21 days): 0.4 mg/L (invertebrates)	Based on chronic: High	Not readily biodegradable	Not bioaccumulative. Based on the measured log Kow value of less than 3.	Tier 2	2.2E-12	3.10E-09	1.2E-11	3.1E-09	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Tetrasodium ethylenediaminetetraacetate	64-02-8	0.0000001	Danio rerio: 35 d-NOEC > 26.8 mg/L Daphnia magna: 21d-NOEC = 22 mg/L. Scenedesmus subspicatus: 72h-EC10 = > 100 mg/L. For Na2EDTA, Daphnia magna: 21d-NOEC = 25 mg/L.	Based on chronic: Low	Not readily biodegradable	Not bioaccumulative	Tier 1 (NICNAS)	NA	NA	NA	NA	NA
Calcium Hydroxide	1305-62-0	850	Acute Fish (measured) = 356 mg/L	Based on acute: Low	N.A. (Inorganic)	N.A. (Inorganic)	Tier 1 (NICNAS)	NA	NA	NA	NA	NA
										Total Risk	**3E-01**	**The calculated risk associated with potential expsorue to COPC identified in flowback water, where drilling fluid is used and assuming 100% mass recovery is below the target of 1 respectively. Hence the chronic health risks are considered to be low and acceptable.**

Notes
1 - Please refer to the individual toxicity profiles for further detail.
2 - Toxicity assessed using NT (2021)
3 - Biodegradation assessed as per NT (2021) and DoEE (2017)
BCF - Bioconcentration Factor
NA - Not Applicable
MOE - Margin of Exposure
NICNAS 2017 - National Assessment of Chemicals Associated with Coal Seam Gas Extraction in Australia
DoEE 2017 - Draft Risk Assessment Guidance Manual: For Chemicals Associated with Coal Seam Gas Extraction, Australian Government, Department of Energy
NT 2021 - Northern Territory Government, Department of Environment, Parks and Water Security, Environment Management Plan Content Guideline, 2021

Toxicity and Dermal Absorption Parameters

C = calculated from chronic value, Ch = chronic value adopted

CAS#	Chemical	Oral/Dermal Exposures				Inhalation Exposures								
		Threshold Chronic TDI or RfD (mg/kg/day)		Dermal Permeability (cm/hr)	Reference	Inhalation Unit Risk $(ug/m^3)^{-1}$	Non-Threshold Slope Factor $(mg/kg/day)^{-1}$		Threshold Chronic TC or RfC (mg/m^3)		NOAEC or LOAEC (mg/m^3)	NOAEL or LOAEL (mg/kg bw/d)	Reference	UF	Reference
	COPC in Hydraulic Fracturing Fluid Injected into Well														
67-56-1	Methanol	0.037	D	3.19E-04	EPI				0.13	converted from RFD		3.7	NICNAS (2017)	100	NICNAS (2017)
64742-47-8	Hydrotreated light petroleum distillate	10	D	1.96E+00	EPI				35	converted from RFD		1000	NICNAS (2017)	100	NICNAS (2017)
111-30-8	Glutaraldehyde	0.04	D	3.25E-04	EPI				0.14	converted from RFD		4	NICNAS (2017)	100	NICNAS (2017)
14808-60-7	Crystalline silica, quartz	Not toxic via oral/dermal exposure							0.003	USEPA (2019)		-			
78330-21-9	Alcohol, C11-14, ethoxylated[B]	0.5	D	1.27E+00	EPI				1.75	converted from RFD		50	NICNAS (2017)	100	NICNAS (2017)
68909-77-3	Ethanol, 2,2'-oxybis-, reaction products with ammonia, morpholine derivatives residues	1	D	1.38E-06	EPI				3.5	converted from RFD		1000	REACH	1000	D
107-22-2	Glyoxal <1% (Ethanedial)	0.133	D	5.88E-05	EPI				0.4655	converted from RFD		13.3	NICNAS (2017)	100	NICNAS (2017)
5064-31-3	Nitrilotriacetic acid, trisodium salt monohydrate	0.01	D	1.13E-11	EPI				0.035	converted from RFD		10	ADWG (2018)	1000	ADWG (2018)
497-19-8	Sodium Carbonate	0.0967	D	3.08E-08	EPI				0.338	converted from RFD		9.67	NICNAS (2017)	100	NICNAS (2017)
533-74-4	Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	0.005	D	5.05E-04	EPI				0.018	converted from RFD		0.5	NRA (1997)	100	NRA (1997)
50-01-1	Guanidine, hydrochloride (1:1)	0.1	D	3.86E-08	EPI				0.350	converted from RFD		100	REACH	1000	D
34590-94-8	(2-methoxymethylethoxy)propanol	1	D	1.36E-04	EPI				3.500	converted from RFD		1000	REACH	1000	D
68155-20-4	Amides, tall oil fatty N,N-bis (hydroxyethyl)	0.75	D	7.14E-02	EPI				2.625	converted from RFD		750	REACH	1000	D
64741-44-2	Distillates (petroleum), straight-run middle	0.03	D	1.36E+00	EPI				0.105	converted from RFD		30	REACH	1000	D
68457-79-4	Phosphorodithioic acid, mixed o,o-bis(iso-bu and pentyl) esters, zinc salts	0.16	D	3.07E+00	EPI				0.560	converted from RFD		160	REACH	1000	D
4719-04-4	Triazine based biocide C572,2',2''-(hexahydro-1,3, 5-triazine-1,3,5-triyl) triethano	0.064	D	7.29E-08	EPI				0.224	converted from RFD		64	REACH	1000	D
10192-30-0	Ammonium hydrogensulfite	0.113	D	6.26E-08	EPI				0.396	converted from RFD		113	REACH	1000	D
848301-67-7	Distillates (Fischer-Tropsch), C8-26 - Branched and Linear	0.2	D	1.36E+00	EPI				0.700	converted from RFD		200	REACH	1000	D
68909-77-3	Filming amine Ethanol, 2,2'-oxybis-, reaction products with ammonia, morpholine derivs. Residues	1	D	1.38E-06	EPI				3.500	converted from RFD		1000	REACH	1000	D
68990-47-6	Fatty acids, tall-oil, reaction products with diethylenetriamine, maleic anhydride, tetraethylenepentamine and triethylenetetramine	1	D	1.01E-03	EPI				3.500	converted from RFD		1000	REACH	1000	D
1120-36-1	1-tetradecene	0.1	D	6.29E+00	EPI				0.350	converted from RFD		100	REACH	1000	D
68910-93-0	Fatty acids, tall-oil, reaction products with polyethylenepolyamines	1	D	1.01E-03	EPI				3.500	converted from RFD		1000	REACH	1000	D
68585-36-4	Phosphoric ester of ethoxylated fatty alcohol	1	D	1.01E-03	EPI				3.500	converted from RFD		1000	REACH	1000	D
629-73-2	Hexadec-1-ene	0.1	D	1.97E+01	EPI				0.350	converted from RFD		100	REACH	1000	D
64742-52-5	Distillates (petroleum), hydrotreated heavy naphthenic	0.8	D	2.52E+02	EPI				2.800	converted from RFD		800	USEPA (2011)	1000	D
64742-53-6	Distillates (petroleum), hydrotreated light naphthenic < 3% DMSO	0.8	D	1.96E+00	EPI				2.800	converted from RFD		800	USEPA (2011)	1000	D
8052-42-4	Bitumen	0.2	D	1.00E-03	EPI				0.700	converted from RFD		200	REACH	1000	D

Notes:

A - Read across data from Boric Acid

B - Read across data from Alcohol ethoxylates C6-C12

C - Read across data from Sodium Sulfite

References:

D - Derived (refer to individual Toxicity Profiles)

EFSA - European Food Safety Authority

EPI - USEPA Estimation Programs Interface (EPI) Suite

J- JECFA - Joint FAO/WHO Expert Committee on Food Additives

NICNAS - National Industrial Chemicals Notification and Assessment Scheme. Assessed at https://www.nicnas.gov.au/

NICNAS (2017) - Department of the Environment and Energy 2017 , National assessment of chemicals associatedwith coal seam gas extraction in Australia, prepared by the National Industrial ChemicalsNotification and Assessment Scheme

NTP - US Department of Health and Serices National Toxicology Program

OECD - Organisation for Economic Co-operation and Development Screening Information Data Set (SIDS)

REACH - ECHA REACH European Chemicals Agency Database: http://apps.echa.europa.eu

Exposure to Chemicals via Incidental Ingestion of Flowback fluid - Drilling Fluids

Chronic Exposures

	General Data/ Equations	Units	Exposure Calculations (RME) Ingestion of Flowback Water by Workers	
	Exposure Parameters			
	Exposure Frequency (EF)	days/year	20	Assume work 5 days per week for 1 month during the fraccing period
	Exposure Duration (ED)	years	0.083	Maximum duration of the frac. Works will be complete in one month.
Use of Drilling	Body Weight (BW)	kg	78	Average male and female adults as per enHealth 2012
	Averaging Time - NonThreshold (ATc)	days	25550	USEPA 1989 and CSMS 1996
	Averaging Time - Threshold (ATn)	days	30.42	USEPA 1989 and CSMS 1996
	Ingestion Rate (IRw)	L/day or L/hr	0.005	Assume Incidental ingestion of 5 ml (1 tsp) of water per day during fraccing.
	Bioavailability (B)	-	100%	Assume 100% bioavailability via ingestion of chemicals in water.
	Intake Factor = IRw*ET*B*EF*ED / BW*AT	L/kg/day	**4.2E-09**	**NonThreshold**
			3.5E-06	**Threshold**

Daily Intake from Water = Concentration in Water x Intake Factor (ref: USEPA 1989)
NonThreshold Risk = Daily Intake from Water for NonThreshold Effects x Slope Factor
Hazard Quotients = (Daily Intake from Water for Threshold Effects/ADI)

	Chemical	Toxicity Data: Non-Threshold Slope Factor	Toxicity Data: Chronic Threshold TDI	Background Intake (% Chronic TDI)	Chronic TDI Allowable for Assessment (TDI-Background)	Concentration in Water	Daily Intake: NonThreshold	Daily Intake: Threshold	Calculated Risk: NonThreshold Risk	Calculated Risk: Chronic Hazard Quotient
		(mg/kg-day)$^{-1}$	(mg/kg/day)		(mg/kg/day)	(mg/L)	(mg/kg/day)	(mg/kg/day)	(unitless)	(unitless)
67-56-1	Methanol		3.7E-02		3.7E-02	0.30	1.3E-09	1.1E-06	--	2.8E-05
64742-47-8	Hydrotreated light petroleum distillate		1.0E+01		1.0E+01	1.50	6.3E-09	5.3E-06	--	5.3E-07
111-30-8	Glutaraldehyde		4.0E-02		4.0E-02	0.30	1.3E-09	1.1E-06	--	2.6E-05
78330-21-9	Alcohol, C11-14, ethoxylatedB		5.0E-01		5.0E-01	1.50	6.3E-09	5.3E-06	--	1.1E-05
107-22-2	Glyoxal <1% (Ethanedial)		1.3E-01		1.3E-01	2.20	9.2E-09	7.7E-06	--	5.8E-05
5064-31-3	Nitrilotriacetic acid, trisodium salt monohydrate		1.0E-02		1.0E-02	1.00	4.2E-09	3.5E-06	--	3.5E-04
497-19-8	Sodium Carbonate		9.7E-02		9.7E-02	0.29	1.2E-09	1.0E-06	--	1.1E-05
533-74-4	Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione		5.0E-03		5.0E-03	4.00	1.7E-08	1.4E-05	--	2.8E-03
50-01-1	Guanidine, hydrochloride (1:1)		1.0E-01		1.0E-01	7.00	2.9E-08	2.5E-05	--	2.5E-04
34590-94-8	(2-methoxymethylethoxy)propanol		1.0E+00		1.0E+00	0.007	2.9E-11	2.5E-08	--	2.5E-08
68155-20-4	Amides, tall oil fatty N,N-bis (hydroxyethyl)		7.5E-01		7.5E-01	0.0000001	4.2E-16	3.5E-13	--	4.7E-13
64741-44-2	Distillates (petroleum), straight-run middle		3.0E-02		3.0E-02	0.0000001	4.2E-16	3.5E-13	--	1.2E-11
68457-79-4	Phosphorodithioic acid, mixed o,o-bis(iso-bu and pentyl) esters, zinc salts		1.6E-01		1.6E-01	0.0000001	4.2E-16	3.5E-13	--	2.2E-12
4719-04-4	Triazine based biocide C572,2',2''-(hexahydro-1,3, 5-triazine-1,3,5-triyl) triethano		6.4E-02		6.4E-02	0.00101	4.2E-12	3.5E-09	--	5.5E-08
10192-30-0	Ammonium hydrogensulfite		1.1E-01		1.1E-01	0.00071	3.0E-12	2.5E-09	--	2.2E-08
848301-67-7	Distillates (Fischer-Tropsch), C8-26 - Branched and Linear		2.0E-01		2.0E-01	0.0000001	4.2E-16	3.5E-13	--	1.8E-12
68909-77-3	Filming amine Ethanol, 2,2'-oxybis-, reaction products with ammonia, morpholine derivs. Residues		1.0E+00		1.0E+00	0.005	2.1E-11	1.8E-08	--	1.8E-08
68990-47-6	Fatty acids, tall-oil, reaction products with diethylenetriamine, maleic anhydride, tetraethylenepentamine and triethylenetetramine		1.0E+00		1.0E+00	0.007	2.9E-11	2.5E-08	--	2.5E-08
1120-36-1	1-tetradecene		1.0E-01		1.0E-01	0.0000001	4.2E-16	3.5E-13	--	3.5E-12
68910-93-0	Fatty acids, tall-oil, reaction products with polyethylenepolyamines		1.0E+00		1.0E+00	0.0000001	4.2E-16	3.5E-13	--	3.5E-13
68585-36-4	Phosphoric ester of ethoxylated fatty alcohol		1.0E+00		1.0E+00	0.0000001	4.2E-16	3.5E-13	--	3.5E-13
629-73-2	Hexadec-1-ene		1.0E-01		1.0E-01	0.0000001	4.2E-16	3.5E-13	--	3.5E-12
64742-52-5	Distillates (petroleum), hydrotreated heavy naphthenic		8.0E-01		8.0E-01	0.0000001	4.2E-16	3.5E-13	--	4.4E-13
64742-53-6	Distillates (petroleum), hydrotreated light naphthenic < 3% DMSO		8.0E-01		8.0E-01	0.0000001	4.2E-16	3.5E-13	--	4.4E-13
8052-42-4	Bitumen		2.0E-01		2.0E-01	0.0000001	4.2E-16	3.5E-13	--	1.8E-12
								Total Risk (mixture)	**--**	**3.5E-03**

Note:
This scenario is deemed protective of the following scenarios due to the less frequent and short duration of exposures:
- Worker exposure during a spill (i.e.a couple breaks on a tank and releases product onto the worker) or leak scenarios

Dermal Exposure to Chemicals via Contact with Flow Back Water - Drilling Fluids

Chronic Exposures

	General Data/ Equations	Units	Exposure Calculations (RME) Dermal Contact with Flow Back Water by Workers	
	Exposure Parameters			
	Exposure Frequency (EF)	days/year	20	Assume work 5 days per week for 1 month during the fraccing period
	Exposure Duration (ED)	years	0.083	Maximum duration of the frac. Works will be complete in one month.
Use of Drilling	Body Weight (BW)	kg	78	Average male and female adults as per enHealth 2012
	Averaging Time - NonThreshold (ATc)	days	25550	USEPA 1989 and CSMS 1996
	Averaging Time - Threshold (ATn)	days	30.42	USEPA 1989 and CSMS 1996
	Surface Area (SAw)	cm^2	2300	Hands and forearms exposed (enHealth 2012) Occupational HSE would require long pants and closed shoes on Australian work sites; forearms conservatively included
	Exposure Time (ET)	hr/day	1	Assume contact with flow back water for 1 hours per day
	Conversion Factor (CF)	L/cm^3	1.E-03	Conversion of units
	Intake Factor = SAw*ET*CF*EF*ED / BW*AT	L-hr/(cm-kg-day)	**1.9E-06** **1.6E-03**	**NonThreshold** **Threshold**

Daily Intake from Water = Concentration in Water x Dermal Permeability x Intake Factor (ref: USEPA 1989, 2004)
NonThreshold Risk = Daily Intake from Water for NonThreshold Effects x Slope Factor
Hazard Quotients = (Daily Intake from Water for Threshold Effects/ADI)

	Chemical	Toxicity Data				Dermal Permeability	Concentration in Water	Daily Intake		Calculated Risk	
		Non-Threshold Slope Factor	Chronic Threshold TDI	Background Intake (% chronic TDI)	Chronic TDI Allowable for Assessment (TDI-Background)			NonThreshold	Threshold	NonThreshold Risk	Chronic Hazard Quotient
		$(mg/kg\text{-}day)^{-1}$	(mg/kg/day)		(mg/kg/day)	(cm/hr)	(mg/L)	(mg/kg/day)	(mg/kg/day)	(unitless)	(unitless)
67-56-1	Methanol		3.7E-02		3.7E-02	3.2E-4	0.30	1.8E-10	1.5E-07	--	4.2E-06
64742-47-8	Hydrotreated light petroleum distillate		1.0E+01		1.0E+01	2.0E+0	1.50	5.7E-06	4.8E-03	--	4.8E-04
111-30-8	Glutaraldehyde		4.0E-02		4.0E-02	3.3E-4	0.30	1.9E-10	1.6E-07	--	3.9E-06
78330-21-9	Alcohol, C11-14, ethoxylatedB		5.0E-01		5.0E-01	1.3E+0	1.50	3.7E-06	3.1E-03	--	6.2E-03
107-22-2	Glyoxal <1% (Ethanedial)		1.3E-01		1.3E-01	5.9E-5	2.20	2.5E-10	2.1E-07	--	1.6E-06
5064-31-3	Nitrilotriacetic acid, trisodium salt monohydrate		1.0E-02		1.0E-02	1.1E-11	1.00	2.2E-17	1.8E-14	--	1.8E-12
497-19-8	Sodium Carbonate		9.7E-02		9.7E-02	3.1E-8	0.29	1.7E-14	1.4E-11	--	1.5E-10
533-74-4	Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione		5.0E-03		5.0E-03	5.1E-4	4.00	3.9E-09	3.3E-06	--	6.5E-04
50-01-1	Guanidine, hydrochloride (1:1)		1.0E-01		1.0E-01	3.9E-8	7.00	5.2E-13	4.4E-10	--	4.4E-09
34590-94-8	(2-methoxymethylethoxy)propanol		1.0E+00		1.0E+00	1.4E-4	0.007	1.8E-12	1.5E-09	--	1.5E-09
68155-20-4	Amides, tall oil fatty N,N-bis (hydroxyethyl)		7.5E-01		7.5E-01	7.1E-2	0.0000001	1.4E-14	1.2E-11	--	1.5E-11
64741-44-2	Distillates (petroleum), straight-run middle		3.0E-02		3.0E-02	1.4E+0	0.0000001	2.6E-13	2.2E-10	--	7.3E-09
68457-79-4	Phosphorodithioic acid, mixed o,o-bis(iso-bu and pentyl) esters, zinc salts		1.6E-01		1.6E-01	3.1E+0	0.0000001	5.9E-13	5.0E-10	--	3.1E-09
4719-04-4	Triazine based biocide C572,2',2"-(hexahydro-1,3, 5-triazine-1,3,5-triyl) triethano		6.4E-02		6.4E-02	7.3E-8	0.00101	1.4E-16	1.2E-13	--	1.9E-12
10192-30-0	Ammonium hydrogensulfite		1.1E-01		1.1E-01	6.3E-8	0.00071	8.5E-17	7.2E-14	--	6.4E-13
848301-67-7	Distillates (Fischer-Tropsch), C8-26 - Branched and Linear		2.0E-01		2.0E-01	1.4E+0	0.0000001	2.6E-13	2.2E-10	--	1.1E-09
68909-77-3	Filming amine Ethanol, 2,2'-oxybis-, reaction products with ammonia, morpholine derivs. Residues		1.0E+00		1.0E+00	1.4E-6	0.005	1.3E-14	1.1E-11	--	1.1E-11
68990-47-6	Fatty acids, tall-oil, reaction products with diethylenetriamine, maleic anhydride, tetraethylenepentamine and triethylenetetramine		1.0E+00		1.0E+00	1.0E-3	0.007	1.4E-11	1.1E-08	--	1.1E-08
1120-36-1	1-tetradecene		1.0E-01		1.0E-01	6.3E+0	0.0000001	1.2E-12	1.0E-09	--	1.0E-08
68910-93-0	Fatty acids, tall-oil, reaction products with polyethylenepolyamines		1.0E+00		1.0E+00	1.0E-3	0.0000001	1.9E-16	1.6E-13	--	1.6E-13
68585-36-4	Phosphoric ester of ethoxylated fatty alcohol		1.0E+00		1.0E+00	1.0E-3	0.0000001	1.9E-16	1.6E-13	--	1.6E-13
629-73-2	Hexadec-1-ene		1.0E-01		1.0E-01	2.0E+1	0.0000001	3.8E-12	3.2E-09	--	3.2E-08
64742-52-5	Distillates (petroleum), hydrotreated heavy naphthenic		8.0E-01		8.0E-01	2.5E+2	0.0000001	4.8E-11	4.1E-08	--	5.1E-08
64742-53-6	Distillates (petroleum), hydrotreated light naphthenic < 3% DMSO		8.0E-01		8.0E-01	2.0E+0	0.0000001	3.8E-13	3.2E-10	--	4.0E-10
8052-42-4	Bitumen										
									Total Risk (mixture)		**7.3E-03**

Note:
This scenario is deemed protective of the following scenarios due to the less frequent and short duration of exposures:
- Worker exposure during a spill (i.e.a couple breaks on a tank and releases product onto the worker) or leak scenarios

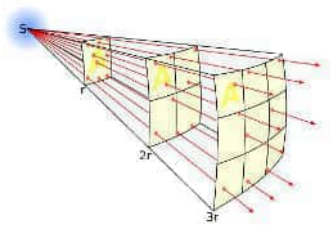
Aerosol Exposure - Drilling Fluids

The concentration of COPC in aerosol spray was estimated by calculating the concentration for driftable droplets using a mixed box model in which steady state concentrations were An emission factor for driftable aerosol was estimated using the algorithm presented below.

Emission Factor for Driftable Aerosol Algorithm

Use of Drilling Fluid

$$Emission\ Factor_{driftable\ aerosol}\left(\frac{L}{m^3}\right) = \frac{Box\ Centre^2(m) \times \left(\frac{Spray\ Vol\ \left(\frac{L}{hr}\right) \times Aerosol_{driftable}(\%)}{BoxVR\ \left(\frac{m^3}{hr}\right)}\right)}{BoxDistance^2\ (m)}$$



Aerosol Exposure Modelling Notes:

1) The inhalation of chemicals in mist/aerosol resultant from irrigation activities is dependent upon the concentration in water, the amount of water used per unit time, how close a person stands to the spray generation, how long they are in a position of exposure and the extent of spray drift (determined by the size of the water droplets and speed/direction of the wind). These equations are applicable for non-volatile contaminants that are inhaled.

2) These equations calculate the concentration for driftable droplets using a simple well mixed box model in which steady state air concentrations are calculated. The 'Inverse square law' is then applied to approximate the air concentration at a distance from the virtual air box. This law assumes the further away a receptor is from the spray source, the density of the droplets will decrease. The density of the spray droplets is inversely proportional to the square of the distance from the source.

Parameter	Units	Value	Description
Spray box length	m	3	Assume a 'spray box' of 3 m long.
Spray box width	m	3	Assume a 'spray box' of 3 m wide.
Box Centre	m	1.5	Distance to centre of box is 1.5 m.
$Box_{Distance}$	m	2	Distance the irrigation worker is from the 'spray box'. Assumed a distance of 2 m.
$Aerosol_{driftable}$	unitless	0.2	Proportion of aerosol spray that drifts outside the 'spray box' and available for exposure. Assumed 0.2, based on a droplet size of 400 – 500 µm that falls approximately 0.3 m in less than 10 seconds, with a lateral drift of approximately 3.5 m in a 5 km/hr wind (i.e. a light breeze) (Grisso et al. 2013).
Spray Volume	L/hr	1800.0	1800 L/min, irrigation value adopted from NZ MtE (2011) Appendix 5A.
Wind speed	m/hr	9000	Based on windspeed of 2.5 m/sec
BoxVR	m^3/hr	81000.0	Ventilation rate of spray in the 'spray box'. Assumed to be 81,000 m3/hr based on a wind speed of 9000 m/hr, and a 'spray box' dimension of 3 x 3 m.

CAS	Chemical	Concentration in Water mg/L	Generation rate of chemical in volume mg/hr	Driftable Aerosol Emission Factor L/m^3
67-56-1	Methanol	0.30	108	2.5E-03
64742-47-8	Hydrotreated light petroleum distillate	1.50	540	2.5E-03
111-30-8	Glutaraldehyde	0.30	108	2.5E-03
78330-21-9	Alcohol, C11-14, ethoxylatedB	0.01	2.6	2.5E-03
107-22-2	Glyoxal <1% (Ethanedial)	2.20	792	2.5E-03
5064-31-3	Nitrilotriacetic acid, trisodium salt monohydrate	1.00	360	2.5E-03
497-19-8	Sodium Carbonate	0.29	104.4	2.5E-03
533-74-4	Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	4.00	1440	2.5E-03
50-01-1	Guanidine, hydrochloride (1:1)	7.00	2520	2.5E-03
14808-60-7	Crystalline silica, quartz	10.00	3600	2.5E-03
34590-94-8	(2-methoxymethylethoxy)propanol	0.007	2.52	2.5E-03
68155-20-4	Amides, tall oil fatty N,N-bis (hydroxyethyl)	0.0000001	0.000036	2.5E-03
64741-44-2	Distillates (petroleum), straight-run middle	0.0000001	0.000036	2.5E-03
68457-79-4	Phosphorodithioic acid, mixed o,o-bis(iso-bu and pentyl) esters, zinc salts	0.0000001	0.000036	2.5E-03
4719-04-4	Triazine based biocide C572,2',2"-(hexahydro-1,3, 5-triazine-1,3,5-triyl) triethano	0.00101	0.3636	2.5E-03
10192-30-0	Ammonium hydrogensulfite	0.00071	0.2556	2.5E-03
848301-67-7	Distillates (Fischer-Tropsch), C8-26 - Branched and Linear	0.0000001	0.000036	2.5E-03
68909-77-3	Filming amine Ethanol, 2,2'-oxybis-, reaction products with ammonia, morpholine derivs. Residues	0.0050000	1.8	2.5E-03
68990-47-6	Fatty acids, tall-oil, reaction products with diethylenetriamine, maleic anhydride, tetraethylenepentamine and triethylenetetramine	0.0070000	2.52	2.5E-03
1120-36-1	1-tetradecene	0.0000001	0.000036	2.5E-03
68910-93-0	Fatty acids, tall-oil, reaction products with polyethylenepolyamines	0.0000001	0.000036	2.5E-03
68585-36-4	Phosphoric ester of ethoxylated fatty alcohol	0.0000001	0.000036	2.5E-03
629-73-2	Hexadec-1-ene	0.0000001	0.000036	2.5E-03
64742-52-5	Distillates (petroleum), hydrotreated heavy naphthenic	0.0000001	0.000036	2.5E-03
64742-53-6	Distillates (petroleum), hydrotreated light naphthenic < 3% DMSO	0.0000001	0.000036	2.5E-03
8052-42-4	Bitumen	0.0000001	0.000036	2.5E-03

Exposure to Chemicals via Inhalation of Mist from the Evaporation Units - Drilling Fluids

Chronic Exposures

Use of Drilli

General Data/ Equations	Units	Exposure Calculations (RME) Inhalation of Mist by Workers	
Exposure Parameters			
Exposure Frequency (EF)	days/year	240	Exposure for 5 days per week minus 4 weeks holidays
Exposure Duration (ED)	years	1	Maximum duration that the flowback tank will be on-site
Exposure Time (ET)	hr/day	1	Professional judgement for irrigation exposure. Assume worker to be near tank for 1 hours every working day.
Driftable aerosol emission factor (EMF)	L/m3	2.50E-03	Calculated
Aerosol Inhalation Bioavailability (AAF)	unitless	1.0	Assume 100% bioavailability
Averaging Time - Threshold (AT)	years	1.0	USEPA 1989 and CSMS 1996
$ITF_{inh,w,shwr} = \frac{EmF \times AAF \times ET_{iw} \times EF \times ED}{365\ \frac{days}{year} \times 24\ \frac{hours}{day} \times AT}$			

Daily Intake = Concentration in Water x Intake Factor (ref: USEPA 1989)
Hazard Quotients = (Daily Intake from Water for Threshold Effects/ADI)

CAS	Chemical	Groundwater Concentration	Aerosol Inhalation Bioavailability	Driftable Aerosol Emission Factor	RfC (Background Corrected)	Threshold Intake and Risk Calculations: Adult Exposure Factor (threshold)	Adult Exposure Adjusted Air Concentration (threshold)	Hazard Index (Adult)
		mg/L	(unitless)	(L/m^3)	(mg/m^3)	(L/m^3)	(mg/m^3)	(unitless)
67-56-1	Methanol	0.3	1.00	2.50E-03	1.30E-01	6.85E-05	2.05E-05	1.58E-04
64742-47-8	Hydrotreated light petroleum distillate	1.5	1.00	2.50E-03	3.50E+01	6.85E-05	1.03E-04	2.94E-06
111-30-8	Glutaraldehyde	0.3	1.00	2.50E-03	1.40E-01	6.85E-05	2.05E-05	1.47E-04
78330-21-9	Alcohol, C11-14, ethoxylatedB	0.0	1.00	2.50E-03	1.75E+00	6.85E-05	5.00E-07	2.85E-07
107-22-2	Glyoxal <1% (Ethanedial)	2.2	1.00	2.50E-03	4.66E-01	6.85E-05	1.51E-04	3.24E-04
5064-31-3	Nitrilotriacetic acid, trisodium salt monohydrate	1	1.00	2.50E-03	3.50E-02	6.85E-05	6.85E-05	1.96E-03
497-19-8	Sodium Carbonate	0.29	1.00	2.50E-03	3.38E-01	6.85E-05	1.99E-05	5.87E-05
533-74-4	Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	4	1.00	2.50E-03	1.75E-02	6.85E-05	2.74E-04	1.57E-02
50-01-1	Guanidine, hydrochloride (1:1)	0	1.00	2.50E-03	3.50E-01	6.85E-05	5.00E-07	1.43E-06
14808-60-7	Crystalline silica, quartz	10	1.00	2.50E-03	3.00E-03	6.85E-05	6.85E-04	2.28E-01
34590-94-8	(2-methoxymethylethoxy)propanol	0.007	1.00	2.50E-03	3.50E+00	6.85E-05	4.79E-07	1.37E-07
68155-20-4	Amides, tall oil fatty N,N-bis (hydroxyethyl)	0.0000001	1.00	2.50E-03	2.63E+00	6.85E-05	6.85E-12	2.61E-12
64741-44-2	Distillates (petroleum), straight-run middle	0.0000001	1.00	2.50E-03	1.05E-01	6.85E-05	6.85E-12	6.52E-11
68457-79-4	Phosphorodithioic acid, mixed o,o-bis(iso-bu and pentyl) esters, zinc salts	0.0000001	1.00	2.50E-03	5.60E-01	6.85E-05	6.85E-12	1.22E-11
4719-04-4	Triazine based biocide C572,2',2''-(hexahydro-1,3, 5-triazine-1,3,5-triyl) triethano	0.00101	1.00	2.50E-03	2.24E-01	6.85E-05	6.92E-08	3.09E-07
10192-30-0	Ammonium hydrogensulfite	0.00071	1.00	2.50E-03	3.96E-01	6.85E-05	4.86E-08	1.23E-07
848301-67-7	Distillates (Fischer-Tropsch), C8-26 - Branched and Linear	0.0000001	1.00	2.50E-03	7.00E-01	6.85E-05	6.85E-12	9.78E-12
68909-77-3	Filming amine Ethanol, 2,2'-oxybis-, reaction products with ammonia, morpholine derivs. Residues	0.005	1.00	2.50E-03	3.50E+00	6.85E-05	3.42E-07	9.78E-08
68990-47-6	Fatty acids, tall-oil, reaction products with diethylenetriamine, maleic anhydride, tetraethylenepentamine and triethylenetetramine	0.007	1.00	2.50E-03	3.50E+00	6.85E-05	4.79E-07	1.37E-07
1120-36-1	1-tetradecene	0.0000001	1.00	2.50E-03	3.50E-01	6.85E-05	6.85E-12	1.96E-11
68910-93-0	Fatty acids, tall-oil, reaction products with polyethylenepolyamines	0.0000001	1.00	2.50E-03	3.50E+00	6.85E-05	6.85E-12	1.96E-12
68585-36-4	Phosphoric ester of ethoxylated fatty alcohol	0.0000001	1.00	2.50E-03	3.50E+00	6.85E-05	6.85E-12	1.96E-12
629-73-2	Hexadec-1-ene	0.0000001	1.00	2.50E-03	3.50E-01	6.85E-05	6.85E-12	1.96E-11
64742-52-5	Distillates (petroleum), hydrotreated heavy naphthenic	0.0000001	1.00	2.50E-03	2.80E+00	6.85E-05	6.85E-12	2.45E-12
64742-53-6	Distillates (petroleum), hydrotreated light naphthenic < 3% DMSO	0.0000001	1.00	2.50E-03	2.80E+00	6.85E-05	6.85E-12	2.45E-12
8052-42-4	Bitumen	0.0000001	1.00	2.50E-03	7.00E-01	6.85E-05	6.85E-12	9.78E-12
							Total Threshold Risk (mixture)	**0.25**

Summary of Risk to Workers - Drilling Fluids
Exposure fo Target Chemicals - Theoretical Data

Receptor/Exposure Pathway	Calculated HI 100% Mass Return
Use of Drilling Fluid	
Workers	
Ingestion of Chemicals via Incidental Contact with Flowback Water	0.004
Dermal Exposure to Chemicals via Incidental Contact with Flowback Water	0.007
Inhalation of mist from the evaporation units	0.2
Total Risk	**0.3**

Chemical Name	CAS Number	Volume or Mass of Chemical (L or kg)	Concentration in Injected Fluid (mg/L)	Parent Compound Purpose	Ecotoxicity[1]	Toxicity[2]	Biodegradation[1,3]	Bioaccummulative[1]	Tier 1 Screening Assessment	Discussion	Tier 2 Assessment Worker Ingestion Risk	Tier 2 Assessment Worker Dermal Risk	Tier 2 Assessment Worker Aerosol Inhalation Risk	Hazard Quotient	Outcome of Tier 2 Worker Risk Assessment[1]
Oxirane, 2-methyl-, polymer with oxirane, di-(9Z)-9-octadecenoate	67167-17-3	400L	543	Defoamer	Polymer of low concern to the environment.	Based on NICNAS: Low	No data	No data	Tier 1 (NICNAS IMAP)	The risk was classified as low as it is a polymer of low concern. A Tier 2 assessment is not required.	NA	NA	NA	NA	NA
Fatty acids, tall-oil	61790-12-3	400L	29	Defoamer	Pimephales promelas: 96-hour LL50 >1,000 (WAF) Daphnia magna: 48-hour EL50 >1,000 (WAF) Selenastrum capricornutum: 72-hour EL50 854.90 (WAF)	Based on acute: Low	Expected to be readily biodegradable	Not bioaccumulative	Tier 1	The risk was classified as low based on acute data and it is expected to be readily biodegradable and not bioaccumulative. A Tier 2 assessment is not required.	NA	NA	NA	NA	NA
Poly Anionic Cellulose	9004-32-4	775 kg	5,085	Shale Stabiliser	96 h LC50 for Brachydanio rerio is >2,500 mg/L 48 h LC50 for Daphnia magna is >5,000 mg/L; 96 h EC50 for Selenastrum capricornutum is 500 mg/L	Based on acute: Low	Not readily biodegradable	Not bioaccumulative	Tier 1 (NICNAS IMAP)	The risk was classified as low based on acute data. It is not expected to be readily biodegradable however it is not expected to be bioaccumulative. A Tier 2 assessment is not required.	NA	NA	NA	NA	NA
Acetic acid, ethenyl ester, polymer with ethenol	25213-24-5	775 kg	2,286	Shale Stabiliser	Poses no unreasonable risk to the environment based on Tier I assessment under the NICNAS IMAP assessment framework.	Based on NICNAS: Low	Not readily biodegradable	Not bioaccumulative	Tier 1 (NICNAS IMAP)	The risk was classified as low based on NICNAS assessment. A Tier 2 assessment is not required.	NA	NA	NA	NA	NA
Barium Sulphate	7727-43-7	61,800 kg	111,994	Weighting Agent	Short-term toxicity: 96 hrs LC50: >3.5 mg/L (Fish) 48 hrs LC50: 14.5 mg/L (Invertebrates) 72 hrs EC50: 1.15 mg/L (Algae) Long-term toxicity: 33 days NOEC: 1.26 mg/L (Fish) 21 days NOEC: 2.9 mg/L (Invertebrates) 72 hrs NOEC: 1.19 mg/L (Algae)	Based on chronic: Low	N.A.(Inorganic)	N.A. (Inorganic)	Tier 1 (NICNAS)	The risk was classified as low based on chronic data. A Tier 2 assessment is not required.	NA	NA	NA	NA	NA
Crystalline silica, quartz	14808-60-7	--	2,286	Weighting Agent	No acute toxicity to fish, Daphnia, or algae, though some physical effects were observed with loading rates of greater than or equal to 10 g/L (OECD 2004). Any harmful effects to aquatic ecosystems are therefore not ecotoxicological in nature. No chronic toxicity data were identified.	Based on Acute: Low	N.A.(Inorganic)	N.A. (Inorganic)	Tier 1	The risk was classified as low based on acute data. The substance is not classified as PBT. It is noted that the substance is hazardous to human health via the inhalation pathways and as such OH&S procedures implemented by Tamboran will minimise human health exposure. A Tier 2 assessment is not required.	NA	NA	NA	NA	NA
Calcium Chloride	10043-52-4	332,000 kg	429,550	Desiccant, Dust Control Agent	Acute Toxicity 96-hr LC50 value was 4,630 mg/L in fathead minnow (Pimephales promelas) 48-hr EC50 was 1,062 mg/L for Daphnia magna 72-hr EC50 = >4,000 for fresh water algae 72-hr EC50 = 2,900 mg/L for fresh water algae (biomass) Chronic Toxicity 21-day NOEC = 160 mg/L for Daphnia magna	Based on acute and chronic: Low	Not applicable (inorganic salt, ionic species ubiquitous in environment)	Not applicable (inorganic salt, ionic species ubiquitous in environment)	Tier 1	The risk was classified as low based on chronic data and acute data. The substance is inorganic and ubiquitous in the environment. A Tier 2 assessment is not required.	NA	NA	NA	NA	NA
Sodium Chloride	7647-14-5	332,000 kg	97	Desiccant, Dust Control Agent	EC50 = 400 to 30000 mg/L EC50 Fish = 1290 mg/L NOEC = 314 mg/L (Daphnia)	Based on Chronic: Low	N.A.(Inorganic)	N.A. (Inorganic)	Tier 1 (NICNAS)	The risk was classified as low based on chronic data. The substance is inorganic and ubiquitous in the environment. The exposure concentration is below the respective ecotoxicity values. A Tier 2 assessment is not required.	NA	NA	NA	NA	NA
Sodium hydroxide	1310-73-2	100 kg	286	Scrubbing Agent	Measured acute endpoints were available for fish (196 mg/L). Measured chronic endpoint were available for Daphnia (240 mg/L)	Based on Chronic: Low	N.A.(Inorganic)	N.A. (Inorganic)	Tier 1	The risk was classified as low based on chronic data. The substance is not classified as PBT. Management of this chemical is addressed in the EMP to prevent accidental release. OH&S procedures implemented by Tamboran will minimise human health exposure risk. A Tier 2 assessment is not required.	NA. Acute toxicity only (irritant and corrosive), not systemically available in body	NA. Acute toxicity only (irritant and corrosive), not systemically available in body	NA. Acute toxicity only (irritant and corrosive), not systemically available in body	NA. Acute toxicity only (irritant and corrosive), not systemically available in body	NA. Acute toxicity only (irritant and corrosive), not systemically available in body
Ethanol, 2,2'-oxybis-, reaction products with ammonia, morpholine derivatives residues	68909-77-3	--	2,286	Corrosion Inhibitor	Leuciscus idus, Fish LC50 (96 h) = 681.2 mg/L Daphnia EC50 = 122 mg/L Green alga ErC50 (72h) = 45 mg/L Microorganism > 1000 mg/L	Based on acute: Low	Not readily biodegradable.	No based on the Log Pow of 0.565	Tier 2	The risk was classified as low based on acute data. It is not expected to be readily biodegradable however it is not a bioaccummulative substance. A Tier 2 assessment is required.	8.03E-04	5.10E-07	4.47E-03	5.28E-03	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Calcium Carbonate	471-34-1	--	113,251	Weighting Agent	96h EC50 for fish >100mg/L 48 h EC50 for Daphnia >100 mg/L 72 h ERC50 for algae >14 mg/L	Based on acute: Low	N.A.(Inorganic)	N.A. (Inorganic)	Tier 1 (NICNAS IMAP)	The risk was classified as low based on acute data. A Tier 2 assessment is not required.	NA	NA	NA	NA	NA
Citric Acid, monohydrate	77-92-9	375kg	857	Drilling Fluid Additive	96 h LC50 fish = 440 to 1,516 mg/L 24 h EC50 value for invertebrates is 85 mg/L 7 d toxic limit concentration values for algae = 300 to 640 mg/L 8 d freshwater static test for the algae Scenedesmus quadricauda, NOEC = 425 mg/L	Based on chronic: Low	Expected to be readily biodegradable	Not bioaccumulative	Tier 1 (NICNAS)	The risk was classified as low based on chronic data and it is expected to be readily biodegradable and not bioaccumulative. A Tier 2 assessment is not required.	NA	NA	NA	NA	NA
Starch	9005-25-8	26,880kg	22,856	Fluid Loss Control Additive	Crassostrea virginica 96 h = 1000 mg/L Orthopristis chrysoptera 96 h = 5000 mg/L Bairdiella chrysoura 96 h = 5000 mg/L	Based on acute: Low	Expected to be readily biodegradable	Not bioaccumulative	Tier 1	The risk was classified as low based on acute data and it is expected to be readily biodegradable and not bioaccumulative. A Tier 2 assessment is not required.	NA	NA	NA	NA	NA
Xanthan Gum	11138-66-2	--	4,286	Viscosifier	Acute Fish (measured) = 420 mg/L	Based on acute: Low	Expected to be readily biodegradable	Not bioaccumulative	Tier 1 (NICNAS IMAP)	The risk was classified as low based on acute data. A Tier 2 assessment is not required.	NA	NA	NA	NA	NA
Polyethylene Glycol	25322-68-3	--	1,429	Defoamer	Fish LC50 = 100 mg/L Invertebrates LC50 = 1000 mg/L Algae EC 50 = 15.91 mg/L	Based on acute: Low	Expected to be readily biodegradable	Not bioaccumulative	Tier 1	The risk was classified as low based on acute data and it is expected to be readily biodegradable and not bioaccumulative. A Tier 2 assessment is not required.	NA	NA	NA	NA	NA
Octan-2-ol	123-96-6	--	1,429	Defoamer	96h-LC50 for fish = 18.57 mg/L 48h-EC50 for invertebrates = 30 mg/L 72h-ErC50 for algae = 48 mg/L 72h-NOErC for algae = 8.7 mg/L	Based on acute: Low	Expected to be readily biodegradable	Not bioaccumulative	Tier 1	The risk was classified as low based on acute data and it is expected to be readily biodegradable and not bioaccumulative. A Tier 2 assessment is not required.	NA	NA	NA	NA	NA
Organic Fibres / Cellulose	9004-34-6	3400kg	28,570	Lost Circulation Material	Poses no unreasonable risk to the environment based on Tier I assessment under the NICNAS IMAP assessment framework.	Based on NICNAS: Low	Expected to be readily biodegradable	Not bioaccumulative	Tier 1 (NICNAS IMAP)	The risk was classified as low based on NICNAS assessment. A Tier 2 assessment is not required.	NA	NA	NA	NA	NA
Poly(oxy-1,2-ethanediyl), alpha-octyl-omega-hydroxy-	27252-75-1	--	514	Lubricant	48h EC50 Invertebrates: 40 mg/L 72h EC50 Algae: 14 mg/L	Based on acute: Low	Expected to be readily biodegradable	Not bioaccumulative	Tier 1	The risk was classified as low based on acute data and it is expected to be readily biodegradable and not bioaccumulative. A Tier 2 assessment is not required.	NA	NA	NA	NA	NA
Distillates, hydrotreated light	64742-47-8	--	60	Lubricant	Lowest acute endpoint for Daphnia = 0.018 mg/L (modelled)	Based on acute: Very high	Readily biodegradable	Yes based on calculated log BCF values for constituents that range from 2.78 to 4.06, and calculated BCF values of 598 to 11,430 L/kg wet-weight	Tier 2	The risk was classified as very high based on acute data. The substance is expected to be readily biodegradable, but is considered to have a potential to bioaccumulate. A Tier 2 assessment is required.	2.11E-05	1.90E-02	1.17E-04	1.91E-02	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Starch, carboxymethyl ether, sodium salt	9063-38-1	--	19,999	Filtration Control Agent	Crassostrea virginica 96 h = 1000 mg/L Orthopristis chrysoptera 96 h = 5000 mg/L Bairdiella chrysoura 96 h = 5000 mg/L	Based on acute: Low	Expected to be readily biodegradable	Not bioaccumulative	Tier 1	The risk was classified as low based on acute data and it is expected to be readily biodegradable and not bioaccumulative. A Tier 2 assessment is not required.	NA	NA	NA	NA	NA
Glutaraldehyde	111-30-8	1775L	357	Biocide	96 h acute Bluegill sunfish LC50 = 11.2 mg/L 48 h acute Oyster larvae LC550 = 2.1 mg/L 96 h acute Green crabs LC50 = 465 mg/L 96 h acute Grass shrimp LC50 = 41 mg/L 48 acute Daphnia magna LC50 = 0.35 mg/L 48 acute Daphnia magna LC50 = 16.3 mg/L 21 d reproductn Daphnia magna LOEC = 4.3 mg/L, NOEC = 2.1 mg/L 96 h algal growth inhibition Selenastrum capricornutum ILm = 3.9 mg/L (median inhibitory limit) 96 h algal growth inhibition Scenedesmus subspicatus EC50 = 1.0 mg/L Bacterial inhibition Sewage microbes IC50 = 25-34 mg/L	Based on Chronic: Moderate	Readily biodegradable	No based on the Log Pow of -0.01	Tier 2	The risk was classified as moderate based on chronic data . The exposure concentration is above the respective ecotoxicity values. A Tier 2 assessment is required.	3.14E-02	4.69E-03	1.75E-01	2.11E-01	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
Methanol	67-56-1	1775L	14	Biocide	LC50s ranged from 15,400 to 29,400 mg/L (fish) 24-hour and 48-hour EC50s were > 10,000 mg/L (Daphnia) Chronic toxicity study to invertebrates, NOEC was 32,000 mg/L	Based on Chronic: Low	Readily biodegradable	Not bioaccumulative based on the Log Kow of -0.74	Tier 1	The risk was classified as low based on chronic data and it is expected to be readily biodegradable and not bioaccumulative. The exposure concentration is below the respective ecotoxicity values. A Tier 2 assessment is not required.	NA	NA	NA	NA	NA
Poly(oxy-1,2-ethanediyl), alpha-hydro-omega-hydroxy-, mono(2-(4,5-dihydro-2-nortall-oil alkyl-1H-imidazol-1-yl)ethyl) ethers	68909-09-1	--	571	Corrosion Inhibitor	Fish (Cyprinodon variegatus) 96 h LC50 > 0.53 mg/L Invertebrate (Acartia tonsa) 48 h LC50 = 3.81 mg/L Invertebrate (Corophium volutator) 10 d LC50 ≥ 13,471 mg/L Algal Toxicity (Skeletonema costatum) 72 h ErC50 = 0.53 mg/L	Based on acute: Low	Not readily biodegradable	Not bioaccumulative	Tier 1	The risk was classified as low based on acute data. A Tier 2 assessment is not required.	NA	NA	NA	NA	NA
Acetic acid	64-19-7	--	286	Corrosion Inhibitor	Acute endpoints: Fish = 75 mg/L (measured), Daphnia EC50 = 32 mg/L Chronic endpoints: Daphnia = 150 mg/L (measured)	Based on chronic: Low	Not readily biodegradable	Not bioaccumulative	Tier 1	The risk was classified as low based on chronic data and it is expected to be readily biodegradable and not bioaccumulative. A Tier 2 assessment is not required.	NA	NA	NA	NA	NA
Magnesium Oxide	1309-48-4	13,250kg	8,057	PH Indicator	96-hour LC50: 306.79 mg/L (Fish) 96-hour EC50: 170.6 mg/L (Invertebrates) 72-hour EC50: >100 mg/L (Algae)	Based on acute: Low	N.A.(Inorganic)	N.A. (Inorganic)	Tier 1 (NICNAS IMAP)	The risk was classified as low based on acute data. A Tier 2 assessment is not required.	NA	NA	NA	NA	NA
Calcium Oxide	1305-78-8	13,250kg	300	PH Indicator	Oncorhynchus mykiss 96-hour LC50: 50.6 mg/L Daphnia magna 48-hour EC50: 49.1 mg/L Pseudokirchneriella subcapitata 72 hour EC10: 79.22 mg/L A 42-day Oncorhynchus mykiss test showed that enhanced Ca2+ diets (60 mg Ca2+) had no effects on survival. A 14-day Crangon septemspinosa test showed an EC10 of 32 mg/L.	Based on chronic: Low	N.A.(Inorganic)	N.A. (Inorganic)	Tier 1	The risk was classified as low based on chronic data. A Tier 2 assessment is not required.	NA	NA	NA	NA	NA
Non-crystalline silica (impurity)	7631-86-9	13,250kg	214	PH Indicator	Acute Aquatic -96-h LL0 Danio-rerio - 10,000 mg/L -24-h ECL50 Daphnia magna ->10,000 mg/L -72hr-NOEL (Scenedesmus subspicatus) - 10,000 mg/L	Based on acute: Low	Not applicable, inorganic substance, ubiquitous in environment.	Not applicable, inorganic substance, ubiquitous in environment.	Tier 1	The risk was classified as low based on acute data. The substance is inorganic and ubiquitous in the environment. The exposure concentration is below the respective ecotoxicity values. It is noted that the substance is hazardous to human health via the inhalation pathways and as such OH&S procedures implemented by Tamboran will minimise human health exposure. A Tier 2 assessment is not required.	NA	NA	NA	NA	NA
2,2',2"- Nitrilotriethanol (TRIETHANOLAMINE)	102-71-6	8200L	6,000	Corrosion Inhibitor	Fish 96h-LC50 of 11,800 mg/L Daphnia 24h-EC50 of 1,390 mg/L Daphnia 21 day NOEC of 16 mg/L Alga EC50 910 mg/L	Based on chronic: Low	Not readily biodegradable	Not bioaccumulative	Tier 1	The risk was classified as low based on chronic data. A Tier 2 assessment is not required.	NA	NA	NA	NA	NA
Ethanamine, N-ethyl-N-hydroxy-	3710-84-7	8200L	1,628	Corrosion Inhibitor	96 hr LC50 (fish): 134 mg/L 48 hr EC50 (invertebrates): 8.2 mg/L 72 hr EC50 (algae): 101 mg/L 28 days NOEC (microorganisms): 100 mg/L	Based on acute: Low	Not readily biodegradable	Not bioaccumulative	Tier 1	The risk was classified as low based on acute data. A Tier 2 assessment is not required.	NA	NA	NA	NA	NA
Ethanolamine	141-43-5	8200L	429	Corrosion Inhibitor	Acute toxicity: 96 h LC50 (fish): 105 mg/L 48 h EC50 (invertebrates): 27.04 mg/L 72 h ErC50 (algae): 2.8 mg/L Chronic toxicity: 41 d NOEC (fish): 1.24 mg/L 21 d NOEC (invertebrates): 0.85 mg/L 72 h ErC10 (algae): 0.7 mg/L	Based on chronic: Low	Expected to be readily biodegradable	Not bioaccumulative	Tier 1	The risk was classified as low based on chronic data and it is expected to be readily biodegradable and not bioaccumulative. A Tier 2 assessment is not required.	NA	NA	NA	NA	NA
Sodium Glycolate (impurity)	2836-32-0	775kg	34	Filtration Control Agent	Green algae (Pseudokirchneriella subcapitata) 72-hr EC50 (growth) = 44.0 mg/L Fathead minnows (Pimephales promelas) . 96-hr LC50 = 164 mg/L. Water fleas (Daphnia magna) 48-hr EC50 = 141 mg/L	Based on acute: Moderate	Glycolic acid is readily biodegradable and as such not persistent in the environment.	Based on the measured log Kow of -1.11 and an estimated BCF of 3. Glycolic acid is not bioaccumulative.	Tier 1	The risk was classified as moderate based on acute data. The substance is expected to be readily biodegradable and not bioaccumulative. The exposure concentration is below the respective ecotoxicity values. A Tier 2 assessment is not required.	NA	NA	NA	NA	NA

AECOM

Newpark Drilling Fluid Recipe

Client Name: Tamboran
Project Name: Beetaloo Chem

Chemical Name	CAS Number	Volume or Mass of Chemical (L or kg)	Concentration in Injected Fluid (mg/L)	Parent Compound Purpose	Ecotoxicity[1]	Toxicity[2]	Biodegradation[1,3]	Bioaccummulative[1]	Tier 1 Screening Assessment	Discussion	Tier 2 Assessment Worker Ingestion Risk	Tier 2 Assessment Worker Dermal Risk	Tier 2 Assessment Worker Aerosol Inhalation Risk	Hazard Quotient	Outcome of Tier 2 Worker Risk Assessment[1]
Hexanedinitrile, hydrogenated, high-boiling fraction	68411-90-5	--	8,811	Shale Inhibitor	96 hr LC50 (fish): 670 mg/L 48 hr EC50 (invertebrates) 1189 mg/L 72 hr EC50/NOEC (algae): >97.4 mg/L	Based on acute: Low	Expected to be readily biodegradable	Not bioaccumulative	Tier 1	The risk was classified as low based on acute data and it is expected to be readily biodegradable and not bioaccumulative. A Tier 2 assessment is not required.	NA	NA	NA	NA	NA
Calcium Carbonate (Limestone)	1317-65-3	81,650kg	127,408	Bridging Agent, Weighting Agent	Acute ecotoxicological endpoint values for aquatic organisms generally greatly exceed 100 mg/L (LMC 2014), indicating very low toxicity.	Based on acute: Low	N.A.(Inorganic)	N.A. (Inorganic)	Tier 1 (NICNAS)	A Tier 1 Human Health Assessment for this chemical has been conducted by NICNAS which concluded that this chemical was identified as low concern to human health. A Tier 2 assessment is not required.	NA	NA	NA	NA	NA
Disodium Pyrophosphate	7758-16-9	200kg	1,429	Acidifier, Buffering Agent	96h LC50 (fish): > 100 mg/l 48h EC50 (invertebrates): 100 mg/L 72h EC50 (algae): 100 mg/L	Based on acute: Low	N.A.(Inorganic)	N.A. (Inorganic)	Tier 1 (NICNAS)	The risk was classified as low based on acute data. A Tier 2 assessment is not required.	NA	NA	NA	NA	NA
Sodium Carbonate	497-19-8	150kg	714	Drilling Aid	96-hour LC50 Bluegill sunfish (Lepomis macrochirus) = 300 mg/L 96-hour LC50 to mosquitofish (Gambusia affinis) = 740 mg/L 48-hour EC50 to the invertebrate Ceriodaphnia cf. dubia = 200 to 227 mg/L	Based on acute: Low	N.A.(Inorganic)	N.A. (Inorganic)	Tier 1	The risk was classified as low based on acute data. A Tier 2 assessment is not required.	NA	NA	NA	NA	NA
Sodium Sulphite	7757-83-7	325kg	1,400	Reducing Agent	Acute toxicity: 96h LC50 Fish: 149.6 mg/L 48h EC50 Invertebrate: 74.9 mg/L 72h EC50 Algae: 36.8 mg/L Chronic toxicity: NOEC Algae: 28 mg/L NOEC Invertebrates: ≥8.41 mg/L NOEC Fish: 50 mg/L	Based on chronic: Low	N.A.(Inorganic)	N.A. (Inorganic)	Tier 1	The risk was classified as low based on chronic data. A Tier 2 assessment is not required.	NA	NA	NA	NA	NA
Sodium Sulphate	7757-82-6	325kg	26	Reducing Agent	Algae; EC50 120h = 1,900 mg/l. Invertebrates (Daphnia magna); EC50 48h = 4,580 mg/l Fish LC50 96h = 7,960 mg/l	Based on acute: Low	N.A.(Inorganic)	Not bioaccumulative	Tier 1 (NICNAS)	The risk was classified as low based on acute data. A Tier 2 assessment is not required.	NA	NA	NA	NA	NA
Diethanolamine	111-42-2	13,000L	2,571	Solvent	Pimephales promelas (fish) 96-h LC50 = 1370 mg/l (nominal) Daphnia magna (invertebrates) 48-h EC50 = 55 mg/l (nominal) Pseudokirchneriella subcapitata 96-h ErC50 = 2.2 mg/l (nominal) Pseudomonas sp. (microorganisms) 16-h TTC = 16 mg/l (nominal) Daphnia magna, the NOEC (21 days) was 0.78 mg/l (nominal, based on analytical verification).	Based on chronic: Low	Expected to be readily biodegradable	Not bioaccumulative	Tier 1	The risk was classified as low based on chronic data and it is expected to be readily biodegradable and not bioaccumulative. A Tier 2 assessment is not required.	NA	NA	NA	NA	NA
Sodium erythorbate	6381-77-7	2000kg	2,857	Oxygen Scavenger	96 h LC50 Fish > 100 mg/L 48 h EC50 Daphnia magna = 84 - 100 mg/L 72 h NOEC alga = 20 mg/L	Based on acute: Low	Not readily biodegradable	Not bioaccumulative	Tier 1 (NICNAS)	The risk was classified as low. It is not expected to be readily biodegradable however it is not a bioaccumulative substance. A Tier 2 assessment is not required.	NA	NA	NA	NA	NA
Methyl alpha-D-glucopyranoside	97-30-3	--	1,371	Spotting Additive	LC50 (96 hr) for fish: 1 770 g/L LOEC (48 h) for invertebrates: 100 mg/L LOEC (72 h) for algae: 125.3 mg/L	Based on acute: Low	Expected to be readily biodegradable	Not bioaccumulative	Tier 1	The risk was classified as low based on acute data and it is expected to be readily biodegradable and not bioaccumulative. A Tier 2 assessment is not required.	NA	NA	NA	NA	NA
1,2,3-Propanetriol, homopolymer	25618-55-7	--	1,307	Spotting Additive	LC50 (96 hrs) for fish: 500 mg/L EC50 (48 h) for invertebrates: 1 g/L EC50/NOEC (72 h) for algae: 1 g/L	Based on acute: Low	Expected to be readily biodegradable	Not bioaccumulative	Tier 1	The risk was classified as low based on acute data and it is expected to be readily biodegradable and not bioaccumulative. A Tier 2 assessment is not required.	NA	NA	NA	NA	NA
1,2,3-Propanetriol, homopolymer, (Z)-9-octadecenoate	9007-48-1	--	1,263	Spotting Additive	LC50 (96 hrs) for fish: 500 mg/L EC50 (48 h) for invertebrates: 1 g/L EC50/NOEC (72 h) for algae: 1 g/L	Based on acute: Low	Expected to be readily biodegradable	Not bioaccumulative	Tier 1	The risk was classified as low based on acute data and it is expected to be readily biodegradable and not bioaccumulative. A Tier 2 assessment is not required.	NA	NA	NA	NA	NA
1-Dodecene, dimer	62132-67-6	--	680	Spotting Additive	LL50 (96 hrs) for fish: 1 g/L EL50 (48 h) for invertebrates: 1 g/L EL50 (48 h) for algae: 1 g/L 21 day NOELR for invertebrates: 125 mg/L WAF.	Based on chronic: Low	Not readily biodegradable	Not bioaccumulative	Tier 1	The risk was classified as low based on chronic data. A Tier 2 assessment is not required.	NA	NA	NA	NA	NA
													Total Risk	**2.4E-01**	The calculated risk associated with potential exposure to COPC identified in flowback water, where the SLB HYBRID recipe is used and assuming 100% mass recovery is below the target of 1, respectively. Hence, chronic health risks are considered to be low and acceptable.

Notes
-- information not available
Tier 1 (NICNAS) - Chemical identified as of low concern for human health, as published in the National Assessment of Chemicals Associated with Coal Seam Gas Extraction in Australia (NICNAS 2017).
1 - Please refer to the individual toxicity profiles for further detail.
2 - Toxicity assessed using NT (2021)
3 - Biodegradation assessed as per NT (2021) and DoEE (2017)
BCF - Bioconcentration Factor
NA - Not Applicable
NICNAS 2017 - National Assessment of Chemicals Associated with Coal Seam Gas Extraction in Australia
DoEE 2017 - Draft Risk Assessment Guidance Manual: For Chemicals Associated with Coal Seam Gas Extraction, Australian Government, Department of Energy
NT 2021 - Northern Territory Government, Department of Environment, Parks and Water Security, Environment Management Plan Content Guideline, 2021

Toxicity and Dermal Absorption Parameters

C = calculated from chronic value, Ch = chronic value adopted

CAS#	Chemical	Oral/Dermal Exposures				Inhalation Exposures										
		Threshold Chronic TDI or RfD (mg/kg/day)		Dermal Permeability (cm/hr)	Reference	Inhalation Unit Risk $(ug/m^3)^{-1}$	Non-Threshold Slope Factor $(mg/kg/day)^{-1}$		Threshold Chronic TC or RfC (mg/m^3)		NOAEC or LOAEC (mg/m^3)	NOAEL or LOAEL (mg/kg bw/d)	Reference	UF	Reference
	COPC in Hydraulic Fracturing Fluid Injected into Well														
111-30-8	Glutaraldehyde	0.04	D	3.25E-04	EPI				0.14	converted from RFD		4	NICNAS (2017)	100	NICNAS (2017)
64742-47-8	Distillates, hydrotreated light	1	D	1.96E+00	EPI				3.5	converted from RFD		1000	OECD (2012)	1000	D
68909-77-3	Ethanol, 2,2'-oxybis-, reaction products with ammonia, morpholine derivatives residues	10	D	1.38E-06	EPI				35	converted from RFD		1000	OECD (2012)	100	D

References:

D - Derived (refer to individual Toxicity Profiles)

EPI - USEPA Estimation Programs Interface (EPI) Suite

NICNAS (2017) - Department of the Environment and Energy 2017 , National assessment of chemicals associatedwith coal seam gas extraction in Australia, prepared by the National Industrial ChemicalsNotification and Assessment Scheme

OECD - Organisation for Economic Co-operation and Development Screening Information Data Set (SIDS)

Exposure to Chemicals via Incidental Ingestion of Flowback fluid - Newpark Recipe

Chronic Exposures

General Data/ Equations		Units	Exposure Calculations (RME) Ingestion of Flowback Water by Workers	
Exposure Parameters				
Exposure Frequency (EF)		days/year	20	Assume work 5 days per week for 1 month during the fraccing period
Exposure Duration (ED)		years	0.083	Maximum duration of the frac. Works will be complete in one month.
Body Weight (BW)		kg	78	Average male and female adults as per enHealth 2012
Averaging Time - NonThreshold (ATc)		days	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (ATn)		days	30.42	USEPA 1989 and CSMS 1996
Ingestion Rate (IRw)		L/day or L/hr	0.005	Assume Incidental ingestion of 5 ml (1 tsp) of water per day during fraccing.
Bioavailability (B)		-	100%	Assume 100% bioavailability via ingestion of chemicals in water.
Intake Factor = IRw*ET*B*EF*ED / BW*AT		L/kg/day	**4.2E-09** **3.5E-06**	**NonThreshold** **Threshold**

Daily Intake from Water = Concentration in Water x Intake Factor (ref: USEPA 1989)
NonThreshold Risk = Daily Intake from Water for NonThreshold Effects x Slope Factor
Hazard Quotients = (Daily Intake from Water for Threshold Effects/ADI)

CAS	Chemical	Toxicity Data: Non-Threshold Slope Factor	Toxicity Data: Chronic Threshold TDI	Toxicity Data: Background Intake (% Chronic TDI)	Toxicity Data: Chronic TDI Allowable for Assessment (TDI-Background)	Concentration in Water	Daily Intake: NonThreshold	Daily Intake: Threshold	Calculated Risk: NonThreshold Risk	Calculated Risk: Chronic Hazard Quotient
		(mg/kg-day)$^{-1}$	(mg/kg/day)		(mg/kg/day)	(mg/L)	(mg/kg/day)	(mg/kg/day)	(unitless)	(unitless)
68909-77-3	Ethanol, 2,2'-oxybis-, reaction products with ammonia, morpholi		1.0E+01		1.0E+01	2285.60	9.6E-06	8.0E-03	--	8.0E-04
64742-47-8	Hydrotreated light petroleum distillate		1.0E+01		1.0E+01	60.00	2.5E-07	2.1E-04	--	2.1E-05
111-30-8	Glutaraldehyde		4.0E-02		4.0E-02	357.13	1.5E-06	1.3E-03	--	3.1E-02
								Total Risk (mixture)		**3.22E-02**

Note:
This scenario is deemed protective of the following scenarios due to the less frequent and short duration of exposures:
- Worker exposure during a spill (i.e.a couple breaks on a tank and releases product onto the worker) or leak scenarios

Dermal Exposure to Chemicals via Contact with Flow Back Water - Newpark Recipe

Chronic Exposures

General Data/ Equations	Units	Exposure Calculations (RME) Dermal Contact with Flow Back Water by Workers	
Exposure Parameters			
Exposure Frequency (EF)	days/year	20	Assume work 5 days per week for 1 month during the fraccing period
Exposure Duration (ED)	years	0.083	Maximum duration of the frac. Works will be complete in one month.
Body Weight (BW)	kg	78	Average male and female adults as per enHealth 2012
Averaging Time - NonThreshold (ATc)	days	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (ATn)	days	30.42	USEPA 1989 and CSMS 1996
Surface Area (SAw)	cm^2	2300	Hands and forearms exposed (enHealth 2012) Occupational HSE would require long pants and closed shoes on Australian work sites; forearms conservatively included
Exposure Time (ET)	hr/day	1	Assume contact with flow back water for 1 hours per day
Conversion Factor (CF)	L/cm^3	1.E-03	Conversion of units
Intake Factor = SAw*ET*CF*EF*ED / BW*AT	L-hr/(cm-kg-day)	**1.9E-06** **1.6E-03**	**NonThreshold** **Threshold**

Daily Intake from Water = Concentration in Water x Dermal Permeability x Intake Factor (ref: USEPA 1989, 2004)
NonThreshold Risk = Daily Intake from Water for NonThreshold Effects x Slope Factor
Hazard Quotients = (Daily Intake from Water for Threshold Effects/ADI)

CAS	Chemical	Toxicity Data				Dermal Permeability	Concentration in Water	Daily Intake		Calculated Risk	
		Non-Threshold Slope Factor	Chronic Threshold TDI	Background Intake (% chronic TDI)	Chronic TDI Allowable for Assessment (TDI-Background)			NonThreshold	Threshold	NonThreshold Risk	Chronic Hazard Quotient
		$(mg/kg\text{-}day)^{-1}$	(mg/kg/day)		(mg/kg/day)	(cm/hr)	(mg/L)	(mg/kg/day)	(mg/kg/day)	(unitless)	(unitless)
68909-77-3	Ethanol, 2,2'-oxybis-, reaction products with ammonia, morpholine de		1.0E+01		1.0E+01	1.4E-6	2285.60	6.1E-09	5.1E-06	--	5.10E-07
64742-47-8	Hydrotreated light petroleum distillate		1.0E+01		1.0E+01	2.0E+0	60.00	2.3E-04	1.9E-01	--	1.90E-02
111-30-8	Glutaraldehyde		4.0E-02		4.0E-02	3.3E-4	357.13	2.2E-07	1.9E-04	--	4.69E-03
									Total Risk (mixture)		**2.37E-02**

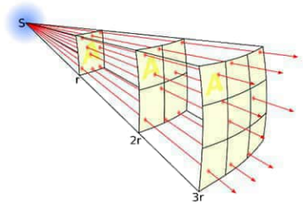
Note:
This scenario is deemed protective of the following scenarios due to the less frequent and short duration of exposures:
- Worker exposure during a spill (i.e.a couple breaks on a tank and releases product onto the worker) or leak scenarios

Aerosol Exposure - Newpark Recipe

The concentration of COPC in aerosol spray was estimated by calculating the concentration for driftable droplets using a mixed box model in which steady state concentrations
An emission factor for driftable aerosol was estimated using the algorithm presented below.

Emission Factor for Driftable Aerosol Algorithm

$$Emission\ Factor_{driftable\ aerosol}\left(\frac{L}{m^3}\right) = \frac{Box\ Centre^2(m) \times \left(\frac{Spray\ Vol\ \left(\frac{L}{hr}\right) \times Aerosol_{driftable}(\%)}{BoxVR\ \left(\frac{m^3}{hr}\right)}\right)}{BoxDistance^2\ (m)}$$



Aerosol Exposure Modelling Notes:

1) The inhalation of chemicals in mist/aerosol resultant from irrigation activities is dependent upon the concentration in water, the amount of water used per unit time, how close a person stands to the spray generation, how long they are in a position of exposure and the extent of spray drift (determined by the size of the water droplets and speed/direction of the wind). These equations are applicable for non-volatile contaminants that are inhaled.

2) These equations calculate the concentration for driftable droplets using a simple well mixed box model in which steady state air concentrations are calculated. The 'Inverse square law' is then applied to approximate the air concentration at a distance from the virtual air box. This law assumes the further away a receptor is from the spray source, the density of the droplets will decrease. The density of the spray droplets is inversely proportional to the square of the distance from the source.

Parameter	Units	Value	Description
Spray box length	m	3	Assume a 'spray box' of 3 m long.
Spray box width	m	3	Assume a 'spray box' of 3 m wide.
Box Centre	m	1.5	Distance to centre of box is 1.5 m.
$Box_{Distance}$	m	2	Distance the irrigation worker is from the 'spray box'. Assumed a distance of 2 m.
$Aerosol_{driftable}$	unitless	0.2	Proportion of aerosol spray that drifts outside the 'spray box' and available for exposure. Assumed 0.2, based on a droplet size of 400 – 500 µm that falls approximately 0.3 m in less than 10 seconds, with a lateral drift of approximately 3.5 m in a 5 km/hr wind (i.e. a light breeze) (Grisso et al. 2013).
Spray Volume	L/hr	1800.0	1800 L/min, irrigation value adopted from NZ MtE (2011) Appendix 5A.
Wind speed	m/hr	9000	Based on windspeed of 2.5 m/sec
BoxVR	m^3/hr	81000.0	Ventilation rate of spray in the 'spray box'. Assumed to be 81,000 m3/hr based on a wind speed of 9000 m/hr, and a 'spray box' dimension of 3 x 3 m.

CAS	Chemical	Concentration in Water mg/L	Generation rate of chemical in volume mg/hr	Driftable Aerosol Emission Factor L/m^3
68909-77-3	Ethanol, 2,2'-oxybis-, reaction products with	2285.60	822816	2.500000E-03
64742-47-8	Hydrotreated light petroleum distillate	60.00	21600	2.500000E-03
111-30-8	Glutaraldehyde	357.13	128565	2.500000E-03

Exposure to Chemicals via Inhalation of Mist from the Evaporation Units - Newpark Recipe

Chronic Exposures

General Data/ Equations	Units	Exposure Calculations (RME) Inhalation of Mist by Workers	
Exposure Parameters			
Exposure Frequency (EF)	days/year	240	Exposure for 5 days per week minus 4 weeks holidays
Exposure Duration (ED)	years	1	Maximum duration that the flowback tank will be on-site
Exposure Time (ET)	hr/day	1	Professional judgement for irrigation exposure. Assume worker to be near tank for 1 hours every working day.
Driftable aerosol emission factor (EMF)	L/m3	2.50E-03	Calculated
Aerosol Inhalation Bioavailability (AAF)	unitless	1.0	Assume 100% bioavailability
Averaging Time - Threshold (AT)	years	1.000	USEPA 1989 and CSMS 1996
$ITF_{inh,w,shwr} = \frac{EmF \times AAF \times ET_{iw} \times EF \times ED}{365\ \frac{days}{year} \times 24\ \frac{hours}{day} \times AT}$			

Daily Intake = Concentration in Water x Intake Factor (ref: USEPA 1989)
Hazard Quotients = (Daily Intake from Water for Threshold Effects/ADI)

CAS	Chemical	Groundwater Concentration	Aerosol Inhalation Bioavailability	Driftable Aerosol Emission Factor	RfC (Background Corrected)	Threshold Intake and Risk Calculations: Adult Exposure Factor (threshold)	Adult Exposure Adjusted Air Concentration (threshold)	Hazard Index (Adult)
		mg/L	(unitless)	(L/m^3)	(mg/m^3)	(L/m^3)	(mg/m^3)	(unitless)
68909-77-3	Ethanol, 2,2'-oxybis-, reaction products with ammoni	2.29E+03	1.00	2.50E-03	3.50E+01	6.85E-05	1.57E-01	4.47E-03
64742-47-8	Hydrotreated light petroleum distillate	6.00E+01	1.00	2.50E-03	3.50E+01	6.85E-05	4.11E-03	1.17E-04
111-30-8	Glutaraldehyde	3.57E+02	1.00	2.50E-03	1.40E-01	6.85E-05	2.45E-02	1.75E-01
							Total Risk (mixture)	**1.79E-01**

Summary of Risk to Workers - Newpark Recipe
Exposure fo Target Chemicals - Theoretical Data

Receptor/Exposure Pathway	Calculated HI 100% Mass Return
Use of Stimulation Fluid in Hydraulic Fracturing	
HVFR Recipe	
Workers	
Ingestion of Chemicals via Incidental Contact with Flowback Water	3.2E-02
Dermal Exposure to Chemicals via Incidental Contact with Flowback Water	2.4E-02
Inhalation of mist from the evaporation units	1.8E-01
Total Risk	**2.4E-01**

Appendix F

Chemical Risk Assessment - Tracers

Human Health Screening Assessment
Chemical Tracers

Tracer Name	Concentration in Injected Fluid (mg/L)	Ecotoxicity	Toxicity	Persistence	Bioaccummulative	Tier 1 Screening Assessment	Tier 2 Assessment Worker Ingestion Risk	Tier 2 Assessment Worker Dermal Risk	Tier 2 Assessment Worker Aerosol Inhalation Risk	Hazard Quotient	Outcome of Tier 2 Worker Risk Assessment[1]
CFT (20 chemicals)	0.75	Algae EC50 = 33.1 mg/L Fish LC50 = 44.6 mg/L Daphnia EC50 > 100 mg/L Algae EC10 = 3.4 mg/L Fish NOEC 28 d = 120 mg/L Daphnia NOEC 21 d = 25 mg/L	Based on chronic: Low	Expected to be readily biodegradable	No based on calculated log Kow of 1.87	Tier 2	3.19E-06	1.01E-05	1.78E-05	3.11E-05	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
GFT (15 chemicals)	1.35	Fish 96h LC50 > 100 mg/L Invertebrates 48h EC50 > 0.1 mg/L Microorganism 3h EC50 > 100 mg/L Fish 96h NOEC = 1000 mg/L	Based on chronic: Low	Not readily biodegradable	Yes based on calculated log Kow of > 4.5	Tier 2	4.74E-06	1.04E-03	2.64E-05	1.08E-03	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
WFT (1 chemical)	200,000	LC50 fish (96 h) > 120 mg/L EC50 daphnia (48h) > 125 mg/L EC50 plants (48h) > 125 mg/L	Based on acute: Low	Not readily biodegradable	No based on log Kow of -10.7	Tier 2	2.34E-01	1.23E-02	NA. Not volatile	2.46E-01	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
WFT (1 chemical)	200,000	Fish 96 h LC50 = 87 mg/L Daphnia 48 h EC50 = 182 mg/L Algae ErC50 > 100 mg/L	Based on acute: Low	Expected to be readily biodegradable	No based on log Kow of 0.07	Tier 2	7.02E-02	6.66E-12	NA. Not volatile	7.02E-02	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).

Toxicity and Dermal Absorption Parameters

C = calculated from chronic value, Ch = chronic value adopted

CAS#	Chemical	Oral/Dermal Exposures				Inhalation Exposures									
		Threshold Chronic TDI or RfD (mg/kg/day)		Dermal Permeability (cm/hr)	Reference	Inhalation Unit Risk $(ug/m^3)^{-1}$	Non-Threshold Slope Factor $(mg/kg/day)^{-1}$		Threshold Chronic TC or RfC (mg/m^3)		NOAEC or LOAEC (mg/m^3)	NOAEL or LOAEL (mg/kg bw/d)	Reference	UF	Reference
	COPC in Hydraulic Fracturing Fluid Injected into Well														
	CFT	0.825	D	6.88E-03	EPI				2.8875	converted from RFD		825.0	OECD (2004)	1000	D
	GFT	1	D	4.79E-01	EPI				3.5	converted from RFD		1000	REACH	1000	D
	WFT	3	EFSA	1.14E-04	EPI				-	Not volatile		-	-	-	-
	WFT	10	JECFA	2.06E-13	EPI				-	Not volatile		-	-	-	-

Notes:

A - Read across data from Boric Acid

B - Read across data from Alcohol ethoxylates C6-C12

C - Read across data from Sodium Sulfite

References:

D - Derived (refer to individual Toxicity Profiles)

EFSA - European Food Safety Authority

EPI - USEPA Estimation Programs Interface (EPI) Suite

FSANZ - Food Standards Australia New Zealand

J- JECFA - Joint FAO/WHO Expert Committee on Food Additives

NICNAS - National Industrial Chemicals Notification and Assessment Scheme. Assessed at https://www.nicnas.gov.au/

NICNAS (2017) - Department of the Environment and Energy 2017 , National assessment of chemicals associatedwith coal seam gas extraction in Australia, prepared by the National Industrial ChemicalsNotification and Assessment Scheme

NTP - US Department of Health and Serices National Toxicology Program

OECD - Organisation for Economic Co-operation and Development Screening Information Data Set (SIDS)

REACH - ECHA REACH European Chemicals Agency Database: http://apps.echa.europa.eu

Exposure to Chemicals via Incidental Ingestion of Flowback fluid - CFT

Chronic Exposures

General Data/ Equations	Units	Exposure Calculations (RME) Ingestion of Flowback Water by Workers	
Exposure Parameters			
Exposure Frequency (EF)	days/year	20	Assume work 5 days per week for 1 month during the fraccing period
Exposure Duration (ED)	years	0.083	Maximum duration of the frac. Works will be complete in one month.
Body Weight (BW)	kg	78	Average male and female adults as per enHealth 2012
Averaging Time - NonThreshold (ATc)	days	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (ATn)	days	30.42	USEPA 1989 and CSMS 1996
Ingestion Rate (IRw)	L/day or L/hr	0.005	Assume Incidental ingestion of 5 ml (1 tsp) of water per day during fraccing.
Bioavailability (B)	-	100%	Assume 100% bioavailability via ingestion of chemicals in water.
Intake Factor = IRw*ET*B*EF*ED / BW*AT	L/kg/day	**4.2E-09** **3.5E-06**	**NonThreshold** **Threshold**

Daily Intake from Water = Concentration in Water x Intake Factor (ref: USEPA 1989)
NonThreshold Risk = Daily Intake from Water for NonThreshold Effects x Slope Factor
Hazard Quotients = (Daily Intake from Water for Threshold Effects/ADI)

Chemical	Toxicity Data: Non-Threshold Slope Factor	Toxicity Data: Chronic Threshold TDI	Toxicity Data: Background Intake (% Chronic TDI)	Toxicity Data: Chronic TDI Allowable for Assessment (TDI-Background)	Concentration in Water	Daily Intake: NonThreshold	Daily Intake: Threshold	Calculated Risk: NonThreshold Risk	Calculated Risk: Chronic Hazard Quotient
	$(mg/kg\text{-}day)^{-1}$	(mg/kg/day)		(mg/kg/day)	(mg/L)	(mg/kg/day)	(mg/kg/day)	(unitless)	(unitless)
CFT		8.3E-01		8.3E-01	0.75	3.1E-09	2.6E-06	--	3.2E-06
							Total Risk (mixture)	**--**	**3.19E-06**

Note:
This scenario is deemed protective of the following scenarios due to the less frequent and short duration of exposures:
- Worker exposure during a spill (i.e.a couple breaks on a tank and releases product onto the worker) or leak scenarios

Dermal Exposure to Chemicals via Contact with Flow Back Water - CFT

Chronic Exposures

General Data/ Equations	Units	Exposure Calculations (RME) Dermal Contact with Flow Back Water by Workers	
Exposure Parameters			
Exposure Frequency (EF)	days/year	20	Assume work 5 days per week for 1 month during the fraccing period
Exposure Duration (ED)	years	0.083	Maximum duration of the frac. Works will be complete in one month.
Body Weight (BW)	kg	78	Average male and female adults as per enHealth 2012
Averaging Time - NonThreshold (ATc)	days	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (ATn)	days	30.42	USEPA 1989 and CSMS 1996
Surface Area (SAw)	cm^2	2300	Hands and forearms exposed (enHealth 2012) Occupational HSE would require long pants and closed shoes on Australian work sites; forearms conservatively included
Exposure Time (ET)	hr/day	1	Assume contact with flow back water for 1 hours per day
Conversion Factor (CF)	L/cm^3	1.E-03	Conversion of units
Intake Factor = $\frac{SAw*ET*CF*EF*ED}{BW*AT}$	L-hr/(cm-kg-day)	**1.9E-06** **1.6E-03**	**NonThreshold** **Threshold**

Daily Intake from Water = Concentration in Water x Dermal Permeability x Intake Factor (ref: USEPA 1989, 2004)
NonThreshold Risk = Daily Intake from Water for NonThreshold Effects x Slope Factor
Hazard Quotients = (Daily Intake from Water for Threshold Effects/ADI)

Chemical	Toxicity Data				Dermal Permeability	Concentration in Water	Daily Intake		Calculated Risk	
	Non-Threshold Slope Factor	Chronic Threshold TDI	Background Intake (% chronic TDI)	Chronic TDI Allowable for Assessment (TDI-Background)			NonThreshold	Threshold	NonThreshold Risk	Chronic Hazard Quotient
	$(mg/kg\text{-}day)^{-1}$	(mg/kg/day)		(mg/kg/day)	(cm/hr)	(mg/L)	(mg/kg/day)	(mg/kg/day)	(unitless)	(unitless)
CFT		8.3E-01		8.3E-01	6.9E-3	0.75	9.9E-09	8.3E-06	--	1.0E-05
								Total Risk (mixture)		**1.01E-05**

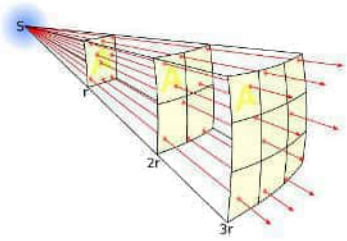
Note:
This scenario is deemed protective of the following scenarios due to the less frequent and short duration of exposures:
- Worker exposure during a spill (i.e.a couple breaks on a tank and releases product onto the worker) or leak scenarios

Aerosol Exposure - CFT

The concentration of COPC in aerosol spray was estimated by calculating the concentration for driftable droplets using a mixed box model in which steady state
An emission factor for driftable aerosol was estimated using the algorithm presented below.

Emission Factor for Driftable Aerosol Algorithm

$$Emission\ Factor_{driftable\ aerosol}\ \left(\frac{L}{m^3}\right) = \frac{Box\ Centre^2(m) \times \left(\frac{Spray\ Vol\ \left(\frac{L}{hr}\right) \times Aerosol_{driftable}(\%)}{BoxVR\ \left(\frac{m^3}{hr}\right)}\right)}{BoxDistance^2\ (m)}$$



Aerosol Exposure Modelling Notes:

1) The inhalation of chemicals in mist/aerosol resultant from irrigation activities is dependent upon the concentration in water, the amount of water used per unit time, how close a person stands to the spray generation, how long they are in a position of exposure and the extent of spray drift (determined by the size of the water droplets and speed/direction of the wind). These equations are applicable for non-volatile contaminants that are inhaled.

2) These equations calculate the concentration for driftable droplets using a simple well mixed box model in which steady state air concentrations are calculated. The 'Inverse square law' is then applied to approximate the air concentration at a distance from the virtual air box. This law assumes the further away a receptor is from the spray source, the density of the droplets will decrease. The density of the spray droplets is inversely proportional to the square of the distance from the source.

Parameter	Units	Value	Description
Spray box length	m	3	Assume a 'spray box' of 3 m long.
Spray box width	m	3	Assume a 'spray box' of 3 m wide.
Box Centre	m	1.5	Distance to centre of box is 1.5 m.
$Box_{Distance}$	m	2	Distance the irrigation worker is from the 'spray box'. Assumed a distance of 2 m.
$Aerosol_{driftable}$	unitless	0.2	Proportion of aerosol spray that drifts outside the 'spray box' and available for exposure. Assumed 0.2, based on a droplet size of 400 – 500 µm that falls approximately 0.3 m in less than 10 seconds, with a lateral drift of approximately 3.5 m in a 5 km/hr wind (i.e. a light breeze) (Grisso et al. 2013).
Spray Volume	L/hr	1800.0	1800 L/min, irrigation value adopted from NZ MtE (2011) Appendix 5A.
Wind speed	m/hr	9000	Based on windspeed of 2.5 m/sec
BoxVR	m^3/hr	81000.0	Ventilation rate of spray in the 'spray box'. Assumed to be 81,000 m3/hr based on a wind speed of 9000 m/hr, and a 'spray box' dimension of 3 x 3 m.

CAS	Chemical	Concentration in Water	Generation rate of chemical in volume	Driftable Aerosol Emission Factor
		mg/L	mg/hr	L/m^3
	CFT	0.75	270	2.500000E-03

Exposure to Chemicals via Inhalation of Mist from the Evaporation Units - CFT

Chronic Exposures

General Data/ Equations	Units	Exposure Calculations (RME) Inhalation of Mist by Workers	
Exposure Parameters			
Exposure Frequency (EF)	days/year	240	Exposure for 5 days per week minus 4 weeks holidays
Exposure Duration (ED)	years	1	Maximum duration that the flowback tank will be on-site
Exposure Time (ET)	hr/day	1	Professional judgement for irrigation exposure. Assume worker to be near tank for 1 hours every working day.
Driftable aerosol emission factor (EMF)	L/m3	2.50E-03	Calculated
Aerosol Inhalation Bioavailability (AAF)	unitless	1.0	Assume 100% bioavailability
Averaging Time - Threshold (AT)	years	1.0	USEPA 1989 and CSMS 1996
$ITF_{inh,w,shwr} = \frac{EmF \times AAF \times ET_{iw} \times EF \times ED}{365\ \frac{days}{year} \times 24\ \frac{hours}{day} \times AT}$			

Daily Intake = Concentration in Water x Intake Factor (ref: USEPA 1989)
Hazard Quotients = (Daily Intake from Water for Threshold Effects/ADI)

						Threshold Intake and Risk Calculations		
CAS	Chemical	Groundwater Concentration	Aerosol Inhalation Bioavailability	Driftable Aerosol Emission Factor	RfC (Background Corrected)	Adult Exposure Factor (threshold)	Adult Exposure Adjusted Air Concentration (threshold)	Hazard Index (Adult)
		mg/L	(unitless)	(L/m^3)	(mg/m^3)	(L/m^3)	(mg/m^3)	(unitless)
	CFT	0.8	1.00	2.50E-03	2.89E+00	6.85E-05	5.14E-05	1.78E-05
							Total Threshold Risk (mixture)	**1.78E-05**

Exposure to Chemicals via Incidental Ingestion of Flowback fluid - GFT

Chronic Exposures

General Data/ Equations	Units	Exposure Calculations (RME) Ingestion of Flowback Water by Workers	
Exposure Parameters			
Exposure Frequency (EF)	days/year	20	Assume work 5 days per week for 1 month during the fraccing period
Exposure Duration (ED)	years	0.083	Maximum duration of the frac. Works will be complete in one month.
Body Weight (BW)	kg	78	Average male and female adults as per enHealth 2012
Averaging Time - NonThreshold (ATc)	days	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (ATn)	days	30.42	USEPA 1989 and CSMS 1996
Ingestion Rate (IRw)	L/day or L/hr	0.005	Assume Incidental ingestion of 5 ml (1 tsp) of water per day during fraccing.
Bioavailability (B)	-	100%	Assume 100% bioavailability via ingestion of chemicals in water.
Intake Factor = IRw*ET*B*EF*ED / BW*AT	L/kg/day	**4.2E-09** **3.5E-06**	**NonThreshold** **Threshold**

Daily Intake from Water = Concentration in Water x Intake Factor (ref: USEPA 1989)
NonThreshold Risk = Daily Intake from Water for NonThreshold Effects x Slope Factor
Hazard Quotients = (Daily Intake from Water for Threshold Effects/ADI)

Chemical	Toxicity Data: Non-Threshold Slope Factor	Toxicity Data: Chronic Threshold TDI	Toxicity Data: Background Intake (% Chronic TDI)	Chronic TDI Allowable for Assessment (TDI-Background)	Concentration in Water	Daily Intake: NonThreshold	Daily Intake: Threshold	Calculated Risk: NonThreshold Risk	Calculated Risk: Chronic Hazard Quotient
	$(mg/kg\text{-}day)^{-1}$	(mg/kg/day)		(mg/kg/day)	(mg/L)	(mg/kg/day)	(mg/kg/day)	(unitless)	(unitless)
GFT		1.0E+00		1.0E+00	1.35	5.6E-09	4.7E-06	--	4.7E-06
							Total Risk (mixture)	**--**	**4.74E-06**

Note:
This scenario is deemed protective of the following scenarios due to the less frequent and short duration of exposures:
- Worker exposure during a spill (i.e.a couple breaks on a tank and releases product onto the worker) or leak scenarios

Dermal Exposure to Chemicals via Contact with Flow Back Water - GFT

Chronic Exposures

General Data/ Equations	Units	Exposure Calculations (RME) Dermal Contact with Flow Back Water by Workers	
Exposure Parameters			
Exposure Frequency (EF)	days/year	20	Assume work 5 days per week for 1 month during the fraccing period
Exposure Duration (ED)	years	0.083	Maximum duration of the frac. Works will be complete in one month.
Body Weight (BW)	kg	78	Average male and female adults as per enHealth 2012
Averaging Time - NonThreshold (ATc)	days	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (ATn)	days	30.42	USEPA 1989 and CSMS 1996
Surface Area (SAw)	cm^2	2300	Hands and forearms exposed (enHealth 2012) Occupational HSE would require long pants and closed shoes on Australian work sites; forearms conservatively included
Exposure Time (ET)	hr/day	1	Assume contact with flow back water for 1 hours per day
Conversion Factor (CF)	L/cm^3	1.E-03	Conversion of units
Intake Factor = $\frac{SAw*ET*CF*EF*ED}{BW*AT}$	L-hr/(cm-kg-day)	**1.9E-06** **1.6E-03**	**NonThreshold** **Threshold**

Daily Intake from Water = Concentration in Water x Dermal Permeability x Intake Factor (ref: USEPA 1989, 2004)
NonThreshold Risk = Daily Intake from Water for NonThreshold Effects x Slope Factor
Hazard Quotients = (Daily Intake from Water for Threshold Effects/ADI)

Chemical	Toxicity Data				Dermal Permeability	Concentration in Water	Daily Intake		Calculated Risk	
	Non-Threshold Slope Factor	Chronic Threshold TDI	Background Intake (% chronic TDI)	Chronic TDI Allowable for Assessment (TDI-Background)			NonThreshold	Threshold	NonThreshold Risk	Chronic Hazard Quotient
	$(mg/kg\text{-}day)^{-1}$	(mg/kg/day)		(mg/kg/day)	(cm/hr)	(mg/L)	(mg/kg/day)	(mg/kg/day)	(unitless)	(unitless)
GFT		1.0E+00		1.0E+00	4.8E-1	1.35	1.2E-06	1.0E-03	--	1.04E-03
								Total Risk (mixture)		**1.0E-03**

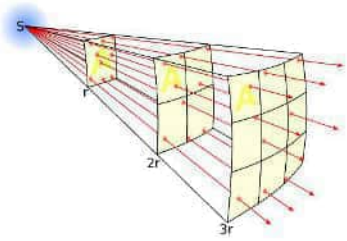
Note:
This scenario is deemed protective of the following scenarios due to the less frequent and short duration of exposures:
- Worker exposure during a spill (i.e.a couple breaks on a tank and releases product onto the worker) or leak scenarios

Aerosol Exposure - GFT

The concentration of COPC in aerosol spray was estimated by calculating the concentration for driftable droplets using a mixed box model in which steady state
An emission factor for driftable aerosol was estimated using the algorithm presented below.

Emission Factor for Driftable Aerosol Algorithm

$$Emission\ Factor_{driftable\ aerosol}\ \left(\frac{L}{m^3}\right) = \frac{Box\ Centre^2(m) \times \left(\frac{Spray\ Vol\ \left(\frac{L}{hr}\right) \times Aerosol_{driftable}(\%)}{BoxVR\ \left(\frac{m^3}{hr}\right)}\right)}{BoxDistance^2\ (m)}$$



Aerosol Exposure Modelling Notes:

1) The inhalation of chemicals in mist/aerosol resultant from irrigation activities is dependent upon the concentration in water, the amount of water used per unit time, how close a person stands to the spray generation, how long they are in a position of exposure and the extent of spray drift (determined by the size of the water droplets and speed/direction of the wind). These equations are applicable for non-volatile contaminants that are inhaled.

2) These equations calculate the concentration for driftable droplets using a simple well mixed box model in which steady state air concentrations are calculated. The 'Inverse square law' is then applied to approximate the air concentration at a distance from the virtual air box. This law assumes the further away a receptor is from the spray source, the density of the droplets will decrease. The density of the spray droplets is inversely proportional to the square of the distance from the source.

Parameter	Units	Value	Description
Spray box length	m	3	Assume a 'spray box' of 3 m long.
Spray box width	m	3	Assume a 'spray box' of 3 m wide.
Box Centre	m	1.5	Distance to centre of box is 1.5 m.
$Box_{Distance}$	m	2	Distance the irrigation worker is from the 'spray box'. Assumed a distance of 2 m.
$Aerosol_{driftable}$	unitless	0.2	Proportion of aerosol spray that drifts outside the 'spray box' and available for exposure. Assumed 0.2, based on a droplet size of 400 – 500 µm that falls approximately 0.3 m in less than 10 seconds, with a lateral drift of approximately 3.5 m in a 5 km/hr wind (i.e. a light breeze) (Grisso et al. 2013).
Spray Volume	L/hr	1800.0	1800 L/min, irrigation value adopted from NZ MtE (2011) Appendix 5A.
Wind speed	m/hr	9000	Based on windspeed of 2.5 m/sec
BoxVR	m^3/hr	81000.0	Ventilation rate of spray in the 'spray box'. Assumed to be 81,000 m3/hr based on a wind speed of 9000 m/hr, and a 'spray box' dimension of 3 x 3 m.

CAS	Chemical	Concentration in Water	Generation rate of chemical in volume	Driftable Aerosol Emission Factor
		mg/L	mg/hr	L/m^3
	GFT	1.35	486	2.500000E-03

Exposure to Chemicals via Inhalation of Mist from the Evaporation Units - GFT

Chronic Exposures

General Data/ Equations	Units	Exposure Calculations (RME) Inhalation of Mist by Workers	
Exposure Parameters			
Exposure Frequency (EF)	days/year	240	Exposure for 5 days per week minus 4 weeks holidays
Exposure Duration (ED)	years	1	Maximum duration that the flowback tank will be on-site
Exposure Time (ET)	hr/day	1	Professional judgement for irrigation exposure. Assume worker to be near tank for 1 hours every working day.
Driftable aerosol emission factor (EMF)	L/m3	2.50E-03	Calculated
Aerosol Inhalation Bioavailability (AAF)	unitless	1.0	Assume 100% bioavailability
Averaging Time - Threshold (AT)	years	1.0	USEPA 1989 and CSMS 1996
$ITF_{inh,w,shwr} = \frac{EmF \times AAF \times ET_{iw} \times EF \times ED}{365\ \frac{days}{year} \times 24\ \frac{hours}{day} \times AT}$			

Daily Intake = Concentration in Water x Intake Factor (ref: USEPA 1989)
Hazard Quotients = (Daily Intake from Water for Threshold Effects/ADI)

						Threshold Intake and Risk Calculations		
CAS	Chemical	Groundwater Concentration	Aerosol Inhalation Bioavailability	Driftable Aerosol Emission Factor	RfC (Background Corrected)	Adult Exposure Factor (threshold)	Adult Exposure Adjusted Air Concentration (threshold)	Hazard Index (Adult)
		mg/L	(unitless)	(L/m^3)	(mg/m^3)	(L/m^3)	(mg/m^3)	(unitless)
64742-47-8	GFT	1.4	1.00	2.50E-03	3.50E+00	6.85E-05	9.25E-05	2.64E-05
							Total Threshold Risk (mixture)	**2.64E-05**

Exposure to Chemicals via Incidental Ingestion of Flowback fluid - WFT

Chronic Exposures

General Data/ Equations	Units	Exposure Calculations (RME) Ingestion of Flowback Water by Workers	
Exposure Parameters			
Exposure Frequency (EF)	days/year	20	Assume work 5 days per week for 1 month during the fraccing period
Exposure Duration (ED)	years	0.083	Maximum duration of the frac. Works will be complete in one month.
Body Weight (BW)	kg	78	Average male and female adults as per enHealth 2012
Averaging Time - NonThreshold (ATc)	days	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (ATn)	days	30.42	USEPA 1989 and CSMS 1996
Ingestion Rate (IRw)	L/day or L/hr	0.005	Assume Incidental ingestion of 5 ml (1 tsp) of water per day during fraccing.
Bioavailability (B)	-	100%	Assume 100% bioavailability via ingestion of chemicals in water.
Intake Factor = IRw*ET*B*EF*ED / BW*AT	L/kg/day	**4.2E-09** **3.5E-06**	**NonThreshold** **Threshold**

Daily Intake from Water = Concentration in Water x Intake Factor (ref: USEPA 1989)
NonThreshold Risk = Daily Intake from Water for NonThreshold Effects x Slope Factor
Hazard Quotients = (Daily Intake from Water for Threshold Effects/ADI)

Chemical	Toxicity Data: Non-Threshold Slope Factor	Toxicity Data: Chronic Threshold TDI	Toxicity Data: Background Intake (% Chronic TDI)	Chronic TDI Allowable for Assessment (TDI-Background)	Concentration in Water	Daily Intake: NonThreshold	Daily Intake: Threshold	Calculated Risk: NonThreshold Risk	Calculated Risk: Chronic Hazard Quotient
	$(mg/kg\text{-}day)^{-1}$	(mg/kg/day)		(mg/kg/day)	(mg/L)	(mg/kg/day)	(mg/kg/day)	(unitless)	(unitless)
WFT		3.0E+00		3.0E+00	200000	8.4E-04	7.0E-01	--	2.3E-01
WFT		1.0E+01		1.0E+01	200000	8.4E-04	7.0E-01	--	7.0E-02
							Total Risk (mixture)	**--**	**3.04E-01**

Note:
This scenario is deemed protective of the following scenarios due to the less frequent and short duration of exposures:
- Worker exposure during a spill (i.e.a couple breaks on a tank and releases product onto the worker) or leak scenarios

Dermal Exposure to Chemicals via Contact with Flow Back Water - WFT

Chronic Exposures

General Data/ Equations	Units	Exposure Calculations (RME) Dermal Contact with Flow Back Water by Workers	
Exposure Parameters			
Exposure Frequency (EF)	days/year	20	Assume work 5 days per week for 1 month during the fraccing period
Exposure Duration (ED)	years	0.083	Maximum duration of the frac. Works will be complete in one month.
Body Weight (BW)	kg	78	Average male and female adults as per enHealth 2012
Averaging Time - NonThreshold (ATc)	days	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (ATn)	days	30.42	USEPA 1989 and CSMS 1996
Surface Area (SAw)	cm^2	2300	Hands and forearms exposed (enHealth 2012) Occupational HSE would require long pants and closed shoes on Australian work sites; forearms conservatively included
Exposure Time (ET)	hr/day	1	Assume contact with flow back water for 1 hours per day
Conversion Factor (CF)	L/cm^3	1.E-03	Conversion of units
Intake Factor = SAw*ET*CF*EF*ED / BW*AT	L-hr/(cm-kg-day)	**1.9E-06** **1.6E-03**	**NonThreshold** **Threshold**

Daily Intake from Water = Concentration in Water x Dermal Permeability x Intake Factor (ref: USEPA 1989, 2004)
NonThreshold Risk = Daily Intake from Water for NonThreshold Effects x Slope Factor
Hazard Quotients = (Daily Intake from Water for Threshold Effects/ADI)

Chemical	Toxicity Data: Non-Threshold Slope Factor	Toxicity Data: Chronic Threshold TDI	Toxicity Data: Background Intake (% chronic TDI)	Chronic TDI Allowable for Assessment (TDI-Background)	Dermal Permeability	Concentration in Water	Daily Intake: NonThreshold	Daily Intake: Threshold	Calculated Risk: NonThreshold Risk	Calculated Risk: Chronic Hazard Quotient
	$(mg/kg\text{-}day)^{-1}$	(mg/kg/day)		(mg/kg/day)	(cm/hr)	(mg/L)	(mg/kg/day)	(mg/kg/day)	(unitless)	(unitless)
WFT		3.0E+00		3.0E+00	1.1E-4	200000.00	4.4E-05	3.7E-02	--	1.2E-02
WFT		1.0E+01		1.0E+01	2.1E-13	200000.00	7.9E-14	6.7E-11	--	6.7E-12
								Total Risk (mixture)		**1.23E-02**

Note:
This scenario is deemed protective of the following scenarios due to the less frequent and short duration of exposures:
- Worker exposure during a spill (i.e.a couple breaks on a tank and releases product onto the worker) or leak scenarios

Summary of Risk to Workers - Chemical Tracers
Exposure fo Target Chemicals - Theoretical Data

Receptor/Exposure Pathway	Calculated HI 100% Mass Return
Use of Chemical Tracers in Hydraulic Fracturing	
CFT Recipe	
Workers	
Ingestion of Chemicals via Incidental Contact with Flowback Water	0.0000032
Dermal Exposure to Chemicals via Incidental Contact with Flowback Water	0.000010
Inhalation of mist from the evaporation units	0.000018
Total Risk	**0.00003**
GFT Recipe	
Workers	
Ingestion of Chemicals via Incidental Contact with Flowback Water	0.0000047
Dermal Exposure to Chemicals via Incidental Contact with Flowback Water	0.0010
Inhalation of mist from the evaporation units	0.000026
Total Risk	**0.001**
WFT Recipe	
Workers	
Ingestion of Chemicals via Incidental Contact with Flowback Water	0.30
Dermal Exposure to Chemicals via Incidental Contact with Flowback Water	0.012
Inhalation of mist from the evaporation units	-
Total Risk	**0.3**

Appendix G

Toxicological Profiles for Halliburton and Schlumberger Recipes

Toxicity Summary - Prop-2-yn-1-ol

Chemical and Physical Properties [1,2]	
CAS number	107-19-7
Molecular formula	C3H4O
Molecular weight	56.06
Solubility in water	1,000 g/L at 20 °C
Melting point	-52 - -48 °C
Boiling point	112 - 115 °C at 101.325 - 101.33 kPa
Vapour pressure	10.84 - 66.37 hPa at 20 - 50 °C
Henrys law constant	0.117 Pa m^3/mol
Explosive potential	Non-explosive
Flammability potential	Flammable
Colour/Form	Colourless liquid with a mild geranium-like odour at 20°C and 1013.25 hPa
Overview	Prop-2-yn-1-ol or propargyl alcohol is a terminal acetylenic compound that is prop-2-yne substituted by a hydroxy group at position 1. It has a role as a Saccharomyces cerevisiae metabolite and an antifungal agent. It is a terminal acetylenic compound, a volatile organic compound and a propynol. It is used to make other chemicals, as a corrosion inhibitor and a soil fumigant.
Environmental Fate [2]	
Soil/Water/Air	Propargyl alcohol's production and use as a corrosion inhibitor, solvent stabilizer, and laboratory reagent may result in its release to the environment through various waste streams. Its former use as a soil fumigant would have resulted in its direct release to the environment. If released to air, an extrapolated vapuor pressure of 15.6 mm Hg at 25 °C indicates propargyl alcohol will exist solely as a vapour in the atmosphere. Vapour-phase propargyl alcohol will be degraded in the atmosphere by reaction with photochemically-produced hydroxyl radicals; the half-life for this reaction in air is estimated to be 37 hours. Propargyl alcohol can also be degraded in the atmosphere by reaction with ozone; however, the rate of this reaction is too slow to be environmentally relevant. Propargyl alcohol does not contain chromophores that absorb at wavelengths >290 nm and therefore is not expected to be susceptible to direct photolysis by sunlight. If released to soil, propargyl alcohol is expected to have very high mobility based upon an estimated Koc of 14. Volatilization from moist soil surfaces is expected to be an important fate process based upon an estimated Henry's Law constant of 1.1X10-6 atm-cu m/mole. Propargyl alcohol may volatilize from dry soil surfaces based upon its extrapolated vapour pressure. The biodegradation half-life of propargyl alcohol was 12.6 and 13 days in an alkaline sandy silt loam from Texas and an acidic sandy loam from Mississippi, respectively. If released into water, propargyl alcohol is not expected to adsorb to suspended solids and sediment based upon the estimated Koc. Volatilization from water surfaces is expected to be an important fate process based upon this compound's estimated Henry's Law constant. Estimated volatilization half-lives for a model river and model lake are 16 and 176 days, respectively. An estimated BCF of 3 suggests the potential for bioconcentration in aquatic organisms is low. Hydrolysis is not expected to be an important environmental fate process since this compound lacks functional groups that hydrolyze under environmental conditions.
Human Health Toxicity Summary [1,2]	
Chronic Repeated Dose Toxicity	The lowest NOAEL derived from repeated dose oral toxicity studies in rats (28-d and 90-d) was 5 mg/kg bw/d. A NOAEL (local and systemic) of 10-20 mg/kg bw/d (highest test dose) was derived from a subchronic dermal toxicity study in rabbits. From the results of repeated dose inhalation toxicity study in rats and mice a

	systemic NOAEC of 9.4 mg/m^3 (4 ppm), a subchronic local NOAEC of 4 ppm and a chronic local LOAEC of 8 ppm was established.
Carcinogenicity	Considering the incidences and distribution of the few benign neoplasms observed in rats and/or mice following 2-year inhalation exposure to Propargyl alcohol vapour, and with special regard to the very weak but still equivocal evidence of carcinogenic activity when referring to respiratory epithelial adenoma, adenomas are supposed to form solely as a reaction to the described sustained damage and inflammation of the respiratory epithelium. It is concluded that Propargyl alcohol has no carcinogenic potential overall.
Mutagenicity/ Genotoxicity	Propargyl alcohol is not genotoxic.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	Propargyl alcohol is not considered to cause toxicological relevant effects on fertility.
Acute Toxicity	The LD50/LC50 values derived from the key-studies were: LD50 (oral, rat) 56.4 mg/kg bw, LD50 (dermal, rabbit) 88 mg/kg bw, LC50 (2 h inhalation, rat) 2000 mg/m^3.
Irritation	Based on the results of the corresponding key studies, Propargyl alcohol is considered to be corrosive after application on skin (destruction of full thickness skin after >= 5 min exposure) and eye.
Sensitisation	Propargyl alcohol was not a skin sensitizer.
Health Effects Summary	Propargyl alcohol is considered to be toxic following acute oral, dermal or inhalation exposure.
Key Study/Critical Effect for Screening Criteria	The lowest NOAEL derived from repeated dose oral toxicity studies in rats (28-d and 90-d) of 5 mg/kg bw/d was considered the most sensitive endpoint.
Ecological Toxicity [1]	
Aquatic Toxicity	Acute tests on all three trophic levels were performed to examine the aquatic toxicity of Prop-2-yn-1-ol. Fish and aquatic invertebrates turned out to be the most sensitive species revealing an LC50 (96h) of 1.53 mg/L and an EC50 (48h) of 3.36 mg/L, respectively. Algae were found to be less sensitive than fish and invertebrates providing an ErC50 (72h) >100 mg/L. Thus, Prop-2-yn-1-ol is considered acutely toxic for aquatic organisms.
Determination of PNEC aquatic	Data from short-term tests with three trophic levels are available. An assessment factor of 1000 is applied to the lowest LC50 of 1.53 mg/L (fish). A PNECaqua of 0.002 mg/L was derived.
Current Regulatory Controls [2,3,4]	
Australian Hazard Classification	Flammable liquid – category 3 Acute toxicity – category 3 Acute toxicity – category 3 Acute toxicity – category 3 Hazardous to the aquatic environment (chronic) – category 2 Skin corrosion – category 1B
Australian Occupational Exposure Standards	No data available.
International Occupational Exposure Standards	10 Hr Time-Weighted Avg: 1 ppm (2 mg/cu m). Skin designation.
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	No data available.

PBT Assessment [1,2]	
P/vP Criteria fulfilled?	No. Expected to be readily biodegradable
B/vB criteria fulfilled?	No. As the Log KoW -0.35 @ 25 °C 59 (Log Pow < 4.5), it is not expected to be bioaccumulative.
T criteria fulfilled?	No. The acute EC50 of Prop-2-yn-1-ol is >1 mg/L in fish, invertebrates and algae. Therefore, it does not meet the screening criteria for toxicity.
Overall conclusion	Not PBT
Revised	April 2022

References

1. ECHA REACH, Prop-2-yn-1-ol. Retrieved 2021: https://echa.europa.eu/.
2. NCBI, 2022. National Center for Biotechnology Information. Available at: https://pubchem.ncbi.nlm.nih.gov/. Retrieved February 2022.
3. HCIS, Hazardous Chemical Information System, Safe Work Australia, Retrieved February 2022: http://hcis.safeworkaustralia.gov.au/HazardousChemical.
4. ILO, International Labour Organisation, International Chemical Safety Cards (ICSCs), Retrieved February 2022: http://www.ilo.org/dyn/icsc/showcard.listcards3?p_lang=en.

Toxicity Summary - Thiourea, polymer with formaldehyde and 1-phenylethanone

Chemical and Physical Properties [1,2]	
CAS number	68527-49-1
Molecular formula	C10H14N2O2S
Molecular weight	226.30
Solubility in water	No data available.
Melting point	No data available.
Boiling point	No data available.
Vapour pressure	No data available.
Henrys law constant	No data available.
Explosive potential	No data available.
Flammability potential	No data available.
Colour/Form	No data available.
Overview	In the absence of available data for thiourea, polymer with formaldehyde and 1-phenylethanone, the assessment on polymers containing formaldehyde monomers from NICNAS has been used in addition to read across data from Phenol, formaldehyde polymer (CAS 9003-35-4). The polymers in this group may be used in the production of formaldehyde resin products and non-resin consumer products such as cosmetics and household cleaning products. In these applications, the formaldehyde resin and/or products manufactured may contain free formaldehyde or may release some or all the formaldehyde they contain (formaldehyde donors). The hazardous properties of free formaldehyde or released formaldehyde are expected to dominate the toxicity profile of these polymers despite minor differences in individual solubility in biological system.
Environmental Fate	
Soil/Water/Air	Biodegradation experiment was conducted for determining the biodegradability of CAS 9003-35-4 (Tisler et al, 1997). The study was performed according to guideline ISO DIS 9408 (Ultimate Aerobic Biodegradability - Method by Determining the Oxygen Demand in a Closed Respirometer) under aerobic conditions. Settled municipal waste water was used as a test inoculum for the study. The percent degradation of test chemical was determined by using industrial waste water samples of test chemical and parameter used was biological oxygen demand. More than 60 % degradation was observed in 10 days of in diluted samples and 80% degradation observed in 10 days of diluted samples. On the basis of this percent degradability value, it is concluded that test chemical is readily biodegradable in nature. The Log Kow (Log Pow) was determined to be 2.8 @ 25 °C This log Koc value indicates that the test chemical has a moderate sorption to soil and sediment and therefore have slow migration potential to ground water.
Human Health Toxicity Summary [1,2,6]	
Chronic Repeated Dose Toxicity	Chronic toxicity oral study for the 50 -60% structurally and functionally similar read across test compounds were studied in male and female Osborne-Mendel rats. The test compounds was fed through the diet at a concentration of 0, 5000, 10000 or 20000 ppm (0, 250, 500 or 1000 mg/Kg bw) for 2 years. The animals were observed weekly for weight, food intake and general condition. Haematological examinations were made at termination. These examinations included white cell counts, red cell counts, haemoglobins and haematocrits. No effects were noted in the treated animals at the mentioned dose level. Based on the observations made, the no observed Adverse Effect Level (NOAEL) for the two test chemicals using Osborne-Mendel rats for a duration of 1 year is considered to be 1000 mg/Kg bw.

	Formaldehyde, oligomeric reaction products with phenol has very low vapour pressure of 3.186 Pa (0.0239 mmHg). Also, the test chemical has a particle size distribution of 53-150 micron, so the potential for the generation of inhalable vapours is very low.
Carcinogenicity	No data available.
Mutagenicity/ Genotoxicity	The data available for the target chemical based on its read across substance and applying weight of evidence Phenol-formaldehyde resin (9003-35-4) does not exhibit gene mutation in vitro. Hence the test chemical is not likely to classify as a gene mutant in vitro.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	Reproductive /chronic oral toxicity study for the CAS 9003-35-4 was performed on male and female Osborne-Mendel rats. 12 male and 12 female were used in each dose group. The test material was fed through the diet at a concentration of 0, 5000, 10000 or 20000 ppm (0, 250, 500 or 1000 mg/Kg bw) for 2 years. Animals were checked for clinical signs, Food consumption and body weight every week. At the termination of the experiments the rats were sacrificed and exsanguinated. The tissues of all the rats were examined macroscopically at the time of sacrifice. The viscera were removed and the liver, kidneys, spleen, heart, and testes were weighed. These organs, the remaining abdominal and thoracic viscera, and one hind leg, for bone, bone marrow, and muscle, were preserved in 10% buffered formalin-saline solution for histopathological examination. For routine histopathology, sections were embedded in paraffin wax and stained with haematoxylin and eosin.No treatment-related clinical signs and premature deaths were observed. No relevant necropsy findings were noted. No effects on testes weight was noted in treated rats at dose concentration 1000mg/kg bw, Based on the observations made, the no observed Adverse Effect Level (NOAEL) for the test chemical using Osborne-Mendel rats for a duration of 2 year is considered to be 1000 mg/Kg bw. Thus, comparing this value with the criteria of CLP regulation test material is not likely to classify as reproductive toxicant.
Acute Toxicity	The acute oral toxicity dose (LD50) was considered based on different studies conducted on rats and mice for the test chemical. The LD50 value is >5000 mg/kg bw, for acute oral toxicity. The acute Inhalation toxicity dose (LC50) was considered based on different studies conducted on rats and mice for the test chemical. The studies concluded that the LC50 value is >5 mg/L (>5000 mg/m^3), for acute inhalation toxicity. The acute dermal toxicity dose (LD50) was considered based on different studies conducted on rats and rabbits for the test chemical. The studies concluded that the LD50 value is >2000 mg/kg bw, for acute dermal toxicity.
Irritation	Breathing formaldehyde vapour can result in irritation of nerves in the eyes and nose, which may cause burning, stinging or itching sensations, a sore throat, teary eyes, blocked sinuses, runny nose, and sneezing.
Sensitisation	No data available.
Health Effects Summary	If the polymers in this group do not readily release free formaldehyde, none of the polymers are expected to have significant health effects. However, where the polymers in this group degrade to free formaldehyde or are capable of releasing formaldehyde, the critical health effects for risk characterisation include sensory irritation and allergic skin reactions.
Key Study/Critical Effect for Screening Criteria	There are no data available on the health hazards of the polymers in this group. However, it is considered that the formaldehyde released from the decomposition of these polymer resins will be the critical driver of toxicity. Sensory irritation is defined as irritation of the nerve endings in the eyes and nose and can produce symptoms such as stinging or burning sensations in the eyes, nose and/or a sore throat. The level of formaldehyde in the air at which these symptoms have been known to start to occur is 0.5 parts per million (ppm). The critical lowest No Observed Adverse Effect (NOAEL) level for the purposes of risk assessment is 1000 mg/kg bw/day from the 1 year repeated oral toxicity study.

Ecological Toxicity [3]	
Aquatic Toxicity	Based on aquatic toxicity data for formaldehyde: Fish: LC50 (96h) Morone saxatilis 6.18 mg/L LC50 (6d) embryos of Danio rerio 6.9 mg/L NOEC (28d) Oryzias latipes ≥ 48 mg/L Aquatic invertebrates: EC50 (48h) Daphnia pulex 5.8 mg/L NOEC (21 d) Daphnia magna > 6.4 mg/L Algae: EC50 (72h) Desmodesmus subspicatus 4.89 mg/L
Determination of PNEC aquatic	Data from short and long-term tests with three trophic levels are available. An assessment factor of 10 is applied to the lowest NOEC of 6.4 mg/L (invertebrates). A PNECaqua of 0.64 mg/L was derived.
Current Regulatory Controls [4,5]	
Australian Hazard Classification	No data available.
Australian Occupational Exposure Standards	Safe Work Australia has an exposure standard for formaldehyde. Where the polymers in this group contain free formaldehyde or release formaldehyde, exposure standards of 1.2 mg/m^3 (1 part per million) time weighted average (TWA) and 2.5 mg/m^3 (2 parts per million) short term exposure limit (STEL) apply.
International Occupational Exposure Standards	No data available.
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	No data available.
PBT Assessment [3]	
P/vP Criteria fulfilled?	No. Based on data for formaldehyde, the substance is expected to be biodegradable.
B/vB criteria fulfilled?	No. Based on data for formaldehyde, due to the low log Kow (0.35), accumulation in organisms is not to be expected.
T criteria fulfilled?	No. Based on data for formaldehyde, the acute and chronic toxicity is >1 mg/L in fish, invertebrates and algae. Therefore, it does not meet the screening criteria for toxicity.
Overall conclusion	Not PBT
Revised	April 2022

References

1. National Industrial Chemicals Notification and Assessment Scheme (NICNAS). Polymers containing formaldehyde monomers: Human health tier II assessment. Retrieved 2022: https://www.industrialchemicals.gov.au/sites/default/files/Polymers%20containing%20formaldehyde%20monomers_%20Human%20health%20tier%20II%20assessment.pdf.
2. NCBI, 2022. National Center for Biotechnology Information. Available at: https://pubchem.ncbi.nlm.nih.gov/. Retrieved February 2022.
3. ECHA REACH Retrieved 2021: https://echa.europa.eu/

4. HCIS, Hazardous Chemical Information System, Safe Work Australia, Retrieved February 2022: http://hcis.safeworkaustralia.gov.au/HazardousChemical.
5. ILO, International Labour Organisation, International Chemical Safety Cards (ICSCs), Retrieved February 2022: http://www.ilo.org/dyn/icsc/showcard.listcards3?p_lang=en.
6. ECHA REACH, Formaldehyde, oligomeric reaction products with phenol, Retrieved 2019: https://echa.europa.eu/
7. ChemIDplus. Retrieved 2019, from Toxnet, Toxicology Data Network, National Library of Medicine: http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB
8. HAZMAP. Retrieved 2019, from Toxnet, Toxicology Data Network, National Library of Medicine: http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB

Toxicity Summary - Sodium bromate

Chemical and Physical Properties [1,2,4,5]	
CAS number	7789-38-0
Molecular formula	BrHO3.Na
Molecular weight	150.90 g/mol
Solubility in water	36.4 g/100 mL at 20 ^{o}C
Melting point	350 ^{o}C
Boiling point	Decomposes at 381 ^{o}C
Vapour pressure	Negligible
Henrys law constant	Negligible
Explosive potential	Risk of fire and explosion on contact with combustible substances or reducing agents.
Flammability potential	Not combustible but enhances combustion of other substances. Gives off irritating or toxic fumes (or gases) in a fire.
Colour/Form	Colourless crystals
Overview	The toxicological effects of these chemicals are mediated primarily through the bromate ion. Following dissociation in water, sodium (Na+) cations are released, which are naturally occurring species and do not contribute to toxicity. Sodium bromate is used in cleaning/washing agents, surface treatments, paints, lacquers and varnishes, and in cosmetics as an oxidising agent. These chemicals dissociate in water and bromate ion is rapidly absorbed from the gastrointestinal tract, at least in part unchanged. It is distributed throughout the body appearing in plasma and urine unchanged and in other tissues as bromide. Bromate is reduced to bromide in several body tissues. Most bromate is excreted in the urine either as bromate or bromide, but some may leave the body in the faeces. Bromine has been detected in adipose tissue of mice following long-term treatment with bromate (US EPA, 2001; REACHb). Sodium bromate and potassium bromate produce similar effects and these chemicals are roughly equivalent in the delivery of bromate ions. Information on potassium bromate has been included in this toxicological profile.
Environmental Fate [1,2,5]	
Soil/Water/Air	Sodium bromate can be assumed to have a negligible vapour pressure, and it is therefore not expected to partition to air. Similar to many inorganic salts, sodium bromate is highly soluble in water and dissociates rapidly (primarily ionic bonds) to release the bromate ion. The bromate ion is expected to have high mobility in water and relatively little bromate is expected to partition to sediments and soils. Bromate ions found in sediments and soils are expected to be mobile in these compartments. Butler et al. (2005a) indicated that bromate is persistent in water even if this ion is thermodynamically unstable (e.g., Takeno 2005) and subject to slow biological reduction under natural conditions. In aqueous solution, bromate is highly stable at room temperature, does not volatilize and is not removed by boiling (Butler et al. 2005a). A number of studies have demonstrated that bromate can be reduced to bromide in soil, using enriched microbial communities and an appropriate carbon source (Rodgers 1980; Butler et al. 2005b). Furthermore, Rodgers (1980) observed 60% to nearly 100% conversion of BrO_3^- to Br^- following 14-day incubation, at 25°C,

	of aerobic and anaerobic soils, both amended and unamended with glucose. These results suggest that natural attenuation of bromate in soil is possible. Considering published information and experimental evidence for metabolic transformation, potassium bromate does not meet the bioaccumulation criteria (BAF, BCF ≥5000)

Human Health Toxicity Summary [1,2,3,4,5,6]	
Chronic Repeated Dose Toxicity	A number of repeated dose oral toxicity studies in animals indicate that the kidney is the major target organ of bromate-associated toxicity, leading to carcinogenicity. Specific non-cancer effects included degenerative, necrotic, nephropathic, and regenerative changes in the kidney. In a repeated dose toxicity study, potassium bromate was administered in the drinking water at concentrations of 0, 150, 300, 600, 1250, 2500, 5000, or 10000 mg/L to male and female Fischer 344 (F344) rats (10/sex/group) for 13 weeks. All animals exposed to >1250 mg/L died within seven weeks. Significant inhibition of body weight gain was observed in males exposed to 600 or 1250 mg/L. Various-sized droplets and regenerative changes were observed in the renal tubules of treated males. A no observed adverse effect level (NOAEL) of 300 mg/L was determined (US EPA, 2001; NTP, 2007; REACHb). In a chronic toxicity/carcinogenicity study, potassium bromate was administered at 0, 250, and 500 ppm concentrations to F344 rats (53/sex/group) for 110 weeks. Daily intake of potassium bromate was equivalent to 12.5 and 27.5 mg/kg bw/day in males and 12.5 and 25.5 mg/kg bw/day in females, respectively. As the growth of males in the high dose group was severely inhibited, the concentration in this group was reduced to 400 ppm at week 60. Body weight gain was significantly reduced in high-dose males, but not in the other treated groups. Survival was reduced in high-dose males by about week 60 and in low-dose males by about week 100. No effect on survival was observed in treated female rats. A variety of non-cancer effects were reported, including: degenerative, necrotic, and regenerative changes in renal tubules; formation of hyaline droplets; thickening of transitional epithelium of the renal pelvis; papillary hyperplasia; and papillary growth. It was noted that the lesions were more extensive in degree and distribution in treated rats compared with controls, especially males. However, in the absence of information on the incidence of these lesions or on the statistical significance of these findings, a NOAEL for non-cancer effects could not be determined (US EPA, 2001; Health Canada, 2010). In another chronic study, potassium bromate was administered to male F344 rats and male B6C3F1 mice in drinking water at concentrations of 0, 0.02, 0.1, 0.2, and 0.4 g/L and 0, 0.08, 0.4, and 0.8 g/L, respectively, for 100 weeks. The doses were equal to 0, 1.5, 7.9, 16.9, and 37.5 mg/kg bw/day and 0, 9.1, 42.4, and 77.8 mg/kg bw/day, respectively, for rats and mice. In male rats, a statistically significant decrease in the mean body weight and survival was noted at the termination of the study at 0.4 g/L. The decrease in survival and body weight was attributed to an excessive mesothelioma burden. The effects on survival and body weight in rats indicate that the maximum tolerated dose (MTD) was reached in this study. A significant dose-dependent increase in the incidence of urothelial hyperplasia was noted in rats in the 0.1 g/L and higher dose groups. Foci of mineralisation of the renal papilla and eosinophilic droplets in the proximal tubule epithelium were also noted, without any information on dose levels. There were no other treatment-related non-neoplastic effects observed in any other tissue examined. On the basis of kidney effects in male rats, a NOAEL of 0.02 g/L (20 ppm; 1.5 mg/kg bw/day) was determined (US EPA, 2001; Health Canada, 2010). These results also indicate that male B6C3F1 mice may be less sensitive to the effects of bromate exposure than rats. Bromate in drinking water had no effect on the body weights and survival of male mice. There was no increased incidence of non-neoplastic lesion in any tissue examined. Therefore, the highest tested dose of 0.8 g/L (77.8 mg/kg bw/day) is a NOAEL for male mice (US EPA, 2001; Health Canada, 2010).

Carcinogenicity	Potassium bromate is currently classified as hazardous as a Category 2 carcinogen with the risk phrase 'May cause cancer' (T; R45) in the HSIS (Safe Work Australia). The available data support this classification (Health Canada, 1999; US EPA, 2001; WHO, 2005; REACHa). Considering that potassium bromate and sodium bromate will produce similar effects through bromate ions, a classification similar to the above is also recommended for sodium bromate. This is supported by the classification of 'bromate moiety' as a carcinogen by other regulatory agencies (Health Canada, 1999; US EPA, 2001; WHO, 2005). The International Agency for Research on Cancer (IARC) has concluded that there is inadequate evidence in humans for the carcinogenicity of potassium bromate. However, there is sufficient evidence in experimental animals for its carcinogenicity and it is classified as possibly carcinogenic to humans (Group 2B) (IARC, 1999). Health Canada has classified the bromate moiety as 'probably carcinogenic to humans, based on sufficient evidence in animals and no data in humans' (Health Canada, 1999). The US EPA has also classified the bromate moiety as a 'probable human carcinogen based on no evidence in humans, but adequate evidence of carcinogenicity in male and female rats' (Group B2 carcinogen) under previous guidelines and as a 'likely human carcinogen by the oral route of exposure, insufficient data for evaluation by the inhalation route' under current guidelines (US EPA, 2001). Recently, the World Health Organization (WHO) evaluated the bromate moiety under the WHO Guidelines for Drinking-water Quality and stated that 'the weight of evidence from rat bioassays clearly indicates that bromate has the potential to be a human carcinogen' (WHO, 2005). Several studies have been conducted in animals by oral administration to evaluate the carcinogenic effects of potassium bromate. The kidney is the major target organ of bromate-associated toxicity, rats are more sensitive than mice to bromate treatment and specific non-cancer effects include degeneration, necrosis, nephropathic, and regenerative changes in kidneys. The chemical produced tumours in kidneys (renal tubular tumours - adenomas and carcinomas) and the thyroid (follicular cell adenomas and carcinomas) and peritoneal mesotheliomas in males rats. However, only kidney tumours were developed in female rats and these were observed in the absence of the significant toxicity observed in the male rats. The chemical also produced a low incidence of renal cell tumours in male mice and the incidence of renal tubular tumours was marginally increased in male Syrian hamsters (IRIS, 2001; US EAP, 2001; WHO, 2005; Health Canada, 2010). The exact mode of action for induction of tumours is not clear. However, considering the detection of 8-hydroxydeoxyguanosine in kidneys of rodents, the role of oxidative stress has been suggested in the formation of kidney tumours. The evidence is insufficient to establish lipid peroxidation and free radical production as key events responsible for the induction of kidney tumours. Even though the role of cell proliferation has also been proposed in the induction of tumours, the mechanism involving cell proliferation remains to be elucidated. Although bromate is mutagenic in bacteria and causes chromosomal aberrations, the role of mutation in the induction of tumours has also been questioned. The US EPA has suggested the predominant mode of action is DNA reactivity at low doses, considering the detection of tumours at relatively early time points and the positive response of bromate in a variety of genotoxicity assays (US EPA, 2001; WHO, 2005; Health Canada, 2010).
Mutagenicity/ Genotoxicity	Although potassium bromate has been found to be genotoxic in a variety of assays (in vitro, in vivo), results were not sufficient to support its classification. The genotoxicity of potassium bromate has recently been linked to oxidative stress (US EPA, 2001; Health Canada, 2001; REACHa; REACHb).
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	Limited data are available on the reproductive or developmental effects. However, the available information indicated that these chemicals are not likely to have specific reproductive or developmental effects.

Acute Toxicity	Oral Potassium bromate is classified as hazardous with the risk phrase 'Toxic if swallowed' (T; R25) in the Hazardous Substances Information System (HSIS) (Safe Work Australia). The available data (median lethal dose—LD50—157 mg/kg bw) support this classification (REACHa). Data are not available for sodium bromate. Considering that both chemicals will produce similar effects through bromate ions, a classification similar to the above is also recommended for sodium bromate (NTP, 2007; Health Canada, 2010; REACHb). Dermal No data are available. Inhalation No data are available. Observation in humans A number of cases of acute bromate toxicity have been reported in humans following accidental or intentional ingestion of permanent hair wave neutralising solution. These products usually contain either 2 % potassium bromate or 10 % sodium bromate. Bromate intoxication leads to gastrointestinal symptoms (abdominal pain, nausea, vomiting, diarrhoea), central nervous system depression, renal failure, and hearing loss. Although these effects are usually reversible, death from renal failure may ensue if medical intervention is not successful. Hearing loss is usually irreversible (US EPA, 2001; NTP, 2007; HSDB; REACHb).
Irritation	Skin Irritation Although limited data are available, the available information indicates that these chemicals are not likely to be corrosive. The purpose of the available study was to identify potential of potassium bromate for skin corrosion using an in vitro method. The study was conducted according to Organisation for Economic Co-operation and Development (OECD) Test Guideline (TG) 431, using a human skin model. The study consisted of a topical exposure of potassium bromate to a human reconstructed model followed by a cell viability test. Potassium bromate was not considered to possess a corrosive potential (REACHa). Eye Irritation Although limited data are available, the available information indicates that these chemicals are not likely to be eye irritants. An eye irritation study was conducted according to OECD TG 437: Bovine Corneal Opacity and Permeability Test Method for Identifying Ocular Corrosives and Severe Irritants. In this test, the damage is assessed by quantitative measurements of changes in corneal opacity and permeability with an opacitometer and a visible light spectrophotometer, respectively. Potassium bromate caused weak opacity but no permeability of the cornea compared with the results of the negative control group. The chemical was considered to be a mild eye irritant (REACHa).
Sensitisation	The available data on potassium bromate indicate that these chemicals are not likely to be skin sensitisers. In a skin sensitisation study conducted according to OECD TG 429 (local lymph node assay—LLNA), potassium bromate (CAS No. 7758-01-2) at 1.25 %, 2.5 %, and 7.5 % (w/v) concentration was applied topically at the dorsum of each ear of female CBA mice once daily on three consecutive days. A further group of mice was treated with the positive control item and a control group of mice was also treated with the vehicle only. Stimulation Indices (S.I.) of 0.90, 0.53, and 0.64 were determined with the test item at concentrations of 1.25, 2.5, and 7.5 % (w/v), respectively. The EC3 value could not be calculated, since none of the tested concentrations induced an S.I. of greater than three. Potassium bromate was not considered to be a skin sensitiser (REACHa).
Health Effects Summary	The critical health effects for risk characterisation include systemic long-term effects of carcinogenicity and systemic acute effects from oral exposure to these chemicals.

Key Study/Critical Effect for Screening Criteria	The Australian Drinking Water guideline for Bromate (0.02 mg/L health) may apply.
Ecological Toxicity [1,5]	
Aquatic Toxicity	Short term toxicity to fish: 1- to 10-d LC50s ranging from 698.0 to 278.6 mg/l BrO3-, respectively for Juvenile spot. Short term toxicity to aquatic algae and cynobacteria: 72h EC50 value was 603.5 (189.3 – n.d.) mg/L for Yield. Short term toxicity to Invertebrates: <24hr LC50 of 112.7 mg/L Daphnia magna 48 hr LC50 of 55.3 mg/L Daphnia magna 72 hr LC50 of 46.8 mg/L Daphnia magna 96hr LC50 46.8 mg/L Daphnia magna 72 hr EC50 of 15954 mg/L for Isochrysis galbana (Haptophyte algae) 24 hr EC50 of 170 mg/L for Crassostrea gigas (Pacific oyster) larvae
Determination of PNEC aquatic	A predicted no-effect concentration (PNEC) was derived from the lowest acceptable toxicity value identified for a freshwater organism—an acute LC50 for Daphnia Magna of 46.8 mg/L. An assessment factor of 100 was applied to account for uncertainties associated with inter- and intra-species variability and extrapolation from a laboratory LC50 to a chronic no-effect value in the field. This calculation resulted in a PNEC of 0.468 mg/L.
Current Regulatory Controls [2,6]	
Australian Hazard Classification	Potassium bromate (CAS No. 7758-01-2) is classified as hazardous, with the following risk phrases for human health in the Hazardous Substances Information System (HSIS) (Safe Work Australia): T; R25 (acute toxicity) T; R45 Carc. Cat 2 (carcinogenicity)
Australian Occupational Exposure Standards	No data available
International Occupational Exposure Standards	Potassium bromate (CAS No. 7758-01-2) has a Workplace Environmental Exposure Level (WEEL) of 0.1 mg/m^3 time weighted average (TWA) in the United States of America (USA).
Australian Food Standards	No data available
Australian Drinking Water Guidelines	Based on health considerations, the concentration of bromate in drinking water should not exceed 0.02 mg/L.
Aquatic Toxicity Guidelines	No data available
PBT Assessment [1,5]	
P/vP Criteria fulfilled?	Not applicable (inorganic salt, ionic species ubiquitous in environment)
B/vB criteria fulfilled?	Not applicable (inorganic salt, ionic species ubiquitous in environment)
T criteria fulfilled?	Not applicable. Acute toxicity data >1 mg/L, thus this substance does not meet the screening criteria for toxicity.
Overall conclusion	Not PBT
Revised	April 2022

References

1. HSDB (n.d.). Hazardous Substances Data Bank. Retrieved 2022, from Toxnet, Toxicology Data Network, National Library of Medicine: https://pubchem.ncbi.nlm.nih.gov/compound/23668195#section=Toxicity

2. National Industrial Chemicals Notification and Assessment Scheme (NICNAS), Bromates: Human health tier II assessment, Retrieved 2022: https://www.nicnas.gov.au/
3. IARC (International Agency for Research on Cancer) (1986). IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans: some naturally occurring and synthetic food components furocoumarins, ultraviolet radiation and potassium bromate. World Health Organization, IARC, 40.
4. IPCS INCHEM, Sodium Bromate, CAS# 7789-38-0
5. ECHA Registration Dossier for Sodium Bromate CAS 7789-38-0, Retrieved 2022 https://echa.europa.eu/registration-dossier/-/registered-dossier/24444/6/2/6
6. National Health and Medical Research Council, Natural Resources Management Ministerial Council, national Water Quality Management Strategy, Australian Drinking Water Guidelines 6, 2011, Version 3.6 Updated 2021.

Toxicity Summary - Calcium chloride

Chemical and Physical Properties [1,4]	
CAS number	10043-52-4
Molecular formula	$CaCl_2$
Molecular weight	110.98
Solubility in water	81.3 g/100 g water at 25 ^oC
Melting point	775 ^oC
Boiling point	1935 ^oC
Vapour pressure	No data found
Henrys law constant	No data found
Explosive potential	No data found
Flammability potential	No data found
Colour/Form	Odourless white powder
Overview	Calcium chloride is easily dissociated into calcium and chloride ions in water. Both ions are essential elements in animals and humans. Calcium is essential for the formation of skeletal structure, neural transmission, muscle contraction, coagulation of the blood, and a range of other physiological functions. Chloride is required for regulating intracellular osmotic pressure and buffering.
Environmental Fate [2,3]	
Soil/Water/Air	Calcium chloride is soluble in water and its vapour pressure is negligible. When released into the environment calcium chloride is distributed into the water in the form of calcium and chloride ions. Calcium chloride is not expected to be absorbed in soil due to its dissociation properties and high water solubility. The chloride ion is mobile in soil and eventually drains into surface water because it is readily dissolved in water. Calcium chloride is not expected to undergo photolysis or biodegradation. Considering its dissociation properties, calcium chloride is not expected to accumulate in living organisms.
Human Health Toxicity Summary [4]	
Chronic Repeated Dose Toxicity	No reliable repeated dose oral studies are available. In one study, which was not conducted according to OECD guidelines, 40-day-old rats were fed 20 mg/g of anhydrous calcium chloride for 12 months (Pamukcu, Yalciner & Bryan, 1977). No differences in mortality, weight gain, or daily food consumption were observed between the test and the control groups. No neoplastic lesions were observed in the gastrointestinal tract, urinary tract, liver, heart, brain or spleen of the animals. Based on food consumption, the daily intake of calcium chloride was estimated to be 440 mg. Considering that 1 mg/g in the diet is equivalent to 100 and 50 mg/kg bw/day for young and old rats, respectively, the dose used in this study corresponded to 1000 to 2000 mg/kg bw/day.
Carcinogenicity	No data available.
Mutagenicity/ Genotoxicity	In an in vitro study, conducted according to OECD guidelines, doses of calcium chloride up to 5 mg/plate were examined in a Salmonella typhimurium mutation test using strains TA92, TA94, TA98, TA100, TA1535 and TA1537 with metabolic activation (Ishidate et al., 1984). In another reverse mutation test, doses up to 10 mg/plate were examined using S. typhimurium strains TA97 and TA102 with or without metabolic activation (Fujita & Sasaki, 1987). No significant increases in mutation frequencies were observed in either study. In two additional bacterial genotoxicity studies, which were not conducted according to OECD test guidelines, no DNA damage was reported at calcium chloride concentrations of up to 0.5 molar (Kanematsu et al., 1980; Olivier & Marzin, 1987). An in vitro chromosome aberration test comparable to OECD test guidelines, using Chinese hamster lung cells (CHL), has also been reported. Cells were exposed to

	calcium chloride at doses up to 4 mg/mL for 48 hours without metabolic activation. No significant increases in polyploid formation or structural chromosome aberration were observed (Ishidate et al., 1984).
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	No data are available on the effects of calcium chloride on fertility. In a series of developmental toxicity studies conducted comparably to OECD TG 414, the effects of calcium chloride on embryo-lethality and teratogenicity were studied in mice, rats and rabbits at different dose levels. The maximum doses of calcium chloride were 189, 176, and 169 mg/kg bw/day in mice, rats and rabbits, respectively. Calcium chloride had no discernible effect on implantation or on maternal or foetal survival. There were no differences in numbers of abnormalities in soft or skeletal tissues between test and control animals. The studies concluded that calcium chloride up to 189 mg/kg bw/day in the mouse, 176 mg/kg bw/day in the rat and 169 mg/kg bw/day in the rabbit had no developmentally toxic effects (Food and Drug Research Laboratories, 1974).
Acute Toxicity	Calcium chloride has low acute toxicity following oral exposure in animal tests. Acute oral toxicity of calcium chloride has been tested in several mice, rat and rabbit studies. The oral lethal median doses (LD50s) values range from 2120–3798 (male) and 2361–4179 (female) mg/kg bw in rats to 2045 (male) and 1940 (female) mg/kg bw in mice (Akatsuka, 1997). Calcium chloride has low acute toxicity from dermal exposure. An acute dermal toxicity study was conducted in rabbits by a scientifically accepted method (Carreon et al., 1981). No adverse effects were observed and no deaths occurred up to 5000 mg/kg bw, the highest applied dose. No significant change was found either at gross necropsy examination or at the site of application except for some skin lesions (see Skin irritation). The dermal LD50 from this study was >5000 mg/kg bw. Reliable studies on acute inhalation toxicity of calcium chloride are not available. In one study, rats were exposed to 40 and 160 mg/m^3 anhydrous calcium chloride (CAS No. 10043-52-4) for four hours. Signs of irritation of the trachea were observed in the animals. No deaths were reported (Sukhanov et al., 1990). However, the reliability of this study is questioned due to insufficient information on the form of calcium chloride and methodology used.
Irritation	No data are available. However, signs of irritation of the trachea were observed in animals in an acute inhalation study (Sukhanov et al., 1990), indicating that calcium chloride is likely to be a respiratory irritant. In studies conducted according to OECD test guidelines, no or only slight skin irritation were observed in rabbits from four-hour exposures to anhydrous calcium chloride (CAS No. 10043-52-4), calcium chloride dihydrate (CAS No. 10035-04-8), and/or calcium chloride hexahydrate (CAS No. 7774-34-7) (Koopman and Pot, 1986b-e). Rabbits exposed for 24 hours to anhydrous calcium chloride and solid or 38 % calcium chloride dihydrate solution had slight to moderate irritation on intact skin and more severe irritation on abraded skin (Norris, 1971a, b; Carreon, Yano & New, 1981). Anhydrous calcium chloride was a severe irritant to rabbit eyes. The cornea and conjunctivae were moderately to severely irritated from one hour until 14 days after treatment, and were still moderately irritated 21 days after treatment. Hydrated forms of calcium chloride were less irritating to the eyes. With the dihydrate form, the cornea and conjunctivae were moderately irritated from one hour to 72 hours post application, and in one rabbit for up to 14 days. The hexahydrate caused slight to moderate irritation of the cornea and conjuntivae, which persisted for up to 48 hours, and in one rabbit, for up to 14 days. The 33 % and 38 % solutions of calcium chloride were slight to moderate eye irritants causing diffuse corneal opacity and slight to moderate conjunctival redness. Slight to moderate chemosis was also observed in some, but not all, rabbits (Norris, 1971a, b; Koopman & Pot, 1986f-i).

Sensitisation	No data available
Health Effects Summary	The critical health effects for risk characterisation are local effects (severe eye irritation). Observations in humans suggest that calcium chloride may be a slight respiratory irritant. From limited repeat dose data in rats, intakes of up to 2000 mg/kg bw/day via diet were without effect. Calcium chloride is neither genotoxic nor carcinogenic, nor a developmental toxicant. In the absence of an appropriate No-Observed-Adverse-Effect Level (NOAEL), the highest dose tested in the oral study (2 000 mg/kg bw/day) is used for human health risk assessment.
Key Study/Critical Effect for Screening Criteria	In the absence of an appropriate No-Observed-Adverse-Effect Level (NOAEL), the highest dose tested in the oral study (2 000 mg/kg bw/day) is used for human health risk assessment.
Ecological Toxicity [2,3]	
Aquatic Toxicity	Several studies on acute toxicity to fish have been reported. The lowest 96-hr LC50 value was 4,630 mg/L in fathead minnow (Pimephales promelas). No chronic toxicity studies on fish conducted under standard guidelines have been reported. There are seven acute toxicity data available for Daphnia. Two of these studies were conducted according to international or national guidelines, giving the 48-hr EC50 of 2,400 mg/L for Daphnia magna and the 48-hr LC50 of 1,830 mg/L for Ceriodaphnia sp. The lowest 48-hr EC50 was 1,062 mg/L for Daphnia magna. The chronic effect of 21-day exposure on reproduction of Daphnia magna has been investigated as a long-term study. The concentration required for 16% and 50% inhibition of reproduction (EC16 and EC50) were 320 and 610 mg/L, respectively. The NOEC = EC16/2 = 320/2 = 160 mg/L. There is one study with fresh water algae, Selenastrum capricornutum, which was conducted according to OECD TG 201. The 72-hr EC50 and EC20 obtained on the basis of growth rate from the study were >4,000 and 2,700 mg/L, respectively. The 72-hr EC50 and EC20 obtained on the basis of biomass from the study were 2,900 and 1,000 mg/L, respectively. The NOECs are calculated as EC20/2, which corresponds to 1,350 and 500 mg/L for growth rate and biomass, respectively.
Determination of PNEC aquatic	Experimental results are available for three trophic levels. Acute E(L)C50 values are available for fish (4,630 mg/L), Daphnia (1,062 mg/L), and algae (2,900 mg/L). Results from a chronic Daphnia study (NOEC = 160 mg/L) and algae study (NOECs = 1,350 and 500 mg/L for growth rate and biomass, respectively) are also available. On the basis that the data consists of short-term results from three trophic levels and chronic studies on Daphnia and algae, an assessment factor of 50 has been applied to the lowest reported NOEC of 160 mg/L for Daphnia.
Current Regulatory Controls [4]	
Australian Hazard Classification	No data available
Australian Occupational Exposure Standards	No data available
International Occupational Exposure Standards	The following exposure standards are identified (Galleria Chemica): • an occupational exposure limit (OEL) of 5 mg/m^3 for calcium chloride (CAS No. 10043-52-4) in Canada; and • an OEL of 2 mg/m^3 for calcium chloride (CAS No. 10043-52-4) in Latvia.
Australian Food Standards	No data available
Australian Drinking Water Guidelines	No data available
Aquatic Toxicity Guidelines	No data available
PBT Assessment	
P/vP Criteria fulfilled?	Not applicable (inorganic salt, ionic species ubiquitous in environment)
B/vB criteria fulfilled?	Not applicable (inorganic salt, ionic species ubiquitous in environment)

T criteria fulfilled?	No chronic toxicity data exist on calcium chloride; however, the acute EC(L)50s are >0.1 mg/L in fish, invertebrates and algae. Thus, calcium chloride does not meet the screening criteria for toxicity.
Overall conclusion	Not PBT

References

1. HSDB (n.d.). *Hazardous Substances Data Bank*. Retrieved 2015, from Toxnet, Toxicology Data Network, National Library of Medicine: http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB
2. IUCLID (2002) IUCLID Data Set for Calcium chloride (CASRN 10043-52-4), UNEP Publications.
3. OECD-SIDS (2002) Screening Information Dataset (SIDS) Initial Assessment Report for Calcium chloride (CASRN 10043-52-4), UNEP Publications.
4. National Industrial Chemicals Notification and Assessment Scheme (NICNAS), IMAP Single Assessment Report, Calcium chloride (CaCl2): Human health tier II assessment, Retrieved 2018: https://www.nicnas.gov.au/

Diammonium Peroxidisulphate

Chemical and Physical Properties [2]	
CAS number	7727-54-0
Molecular formula	$H_8N_2O_8S_2$
Molecular weight	--
Solubility in water	228.2 g/mol
Melting point	Decomposition temperature 120 °C
Boiling point	Decomposes
Vapour pressure	No data available
Henrys law constant	No data available
Explosive potential	Not explosive.
Flammability potential	Not flammable.
Colour/Form	White granules
Overview	Ammonium persulfate is distributed into the water compartment in the ionic form of the ammonium cation and persulfate ion. The persulfate anion will readily hydrolyze (decompose) into sulfate ions. Diammonium peroxidisulphate is a widely used reagent in biochemistry and molecular biology for the preparation of polyacrylamide gels and is also used in hair bleach
Environmental Fate[1,4,5]	
Soil/Water/Air	The inorganic persulfates are soluble in water and their vapour pressures are negligible. Ammonium persulfate will be distributed into the water compartment in the ionic form of the ammonium cation and persulfate anion. Ammonium persulfate is expected to degrade in the environment mainly via hydrolysis, but metal catalyzed decomposition, and reactions with organic chemicals in the soil or water also are possible. Persulfates are not expected to adsorb to soil due to its dissociation properties, instability (hydrolysis) and high water solubility. Persulfates should behave as free ions or decompose into sulfate ions. In soils, upon decomposition, the cation could form more stable sulfate or bisulfate salts. Persulfates are not expected to bioaccumulate in the soil or in aqueous solution. They will decompose into inorganic sulfate or bisulfate
Human Health Toxicity Summary [1,3,4,5,6]	
Chronic Repeated Dose Toxicity	28-day repeated dose oral (dietary) toxicity studies in rats were conducted and the NOAELs for sodium and ammonium salts were 41 mg/kg bw/day and the top dose of 137 mg/kg bw/day, respectively (FMC Corporation 1979a, 1979c). A well-conducted 90-day inhalation study of ammonium persulfate revealed evidence of inflammation of the airways, reduced body weight gain, rales, increased respiratory rate and increased lung weights at the LOAEL of 25 mg/m^3 (FMC 1998). A NOAEL of 5 mg/m^3 was identified by the OECD (2005) based on sporadic rales and respiratory effects seen (in females only) at the NOAEL of 10.3 mg/m^3. No long term dermal studies were available. In humans, pulmonary function tests conducted on employees of a persulfate production facility indicated no adverse effects on pulmonary function at workplace levels, measured at 0.5 mg/m^3 (FMC Corporation 1992). Follow-up of these same employees indicated that exposure at 0.5 mg/m^3 had no long-term effects on pulmonary function (Greaves 1997).
Carcinogenicity	NA - not listed on Chemical Carcinogenesis Research Information System (CCRIS) or International Agency for Research on Cancer (IARC) Databases, or documented by US EPA. In a non-guideline dermal study, female SENCAR mice were exposed twice weekly to 0.2 mL of a 200 mg/mL solution of ammonium

	persulfate for 51 weeks (Kurokawa et al. 1984). It was concluded that ammonium persulfate is neither a tumour promoter nor a complete carcinogen when applied to the skin.
Mutagenicity/ Genotoxicity	Ammonium persulfates are not genotoxic. Negative results for mutagenicity are available from Ames tests in S. typhimurium strains TA97 or TA102 (Ishidate 1984) for ammonium persulfate. Ammonium persulfate was not clastogenic to Chinese hamster fibroblasts in the absence of metabolic activation in a chromosome aberration test (Ishidate et al. 1988).
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	In a developmental/reproduction study with ammonium persulfate in rats (OECD 421), no effects on reproductive performance, fertility, fetal anomalies, fetal viability, spermatogenesis, spermatogenic cycle were reported up to 250 mg/kg/day. Dose levels were chosen based on the acute lethality studies for the ammonium salt and on a 90-day repeat-dose study in rats with the sodium salt (high dose: 225 mg/kg/day). In the developmental/reproduction study, animals were dosed prior to and during mating through gestation until lactation day 4. There was a transient depression in pup body weight at the 250 mg/kg dose level on lactation day 0 which resolved by day 4. This effect was not considered adverse. Based on the available data, the persulfates do not show evidence of reproductive or developmental toxicity. The NOAEL is 250 mg/kg bw/day.
Acute Toxicity	The substance is irritating to the eyes, the skin and the respiratory tract. Inhalation of dust may cause asthma-like reactions. The ammonium salt gave no evidence of genotoxic activity in bacterial mutagenicity tests (including the Ames assay) or in tests for chromosomal damage with mammalian cells in culture. The acute oral LD50 for ammonium persulfate in rats is between 495 mg/kg bw to 700 mg/kg bw in females and from 600 mg/kg bw to 820 mg/kg bw in males. The acute dermal LD50s in rats and rabbits are >5,000 mg/kg. In acute inhalation studies in rats, the 4-hour LC50 was generally greater than the maximum attainable concentration (>2,950 mg/m^3 for ammonium persulfate).
Irritation	Ammonium persulfate is non-irritating to the skin in animal studies but may be slightly irritating to the eye of rabbits. There were no data available for respiratory irritation. Studies in humans indicate that aqueous solutions of 5% persulfate or higher can cause skin irritation.
Sensitisation	Results of animal skin sensitization tests (Buehler Test and Maximization Test) were negative when persulfate was applied topically, but was positive when persulfate was injected intradermally in induction and challenge phases in a non-standard Maximization Test. Ammonium persulfate at approximately 50 mg/m^3 for four hours induced airway hyper-responsiveness (AHR) (Mensing et al. 1995). Numerous dermal challenge tests indicate that all persulfates are dermal and respiratory sensitizers in humans occupationally exposed to persulfates in hairdressing salons and, in one case, in a production facility.
Health Effects Summary	Ammonium persulfate have low acute dermal and inhalation toxicity but are harmful by the oral route. The chemicals were non-irritating to slightly irritating to eyes and respiratory system and not a skin irritant in animal studies, whilst studies in humans indicate that the chemicals can cause irritation. The chemicals are capable of inducing skin and respiratory sensitisation in animals and these are also the major chronic effects observed in humans. The chemicals were not genotoxic or shown to cause tumour induction or promotion in a mouse skin model. Repeated oral exposures to ammonium persulfate provided evidence that persulfates are not reproductive or developmental toxicants. Overall, the main critical effects to human health are sensitisation and irritancy.
Key Study/Critical Effect for Screening Criteria	The most sensitive endpoint was effects on the respiratory system with a NOAEC of 10.3 mg/m^3 (equivalent to (2.1 mg/kg bw/day) in a 90-day inhalation study (FMC Corporation 1998). Local effects, including respiratory tract inflammation, increased lung weight and rales were observed in rats at the LOAEC of 25 mg/m^3.

	Drinking water guideline value = 0.0819 ppm
Ecological Toxicity [2,3,6]	
Aquatic Toxicity	Acute Aquatic - Fish -96-hr LC50 Oncorhynchus - 76.3 mg/L -48-hr EC50 Daphnia magnaL - 120 mg/L -72-hr EC10 Phaedactylum tricornutum - 320 mg/L Acute Aquatic - Invertebrate -Daphnia magna reproduction test - NOEC of 20.8 mg/L (ECHA)
Determination of PNEC aquatic	PNECaquatic: Experimental results are available for three trophic levels. Acute E(L)C50 values are available for fish (76 mg/L), Daphnia (120 mg/L), and algae (320 mg/L). On the basis that the data consists of short-term results from three trophic levels, an assessment factor of 1,000 has been applied to the lowest reported effect concentration of 76 mg/L for fish. The PNECaquatic is 0.076 mg/L.
Current Regulatory Controls [6]	
Australian Hazard Classification	Xn(Harmful); R22 (Harmful if swallowed) Xi (Irritant); R36/37/38 (Irritating to eyes, respiratory system and skin), R42/43 (May cause sensitisation by inhalation and skin contact).
Australian Occupational Exposure Standards	Time Weighted Average (TWA) of 0.01 mg/m^3.
International Occupational Exposure Standards	Time Weighted Average (TWA): 0.1 mg/m^3 (Belgium, Canada, Ireland, Italy, Portugal, Spain, US) 2 mg/m^3 (Denmark, Iceland, Norway)
Australian Food Standards	Ammonium persulfate is listed in Schedule 18–Processing Aids- S18.08 Permitted processing aids—Miscellaneous purposes (section 1.140): Yeast washing agent under GMP conditions (Food Standards Australia New Zealand 2013).
Australian Drinking Water Guidelines	No data available
Aquatic Toxicity Guidelines	No data available
PBT Assessment	
P/vP Criteria fulfilled?	No. Not applicable, inorganic salt, ionic species ubiquitous in environment.
B/vB criteria fulfilled?	No. Not applicable, inorganic salt, ionic species ubiquitous in environment.
T criteria fulfilled?	No chronic toxicity data exist; however, the acute EC(L)50s are >0.1 mg/L in fish, invertebrates and algae. Thus does not meet the screening criteria for toxicity.
Overall conclusion	Not PBT
Revised	April 2022

References

1. ECHA European Chemicals Agency, Registered Substance Database, Cellulase, http://echa.europa.eu
2. HSDB (n.d.). *Hazardous Substances Data Bank*. Toxnet, Toxicology Data Network, National Library of Medicine: http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB
3. IPCS *Ammonium persulphate: Summary*, 2010. International Programme on Chemical Safety and the Commission of the European Communities (IPCS and CEC).
4. OECD IUCLID Data Set for Ammonium persulfate (CAS No. 7727-54-0); Potassium persulfate (CAS No. 7727- 27-1); Sodium persulfate (CAS No. 7775-27-1), UNEP Publications, 2005.
5. OECD. Screening Information Dataset (SIDS) Initial Assessment Report for Ammonium persulfate (CAS No. 7727-54-0); Potassium persulfate (CAS No. 7727- 27-1); Sodium persulfate (CAS No. 7775-27-1), UNEP Publications, 2005.

6. Department of the Environment and Energy 2017 , National assessment of chemicals associated with coal seam gas extraction in Australia, prepared by the National Industrial Chemicals Notification and Assessment Scheme

Toxicity Summary - Dicoco dimethyl quaternary ammonium chloride

Chemical and Physical Properties [2]	
CAS number	61789-77-3
Molecular formula	$C_{26}H_{56}ClN$
Molecular weight	418.18 g/mol
Solubility in water	40-5040 mg/L
Melting point	94 ˚C
Boiling point	135 ˚C
Vapour pressure	Low
Henrys law constant	No data found
Explosive potential	No data found
Flammability potential	No data found
Colour/Form	Solid
Overview	Dicoco dimethyl quaternary ammonium chloride is from a subgroup of quaternary ammonium salts that are derived from chemicals that have a biological origin. The substance represented by CAS# 61789-77-3 is expected to be a mixture of discrete chemicals with two alkyl chains of six to 18 carbons derived from coconut oil. Commercially available quaternary ammonium surfactants are often prepared indirectly from natural fats and oils. Natural fats derived from the fatty tissue of sheep or cattle, oil obtained from the kernel of the seed of *Cocos nucifera* (coconut), and seeds of *Glycine soja* (soybean) are used to prepare tallow alkyl-, coconut oil alkyl-, and soybean oil alkyl-ammonium compounds, respectively (Ash and Ash, 2004a; b). These surfactants have carbon chains with even numbers of carbon atoms, as fatty acid biosynthesis occurs mainly through addition of two carbon units in the form of acetyl-CoA (Voet and Voet, 1990). The major process for transforming fats and oils of biological origins into oleochemicals is the hydrolysis of natural triglycerides into glycerine and mixed fatty acids (Corma, et al., 2007). Reaction of these fatty acids and ammonia followed by hydrogenation produces fatty amines (Corma, et al., 2007), which are then alkylated at the nitrogen atom by reaction with chloromethane (de Oude, 1992). Alternatively, the fatty acids may be reacted with trimethylamine followed by hydrogenation to form quaternary ammonium compounds (Qadir, et al., 2014). Chemicals in this group are a source of cationic surfactants that have a wide range of industrial applications reported internationally. They are used in cleaning and washing agents as well as cosmetics, such as hair conditioners, hand soaps and deodorants. Due to their biocidal activity, they are used in agricultural and non-agricultural pesticides, disinfectants and preservatives (Nordic Council of Ministers, 2015; US EPA, 2015). There is also some indication of use as algaecides, indicating potential water treatment uses (US EPA, 2015; US NLM, 2011).
Environmental Fate [2]	
Soil/Water/Air	The chemicals in this group are all salts of quaternary ammonium surfactants and are therefore expected to have low volatility (de Oude, 1992). The water solubility values reported were determined at the critical micelle concentrations (CMCs), as is appropriate for surface-active substances. CMCs decrease with increasing alkyl chain lengths, and di-alkyl quaternary ammonium compounds have lower CMCs

	compared to mono-alkyl quaternary ammonium compounds with comparable alkyl chain lengths (Tezel, 2009). The octanol-water partition coefficient parameter (K) of the chemicals in this group is not considered to provide a reliable indicator of the partitioning behaviour of surface active substances in the environment (McWilliams and Payne, 2001; Shorts, et al., 2010), and therefore has not been reported. The quaternary ammonium cations from substances in this group partition between water and sediment, or remain in soil when released from industrial uses. The chemicals in this group are quaternary ammonium salts. If discharged into natural waters, the chemicals are expected to dissociate and release their quaternary ammonium cations. The quaternary ammonium cations can adsorb to clays and natural organic materials, such as humic substances (de Oude, 1992). They are expected to remain in soil as they are strongly adsorbed and immobile (Zhang, et al., 2015). The quaternary ammonium cations from substances in this group are biodegradable. Di-alkyl quaternary ammonium cations are also found to be rapidly biodegradable in water, undergoing 79 to 80% degradation after 2 days for those with C alkyl chains (CAS RNs 61789-80-8 and 61789-77-3) (US EPA, 2016). The quaternary ammonium cations from substances in this group have low to moderate bioaccumulation potential in aquatic organisms. The chemicals in this group are not expected to undergo long-range transport based on their low volatility and their biodegradability in the environment. Quaternary ammonium cations adsorbed to clays, sediment and soil containing organic carbon (de Oude, 1992; Ivankovic and Hrenovic, 2010) are strongly bound and immobile (Zhang, et al., 2015). Limited human health toxicity information is available for Dicocodimethylquaternaryammonium chloride, as such, information for dioctadecyldimethylammonium chloride (DODMAC) has been included below.
Human Health Toxicity Summary [1, 3]	
Chronic Repeated Dose Toxicity	Following repeated oral exposure of 500 mg/kg bw/d of DODMAC to rats degeneration of adrenal cortex was induced. No adverse effects were reported up to 100 mg/kg bw/d DODMAC (NOAEL). After repeated dermal application to rabbits, local irritation but no systemic toxic effects were observed up to 40 mg/kg bw/d (NOAEL). A systemic LOAEL was not determined. There is no information on effects after prolonged inhalation exposure to rodents.
Carcinogenicity	No data is available on carcinogenic effects of DODMAC. There are no data from mutagenicity studies which give concern regarding carcinogenicity of both substances.
Mutagenicity/ Genotoxicity	DODMAC showed negative results in bacterial mutation tests and in an *in vitro* chromosomal aberration test. There is no evidence of a genotoxic potential of the substance
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	In an oral study on rats according to OECD Guideline 421 a dose of 500 mg/kg bw/d led to impaired reproductive performance in combination with clear signs of general toxicity. Based on the reduced mating, fertility and gestation indices a NOAEL for reproductive toxicity of 125 mg/kg/d can be estimated.
Acute Toxicity	In rats, the substance exhibited only low acute toxicity with oral LD50 > 2000 mg/kg bw, dermal LD50 > 200 mg/kg bw and inhalation LC50 > 180 mg/l/1 hour
Irritation	Pure DODMAC causes serious damage to the eyes but only moderate irritation to the skin of rabbits. Data on respiratory irritation is not available. Technical grade DODMAC, however, has proven to be corrosive to the skin of rabbits because of a high content of isopropanol

Sensitisation	DODMAC enhances the allergic potency of other chemical substances, but does not seem to cause skin sensitization by itself as judged on the basis of tests with relevant concentrations of DODMAC.
Health Effects Summary	
Key Study/Critical Effect for Screening Criteria	The key study chosen for the determination of a drinking water guidance value is the subacute oral rat study, where the NOAEL was 100 mg/kg/d. The oral RfD for Dicoco dimethyl quaternary ammonium chloride is thus based on the NOAEL of 100 mg/kg/day. Uncertainty factors: 10 (interspecies variability); 10 (intraspecies variability); 10 (subchronic to chronic). Oral RfD: 100/1000 = 0.1 mg/kg/day Drinking water guideline value = 0.39 ppm
Ecological Toxicity [2]	
Aquatic Toxicity	The following measured median lethal concentration (LC50) and median effective concentration (EC50) values for model organisms across three trophic levels were reported in the Screening-Level Hazard Characterisation conducted by the United States Environmental Protection Agency (US EPA, 2008), the European Union Risk Assessment Report (IHCP, 2009), and the databases included in the OECD QSAR Toolbox (LMC, 2013) Fish *Lepomis macrochirus* (Bluegill) 96 h LC50 = 1.04 mg/L Invertabrate Dap*hnia magna* (Water flea) 48 h LC50 = 0.16 mg/L Algae *Pseudokirchneriella subcapitata* (Green algae) 96 h EC50 = 0.46 mg/L The following no-observed effect concentration (NOEC) values for model organisms across two trophic levels were reported in the European Union Risk Assessment Report (IHCP, 2009) and the databases included in the OECD QSAR Toolbox (LMC, 2013). Invertebrates *Daphnia magna* (Water flea) 21 d NOEC = 0.38 mg/L Algae *Pseudokirchneriella subcapitata* (Green algae) 96 h NOEC = 0.16 mg/L While the chemicals in this group can be very toxic to aquatic organisms, they are efficiently removed from wastewater in sewage treatment plants and they typically undergo rapid biodegradation in water and soil.
Determination of PNEC aquatic	The calculated PNEC for mono-alkyl quaternary ammonium compounds with C alkyl chains is 3.6 µg/L based on the 72 h NOEC of 0.0018 mg/L for algae. The laboratory endpoint value for algae was divided by an assessment factor of 10 to account for interspecies variation and the derived value was then multiplied by a factor of 20 to account for the 5% bioavailable fraction in environmental waters. The calculated PNEC for di-alkyl quaternary ammonium compounds with C alkyl chains is 2.8 µg/L based on the 96 h EC50 of 0.014 mg/L for algae. This value was calculated by a similar procedure as applied to the mono-alkyl quaternary ammonium compound, but using an assessment factor of 100 in accordance with standard methodology for deriving PNECs from acute toxicity endpoint values (EPHC, 2009).
Current Regulatory Controls[2]	
Australian Hazard Classification	No data available
Australian Occupational Exposure Standards	No data available
International Occupational Exposure Standards	No data available
Australian Food Standards	No data available
Australian Drinking Water Guidelines	No data available

Aquatic Toxicity Guidelines	The use of the chemicals in this group is not subject to any specific national environmental regulations.
PBT Assessment [2]	
P/vP Criteria fulfilled?	Not Persistent (Not P). Based on results obtained from biodegradation studies, all chemicals in this group are categorised as Not Persistent.
B/vB criteria fulfilled?	Not Bioaccumulative (Not B). Based on the available measured bioconcentration data, all chemicals in this group are categorised as Not Bioaccumulative.
T criteria fulfilled?	Toxic (T). Based on available acute ecotoxicity values below 1 mg/L and/or chronic ecotoxicity values below 0.1 mg/L, all chemicals in this group are categorised as Toxic.
Overall conclusion	Not P, Not B, T. The chemicals in this group are not PBT substances according to domestic environmental hazard criteria.
Revised	December 2018

References

1. European Commission Joint Research Centre 2009, European Union Risk Assessment Report, Dioctadecyldimethylammonium chloride, CAS no. 107-64-2.
2. National Industrial Chemicals Notification and Assessment Scheme (NICNAS). IMAP, Mono- and Di-Alkyl Quaternary Ammonium Surfactants: Environmental Tier II Assessment, Retrieved 2018: https://www.nicnas.gov.au
3. OECD (1996) SIDS Initial Assessment Profile for Dioctadecyldimethylammonium chloride, CAS Number 107-64-2

Poly(tetrafluoroethylene)

Chemical and Physical Properties[1,2]	
CAS number	9002-84-0
Molecular formula	(No data available.
Molecular weight	Likely >1000 MW
Solubility in water	No data available.
Melting point	No data available.
Boiling point	No data available.
Vapour pressure	No data available.
Henrys law constant	No data available.
Explosive potential	No data available.
Flammability potential	No data available.
Colour/Form	No data available.
Overview	No studies are available. The polymer is not expected to be readily biodegradable. Biodegradation is limited due to the very high molecular weight and the low water solubility of the polymer. Due to its high molecular weight, the polymer is not expected to bioaccumulate. This chemical has been identified by NICNAS to be of low concern to human health and thus required no further assessment.
Environmental Fate[1,2]	
Soil/Water/Air	The polymer is not expected to be readily biodegradable. Biodegradation is limited due to the very high molecular weight and the low water solubility of the polymer. Due to its high molecular weight, the polymer is not expected to bioaccumulate.
Human Health Toxicity Summary[1,2]	
Chronic Repeated Dose Toxicity	No data available.
Carcinogenicity	No data available.
Mutagenicity/ Genotoxicity	No data available.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	No data available.
Acute Toxicity	No data available.
Irritation	No data available.
Sensitisation	No data available.
Health Effects Summary	This chemical has been identified by NICNAS to be of low concern to human health.
Key Study/Critical Effect for Screening Criteria	No data available.
Ecological Toxicity[1,2]	
Aquatic Toxicity	Limited information is available. The polymer is expected to be a low concern for toxicity to aquatic organisms. Due to its poor solubility and high molecular weight, it is not expected to be bioavailable. It does not contain any reactive functional groups.

Determination of PNEC aquatic	No PNEC values were calculated.
Current Regulatory Controls	
Australian Hazard Classification	No data available.
Australian Occupational Exposure Standards	No data available.
International Occupational Exposure Standards	No data available.
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	No data available.
PBT Assessment[1,2]	
P/vP Criteria fulfilled?	The polymer is not readily biodegradable, hence it meets the screening criteria for persistence.
B/vB criteria fulfilled?	The polymer is expected to have a very high molecular weight and poor water solubility. It is not expected to be bioavailable, hence this polymer does not meet the criteria for bioaccumulation.
T criteria fulfilled?	There are no aquatic toxicity studies on the polymer. It is expected to have low concern for aquatic toxicity because of its very high molecular weight and poor water solubility. As such, the polymer does not meet the criteria for toxicity.
Overall conclusion	Not PBT
Revised	April 2022

References

1. National Industrial Chemicals Notification and Assessment Scheme (NICNAS). IMAP, Human Health Tier 1 Assessment. Retrieved: https://www.industrialchemicals.gov.au/chemical-information/search-assessments?assessmentcasnumber=9002-84-0
2. Categorization Results from the Canadian Domestic Substance List, Ethene, tetrafluoro-, homopolymer, accessed: https://canadachemicals.oecd.org/ChemicalDetails.aspx?ChemicalID=C23E53B5-40B4-4438-BEAA-A4E4B5A7D06E

Toxicity Summary - Propan-2-ol (Isopopranol)

Chemical and Physical Properties[1,3,4,5,6]	
CAS number	67-63-0
Molecular formula	C_3H_8O
Molecular weight	60.10 g/mol
Solubility in water	100 vol% at 20 °C (miscible)
Melting point	-88.5 °C
Boiling point	82.5 °C
Vapour pressure	45.4 mm Hg at 25ºC
Henrys law constant	7.52 x 10^{-6} atm m^3/mole
Explosive potential	Is classified as explosive. The vapours may form an explosive mixture with air.
Flammability potential	Flammable liquid and vapour.
Colour/Form	Colourless liquid with a pleasant odour.
Overview	Isopropanol (IPA) is a high production volume chemical which has wide use as an industrial solvent and as a component in numerous industrial and consumer products. It has a potential for widespread exposure to both workers and consumers. Based upon physical and chemical properties, isopropanol is not expected to persist in the environment. Aerobic biodegradation of isopropanol occurs rapidly. IPA is not expected to persist in soil due to low soil adsorption and rapid evaporation to air. In the air, isopropanol is subject to rapid oxidation by hydroxyl radical attack. IPA has a low order of toxicity to aquatic organisms and plants, and bioconcentration in aquatic organisms is not expected to occur.
Environmental Fate[1,4,5,6]	
Soil/Water/Air	Based on calculated results from a Level I fugacity model, isopropanol is expected to partition primarily to the aquatic compartment (77.7%) with the remainder to the air (22.3%) (OECD, 1977a,b). Aerobic biodegradation of isopropanol has been shown to occur rapidly under nonacclimated conditions, based on a result of 49% biodegradation from a 5-day BOD test (Bridie *et al.*, 1979). Additional biodegradation data developed using standardized test methods show that isopropanol is readily biodegradable in both freshwater and saltwater media (72 to 78% biodegradation in 20 days) (Price *et al.*, 1974). Bioconcentration of isopropanol in aquatic organisms is not expected to occur based on a measured log n-octanol/water partition coefficient (log Kow) of 0.05, a calculated bioconcentration factor of 1 for a freshwater fish, and the unlikelihood of constant, long-term exposures (OECD 1977a,b).
Human Health Toxicity Summary [1,2,3,4,5,6]	
Chronic Repeated Dose Toxicity	Considering the lowest observed adverse effect levels (LOAELs) available from a 12-week rat study (1390 mg/kg bw/day), and based on the treatment-related effects reported in various repeated dose toxicity studies, the chemical is not considered to cause serious damage to health from repeated oral exposure. Male Wistar rats were administered the chemical at concentrations of 0, 1, 2, 3, or 5 % (0, 870, 1390, 1700, or 2500 mg/kg bw/day) in drinking water for 12 weeks. The top dose was reduced to 4 % due to unpalatability after two weeks. Significantly decreased bodyweights were seen at the two highest doses and dose-related increases in relative liver and kidney weights were also significant at 1390 mg/kg bw/day and above. Relative adrenal weights were also significantly increased at the two highest doses; increased testis weight was noted only at the top dose. A dose-dependent increase of hyaline casts and hyaline droplet formation in the proximal tubules of the kidneys was also noted. The no observed adverse effect level (NOAEL) was determined to be 870 mg/kg bw/day, based on

	liver and kidney effects observed at the LOAEL of 1390 mg/kg bw/day (OECD, 2002; EFSA, 2005). In another repeated dose study, rats (strain not specified) were administered the chemical in drinking water at doses of 600 or 2300 mg/kg bw/day for males and 1000 or 3900 mg/kg bw/day for females for 27 weeks. Male rats showed decreased bodyweight gain during the first 13 weeks and increased bodyweight gain for the remainder of the treatment. Female rats showed decreased bodyweight gain throughout the dosing period. No other effects were reported. The NOAELs were 2300 and 1000 mg/kg bw/day for males and females, respectively. The LOAEL in females was 3900 mg/kg bw/day but could not be established in males (OECD, 2002). Several repeated dose inhalation studies were available in rats and mice. Considering the no observed adverse effect concentrations (NOAECs) available from these studies (500 ppm), and based on the treatment-related effects reported, the chemical is not considered to cause serious damage to health from repeated inhalation exposure. The kidney appears to be the target organ with kidney lesions and changes in urine chemistry indicative of impaired kidney function observed at doses ≥2500 ppm in animals exposed to the chemical for 78 weeks (effects not observed in 13-week studies). Transient signs of narcosis were observed for both mice and rats at doses ≥1500 ppm (OECD, 2002; REACH; US EPA, 1986). The investigation by Burleigh-Flayer et al. (1997), showed chronic kidney effects in rodents and is the only study that conducted lifetime rodent exposure to isopropanol. The kidney effects seen in this study were not reported in the 13-week studies by Burleigh-Flayer et al. (1994) which possibly indicates that longer term exposure is necessary for the development of the lesions. The increased hyaline droplets in the kidney observed in the study of Burleigh-Flayer et al. (1994) are a male rat-specific nephropathy and is not considered to be relevant to humans. The LOAEC and NOAEC established from the critical study were 2500 and 500 ppm, respectively, which are equivalent to 1275 and 255 mg/kg bw/day, respectively. Although limited information is available, it has been reported that oral intake of low doses of the chemical (2.6 or 6.4 mg/kg bw/day) by groups of eight men for six weeks had no effect on their blood cells, serum or urine and also produced no clinical symptoms (HSDB).
Carcinogenicity	Based on available data, the chemical is not considered to be carcinogenic (OECD, 2002; WHO, 1990a; EFSA, 2005; REACH). The International Agency for Research on Cancer (IARC) has concluded that there is inadequate evidence for the carcinogenicity of isopropanol in laboratory animals and humans, placing the chemical in Group 3 (Not classifiable as to its carcinogenicity to humans) (IARC, 1999). Although there are no carcinogenicity studies available for the chemical by oral exposure, studies are available for inhalation exposure in rats and mice. In a carcinogenicity study (OECD TG 451), F344 rats were exposed (whole-body) through inhalation to vapours of the chemical at concentrations of 0, 500, 2500, and 5000 ppm for six hours a day, five days a week for two years. The only neoplastic lesion found was stated to be increased frequency of interstitial (Leydig) cell adenoma of the testis (77.3, 86.7 and 94.7 % at low, mid and top dose groups, respectively). The authors did not consider the tumours to be treatment related as testicular adenomas are a common finding in aged male rats and that incidence of this spontaneous tumour reported for the control group (64.9 %) of this study was lower than the historical incidence (88 %) of control F344 rats of numerous two-year National Toxicology Program (NTP) carcinogenicity studies. In a similar carcinogenicity study, CD-1 mice were also exposed (whole-body) through inhalation to vapours of the chemical at concentrations of 0, 500,

	2500, and 5000 ppm for six hours a day, five days a week for 18 months. No increased frequency of neoplastic changes was reported in any of the treated groups (OECD, 2002; EFSA, 2005; REACH).
Mutagenicity/ Genotoxicity	The chemical does not show specific reproductive or developmental toxicity. Any reproductive and developmental effects were only observed secondary to maternal toxicity.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	The chemical does not show specific reproductive or developmental toxicity. Any reproductive and developmental effects were only observed secondary to maternal toxicity. Several one or two-generation reproductive toxicity studies (rats) and developmental studies (rats and rabbits) were available. Other than a statistically significant reduction in the male mating index observed in a recent two generation study (high dose, 1000 mg//kg bw/day second generation males), there were no other effects on reproductive indices, including fertility and gestational indices and histopathology of the reproductive organs. The NOAELs for reproductive toxicity were reported as ≥500 mg/kg bw/day. A benchmark dose (BMD) assessment was conducted for the study's developmental and reproductive findings (Shipp et al., 1996). For the offspring developmental effects, BMD dosages (BMDL5) of 449 and 418 mg/kg/day were estimated for the F1 and F2 generations, respectively. Based upon the decrease in male mating index observations in the P2 males, a BMDL10 of 407 mg/kg/day was estimated for reproductive effects (OECD, 2002; EFSA, 2005; REACH). Developmental effects, including a reduction in postnatal survival and decreased foetal bodyweights, occurred only at maternally toxic doses. No accompanying malformations were observed. In a developmental toxicity study (US EPA TSCA Guidelines), pregnant Sprague Dawley (SD) rats were administered the chemical by gavage at 0, 400, 800 or 1200 mg /kg bw/day on gestational days 6–15. In the same study, pregnant New Zealand white rabbits were dosed orally with the chemical at 0, 120, 240 or 480 mg/kg bw/day during gestational days 6–18. There was no evidence of developmental toxicity in rats and rabbits at any tested dose. There was mortality of two dams (8%) at 1200 mg/kg and one dam (4%) at 800 mg/kg. Reduced maternal gestational weight gain associated with significantly reduced gravid uterine weights was noted in the higher dose group. The NOAEL for maternal toxicity in rats was reported to be 400 mg/kg bw/day. The NOAEL for developmental toxicity in rats was established as 400 mg /kg bw/day, based on significantly reduced foetal litter body weights at the 800 and 1200 mg/kg dose levels. The NOAEL for maternal toxicity in rabbits was determined to be 240 mg/kg bw/day, based on decreased maternal bodyweight and profound clinical signs (peripheral vasodilatation, cyanosis, lethargy, laboured respiration) of toxicity seen at the top dose. There was no evidence of any developmental toxicity and the NOAEL for developmental toxicity was established as the highest dose: 480 mg/kg bw/day. There was no evidence of any teratogenicity in either studies in rats and rabbits (US EPA, 1995; OECD, 2002; EFSA, 2005; HSDB; REACH).
Acute Toxicity	The chemical was of low acute toxicity in animal tests following oral exposure. The median lethal dose (LD50) in rats is greater than 2000 mg/kg bw. Observed effects included irritation and respiratory arrest while under narcosis (OECD, 2002; WHO, 1990a; HSDB). The chemical was of low acute toxicity in an animal test following dermal exposure. The median lethal dose (LD50) in rats is greater than 2000/kg mg/kg bw. Observed effects were not reported (OECD, 2002; WHO, 1990a; HSDB). The chemical was of low acute toxicity in animal tests following inhalation exposure with reported median lethal concentrations (LC50) >20 mg/L in rats (OECD, 2002; HSDB). Observed effects included severe irritation of the mucous membranes and central nervous system depression as indicated by ataxia, prostration and narcosis.

	The chemical is currently classified with the risk phrase 'Vapours may cause drowsiness and dizziness (R67)' in Australia (Safe Work Australia—HSIS). In an acute inhalation toxicity study (OECD TG 403), Fischer 344 (F344) rats were exposed (whole-body exposure) to the chemical at 500, 1500, 5000, and 10000 ppm for six hours (instead of the standard four hours). Transient concentration-related narcosis and/or central nervous system sedation was noted in the study and the motor activity was decreased at 1500 ppm (males only), 5000 ppm (both sexes). Severe central nervous system depression was seen in the 10000 ppm group. After one and six hours exposure at 10000 ppm, prostration, severe ataxia, decreased arousal, slowed or laboured respiration, decreased neuromuscular tone, hypothermia, and loss of reflex function was observed (OECD, 2002; REACH). Acute intoxication incidents in humans with the chemical have been reported (WHO, 1990b; OCED, 2002; HSDB). Ingestion and inhalation are the common routes of poisoning in humans. Acute intoxication of the chemical has a rapid onset (30–60 minutes) following ingestion, and reported symptoms included drowsiness, poor coordination, abdominal pain, cramps, nausea, vomiting and diarrhea, with unconsciousness and death following massive exposure. Inhaling high concentrations of the chemical can cause nausea, headache, light headedness, drowsiness, ataxia and deep narcosis (WHO, 1990b; OECD, 2002; HSDB).
Irritation	Isopropanol applied to the intact or abraded skin of rabbits and guinea pigs produced negligible irritation (Nixon *et al.*, 1975). Liquid isopropanol is moderately irritating to the eyes of rabbits (Griffith *et al.*, 1980; WHO, 1990). Isopropanol produced little irritation when tested on the skin of six human subjects (Bevan, 2012).The chemical is classified as hazardous with the risk phrase 'Irritating to eyes' (Xi; R36) in HSIS (Safe Work Australia). The available data support this classification (OECD, 2002; WHO, 1990a; REACH).
Sensitisation	There have been reports of isolated cases of dermal irritation and/or skin sensitization (Bevan, 2012). Except for three case reports, the positive reactions were observed on patch testing patients with contact dermatitis due to ethanol. These patients also had a positive reaction to ethanol. The chemical does not contain a structural alert for skin sensitisation (OECD Toolbox).
Health Effects Summary	The critical health effects for risk characterisation include the potential for eye irritation and intoxication symptoms following inhalation of high vapour concentrations.
Key Study/Critical Effect for Screening Criteria	The most appropriate NOAEC for risk assessment, determined from the 104-week study by Burleigh-Flayer et al. (1997), is 255 mg/kg bw/day based on kidney effects at the LOAEC of 1275 mg/kg bw/day. Uncertainty factors: 10 (interspecies variability); 10 (intraspecies variability) Oral Reference Dose = 255/100 = 2.55 mg/kg/day Drinking water = 10 mg/L
Ecological Toxicity [2,4,5]	
Aquatic Toxicity	The 96-hour LC50 in *Pimephales promelas* is 9,640 mg/L (Veith *et al.*, 1983). The 24- hour EC50 in *Daphnia magna* is >10,000 mg/L (Brinkmann and Kuehn, 1977). Chronic aquatic toxicity has also been shown to be of low concern, based on 16- and 21-day NOEC values of 141 and 30 mg/L, respectively, for the freshwater invertebrate *Daphnia magna* (Hermens *et al.*, 1985); OECD, 1977a,b). Toxicity of isopropanol to plants is expected to be low, based on a 7-day toxicity threshold value of 1,800 mg/L for freshwater algae (Bringmann and Kuehn, 1980).
Determination of PNEC aquatic	PNECaquatic: Experimental results are available for three trophic levels. Acute E(L)C50 values are available for fish (9,640 mg/L) and invertebrates (>10,000 mg/L). Results from chronic studies are available for invertebrates (16- and 21-day NOECs for Daphnia are 141 and 30 mg/L, respectively). On the basis that the data consists of a chronic study on one trophic level, an assessment factor of 100 has been applied to the lowest reported NOEC of 30 mg/L for Daphnia. The PNECaquatic is 0.3 mg/L.
Current Regulatory Controls [7]	

Australian Hazard Classification	The chemical is classified as hazardous, with the following risk phrases for human health in the Hazardous Substances Information System (HSIS) (Safe Work Australia): Xi; R36 (Irritation) R67 (Vapours may cause drowsiness and dizziness)
Australian Occupational Exposure Standards	The chemical has an exposure standard of 983 mg/m³ (400 ppm) time weighted average (TWA) and 1230 mg/m³ (500 ppm) short-term exposure limit (STEL).
International Occupational Exposure Standards	The following exposure standards are identified (Galleria Chemica): An exposure limit (TWA) of 245–999 mg/m³ (100–400 ppm) in countries such as Canada, Denmark, Iceland, Germany, Norway, Sweden, Spain, Switzerland, UK, and USA. An exposure limit (STEL) of 600–1250 mg/m³ (250–500 ppm) in countries such as Canada, France, Spain, Sweden, Switzerland, UK, and USA.
Australian Food Standards	Isopropanol is listed in Standard 1.3.1 of the Australia New Zealand Food Standards Code and has a permitted use as a food additive at a maximum permitted level of 1000 mg/kg (Food Standards Australia New Zealand 2013).
Australian Drinking Water Guidelines	No data available
Aquatic Toxicity Guidelines	No data available
PBT Assessment [4,5]	
P/vP Criteria fulfilled?	Isopropanol is readily biodegradable and thus it does not meet the screening criteria for persistence.
B/vB criteria fulfilled?	Based on a measured log Kow of 0.05 and a calculated BCF of 1, isopropanol does not meet the screening criteria for bioaccumulation.
T criteria fulfilled?	The chronic toxicity data on isopropanol show NOECs of >0.01 mg/L. Thus, isopropanol does not meet the screening criteria for toxicity.
Overall conclusion	Not a PBT substance (based on screening data).
Revised	December 2019

References

1. HSDB (n.d.). *Hazardous Substances Data Bank*. Retrieved 2017, from Toxnet, Toxicology Data Network, National Library of Medicine: http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB
2. ECHA REACH database: http://apps.echa.europa.eu/registered/registered-sub.aspx
3. IPCS Inchem, Isopropyl Alcohol, CAS#67-63-3
4. OECD (1997a). IUCLID Data Set for 2-Propanol (CAS No. 67-63-0), UNEP Publications.
5. OECD (1997b) Screening Information Dataset (SIDS) Initial Assessment Report for 2- Propanol (CAS No. 67-63-0), UNEP Publications.
6. National Industrial Chemicals Notification and Assessment Scheme (NICNAS). IMAP, Human Health Tier II Assessment for 2-Propanol CAS Number: 67-63-0, Retrieved 2018: https://www.nicnas.gov.au
7. Safe Work Australia 2011. Workplace Exposure Standards for Airborne Contaminants.
8. Department of the Environment and Energy 2017 , National assessment of chemicals associated with coal seam gas extraction in Australia, prepared by the National Industrial Chemicals Notification and Assessment Scheme

Toxicity Summary - Potassium chloride

Chemical and Physical Properties[1,2,3,8,9,10]	
CAS number	7447-40-7
Molecular formula	KCl
Product name	--
Molecular weight	74.55 g/mol
Solubility in water	34.20 at 20 ◦C
Melting point	771.00 ◦C
Boiling point	1500 ◦C
Vapour pressure	White crystals or crystalline powder
Henrys law constant	No data found
Explosive potential	No data found
Flammability potential	Not explosive
Colour/Form	Not flammable
Overview	Potassium is an essential element in the body. It is the main intracellular cation with 98% of total body potassium located within the cells. It is mainly used in fertilisers, medicine, lethal injections, scientific applications, feedstock, food processing and as a sodium substitute in table salt. Potassium chloride is an essential element with homeostatic physiological processes regulating levels in the body. In cases of increased exposure to high levels of potassium significant health effects in people with kidney disease or other conditions, such as heart disease may result. Potassium chloride as an inorganic salt is not subjected to further degradation processes in the environment once it dissociates into its respective ions. In water, potassium chloride is highly water soluble, and readily undergoes dissociation. In soil, transport and leaching of potassium and chloride ions is affected by the clay minerals (type and content), pH, and organic matter. This chemical has been identified by NICNAS to be of low concern to human health based on an initial screening approach and thus required no further assessment.
Environmental Fate[1,3,8,9]	
Soil/Water/Air	KCl is a solid inorganic salt that is highly soluble in water (342 g/L at 20º C). Potassium chloride fully dissociates in aqueous solutions to K+ and Cl- ions. Cl, either as an inorganic salt or as K+ and Cl- ions, is ubiquitous in the environment. There is no potential for bioaccumulation or bioconcentration. Potassium and chloride ions are essential to all living organisms and their intracellular and extracellular concentrations are actively regulated.

Human Health Toxicity Summary [1,3,8,9]	
Chronic Repeated Dose Toxicity	Fourteen female rats were given KCl in their drinking water (approximately 5,250 mg/kg/day) for 105 days. Ten rats were sacrificed after 105 days of exposure for examination of the heart, kidneys and the adrenals; four rats (recovery group) were kept for an additional month. KCl exposure resulted in decreased heart weight, increased kidney weight, and enlargement of part of the adrenals. All changes were reversible within one month of exposure (Bacchus, 1951).F344/Slc male rats were given 0, 110, 450 or 1,820 mg/kg/day KCl in feed for two years. At the end of the study, survival rates were 48%, 64%, 58% and 84% in the controls, 110, 45 and 1,820 mg/kg/day groups. Nephritis was reported to be predominant in all groups, including the controls. The only treatment-related effect observed was gastritis(inflammation of the stomach lining). The incidence of gastritis and ulcers were 6%, 18%, 18% and 30% in the controls, 110, 450 and 1,820 mg/kg/day groups (Imai *et al.*, 1968). Male and female Wistar rats were fed diets containing 0 or 3% KCl over a total period of 30 months: Examination after 13 weeks (10 rats/sex/group), after 18 months (15 rats/sex/group) and after 30 months (50 rats/sex /group). Due to the reduction of feed intake the mean test substance intake and mean body weight decreased in time. After 30 months of treatment, there was hypertrophy of the zona glomerulosa in the adrenals (24/50 treated rats versus 4/50 in controls); and cystitis in the urinary bladder (males: 3/59; females 3/50) and single epithelial hyperplasia of the bladder (males 3/50; females 2/50) (Lina *et al.*, 1994; Lina and Kuijpers, 2004)**.**
Carcinogenicity	Potassium chloride has not been evaluated and is not listed by the IARC as a carcinogen. In a long-term study, male rats (50 per group) were fed potassium chloride in the diet at levels of 110, 450 or 1820 mg/kg bw/day for 2 years. No carcinogenic effects were observed in male rats.
Mutagenicity/ Genotoxicity	No gene mutation ns were reported in bacterial tests, with and without metabolic activation. However, high concentrations of potassium chloride showed positive results in a range of genotoxic screening assays using mammalian cells in culture. The action of potassium chloride in culture seems to be an indirect effect therefore further *in vivo* studies were not considered necessary.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	A developmental study revealed no foetotoxic or teratogenic effects of potassium chloridel in doses up to 235 mg/kg/day (mice) and 310 mg/kg/day (rats). No fertility study has been located. Further human and ecological assessment was not recommended by the OECD SIDS.
Acute Toxicity	Potassium chloride is an essential element with homeostatic physiological processes regulating levels in the body. In cases of increased exposure to high levels of potassium significant health effects in people with kidney disease or other conditions, such as heart disease may result. Adverse health effects due to consumption of potassium from drinking water are unlikely to occur in healthy individuals. Acute effects are rare in humans although under particular circumstances severe effects may occur. Lethal effects were observed in a 2 month old baby fed 15,000 mg potassium chloride for 2 days and in another case report where an adult woman had ingested slow released potassium chloride tablets (35, 000 mg). The most common form of ingestion is through drinking water. It is not considered necessary to establish a health-based guideline value for potassium in drinking water due to its lack of toxicity.
Irritation	Slight skin and eye irritant. A threshold concentration for skin irritancy of 60% was seen when potassium chloride in aqueous solution was in contact with skin of human volunteers. The threshold concentration when applied to broken skin was 5%.
Sensitisation	No data found.

Key Study/Critical Effect for Screening Criteria	In a two-year rat feeding study, there was an increased incidence of gastritis and ulcers at dose levels of >110 mg/kg/day (Imai *et al.*, 1968). There was no NOAEL. Thus, the LOAEL for this study is 110 mg/kgday. Since the gastritis and ulcers are the result of a localized irritation effect of the test substance (site of contact) in the gastrointestinal tract, an uncertainty factor for interspecies variability is deemed unnecessary. For systemic effects, the NOAEL for the two-year rat feeding study is considered to be 1,820 mg/kg/day, the highest dose tested. Uncertainty factors: 10 (intraspecies variability); 10 (interspecies variability); 1 (intraspecies variability) Oral Reference Dose = 1,820/100 = 18.2 mg/kg/day Drinking water guideline: 71 ppm
Ecological Toxicity [1,3,8,9,10]	
Aquatic Toxicity	In a guideline study, the 96-hour LC50 in *Pimephales promelas* was reported to be 880 mg/L (Mount *et al.*, 1997). The 48-hour LC50 values from two studies on *Lepomis macrochirus* (Patrick *et al.*, 1968; Trama, 1954), and one study each on *Oncorhyncusmykiss* and *Ictalurus punctatus* (Waller *et al.*, 1993) ranged from 720 to 2,010 mg/L. In a guideline study, the 48-hour EC50s in *Daphnia magna* and *Ceriodaphnia dubia* were660 and 630 mg/L, respectively (Mount *et al.*, 1997; ECHA REACH database). The 48-hour EC50 in *Daphnia magna* in another study was also reported to be 177 mg/L (Biesinger and Christensen, 1972).The toxicity of KCl has been investigated in one algae species (*Nitzschia linearis*), showing 120 hour-EC50 (growth rate) of 1,337 mg/L (Patrick *et al.*, 1968). The 72-hour EC50 to *Scenedesmus subspicatus* is >100 mg/L (growth rate), with a NOEC of >100 mg/L (ECHA REACH database). In a fish early-life-stage test with the fathead minnow (*Pimephales promelas*), the 7-day NOEC is 500 mg/L (ECHA REACH database). A long term (21-day) study has been performed on *Daphnia magna* where effects on reproduction were investigated for several metals. A 16% impairment of reproduction (LOEC) was observed at a concentration of 53 mg/L of K +, equal to KCl concentration of 101 mg/L (Biesinger and Christensen, 1972). The measured NOEC for Daphnia is 373 mg/L
Determination of PNEC aquatic	PNECaquatic: On the basis of the chronic results for Daphnia, an assessment factor of 100 has been applied to the lowest reported effect concentration of 373 mg/L. The PNECaquatic is determined to be 3.73 mg/L.
Current Regulatory Controls	
Australian Food Standards	No data found
Australian Drinking Water Guidelines	No data found
Aquatic Toxicity Guidelines	No data found
PBT Assessment[1,8,9,10]	
P/vP Criteria fulfilled?	Potassium chloride is an organic salt that dissociates completely to potassium and chloride ions in aqueous solutions. Biodegradation is not applicable to these inorganic ions; both potassium and chloride ions are also ubiquitous and are present in most water, soil and sediment. For the purposes of this PBT assessment, the persistent criteria is not considered applicable to this inorganic salt.
B/vB criteria fulfilled?	Potassium and chloride ions are essential to all living organisms and their intracellular and extracellular concentrations are actively regulated. Thus, potassium chloride is not expected to bioaccumulate.
T criteria fulfilled?	The measured chronic toxicity data for potassium chloride was 373 mg/L for Daphnia. Thus, potassium chloride does not meet the screening criteria for toxicity
Overall conclusion	Not PBT

References

1. WHO (2009). Potassium in drinking-water. Background document for development of Guidelines for Drinking-water Quality. World Health Organization WHO/HSE/WSH/09.01/7.
2. HSDB Hazardous Substance Databank (HSDB) Potassium Chloride. Toxnet http://toxnet.nlm.nih.gov U.S. National Library of Medicine.
3. IARC, 2009: IARC Monographs on the Evaluation of Carcinogenic Risks to Humans. International Agency for Research on Cancer. World Health Organisation.
4. Material Safety Data Sheet Potassium chloride. ScienceLabs.com Inc. http://www.sciencelab.com/msds.php?msdsId=9927402
5. WHO Poisons Information Monograph for Potassium Chloride. Electronic record accessed from www.inchem.org World Health Organization.
6. UNEP Potassium Chloride Screening Information Dataset (SIDS) Initial Assessment Report for 13th SIAM (Bern, 6-9 November 2001. United Nations Environment Programme (UNEP) http://www.inchem.org/documents/sids/sids/KCHLORIDE.pdf
7. ECHA REACH database: http://apps.echa.europa.eu/registered/registered-sub.aspx
8. IUCLID Data Set for Potassium chloride (CAS No. 7447-40-7), UNEP Publications.
9. OECD (2001b). OECD-Screening Information Assessment Report (SIAR) for Potassium chloride (CAS No. 7447-40-7), UNEP Publications.
10. Department of the Environment and Energy 2017 , National assessment of chemicals associated with coal seam gas extraction in Australia, prepared by the National Industrial Chemicals Notification and Assessment Scheme

Toxicity Summary - Talc

Chemical and Physical Properties [1,4]	
CAS number	14807-96-6
Molecular formula	H2-O3-Si 3/4Mg or Mg3Si4O10(OH)2
Molecular weight	78.10 (estimate)
Solubility in water	Insoluble in water, cold acids or in alkalis
pH	9.0 to 9.5
Melting point	800-900°C (disintegration; WHO 2005)
Boiling point	549.7°C (estimate)
Vapour pressure	NA
Henrys law constant	NA
Explosive potential	NA
Flammability potential	Not flammable
Colour/Form	white to gray-white, fine crystalline powder.
Overview	Talc finely powdered hydrous magnesium silicate mineral sometimes found in association with asbestos. After being mined, it is processed to remove impurities and powdered. Talc is a useful commercial product due to its fragrance retention, luster, purity, softness, and whiteness as well as its chemical inertness and oil and grease adsorption. Talc is a mineral composed of hydrated magnesium silicate. Talc refers to both mineral talc and industrial mineral products that are marketed under the name talc and contain proportions of mineral talc that range from about 35% to almost 100%. Industrial talc generally refers to products that contain abundant minerals other than talc; cosmetic talc now normally contains >98% talc but the content may have been lower in the past. Pharmaceutical talc contains >99% talc. Talcum powder is cosmetic-grade talc. This chemical has been identified by NICNAS to be of low concern to human health based on an initial screening approach and thus required no further assessment. Further assessment of the environmental risks from the use of this chemical is also not required.
Environmental Fate [2,3]	
Soil/Water/Air	As a mineral, talc does not biodegrade

Human Health Toxicity Summary [1,2]	
Chronic Repeated Dose Toxicity **Carcinogenicity**	Talc-based body powder, when used perineally, is classified by IARC as group 2B as possibly carcinogenic to humans. However, talc for general use not containing asbestos or asbestiform fibres is classified as group 3 as not classifiable to its carcinogenicity to humans. Talc containing asbestiform fibres is classified by IARC as group 1 for carcinogenic to humans. Talc alone failed to induce respiratory tumors, granulomas or mesothelial proliferation in a hamster study but produced tumours of the larynx, trachea and lungs when tested in association with benzo(a)pyrene. In a rat study of aerosol talc there was some evidence of carcinogenic activity of talc in male F344/N rats and clear evidence of carcinogenic activity in female F344/N rats. No evidence of carcinogenicity was evident in intraperitoneal or inhalation studies in hamsters. Male and female Wistar rats were given in their diet 0 or 50 mg/kg of commercial talc [characteristics unspecified] for the life of the animals (average survival was 702 and 649 days, respectively). There was no significant difference in the talc-fed animals compared with control animals (Gibel *et al.*, 1976). In humans and experimental animals, the effects of talc are dependent on the route of exposure, and the dose and properties of the talc. Talc pneumoconiosis was somewhat more prevalent and severe among miners exposed to talc containing asbestiform minerals and/or asbestos than among those exposed to talc without such contaminants. However, the role of quartz and asbestos in the observed pneumoconiosis could not be ruled out. Among drug users, intravenous injection of talc present as a filler in the drugs resulted in microembolization in a variety of organs and alterations in pulmonary function. In animal studies, talc has been shown to cause granulomas and mild inflammation when inhaled. Observations of the effects that occurred in the lungs of rats exposed by inhalation to talc suggested that the operative mechanisms may be similar to those identified for carbon black, and talc is known to cause the release of cytokines, chemokines and growth factors from pleural mesothelial cells. IARC: There is *inadequate evidence* in humans for the carcinogenicity of inhaled talc not containing asbestos or asbestiform fibres. There is *limited evidence* in experimental animals for the carcinogenicity of talc not containing asbestos or asbestiform fibres. Inhaled talc not containing asbestos or asbestiform fibres is *not classifiable as to its carcinogenicity (Group 3)*.
Mutagenicity/ Genotoxicity	Talc was not mutagenic in host-mediated assays in mice. It did not produce chromosomal aberrations or dominant lethal mutations in rats. The IARC (1987) review of talc included unpublished results from a 1974 study conducted by Litton Bionetics that showed no mutagenic activity for talc *in vitro* or *in vivo.* Talc did not induce mutations in *Salmonella typhimurium* strains TA1530 or HisG46, or in the yeast, *Saccharomyces cerevisiae.* No chromosomal aberrations were observed in human fibroblasts treated with talc *in vitro. In vivo* tests conducted in rats gave negative results for induction of chromosomal aberrations in bone marrow cells and dominant lethal mutations in germinal cells
Reproductive Toxicity **Developmental Toxicity/Teratogenicity**	No teratological effects were observed in hamsters, rats, mice, or rabbits after oral administration of 900-1600 mg/kg. No teratologic effects were observed in hamsters, rats, mice, or rabbits after oral administration of talc. The doses used were 1,600 mg/kg for rats and mice on days *6* through 15 of gestation; 1,200 mg/kg for hamsters on day 6 through 10 of gestation; and 900 mg/kg for rabbits on days 6 through 18 of gestation
Acute Toxicity	Acute inhalation exposure to talc causes symptoms such as cough, dyspnea, sneezing, vomiting, and cyanosis. Other inhalation exposure symptoms include diffuse pleural thickening and fibrous adhesions of pleural surfaces. Respiratory distress syndrome has been reported in children after massive accidental inhalation of talcum powder. Animal (rat, dog, rabbit) studies showed internal accumulation of talc after short- and long-term inhalation exposure as well as numerous lung afflictions such as fibrosis and inflammation.
Irritation	In monkey eyes, talc in the anterior chamber has induced persistent glaucoma. Talc can induce severe granulomatous reactions when introduced into wounds. It has induced granulomas in and about the human eye when as a dusting powder for surgeons' gloves.

Sensitisation	Talc particles are smaller than 1 um and these particles are respirable and produce an intense inflammatory response characterized by cough, rhinitis, dyspnea, and vomiting.
Health Effects Summary	This chemical has been identified by NICNAS to be of low concern to human health, and it is listed by the US Food and Drug Administration (FDA) as a Generally Recognised as Safe (GRAS) substance.
Key Study/Critical Effect for Screening Criteria	There are no adequate studies for which to derive am oral reference dose. Talc is poorly absorbed from the gastrointestinal tract, if at all, and the limited data available by the oral route indicate that talc is essentially non-toxic by the oral route of exposure
Ecological Toxicity [2,3,4]	
Aquatic Toxicity	No data were found. Talc is expected to have low toxicity to the environmental based on its ubiquity in the environment, its low bioavailability, and its widespread use in consumer products (Zazenski et al. 1995).
Determination of PNEC aquatic	PNEC values for talc cannot be calculated.
Current Regulatory Controls	
Australian Hazard Classification	No data available
Australian Occupational Exposure Standards	TWA: 2.5 mg/m^3
International Occupational Exposure Standards	NIOSH: TWA 2 mg/m^3
Australian Food Standards	No data available
Australian Drinking Water Guidelines	No data available
Aquatic Toxicity Guidelines	No data available
PBT Assessment [4]	
P/vP Criteria fulfilled?	Talc does not biodegrade in the environment. It is a naturally-occurring mineral and is persistent in the environment. However, for the purposes of this PBT assessment, it does not meet the criteria for persistence.
B/vB criteria fulfilled?	Talc is not expected to be bioavailable to aquatic organisms; thus, it is does not meet the criteria for bioaccumulation
T criteria fulfilled?	Talc is not expected to be bioavailable to aquatic organisms; thus, it is does not meet the criteria for toxicity.
Overall conclusion	It is not currently possible to categorise the environmental hazards of metals and other inorganic chemicals according to standard persistence, bioaccumulation and toxicity (PBT) hazard criteria. These criteria were developed for organic chemicals and do not take into account the unique properties of inorganic substances and their behaviour in the environment (UNECE 2007; US EPA 2007).
Revised	April 2018

References

1. HSDB (n.d.). *Hazardous Substances Data Bank*. Retrieved 2015, from Toxnet, Toxicology Data Network, National Library of Medicine: http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB

2. IARC (2010) Carbon Black, Titanium Oxide and Talc. Volume 93. International Agency for Research on Cancer Monographs on the Evaluation of Carcinogenic Risks to Humans. Available at http://monographs.iarc.fr/ENG/Monographs/vol93/mono93.pdf.

3. Pfizer (2006) Material Safety Data Sheet for Gemfibrozil Tablets, 90mg. Available at http://www.pfizer.com/files/products/material_safety_data/CI-719.pdf.

4. Department of the Environment and Energy 2017 , National assessment of chemicals associated with coal seam gas extraction in Australia, prepared by the National Industrial Chemicals Notification and Assessment Scheme

Toxicity Summary - Fatty acids, tall-oil, ethoxylated

Chemical and Physical Properties[1]	
CAS number	61791-00-2
Molecular formula	C(18-50)H(34-98)O(3-8)
Molecular weight	UVCB
Solubility in water	No data available.
Melting point	-85 °C at 101.3 kPa
Boiling point	No data available.
Vapour pressure	No data available.
Henrys law constant	No data available.
Explosive potential	Non-explosive (100%)
Flammability potential	Not classified
Colour/Form	Liquid
Overview	This substance is used by consumers, in articles, by professional workers (widespread uses), in formulation or re-packing, at industrial sites and in manufacturing.
Environmental Fate[1]	
Soil/Water/Air	One study investigating the adsorption/desorption behaviour of Fatty acids, tall-oil, ethoxylated (CAS 61791-00-2) is available. The study was performed according to GLP and OECD guideline 121 (BASF 2017). 6 different peaks were observed with log Koc values ranging from < 1.8 to > 5.63. The two main components (> 85%) show log Koc values > 4. Thus, adsorption of Fatty acids, tall-oil, ethoxylated to solid soil is expected. The test with the source substance was conducted according to OECD Guideline 301B, under GLP conditions (BASF 2005). Domestic, non-adapted activated sludge was exposed to the test substance for 28 days at 22°C, and biodegradation was measured by CO2 consumption. After 28 days, the test substance reached a biodegradation of 90 - 100 %. Based on the results for the read-across substance, Fatty acids, tall oil, ethoxylated (EO > 1 < 2.5) (CAS 61791-00-2) is considered to be readily biodegradable. The test substance consists of components with log Kow values in the range of 5 to > 10 (KOWWIN v1.68) indicating a potential for bioaccumulation. But due to rapid environmental biodegradation, metabolisation via enzymatic hydrolysis (monoesters and diesters) as well as sterical hindrance of crossing biological mebranes (high molecular weight of diesters) a relevant uptake and bioaccumulation in aquatic organisms is not expected. This is supported by low BCF values of < 100 L/kg ww (BCFBAF v3.01, Arnot-Gobas, including biotransformation, upper trophic) calculated for different components of the UVCB (mono- and diester EO1 to EO5). Thus, taking all information into account, the test substance is not considered to be bioaccumulative.
Human Health Toxicity Summary [1]	
Chronic Repeated Dose Toxicity	Under the conditions of this Combined Repeated Dose Toxicity Study with the Reproduction/Developmental Toxicity Screening Test, the oral administration by gavage of test substance to Wistar rats revealed no adverse signs of toxicity in male and female animals at a dose level of 1000 mg/kg bw/d. Thus, the no observed adverse effect level (NOAEL) for general systemic toxicity was 1000 mg/kg bw/d for male and female Wistar rats.
Carcinogenicity	No data available.
Mutagenicity/ Genotoxicity	The test substance is not mutagenic in bacteria, as determined in an OECD 471 study. The test substance is not chromosome damaging, as determined in an OECD 487 study.

	The test substance is not mutagenic in mammalian cells, as determined in an OECD 476 study.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	Under the conditions of this Combined Repeated Dose Toxicity Study with the Reproduction/Developmental Toxicity Screening Test, the oral administration by gavage of the test substance to Wistar rats revealed no adverse signs of toxicity in male and female animals at a dose level of 1000 mg/kg bw/d. Thus, the no observed adverse effect level (NOAEL) for general systemic toxicity was 1000 mg/kg bw/d for male and female Wistar rats. The NOAEL for reproductive performance and fertility was set to 1000 mg/kg bw/d for male and female Wistar rats.
Acute Toxicity	In an acute oral toxicity study performed similar to OECD guideline 401 (BASF 1971), three groups of rats consisting of 10 animals/sex/dose were treated by single gavage application with an aqueous solution of the test substance (10000, 8000, 6400 mg/kg bw). The animals were observed for mortality and for clinical symptoms of toxicity over a period of 7 days. At the end of the observation period, the surviving animals were sacrificed for the purpose of necropsy. No mortality occurred at the tested concentrations. At all doses mastication, irregular breathing, redness of the eyes and closed eyes were seen immediately after dosing. The next morning mastication and irregular breathing was observed. On the following days, no clinical sings were observed. Pathological examination revealed hydrometra in 3 animals exposed to 10000 mg/kg bw, 2 animals exposed to 8000 mg/kg bw, and 3 animals exposed to 6400 mg/kg bw. Based on the results obtained under the test conditions of this study, the acute oral LD50 was determined to be > 10000 mg/kg bw. To evaluate the potential acute inhalation toxicity of the test substance an Inhalation Risk Test conducted according to a BASF internal testing method (BASF 1971). The test demonstrates the toxicity of an atmosphere saturated with vapours of the volatile components of a test substance at the temperature chosen for vapour generation (20 °C). Rats were exposed sequentially to the vapours, generated by bubbling 200 l/h air through a substance column of about 5 cm above a fritted glass disc in a glass cylinder. The animals were exposed for 8 hour. The exposure concentration was estimated to be 0.28 mg/L based on evaporated substance. In addition to mortality, clinical signs were recorded and necropsy on surviving animals performed. No mortality occurred and no clinical sign were noted during exposure and observation period. In one animal exposed for 8 hours hydrometra was observed after necropsy. Since no mortality occurred at the concentrations tested an LC50 estimation cannot be made. In another Inhalation Risk Test of similar design, Rats (12 animals) were exposed sequentially to the vapours, generated by bubbling 200 l/h air through a substance column of about 5 cm above a fritted glass disc in a glass cylinder. This time vapours were generated at 20 °C as well as 50 °C. The exposure concentrations were 0.04 mg/L and 0.34 mg/L. Rats were exposed for 8 hour. As in the previous study, no mortality occurred after exposure up to 8 hours. Clinical sings observed in the animals exposed to the vapour generated at 20°C included mild escape attempts when exposure began and at the end of the exposure period slight eye irritation was observed. The next day, the animals were without symptoms. In the animals exposed to the vapour generated at 50 °C escape attempts were noted in the first 60 minutes of exposure. Exposure to the saturated atmosphere caused slight eye irritation. At the end of the exposure period, all clinical signs were resolved. Since no mortality occurred at the concentrations tested an LC50 estimation cannot be made. Based on the inhalation studies, no conclusion on LC50 can be drawn, because the tested concentrations are too low in relation to the classification criteria.
Irritation	The test substance was not irritant or corrosive to the skin in a GLP-compliant OECD 431 and 439 study. The test substance was not irritant to the eyes in a GLP-compliant OECD 492 study. Based on the available information, classification for skin and eye irritation is not warranted, in accordance with EU Classification, Labelling and Packaging of Substances and Mixtures (CLP) Regulation No. (EC) 1272/2008.

Sensitisation	The test substance did not show an indication of skin sensitising potential in an OECD 429 (LLNA) study. However, an earlier Buehler test (OECD 406) did indicate skin sensitising potential of the substance.
Health Effects Summary	Possible sensitiser.
Key Study/Critical Effect for Screening Criteria	The oral repeated dose toxicity in rats was considered the most sensitive endpoint with a NOAEL of 1000 mg/kg bw/day.
Ecological Toxicity [1]	
Aquatic Toxicity	Short-term toxicity tests with the target substance for all trophic levels (fish, daphnia, algae) are available. The test substance did not indicate to be harmful to freshwater fish (96h-LL50 > 100 mg/L), but showed to be toxic to aquatic invertebrates (48h-EL50 = 12.41 mg/L) and harmful to algae (72h-EL50 = 39.7 mg/L). Hence, aquatic invertebrates were most susceptible to the test substance and this effect value was used for the PNEC derivation. Long-term toxicity data with the source substance are only available for algae. The algal test revealed the substance to be of low toxicity to algae (72h-EL10 = 7.08 mg/L). In addition, data are available for toxicity to microorganisms. A test on respiration inhibition with activated sludge resulted in an 3h-EC10 of > 10000 mg/L indicating that detrimental effects in STPs are not to be expected.
Determination of PNEC aquatic	A PNECaqua = 0.012 mg/L can be calculated based on the lowest acute toxicity value (EL50 = 12.41 mg/L) for aquatic invertebrates (Daphnia) with the assessment factor of 1000.
Current Regulatory Controls	
Australian Hazard Classification	No data available.
Australian Occupational Exposure Standards	No data available.
International Occupational Exposure Standards	No data available.
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	No data available.
PBT Assessment[1]	
P/vP Criteria fulfilled?	No. Based on the results from the read-across substance, Fatty acids, tall oil, ethoxylated (EO > 1 < 2.5) (CAS 61791-00-2) is considered to be readily biodegradable.
B/vB criteria fulfilled?	No. The test substance consists of components with log Kow values in the range of xx to > 10 (KOWWIN v1.68) indicating a potential for bioaccumulation. But due to rapid environmental biodegradation, metabolisation via enzymatic hydrolysis (monoesters and diesters) as well as sterical hindrance of crossing biological membranes (high molecular weight of diesters) a relevant uptake and bioaccumulation in aquatic organisms is not expected. This is supported by low BCF values of < 100 L/kg ww (BCFBAF v3.01, Arnot-Gobas, including biotransformation, upper trophic) calculated for different components of the UVCB (mono- and diester EO1 to EO5). Thus, taking all information into account, the test substance is not considered to be B or vB.
T criteria fulfilled?	No. Available short-term and long-term toxicity tests with aquatic organisms resulted in effect values > 1 mg/L. Thus, this substance does not meet the screening criteria for toxicity.
Overall conclusion	Not PBT

Revised	January 2019

References

1. ECHA REACH, Fatty acids, tall-oil, ethoxylated, Retrieved 2019: https://echa.europa.eu/

Toxicity Summary - Hexadec-1-ene

Chemical and Physical Properties[1,2,3]	
CAS number	629-73-2
Molecular formula	C16H32
Molecular weight	224.42
Solubility in water	0.00144 at 25°C
Melting point	4.1
Boiling point	284.9 at 1013 hPa
Vapour pressure	0.00352 hPa at 25°C
Henrys law constant	0.541 – 16.9 atm-m^3/mole
Explosive potential	No data available
Flammability potential	No data available
Colour/Form	Hexadec-1-ene are liquids at room temperature.
Overview	Hexadec-1-ene also known as 1-hexadecene are mono-olefins. It is an alkene in the C6-C18 range. These products are produced commercially in closed systems and are used primarily as intermediates in the production of other chemicals. No non-intermediate applications have been identified. Any occupational exposures that do occur are most likely by the inhalation and dermal routes.
Environmental Fate[1]	
Soil/Water/Air	Members of this category do not contain any hydrolysable functional groups, so will not undergo hydrolysis. Category members with carbon numbers from C6 to C24 have been shown to be readily biodegradable in biodegradation screening tests. The estimated half-life of 1-hexene in air is 10.2 hours. The soil adsorption coefficients (Koc) range from 149 for C6 to 230,800 for C18, indicating increasing partitioning to soil/sediment with increasing carbon number. It is expected that C16-C18 olefins would partition primarily to soil. Volatilization from water is predicted to occur rapidly (hours to days).
Human Health Toxicity Summary[1,2,3]	
Chronic Repeated Dose Toxicity	Repeated-dose studies, using the inhalation (C6 alpha), dermal (C12-C16), or oral (C6 alpha and internal linear/branched; C8 and C14 alpha; and C16, C18 and C20-C24 internal linear/branched) routes of exposure, have shown comparable levels of low toxicity in rats. In females, alterations in body and organ weights, changes in certain clinical chemistry/hematology values, and liver effects were noted (NOELs of ≥ 100 mg/kg oral or ≥ 3.44 mg/L (1000 ppm) inhalation). In males, alterations in organ weights, changes in certain clinical chemistry/hematology values, liver effects, and male rat-specific kidney damage that is likely associated with the alpha 2- globulin protein were noted (LOELs ≥ 100 mg/kg oral only). The male rat kidney damage was seen in oral studies with C6, C8 and C14 linear alpha olefins and C6 internal branched olefins, but was not seen in studies with C16/C18 or C20 - C24 internal linear/branched olefins. The noted liver effects were seen in oral studies with C14 alpha olefins (minimal-to-mild hepatocyte cytoplasmic vacuolation with increased liver weight in males and females) and with C20-C24 internal olefins (minimal centrilobular hepatocyte hypertrophy with increased liver weight in females only). No effects were present in the study with C20-C24 internal olefins following a 4-week recovery period, indicating reversibility of the observed effects. These liver effects seen only with the larger molecules may be indirect effects of an intensified liver burden, rather than a direct toxic effect of the olefin. Based on evidence from neurotoxicity screens included in repeated dose studies with C6 and C14 alpha olefins and with C6, C16/C18 and C20-C24 internal linear/branched olefins, the category members are not neurotoxic.

Carcinogenicity	No carcinogenicity tests have been conducted on C6 – C18 alpha or internal olefins; however, there are no structural alerts indicating a potential for carcinogenicity in humans.
Mutagenicity/ Genotoxicity	Based on the weight of evidence from studies with alpha and internal olefins, category members are not genotoxic.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	Based on evidence from reproductive/developmental toxicity screens in rats with C6 and C14 alpha olefins and C6 and C18 linear/branched internal olefins, along with the findings of no biologically significant effects on male or female reproductive organs in repeated dose toxicity studies, the category members are not expected to cause reproductive or developmental toxicity.
Acute Toxicity	Olefins (alkenes) ranging in carbon number from C6 to C24, alpha (linear) and internal (linear and branched) demonstrate low acute toxicity by the oral, inhalation and dermal routes of exposure: Rat oral LD50 >5 g/kg; rat 4-hr inhalation LC50 range = 110 mg/L (32,000 ppm) to 6.4 mg/L (693 ppm) for C6 to C16; and rat/rabbit dermal LD50 > highest doses tested (1.43 - 10 g/kg).
Irritation	These materials are not eye irritants. Prolonged exposure of the skin for many hours may cause skin irritation.
Sensitisation	These materials are not skin sensitizers.
Health Effects Summary	Olefins (alkenes) ranging in carbon number from C6 to C24, alpha (linear) and internal (linear and branched) demonstrate low acute and chronic toxicity by the oral, inhalation and dermal routes of exposure.
Key Study/Critical Effect for Screening Criteria	The repeated dose toxicity in rats was considered the most sensitive endpoint with a NOEL of 100 mg/kg.
Ecological Toxicity [1,2,3]	
Aquatic Toxicity	Short term toxicity 96-hr LC50 > solubility Actual concentration negligible. Fish 96-hr LL0 = 1000 mg/L (nominal) Long term toxicity: NOEC (21 days) 19.4 µg/L (invertebrates)
Determination of PNEC aquatic	An assessment factor of 1000 is applied to the lowest NOEC of 19.4 µg/L (invertebrates). A PNECaqua of 0.0019 µg/L was derived.
Current Regulatory Controls[4]	
Australian Hazard Classification	No data available.
Australian Occupational Exposure Standards	No data available.
International Occupational Exposure Standards	No data available.
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	No data available.
PBT Assessment[1,2]	
P/vP Criteria fulfilled?	No. Readily biodegradable. The C6-C18 olefins have been shown to degrade to an extent of approximately 8 to 81% in standard 28-day biodegradation tests.
B/vB criteria fulfilled?	No. Based on calculated bioconcentration factors, hexadec-1-ene are not expected to bioaccumulate (BCF = 71).

T criteria fulfilled?	No. Chronic toxicity data >0.01 mg/L in fish, thus the substance does not meet the screening criteria for toxicity.
Overall conclusion	Not PBT
Revised	December 2021

References

1. ECHA REACH, Hexadec-1-ene, Retrieved 2021: https://echa.europa.eu/
2. OECD (2005) SIDS Initial Assessment Profile on Higher Olefins
3. NCBI, 2021. National Center for Biotechnology Information. Available at: https://pubchem.ncbi.nlm.nih.gov/. Retrieved December 2021.
4. ANZG, 2018. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia. Available at www.waterquality.gov.au/anz-guidelines.
5. NHMRC, 2018. Australian Drinking Water Guidelines 6, 2011, Version 3.5 Updated August 2018. National Water Quality Management.
6. HCIS, Hazardous Chemical Information System, Safe Work Australia, Retrieved December 2021: http://hcis.safeworkaustralia.gov.au/HazardousChemical.
7. ILO, International Labour Organisation, International Chemical Safety Cards (ICSCs), Retrieved December 2021: http://www.ilo.org/dyn/icsc/showcard.listcards3?p_lang=en.

Toxicity Summary - Poly(vinylidene chloride-co-methyl acrylate)

Chemical and Physical Properties [1,2, 3,4,5]	
CAS number	25038-72-6
Molecular formula	$(CH_2CCl_2)_x[CH_2CH(CO_2CH_3)]_y$
Molecular weight	Assumed to be greater than 1,000 Da
Solubility in water	Not soluble in water
pH	No data found
Melting point	No data found
Boiling point	80.2 ^oC
Vapour pressure	86.3 mm/Hg at 25C
Henrys law constant	No data found
Explosive potential	Stable under recommended storage and use conditions. Fine dusts of these resins are capable of forming.
Flammability potential	No data found
Colour/Form	White odourless granules
Overview	Poly(Vinylidene Chloride-Co-Methyl Acrylates) are polyvinylidene chloride (PVDC) copolymer made from polymerizing vinylidene chloride with comonomers like vinyl chloride and alkyl acrylates. This polymer is used extensively in packaging applications for food, pharmaceuticals, hygiene products, and sterilized medical products. It offers excellent barrier performance to moisture, oxygen, and doors. The resins are essentially non-irritating to the eyes and skin. Dust may cause temporary mechanical irritation to the skin and eyes under extreme conditions. However, it is considered to present no significant health hazard. The polymers are expected to be inert in the environment. They are unlikely to accumulate in the food chain, and are practically nontoxic to aquatic organisms on an acute basis. There is a significant lack of toxicological data related to this polymer and suitable surrogates are not readily available. The polymers are relatively stable and inert and unlikely to present health concerns based on chemical considerations. As this product is a granular substance, dusting potential and particulate inhalation (physical hazard) may warrant further investigation for occupational concerns and large-scale environmental release of the powder in close proximity to residential areas. This chemical has been identified by NICNAS to be of low concern to human health based on an initial screening approach and thus required no further assessment. Further assessment of the environmental risks from the use of this chemical is also not required.

Environmental Fate [1,2,3]	
Soil/Water/Air	Poly(Vinylidene Chloride-Co-Methyl Acrylates) are inert polymers that are not soluble in water and will sink into sediment or float depending on product density. No appreciable biodegradation is expected, but surface photodegradation with exposure to sunlight and degradation due to mechanical action would be expected. Poly(Vinylidene Chloride-Co-Methyl Acrylates) are not expected to accumulate in the food chain due to their relatively high molecular weight (bioconcentration potential is low). They are practically nontoxic to fish and aquatic organisms on an acute basis.
Human Health Toxicity Summary [1,3,4]	
Chronic Repeated Dose Toxicity	Repeated exposures to dusts are not anticipated to result in systemic toxicity or permanent lung injury, however, excessive exposures may cause less severe respiratory effects.
Carcinogenicity	No data found.
Mutagenicity/ Genotoxicity	No data found.
Reproductive Toxicity Developmental Toxicity/Teratogenicity	No data found.
Acute Toxicity	No data found.
Irritation	Contact with solids or dusts may cause irritation or corneal injury due to mechanical action. Thermal degradation of the polymer may generate hydrogen chloride gas at concentrations that may cause eye irritation. Dust may cause irritation to upper respiratory tract (nose and throat). Thermal degradation of the resin may generate hydrogen chloride gas at concentrations that may cause respiratory irritation. Material has very low toxicity if swallowed. Harmful effects are not anticipated from swallowing small amounts.
Sensitisation	Brief contact is essentially non-irritating. Prolonged contact may cause slight irritation with local redness.
Health Effects Summary	This chemical has been identified by NICNAS to be of low concern to human health.
Key Study/Critical Effect for Screening Criteria	No data found.
Ecological Toxicity [2,3,5]	
Aquatic Toxicity	This polymer has no readily dissociable function groups and thus expected to be non-ionic species in the environment. The methylacrylate-vinylidene chloride copolymer is not expected to be highly soluble in water based on its predominantly hydrophobic structure. If discharged to the aquatic environment, this polymer is expected to partition to soil or sediment. It is not expected to be highly mobile if released to the soil compartment (Beothling and Nabholz 1997). As such, this polymer is expected to have low bioavailability and their adverse effects results from physical effects such as occlusion of respiratory organs (e.g. the gills of fish). These adverse effects occur only at very high loading levels in water (Beothling and Nabholz, 1997). Therefore, this polymer is expected to have low toxicity to aquatic life.
Determination of PNEC aquatic	This chemical has been identified by NICNAS to be of low concern to the environment and has not been assessed further.
Current Regulatory Controls[2]	
Australian Hazard Classification	No data found
Australian Occupational Exposure Standards	No data found

International Occupational Exposure Standards	No data found
Australian Food Standards	No data found
Australian Drinking Water Guidelines	No data found
Aquatic Toxicity Guidelines	No data found
PBT Assessment [1,3,4,6]	
P/vP Criteria fulfilled?	The polymers are synthetic addition polymers with stable carbon-chain backbones. If released to the environment, the polymers in this group are not expected to undergo rapid degradation, and are considered to be Persistent according to domestic hazard criteria (EPHC 2009).
B/vB criteria fulfilled?	Polymers with a NAMW greater than 1,000 Da cannot cross biological membranes (Nabholz 1997). Therefore, this polymer is considered to be not bioaccumulative according to domestic hazard criteria (EPHC 2009).
T criteria fulfilled?	No relevant toxicity data are available. This polymer is not expected to be toxic according to domestic environmental hazard criteria (EPHC 2009).
Overall conclusion	Not PBT

References

1. Vinylidene Chloride Monomer and Polymers. A technical report on VDC and PVDC. Kirk-Othmer: Encyclopaedia of Chemical Technology, Fourth Edition, Vol. 24, John Wiley and Sons Inc. 1997.
2. Saran PVDC Resins and Films and the Environment. The Dow Chemical Company, 2005.
3. Saran Polyvinylidene Chloride (PVDC) Resins, Product Safety Assessment. The Dow Chemical Company, 2013.
4. Sigma-Aldrich Co., (2011) *Product Identification: Poly(vinylidene chloride-co-methyl acrylate)*. Sigma- Aldrich 3050 Spruce St.St. Louis, MO 63103. From http://www.sigmaaldrich.com/catalog/ProductDetail.do?D7=0&N5=SEARCH_CONCAT_PNO|BRAND_KEY&N4=430404|ALDRICH&N25=0&QS=ON&F=SPEC
5. Department of the Environment and Energy 2017 , National assessment of chemicals associated with coal seam gas extraction in Australia, prepared by the National Industrial Chemicals Notification and Assessment Scheme

Toxicity Summary - 2-Propenoic acid, polymer with sodium phosphinate and 2-Propenoic acid, sodium salt, polymer with 2-propenamide

Chemical and Physical Properties[1,2,3]	
CAS number	129898-01-7 25085-02-3
Molecular formula	(C3H4O2.H3O2P.Na)x.xNa (C3H5NO.C3H4O2.Na)x
Molecular weight	Likely >1000 MW
Solubility in water	No data available.
Melting point	No data available.
Boiling point	No data available.
Vapour pressure	No data available.
Henrys law constant	No data available.
Explosive potential	No data available.
Flammability potential	No data available.
Colour/Form	No data available.
Overview	No studies are available. The polymer is not expected to be readily biodegradable. Biodegradation is limited due to the very high molecular weight and the low water solubility of the polymer. Due to its high molecular weight, the polymer is not expected to bioaccumulate. This chemical has been identified by NICNAS to be of low concern to human health and thus required no further assessment.
Environmental Fate[2]	
Soil/Water/Air	The polymer is not expected to be readily biodegradable. Biodegradation is limited due to the very high molecular weight and the low water solubility of the polymer. Due to its high molecular weight, the polymer is not expected to bioaccumulate.
Human Health Toxicity Summary	
Chronic Repeated Dose Toxicity	No data available.
Carcinogenicity	No data available.
Mutagenicity/ Genotoxicity	No data available.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	No data available.
Acute Toxicity	No data available.
Irritation	No data available.
Sensitisation	No data available.
Health Effects Summary	This chemical has been identified by NICNAS to be of low concern to human health.
Key Study/Critical Effect for Screening Criteria	No data available.
Ecological Toxicity[2]	

Aquatic Toxicity	Limited information is available. The polymer is expected to be a low concern for toxicity to aquatic organisms. Due to its poor solubility and high molecular weight, it is not expected to be bioavailable. It does not contain any reactive functional groups.
Determination of PNEC aquatic	No PNEC values were calculated.
Current Regulatory Controls	
Australian Hazard Classification	No data available.
Australian Occupational Exposure Standards	No data available.
International Occupational Exposure Standards	No data available.
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	No data available.
PBT Assessment	
P/vP Criteria fulfilled?	The polymer is not readily biodegradable, hence it meets the screening criteria for persistence.
B/vB criteria fulfilled?	The polymer is expected to have a very high molecular weight and poor water solubility. It is not expected to be bioavailable, hence this polymer does not meet the criteria for bioaccumulation.
T criteria fulfilled?	There are no aquatic toxicity studies on the polymer. It is expected to have low concern for aquatic toxicity because of its very high molecular weight and poor water solubility. As such, the polymer does not meet the criteria for toxicity.
Overall conclusion	Not PBT
Revised	April 2022

References

1. National Industrial Chemicals Notification and Assessment Scheme (NICNAS). IMAP, Human Health Tier 1 Assessment. Retrieved: https://www.nicnas.gov.au
2. Categorization Results from the Canadian Domestic Substance List, 2-Propenoic acid, polymer with sodium phosphinate
3. U.S National Library of Medicine, Toxicology Data Network, ChemIDplus, CAS#38193-60-1. Accessed https://chem.nlm.nih.gov/chemidplus/rn/38193-60-1

Toxicity Summary - Aliphatic Alcohols, ethoxylated

Chemical and Physical Properties[1]	
CAS number	68951-67-7
Molecular formula	No data available.
Molecular weight	No data available.
Solubility in water	Soluble in water
Melting point	-3 °C
Boiling point	No data available.
Vapour pressure	No data available.
Henrys law constant	No data available.
Explosive potential	No data available.
Flammability potential	No data available.
Colour/Form	Yellow liquid, mild odour
Overview	Principle Route of Exposure: Eye or skin contact, inhalation Causes severe eye irritation which may damage tissue. Causes skin irritation. Harmful if swallowed. Limited data is available for CAS #68951-67-7, as such read across data from CAS #69227-22-1 has been utilised.
Environmental Fate[1]	
Soil/Water/Air	This substance is expected to be readily biodegradable (84% @ 28d) (similar substances). Based on an estimated log Kow value of 4.3 – 5.36, and BCF value of 1.1 – 1.8, it is not expected to be bioaccumulative. Mobility in soil: KOC = >4
Human Health Toxicity Summary [1]	
Chronic Repeated Dose Toxicity	No data available to indicate product or components present at greater than 0.1% are chronic health hazards.
Carcinogenicity	Did not show carcinogenic effects in animal experiments (similar substances)
Mutagenicity/ Genotoxicity	In vitro tests did not show mutagenic effects. In vivo tests did not show mutagenic effects. (similar substances)
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	Animal testing did not show any effects on fertility.
Acute Toxicity	LD50 Oral: 600 mg/kg (Rat) (similar substance) LD50 Dermal: > 5200 mg/kg (Rabbit) (similar substance) LD50 Inhalation: > 0.22 mg/L (saturated concentration) (Rat) (similar substance)
Irritation	May cause mild respiratory irritation. Causes severe eye irritation which may damage tissue. Causes skin irritation.
Sensitisation	Did not cause sensitization on laboratory animals (guinea pig) (similar substances)
Health Effects Summary	Causes severe eye irritation which may damage tissue. Causes skin irritation. Harmful if swallowed.
Key Study/Critical Effect for Screening Criteria	

Ecological Toxicity [1]	
Aquatic Toxicity	Acute Toxicity to fish: NOEC 2.19 mg/L (fathead minnow) NOEC 0.740 mg/L (fathead minnow) Chronic Toxicity to fish: NOEC 0.280 mg/L (fathead minnow) NOEC 0.160 mg/L (fathead minnow) Acute Toxicity to invertebrates: EC50 0.510 mg/L (Daphnia magna) EC50 0.247 mg/L (Daphnia magna) Acute Toxicity to algae: EC50 1.90 mg/L (duckweed)
Determination of PNEC aquatic	On the basis that the data consists of short term results from three trophic levels, an assessment factor of 1000 has been applied to the lowest reported effect concentration of 0.14 mg/L for Daphnia. The PNEC aquatic is 0.14 µg/L.
Current Regulatory Controls [1]	
Australian Hazard Classification	H302 - Harmful if swallowed H315 - Causes skin irritation H318 - Causes serious eye damage
Australian Occupational Exposure Standards	No data available.
International Occupational Exposure Standards	No data available.
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	No data available.
PBT Assessment	
P/vP Criteria fulfilled?	No. Expected to be readily biodegradable.
B/vB criteria fulfilled?	No. Based on an estimated log Kow value of 4.3 – 5.36, and BCF value of 1.1 – 1.8, it is not expected to be bioaccumulative.
T criteria fulfilled?	No. The acute aquatic toxicity of this chemical is >0.01 mg/L. Thus, it is not expected to meet the screening criteria for toxicity.
Overall conclusion	Not PBT
Revised	April 2022

References

1. Halliburton Safety data sheet Date / Revised: 07.02.2018 Version: 19 Product: DCA-32002
2. USEPA CompTox Chemicals Dashboard, retrieved April 2022: https://comptox.epa.gov/dashboard/chemical/hazard/DTXSID5041936

Toxicity Summary - Diutan/Duitan Gum

Chemical and Physical Properties [1]	
CAS number	595585-15-2 and 125005-87-0
Molecular formula	(C6H12O6. C6H12O5. C6H10O7)x.xC2H4O2. xCa.xK.xMg.xNa
Molecular weight	> 1,000,000 g/mol
Solubility in water	6.3 g/L at pH 1 @ 200C > 40 g/L at pH range 7 and 10 @ 200C
pH	No data found.
Melting point	Duitan decomposed from approximately 175 ± 0.5C without melting.
Boiling point	No data found.
Vapour pressure	≈ 0.1 kPa at 25 C
Henrys law constant	NA
Explosive potential	Not explosive
Flammability potential	Not flammable
Colour/Form	White to tan powder
Overview	The polymer Diutan is suitable for a wide variety of thickening and suspending applications. Diutan is likely to be used in the following categories of application: cementitious packaged products, viscosifier for spacer fluids, and viscosifier for oil field drilling fluid, oil field cementing, firefighting foams, concrete, tyre /pneumatic application sealants, cleaners and coatings. There is limited toxicological data available for Diutan. The following information below is obtained from the National Industrial Chemicals Notification and Assessment Scheme (NICNAS).
Environmental Fate [1]	
Soil/Water/Air	The polymer, Duitan is expected to be highly mobile in solids and was found to be readily biodegradable via biotic and abiotic processes under the OECD TG 301 B Ready Biodegradability: CO2 Evolution Test. Based on the molecular weight, water solubility and Kow value (log Kow -2.76) the polymer is not expected to bioaccumulate.

Human Health Toxicity Summary [1]	
Chronic Repeated Dose Toxicity	In a 28-day oral repeat dose study in rats, a No Observed Effect Level (NOEL) was established as 1000 mg/kg bw/day, based on the absence of treatment related effects.
Carcinogenicity	Diutan not listed as an IARC carcinogen
Mutagenicity/ Genotoxicity	The polymer was not mutagenic to bacteria and not clastogenic to human lymphocyte treated in vitro.
Reproductive Toxicity Developmental Toxicity/Teratogenicity	No data found.
Acute Toxicity	The polymer is of low acute toxicity via the oral route. Dermal toxicity was not tested. An acute inhalation study in rats showed effects that were seen in both the test and control animals to a similar extent, and therefore cannot be attributed to the notified polymer. However the level of airborne dust achieved in this study (0.316 mg/L) was well below the cutoff of 5 mg/L for determining hazard classification for this endpoint. The U.S. Environmental Protection Agency (USEPA) identified concerns for lung effects from inhalation exposure to the notified polymer when it was assessed as a new chemical in the USA, based on structural analogues and submitted test data. The concern is that fine respirable particles of a high molecular weight substance, when inhaled deep into the lungs, would absorb water and cause congestion (communication from notifier). While the USEPA does not expect water-soluble polymers to exhibit lung toxicity because they are expected to rapidly clear the respiratory tract and therefore not cause an overloading effect, they require testing on new chemicals of this type under their exposure –based authority (USEPA, 2006). In this case the USEPA considered that significant inhalation exposure would not occur under the use conditions described for the USA, but that significant human exposure could occur under other scenarios. They have therefore recommended that a 90-day inhalation study with 60-day holding period be performed if additional applications for the chemical commence.
Irritation	Based on a study in rabbits the polymer is considered to be slightly irritating to the eyes, but not classifiable. A dermal irritation study was carried out on an analogue chemical containing the same monosaccharide units, but with a different molecular weight and branching structure. The protocol for this study was more severe than the OECD test method, as it used a 24 h rather than 4 h exposure time, abraded skin and occlusive covering. The test substance was not washed from the skin after the exposure period. Under the conditions of this test the analogue polymer was moderately irritating, with mild erythema and slight to moderate oedema. Additional information on the irritation potential of the polymer is available from the irritation effects of a 50% solution of the notified polymer in the guinea pig sensitisation study (24 h exposure time). In this study there was mild to moderate erythema, but oedema was absent. Based on the results of these two studies, it is considered that the notified chemical would not be classified as a skin irritant
Sensitisation	There was no evidence of sensitisation potential to the polymer in the guinea pig maximisation test. Therefore the notified polymer is considered not to be a potential skin sensitiser.
Health Effects Summary	Available data on the polymer indicates that it is of low toxicity, however there are concerns about possible adverse effects on lungs after inhalation exposure. The hydrophilic nature of the notified polymer in powder form can contribute to mechanical irritation and collection in the eyes, on the skin or in the airways when dust is generated.

Key Study/Critical Effect for Screening Criteria	The NOEL of 1000 mg/kg bw/day, derived from a 28-day rat oral study will be used to derive a drinking water guidance value. Uncertainty factors: 10 (interspecies variability); 10 (intraspecies variability), 10 (subacute to chronic). Oral RfD = 1000/1000 = 1 mg/kg/day Drinking water guideline = 3.9 ppm
Ecological Toxicity [1]	
Aquatic Toxicity	The results of the aquatic toxicity tests conducted by NICNAS are listed below. *Organism* — *Duration* — *End Point* — *mg/L* Freshwater Fish — 96 h — LC_{50} — > 100 Freshwater Daphnia — 48 h — LC_{50} — > 100 Marine water Copepod — 48 h — LC_{50} — 250 Freshwater Algae — 0-72 h — E_bC_{50} — > 100 E_rC_{50} — > 100 Marine water Algae — 0-72 h — E_bC_{50} — > 1000 E_rC_{50} — > 1000
Determination of PNEC aquatic	Using the lowest value of > 100 mg/L for freshwater organism and a safety factor of 100 (based on 3 experimental results) for fish/Daphnia/algal acute toxicity endpoints, a Predicted No Effect Concentration (PNEC) for freshwater is > 1 mg/L.
Current Regulatory Controls	
Australian Hazard Classification	Based on the available data, the Diutan is not classified as a hazardous substance in accordance with the NOHSC Approved Criteria for Classifying Hazardous Substances (NOHSC 2004).
Australian Occupational Exposure Standards	No data available.
International Occupational Exposure Standards	No data available.
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No data available
Aquatic Toxicity Guidelines	No data available.
PBT Assessment [1]	
P/vP Criteria fulfilled?	Diutan expected to readily biodegrade. Thus, it is not expected to meet the screening criteria for persistence
B/vB criteria fulfilled?	Based on the molecular weight, water solubility and Kow value (log Kow -2.76) Diutan is not expected to bioaccumulate.
T criteria fulfilled?	The acute aquatic toxicity of guar gum is >0.1 mg/L. Thus, Diutan is not expected to meet the screening criteria for toxicity
Overall conclusion	Not a PBT substance.
Revised	April 2022

References

1. National Industrial Chemicals Notification and Assessment Scheme (NICNAS), Full Public Report, Diutan Gum, 2006.

Toxicity Summary - Non Crystalline Silica

Chemical and Physical Properties [1]	
CAS number	7631-86-9
Molecular formula	SiO_2
Molecular weight	60.1 g/mol
Solubility in water	Insoluble
Melting point	1710 °C
Boiling point	2230 °C
Vapour pressure	NA
Henrys law constant	NA
Explosive potential	NA
Flammability potential	NA
Colour/Form	Amorphous powder
Overview	Non crystalline silica (silica gel/amorphous silica) is silicon dioxide, an inorganic compound which is ubiquitous in the environment. Amorphous silica is incorporated in a variety of food products as anti-caking agent and as an excipient in pharmaceuticals.
Environmental Fate [2,3]	
Soil/Water/Air	Silicon oxides are the most abundant compounds in the earth's crust mass. Synthetic amorphous silica and silicates are released into the environment are expected to be distributed mainly into soils and sediments, weakly into water and probably not at all in the air due to their physico-chemical properties, particularly low water solubility and very low vapour pressure. Synthetic amorphous silica and silicates released into the environment are expected to combine indistinguishably with the soil or sediment due to their similarity with inorganic soil/sediment matter and will be subjected to natural processes under environmental conditions (cation exchange, dissolution, sedimentation). Biodegradation is not applicable to these inorganic substances. The bioavailable form of synthetic amorphous silica and silicates is the dissolved form which exists exclusively as monosilicic [Si(OH)4] acid under environmental pH. In analogy to the general chemical reaction of weak acids and salts of weak acids with water, the water-soluble fraction of silica acts as a weak acid and, therefore, will tend to lower the pH value, while that of a silicate acts as a base tending to bind protons and, thus, raise the pH value by forming hydroxyl ions. But pH shifts which are measurable at high loadings under laboratory conditions are not expected to occur from the anthropogenic deposition in the aquatic environment of synthetic amorphous silicas due to low aquatic releases and sufficient natural buffer capacities. Finally, these materials are supposed to combine indistinguishably with the soil layer or sediment due to their chemical similarity with inorganic soil matter. Dissolved silica can be actively assimilated by some marine and terrestrial organisms as normal natural processes mainly related to structural function.
Human Health Toxicity Summary [4]	
Chronic Repeated Dose Toxicity	Inhalation: Based on the available data in animals and humans, the chemicals are considered to have repeated dose inhalation toxicity, warranting hazard classification. The reported lowest observed adverse effect concentration

	(LOAEC) for adverse pulmonary effects in various rat and mice studies ranged between 1–5 mg/m^3 (US EPA, 1996). Non-neoplastic adverse effects specific to the lungs of rodents included granulomatous lesions in the walls of the large bronchi, pulmonary fibrosis, hyperplasia of the alveolar compartment and increases in lung collagen content. A No Observed Adverse Effect Concentration (NOAEC) of 50 mg/m^3 was established in an 8-month rat inhalation study based on no adverse effects at 50 mg/m^3 (Johnston et al. 2000). It is noted that the transient pulmonary inflammatory response which returned to control levels after exposure stopped. <u>Dermal (in humans):</u> Long-term (3–34 years) occupational dermal exposure to silica dusts are reported to be associated with connective tissue diseases with a potential to produce progressive systemic scleroderma. While there is debate about a true cause and effect relationship, there is evidence to show a link between scleroderma and lung silicosis in occupational settings (Thomas et al., 2000). <u>Inhalation (in humans):</u> In humans, inhaled particles of crystalline silica can be transported to other parts of the body through the lymphatic system (US EPA, 1996; Thomas et al., 2000). Two forms of silicosis—accelerated (develops 5–10 years after initial exposure) and chronic (develops 10 years after initial exposure)—have been reported after repeated occupational exposure to crystalline silica dust, mainly that from quartz (US EPA, 1996; WHO, 2000). In a study of 67 gold mine workers in Canada, there was a significant linear relationship between lung quartz concentration and the severity of silicosis. While there were other particles detected in the lung tissue, quartz was the only significant indicator of silicosis severity (WHO, 2000).
Carcinogenicity	The International Agency for Research on Cancer (IARC) has classified the chemical as 'Carcinogenic to humans' (Group 1), based on sufficient evidence for carcinogenicity in humans and experimental animals.
Mutagenicity/ Genotoxicity	In vitro studies with chemicals in this group gave both positive and negative results. The majority of positive genotoxicity assay results can be explained by the generation of reactive oxygen species (OECD, 2011) resulting in DNA damage. Since DNA damage is secondary to crystalline silica-induced oxidative damage, a direct genotoxic effect is not expected. Based on this information, it is not expected that chemicals in this group directly induce heritable mutations in human germ cells. Therefore, the available data do not warrant hazard classification.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	An early limited one-generation study on rats gave no evidence of adverse effects on reproduction performance at 500 mg/kg/day, the highest dose tested (NOAEL). But the reliability is poor due to the small group size of animals. SAS was examined for embryotoxic and developmental effects during the gestation phase in various animals' species, rat, mouse, rabbit and hamster, at oral doses up to 1,600 mg/kg/day. There were no significant signs of maternal or embryotoxic/developmental toxic effects in any species tested. The number of abnormalities seen in either soft or skeletal tissues of the test groups did not differ from the frequencies occurring spontaneously in the control animals.
Acute Toxicity	No guideline studies have been conducted to assess the acute inhalation exposure to crystalline silica. Studies conducted using a single intratracheal instillation of crystalline silica in rodents have shown significant lung pathology such as the formation of silicotic nodules and lung fibrosis (WHO, 2000). However, these studies are not directly relevant for human exposure. A single intratracheal instillation of quartz (50 mg, particle size <5 mm in diameter) in male rats (strain unspecified) resulted in a three-fold increase in water, protein and phospholipid content in lungs within 28 days of administration (WHO, 2000). In another study, 12 mg of quartz (particle size <5 mm in diameter) was administered to male and female rats (strain unspecified) using a single

	intratracheal instillation. Discrete silicotic granulomas in the lungs of both sexes were observed 21–30 days after instillation (WHO, 2000).
Irritation	Synthetic amorphous silicas are not irritating to the skin of rabbits exposed to 0.19 g (one case) or 0.5 g of dry or moistened test item under occlusive conditions for 4 or 24 hours. All products tested as a powder (0.1 g) have shown no or only weak and transient irritating effects on the conjunctivae of the eyes of rabbits with the iris and cornea not affected at all.
Sensitisation	No experimental data are available on the synthetic amorphous silicas. Medical surveillance records on workers gave no evidence of skin sensitization over decades of practical experience.
Health Effects Summary	The critical health effects for risk characterisation include local long-term effects (carcinogenicity) and harmful effects following repeated exposure through inhalation (silicosis). According to NICNAS, A Tier III assessment might be necessary to provide further information whether the current exposure controls are appropriate to offer adequate protection to workers. All other risks are considered to have been sufficiently assessed at the Tier II level, subject to implementing any risk management recommendations, and provided that all requirements are met under workplace health and safety and poisons legislation as adopted by the relevant state or territory.
Key Study/Critical Effect for Screening Criteria	The NOAEC of 50 mg/m^3 based on an 8-month rat inhalation study will be carried forward for the risk assessment. Uncertainty factors: 10 (interspecies variability); 10 (intraspecies variability)
Ecological Toxicity [2,3]	
Aquatic Toxicity	Studies on fish, Daphnia and algae using excess loadings of SAS or NAS showed no acute toxicity, although physical effects on Daphnia were observed in tests using unfiltered test medium. Test results, based on loading rates, are as follows: 96hr-LL0 *(Brachydanio rerio)* is 10,000 mg/L for SAS and NAS; 24hr-EL50 *(Daphnia magna)* >10,000 mg/L for SAS; 72hr-NOEL *(Scenedesmus subspicatus)* is 10,000 mg/L for NAS. There are no chronic aquatic toxicity data, but due to the known inherent physico-chemical properties, absence of acute toxic effects as well as the ubiquitous presence of silica/silicates in the environment, there is no evidence of harmful long-term effects arising from exposure to synthetic amorphous silica/silicates.
Determination of PNEC aquatic	Not applicable
Current Regulatory Controls [4,5]	
Australian Hazard Classification	Not specifically listed on the HSIS (Safe Work Australia)
Australian Occupational Exposure Standards	Silica (CAS No. 7631-86-9) is listed as 'Fumed silica (respirable dust)' with an exposure standard of 2 mg/m3 TWA – although the CAS No. used for this entry is the same as the crystalline form, it refers to the amorphous form of the chemical.
International Occupational Exposure Standards	No data available
Australian Food Standards	Silica is regarded as GRAS (generally recognised as safe) for food use (FDA, 2013)
Australian Drinking Water Guidelines	To minimise an undesirable scale build up on surfaces, silica (SiO2) within drinking waters should not exceed 80 mg/L.
Aquatic Toxicity Guidelines	No data available
PBT Assessment	
P/vP Criteria fulfilled?	No. Not applicable, inorganic substance, ubiquitous in environment.
B/vB criteria fulfilled?	No. Not applicable, inorganic substance, ubiquitous in environment.

T criteria fulfilled?	No. Chronic toxicity data not available. Acute data >0.1 mg/L in fish, invertebrates and algae, hence does not meet the screening criteria for toxicity.
Overall conclusion	Not PBT
Revised	December 2018

References

1. HSDB. Hazardous Substances Data Bank. Retrieved 2015, from Toxnet, Toxicology Data Network, National Library of Medicine: http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB
2. IUCLID (2004) IUCLID Data Set for Synthetic Amorphous Silica and Silicates: Silicon Dioxide (CAS No. 7631-86-9, 112945-52-5, 112926-00-8; Silicic Acid, Aluminum Sodium Salt (CAS No. 1344-00-9); Silicic Acid, Calcium Salt (CAS No. 1344-95-2), UNEP Publications.
3. OECD-SIDS (2004) Screening Information Dataset (SIDS) Initial Assessment Report for Synthetic Amorphous Silica and Silicates: Silicon Dioxide (CAS No. 7631-86-9, 112945-52-5, 112926-00-8; Silicic Acid, Aluminum Sodium Salt (CAS No. 1344-00-9); Silicic Acid, Calcium Salt (CAS No. 1344-95-2), UNEP Publications.
4. National Industrial Chemicals Notification and Assessment Scheme (NICNAS). Crystalline silica: Human health tier II assessment, Retrieved 2018: https://www.nicnas.gov.au
5. NHMRC, 2011. Australian Drinking Water Guidelines 6. Volume 1. National Water Quality Management Strategy. National Health and Medical Research Council.

Polyethylene glycol monohexyl ether

Chemical and Physical Properties [1,2]	
CAS number	31726-34-8
Molecular formula	(C2-H4-O)mult-C6-H14-O
Molecular weight	146.228 g/mol
Solubility in water	Soluble in water.
Melting point	5C
Boiling point	High boiling points
Vapour pressure	Low vapour pressure
Henrys law constant	Low henrys law constant
Explosive potential	No data available.
Flammability potential	Thermal decomposition can lead to release of irritating gases and vapours
Colour/Form	Clear yellow liquid with alcohol odour
Overview	Polyethylene glycol monohexyl ether (also known as poly(oxy-1,2-ethanediyl), α-hexyl-ω-hydroxy, hexan-1-ol, ethoxylated; and hexyl poly[oxyethylene] ether). The chemical is an Ethoxylated Alcohol (EA), a major class of non-ionic surfactants, used in oilfield applications, as solvents in cleaning fluids; in the manufacture of paper products; in adhesives and binding agents; in paints, lacquers, and varnishes; in surface treatments; in cosmetics; in nonagricultural pesticides and preservatives; in construction materials; in pharmaceuticals; as corrosion inhibitors; as antifreezing agents; in aerosol propellants; and in lubricants. Limited data is available for Polyethylene glycol monohexyl ether. Information on Alcohol Ethoxylates from the HERA report (2009) and ethylene glycol monobutyl ether (EGBE) CAS 111-76-2 has been included in this toxicity profile.
Environmental Fate[1,2]	
Soil/Water/Air	EAs undergo rapid primary and biodegradation under both laboratory and field conditions. In surface water, sediment, and soil aerobic and anaerobic biodegradation will occur. In addition, EA may be taken up by plants or animals living in the surface water or soil The proposed half-lives in river water at 12C range from 4 to 24 hours (based on experimental data). EAs are not bioaccumulative, based on a log Kow value greater than 3, and a maximum BCF value of under 800. EAs are rather water soluble and the vapour pressures of EAs are relatively low, the Henry's law constants of EAs can be expected to be very low. As a result, volatilisation of surfactants can be expected to be negligible. Further work reported by Environment Canada and Health Canada (2006) has established that the degree of bioaccumulation expected from EA is well below the Canadian bioconcentration criterion of 5000. The sixteen measured BCF values for 15 EA homologues showed the lack of a linear relationship between alkyl or ethoxylate chain length and BCF, with the highest measured BCF value being under 800. Environment Canada (2006) concluded that it is evident that the EA metabolism rates prevent any significant accumulation. The data indicated that there may be an optimal structural combination of ethoxylate and alkyl chain lengths, at or around C14EO7, where BCF is maximized, but even the measured BCF for this chemical is well below the criterion of 5000. Thus Environment

	Canada (2006) concluded that ethoxylated aliphatic alcohols are not bioaccumulative.
Human Health Toxicity Summary [1,2,3]	
Chronic Repeated Dose Toxicity	In two chronic long-term toxicity studies which also investigated the carcinogenic potential of EAs, no adverse effects were observed up to a dose level of 50 mg/kg/day. In several dermal and oral subchronic studies over 90 days the range of NOELs/NOAELs was 50 to 700 mg/kg/day. Most of the 90-day oral feeding studies were in many respects similar to OECD test method 407. Two studies, one dermal and one oral repeated dose studies were conducted in compliance with GLP regulations. In the oral GLP-compliant study with C14-15AE7, the NOEL was established at the 50 mg/kg bw/d exposure level. However, the same product was tested in a non-GLP 90-day oral feeding study and the NOAEL was determined to be at the highest exposure level of 700 mg/kg bw/d. C14-15AE7 was also examined in two 2-year feeding studies. Dose related body weight depressions in females in the upper two treatment levels were seen. At termination, elevated organ-to-body weight ratios were noted in the liver, kidney and heart. No effects have been observed on the organs of the reproductive system. Moreover, no treatment-related histopathology and no increase in tumour incidence were reported. It was concluded that the NOAEL should be established at the 0.5% level which converts to a dose of about 190 mg/kg bw/d for female rats. In the other long term study dose related body-weight depression were observed in females in the upper two treatment levels (*i.e.*, 100 and 250 mg/kg bw/d). Based on these findings, the NOAEL was established at the 50 mg/kg/d exposure level. In a 2-year feeding study with C12-14AE6.5 the NOAEL was established to be 50 mg/kg bw/d. At the higher dose levels (*i.e.*, 250 and 500 mg/kg bw/d) reduced food consumption and body weight gain was observed. At study termination, elevated organ-to-body weight ratios were noted for the liver, kidney and brain in females at the 250 and 500 mg/kg bw/d dose levels. These differences were not accompanied by histological changes in the organs examined. This study was not indicated to be GLP or OECD compliant but should be regarded as suitable as the study was conducted following the principles and procedures of the OECD guideline. A number of different alcohol ethoxylates with different structural characteristics were evaluated (*e.g.*, carbon chains raging in length from C9 to C14-16 and ethoxy unit length from 3 to 20). Despite differences in protocols and study periods the overall toxicological response was qualitatively and quantitatively similar and a contribution of structural characteristics to toxicity could not be established. No clear trends in the toxicity after repeated exposure with structural components of the test material could therefore be determined. Dermal treatment of 10 rats per sex per group for 90-days with 1%, 10% and 25% C9- 11AE6 did not result in any significant compound related effects (Gingell and Lu, 1991). In-life observations included clinical observations for e.g., skin irritation, body weights, urine and blood collection and analysis. At necropsy organs and tissues collected were preserved in buffered formalin and histopathologically examined. Scores for signs of irritation at the application site throughout the study were zero but at 10% and 25% dry and flaky skin was noted. Relative kidney weights were increased in both sexes at the 25% treatment level, but no histological lesions could be determined. As a result of the observation of the increases in relative kidney weight, the NOAEL was established at the 10% level. This exposure level reflects a dose of about 80 mg/kg bw/d. This study followed the principles of the OECD procedure 411 and was GLP compliant. When given by gavage the most prominent finding was local irritation in the gastrointestinal tract. In repeated dose feeding studies the liver was the most prominent target organ. EAs induced increased relative liver weights and in some cases liver hypertrophy. This effect could however be related to an induction of liver metabolism and would normally considered an adaptive rather than an adverse effect. The NOAEL in the chronic toxicity studies is based on reduced body weight gain and increased relative organ weights only. The NOAEL of 50 mg/kg bw/d that is taken forward to the risk characterisation is based on the lowest

	NOAEL in a chronic oral feeding study in rats which was equal to the lowest NOAELs in subchronic feeding studies in rats.
Carcinogenicity	The carcinogenic potential of C14-15AE7 in rats has been evaluated in a one- to two-year oral feeding study (Procter and Gamble Ltd., 1979). C14-15AE7 was administered at dietary levels of 0, 0.1, 0.5 and 1% to four groups of Charles River rats (*i.e.*, 65 of each sex) for a period of one or two years. Fifteen males and females from the control and the 0.5% dose group, 15 males and 14 females from the 0.1% dose group, and 14 males and 15 females from the 1% dose group were sacrificed after an interim of 1 year exposure. The remaining animals were treated for the full 2-year period. Administration of C14-15AE7 for a period of 1 or 2 years did not produce any compound related changes in general behaviour and appearance. The survival rate of the test animals was comparable if not better than the controls. Body weights of females fed with 0.5% C14-15AE7 and males and females fed with 1% C14-15AE7 had significantly lower weight gains than the control. At necropsy, no compound related effects were observed in organ to body weight determinations. In conclusion, there was no evidence to indicate that treatment related changes of a carcinogenic nature were produced in rats by repeated ingestion of 0.1, 0.5 and 1% C14-15AE7. No carcinogenic effects were observed in a two-year study in which 100 Sprague-Dawley rats were fed with C12-13AE6.5 containing diet at doses up to 1% (*i.e.*, 500 mg/kg bw/d) (Exxon; Talmage, 1994). Reduced food consumption was noted at the higher dose levels (*i.e.*, 0.5 and 1% for females and 1% for males), resulting in a lower body weight gain compared to the control group. No treatment-related histopathology was found and no increase in tumour incidence was observed. Thus, on the basis of this study, C12-13AE6.5 is not considered to be carcinogenic No treatment-related lesions were observed when C12-13AE6.5 was applied to the backs of ICR Swiss mice three times a week at 0, 0.2, 1.0 or 5.0% for 18 month (Shell Chemicals Ltd., 2002; Talmage, 1994). On the basis of the information presented it can be concluded that alcohol ethoxylates are not carcinogenic.
Mutagenicity/ Genotoxicity	In all available *in vitro* and *in vivo* genotoxicity assays, there was no indication of genetic toxicity of broad range of structurally different alcohol ethoxylates.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	In a two-generation study conducted in Charles River CD rats, the reproductive toxicity and developmental effects of C14-15AE7 were evaluated at dietary levels of 0.05%, 0.1% and 0.5% (*i.e.*, about 25, 50 and 250 mg/kg bw/d). No compound related differences were seen between control and treated rates with restpect to fertility, gestation or viablilty indices. No treatment-related changes in behaviour or appearance were observed in the parental rats or pups throughout the study. The reproductive toxicity and developmental effects of C12AE6 was evaluated in a feeding study using a similar experimental design as described above (Little, 1977; Shell Chemicals Ltd., 2002; Talmage, 1994). Rats were exposed in a two-generation study to the compound at dose levels of 25, 50 or 250 mg/kg bw/d. No treatment related effects in the parents or pups on general behaviour, appearance or survival were observed. Fertility of treated groups was comparable with the controls. The presented information indicates that the investigated EAs did not cause reproductive toxicity when applied orally or dermally.
Acute Toxicity	EAs are of low oral, dermal and inhalation toxicity. Alcohol ethoxylates have been shown to have a low to moderate order of acute oral toxicity in the rat with LD50 values ranging between 0.6 to more than 10 g/kg. The structure of the test compound influenced acute toxicity determined by the relative number of ethoxy units, whereas, carbon chain length was not correlated with the acute oral toxicity. The degree of ethoxylation of the EA appeared to be the only factor found to be of relevance in acute oral toxicity with the compounds with ethoxylate chains between 5 and 14 being more toxic by oral consumption than those with less than 4 or more than 21 ethoxy units. Clinical findings observed

	in the test animals after treatment were indicative of gastrointestinal irritation such as ulcerations of the stomach, pilo-erection, diarrhoea and lethargy and may be linked with administration of a bolus dose, in particular in cases where the test item was administered undiluted. There is further an apparent sex difference for a group ethoxylates with LD50 values below 2,000 mg/kg, with females being more susceptible to the acute oral toxicity than males. It should be noted that there is unpublished information suggesting that this is not a sex specific phenomenon, but an effect related to body weight; lighter animals being more susceptible than heavier animals. Alcohol ethoxylates are considered to be of low acute inhalation toxicity to rats with LC50 values exceeding the saturated vapour concentration in air. Acute toxic thresholds were reached only when animals were exposed to the undiluted test chemical in form of a respirable mist or aerosol. Alcohol ethoxylates were shown to have a low order of acute dermal toxicity in the rat and rabbit with LD50 values typically greater than the maximum applied dose, ranging from greater than 0.8 to greater than 5 g/kg in rats. LD50 values in rabbits were greater than 2 g/kg but less than 5 g/kg. There was no relationship between compound structure and dermal toxicity.
Irritation	High quality studies investigating the skin and eye irritation potential of alcohol ethoxylates have shown that the use of these compounds in household cleaning products is of low concern. When tested undiluted EAs were found to be slightly too severely irritating to skin in rabbits and rats and mildly to severely irritating to the rabbit eye. However, if the skin or eye irritation potential was investigated at in-use concentrations, EAs were only mildly irritating to skin and eyes.
Sensitisation	EAs are not considered to be skin sensitizers.
Health Effects Summary	The critical human health effects of the AEs for risk characterisation are acute oral toxicity and skin and eye irritation. The severity of irritation appears to increase directly with the chemical concentration. Skin irritation, but not eye irritation, generally decreases with an increasing degrees of ethoxylation.
Key Study/Critical Effect for Screening Criteria	EAs of different structures with regard to the length of the alkyl chain and the degree of ethoxylation were evaluated in oral and dermal repeated dose toxicity studies. The lowest NOAEL of the EAs for systemic toxicity was 50mg/kg/day in a 2-year oral feeding study in rats. Effects observed at the LOAEL were related to significantly elevated organ-to-body weight ratios for liver, kidney and heart. No adverse histopathological changes were observed at the LOAEL. Uncertainty factors: 10 (interspecicies variability); 10 (intraspecies variability) Oral RfD = 50/100 = 0.5 mg/kg/day Drinking water guidance value = 1.95 ppm
Ecological Toxicity [3]	
Aquatic Toxicity	Acute Aquatic - Fish -96-hr LC50 Oncorhynchus mykiss - 1,464 mg/L -96-hr LC50 Pimephales promelas - range from 1,580 mg/L - 2,137 mg/L -96 hr LC50 - Lepomis machrochirus - 1,490 mg/L Acute Aquatic - Invertebrate -48-hr EC50 Daphnia magna - range from - 881 mg/L - 2,650 mg/L Acute Aquatic - Algae and other aquatic plants -72-hr EC50 Pseudokirchneriella subcapitata - 911 mg/L -72-hr EC50 Selenastrum capricornutum - 720 mg/L Chronic Aquatic - Fish -21-day NOEC Brachydanio rerio - > 100 mg/L Chronic Aquatic - Invertebrate - 21-day NOEC Daphnia magna - >100 mg/L
Determination of PNEC aquatic	PNECaquatic: Experimental results are available for three trophic levels. Acute E(L)C50 values are available for fish, algae and invertebrates. Results from chronic studies are available for invertebrates and fish. As such, an assessment factor of 100 has been applied to the lowest reported NOEC of 100 mg/L for Daphnia. The PNECaquatic is 1 mg/L.

Current Regulatory Controls [1,2]	
Australian Hazard Classification	No data available.
Australian Occupational Exposure Standards	No data available.
International Occupational Exposure Standards	No data available.
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	No data available.
PBT Assessment [2]	
P/vP Criteria fulfilled?	EAs are readily biodegradable and as such not persistent in the environment.
B/vB criteria fulfilled?	Based on a log Kow value greater than 3, and a maximum BCF value of under 800. EAs are not bioaccumulative.
T criteria fulfilled?	The acute aquatic toxicity of EAs are > 0.01 mg/L. Hence the substance does not fulfill the screening criteria for toxic (T)
Overall conclusion	Not PBT
Revised	April 2022

References

1. National Industrial Chemicals Notification and Assessment Scheme (NICNAS). IMAP, Human Health Tier II Assessment for Ethoxylates of aliphatic alcohols (>C6). Retrieved: https://www.industrialchemicals.gov.au/sites/default/files/Ethoxylates%20of%20aliphatic%20alcohols%20%28Greater%20ThanC6%29_Human%20health%20tier%20II%20assessment.pdf
2. Human and Environmental Risk Assessment (HERA) on Ingredients of Household Cleaning Products: Alcohol Ethoxylates (2009). Available at http://www.heraproject.com
3. ECHA REACH Registration Dossier for 2-butoxyethanol CAS 111-76-2, accessed: https://echa.europa.eu/registration-dossier/-/registered-dossier/15247

Toxicity Summary - Fumaric acid and monosodium fumarate

Chemical and Physical Properties [2,3,5,8]	
CAS number	Fumaric Acid: 110-17-8 Monosodium Fumarate: 7704-73-6
Molecular formula	Fumaric Acid: C4H4O4 Monosodium Fumarate: C4H3NaO4
Molecular weight	Fumaric Acid: 116.07 g/mol Monosodium Fumarate: 138.06 g/mol
Solubility in water	Fumaric Acid: 7000 mg/L @ 25C Monosodium Fumarate: Soluble in water
pH	No data found
Melting point	287 C
Boiling point	522 C
Vapour pressure	1.54X10-4 mm Hg at 25 deg C
Henrys law constant	No data found
Explosive potential	Dust presents explosion hazard
Flammability potential	Non flammable
Colour/Form	Fumaric Acid: Colourless odourless crystals or powder Monosodium Fumarate: Odourless, white crystalline powder
Overview	Fumaric acid is an organic dicarboxylic acid naturally present in all organisms. It predominantly originates from the oxidation of succinate and is further converted to malic acid in the tricarboxylic acid cycle. Exogenous fumaric acid will be rapidly metabolised by well-recognised pathways, and neither fumarate nor its metabolites would be expected to accumulate in human or animal tissues. Fumaric acid is used primarily in liquid pharmaceutical preparations as an acidulant and flavoring agent. Fumaric acid is approved for use as a food additive in Australia, and use as a therapeutic agent in the treatment of psoriasis and other skin disorders, as wells as a feed additive for all animals without a maximum level. A Tier 1 human health risk assessment has been performed by the Australian Government Department of Health, National Industrial Chemicals Notification and Assessment Scheme (NICNAS), indicating the chemical is not considered to pose an unreasonable risk to the health of workers and public health. The highest category use is listed as Cosmetic and the data available on the function of the chemical indicate that it may be used in cosmetics but only at low concentrations. Monosodium fumarate is the sodium salt of fumaric acid, and is a food additive, used as a flavour enhancer and acidity regulator. The WHO JECFA has listed a group ADI of “not specified” for fumaric acid and its salts in 1999. Limited information is available for monosodium fumarate, and as such Fumaric acid has been used as its surrogate.

Environmental Fate [5]	
Soil/Water/Air	If released to soil, fumaric acid is expected to have very high mobility based upon an estimated Koc of 7. The pKa values of fumaric acid are 3.03 and 4.54, indicating that this compound will exist almost entirely in anion form in the environment and anions generally do not adsorb more strongly to soils containing organic carbon and clay than their neutral counterparts. Volatilization from moist soil is not expected because the acid exists as an anion and anions do not volatilize. Using a Warburg respirometer and a sewage inoculum, 5-day Theoretical BODs of 57-70% were reported, suggesting that biodegradation may be an important environmental fate process in soil. If released into water, fumaric acid is not expected to adsorb to suspended solids and sediment based upon the estimated Koc. The half-life of fumaric acid in various natural waters ranged from 1-15 days using river die-away studies, indicating that biodegradation is an important environmental fate process in water. Fumaric acid's pKa values indicate it will exist almost entirely in the anion form at pH values of 5 to 9 and therefore volatilization from water surfaces is not expected to be an important fate process. An estimated BCF of 3 suggests the potential for bioconcentration in aquatic organisms is low. Hydrolysis is not expected to be an important environmental fate process since this compound lacks functional groups that hydrolyze under environmental conditions. Fumaric acid will be degraded in brightly sunlit natural waters by reaction with photochemically produced hydroxyl radicals with a half-life of 45 days.
Human Health Toxicity Summary [5,6]	
Chronic Repeated Dose Toxicity	Eight groups of 14 weanling rats were kept on diets containing 0, 0.1 and 1.0% fumaric acid and 1.38% sodium fumarate for one year (half the groups) or two years. No adverse effect was noted on rate of weight gain, haemoglobin, blood picture, calcium balance as shown by bone histology, or on the histology of liver, kidney, spleen and stomach (Levey et al., 1946). In another experiment five groups of 12 male and 12 female rats were fed diets containing 0, 0.1, 0.5, 0.8 and 1.2% of fumaric acid for two years without toxic effects on growth or food consumption. A further four groups of 12 male rats were kept for two years on diets containing 0, 0.5, 1.0 and 1.5% fumaric acid. Only at the 1.5% level was there a very slight increase in mortality rate and some testicular atrophy. Gross and microscopic examination of major organs revealed no abnormalities and tumour incidence was not significantly different between the groups (Fitzhugh & Nelson, 1947). Seventy-five chronically disabled subjects ranging in age from 29-91 years received 500 mg fumaric acid daily for one year without any toxic manifestations in haemoglobin level, RBC and WBC, nonprotein nitrogen level, creatinine level, bromosulfonphthalein excretion and phenolsulfonphthalein excretion (Levey et al., 1946).
Carcinogenicity	Based on the available data, fumaric acid is not considered to be a carcinogen. Fumaric acid has not been classified by International Agency for Research on Cancer (IARC) or the United States Environment Protection Agency (USEPA).
Mutagenicity/ Genotoxicity	Fumaric acid is not considered to be a mutagen.
Reproductive Toxicity Developmental Toxicity/Teratogenicity	No data found

	Eight groups of 14 weanling rats were kept on diets containing 0, 0.1 and 1.0% fumaric acid and 1.38% sodium fumarate for one year (half the groups) or two years. No adverse effect was noted on rate of weight gain, haemoglobin, blood picture, calcium balance as shown by bone histology, or on the histology of liver, kidney, spleen and stomach (Levey et al., 1946). In another experiment five groups of 12 male and 12 female rats were fed diets containing 0, 0.1, 0.5, 0.8 and 1.2% of fumaric acid for two years without toxic effects on growth or food consumption. A further four groups of 12 male rats were kept for two years on diets containing 0, 0.5, 1.0 and 1.5% fumaric acid. Only at the 1.5% level was there a very slight increase in mortality rate and some testicular atrophy. Gross and microscopic examination of major organs revealed no abnormalities and tumour incidence was not significantly different between the groups (Fitzhugh & Nelson, 1947). Seventy-five chronically disabled subjects ranging in age from 29-91 years received 500 mg fumaric acid daily for one year without any toxic manifestations in haemoglobin level, RBC and WBC, nonprotein nitrogen level, creatinine level, bromosulfonphthalein excretion and phenolsulfonphthalein excretion (Levey et al., 1946).
Acute Toxicity	Fumaric acid has low acute toxicity via oral, inhalation, or dermal exposure. The LD50s for the oral administration of fumaric acid in rats range from 8,000 to 10,700 mg/kg bw and 3,600 to 4,800 mg/kg bw for rabbits. Inhalation LD50s for rats is reported to be 1,306 mg/L and a dermal LD50 of 20,000 mg/kg bw has been reported for rabbits.
Irritation	The available data show that fumaric acid is a mild irritant of the skin and may cause respiratory tract irritation. Furmaric acid is considered to cause serious eye irritation. Ingestion of fumaric acid may cause abdominal cramps, diarrhoea and nausea.
Sensitisation	The chemical is considered to be not sensitising.
Health Effects Summary	Fumaric acid occurs naturally in the metabolism, and is approved for use as a food additive in Australia as well as a feed additive for all animals without a maximum level. A Tier 1 human health risk assessment has been performed by the NICNAS, indicating the chemical is not considered to pose an unreasonable risk to the health of workers and public health. It is considered to have low acute and chronic health effects.
Key Study/Critical Effect for Screening Criteria	WHO JECFA in 1975 derived an acceptable daily intake of 6 mg/kg bw for adults and children for use as a food additive. The key study chosen was the two-year rat feeding study by Fitzhugh & Nelson, (1947). No adverse chronic effects from fumaric acid dosing were seen in animals exposed below 1.2% (600 mg/kg bw). However it is to be noted that in 1989, the ADI was changed to 'not specified' when Fumaric Acid was evaluated as a flavouring agent by the JECFA. Drinking water guideline value = 23 ppm
Ecological Toxicity [3,5]	
Aquatic Toxicity	Acute Aquatic -96-h LC50 Danio rerio - >100 mg/L -48-h EC50 daphnia magna - >100 mg/L -72-h EC50 Pseudokirchneriella subcapitata - >100 mg/L -48-hr EC50 Daphnia magna - 62,630 mg/L
Determination of PNEC aquatic	PNECaquatic: Experimental results are available for three trophic levels. Acute E(L)C50 values are available for fish (245 mg/L), Daphnia (212 mg/L), and algae (41 mg/L). On the basis that the data consists of short-term results from three trophic levels, an assessment factor of 1,000 has been applied to the lowest reported effect concentration of 41 mg/L for algae. The $PNEC_{aquatic}$ was calculated to be 0.041 mg/L.
Current Regulatory Controls	
Australian Hazard Classification	No data found.

Australian Occupational Exposure Standards	No data found.
International Occupational Exposure Standards	No data found.
Australian Food Standards	No data found.
Australian Drinking Water Guidelines	No data found.
Aquatic Toxicity Guidelines	No data found
PBT Assessment[3,5]	
P/vP Criteria fulfilled?	Fumaric acid is readily biodegradable and as such not persistent in the environment.
B/vB criteria fulfilled?	Based on the measured log Kow of <3 Fumaric acid is not bioaccumulative.
T criteria fulfilled?	The acute aquatic toxicity of Fumaric acid is > 0.01 mg/L. Hence the substance does not fulfill the screening criteria for toxic (T)
Overall conclusion	Not a PBT substance (based on screening data).

References

1. Centres for Disease Control and Prevention, The National Institute for Occupational Safety and Heatlh (NIOSH), Fumaric Acid, 2014
2. European Commission, Health and Consumer Protection Directorate-General, Report of the Scientific Committee on Animal Nutrition on the Safety of Fumaric Acid. 2003.
3. HSDB (n.d.). *Hazardous Substances Data Bank*. Retrieved from Toxnet, Toxicology Data Network, National Library of Medicine: http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB
4. National Industrial Chemicals Notification and Assessment Scheme (NICNAS), 2014. Inventory Multi-Tiered Assessment and Prioritisation (IMAP), Human Health Tier 1 Assessment for Fumaric Acid, CAS Number 110-17-8.
5. Safety Data Sheet, Fumaric Acid. Bazan Group, Gadiv Petrochemical Industries Ltd. 2013.
6. WHO Toxicological Evaluation of Some Food Colours, Enzymes, Flavour Enhancers, Thickening Agents, and Certain Food Additives, WHO Food Additives Series 6. 1975
7. WHO Evaluations of the Joint FAO/WHO Expert Committee on Food Additives (JECFA), Fumaric Acid, 1989.
8. WHO Evaluations of the Joint FAO/WHO Expert Committee on Food Additives (JECFA), Sodium Fumarate, 1989.

Toxicity Summary - Boric acid / sodium tetraborate / boronatrocalcite / borax

Chemical and Physical Properties[1,3,5,8,9]	
CAS number	Boric Acid: 10043-35-3 Sodium Tetraborate: 1330-43-4 Boronatrocalcite: 1319-33-1 Borax: 1303-96-4
Molecular formula	Boric acid: H_3BO_3 Sodium Tetraborate: $Na_2B_4O_7$ Boronatrocalcite: $CaNaH_{12}(BO_3)5.2H_2O$ Borax: (Na2(B4O7).10H2O)
Molecular weight	Boric acid: 61.833 g/mol Sodium Tetraborate: 201.220 g/mol Boronatrocalcite: 405.23 g/mol Borax: 381.37
Solubility in water	Boric acid: 50 g/l at 25 °C Sodium Tetraborate: 3.1% at 25 °C Boronatrocalcite: no data found Borax: 59.3 g/L at 25 °C
pH	Boric acid: 6.1 in a 0.1% (wt) solution Sodium Tetraborate: 9.3 at 20 °C (3% solution) Boronatrocalcite: no data found Borax: no data found
Melting point	Boric Acid: 170.9 °C Sodium Tetraborate: 743 °C Boronatrocalcite: no data found Borax: 75 °C (decomposes)
Boiling point	Boric Acid: 300 °C Sodium Tetraborate: 1,575 °C (decomposes) Boronatrocalcite: no data found Borax: no data found
Vapour pressure	Boric acid: 9.9 x 10^{-6} Pa @ 25 °C Sodium Tetraborate: Negligible at 20 °C Boronatrocalcite: no data found Borax: Negligible
Henrys law constant	No data found
Explosive potential	Not explosive
Flammability potential	Not flammable

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Toxicity Summary - 2-hydroxy-N,N,N-trimethylethanaminium (Choline Chloride)

Chemical and Physical Properties[1,2,3,4]	
CAS number	67-48-1
Molecular formula	$C_5H_{14}NOCl$
Molecular weight	139.63 g/mole
Solubility in water	Very soluble in water and alcohol
Melting point	247°C
Boiling point	Decomposition upon heating
Vapour pressure	6.57 x 10^{-8} Pa at 25°C
Henrys law constant	2.06*10E-11 Pa*m³/mole at 25°C
Explosive potential	Not explosive
Flammability potential	Combustible. Gives off irritating or toxic fumes (or gases) in a fire.
Colour/Form	white crystalline solid
Overview	Choline chloride is a quaternary amine salt, it dissociates in water into the corresponding positively charged quaternary hydroxyl alkylammonium ion and the negatively charged chloride ion. Choline chloride has neither explosive nor oxidizing properties due to its molecular structure Choline is a dietary component and found in foods as free choline and as esterified forms such as phosphocholine, glycerophosphocholine, sphingomyeline, and phosphatidylcholine. It functions as a precursor for acetylcholine, phospholipids, and the methyl donor betaine and is important for the structural integrity of cell membranes, methyl metabolism, cholinergic neurotransmission, transmembrane signalling, and lipid and cholesterol transport and metabolism. Evidence from animal studies and from human exposure indicates that choline chloride has low toxicity, is not mutagenic and has no developmental toxicity. This is not unexpected in view of its presence in the diet and its production in metabolic processes in the body; it fulfils key roles in nerve transmission, cell membrane integrity, and lipid metabolism. Only limited animal data are available on effects on fertility, but the normal exposure of humans to appreciable amounts of choline chloride both from the diet and formed from normal metabolic processes, would argue against it having any significant adverse effects on fertility. This is supported by the fact that it has been widely used as an animal feed additive for decades with no apparent adverse effects being noted on fertility. A Tier 1 Human Health Assessment for this chemical has been conducted by NICNAS which concluded that this chemical was identified as low concern to human health.
Environmental Fate[1,3,4]	
Soil/Water/Air	Distribution modelling using Mackay Level I indicates water (100 %) to be the main target compartment. The amount in the other compartments is with < 0.0001 % negligible. Choline chloride is readily biodegradable according to OECD-criteria (MITI-I Test; BOD measurements) reaching 93 % degradation within 14 days. Due to the chemical structure hydrolysis can be excluded. In the atmosphere choline chloride will be rapidly degraded according to a half-life time (t½) of about 6.9 hours for hydroxyl-radicals based on a 12 hours day. Due to the measured and calculated logKow of –3.77 and –5.16 both at 25°C, respectively, and a calculated logKoc of 0.37 a bio- or geoaccumulation is not to be expected.

Human Health Toxicity Summary [1,3,4,5]	
Chronic Repeated Dose Toxicity	A 72-week feeding study was conducted to investigate the impact of choline chloride on the liver tumour promoting activity of phenobarbital and DDT in diethylnitroamineinitiated Fischer 344 rats (Shivapurkar *et al.*, 1986). Animals received approximately 500 mg/kg-day choline chloride. Following the end of the exposure period, the animals were kept on the same untreated diet as the control group until study termination at week 103. Histopathology was limited to the liver and organs that developed gross abnormalities. There were no significant differences between treated and control animals on survival rates, body weights, and relative liver weights. Neither was there any increased number of neoplastic liver nodules, hepatocellular carcinomas, lung tumours, leukaemia nor other tumours between treated and control animals. The NOAEL for choline chloride in this study is 500 mg/kg/day In humans, oral administration of 10,000 mg/day choline chloride in a pilot study treating a small number of patients with Alzheimer's disease, resulted in a slight hypotensive effect (Boyd *et al.*, 1977). This dose was regarded as a LOAEL by the Standing Committee on the Scientific Evaluation of Dietary Reference Intake (2000).
Carcinogenicity	No studies were located.
Mutagenicity/ Genotoxicity	Choline chloride was not mutagenic to bacteria in reverse mutation assays (Haworth *et al.*, 1984; JETOC, 1997; Litton Bionetics, 1977). A small, but statistically significant, and dose-related increase in sister chromatid exchanges (SCEs) in Chinese Hamster Ovary (CHO) cells was reported at 50 and 500 µg/ml choline chloride in the absence of S9 only (Bloom *et al.*, 1982). No higher concentrations were examined. These results could not be confirmed in another study using CHO cells at concentrations of choline chloride up to 5,000 µg/ml. (Galloway *et al.*, 1985). In a gene conversion assay with *Saccharomyces cerevisiae* strain D4, choline chloride was negative in the presence and absence of metabolic activation (Litton Bionetics, 1977). No *in vivo* genotoxicity studies were available.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	Pregnant female mice were given in their feed 1,250 to 20,000 mg/kg choline chloride during gestational days 1 to 18 (BASF AG, 1966). Maternal body weight gain was reduced in all treated groups except for the 1,250 mg/kg group. Determination of maternal weight gain of dams with embryonic/foetal absorptions showed that there was no All foetuses were resorbed in the 20,000 mg/kg group. Embryonic/foetal lethality of 35% and 69% were seen in the 4,160 and 10,800 mg/kg groups, respectively. No resorptions occurred in the 1,250 mg/kg group. Developmental toxicity was seen in all but the 1,250 mg/kg group. No statistically significant increases in malformations were observed in any dose group. The NOAELs for maternal and developmental toxicity is 1,250 mg/kg/day.
Acute Toxicity	The oral LD50 in rats was reported to be between 3,150 and 5,000 mg/kg (BASF AG, 1963a, 1969).
Irritation	Application of a 70% aqueous solution to the skin of rabbits for 20 hours under occlusive conditions resulted in only minor skin irritation (BASF AG, 1963b). Slight eye irritation was seen in the eyes of rabbits after instillation of a 70% aqueous solution of choline chloride; no effects were seen one day after exposure (BASF AG, 1963c).
Sensitisation	No data are available in animals. In a Human Repeated Insult Patch Test, there was no evidence of dermal sensitization in two hundred subjects given 0.5% (w/v) aqueous solution of choline chloride during the induction phase and 0.2% (w/v) aqueous solution during the challenge phase (Colgate-Palmolive, 2003).
Health Effects Summary	This chemical has been identified by NICNAS to be of low concern to human health.

Key Study/Critical Effect for Screening Criteria	The Standing Committee on the Scientific Evaluation of Dietary Reference Intakes selected hypotension as the critical effect from the study by Boyd *et al.* (1977) when deriving a Tolerable Upper Intake Level. Boyd *et al.* (1977) reported a LOAEL of 10,000 mg/day choline chloride (7,500 mg/day choline). An uncertainty factor of 2 was chosen because of the limited data regarding hypotension and the inter-individual variation in response to cholinergic effects. Thus, the value for the Tolerable Upper Intake Value for repeated exposure of adults to choline is 3,500 mg/day choline. The oral RfD for choline chloride is derived by using the LOAEL of 10,000 mg/day from the Boyd *et al.* (1977) study, which is divided by an uncertainty factor of 2, to obtain a value of 5,000 mg/day or 71 mg/kg/day for a 70 kg person. Oral RfD = 71 mg/kg/day Drinking water guideline value = 248 ppm
Ecological Toxicity [4]	
Aquatic Toxicity	The 96-hour fish LC50 value is >100 mg/L (nominal and measured) in *Oryzias latipes* (MOE Japan, 1999a), and the 48-hour in vertebrate EC50 is 349 mg/L (nominal and measured) in *Daphnia magna* (MOE Japan, 1999b). The 72-hour EC50 to *Pseudokirchneriella subcapitata* is >1,000 mg/L (nominal and measured) based on growth rate; the 72-hour NOEC is 32 mg/L (MOE Japan, 1999c). In a 21-day *Daphnia magna* reproduction test, the nominal and measured NOEC was reported to be 30.2 mg/L (MOE Japan, 1999d).
Determination of PNEC aquatic	PNECaquatic: Experimental results are available for three trophic levels. Acute E(L)C50 values are available for fish (>100 mg/L), invertebrates (349 mg/L), and algae (>1,000 mg/L). Results from chronic studies are available for invertebrates (21-day NOEC = 30.2 mg/L) and algae (72-hour NOEC = 32 mg/L). On the basis that the data consists of chronic studies on two trophic levels, an assessment factor of 10 has been applied to the lowest reported NOEC of 30 mg/L for Daphnia. The PNECaquatic is 3.02 mg/L.
Current Regulatory Controls	
Australian Hazard Classification	No data available
Australian Occupational Exposure Standards	No data available
International Occupational Exposure Standards	No data available
Australian Food Standards	No data available
Australian Drinking Water Guidelines	No data available
Aquatic Toxicity Guidelines	No data available
PBT Assessment [3]	
P/vP Criteria fulfilled?	Choline chloride is readily biodegradable and thus it does not meet the screening criteria for persistence.
B/vB criteria fulfilled?	Based on a measured log Kow of -3.77 and a calculated BCF of 0.59, choline chloride does not meet the screening criteria for bioaccumulation.
T criteria fulfilled?	The chronic toxicity data on choline chloride show NOECs of >0.01 mg/L. Thus, choline chloride does not meet the screening criteria for toxicity.
Overall conclusion	Not a PBT substance (based on screening data).
Revised	December 2018

References

1. HSDB (n.d.). *Hazardous Substances Data Bank*. Retrieved 2017, from Toxnet, Toxicology Data Network, National Library of Medicine: http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB
2. IPCS Inchem, Choline Chloride, CAS# 67-48-1
3. National Industrial Chemicals Notification and Assessment Scheme (NICNAS), IMAP Environment Tier I summary all tranches, 10 Mar 2017.
4. OECD (2004). SIDS Initial Assessment Report for Choline chloride (CAS No. 67-48-1)
5. UNEP Publications.Standing Committee on the Scientific Evaluation of Dietary Reference Intake. Institute of Medicine (2000). Dietary Reference Intakes for Thiamin, Riboflavin, Niacin, Vitamin B6, Folate, Vitamin B12, Pantothenic Acid, Biotin, and Choline. National Academy Press, Washington D.C.
6. National Industrial Chemicals Notification and Assessment Scheme (NICNAS). IMAP, Human Health Tier 1 Assessment. Retrieved 2018: https://www.nicnas.gov.au

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Toxicity Summary - Acetic acid

Chemical and Physical Properties[1,6]	
CAS number	64-19-7
Molecular formula	$C_2H_4O_2$
Product name	Acetic Acid 60%
Molecular weight	60 g/mol
Solubility in water	1000 g/L at 25°C
pH	1.38
Melting point	16.6 °C
Boiling point	117.9 °C
Vapour pressure	1.5 kPa at 20°C
Henrys law constant	0.0101 Pa m^3/mol
Explosive potential	Above 39°C explosive vapour mixtures may be formed. Risk of fire and explosion on contact with strong oxidants.
Flammability potential	Flammable. Flashpoint = 39°C
Colour/Form	Clear colourless liquid with a pungent vinegar smell
Overview	Acetic acid is naturally occurring as the acid in apple cider vinegar and other fruit derived products. Acetic acid is recognised by Food Standards Australia New Zealand (FSANZ) and the US Food and Drug Administration (FDA) as safe as a food additives (e.g. flavouring agent, preservative).
Environmental Fate[1]	
Soil/Water/Air	When released into the environment, acetic acid is not expected to adsorb onto suspended solids or sediments. Acetic acid dissociates in aqueous media to H+ and the acetate anion ($CH_3CO_2^-$). The compound is expected to be present in the dissociated form, where volatilisation is not an important process. Based on the range of expected Koc values, acetic acide is expected to have a very high to moderate mobility in soil. In air acetic acid will exist soley in the vapour phase where it is degraded with photochemically produced hydroxyl radicals with a half-life for this reaction in air of approximately 22 days. Acetic acid is readily biodegradable, and biodegrades rapidly under aerobic and anaerobic conditions. Based on an estimated bioconcentration factor of 3.2, the potential for bioaccumulation is low.

Human Health Toxicity Summary [1,2,5,6]	
Chronic Repeated Dose Toxicity	In a six-month repeat dose oral toxicity study (Lamb and Evard 1919), pigs were initially fed acetic acid at 155 mg/kg bw/day with the dose was raised every 10 to 30 days until a final dose of 380 to 450 mg/kg bw/day was reached after 60 days. There was no mortality and no effects on body weight or acid-base balance noted in this study (REACH 2013). A NOAEL was not established in this study. Repeated intra-gastric administration of the chemical at 3% concentration in animals (unspecified) for six months resulted in chronic inflammation of the oesophageal mucosa (HSDB 2013). Similarly, intra-gastric administration to rats of 3 mL of a 10% solution for 90 days produced a drop in haemoglobin concentration and erythrocyte count (HSDB 2013). In another similar study, pigs were fed daily diets containing the chemical at 0, 240, 720, 960 and 1200 mg/kg bw/day for successive 30-day periods for a total of 150 days (HSDB 2013).There were no significant differences in growth rate, weight gain, early morning urinary ammonia and terminal blood pH between controls and test groups. A NOEL or NOAEL was not indicated by the authors. Based on the available information and taking a conservative approach, the NOAEL in the study is considered to be 1200 mg/kg bw/day, the highest tested dose with no adverse effects. This NOAEL will be used for human health risk assessment. In the only available dermal repeat dose toxicity study (Slaga et al. 1975), acetic acid was applied dermally to mice at doses of 1 to 40 mg/animal, one to three times/week for 32 weeks. Single dermal applications of acetic acid at doses of up to 40 mg/animal did not induce mortality. However, more than one application per week of 10 mg acetic acid or more caused excessive mortality. 33% of mice died when 10 mg acetic acid/animal was applied dermally three times/week and approximately 50% of mice died when 20 mg was applied twice a week. No biochemical or histopathological effects were reported. A LOAEL of 10 mg/animal was suggested by the authors, however it was expressed in terms of ‘mg/animal’ rather than ‘mg/kg bw/day’ and it therefore cannot be adopted. Dermal NOAEL or LOAEL for acetic acid are not available. Repeated oral, inhalation and dermal exposure of humans to pure acetic acid has been reported to have effects on the gastrointestinal tract and to cause digestive disorders including heartburn and constipation, chronic inflammation of the respiratory tract, pharyngitis, catarrhal bronchitis, darkening of skin, skin dermatitis and erosion of the exposed front teeth enamel. In addition, skin on the palms of hands can become dry, cracked and hyperkeratotic. These observed effects were not associated with any systemic findings, suggesting the effects observed could be due to its corrosive action (EC 2012; HSDB 2013).
Carcinogenicity	In a carcinogenicity study (Slaga et al. 1975), acetic acid was tested as the promoter for tumour development in mice. Acetic acid was applied dermally to mice initiated with a carcinogenic agent, dimethylbenz(a)anthracene (DMBA) at doses of 1 to 40 mg/animal, one to three times/week for 32 weeks. Control animals received acetic acid dermally once per week. No further details were provided about the exposure duration. Single dermal application of acetic acid at doses of up to 40 mg/animal did not induce mortality. However, more than one application per week of 10 to 40 mg acetic acid caused excessive mortality. Thirty three per cent of mice died when 10 mg acetic acid/animal was applied dermally three times/week and approximately 50% of mice died when 20 mg was applied twice a week. No biochemical or histopathological effects were reported. Acetic acid did not produce any carcinogenic effects in mice (REACH 2013). In another study, oral administration of the chemical as a 3% solution in rats, three times/week for eight months did not induce tumours in the oesophagus and fore-stomach, although epithelial hyperplasia was observed. When dosed in combination with the known carcinogen, N-nitrososarcosine ethyl ester (positive control), there was an increase in oesophageal/stomach tumour formation (REACH 2013). Based on the limited available data, acetic acid is not likely to be a carcinogen.

Mutagenicity/ Genotoxicity	Acetic acid was not mutagenic in bacterial reverse mutation assays using Salmonella typhimurium strains TA100, TA1535, TA97 and TA98 with and without metabolic activation (Ishidate et al. 1984). Acetic acid was negative in the chromosome aberration assay using Chinese hamster lung fibroblasts at concentrations of up to 1 mg/mL with or without metabolic activation. In one study using Chinese hamster ovary Kl cells, acetic acid induced chromosomal aberrations at the initial pH of 6.0 or below (about 10 to 14 mM of acid) both with and without S9 mix (REACH 2013). However, when the culture medium was neutralised to pH 7.2 with sodium hydroxide, no clastogenic activity was observed. Moreover, pH lower than 6.0 (pH 5.7 or below) were also found to be cytotoxic. Chromosomal aberrations induced at these high concentrations were therefore considered to be artefacts due to acidification of the culture medium. Acetic acid was concluded not to be clastogenic when tested in cultured Chinese hamster K1 cells (REACH 2013; HSDB 2013). It was concluded that acetic acid is not mutagenic.
Reproductive Toxicity	No data available
Developmental Toxicity/Teratogenicity	In two developmental toxicity studies conducted according to the EU Method B.31 (prenatal developmental toxicity study), acetic acid was administered by gavage to pregnant female Wistar rats and CD-1 mice at 16, 74.3, 345, and 1600 mg/kg bw/day during gestation days 6 to 15 (10 consecutive doses) (REACH 2013). In a similar study, the chemical was administered by gavage to female Dutch rabbits at 16, 74.3, 345, and 1600 mg/kg bw/day during gestation days 6 to 18 (13 consecutive doses) (REACH 2013). There were no clearly discernible effects on implantation, maternal survival or foetal survival in any species at any of the doses. The number of abnormalities seen in either soft or skeletal tissues of the test groups did not differ significantly from those occurring spontaneously in the controls. No NOAEL could be established for maternal toxicity or foetal developmental effects. Based on the available data, the chemical does not show developmental toxicity.
Acute Toxicity	Acetic acid was of low acute toxicity in animal tests following oral exposure. The median lethal dose (LD50) observed in two rat studies is greater than 2000 mg/kg bw (REACH2013). In one study, groups of unfasted rats were fed 2239, 2512, 2859, 3100, 3500, 4000, 4467 mg/kg bw sodium acetate and observed for six days (REACH 2013). The acute oral median lethal dose (LD50) of the sodium salt of acetic acid was found to be 3310 mg/kg bw for rats. Acetic acid was of moderate acute toxicity in rabbits following dermal exposure. The LD50 in rabbits was 1060 mg/kg bw (HSDB 2013). Details regarding the concentration of the administered test substance were not provided. The moderate acute dermal toxicity is believed to be due to its local corrosive effects rather than any systemic toxicity. Acetic acid was of low acute toxicity in animal tests following inhalation exposure. In an acute inhalation study, mice were exposed to various concentrations of acetic acid (experimental details and concentration range not provided) (HSDB 2013). Clinical signs of respiratory irritation were evident at concentrations of 2.46 mg/L and higher. Animals exposed to concentrations higher than 11.07 mg/L died within 27 hours of exposure. Surviving mice recovered quickly and showed no abnormalities three days after exposure. The median lethal concentration (LC50) was determined by the Weil's method and was estimated to be 13.8 mg/L in the mouse. Severe health effects have been reported in humans following accidental exposure to acetic acid by different routes, mainly due to the local corrosive effects of the chemical leading to systemic effects (HSDB 2013).

Irritation	Pure acetic acid is corrosive to skin. In animal studies, severe skin burns were reported in guinea pigs following application to intact or abraded skin of patches of 80% solution of the chemical, moderate to severe burns at 50 to 80% solution, mild injury at 50% solution, and no effect at 10% solution (HSDB 2013). In a study with rabbits, the chemical was considered to be slightly irritating at concentrations of 3.3% and 10% (REACH 2013). In another study with rabbits, a concentration of 2.5% of the chemical was not irritating while concentrations of 10 to 25% caused moderate to severe erythema, slight to severe oedema, skin lesions over the application site and eschar formation (REACH 2013). A 10% solution was therefore considered a skin irritant. As part of a study to select the optimum testing conditions for predicting hazard to the human eye, 3%and 10% aqueous acetic acid were tested in rabbit eyes (REACH 2013). Materials were applied directly to the central corneal surface. Irritation was followed for up to 21 days and scored according to the Draize scale. The 3% acetic acid gave moderate irritation and 10% acetic acid was severely irritating or corrosive. In other studies, instillation of 0.5 mL of a 1% acetic acid solution in the eyes of rabbits caused a severe burn (Smyth et al. 1951). Solutions of 5% induced injury in eyes of rabbits which healed by 14 days, while a 10% solution resulted in severe permanent damage (Henschler 1973). Based on the results of the studies pure acetic acid is considered to be corrosive to eyes. In an acute inhalation study in mice, clinical signs of respiratory irritation were evident at concentrations of 2.46 mg/L and higher (see Section A28.5.2.3). Acetic acid vapours were reported to cause damage to nose, throat and lungs in humans (SCOEL 2012). Acetic acid is considered to be a respiratory tract irritant. Chemical burns and eye and nasal irritation have been reported in humans following exposure
Sensitisation	No experimental data were available, however the US National Institute of Occupational Safety and Health (NIOSH) Pocket Guide to Chemical Hazards mentions skin sensitisation as one of the symptoms of acetic acid exposure (NIOSH 2010). A 1994 report (Kivity et al. 1994) describes a late asthmatic response to inhaled glacial acetic acid by an asthma patient. Based on reports of patients with bronchial asthma reacting to acetic acid challenge, it is believed that acetic acid may cause allergic reactions in humans (HSDB 2013). Some researchers consider acetic acid capable of causing a syndrome known as ‘reactive airways dysfunction’, which resembles bronchial asthma. Symptoms include dyspnoea, wheezing, and cough.
Health Effects Summary	Acetic acid has low acute oral and inhalation toxicity but moderate dermal toxicity. LD50 for oral, dermal and inhalation routes were >3100 mg/kg bw, 1060 mg/kg bw and 13.8 mg/L, respectively in laboratory animals. It is corrosive to skin, eyes and respiratory tract. Acetic acid has low repeat dose toxicity by oral and dermal routes. Information on toxicity by the inhalation route is not available. It is not genotoxic or carcinogenic and does not have any developmental effects in animals. Information on effects on fertility is not available. The critical health effect of acetic acid for risk characterisation is its corrosivity.
Key Study/Critical Effect for Screening Criteria	A NOEL or NOAEL was not established in any of the repeat dose studies. Based on the available information and taking a conservative approach, the highest tested dose with no adverse effects in the repeat dose oral study (1200 mg/kg bw/day) was taken as the NOAEL for human health risk assessment.
Ecological Toxicity [2]	
Aquatic Toxicity	Acute endpoints: Fish = 75 mg/L (measured), Daphnia EC50 = 32 mg/L (Dept. Env. (2013a) in LMC, 2012 Chronic endpoints: Daphnia = 150 mg/L (measured)
Determination of PNEC aquatic	PNECaquatic: On the basis of the chronic results for Daphnia, an assessment factor of 10 has been applied to the lowest reported effect concentration of 150 mg/L. The PNECaquatic is determined to be 15 mg/L.

Current Regulatory Controls	
Australian Hazard Classification	Acetic acid is classified as hazardous, with the following risk phrase for human health in the Hazardous Substances Information System (HSIS) (Safe Work Australia 2013): C; R35 (Corrosive, causes severe burns). Mixtures containing the chemical are classified as hazardous with the following risk phrases based on the concentration (Conc) of the chemical in the mixtures: Conc >=90%: C; R35 (Corrosive, causes severe burns) ≥25% Conc <90%: C; R34 (Corrosive, causes burns) ≥10% Conc <25%: Xi; R36/38 (Irritant, Irritating to eyes and skin).
Australian Occupational Exposure Standards	The chemical has an exposure standard of 25 mg/m³ (10 ppm) Time Weighted Average (TWA) and 37 mg/m³ (15 ppm) Short-Term Exposure Limit (STEL) (Safe Work Australia 2013).
International Occupational Exposure Standards	The following exposure standards are identified in Galleria Chemica (2013). Occupational Exposure limit (TWA): 10 to 25 mg/m^3 [China, Canada, Denmark, Germany, Ireland, South Africa, Spain, Sweden, Switzerland, and the US]. An exposure limit (STEL): 15 to 50 mg/m^3 [China, Canada, France, Ireland, Singapore, South Africa, Spain, Sweden, Switzerland, and the US].
Australian Food Standards	Acetic acid is allotted the following International Numbering System of food additives number: INS 260 (Food Standards Australia New Zealand 2013).
Australian Drinking Water Guidelines	No data found
Aquatic Toxicity Guidelines	No data found
PBT Assessment	
P/vP Criteria fulfilled?	No. The acetate ion of acetic acid is readily biodegradable and thus it does not meet the screening criteria for persistence.
B/vB criteria fulfilled?	The log Kow for acetic acid is reported to be -0.136. Acetate is also found in the body and is metabolized as part of the body's biochemical pathways. Thus, acetic acid (specifically, the acetate ion) does not meet the screening criteria for bioaccumulation.
T criteria fulfilled?	No. The NOECs from the chronic aquatic toxicity data on acetic acid are >1 mg/L, hence does not meet the screening criteria for toxicity.
Overall conclusion	Not PBT

References

1. National Industrial Chemicals Notification and Assessment Scheme (NICNAS). IMAP, Human Health Tier II Assessment for Acetic acid, Retrieved 2019: https://www.nicnas.gov.au
2. HSDB (n.d.). *Hazardous Substances Data Bank*. Retrieved 2015, from Toxnet, Toxicology Data Network, National Library of Medicine: http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB
3. ECHA REACH, Acetic Acid, Retrieved 2015: http://apps.echa.europa.eu
4. JECFA http://apps.who.int/ipsc/database/evaluations/chemical.aspx?chemID=4785
5. U.S. EPA HPVIS database, http://www.epa.gov/chemrtk/hpvis/index.html
6. OECD, Acetic Acid, Retrieved 2015: http://www.echemportal.org
7. IPCS Acetic Acid, Retrieved 2015: http://www.inchem.org

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Toxicity Summary - Acrylamide polymers: Acrylamide, 2-acrylamido-2-methylpropanesulfonic acid, sodium salt polymer and Polymer of 2-acrylamido-2- ethylpropanesulfonic acid sodium salt and methyl acrylate

Chemical and Physical Properties [2, 3, 4]	
CAS number	38193-60-1, 136793-29-8, 9003-06-9, 25987-30-8
Molecular formula	38193-60-1: $(C_7H_{13}NO_4S.C_3H_5NO.Na)_x$ 136793-29-8: $C_{11}H_{18}NNaO_6S$
Molecular weight	Likely >1000 MW
Solubility in water	No data available.
Melting point	No data available.
Boiling point	No data available.
Vapour pressure	No data available.
Henrys law constant	No data available.
Explosive potential	No data available.
Flammability potential	No data available.
Colour/Form	No data available.
Overview	No studies are available for the Acrylamide polymers. Information for 2-Acrylamido-2-methylpropanesulfonic acid, ammonium salt will be referenced in the following sections. 2-Acrylamido-2-methylpropanesulfonic acid, ammonium salts are generally incorporated into polymers. As such, the fate of the monomer is tied to the polymer and no hydrolysis, movement, biodegradation or bioaccumulation of the polymer is expected. A Tier 1 Human Health Assessment for Acrylamide, 2-acrylamido-2-methylpropanesulfonic acid, sodium salt polymer has been conducted by NICNAS which concluded that this chemical was identified as low concern to human health.
Environmental Fate [2]	
Soil/Water/Air	The polymers are not expected to be readily biodegradable. Biodegradation is limited due to the very high molecular weights and the low water solubilities of the polymers. Due to their high molecular weight, the polymers are not expected to bioaccumulate.
Human Health Toxicity Summary [2]	
Chronic Repeated Dose Toxicity	A repeat dose 28 day oral toxicity study carried out in rats with a 50% aqueous solution of 2-Acrylamido-2-methylpropanesulfonic acid, ammonium salt indicated no treatment related toxic effects.
Carcinogenicity	No information available.
Mutagenicity/ Genotoxicity	2-Acrylamido-2-methylpropanesulfonic acid, ammonium salt did not induce a mutagenic response in bacteria and no clastogenicity was observed when a 50% solution of the notified chemical was tested in albino mice cells in vitro.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	No data available.

Acute Toxicity	Aqueous solutions containing 50% of 2-Acrylamido-2-methylpropanesulfonic acid, ammonium salt exhibited low acute oral and dermal toxicity in rats (LD50 > 5 000 mg/kg, and 2 000 mg/kg respectively).
Irritation	2-Acrylamido-2-methylpropanesulfonic acid, ammonium salt was non-irritant to rabbit skin and a slight eye irritant in rabbits.
Sensitisation	A 50% aqueous solution of 2-Acrylamido-2-methylpropanesulfonic acid, ammonium salt showed minimal sensitisation potential when tested in guinea pigs.
Health Effects Summary	This chemical has been identified by NICNAS to be of low concern to human health.
Key Study/Critical Effect for Screening Criteria	No data available
Ecological Toxicity [2]	
Aquatic Toxicity	Limited information is available. The polymers are expected to be a low concern for toxicity to aquatic organisms. Due to their poor solubility and high molecular weights, they are not expected to be bioavailable. The polymers do not contain any reactive functional groups. Ecotoxicity data for 2-Acrylamido-2-methylpropanesulfonic acid, ammonium salt indicate that it is practically non-toxic to fish, water fleas and algae.
Determination of PNEC aquatic	No PNEC values were calculated.
Current Regulatory Controls [5]	
Australian Hazard Classification	No data available
Australian Occupational Exposure Standards	No data available
International Occupational Exposure Standards	No data available
Australian Food Standards	No data available
Australian Drinking Water Guidelines	Based on health considerations, the concentration of acrylamide in drinking water should not exceed 0.0002 mg/L.
Aquatic Toxicity Guidelines	No data available
PBT Assessment [1, 2]	
P/vP Criteria fulfilled?	The polymers are not readily biodegradable, hence they meet the screening criteria for persistence.
B/vB criteria fulfilled?	The polymers are expected to have very high molecular weights and poor water solubility. They are not expected to be bioavailable, hence the polymers do not meet the criteria for bioaccumulation.
T criteria fulfilled?	There are no aquatic toxicity studies on the polymers. They are expected to have low aquatic toxicity because of their very high molecular weights and poor water solubility. As such, the polymers do not meet the criteria for toxicity.
Overall conclusion	Not PBT substances
Revised	December 2018

References

1. Categorization Results from the Canadian Domestic Substance List, CAS# 38193-60-1

2. National Industry Chemicals Notification and Assessment Scheme. 2-Acrylamido-2-methylpropanesulfonic acid, ammonium salt, July 1997.
3. U.S National Library of Medicine, Toxicology Data Network, ChemIDplus, CAS#38193-60-1. Accessed 2017 at https://chem.nlm.nih.gov/chemidplus/rn/38193-60-1
4. National Industrial Chemicals Notification and Assessment Scheme (NICNAS). IMAP, Human Health Tier 1 Assessment. Retrieved 2018: https://www.nicnas.gov.au
5. National Health and Medical Research Council, Natural Resources Management Ministerial Council, national Water Quality Management Strategy, Australian Drinking Water Guidelines 6, 2011, Version 3.3 Updated November 2016.

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Toxicity Summary - Acrylonitrile

Chemical and Physical Properties [1,2,3,4]	
CAS number	107-13-1
Molecular formula	C3H3N
Molecular weight	53.06
Solubility in water	73 g/L at 20 °C
Melting point	– 88.55 °C
Boiling point	77.3 °C
Vapour pressure	12.4 kPa at 20 °C
Henrys law constant	9.0 Pa ·m^3/mole at 20 °C
Explosive potential	Sax (1989) presents that acetonitrile forms explosive mixtures with air. The lower explosive limit is 3.05% in volume and the upper explosive limit 17% in volume.
Flammability potential	Acetonitrile is highly flammable, with a lower flammability limit of 4.4% in volume and an upper flammability limit of 16% in volume.
Colour/Form	Volatile, colourless liquid with a sweet ether-like odour
Overview	Acrylonitrile was first prepared in 1893 but had no significant technical or commercial applications until the late 1930s when a synthetic rubber based on a co-polymer of butadiene and acrylonitrile was introduced in Germany (Langvardt, 1984). In USA, projects relating to nitrile rubber received special support during World War II because of their strategic importance and acrylonitrile became established as a monomer of commercial importance. Demand for acrylonitrile began to soar following the introduction of acrylic fibres in 1950. Today, acrylonitrile is an industrial intermediate used predominantly in the production of polymeric materials, with acrylic fibres accounting for 60% and plastics for 25% of world consumption (SRI, 1995). Other uses include the production of adiponitrile and acrylamide monomers and the co-polymerisation with other monomers to produce polymer emulsions, elastomers and nitrile rubber. From the early 1940s to the mid-1960s, acrylonitrile was mainly manufactured by the dehydration of ethylene cyanohydrin produced from ethylene oxide and aqueous hydrocyanic acid. Nowadays, all acrylonitrile is produced by direct catalytic conversion of propene, oxygen (as air) and ammonia (SRI, 1995). Processes based on propane or ethylene have been developed and may become commercially viable in the future where propane or ethylene feedstock is readily available. In 1995, global acrylonitrile capacity amounted to 4.5 million metric tonnes (t) (SRI, 1995).
Environmental Fate[1]	
Soil/Water/Air	Acrylonitrile is readily to fairly degradable in water, soil and in the troposphere. Its toxicity to aquatic vertebrates and invertebrates, algae and aquatic plants is slight to moderate. Bioaccumulation is expected to be slight to negligible. As there are no readily hydrolysable groups on the acrylonitrile molecule, hydrolysis is not expected to be an environmentally significant process. The vapour pressure of acrylonitrile puts it in the category of highly volatile chemicals (Mensink et al., 1995). However, the water solubility is also high. The Henry's Law constant can provide an indication of the volatility characteristics of compounds (Lyman et al., 1982). The characteristics of acrylonitrile indicate that although the volatilisation from aquatic systems is not rapid, it may be a significant removal process in the environment. Therefore, the high vapour pressure is mediated by the high water solubility. The volatilisation half-life of acrylonitrile in a typical pond, river and lake has been estimated at 6, 1.2 and 4.8 days respectively (Howard, 1989). The US EPA has previously suggested that although acrylonitrile is quite volatile, large spillages of the substance could lead to groundwater contamination (DoE, 1993).
Human Health Toxicity Summary [1,2,3]	

Chronic Repeated Dose Toxicity	Repeated-dose toxicity studies involving inhalation, ingestion or subcutaneous or intraperitoneal injection of acrylonitrile for 1-12 months in rats, mice, guinea pigs, rabbits, cats, dogs and monkeys showed a narrow range between lethal and no observed adverse effect levels. The most consistently observed effects were decreased body weight gain, irritation of the respiratory tract, kidney damage and reversible ataxia or paralysis. Retching and vomiting, adrenal hyperplasia, increased liver weight, hyperplasia of the gastric mucosa and biochemical effects such as small reductions in haemoglobin, haematocrit and erythrocyte counts and small increases in alkaline phosphatase were observed in some studies.
Carcinogenicity	The carcinogenic potential of acrylonitrile has been investigated in three strains of rats exposed to 5-80 ppm in air (2 studies), 1-500 ppm in drinking water (5 studies), or 0.1-10 mg/kg by gavage (2 studies). Exposure-related tumours were found in all studies. The most common forms were astrocytomas of the CNS and carcinomas of the zymbal gland, both of which rarely occur spontaneously in experimental animals. Tumours of the mammary gland, tongue, small intestine and forestomach (oral exposure only) were less consistent across studies. A 2-year bioassay in mice, where metabolism via CNEO plays a greater role than in rats, is currently underway within the US National Toxicology Program. Acrylonitrile has also been evaluated by the International Agency for Research on Cancer (IARC). In 1979 and 1987, IARC concluded that there was limited evidence of carcinogenicity of acrylonitrile in humans and sufficient evidence of carcinogenicity in animals and therefore assigned the chemical to group 2A: agents that are probably carcinogenic to humans (IARC, 1979, 1987). In February 1998, all published literature on acrylonitrile was re-evaluated by an IARC working group comprising 30 experts from 12 countries. The group concluded that although additional studies confirmed that acrylonitrile is a potent multi-site carcinogen in rats, the combined epidemiological evidence did not support a credible association between acrylonitrile exposure and cancer. As such, IARC determined that there was inadequate evidence in humans but sufficient evidence in experimental animals for the carcinogenicity of acrylonitrile and re-classified the chemical in group 2B: agents that are possibly carcinogenic to humans (IARC, 1999).
Mutagenicity/ Genotoxicity	The genetic toxicity of acrylonitrile has been investigated in numerous in vitro and in vivo test systems. In vitro, it was weakly positive in several bacterial, fungal and mammalian mutagenicity assays and mammalian and fungal cytogenetic tests, particularly in the presence of metabolic activation. Where CNEO was tested in parallel assays, it was mutagenic in the absence of metabolic activation. In vivo, acrylonitrile tested negative in several dominant lethal, micronucleus and chromosome aberration assays. Studies in Drosophila using various genetic markers gave positive results. In vitro and in vivo assays for DNA binding and unscheduled DNA synthesis yielded negative results in tests using the most reliable techniques. On balance, it appears that acrylonitrile has little affinity for DNA, whereas the metabolite CNEO is a direct-acting mutagen in vitro. It is conceivable that the lack of genotoxicity of acrylonitrile in several in vivo tests is due to limited formation and/or rapid degradation of CNEO in intact mammals.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	In a 3-generation rat study, up to 35 mg/kg/day had no effect on fertility. In sub-acute studies in rats and mice, there was evidence of defective spermatogenesis at oral doses approaching acutely toxic levels, whereas several long-term studies found no abnormalities in male reproductive organs. In developmental toxicity studies in rats, hamsters, and rat embryos exposed in vitro, acrylonitrile showed some potential to cause foetal toxicity, but developmental effects in vivo occurred only at exposure levels associated with marked maternal toxicity.
Acute Toxicity	Acrylonitrile is acutely toxic by all routes of administration. In the rat, the LD50 is 72-186 mg/kg from oral and 148-282 mg/kg from skin exposure, and the 4 h LC50 from inhalation is 138-558 ppm (0.47-1.2 mg/L). The acute toxicity is roughly similar in other species, including mice, guinea pigs, rabbits, cats and dogs. Irrespective of route or test species, a lethal dose causes central nervous system (CNS) excitation followed by paralysis and respiratory arrest. The target organs are the gastrointestinal tract (bleeding), adrenals (haemorrhagic necrosis), brain (oedema) and lungs (oedema).
Irritation	Acrylonitrile is irritating to the skin and eyes. Repeated airborne exposure induces inflammatory and hyperplastic changes in the nasal mucosa, indicating a potential for irritation of the respiratory system.

Sensitisation	A guinea pig maximisation test for skin sensitisation was strongly positive. There are no data on respiratory sensitisation.
Health Effects Summary	Acrylonitrile is acutely toxic to humans by inhalation, in contact with skin and if swallowed. It is also a severe eye irritant and may cause sensitization by skin contact. Repeat dose toxicity studies in animals have shown treatment related changes in the gastrointestinal tract, central nervous system and adrenal gland. There are occasional reports of liver and kidney damage. It is a rodent carcinogen, tumours being observed in the brain, Zymbal gland, gastrointestinal tract and mammary gland. Detailed, recent epidemiological studies do not however provide evidence of human carcinogenicity. Acrylonitrile is an in vitro mutagen, indicating that the mechanism of carcinogenicity may be genotoxic. This is not however supported by the results of in vivo mutagenicity studies. It is concluded that there is a need for active management of the identified risk and further consideration of the risk management measures currently being applied in relation to workers, consumers and the population exposed via the environment.
Key Study/Critical Effect for Screening Criteria	In animals repeated exposure to acrylonitrile results in damage to the gastrointestinal tract, central nervous system and adrenal gland. There are occasional reports of liver and kidney damage. The respiratory tract is also affected following inhalation exposure, based on histopathological changes in the nasal turbinates of rats in the Quast et al.,(1980) two year study. A LO(A)EL of 20 ppm was established in the study, treatment-related nasal changes being evident at this exposure level, and this was used as a starting point in the risk assessment in relation to inhalation exposure. A No Adverse Effect Level (NAEL) of 4 ppm for the inhalation route was been derived from the LO(A)EL of 20 ppm, by application of a safety factor of 5. In relation to oral administration of acrylonitrile, the N(A)OEL is estimated to be 3 ppm (0.25 mg/kg/day) in drinking water, based on the information from the Biodynamics study (1980) study in rats which showed systemic toxicity, probably attributable to metabolic release of cyanide.
Ecological Toxicity [6]	
Aquatic Toxicity	The data set for acrylonitrile includes a wide range of information on short and long term toxicity in fish, Daphnia and other aquatic invertebrates. Acrylonitrile is moderately toxic to fish, with 96-hour LC50 for fresh water fish generally lying in the range of 10 - 20 mg/l (nominal). A recent short term study in the saltwater species Cyprinodon variegatus, carried out in full compliance with current protocols, reported a 96-hour LC50 of 8.6 mg/l. The lowest 48 hour EC50 for Daphnia was 7.6 mg/l. The fish early life stage toxicity test in Pimephales promelas, using flow-through conditions, provided a LOEC/NOEC of 0.34 mg/l, while a 30 day flow through test in mature fish of the same species provided a long-term LC50 of 2.6 mg/l. If the value of 0.34 mg/l is taken as a LOEC, a NOEC may be derived by application of safety factor of 2, giving a NOEC of 0.17 mg/l.
Determination of PNEC aquatic	Applying an assessment factor of 10 to the NOEC (0.17 mg/l) derived from the fish early life stage toxicity test gives a PNEC of 17 µg/l.
Current Regulatory Controls [1,7]	
Australian Hazard Classification	The chemical is classified as hazardous, with the following risk phrases for human health in the Hazardous Chemical Information System (HCIS) (Safe Work Australia): H225 (Highly flammable liquid and vapour) H350 (May cause cancer) H331 (Toxic if inhaled) H311 (Toxic in contact with skin) H301 (Toxic if swallowed) H335 (May cause respiratory irritation) H315 (Causes skin irritation) H318 (Causes serious eye damage) H317 (May cause an allergic skin reaction) H411 (Toxic to aquatic life with long-lasting effects)
Australian Occupational Exposure Standards	The current national occupational exposure standard for acrylonitrile in Australia is 2 ppm (4.3 mg/m3) expressed as an 8 h TWA airborne concentration, Carcinogen Category 2, with a ‘skin’ notation (NOHSC, 1995a).

International Occupational Exposure Standards	The following exposure standards are identified: 8h TWA: Austria 2 ppm (4.5 mg/m^3) Belgium 2 ppm (4.3 mg/m^3) Denmark 2 ppm (4.0 mg/m^3) Finland 2 ppm (4.3 mg/m^3) France 2 ppm (4.0 mg/m^3) Germany 3 ppm (7.0 mg/m^3) Hungary 0.23 ppm (0.5 mg/m^3) India 2 ppm (4.3 mg/m^3) Ireland 2 ppm (4.5 mg/m^3) Japan 2 ppm (4.3 mg/m^3) Netherlands 4 ppm (9 mg/m^3) Philippines 20 ppm (43 mg/m^3) Poland 5 ppm (10 mg/m^3) Russia 0.23 ppm (0.5 mg/m^3) Spain 2 ppm (4.5 mg/m^3) Sweden 2 ppm (4.5 mg/m^3) Turkey 20 ppm (43 mg/m^3) United Kingdom 2 ppm (4 mg/m^3) USA (NIOSH) 1 ppm (2.2 mg/m^3) USA (OSHA) 2 ppm (4.3 mg/m^3) Short-term exposure limits (STEL): Finland 4 ppm (9 mg/m^3) France 15 ppm (32.5 mg/m^3) Netherlands 10 ppm (22 mg/m^3) Sweden 6 ppm (14 mg/m^3) USA (NIOSH) 10 ppm (22 mg/m^3) USA (OSHA) 10 ppm (22 mg/m^3)
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	A freshwater low reliability trigger value of 160 µg/L was calculated for acetonitrile using an AF of 1000. In the absence of marine data, this was adopted as a marine low reliability trigger value.
PBT Assessment	
P/vP Criteria fulfilled?	No. Acrylonitrile is readily to fairly degradable in water, soil and in the troposphere
B/vB criteria fulfilled?	No. The low log Pow (0.00-0.30) measures for acrylonitrile suggest bioaccumulation will not occur.
T criteria fulfilled?	Yes. Chronic toxicity data <1 mg/L in fish, thus acrylonitrile meet the screening criteria for toxicity.
Overall conclusion	Not PBT
Revised	January 2019

References

1. NICNAS (1998) Priority Existing Chemical 10, Acrylonitrile: Retrieved 2019: https://www.nicnas.gov.au
2. OECD (1998) European Union Risk Assessment Report, Acetonitrile, Retrieved 2019: http://www.echemportal.org
3. ECHA REACH, Acrylonitrile, Retrieved 2019: https://echa.europa.eu
4. HSDB (n.d.). *Hazardous Substances Data Bank*. Retrieved 2019, from Toxnet, Toxicology Data Network, National Library of Medicine: http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB
5. ANZECC & ARMCANZ (2000), Australian and New Zealand Guidelines for Fresh and Marine Water Quality
6. OECD (2005) SIDS Initial Assessment Profile on Acrylonitrile

7. Hazardous Chemical Information System (HCIS), Safe Work Australia. Retrieved 2019: http://hcis.safeworkaustralia.gov.au/

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Toxicity Summary - Alcohols, C10-16, ethoxylated propoxylated

Chemical and Physical Properties[1]	
CAS number	69227-22-1
Molecular formula	No data available.
Molecular weight	No data available.
Solubility in water	Soluble in water
Melting point	-3 °C
Boiling point	No data available.
Vapour pressure	No data available.
Henrys law constant	No data available.
Explosive potential	No data available.
Flammability potential	No data available.
Colour/Form	Yellow liquid, mild odour
Overview	Principle Route of Exposure: Eye or skin contact, inhalation Causes severe eye irritation which may damage tissue. Causes skin irritation. Harmful if swallowed.
Environmental Fate[1]	
Soil/Water/Air	This substance is expected to be readily biodegradable (84% @ 28d) (similar substances). Based on an estimated log Kow value of 4.3 – 5.36, and BCF value of 1.1 – 1.8, it is not expected to be bioaccumulative. Mobility in soil: KOC = >4
Human Health Toxicity Summary [1]	
Chronic Repeated Dose Toxicity	No data available to indicate product or components present at greater than 0.1% are chronic health hazards.
Carcinogenicity	Did not show carcinogenic effects in animal experiments (similar substances)
Mutagenicity/ Genotoxicity	In vitro tests did not show mutagenic effects. In vivo tests did not show mutagenic effects. (similar substances)
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	Animal testing did not show any effects on fertility.
Acute Toxicity	LD50 Oral: 600 mg/kg (Rat) (similar substance) LD50 Dermal: > 5200 mg/kg (Rabbit) (similar substance) LD50 Inhalation: > 0.22 mg/L (saturated concentration) (Rat) (similar substance)
Irritation	May cause mild respiratory irritation. Causes severe eye irritation which may damage tissue. Causes skin irritation.
Sensitisation	Did not cause sensitization on laboratory animals (guinea pig) (similar substances)
Health Effects Summary	Causes severe eye irritation which may damage tissue. Causes skin irritation. Harmful if swallowed.
Key Study/Critical Effect for Screening Criteria	
Ecological Toxicity [1]	

Aquatic Toxicity	Toxicity to fish: LC50 (96h) 0.59 mg/L (Pleuronectes platessa) (similar substance) LC50 (96h) 1.6 mg/L (Pimephales promelas) (similar substace) LC50 (96h) 3 mg/L (Brachydanio rerio) (similar substance) Toxicity to invertebrates: EC50 (48h) 0.14 mg/L (Daphnia magna) (similar substance) EC50 (48h) 2 mg/L (Daphnia magna) (similar substance) Toxicity to algae: EC50 (72h) 0.75 mg/L (Pseudokirchnerella subcapitata) (similar substance) ErC50 (48h) 0.7 mg/L (Skeletonema costatum) EC10 9.79 mg/L (Selenastrum capricornutum) (similar substance) ErC50 1.1 mg/L (Scenedesmus subspicatus) (similar substance) Toxicity to microorganisms: ErC50 (16.9h) > 10 g/L (Pseudomonas putida) (similar substance)
Determination of PNEC aquatic	On the basis that the data consists of short term results from three trophic levels, an assessment factor of 1000 has been applied to the lowest reported effect concentration of 0.14 mg/L for Daphnia. The PNEC aquatic is 0.14 µg/L.
Current Regulatory Controls [1]	
Australian Hazard Classification	H302 - Harmful if swallowed H315 - Causes skin irritation H318 - Causes serious eye damage
Australian Occupational Exposure Standards	No data available.
International Occupational Exposure Standards	No data available.
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	No data available.
PBT Assessment	
P/vP Criteria fulfilled?	No. Expected to be readily biodegradable based on similar substances.
B/vB criteria fulfilled?	No. Based on an estimated log Kow value of 4.3 – 5.36, and BCF value of 1.1 – 1.8, it is not expected to be bioaccumulative.
T criteria fulfilled?	No. The acute aquatic toxicity of this chemical is >0.01 mg/L. Thus, it is not expected to meet the screening criteria for toxicity.
Overall conclusion	Not PBT
Revised	January 2019

References

1. Redacted

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Toxicity Summary - Alcohols, C6-12, ethoxylated propoxylated

Chemical and Physical Properties[1]	
CAS number	68937-66-6
Molecular formula	No data available.
Molecular weight	No data available.
Solubility in water	Soluble in water
Melting point	-3 °C
Boiling point	No data available.
Vapour pressure	No data available.
Henrys law constant	No data available.
Explosive potential	No data available.
Flammability potential	No data available.
Colour/Form	Yellow liquid, mild odour
Overview	Principle Route of Exposure: Eye or skin contact, inhalation Causes severe eye irritation which may damage tissue. Causes skin irritation. Harmful if swallowed.
Environmental Fate[1]	
Soil/Water/Air	This substance is expected to be readily biodegradable (60% @ 28d) (similar substances). Based on an estimated log Kow value of 4.3 – 5.36, and BCF value of 1.1 – 1.8, it is not expected to be bioaccumulative. Mobility in soil: KOC = >4
Human Health Toxicity Summary [1]	
Chronic Repeated Dose Toxicity	No data available to indicate product or components present at greater than 0.1% are chronic health hazards.
Carcinogenicity	Did not show carcinogenic effects in animal experiments (similar substances)
Mutagenicity/ Genotoxicity	In vitro tests did not show mutagenic effects. In vivo tests did not show mutagenic effects. (similar substances)
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	Animal testing did not show any effects on fertility.
Acute Toxicity	LD50 Oral: 600 mg/kg (Rat) (similar substance) LD50 Dermal: > 5200 mg/kg (Rabbit) (similar substance) LD50 Inhalation: > 0.22 mg/L (saturated concentration) (Rat) (similar substance)
Irritation	May cause mild respiratory irritation. Causes severe eye irritation which may damage tissue. Causes skin irritation.
Sensitisation	Did not cause sensitization on laboratory animals (guinea pig) (similar substances)
Health Effects Summary	Causes severe eye irritation which may damage tissue. Causes skin irritation. Harmful if swallowed.
Key Study/Critical Effect for Screening Criteria	
Ecological Toxicity [1]	

Aquatic Toxicity	Toxicity to fish: LC50 (96h) 0.59 mg/L (Pleuronectes platessa) (similar substance) LC50 (96) 1.4 mg/L (Pimephales promelas) (similar substance) NOEC 4.4 mg/L (Pimephales promelas, juvenile) Toxicity to invertebrates: EC50 (48h) 0.14 mg/L (Daphnia magna) (similar substance) EC50 (48h) 0.39 mg/L (Cerodaphnia dubia) (similar substance) Toxicity to algae: EC50 (72h) 0.75 mg/L (Pseudokirchnerella subcapitata) (similar substance) EC50 (96h) 0.7 mg/L (Pseudokirchneriella subapitata) (similar substance) CD10 8 mg/L (Pseudokirchneriella subapitata) EC10 2 mg/L (Brachionus calyciflorus) Toxicity to microorganisms: EC50 (48h) 0.39 mg/L (Cerodaphnia dubia) (similar substance)
Determination of PNEC aquatic	On the basis that the data consists of short term results from three trophic levels, an assessment factor of 1000 has been applied to the lowest reported effect concentration of 0.14 mg/L for Daphnia. The PNEC aquatic is 0.14 µg/L.
Current Regulatory Controls [1]	
Australian Hazard Classification	H302 - Harmful if swallowed H315 - Causes skin irritation H318 - Causes serious eye damage
Australian Occupational Exposure Standards	No data available.
International Occupational Exposure Standards	No data available.
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	No data available.
PBT Assessment	
P/vP Criteria fulfilled?	No. Expected to be readily biodegradable based on similar substances.
B/vB criteria fulfilled?	No. Based on an estimated log Kow value of 4.3 – 5.36, and BCF value of 1.1 – 1.8, it is not expected to be bioaccumulative.
T criteria fulfilled?	Not applicable. Chronic toxicity data >1 mg/L in invertebrates, thus sodium hydroxide does not meet the screening criteria for toxicity.
Overall conclusion	Not PBT
Revised	January 2019

References

1. Redacted

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Toxicity Summary - Ethoxylated of aliphatic alcohols (>C6)

Chemical and Physical Properties [1,2,3]	
CAS number	112-59-4, 3055-93-4, 3055-94-5, 3055-95-6, 3055-97-8, 4536-30-5, 5274-68-0, 25190-05-0, 9002-92-0, 9004-95-9, 9004-98-2, 9005-00-9, 9043-30-5, 31726-34-8, 24938-91-8, 26183-52-8, 26468-86-0, 27252-75-1, 27306-79-2, 31943-12-1, 32128-65-7, 37281-47-3, 37702-39-9, 39587-22-9, 52292-17-8, 61723-78-2, 68439-45-2, 68439-46-3, 68439-49-6, 68439-50-9, 68439-54-3, 61791-13-7, 61791-28-4, 61827-42-7, 64425-86-1, 66455-14-9, 66455-15-0, 69227-20-9, 67254-71-1, 68002-97-1, 68131-39-5, 68131-40-8, 68155-01-1, 68213-23-0, 68526-94-3, 68551-12-2, 97953-22-5, 68920-66-1, 68991-48-0, 78330-21-9
Molecular formula	Unspecified
Molecular weight	Unspecified
Solubility in water	0.1876 - 13.18 mg/L at 25 °C (C12-14 ethoxylated, 1-2.5 EO) (CAS 68131-39-5) 1.69 - 246.7 mg/L at 25 °C (C9-11, ethoxylated (EO < 2.5) (CAS 68439-46-3)
Melting point	7.2 °C at 101.3 kPa (CAS 68131-39-5) -20 °C at 101.3 kPa (CAS 68439-46-3)
Boiling point	271.11 - 516.11 °C (CAS 68131-39-5) 260 °C (CAS 68439-46-3)
Vapour pressure	< 1 Pa at 25 °C (CAS 68131-39-5) 0.004 - 117 Pa at 20 °C (CAS 68439-46-3)
Henrys law constant	No data available.
Explosive potential	Non explosives
Flammability potential	Non flammable
Colour/Form	Organic liquid, colourless to light yellow
Overview	The chemicals in this group are structurally related alcohol ethoxylates (AEs), ethoxylated ethers of aliphatic alcohols, where the alky chain length is six carbons or higher. Ethoxylates of shorter chain alcohols (C<6) do not show the same degree of surfactancy compared to the chemicals in this group. Commercially available AEs generally consist of a mixture of various AE homologues of varying carbon chain lengths and degree of ethoxylation. The chemicals contain a hydrophobic alkyl chain attached via an ether linkage to a hydrophilic ethylene oxide (EO) chain that gives them their characteristic surfactant properties. The hydrophobic alkyl and the hydrophilic EO chains can vary in length depending on method of production and source of the precursor chemicals (HERA, 2009). Although most of chemicals of this group are polymers according to the definition in the Industrial Chemicals (Notification and Assessment) Act (1989), the individually named members do not necessarily meet the polymer of low concern (PLC) criteria as the number-average molecular weight (NAMW) >1000 Da. Lower molecular weight forms of these chemicals (MW <500) are expected to be used in commercial, domestic and cosmetic products. The chemicals are used extensively as non-ionic surfactants in a wide range of cosmetic and domestic products. The chemicals in this group are expected to have similar physicochemical and toxicological properties, which depend on the alkyl chain length and the number of EO units.
Environmental Fate [2,3]	
Soil/Water/Air	Alcohol ethoxylates are readily biodegradable under aerobic conditions and also anaerobically biodegradable (HERA, 2009). The main mechanism of primary biodegradation for the linear and essentially linear AE is the central cleavage of the molecule, leading to the formation of long chain alcohol and polyethylene glycol (HERA, 2009; Marcomini et al., 2000a; Marcomini et al., 2000b). Long chain alcohols themselves are readily biodegradable up to C18 (SIDS, 2006). Abiotic degradation in water, soil, sediment and air is not expected to occur because of the chemical structures of AE homologues. Neither hydrolysis under normal

	environmental conditions (pH range from 4 to 9) nor photolysis in the atmosphere, in water, or when absorbed to soil and sediment surfaces, is to be considered (HERA, 2009). Experimentally determined BCF-values given for pure homologues and summarized in the publication of Tolls et al. (2000) are used as read-across data for the endpoint bioaccumulation in water. It can be stated that bioaccumulation of alcohol ethoxylates is regarded to be negligible as the surfactants will be rapidly metabolised. For more detail see endpoint summary for bioaccumulation. Concerning transport and distribution of the alcohol ethoxylate mixtures a high adsorption of the substances is determined by using QSAR-models. Adsorption onto surfaces is an intrinsic property of alcohol ethoxylates and thus a high Koc-value is expected.
Human Health Toxicity Summary [1]	
Chronic Repeated Dose Toxicity	The chemicals in this group are not expected to cause serious damage to health fr In several 90-day oral feeding studies in rats (similar to OECD TG 407), the NOAEL was established between 50 and 700 mg/kg bw/day (calculated from dietary levels) for group members (CAS Nos. 68439-50-9 and 68131-39-5, ranging from C12–15 with EO7). Effects observed at higher concentrations included reduction in mean body weights, and increases in relative liver and kidney weights. These changes were considered to be adaptive and related to the poor palatability of the test chemicals. No treatment related histopathological changes were reported (SCCS, 2007; HERA 2009; CIR, 2012). Similar effects were seen in longer-term studies. Alcohols, C12-13, ethoxylated (CAS No. 66455-14-9; EO6.5) and alcohols, C14-15, ethoxylated (CAS No. 68951-67-7, EO7, not listed on AICS) were given to rats in one- and two-year chronic feeding studies at levels between 0.1 and 1 %. The NOAEL was established between 50 and 192 mg/kg bw/day (calculated from dietary level). Effects observed at higher levels included reduction in mean body weights, and increase in relative liver and kidney weights. These changes were considered to be adaptive and may be due to poor palatability of the test chemicals. No treatment related lesions were observed (SCCS, 2007; HERA, 2009; CIR, 2012).om repeated oral and dermal exposure. In a 90-day study (OECD TG 411), Fischer rats were exposed to the chemical (C9–11 with 6 EO units, CAS No. 68439-46-3) at 1, 10 or 25 % concentration, 3 days/week. The application site was shaved but not covered. There were no significant treatment related effects at any concentration. Dry and flaky skin was observed in the 10 and 25 % dose groups. Increased relative kidney weights were observed in the 25 % dose groups. However, no histological lesions were observed. The NOAEL was established at 10 %, equivalent to 80 mg/kg bw/day (HERA, 2009).
Carcinogenicity	Based on the data available, the chemicals in this group are not considered to be carcinogenic. Two chemicals, alcohols, C12-13, ethoxylated (CAS No. 66455-14-9; EO6.5) and alcohols, C14-15, ethoxylated (CAS No. 68951-67-7, EO7, not listed on AICS) were administered at up to 1 % in the diet to rats for one and two years, respectively. No treatment related histopathological effects or increased tumour incidences were observed in either study (HERA, 2009; CIR, 2012). The chemicals are synthesised through processes which may result in 1,4-dioxane as an impurity. This impurity is classified as a Carcinogen—Category 3 (R40—Limited evidence of a carcinogenic effect). However, it is reported that cosmetic industry uses additional purification steps to remove the 1,4-dioxane residual in PEG before blending into cosmetic formulations (CIR, 2012).

Mutagenicity/ Genotoxicity	Based on the data available, the chemicals in this group are not considered to be genotoxic. The group members (CAS Nos. 68439-50-9, 68131-39-5 and 64425-86-1) and several analogue chemicals (ranging from C12–18 and EO3–21) produced negative results in several in vitro and in vivo tests for gene mutation and clastogenicity. Negative results were reported in bacterial reverse mutation tests for mutagenicity against Salmonella typhimurium (strains TA98, TA100, TA102, TA104, TA1535, TA1537 and TA1538) and Escherichia coli (strains WP2 and WP2uvrA pKM101), with or without metabolic activation. Negative results were also reported in chromosomal aberration tests in Chinese hamster V79, Chinese hamster ovary, mouse lymphoma and rat liver cell lines (SCCP, 2007; HERA, 2009; CIR, 2012). These chemicals did not induce chromosomal damage in Chinese hamster or Tunstall Wistar rat bone marrow cells after acute oral doses ranged between 250 and 3400 mg/kg bw (HERA, 2009).
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	Based on the data available, the chemicals of this group are not considered to cause reproductive or developmental toxicity. In a two-generation reproductive and developmental toxicity study, the chemical (C14-15EO7) was administered in the diet of Charles River CD rats (n=25/sex/group, at doses of 0, 25, 50 or 250 mg/kg bw/day). The NOAEL for reproductive toxicity was established as 250 mg/kg bw/day (or 0.5 % of the diet). No treatment related effects were reported with respect to fertility, gestation, or viability indices or other histopathological parameters. The NOAEL for developmental toxicity was established as 50 mg/kg bw/day based on reduced pup body weights in the second generation at 250 mg/kg bw/day (HERA 2009; CIR, 2012). In a two-generation reproductive and developmental toxicity study, the chemical (C9-11EO6) was applied dermally to Fischer 344 rats (n=30/sex/group, at doses of 0,10, 100 or 250 mg/kg bw/day, 3 times a week except mating periods). No treatment related effects were reported with respect to mating, fertility, gestation, or viability indices and mean gestational length in both generations. No effects on testicular weights or sperm counts were observed in the male rats. The NOAEL for reproductive toxicity was established as 250 mg/kg bw/day. The NOAEL for developmental toxicity was >250 mg/kg bw/day, based on no effects seen in growth and development in the offspring up to the highest dose tested (HERA 2009; CIR, 2012). In a two generation study, the chemical (C12EO6) was administered in the diet of female rabbits at doses of 0, 50, 100 or 200 mg/kg bw/day from gestation days 2 to 16. Ataxia and a slight decrease in body weight were observed at 100 and 200 mg/kg bw/day, indicating maternal toxicity. Nine rabbits in the control group and 31 in the treatment groups died during the study (details not available). There were no treatment related effects on implantations, number of live foetuses and spontaneous abortions. The NOAEL for maternal toxicity was reported as >50 mg/kg bw/day (HERA, 2009). Although certain short chain monoethylene glycol ethers such as 2-ethoxyethanol (CAS No. 110-80-5) are known reproductive toxicants, the ability of the glycol ethers to cause testicular toxicity decreases with increasing chain length, with effects not observed with chain lengths greater than C2 (OECD, 2004).

Acute Toxicity	Based on the available animal (rats, mice and guinea pigs) studies, the chemicals in this group are expected to have low to moderate acute oral toxicity (REACHa-h; OECD, 2005; HERA, 2009; CIR, 2012). The LD50 in rats ranged from 600 mg/kg bw to greater than 20 g/kg bw. Observed sublethal effects for the chemical with the highest toxicity (C15–16 and EO10) included diarrhoea, pilo-erection, ataxia, abnormal posture, difficult laboured breathing, salivation, lacrimation, bloody noses and lethargy. Data from HERA assessment studies show that the chemicals with ethoxylate chains (EO) between 5 and 15 units were more toxic by the oral route than those with less than 4 or greater than 21 units. No relationship between the alcohol chain length and toxicity was observed (HERA, 2009). The chemicals of this group exhibit low acute dermal and inhalation toxicity. The chemicals (C9 to C15 with 3–13 EO units) were of low acute toxicity in rats and rabbits following dermal exposure. The LD50 ranged from 2000 to 5000 mg/kg bw. Sub-clinical effects included wet appearance of the fur, little or no urine, laboured breathing, lethargy, diarrhoea, ataxia, muscle tremours and decreased activity. There was no relationship between the alcohol chain length or number of ethoxylate groups and toxicity. Very high dermal doses of the chemicals (>16000 mg/kg bw) applied dermally for 24 hours in rabbits led to severe skin irritation, ataxia and lung lesions (HERA, 2009; CIR, 2012). In a guideline study (Test Guideline (TG) 403), a single static inhalation exposure to substantially saturated vapour (equivalent to 131.58 ppm - calculated) of C6EO1-2.5 (CAS No. 112-59-4), resulted in no mortality or other signs of inhalation toxicity in Sprague- Dawley (SD) rats (REACHa).
Irritation	The chemicals in this group are reported to be moderate to severe skin irritants in animal studies. The degree of irritation was reported to be dependent on the type of patch (occluded vs semi-occluded), exposure time (ranging from 4 hours up to 4 weeks) and the concentration used. Undiluted chemicals were moderately to severely irritating, 1–10 % was mildly irritating and 0.1 % and 0.5 % were non-irritating. There was also a general trend between the severity of irritation and the degree of ethoxylation. Chemicals with three and less ethoxylate units appeared to be more irritating than chemicals with higher degree of ethoxylation. No trend in irritation potential with respect to the length of carbon chain could be established. Available data indicates that undiluted AEs can produce varying degrees of eye irritation ranging from moderate to severe irritancy. The severity of irritation was found to be concentration dependent, with up to 1 % minimally irritating and concentrations in the range of 1 to 10 % slightly to moderately irritating. In most cases, following exposure, the eyes of the treated animals recovered a few days after exposure. Further tests showed that rinsing the eye 30 seconds after application with tap water may reduce the severity of the effects. No clear relationship could be established between the number of EO units or carbon chain length and eye irritation potency.
Sensitisation	Based on available data, the chemicals in this group are not skin sensitisers.
Health Effects Summary	The chemicals in this group are synthesised from linear alcohols (primary or secondary) or branched alcohols. The commercial AEs may also contain un-reacted alcohol as reaction by-products at about 5 % but with variations between different commercial products (HERA, 2009). Available data on linear and branched chain alcohols show that they have low acute and systemic toxicity and exhibit similar patterns of absorption, metabolism, and excretion to alcohol ethoxylates. They are also shown to have no skin sensitisation potential. A potential for skin and eye irritation exists with alcohols >11 carbon chain length (OECD, 2006; OECD, 2006a).
Key Study/Critical Effect for Screening Criteria	The critical human health effects for risk characterisation are acute oral toxicity and skin and eye irritation. The irritant effects are similar to those produced by other surfactants, and the severity of irritation appears to increase directly with concentration and generally decrease with an increasing number of ethoxylate units.

Ecological Toxicity [2,3]	
Aquatic Toxicity	The 96 h LC50 value for Alcohols, C9-11, ethoxylated with Oncorhynchus mykiss was 5 - 7 mg/L based on nominal concentrations. In the long term toxicity test to Lepomis macrochirus, the NOEC (30 days) was 0.11 – 0.33 mg/L. In the short–term toxicity test to Daphnia magna, the EC50 (48 h) was 2.5 mg/L. In the long term toxicity test to Daphnia magna, the NOEC (21 days) was 0.77 – 1.75 mg/L. In the short–term toxicity test to Pseudokirchneriella subcapitata (green algae), the EC50 (96 h) was 1.4 mg/L. The EC50 (3 h) for microorganisms was 140 mg/L. In a study conducted with two different fish species (bluegill sunfish and fathead minnow) the effects of C14 -15 alcohol ethoxylates (7EO) were determined (Dorn et al., 1995, Shell). In two experiments fish were exposed for 10 d in a laboratory assay and for 30 d in an outdoor stream mesocosm. Effect parameters determined were survival and growth of juvenile bluegills and survival and reproduction of fathead minnows. In the laboratory experiment the NOEC for survival and swimming performance of bluegills and for survival of fathead minnows was 0.16 mg/L. In the stream mesocosm the NOEC for bluegill survival and growth was >0.33 mg/L and for fathead minnow survival 0.28 mg/L. There was an indication of decreased egg laying by fathead minnow in the streams at concentrations of 0.33 mg/L or greater. On the basis of the reported results a worst-case NOEC of 0.16 mg/L is assumed. One publication is available for an alcohol ethoxylate mixture with a chain length of C12 - C13 and approximately 6.5 ethoxy groups (Gillespie et al. 1999). The 21 days flow-through chronic experiment on daphnids is conducted according to the guidelines USEPA-TSCA (U.S. EPA, 1992) and ASTM (1988) and is well documented in the paper. Nevertheless the degree of ethoxylation of the tested mixture described in the paper (6.5 EO) is higher than the degree of ethoxylation described for CAS 68131-39-5 (2.5 EO). The NOEC of 0.77 mg/L for reproduction can be used for read-across.
Determination of PNEC aquatic	A PNECaquatic of 11 µg/L was calculated using the lowest chronic endpoint of NOEC of 0.11 mg/L for Daphnia magna. An assessment factor of 10 was used.
Current Regulatory Controls [1]	
Australian Hazard Classification	No data available.
Australian Occupational Exposure Standards	No specific exposure standards are available.
International Occupational Exposure Standards	No specific exposure standards are available.
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	Trigger values for freshwater (95% species) (ANZECC 2000): Alcohol ethoxyolated sulfate (AES) = 650 μgL^{-1} Alcohol ethoxylated surfactants (AE) = 140 μgL^{-1}
PBT Assessment	
P/vP Criteria fulfilled?	No. These chemicals were found to be readily biodegradable. Thus, it does not meet the screening criteria for persistence.
B/vB criteria fulfilled?	No. Bioaccumulation in organisms is expected to be negligible, due to biotransformation and excretion of alcohol ethoxylates.
T criteria fulfilled?	No. The NOECs from the chronic aquatic toxicity data are >0.01 mg/L, hence does not meet the screening criteria for toxicity.

Overall conclusion	Not PBT
Revised	January 2019

References

1. National Industrial Chemicals Notification and Assessment Scheme (NICNAS). IMAP, Human Health Tier II Assessment for Ethoxylates of aliphatic alcohols (>C6):, Retrieved 2019: https://www.nicnas.gov.au
2. ECHA REACH, Alcohols, C9-11 ethoxylated, < 2.5 EO, Retrieved 2017: https://echa.europa.eu/information-on-chemicals/registered-substances
3. ECHA REACH, Alcohols, C12-15 ethoxylated, Retrieved 2017: https://echa.europa.eu/information-on-chemicals/registered-substances

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Toxicity Summary - Alcohols, C6-12, ethoxylated propoxylated

Chemical and Physical Properties[1]	
CAS number	68937-66-6
Molecular formula	No data available.
Molecular weight	No data available.
Solubility in water	Soluble in water
Melting point	-3 °C
Boiling point	No data available.
Vapour pressure	No data available.
Henrys law constant	No data available.
Explosive potential	No data available.
Flammability potential	No data available.
Colour/Form	Yellow liquid, mild odour
Overview	Principle Route of Exposure: Eye or skin contact, inhalation Causes severe eye irritation which may damage tissue. Causes skin irritation. Harmful if swallowed.
Environmental Fate[1]	
Soil/Water/Air	This substance is expected to be readily biodegradable (60% @ 28d) (similar substances). Based on an estimated log Kow value of 4.3 – 5.36, and BCF value of 1.1 – 1.8, it is not expected to be bioaccumulative. Mobility in soil: KOC = >4
Human Health Toxicity Summary [1]	
Chronic Repeated Dose Toxicity	No data available to indicate product or components present at greater than 0.1% are chronic health hazards.
Carcinogenicity	Did not show carcinogenic effects in animal experiments (similar substances)
Mutagenicity/ Genotoxicity	In vitro tests did not show mutagenic effects. In vivo tests did not show mutagenic effects. (similar substances)
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	Animal testing did not show any effects on fertility.
Acute Toxicity	LD50 Oral: 600 mg/kg (Rat) (similar substance) LD50 Dermal: > 5200 mg/kg (Rabbit) (similar substance) LD50 Inhalation: > 0.22 mg/L (saturated concentration) (Rat) (similar substance)
Irritation	May cause mild respiratory irritation. Causes severe eye irritation which may damage tissue. Causes skin irritation.
Sensitisation	Did not cause sensitization on laboratory animals (guinea pig) (similar substances)
Health Effects Summary	Causes severe eye irritation which may damage tissue. Causes skin irritation. Harmful if swallowed.
Key Study/Critical Effect for Screening Criteria	
Ecological Toxicity [1]	

Aquatic Toxicity	Toxicity to fish: LC50 (96h) 0.59 mg/L (Pleuronectes platessa) (similar substance) LC50 (96) 1.4 mg/L (Pimephales promelas) (similar substance) NOEC 4.4 mg/L (Pimephales promelas, juvenile) Toxicity to invertebrates: EC50 (48h) 0.14 mg/L (Daphnia magna) (similar substance) EC50 (48h) 0.39 mg/L (Cerodaphnia dubia) (similar substance) Toxicity to algae: EC50 (72h) 0.75 mg/L (Pseudokirchnerella subcapitata) (similar substance) EC50 (96h) 0.7 mg/L (Pseudokirchneriella subapitata) (similar substance) CD10 8 mg/L (Pseudokirchneriella subapitata) EC10 2 mg/L (Brachionus calyciflorus) Toxicity to microorganisms: EC50 (48h) 0.39 mg/L (Cerodaphnia dubia) (similar substance)
Determination of PNEC aquatic	On the basis that the data consists of short term results from three trophic levels, an assessment factor of 1000 has been applied to the lowest reported effect concentration of 0.14 mg/L for Daphnia. The PNEC aquatic is 0.14 µg/L.
Current Regulatory Controls [1]	
Australian Hazard Classification	H302 - Harmful if swallowed H315 - Causes skin irritation H318 - Causes serious eye damage
Australian Occupational Exposure Standards	No data available.
International Occupational Exposure Standards	No data available.
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	No data available.
PBT Assessment	
P/vP Criteria fulfilled?	No. Expected to be readily biodegradable based on similar substances.
B/vB criteria fulfilled?	No. Based on an estimated log Kow value of 4.3 – 5.36, and BCF value of 1.1 – 1.8, it is not expected to be bioaccumulative.
T criteria fulfilled?	Not applicable. Chronic toxicity data >1 mg/L in invertebrates, thus sodium hydroxide does not meet the screening criteria for toxicity.
Overall conclusion	Not PBT
Revised	January 2019

References

1. Redacted

AECOM Imagine it. Delivered.

Toxicity Summary - Amides, tall-oil fatty, N,N-bis(hydroxyethyl)

Chemical and Physical Properties [1,2]	
CAS number	68155-20-4
Molecular formula	UVCB
Molecular weight	370 (typical C18 monounsaturated)
Solubility in water	Dispersible
Melting point	<25 °C (liquid)
Boiling point	>300 °C (estimated)
Vapour pressure	$<1.0\times10^{-10}$ (estimated)
Henrys law constant	$<1.0\times10^{-10}$ (estimated)
Explosive potential	No data available.
Flammability potential	No data available.
Colour/Form	Liquid
Overview	Non-confidential information in the IUR indicated that the industrial processing and uses of the chemical include other basic organic chemical manufacturing as surface active agents and intermediates; pesticide and other agricultural chemical manufacturing as surface active agents; soap and cleaning compound manufacturing as surface active agents; support activities for mining as surface active agents; and petrochemical manufacturing as surface active agents. Non-confidential commercial and consumer uses of this chemical include lubricants, greases and fuel additives.
Environmental Fate [1,2]	
Soil/Water/Air	The members of the fatty nitrogen derived amides category are long-chain alkyl substituted amides used in commercial product mixtures. The category consists of three subcategories: Subcategory I, fatty acid amides; Subcategory II, fatty alkanolamides; and Subcategory III, fatty acid reaction products with amines. For the purpose of this discussion only, a one-member Subcategory, Subcategory IV, which contains CASRN, 61790-63-4, has been considered as part of Subcategory II. The components of Subcategory I are solids possessing low vapor pressure and low water solubility. The substances in Subcategory II contain solids and liquids with negligible to low vapor pressure and tend to be dispersible in water. The substances in Subcategory III also contain solids and liquids possessing negligible to low vapor pressure that tend to be dispersible in water. The fatty acid amides (Subcategory I) and the fatty acid reaction products with amines (Subcategory III) are expected to possess low mobility in soil. The fatty alkanolamides (Subcategory II) are expected to possess moderate to high mobility in soil. Volatilization is low to moderate for the fatty acid amides and low for the fatty alkanolamides and the fatty acid reaction products with amines. The rate of hydrolysis is considered negligible for all category members. The rate of atmospheric photooxidation is considered moderate to rapid for members of each subcategory; however, this is not expected to be an important environmental fate process since these substances are not expected to exist in the vapor phase in the atmosphere. The overall weight of evidence suggests that the members of the fatty nitrogen derived amides category should possess low persistence (P1) and low bioaccumulation potential (B1) with the exception of two members of subcategory III. Fatty acids, tall-oil, reaction products with tetraethylenepentamine and fatty acids, tall-oil, reaction products with polyethylenepolyamines are expected to possess low persistence (P1), but moderate bioaccumulation potential (B2).
Human Health Toxicity Summary [1,2, 3]	

Chronic Repeated Dose Toxicity	Based on read-across from CAS 120-40-1, an oral repeated dose toxicity study reported NOEL = 0.1% which corresponds to 50 mg/kg/day. No rats died as a result of being treated with the test substance. Two males treated with diet containing 1.0% test substance were euthanized on Days 23 and 58 because of weight loss and respiratory distress. Extensive lung abscess formation was seen at autopsy and bronchopneumonia was confirmed histologically. Growth was inhibited significantly in males and females at and above the 0.5% dietary concentration. Food intake was reduced at all dietary levels except 0.1%, and was attributed to an effect of the test substance on palatability of the diet. The rats in the palatability study showed exclusive preference to the control feed than the treated feed, virtually no test diet was consumed at any dietary levels incorporated. Hematological examination revealed statistically significant reductions in hemoglobin levels and red cell counts in females at the 2.0 and 1.0% dietary concentration and in hemoglobin levels in males at the 2.0% level. Examination of the femoral bone marrow smears showed not deviation from normality. Serum chemistry revealed significantly high serum levels of glutamic-oxaloacetic transaminase in females at the 0.5% level and higher, but only at the 0.5% level in males. Urinalysis was comparable across all groups for males and females. Gross examinations were unremarkable. Statistically significant increases in relative kidney weight in all test groups except at 0.1% in females and at 2.0 and 1.0% in males; and increases in relative liver weight in females at 2.0 and 1.0% were seen. These were attributed to the decreases in body weight. Types and incidence of pathological lesions seen histologically were comparable in control and test groups. Gonads were examined histologically, thus this study meets SIDS requirements for a reproductive screen.
Carcinogenicity	Not regarded as carcinogenic.
Mutagenicity/ Genotoxicity	Based on read-across from CAS 120-40-1, the test substance did not induce reverse mutations in the tested strains of Salmonella typhimurium in the presence or absence of S-9 activation.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	Based on read-across from CAS 68603-42-9, the results from a developmental toxicity study showed that repeated oral administration of COMPERLAN KD to pregnant rats on day 6 through 15 of gestation, caused no symptoms of cumulative toxicity up to a dose level of 1000 mg/kg/day. With the exception of salivation and propulsion of the head during the dose administration, there were no treatment-related effects. Also, COMPERLAN KD does not reveal any embryotoxic or teratogenic potential at dose levels up to 1000 mg/kg/day (author of the report).
Acute Toxicity	Acute oral and dermal toxicities of CASRN 68140-00-1 in rat and rabbit, respectively, are low. Based on read-across from CAS 68140-00-1, an oral acute toxicity test on rats reported LD50 > 5 g/kg. All animals survived the 8-day observation period and no adverse effects were observed. With respect to the determined LD50 value, it is assumed that the LD50 value for female rats also exceeds the limit dose of > 2000 mg/kg body weight. In a dermal acute toxicity test on rabbits, LD50 > 2 g/kg was reported. All animals survived. All animals appeared normal through day 14. Two females that had abraded skin lost weight (0.01 and 0.25 kg) over the 14-day post-exposure period. All remaining rabbits gained weight through day 14. Swiss-Webster mice (4 males/dose) were administered “Alkanolamide #1”, identified in the robust summary as CASRN 68144-20-4, via whole body exposure for 3 hours. Doses were 86- 219 mg/m3 (0.086 – 0.219 mg/L). Animals were observed for several days. No mortality was observed. LC50 > 0.219 mg/L
Irritation	The test article produced sensory irritation later in the exposure at low concentrations. Pulmonary irritation also occurred later in these exposures.
Sensitisation	Did not cause sensitization on laboratory animals (similar substances)

Health Effects Summary	Acute oral and dermal toxicities of CASRN 68140-00-1 in rat and rabbit, respectively, are low. CASRNs 142-78-9 and 68140-00-1 were negative for gene mutations in bacteria in vitro. No data are available for the repeated-dose/reproductive/developmental toxicity and genetic toxicity (chromosomal aberrations) endpoints. The repeated-dose/reproductive/developmental toxicity and genetic toxicity (chromosomal aberrations) endpoints are identified as data gaps
Key Study/Critical Effect for Screening Criteria	
Ecological Toxicity [1, 3]	
Aquatic Toxicity	Based on read-across for CAS No: 68603-42-9 Daphnia: EC50 (24-hour): 3.3 mg active matter/l Daphnia: 48-hour LC50 = 2.15 and 2.64 mg/l Based on read-across for CAS No: 112-84-5 The experiment measured the survival and reproduction of Daphnia magna over a 21-day exposure to the test and control substances. Daphnids were cultured in the laboratory using Elendt M7 medium and a daily feeding regiment of green algal cells (Chlorella vulgaris). Four experimental groups: control (Elendt M7 medium), solvent control (0.1 ml methanol/l), 33 µg/l, and 100 µg/l (nominal concentrations) were used in a static-renewal exposure system. All test solutions were prepared with Elendt M7 medium. Replicate test vessels consisted of 4 oz glass bottles containing 100 ml of test solution. There were 10 replicates per experimental group. On the day of test initiation, neonate daphnids were removed from cultures and placed in a crystallizing dish containing Elendt M7 medium. One daphnid was placed in each replicate test vessel, and each vessel was randomly placed in the testing area. Light intensity was not measured, but ambient laboratory lighting was provided with a photoperiod of 16 hours light/8 hours dark. Each day, test solutions were renewed, and the daphnids were fed 1.7 x 10(5) cells/ml of Chlorella vulgaris. Adult survival and reproduction was assessed each day and neonates were removed daily. The pH, dissolved oxygen (DO) and total hardness (as mg/l CaCO(3)) were measured on test days 0, 1, every Tuesday and Friday and on day 21. Means and ranges for temperature, water pH, DO and total hardness were 19.7 °C (14.5 - 25.0 °C), 7.6 (7.2 - 8.1), 8.2 mg/l (4.5 - 9.3 mg/l) and 245 mg/l (234 - 256 mg/l) as CaCO(3), respectively. Concentrations of the test substance in exposure solutions were measured on test days 0, 1, 5, 9, 12, 16 and 19 in both the old and the new solutions. Effect concentrations were based on mean measured concentrations. 21 d NOEC = 0.08 mg/L
Determination of PNEC aquatic	Applying an assessment factor of 1000 to the NOEC (0.08 mg/l) gives a PNEC of 0.08 µg/l.
Current Regulatory Controls	
Australian Hazard Classification	No data available.
Australian Occupational Exposure Standards	No data available.
International Occupational Exposure Standards	No data available.
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	No data available.
PBT Assessment	
P/vP Criteria fulfilled?	No. Expected to be readily biodegradable based on similar substances.

B/vB criteria fulfilled?	No. Based on BAF = 108 and log Kow of 3 (estimated)
T criteria fulfilled?	No. Acute toxicity data was >1 mg/L.
Overall conclusion	Not PBT
Revised	January 2019

References

1. OECD, Amides, tall-oil fatty, N,N-bis(hydroxyethyl), Retrieved 2019: http://www.echemportal.org
2. USEPA Hazard Characterization Document, Fatty Nitrogen Derived (FND) Amides Category, September 2010
3. Redacted

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Toxicity Summary - Amine oxides, cocoalkyldimethyl

Chemical and Physical Properties	
CAS number	61788-90-7
Molecular formula	CH3.(CH2)R.N(CH3)2:O, where R is 9-17
Molecular weight	237 (70% C12: 30% C14) (molecular weight will vary depending on structure)
Solubility in water	409.5 g/L
Melting point	Average: 130.5
Boiling point	Decomposes before boiling
Vapour pressure	Predicted vapour pressure values are < 4.6E-7 hPa
Henrys law constant	No data available.
Explosive potential	No data available.
Flammability potential	No data available.
Colour/Form	No data available.
Overview	Surfactants known as amine oxides (AO) contain even numbered linear alkyl chains ranging from C8 to C20. Also known as fatty alkyl dimethyl AOs, they are usually produced by reacting alkyl dimethyl amines with hydrogen peroxide in water. The AOs are produced, transported and used in water solutions, typically at a 25-35% activity level. The AOs are produced and used either as single chain length substances (e.g., C12) or as a mixture of different chain lengths (e.g., C12 to C18). All of the substances in this category are surfactants, consisting of a polar “head” (the amine oxide) and a relatively inert, hydrophobic “tail” (the long alkyl substituent). AOs are used in cleaning and personal care products as foam stabilizers, thickeners, emollients, emulsifying and conditioning agents. Primary uses are in liquid hard surface cleaners, laundry and dishwashing detergents, shampoos and hair conditioning products.
Environmental Fate[1]	
Soil/Water/Air	AOs are highly water soluble (C10-16 AO = 409.5g/L). AO is fully biodegradable under both aerobic and anaerobic conditions and is effectively removed during wastewater sewer transport (“pipe loss” >90%) and in biological wastewater treatment (~98%). It has low potential for bioaccumulation (BCF <87 L/kg). These characteristics help to minimize the potential for environmental exposure, and for indirect human exposures via drinking water and/or fish consumption.
Human Health Toxicity Summary [1]	
Chronic Repeated Dose Toxicity	In four repeated-dose studies with rats and mice exposed to AO via oral and dermal routes (all with CAS No 70592-80-2), three dermal studies were designed to assess the effect of repeated exposure on skin at maximum doses of 1.5 mg AO/kg-bw/day. Higher doses were tested in a 90-day dietary study with rabbits. No treatment-related clinical chemistry, hematology and histopathological changes were observed. In these studies, LOAELs ranged from 87 to 150 mg AO/kg bw/day with the highest oral NOAEL below the lowest LOAEL as 80 mg AO/kg bw/day. Signs of toxicity observed in the oral study included suppressed mean body weight gain, lenticular opacities and diarrhoea; in the dermal studies, local dermal irritation was evident.
Carcinogenicity	The carcinogenic potential of amine oxides has been thoroughly investigated in three carcinogenicity studies in rats or mice by dermal, dietary, or drinking water routes. In all cases the substances demonstrated no evidence of a carcinogenic response.

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Mutagenicity/ Genotoxicity	In five in vitro bacterial (Salmonella) mutagenicity studies, AO shows no evidence of mutagenicity either with or without S9 metabolic activation at concentrations up to 250 ug/plate (higher concentrations caused cytotoxicity). Three in vivo studies investigated clastogenic effects on a close structural analog of the category, 1-(methyldodecyl)dimethylamine-N-oxide including: a mouse micronucleus, a Chinese hamster micronucleus and a Chinese hamster cytogenetics study. These studies were all negative showing no increase in micronuclei or chromosome aberrations. An in vivo mouse dominant lethal assay showed no evidence of heritable effects. Two AOs (CAS No 1643-20-5 and CAS No 3332-27-2) were negative in an in vitro cell transformation assay tested at concentrations up to 20 ug/ml.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	No evidence of reproductive toxicity or fertility effects was observed in a study in which rats were given dietary doses of AO in the diet over two generations (CAS No 1643-20-5). No macroscopic or histopathological changes were attributable to treatment with the test substance. The maternal NOAEL from this reproductive study was >40 mg AO/kg bw/day, which was the highest dose tested. At all treatment levels, the rate of bodyweight gain for the F1 and F2 offspring was reduced during the lactation period, however, this reduction was not greater than 10%. This effect appeared to be dose-related, but was not statistically significant until after weaning in the mid and high dose levels. This was not considered an adverse effect since the body weight change only reached statistical significance when the rat pups were getting the majority of their calories from solid food (Developmental NOAEL >40 mg/kg bw/day). In three developmental toxicity studies via gavage in rats and rabbits (with CAS No 1643-20-5 & 70592-80-2), effects such as decreased fetal weight or delayed ossification, were most often observed only at maternally toxic doses and were associated with the irritation effects of AO on the gastrointestinal tract. No decreases in litter size, no changes in litter parameters, no malformations or significant differences in skeletal defects were observed at oral doses up to 25 mg/kg bw/day in rats (based on decreased fetal weight at 100 mg/kg bw/day) and >160 mg/kg bw/day in rabbits (the highest dose tested).
Acute Toxicity	In rat oral acute toxicity limit tests, no deaths occurred at single doses of 600 mg C10-16 AO/kg bw or less (for CAS No 70592-80-2). In multi-dose studies, acute oral LD50 values for rats ranged from 846 mg AO/kg bw to 3873 mg AO/kg bw (both values for CAS No 61788-90-7), with several other AO's having rat oral LD50's falling within this range. In single dose acute dermal toxicity limit tests, no deaths occurred at a dose of 520 mg AO/kg bw (CAS No 70592-80-2). This dose was equivalent to 2 mL/kg of a 30% formulation. There were no deaths observed in a rat acute inhalation study to aerosol droplets of a consumer product providing a dose of 0.016 mg AO/L.
Irritation	In a series of studies on rabbits, AO's of varying chain length showed consistent results and all 1) were not irritating to the skin or eyes at low concentrations (1%), 2) were moderately irritating at 5%, and 3) more severely irritating when tested as produced (e.g., ~30% aqueous solutions). In studies that included rinsing, eye irritation effects diminished with rinsing after 30 seconds of exposure and were slight with rinsing after 4 seconds of exposure. In Draize rabbit eye irritation tests using ~30% AO solutions, rabbits experienced severe to moderate irritation. (The maximum concentration of AO is 10% active in consumer products.) Accidental eye exposure in manufacturing employee incidents and consumer incidents established that eye irritation effects of exposure during manufacturing and use of products containing AO and other surfactants are moderate, transient and reversible
Sensitisation	There is no indication of skin sensitization for the AO category based on the available animal and human data.
Health Effects Summary	The chemicals in this category present properties indicating a hazard for human health (skin and eye irritation). However, these hazards do not warrant further work as they are related to reversible, transient and non-lasting effects. Nevertheless, these hazards should be noted by chemical safety professionals and users.
Key Study/Critical Effect for Screening Criteria	Skin and eye irritation.

Ecological Toxicity [1,2,3]	
Aquatic Toxicity	Extensive aquatic toxicity data are available for commercially representative amine oxides (C10 to C18) that are single chain length as well as mixtures. Based on hazard data, freshwater green algae are considered the most sensitive species, for acute and chronic endpoints. Acute toxicity is affected by chain length for fish and invertebrates. Chain length affects hydrophobicity, wherein longer chain-lengths increase the rate of uptake and decrease depuration. All but four supporting AO's have been tested for acute toxicity in fish, daphnia, and algae. The range of acute LC50/EC50/ErC50 values based on a review of the aquatic toxicity data on AO were 0.60-32 mg/L for fish, 0.50-10.8 mg/L for Daphnia magna and 0.010-5.30 mg/L for algae. Chronic toxicity data were normalized to a chain length of 12.9 carbon atoms, as this average chain length represents the largest volume product for North America (CAS No 70952-80-2). Chronic toxicity (NOEC, EC20) for an amine oxide of average chain length of C12.9 ranged as follows for the different trophic levels: 0.010-1.72 mg/L for algae, 0.28 mg/L for Daphnia (flow through) and 0.31 mg/L for fish (flow through). These are based on geometric mean values, and a dataset of 21 chronic toxicity studies. Based on a chronic periphyton microcosm bioassay that included 110 taxa of algae (most sensitive species), a NOEC value of 0.050 mg/L was derived when normalized for a C12.9 amine oxide.
Determination of PNEC aquatic	Chronic toxicity values are reported for fish, aquatic invertebrates, and freshwater algae. Since there is valid chronic toxicity data for three trophic levels, an assessment factor of 10 is used (in accordance with EU guidance). Based on the NOEC for freshwater algae (the most sensitive species), the aquatic PNEC is 0.01 µg/L.
Current Regulatory Controls [4]	
Australian Hazard Classification	No data available.
Australian Occupational Exposure Standards	No data available.
International Occupational Exposure Standards	No data available.
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	No data available.
PBT Assessment	
P/vP Criteria fulfilled?	No. AOs are highly removed by conventional sewage treatment systems and biodegrade rapidly and completely under aerobic and anaerobic conditions.
B/vB criteria fulfilled?	No. BCFWIN predictions using the calculated logKow value of < 2.7 as input parameters (derived for C10-16 AO), calculated bioconcentration factor < 87 for C12-14 AO (The Procter & Gamble Company, 2002C). Thus the potential for bioaccumulation of AOs in aquatic organisms is considered to be low.
T criteria fulfilled?	Yes. Chronic toxicity data < 1 mg/L fish, aquatic invertebrate and/or algae, thus AO does not meet the screening criteria for toxicity.
Overall conclusion	Not PBT
Revised	January 2019

References

1. OECD (2001) SIDS Initial Assessment Profile for Amine Oxides (AO)

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Toxicity Summary - Benzaldehyde

Chemical and Physical Properties[1,2,3]	
CAS number	100-52-7
Molecular formula	C7H6O
Molecular weight	106.12
Solubility in water	6.55 g/L at 25°C
Melting point	-26°C
Boiling point	179.2°C
Vapour pressure	0.130 kPa (0.97 mmHg) at 20°C
Henrys law constant	2.85 Pa.m³.mol-1 @ 25 °C
Explosive potential	Non explosive
Flammability potential	Non flammable
Colour/Form	Colourless or yellow liquid with an almond-like odour.
Overview	Benzaldehyde is a colourless liquid that becomes yellowish with age. It smells a little like almond and has a burning, aromatic taste. Benzaldehyde is very soluble in water. Benzaldehyde occurs naturally in plants. It can be formed in the atmosphere from the reaction of some chemicals with sunlight. It has been detected in air associated with volcanoes. Benzaldehyde is an important commercial chemical that is used to make other chemicals. It is also used as a preservative in cosmetics, personal care products, food and select car detailing products. It is used as a solvent for oils, flavouring, and in synthetic perfumes. It may be a tobacco additive. It was formerly used as an insecticide.
Environmental Fate [2,3]	
Soil/Water/Air	The test substance is readily biodegradable. The test substance was shown to degrade under influence of light with a DT50 of 9.4 hours. In addition under anaerobic conditions complete biodegradation is expected. As the logKow is 1.4, the potential for bioaccumulation and sorption of the test substance is considered to be low. The Henry Constant was calculated to be 2.85 Pa m^3/mol. A calculation with Simple Treat shows that the test substance will degrade in the Sewage Treatment Plant for > 88% with at maximum about 12% to end up in the water compartment.

Human Health Toxicity Summary [1]	
Chronic Repeated Dose Toxicity	Based on the data available, the chemical is not considered to cause serious damage to health from repeated oral and inhalation exposure. In a repeated dose oral toxicity study, Fischer rats (male/female, 10/sex/dose) were administered the chemical by oral gavage at doses of 0, 50, 100, 200, 400 or 800 mg/kg bw/day, five days a week, for 13 weeks. Mortalities and histopathological changes including lesions in the brain (degeneration and necrosis of the cerebellum and necrosis in the hippocampus), renal tubular necrosis, hyperplasia and/or hyperkeratosis of the forestomach, and degeneration of the liver were observed in both sexes at the highest tested dose level. Depressed body weights (26 % lower than controls) were also observed for male rats at this dose. A no observed adverse effect level (NOAEL) of 400 mg/kg bw/day was established (NTP, 1990; OECD, 2002; CIR, 2006; REACH). A similar repeated dose oral toxicity study on B6C3F1 mice (male/female, 10/sex/dose) was also conducted. The mice were administered the chemical by oral gavage at doses of 0, 75, 150, 300, 600 or 1200 mg/kg bw/day, five days a week, for 13 weeks. Within the first week of dosing, 9/10 males and 1/10 females died at the highest tested dose. Mild to moderate renal tubular degeneration in all males was observed in the high dose group and 1/10 males in the 600 mg/kg/day group. Depressed body weights (9 % lower than controls) were also observed for the males at 600 mg/kg bw/day. The NOAEL was determined to be 300 mg/kg bw/day for male mice and 600 mg/kg bw/day for female mice (NTP, 1990; OECD, 2002; CIR, 2006; REACH). In another repeated dose oral toxicity study, similar to OECD TG 408, groups of Osborne–Mendel rats (male/female, five/sex/dose) were fed a powdered diet containing the chemical at concentrations of 1000 ppm for 28 weeks, or 10000 ppm (approximately 500 mg/kg bw/day) daily for 16 weeks. No effects on body weight or haematological parameters and no macroscopic/microscopic changes in selected organs were noted at 10000 ppm (CIR, 2006; REACH). In a repeated dose inhalation toxicity study conducted similarly to OECD TG 412, groups of Sprague Dawley (SD) rats (male/female, 14/sex/dose) were exposed (whole body) to the vapours of the chemical at 0, 500, 750 and 1000 ppm, six hours a day for 14 days. Significant reduction in body weight was observed for all males but only at 1000 ppm for females. Mortalities occurred in the two higher dose groups. All groups exhibited clinical toxicity symptoms including reduced motor activity, hypothermia, respiratory problems and nasal and ocular irritation. With increased concentrations, the severity of nasal and ocular irritation increased. At the two highest doses, the rats displayed aggressive behaviour and central nervous system symptoms (tremors, piloerection, diuresis, seizures and sensitivity to noise). The most prominent histopathological observation was goblet cell metaplasia in the respiratory epithelial lining of the nasal septum, which was found in males at doses 500 and 1000 ppm, but not in females. A no observed adverse effect concentration (NOAEC) could not be determined due to the clinical observations (indicative of neurotoxicity), hypothermia, and goblet cell metaplasia which were seen at concentrations of 500 ppm and above. The lowest observed adverse effect concentration (LOAEC) was reported to be 500 ppm in this study (CIR, 2006; HSDB; REACH). In another repeated dose inhalation toxicity study with limited documentation (non-guideline), rats were exposed to the chemical at 186 ppm (803 mg/m^3), four hours a day, five days a week for two weeks. Respiratory irritation was observed during exposure. No other effects were reported (EC, 2000; OECD 2002).

Carcinogenicity	Although the chemical has been reported to have 'some evidence of carcinogenic activity' in B6C3F1 mice, there was 'no evidence of carcinogenic activity' in Fischer 344 rats receiving 200 or 400 mg/kg bw/day (NTP, 1990). It was further concluded that the increased incidences of pancreatic acinar cell neoplasms in male rats and squamous cell papillomas of the forestomach in mice were probably due to the high concentrations of corn oil (mild irritant and mitogen) used as a vehicle in these studies (US EPA, 2001). The chemical is also considered not to have mutagenic or genotoxic potential (see Genotoxicity). Therefore, the chemical is not considered to have carcinogenic potential. In a combined chronic toxicity–carcinogenicity study (OECD TG 451), groups of eight-week-old Fischer 344 rats (male/female, 50/sex/dose) were administered (gavage) the chemical in corn oil at doses of 200 or 400 mg/kg bw, five days a week for two years. At the highest dose, mortality in male rats was significantly higher than the controls. No dose-related effects on body weight and clinical signs were observed. As squamous cell papillomas of the forestomach were seen in only two female rats in the high dose group and there was a lack of supporting hyperplasia, these were not considered to be due to the administration of the chemical. Significant increases in the incidences of pancreatic acinar cell hyperplasia and tumours were observed in male rats only at the high dose. Unpublished National Toxicology Program (NTP) studies indicated that pancreatic acinar cell tumours found in rats gavaged with corn oil were not autunomous as these tumours failed to transplant. Therefore, based on the facts that these tumours failed to transplant, were present in variable numbers in control animals, and increased only at the high dose, it was concluded that pancreatic acinar cell hyperplasia and tumours were not considered as evidence of carcinogenic activity for the chemical (NTP, 1990; EC, 2000; HSDB; REACH). It was further concluded that the increased incidence of tumours specific to male rats in this study was probably due to the use of corn oil as a vehicle in this study (US EPA, 2001). In the same carcinogenicity study, groups of eight-week-old B6C3F1 mice (male and female, 50/sex/dose) were administered (gavage) the chemical in corn oil at doses of 200 or 400 mg/kg bw (in males), 300 or 600 mg/kg bw (in females), five days a week for two years. Although no significant differences in mean body weights and survival were observed between any groups of mice, effects were noted in the forestomach of mice. The incidences of uncommonly occurring squamous cell papillomas of the forestomach in both exposure groups were significantly greater as compared to the controls (male: vehicle control, 1/50; low dose, 2/50; high dose, 5/50; female: 0/50; 5/50; 6/50). The increased incidences of papillomas were accompanied by significantly increased incidences of focal hyperplasia in the forestomach in both sexes of the 400 mg/kg bw group and in females of the 200 mg/kg bw group, compared with vehicle controls. The NTP considered that the increase in papillomas was due to a concurrent increase in hyperplasia following treatment with the chemical and concluded that there was 'some evidence of carcinogenicity' in mice. It was also concluded male and female mice might have been able to tolerate higher doses (NTP, 1990; REACH).

Mutagenicity/ Genotoxicity	Overall, the data indicate that the chemical has no mutagenic or genotoxic potential. Although there is no mutagenic activity in bacterial systems, the chemical does have weak clastogenic effects in some mammalian cell assays. There are also no in vivo data available. The chemical gave negative results in several in vitro bacterial reverse mutation assays with Salmonella typhimurium at concentrations up to 3333 mg/plate. Induction of chromosomal aberrations was also not observed in Chinese hamster ovary (CHO) cells, treated with the chemical up to 500 mg/mL in the absence of S9 or with up to 1600 ug/mL with S9 (NTP, 1990; REACH). In an in vitro chromosomal aberration assay (OECD TG 473) in the Chinese hamster cell line B241, a significant percentage (13 %; 21/162) of the cells displayed abnormalities following exposure to a concentration of 5.3 nM of the chemical for 24 hours (CIR, 2006). Cytogenetic tests with CHO cells reported an increased number of sister chromatid exchanges at doses of 50 mg/ml and 160 mg/ml in the absence of S9 or at 1600 mg/mL with S9 (NTP, 1990; HSDB; REACH). The chemical gave positive results in a mouse lymphoma forward mutation assay (OECD TG 476) with mouse lymphoma L5178Y cells. The concentrations of the chemical tested in this assay were 0, 50, 100, 200, 400, and 800 mg/mL. Although significant increases in mutant fractions were observed at a dose of 400 mg/mL, the positive response was noted to be close to the cytotoxic dose of 640 mg/ml (HSDB; REACH). Negative results were obtained with the chemicals in an in vivo sex-linked recessive lethal test with Drosophila melanogaster (NTP, 1990; OECD, 2002; HSDB; REACH).
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	Although limited data are available, the available information indicates that the chemical does not show specific reproductive or developmental toxicity. Benzyl derivatives, including benzaldehyde, have been reported to produce no evidence of reproductive and developmental toxicity during various studies. It was also stated that as benzyl derivatives generally follow similar metabolic pathways, studies conducted on benzyl derivatives provide adequate evidence for benzaldehyde (US EPA, 2001). As part of reviewing the reproductive toxicity and teratogenicity of benzaldehyde and related compounds (benzyl acetate, benzyl alcohol, and benzoic acid and its salts), the Joint Food and Agriculture Organization of the United Nations (FAO) and the World Health Organization (WHO) Expert Committee on Food Additives concluded that 'delayed development and reduced foetal and postnatal pup body weights were observed in developmental toxicity studies in rats, mice, hamsters and rabbits, but only at doses that were toxic to the mother' (CIR, 2006). In a poorly-documented one-generation reproductive toxicity study (non-guideline), male and female rats were administered the chemical by oral gavage at doses of 0 or 5 mg/kg bw/day in oil, once every second day for 32 weeks. Dosing commenced at 75 days before breeding with untreated males; two pregnancies per rat were studied, one at 75 days and one at 180 days. The number of gestating females, number of live-born offspring, pup weights at birth and on postnatal days 7 and 21, and pup viability were recorded. The incidences of pregnancy were reported to be lower for treated females compared with controls. All other parameters were reported to be similar between the treatment and control groups. It was concluded that the treatment did not cause a significant change in any of the reproductive parameters measured. (US EPA, 2001; OECD, 2002; CIR, 2006; REACH).

Acute Toxicity	In an acute oral toxicity study conducted similar to the Organisation for Economic Co-operation and Development (OECD) Test Guideline (TG) 401, groups of male Wistar rats were administered (by gavage) the chemical at doses of 0.8, 1.0, 1.1, 1.2, 1.3, 1.5, and 1.8 mL/kg bw and observed twice daily for 14 days. The acute median lethal dose (LD50) was reported to be 1.43 mL/kg bw (1430 mg/kg bw), with a mortality rate of 100 % (10/10) at the highest tested dose. Observed sub-lethal effects included sedation, staggering, weight loss and a rough coat (REACH). In another acute oral toxicity study with limited data, male and female rats were administered the chemical at doses of 1100–1540 mg/kg bw. An LD50 of 1300 mg/kg bw was established (OECD, 2002; REACH). Although limited information is available, the chemical is likely to have low acute dermal toxicity in animal tests following dermal exposure. In an acute dermal toxicity study in rabbits with limited available data, an LD50 of >1250 mg/kg bw was reported (OECD, 2002; HSDB; REACH). Although limited data are available, the available information indicates that the chemical has moderate acute toxicity in animal tests following inhalation exposure and is recommended for classification. In an acute inhalation toxicity study conducted according to OECD TG 436, Wistar rats (male/female) were exposed (nose only) to the vapours of the chemical at 1 and 5 mg/L for four hours and observed up to 14 days. Clinical effects were observed in most animals following exposure at 5 mg/L including lethargy, flat/hunched postures, ventrolateral recumbency, respiratory difficulties and piloerection. Four animals out of six (one male and three females) died following exposure at 5 mg/L. A median lethal concentration (LC50) of <5mg/L was established, based on mortalities at the highest tested dose (REACH). An increased incidence of respiratory symptoms was noted among workers exposed to vapour of the chemical at atmospheric concentrations of >5 mg/m^3 (OECD, 2002).
Irritation	Although limited data are available, the available information indicates that the chemical is not likely to be a skin irritant. In two skin irritation studies (non-guideline) with limited data, the undiluted chemical (500 mg) was applied to the intact or abraded skin of New Zealand White rabbits for 24 hours with observation up to seven days. Although the exact details were not provided, slight skin irritation was observed (EC, 2000). Although limited data are available, the chemical had been reported to be an eye irritant in animal studies. The available information is not sufficient to support a classification. In an eye irritation study (non-guideline), one drop of the undiluted chemical was applied to the conjunctival sac of a rabbit. Observations were made at one, 24 and 48 hours following application. Immediate irritation effects were noted at one hour and within 24 hours, the anterior portion of the cornea was damaged. The cornea was cleared within 48 hours and only erythema of the conjunctiva and nictitating membrane was noted at this stage. Although the rabbit died on the sixth day, the death was not related to the application of the chemical (CIR, 2006; REACH). In another eye irritation study (non-guideline) with limited data, the chemical (100 µL, concentration not stated) was instilled into the eyes of two rabbits and observed for seven days. The chemical was observed to be slightly irritating to the eyes (REACH).

Sensitisation	Although the chemical has produced skin sensitisation reactions in some tests, based on the weight of evidence, the chemical is not likely to be a skin sensitiser. It is also noted that the chemical is rapidly metabolised to benzoic acid in the skin. Clinical reports of allergy to the chemical are rare and benzoic acid has also been reported not to produce sensitisation in clinical trials in humans (CIR, 2006). In a Magnusson-Kligman skin sensitisation test conducted by the US EPA, guinea pigs (10/group) were initially exposed to the chemical intradermally by a 0.1 mL injection of 3 % chemical in paraffin oil followed by topical application to a patch of skin (occluded for 48 hours) of 15 % chemical in petrolatum. The skin was later challenged by a topical application (occluded for 24 hours) of 7 % chemical in petrolatum on a patch of skin. As the chemical failed to induce erythema in either group, the chemical was concluded not to be a skin sensitiser (CIR, 2006). In a skin sensitisation study that compared four testing methods of 32 fragrance materials on Himalayan guinea pigs, the chemical tested positive for allergenicity in the Draize test (DT), the maximisation test (MT) and Freund's complete adjuvant (FCA) test. The guinea pigs were injected intradermally with the chemical at doses of 0.05 mL (0.1 % solution), 0.1 mL (5 % solution) and 0.05 mL (undiluted) for DT, MT and FCA, respectively (EC, 2000; CIR, 2006; REACH). The chemical was reported to be non-sensitising in the open epicutaneous test (OET) for the same study as reported above. The guinea pigs were exposed to the chemical (undiluted, 0.03 , 0.1, 0.3, 1, 3, 10, or 30 %) at a dose of 0.1 mL on an 8 cm2 area of shaved skin on the flank. Applications were repeated once a day for 21 days and the sites were scored for signs of irritation 24 hours following each treatment. The acute minimum irritating concentration was 10 % and after 21 exposures was 3 %. The animals were challenged with 3 % (minimum irritating concentration for day 21) or an unspecified lower concentration on a 2 cm2 area of shaved skin at two weeks post-exposure. The sites were scored at 24, 48 and 72 hours. No sensitisation effects were observed (CIR, 2006; REACH). In a guinea pig skin maximisation test (OECD TG 406), animals were injected intradermally with 2.7 % of the chemical and followed by three epidermal challenges with 2.1, 2.1 and 0.64 % of the chemical. It was noted that only one intradermal induction was performed and no additional topical induction. Also, there were three challenge reactions instead of one. The time between induction and challenge applications was also not stated. No sensitisation effects were observed (REACH).
Health Effects Summary	The critical health effects for risk characterisation include systemic acute effects (acute toxicity from oral and inhalation exposure).
Key Study/Critical Effect for Screening Criteria	The chemical has been reported to possibly cause respiratory failure, depression of the CNS and convulsions at high concentrations (HSDB). A young woman died after ingesting 50–60 ml (700–2000 mg/kg) of the chemical. At autopsy, yellowish-white pulp with a strong odour of bitter almond was found in the stomach. The time between consumption and death was not specified. In another case, a man had to be revived from near death following ingestion of 40 ml of a derivative of the chemical (o-hydroxybenzaldehyde). Based on these two studies, a lethal oral dose of 600–900 mg/kg bw was calculated for the chemical in the absence of prompt treatment (NTP, 1990; EC, 2000; CIR, 2006). In a case study, workers exposed to vapour of the chemical at atmospheric concentrations of >5 mg/m^3 reported an increased incidence of respiratory symptoms (OECD, 2002). In an inhalation toxicity study, human volunteers were exposed to 4.5 ppm (19.5 mg/m^3) of the chemical for one minute. Irritation of the eyes and upper respiratory tract were observed. In an occupational study, workers exposed to the chemical vapour at atmospheric concentrations of >5 mg/m^3 reported symptoms of slight eye irritation and considerable skin irritation (OECD, 2002).

Ecological Toxicity [2,3]	
Aquatic Toxicity	Acute LC50 for freshwater fish is 1.07 mg/L, freshwater invertebrates is 16.2 mg/L and EC10 for freshwater algae is 20 mg/L. Chronic NOEC for freshwater fish is 0.12 mg/L. The overall acute dataset on aquatic organisms yields a lowest LC50 value for fish of 1.07 mg/L and a NOEC of 0.12 mg/L. However, the substance is readily biodegradable and has a low potential for bioaccumulation. Based on the second ATP to CLP the test substance was classified as Chronic category 3 for aquatic toxicity.
Determination of PNEC aquatic	Ecotoxicological data indicate that benzaldehyde is acutely toxic to fish, harmful to daphnia and very slightly toxic to algae. Using an uncertainty factor of 100 on the lowest LC50 to fish a PNEC (Predicted No Effect Concentration) of 10.7 ug/L is calculated, for aquatic organisms.
Current Regulatory Controls [1]	
Australian Hazard Classification	The chemical is classified as hazardous, with the following risk phrases for human health in the Hazardous Substances Information System (HSIS) (Safe Work Australia): Harmful if swallowed, Xn; R22 (Acute toxicity)
Australian Occupational Exposure Standards	No specific exposure standards are available.
International Occupational Exposure Standards	The following exposure standards are identified (Galleria Chemica). The chemical has an exposure standard of 5 mg/m^3 time weighted average (TWA) in Bulgaria, Hungary, Latvia and Russia; 10 mg/m^3 in Poland; and 2 ppm in the USA. Short-term exposure limits (STEL) of 4 ppm in the USA and Canada; 10 mg/m^3 in Hungary; and 40 mg/m^3 in Poland have been reported.
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	No data available.
PBT Assessment	
P/vP Criteria fulfilled?	No. Expected to be readily biodegradable.
B/vB criteria fulfilled?	No. As the Log Pow is 1.4 (Log Pow < 4.5), it is not expected to be bioaccumulative.
T criteria fulfilled?	No. The chronic aquatic toxicity of the chemical is > 0.01 mg/L. Hence the substance does not fulfil the screening criteria for toxicity.
Overall conclusion	Not PBT
Revised	January 2019

References

1. National Industrial Chemicals Notification and Assessment Scheme (NICNAS). IMAP, Human Health Tier II Assessment for Benzaldehyde: Retrieved 2019: https://www.nicnas.gov.au
2. ECHA REACH, Benzaldehyde, Retrieved 2019: https://echa.europa.eu/
3. OECD (2002) SIDS Initial Assessment Profile for Benzaldehyde

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Toxicity Summary - Butyl alcohol

Chemical and Physical Properties[1,2,3]	
CAS number	71-36-3
Molecular formula	C4H10O
Molecular weight	74.12
Solubility in water	77 g/l at 20 °C
Melting point	-89.9 °C
Boiling point	117.6 °C
Vapour pressure	0.56 kPa at 20 °C
Henrys law constant	0.054 Pa m³/mol
Explosive potential	Non-explosive
Flammability potential	Flammable
Colour/Form	Colourless liquid with a mildly alcoholic odour.
Overview	n-Butyl alcohol is used as a solvent in surface coatings. These can include varnishes, resins, waxes and gums. It is also used in the manufacture of other butyl compounds. n-Butyl alcohol is a product of fermentation. It has also been detected in the volatiles of foods such as cheese, muskmelon and cooked rice. People that work in industries where products containing n-butyl alcohol are used will have the highest exposure. These could include varnishing of automobiles, painting shops and fabric coating. Exposure will happen by eating foods containing n-butyl alcohol and breathing in fumes from cooking certain foods. n-Butyl alcohol can be found in surface water and air. It is often found in indoor air of new construction. It breaks down in air by reaction with radicals. It is expected to evaporate from soil and water surfaces. n-Butyl alcohol that remains in soil or water will be broken down by microorganisms. It is not expected to build up in aquatic organisms.
Environmental Fate[1]	
Soil/Water/Air	Based on level III fugacity modelling, BA will partition 83.5% in air, 5.9% in soil, 10.6% in water, <0.1% in suspended solids, and <0.1% in biota and in sediment. BA degrades in air by reaction with hydroxyl radicals, having a half-life in air of 1.2 to 2.3 days. The volatilization half-life for BA in water is estimated to be 2.4 hours for streams, 3.9 hours for rivers and 126 days for lakes.
Human Health Toxicity Summary [1]	
Chronic Repeated Dose Toxicity	A no observed adverse effect level (NOAEL) of 125 mg/kg bw/day and a lowest observed adverse effect level (LOAEL) of 500 mg/kg bw/day in male and female CD rats was reported based on results from a repeat dose oral study using the chemical (OECD 2001). Groups of male and female rats (30/sex/group) were administered the chemical via gavage at 0, 30, 125 or 500 mg/kg/day for 13 weeks. It was reported that ataxia (impaired muscle coordination) and hypoactivity were observed at the highest dose during the final six weeks of the study. No treatment related effects were reported in the 30 and 125 mg/kg/ bw/day dose groups (OECD 2001). In a non-guideline study, the chemical was applied to the skin of rabbits under occlusive conditions over a period of 21 days. Local effects were reported such as drying of the skin, cracking, wrinkling and exfoliation of the epidermis. However, no systemic toxicity was reported (REACH). In another non-guideline repeat dose dermal study on rabbits, 42 to 55 mL/kg of the chemical applied to the skin of rabbits over four consecutive days resulted in 100 % mortality. However, the same study reported that 30 applications of 20 mL/kg of the chemical over six weeks did not produce any deaths (OECD 2001).

Carcinogenicity	OECD (2001) reported that based on the number of negative mutagenicity and clastogenicity findings, the chemical is not expected to be a carcinogen. A weight of evidence study reported that the chemical is not expected to have carcinogenic potential as it does not contain structural components to support carcinogenicity (REACH, HSDB).
Mutagenicity/ Genotoxicity	The chemical is not expected to be genotoxic. The chemical tested negative in a number of tests for genotoxicity. These included several in vitro tests (OECD Guideline 473: mammalian chromosome aberration test on Chinese hamster lung fibroblasts V79; OECD Guideline 471: bacterial reverse mutation assay on S. typhimurium TA 98, TA 100, TA 98, TA 1535 and TA 1537; OECD Guideline 476: mammalian cell gene mutation test on Chinese hamster lung fibroblasts V79) and in vivo tests (OECD Guideline 474: mouse micronucleus) (OECD 2001, REACH).
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	The chemical is not expected to be toxic to reproduction (OECD 2001). In a non-guideline study, male and female Sprague Dawley (SD) rats were exposed to the chemical via inhalation at 0, 3000 or 6000 ppm for seven hours/day. Female rats were exposed to the chemical throughout gestation, while males were exposed to the chemical for six weeks prior to mating. No harmful effects on fertility or pregnancy rate were reported at any of the dose levels. In another non-guideline study, no testicular toxicity (effect on testes weight or histopathology) was reported in SD male rats that were administered the chemical via oral intubation at 533 mg/kg bw/day over six days (OECD 2001). Any developmental effects were only reported to be observed secondary to maternal toxicity, so the chemical is not expected to be a developmental toxin. OECD (2001) reported that the chemical showed mild foetotoxicity and developmental variations in offspring only at or near the maternally toxic and, in some cases, lethal dose of 8000 ppm. Offspring of female SD rats exposed via inhalation to 0, 3500, 6000 or 8000 ppm of the chemical on gestations days 1 to 19, reported a reduction of foetal weights at 6000 and 8000 ppm and a slight increase in skeletal malformations at 8000 ppm but not at the lower dosage levels. At a maternally toxic dose of 8000 ppm, decreased weight gain, food consumption and dam deaths were reported. The NOAEL for offspring and dams was 3500 ppm as there was a slight decrease in foetal weight at the 6000 ppm dose level. In another 20 day study in male and female SD rats exposed to 0, 3000 or 6000 ppm of the chemical via inhalation, a small number of behavioural and neurochemical variations in offspring at 6000 ppm were reported. No maternal toxicity was reported throughout gestation for females or for six weeks prior to mating for males as a result of maternal or paternal exposure. However, the effects observed in offspring were not regarded as biologically significant by the authors due to inconsistences between dose-response patterns.
Acute Toxicity	The chemical is reported to be slightly acutely toxic via the oral route of exposure. Oral median lethal doses (LD50s) in rats were reported between 790 and 4360 mg/kg bw (OECD 2001). The chemical is reported to have low toxicity via the dermal route of exposure. The lowest LD50 in rabbits was reported to be 3402 mg/kg bw (OECD 2001). The chemical is reported to be of low acute toxicity via the inhalation route of exposure. The median lethal concentration (LC50) in rats was reported to be greater than 5000 ppm (OECD 2001).

Irritation	Based on an inhalation study in mice, it was reported that 1268 ppm (3909 mg/ m^3) of the chemical was predicted to be intolerable in humans, 127 ppm (390.9 mg/ m^3) would be uncomfortable in humans and 13 ppm (40 mg/ m^3) was expected to have no effect on humans (OECD 2001). Moderate irritation was reported in a 24 hour patch test (non-guideline study) where 405 or 500 mg of the chemical was applied to the skin of the rabbits. It was reported that these effects may be due to the chemical's defatting (chemical dissolving of dermal lipids from the skin) and drying characteristics (OECD 2001). Another non-guideline study reported the chemical was a skin irritant in several Vienna white rabbits exposed to 0.5 mL of the chemical for five minutes, one hour or two hours under occlusive conditions. The animals were observed for eight days. The authors concluded that exposure for two hours under occlusive conditions resulted in higher Draize scores and observed superficial necrosis (death of tissue). However, there was no full thickness destruction of the skin (REACH). The chemical was reported to be a severe eye irritant when tested according to OECD Test Guideline (TG) 405 using 0.1 mL of the chemical applied to three New Zealand white rabbits. Severe occular lesions were present at the end of the seven day observation period, indicating severe eye damage and irreversible effects on the eye (REACH). The chemical was reported to be a severe eye irritant in rabbits in non-guideline studies where 1.62 or 20 mg of the chemical was applied into rabbit eyes over a 24 or 72 hour period (OECD 2001). An additional non-guideline study reported severe corneal irritation when 0.005 mL of the chemical was applied into rabbit eyes.
Sensitisation	Based on available repeat dose dermal studies, the chemical is not expected to be a skin sensitiser. OECD (2001) reported that human studies and experience show that the chemical is not likely to be a skin sensitiser.
Health Effects Summary	The critical health effects for risk characterisation include local effects (serious damage to the eyes and respiratory irritation). The chemical also possesses hazardous properties such as skin irritation, harm if ingested and chemical vapours causing drowsiness and dizziness.
Key Study/Critical Effect for Screening Criteria	n-Butyl alcohol was only slightly toxic to experimental animals following acute oral, dermal, or inhalation exposure. The acute oral LD50 values for female rats ranged from 790 to 4360 mg/kg.
Ecological Toxicity [3]	
Aquatic Toxicity	Results on acute aquatic toxicity are available for fish (Pimephales promelas, LC50 (96h) 1376 mg/l), invertebrates (Daphnia magna, EC50 (48h) 1328 mg/L), and algae (Selenastrum capricornutum, EC50 (96h) 225 mg/L). EC10 (17h) as determined for Pseudomonas putida was 2476 mg/L. Furthermore, based on the chronic NOECrepro (21d) of 4.1 mg/L for Daphnia magna butan-1-ol is very likely not harmful to aquatic organisms. Thus, no adverse effects were observed.
Determination of PNEC aquatic	A PNECaqua = 0.082 mg/L can be calculated based on the lowest chronic toxicity value (21 day NOEC = 4.1 mg/L) for aquatic invertebrates (Daphnia) with the assessment factor of 50.
Current Regulatory Controls[4]	
Australian Hazard Classification	The chemical is classified as hazardous with the following risk phrases for human health in the Hazardous Substances Information System (HSIS) Safe Work Australia: Xn; R22 (Harmful if swallowed) Xi; R37/38-41 (Irritating to respiratory system and skin. Risk of serious damage to eyes) R67 (Vapours may cause drowsiness and dizziness)
Australian Occupational Exposure Standards	The chemical has an exposure standard of 152 mg/m^3 (50 ppm) Peak limitation Time Weighted Average (Ceiling TWA).

International Occupational Exposure Standards	The following exposure standards were identified (Galleria Chemica): Ceiling TWA: 150- 152 mg/m³ (50 ppm). India, Indonesia, Japan (OEL), Malaysia and USA [National Institute for Occupational Safety and Health (NIOSH)]. Ceiling TWA: 90 mg/m³ (30 ppm). Canada (British Colombia), Estonia, Russia and Sweden. TWA: 150- 154 mg/m³ (50 ppm). Canada (Yukon), Chile, Denmark, Egypt, Iceland, Poland and Switzerland. TWA: 300- 310 mg/m³ (100 ppm). Germany, Greece, Taiwan and USA [Occupational Safety and Health Administration (OSHA)]. TWA: 45- 75 mg/m³ (15-25 ppm). Canada (Alberta, British Colombia, Saskatchewan), Estonia, Hungary, Ireland, Japan [Workplace Exposure Standards (WES) and Working Environment Evaluation Standards (WEES)], Norway and Sweden.
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	No data available.
PBT Assessment	
P/vP Criteria fulfilled?	No. n-Butanol is considered readily biodegradable.
B/vB criteria fulfilled?	No. Due to the low log Pow (1.0), accumulation in organisms is not to be expected.
T criteria fulfilled?	Not applicable. Chronic toxicity data >1 mg/L in invertebrates, thus butyl alcohol does not meet the screening criteria for toxicity.
Overall conclusion	Not PBT
Revised	January 2019

References

1. NICNAS (2017) Human Health Tier II Assessment for 1-Butanol: Retrieved 2019: https://www.nicnas.gov.au
2. OECD (2005) SIDS Initial Assessment Profile on 1-Butanol
3. ECHA REACH, 1-Butanol, Retrieved 2019: https://echa.europa.eu/

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Toxicity Summary - Chlorous acid, sodium salt

Chemical and Physical Properties [1,2,3]	
CAS number	7758-19-2
Molecular formula	ClHO2.Na
Molecular weight	90.4
Solubility in water	571 g/L at 20 °C
Melting point	234 °C
Boiling point	Decomposes > 170 °C. Poor purity of test substance, accurate value cannot be obtained.
Vapour pressure	1.1 x 10^{-7} Pa at 25°C
Henrys law constant	No data available.
Explosive potential	At normal temperature and pressure, the natural form of chlorine dioxide is unstable, highly reactive (an oxidizing agent) and explosive. It is explosive when its concentration in air exceeds 10% v/v when it is easily detonated by sunlight, heat, contact with mercury or carbon monoxide (O'Neil et al. 2001).
Flammability potential	Non-flammable
Colour/Form	White crystals or crystalline powder, odourless
Overview	The commercial production of sodium chlorite is carried out in two steps: firstly, sodium chlorate is reacted with an acid to generate chlorine dioxide (gas) and secondly, chlorine dioxide is reacted with caustic soda, catalysed by hydrogen peroxide, to form sodium chlorite. The industrial product formed is a solution of 34.5%; the commercial grade is obtained by dilution with water. Chlorine dioxide may also be produced from sodium chlorate. The total amount of sodium chlorite (as 100%) sold on average in the EU Member States (15) for the years 1998-2000 was 11 800 tonnes per year. This includes use as preservatives for liquid cooling and processing systems; food and feed area disinfectants; food or feedstocks; molluscicides; and slimicides and other non-defined biocidal use. The estimated annual total consumption of sodium chlorite in Japan is 4000 tonnes.
Environmental Fate [2]	
Soil/Water/Air	Irradiation of sodium chlorite solutions indicated a photodegradation half-life of about 30 minutes with a steady increase in pH (pH 8 to 12.6) and major products identified as hydroxide, chlorine dioxide and chloride with chlorate and hypochlorite as minor products and trace amounts of chlorine. The radiation dose (9000 j/m^2) needed to produce a 50% reduction in chlorite concentration suggests that the doses (200-250 j/m^2) used for drinking water disinfection would not result in a significant reduction in chlorite concentrations (Cosson and Ernst, 1994; Leitner et al., 1992). It is not considered technically appropriate to perform a ready biodegradation test on sodium chlorite. As ready biodegradation studies measure oxygen consumption or carbon dioxide production, none of these techniques can be used to analyse mineralization of this compound. However, sodium chlorite is expected to be rapidly reduced to sodium chloride in the environment, especially in anaerobic conditions. Due to its extremely low lipophilicity and high instability in water, sodium chlorite and hence chlorine dioxide are not expected to bioaccumulate in fish.

Human Health Toxicity Summary [1,2]	
Chronic Repeated Dose Toxicity	In a study used by the World Health Organization (WHO) to establish a drinking water guideline for chlorite in 1993, rats were administered sodium chlorite at doses of 0, 10, 50, 100, 250 and 500 mg/L (equivalent to 0, 1, 5, 10, 25 and 50 mg/kg bw/day) via drinking water for 30, 60 or 90 days (Heffernan et al. 1979). After 30 days, haematological parameters were depressed indicating slight anaemia at 10 and 25 mg/kg bw/day. These were correcting at 60 days and returned to near normal levels by 90 days. Decreases in erythrocyte glutathione levels were observed at 5 mg/kg bw/day and above, but given the magnitude of variations normally seen in mammals, the toxicological significance of these changes was uncertain. The No Observed Adverse Effect Level (NOAEL) established from this study was 5 mg/kg bw/day. In a 14-day range finding study conducted to OECD TG 407, rats were administered sodium chlorite daily by gavage at doses of 0, 25, 50, 100 or 200 mg/kg bw day (CMA 1992a; Harrington et al. 1995a). At 200 mg/kg bw/day, 3 of 10 animals died. At 100 mg/kg bw/day, changes in haematological parameters were seen and body weight gains were reduced. At 50 mg/kg bw/day, body weights in males were reduced and at both 25 and 50 mg/kg bw/day haematocrits were slightly reduced. A follow-up 90-day study was performed in which rats were administered sodium chlorite daily by gavage at doses of 0, 10, 25 or 80 mg/kg bw day (CMA 1992b; Harrington et al. 1995a). At 80 mg/kg bw/day, four of 30 animals died and surviving animals displayed hypoactivity, piloerection and hunched posture. At 25 mg/kg bw/day, one of 30 animals died. Increased salivation was observed at both doses. Treatment-related haematological changes consisting of reduced erythrocyte counts, reduced associated erythrocyte parameters and morphological changes in erythrocytes were observed at 80 mg/kg bw/day. These were accompanied by increases in absolute and relative spleen weights, histopathological abnormalities in the spleen and evidence of irritation of the gastric mucosa. At 25 mg/kg bw/day, minor clinical signs and occasional histopathological abnormalities in the stomach mucosa were seen. There were no haematological changes considered treatment related at this dose. A NOAEL was established at 10 mg/kg bw/day. Data on repeat dose toxicity were also available from a two-generation reproductive toxicity study in rats conducted to OECD TG 416 (Chlorine Dioxide Panel of the Chemical Manufacturers Association 1996; Gill et al. 2000). This study was used by the WHO to revise an earlier drinking water quality guideline for chlorite and chlorate (WHO 2005). A NOAEL of 35 ppm (approximately 3.9 mg/kg bw/day) was derived based on decreased liver weights in two generations. Repeated dose toxicity studies have also been performed in mice. Mice were treated for 30 days with doses equivalent to 0, 0.19, 1.9 and 19 mg/kg bw/day sodium chlorite in drinking water (Moore and Calabrese 1980). Slight changes in haematological parameters suggestive of effects on erythrocyte cell membranes were seen at 19 mg/kg bw/day. A NOAEL of 1.9 mg/kg bw day was established. Similarly, in more limited studies, mice were administered sodium chlorite in drinking water at doses up to approximately 17 mg/kg bw/day for 30, 90 or 180 days. No effects on water consumption, body weight gain, kidney weights or kidney histology were seen (Connor et al. 1985). Also, no dose-related immunomodulatory effects were seen in a study of immunotoxicity in mice receiving sodium chlorite in drinking water at levels up to 30 mg/L for 28 days (Karrow et al. 2001). In conclusion, several rodent studies of 30 to 90 days' duration have reported haemotoxicity from repeated doses of sodium chlorite. A guideline 90-day repeated dose toxicity study in rats reported reduced erythrocyte counts, reduced associated erythrocyte parameters and morphological changes in erythrocytes at 80 mg/kg bw/day. At lower doses, minor clinical signs and occasional histopathological abnormalities in the stomach mucosa were seen. A NOAEL for repeated dose oral toxicity was established from this 90-day study at 10 mg/kg bw/day.

Carcinogenicity	A limited number of carcinogenicity studies indicated that sodium chlorite is not carcinogenic in laboratory animals. In an oral carcinogenicity study conducted similarly to OECD TG 451, groups of 50 male and 50 female rats were exposed to sodium chlorite in drinking water at concentrations of 0, 300 or 600 mg/L (estimated to be 0, 18 or 32 mg/kg bw/day for males and 0, 28 or 41 mg/kg bw/day for females) for 85 weeks. The original study envisaged an exposure period of 104 weeks, but was stopped at 85 weeks due to infections in all groups. At this time there were no significant changes in organ weights and haematological or clinical chemistry findings between groups. Tumours developed in the testis, uterus, pituitary gland, thyroid gland (males) and adrenal gland (males) of both treated and control rats. However, the incidences of tumours and non-neoplastic lesions in the three groups were not significantly different. There were no findings suggestive of a carcinogenic effect of sodium chlorite (Shimoyama et al., 1985). In another oral carcinogenicity study conducted similarly to OECD TG 451, groups of 50 male and 50 female B6C3F1 mice were exposed to sodium chlorite in drinking water at concentrations of 0, 250 or 500 mg/L (estimated to be 0, 36 and 71 mg/kg bw/day) for 85 weeks (Yokose et al., 1987). After 85 weeks, surviving animals were euthanised and histopathological examinations were performed. Although tumours developed in a variety of organs in all animals including controls, the only significant change was an increase in lung adenomas in highest dose males: 5/43 (12 %) in this group, compared with 0/35 (0 %) in the control group. Based on an absence of dose-related increases in the incidence of lung adenomas and the lack of increased incidence of lung adenocarcinomas, the authors concluded that sodium chlorite had no carcinogenic potential.
Mutagenicity/ Genotoxicity	Sodium chlorite is not mutagenic or genotoxic. In vitro genotoxicity test results for sodium chlorite are not available. In the three in vivo tests that looked at chromosomal damage or sperm head abnormality, sodium chlorite gave negative results for genotoxicity (Meier et al., 1985). In vitro tests using chlorine dioxide have been reported in the literature. Chlorite (and chlorate) ions are produced following dissolution of chlorine dioxide in aqueous media. Therefore, in vitro test results for chlorine dioxide are regarded as relevant to sodium chlorite. Two of the three in vitro tests, the mouse lymphoma forward mutation assay and in vitro transformation of BALB/3T3 cells, were negative for chlorine dioxide, whereas the chromosome aberration frequencies test in Chinese hamster ovary cells was positive (Scopas, 1986a, Scopas, 1986b and Scopas, 1986c). Across all available studies, data suggest that sodium chlorite (and chlorine dioxide) has low genotoxic potential.

Reproductive Toxicity / Developmental Toxicity/Teratogenicity	Based on a series of studies of fertility and sperm parameters in rats, sodium chlorite is not considered to be toxic to the reproductive system. Studies in rats and rabbits did not show any effect of sodium chlorite on development. In a rabbit study conducted according to US EPA guidelines, sodium chlorite was administered via drinking water to groups of 16 pregnant New Zealand White rabbits at concentrations of 0, 200, 600 or 1200 mg/L during gestation days (GD) 7–19 (Harrington et al., 1995b). At 600 and 1200 mg/L, dose-related reductions in water consumption (due to palatability problems), food consumption and body weight gain were observed. No treatment-related abnormalities were observed at maternal necropsy. Overall, data indicate that sodium chlorite does not cause developmental toxicity at doses below those associated with maternal toxicity. In a two-generation reproduction study in rats conducted according to OECD TG 416 (Gill et al. 2000), groups of 30 male and 30 female Sprague-Dawley rats were administered sodium chlorite via drinking water at doses of 0, 35, 70 or 300 ppm (approximately 0, 4, 7.6 or 28.2 mg/kg bw/day for males and 0, 3.9, 8 and 38.7 mg/kg bw/day for females) (Chlorine Dioxide Panel of the Chemical Manufacturers Association 1996; Gill et al. 2000). Dosing was conducted in the parental F0 generation commencing 10 weeks prior to mating, until weaning of the F2 generation. Males were exposed through mating and then sacrificed. Females were exposed through mating, pregnancy and lactation and were sacrificed following weaning of litters. F1 pups were continued on the same treatment regime as the parents. At 14 weeks they were mated to produce the F2 generation. Reductions in food and water consumption and body weight gain were observed for all generations, attributed to unpalatability of the formulated drinking water. At 35 and 70 ppm, minor reductions in several haematological parameters were observed in F1 female pups. These appeared within the range of historical control data and were not regarded as toxicologically significant. At 70 ppm, a reduction in liver weight was also observed in F0 females and F1 males and females. A slight decrease in the maximum response to auditory startle stimulus was also observed in F2 pups. At 300 ppm, reductions in haematological parameters were seen in F1 male and female pups and adults. Reduced liver weights were seen in F0 adult males, F1 adult males and females and F1 pups. Reduced thymus and spleen weights were also seen in both generations. A slight decrease in absolute brain weight was seen in F1 male pups at post-natal day (PND) 11 but not at PND 25. In F2 pups at this dose, there was a slightly lowered incidence of normal righting reflexes and a slight decrease in the maximum response to auditory startle stimulus. Reduced pup body weight at birth and during lactation in F1 and F2 generations were also observed. Delays in preputial separation and vaginal openings were reported for F1 pups. Despite systemic toxicity, the authors reported no treatment-related changes to oestrous cyclicity, sperm motility, sperm morphology, or mating, fertility or gestational indices. Also, there were no treatment-related changes in number of pups born, sex ratios, live birth index or pup survival indices. There were no treatment-related changes in serum T3 or T4 in F1 pups or F1 adults. On the basis of historical data, delays in preputial separation and vaginal openings reported for F1 pups were attributed to reduced body weight rather than a direct treatment-related effect. Similarly, slight decreases in brain weight in male pups were consistent with decreased body weight. The toxicological significance of decreases in auditory startle stimulus response at 70 and 300 ppm was unclear. The magnitude of responses was small compared to known neuroactive chemicals, dose response to the stimulus was weak, there was a lack of corroborative evidence from neuropathology or other test of motor function or arousal, and the decreases in response were not replicated upon later examination of the same animals at PND 60 (Gill et al. 2000). A NOAEL of 35 ppm (approximately 3.9 mg/kg bw/day) with a LOAEL at 70 ppm (approximately 7.6 mg/kg bw/day) were derived based on decreased liver weights.

Acute Toxicity	Sodium chlorite has moderate acute oral toxicity. An acute oral toxicity study in rats, similar to OECD Test Guideline TG 401, derived a lethal median dose (LD50) of 284 mg/kg bw for sodium chlorite. At doses of 250 mg/kg bw and above, the main clinical signs were prostration and cyanosis (Atochem, 1984). Sodium chlorite has high acute dermal toxicity. In a dermal toxicity study in rabbits, conducted according to US EPA test guidelines, various doses of an aqueous slurry (80 %) of sodium chlorite were administered under semi-occlusive dressings to over 10 % of the body surface area for 24 hours. Animals were observed for clinical signs immediately after dosing, at one and four hours and then once daily for 14 days following exposure. Slight depression and dose-related dermal irritation consisting of skin thickening, epidermal scaling, necrosis and sloughing were noted in all animals. The study reported a dermal LD50 of 134 mg/kg bw (Degussa Corporation, 1984).
Irritation	Sodium chlorite is a severe skin irritant. Necrosis was observed in rabbits in the skin irritation studies. In one skin irritation study conducted according to US EPA test guidelines, 0.5 g sodium chlorite powder (80 % pure) was applied to three male and three female New Zealand White rabbits under occlusive conditions for four hours. Dermal responses were assessed at 30–60 minutes on day one, and once daily for 21 days after application. Irritation consisted of erythema (grades 1–3) in all sites at 30–60 minutes and 24 hours after dosing, persisting through day seven at two sites. Oedema (grade one) was observed at one site at 30–60 minutes and at two sites at 48 hours. Other dermal effects included blanching, thickening, necrosis, sloughing, and blackened areas (REACH, 2014). In another study in rabbits, edema cutis and subcutis were observed immediately after patch removal followed by formation of eschar within 24–48h. Dose and other details of the test were not provided (REACH, 2014) A 34.5 % solution of sodium chlorite, applied to rabbit skin for four hours under semi-occlusive conditions, did not elicit any irritation effects. Only one of three animals displayed slight erythema and dryness of the skin (Elf Atochem SA, 1994). In the only eye irritation study available and conducted according to US EPA test guidelines, sodium chlorite was found to be a severe eye irritant. A 31.5 % sodium chlorite solution was applied to the eyes of rabbits. Six of the nine rabbits showed corneal opacity that did not reverse by rinsing the eyes 30 seconds after instillation. All animals showed iris damage and exhibited moderate to severe redness and chemosis which was also not abolished by rinsing. Superficial corneal vascularisation and transient cases of haemorrhaging and adhesion of conjunctivae to cornea were also seen (Atochem, 1985).
Sensitisation	Sodium chlorite is not considered to be a skin sensitiser. A guinea pig maximisation test conducted according to OECD TG 406 reported no clinical signs and no cutaneous reactions upon a challenge application of 1 % sodium chlorite in normal saline. Sodium chlorite was concluded not to be a skin sensitiser (CEFIC sodium chlorite sector group, 2002).
Health Effects Summary	The critical health effects for risk characterisation include acute effects from oral and dermal exposure, and severe skin and eye irritation and repeated dose toxicity from oral exposure.
Key Study/Critical Effect for Screening Criteria	A guideline two-generation reproductive toxicity study in rats also reported haemotoxicity, as well as hepatotoxicity and slight neurobehavioural changes at doses below those associated with no effects in repeated dose studies. The study reported no effects on fertility or development. Accordingly, a NOAEL for hepatotoxicity was established from this 2- generation study at 3.9 mg/kg bw/day. The LOAEL was approximately 7.6 mg/kg bw/day. This NOAEL is used for this human health risk assessment.
Ecological Toxicity [2]	

Aquatic Toxicity	Sodium chlorite, in general, shows low acute toxicity to fish with LC50 values above 100 mg/l for zebrafish, sheepshead minnow and rainbow trout and slightly lower for bluegill sunfish. Due to extremely low lipophilicity and high instability in water, sodium chlorite is not expected to bioaccumulate in fish. Sodium chlorite is more toxic to invertebrates with high toxicity to Daphnia magna (sodium chlorite, LC50 48-hour = 0.063 mg/l) and the crustacean, Mysidopsis bahia (sodium chlorite LC50 96-hour = 0.65 mg/l). However, the mollusc, Crassostrea virginica was much less sensitive (sodium chlorite 96 hours NOEC was 70.6 mg/l and the EC50 (shell growth) was 129 mg/l). The green algae were more sensitive to sodium chlorite than fish or oyster and toxicity increased with time (ECr50 value at 72 hours was recorded as 1.2 mg/l).
Determination of PNEC aquatic	Using an uncertainty factor of 100 on the lowest LC50 to Daphnia a PNEC (Predicted No Effect Concentration) of 0.63 ug/L is calculated, for aquatic organisms.
Current Regulatory Controls[1]	
Australian Hazard Classification	The chemical is not listed on the Hazardous Substances Information System (HSIS) (Safe Work Australia).
Australian Occupational Exposure Standards	There is no specific exposure standard for sodium chlorite. However, the permissible exposure limits for dusts apply: · Time Weighted Average (TWA): 10 mg/m^3 measured as inspirable dust.
International Occupational Exposure Standards	There are no specific exposure standards for sodium chlorite. However, the following exposure standards for particulates are identified (Galleria Chemica 2013). TWA: · 10 mg/m^3 [Canada, Ireland, Spain] · 5 mg/m^3 [US] · 1 mg/m^3 [Latvia].
Australian Food Standards	Sodium chlorite has the following listings in the Australia New Zealand Food Standards Code – Standard 1.3.3 Processing Aids (Food Standards Australia and New Zealand 2013): · As a permitted bleaching agent, washing and peeling agent (maximum level 1 mg/kg available chlorine) · As a permitted processing aid with miscellaneous functions (anti-microbial agent for meat, fish, fruit and vegetables; maximum level is the limit of determination for chlorite, chlorate, chlorous acid and chlorine dioxide).
Australian Drinking Water Guidelines	The National Health and Medical Research Council (NHMRC) Australian Drinking Water Guidelines lists chlorite under microbial, chemical and physical characteristics as a by-product of chlorine dioxide disinfection. The guideline value for chlorite based on health considerations is 0.8 mg/L (NHMRC 2011).
Aquatic Toxicity Guidelines	No data available.
PBT Assessment [3]	
P/vP Criteria fulfilled?	No. Not expected to be persistent due to its instability.
B/vB criteria fulfilled?	No. There is no concern for potential bioaccumulation from chlorine chlorite.
T criteria fulfilled?	Yes. Acutely toxic to aquatic invertebrates.
Overall conclusion	Not PBT
Revised	January 2019

References

1. National Industrial Chemicals Notification and Assessment Scheme (NICNAS). IMAP, Human Health Tier II Assessment for Chlorous acid, sodium salt: Retrieved 2019: https://www.nicnas.gov.au

2. National Industrial Chemicals Notification and Assessment Scheme (NICNAS, 2017). National assessment of chemicals associated with coal seam gas extraction in Australia. Human health hazards of chemicals associated with coal seam gas extraction in Australia.
3. OECD (2009) SIDS Initial Assessment Profile on Sodium chlorite and chlorine dioxide
4. ECHA REACH, Sodium chlorite, Retrieved 2019: https://echa.europa.eu/

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Toxicity Summary - Cinnamaldehyde

Chemical and Physical Properties [1,2,3,4]	
CAS number	104-55-2
Molecular formula	C9H8O
Molecular weight	132.16
Solubility in water	2.11 g/L at 22 °C
Melting point	-18 °C
Boiling point	250°C
Vapour pressure	3.85 Pa at 25 °C
Henrys law constant	0.162 Pa.m³.mol-1 at 25 °C
Explosive potential	Non-explosive
Flammability potential	Non-flammable
Colour/Form	Yellowish oily liquid with strong odour of cinnamon
Overview	Cinnamaldehyde is a plant natural product that is present in some essential oils extracted from plants. For large scale applications such as in the flavouring and fragrance industries, this chemical is synthesised.
Environmental Fate [1,3]	
Soil/Water/Air	Cinnamaldehyde is expected to remain in soil, or partition to water and sediment, when released as a result of industrial uses. It is not expected to be persistent in the environment and is expected to undergo rapid and ultimate biodegradation in water. Cinnamaldehyde is not expected to bioaccumulate in aquatic organisms. No evidence has been identified to indicate that Cinnamaldehyde biomagnify through the aquatic food chain. The atmospheric oxidation half-life of cinnamaldehyde was estimated using the level III multimedia model. It was estimated that the substance is not persistent in air medium as the half-life period of cinnamaldehyde in air is only 0.31 days. This indicates that cinnamaldehyde is rapidly phototransformed in air. The Hydrolysis rate constant of Cinnamaldehyde is estimated to be 3.36 x 10-17 cm3/molecule-sec. at half-life of 3.411 days indicating that the substance is slowly hydrolysable.
Human Health Toxicity Summary [2,4]	
Chronic Repeated Dose Toxicity	Cinnamaldehyde is 'generally regarded as safe' for use as a flavour ingredient by the US Food and Drug Administration (US FDA, 2015), reflecting the low level of concern regarding its potential for long-term toxicity via the oral route. Considering the no observed adverse effect levels (NOAELs) of 68–200 mg/kg bw/day, based on 17-week to 2-year rat studies (read across), and no toxicologically significant treatment-related effects reported in various studies, repeated oral exposure to the chemical is not considered to cause serious damage to health. Based on the limited data available, the chemical is not considered to cause serious damage to health by repeated dermal exposure.
Carcinogenicity	Based on the limited data available for cinnamaldehyde and trans-cinnamaldehyde (CAS No. 14371-10-9), the chemical is not expected to have carcinogenic potential. In a two-year carcinogenicity study, groups of F344/N rats and B6C3F1 mice (50 animals/sex/dose) were fed microencapsulated trans-cinnamaldehyde (CAS No. 14371-10-9) by daily gavage at doses of 0, 1000, 2100 or 4100 ppm (equivalent to 0, 50, 100 or 200 mg/kg bw/day). Increased incidences of preputial and prostate gland adenomas and mononuclear cell leukaemia were considered to be within the historical range in controls, or likely to represent biological variations unrelated to exposure to the chemical. No other treatment-related neoplasms or non-neoplastic lesions were reported in either species (Adams et al., 2004; NTP, 2004; REACH; US HPVIS, 2009).

Mutagenicity/ Genotoxicity	The chemical cinnamaldehyde contains an a,b-unsaturated aldehyde group, a common structural alert for genotoxicity due to the ability of the chemical to form DNA adducts. However, based on the available data, the chemical is not considered to be genotoxic. The chemical cinnamaldehyde and the isomer trans-cinnamaldehyde (CAS No. 14371-10-9) were negative for point mutations in almost all strains of Salmonella typhimurium in the Ames test. A positive result was found only with TA100 strain, and in only two out of eleven tests. Evidence of genotoxic activity was also observed in isolated mammalian cells. However, these results were weakly positive and observed at cytotoxic concentrations. A sex-linked recessive lethal test in Drosophila melanogaster demonstrated that systemically-available chemical (administered via injection) could enter germ cells and induce mutations; however, oral dosing did not produce the same effect. Importantly, the reported activity in in vitro and insect studies did not translate into significant genotoxic activity in mammalian systems in vivo.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	The chemical is not expected to have the potential for reproductive or developmental toxicity. Any developmental effects were only observed secondary to maternal toxicity. In a two-generation study in rats (strains not reported), cinnamaldehyde (absolute dose 2 mg—route not specified) was dosed every two days for 223 and 210 days and did not have any effects on body weight gain, reproductive ability, development or viability of offspring (NTP, 2004). Cinnamaldehyde in olive oil was administered to female SD rats via oral gavage at doses of 0, 5, 25 or 250 mg/kg bw/day on gestation days (GD) 7–17. Treatment-related, increased incidence of defective cranial ossification in all dose groups was observed. Renal abnormalities including dilated pelvis and reduced papilla and dilated ureters were observed at low and mid doses, but not at high dose. Offspring at ≥25 mg/kg bw/day had significantly increased instances of reduced ossification of the tympanic bulla. An increase in the incidence of abnormal sternebrae was also reported in the 25 mg/kg bw/day group. However, these effects were not found to be dose-related and may be attributed to a decrease in maternal weight gain that was noted in the mid- and high-dose groups. A LOAEL of 5 mg/kg bw/day for developmental toxicity was reported based on the reduced cranial ossification and kidney variations. A LOAEL of 25 mg/kg bw/day was reported for maternal toxicity based on the reduced weight gain observed in the dams (Adams et al., 2004; NTP, 2004; US HPVIS, 2009; HSDB; REACH). No signs of toxicity were reported in the dams or in the offspring of CD-1 mice after exposure to 1200 mg/kg bw/day during GD 6–13 (cinnamaldehyde) or GD 7–14 (trans-cinnamaldehyde) (NTP, 2004; US HPVIS, 2009; REACH).
Acute Toxicity	Cinnamaldehyde has low acute oral toxicity based on animal studies. The median lethal dose (LD50) in rats is >2000 mg/kg bw. Cinnamaldehyde has moderate acute dermal toxicity based on animal studies, warranting hazard classification. The dermal LD50 in rabbits was in the range of 620–1260 mg/kg bw (Bickers et al., 2005; Cocchiara et al., 2005; FFHBVC, 2005; and US HPVIS, 2009). Albino rabbits (2 animals/dose) were administered a single dose of cinnamaldehyde (0, 0.25, 0.50, 1.0, 2.0 or 4.0 mL/kg bw—equivalent to 0, 263, 525, 1050, 2100 or 4200 mg/kg bw) by application to intact and abraded skin. All animals in the 1.0 mL/kg and higher dose groups died after treatment. The LD50 was reported to be 620 mg/kg bw (Cocchiara et al., 2005; FFHPVC, 2005; US HPVIS, 2009; REACH).
Irritation	Respiratory irritation was assessed in CF-1 female mice by recording their respiratory rate following exposure to nebulised cinnamaldehyde for 1 minute, either through nose-only breathing or via a tracheal cannula. Marked respiratory depression with nose-only inhalation was observed. The ED25 (dose providing a 25 % reduction in respiratory rate) was calculated to be 241 µg/L. No significant effects were observed when inhalation was through the tracheal cannula (Cocchiara et al., 2005). Cinnamaldehyde produced severe irritation in rabbits when applied undiluted, mild irritation in mice and guinea pigs at concentrations of 3–5 %, and was non-irritating to rabbits at 1 % (Bickers et al., 2005). The US EPA considers cinnamaldehyde a strong skin irritant in guinea pigs (no study details provided) (US HPVIS, 2009). Several international agencies have concluded that cinnamaldehyde is an eye irritant (US HPVIS, 2009; REACH), and a number of notifications to the Classification and Labelling Inventory by industry in the European Union have indicated the chemical as irritating to the eyes (ECHA C&L).

Sensitisation	The chemical was considered to be a moderate to strong skin sensitiser based on the positive results in several local lymph node assays (LLNA). The EC3 value (concentration required to provoke a 3-fold increase in lymph node cell proliferative activity compared with controls) was reported to be as low as 0.2 % (SCCS, 2012).
Health Effects Summary	Cinnamaldehyde is a well-recognised and frequently reported consumer contact allergen (SCCNFP, 1999; RIVM, 2009; SCCS, 2012; IFRA, 2013). It is one of eight components of the diagnostic test, the fragrance mix, used by dermatologists to determine if a patient has allergies to common chemicals used in fragrances. It is an established contact allergen in humans according to the Scientific Committee on Consumer Safety (2012), and accounts for 5–36 % of the reactions to the fragrance mix (SCCNFP, 1999). A number of human repeat insult patch tests (HRIPTs) have been undertaken to determine the skin sensitisation potential of cinnamaldehyde in healthy volunteers, as well as groups of subjects suspected of skin allergies to fragrances (SCCNFP, 1999; NTP, 2004; Cocchiara et al., 2005). Although fewer cases of sensitisation were found when the concentration of the chemical was less than 1 %, positive allergic responses have been reported in cases where the administered concentration of cinnamaldehyde was as low as 0.2 % (Cocchiara et al., 2005). Skin irritation effects were generally predominant at concentrations above 3 % cinnamaldehyde, and often impeded the interpretation of results from the patch testing (SCCNFP, 1999; NTP, 2004). Many cases of skin sensitisation have occurred following occupational and consumer exposure to the chemical. Workers in spice manufacturing plants, hairdressing salons and bakeries have reported cases of contact dermatitis that were traced back to cinnamaldehyde. In addition, exposure of consumers to toothpaste, cosmetics and perfumes containing the chemical as a fragrance ingredient have resulted in a number of case studies identifying cinnamaldehyde as an agent responsible for the allergic reactions (see SCCNFP, 1999; NTP, 2004; Cocchiara et al., 2005 for review).
Key Study/Critical Effect for Screening Criteria	The critical health effect for risk characterisation is skin sensitisation. Other observed health effects include systemic acute effects (acute toxicity from dermal exposure) and local effects (eye/skin/respiratory irritation).
Ecological Toxicity [1]	
Aquatic Toxicity	The following data are measured acute toxicity values for cinnamaldehyde: Danio rerio (Zebrafish) EC Directive 92/69/EEC C.1 Acute Toxicity for Fish: 96 h LC50 = 3.1 mg/L; Daphnia magna (Water flea) OECD TG 202: 48 h EC50 = 3.86 mg/L; Pseudokirchneriella subcapitata (Green algae) OECD TG 201: 72 h EC50 = 4.07 mg/L. In the chronic toxicity study, the 72 h NOEC value of 2.0 mg/L was reported for Pseudokirchneriella subcapitata (Green algae) OECD TG 201.
Determination of PNEC aquatic	A PNECaqua = 0.2 mg/L can be calculated based on the chronic toxicity value (72 h NOEC = 2 mg/L) for green algae with the assessment factor of 10.
Current Regulatory Controls[4]	
Australian Hazard Classification	The chemical is not listed in the Hazardous Substances Information System (HSIS) (Safe Work Australia).
Australian Occupational Exposure Standards	No specific exposure standards are available for the chemical.
International Occupational Exposure Standards	The US Temporary Emergency Exposure Limits (TEELs) for cinnamaldehyde are 14, 150 and 670 mg/m^3 (Galleria Chemica).
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	No data available.

PBT Assessment	
P/vP Criteria fulfilled?	Not applicable (inorganic salt, ionic species ubiquitous in environment)
B/vB criteria fulfilled?	Not applicable. Bioaccumulation is not applicable to these inorganic ions; sodium and hydroxide ions are ubiquitous and are present in most water, soil and sediment.
T criteria fulfilled?	Not applicable. Chronic toxicity data >1 mg/L in invertebrates, thus sodium hydroxide does not meet the screening criteria for toxicity.
Overall conclusion	Not PBT
Revised	January 2019

References

1. NICNAS (2017a) Environment Tier II Assessment for Cinnamic Aldehydes
2. NICNAS (2017b) Human Health Tier II assessment for 2-Propenal, 3-phenyl-
3. HSDB (n.d.). *Hazardous Substances Data Bank*. Retrieved 2015, from Toxnet, Toxicology Data Network, National Library of Medicine: http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB
4. ECHA REACH, Cinnamaldehyde, Retrieved 2017: https://echa.europa.eu/information-on-chemicals/registered-substances

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Toxicity Summary - Citric acid

Chemical and Physical Properties[2,3,5]	
CAS number	77-92-9
Molecular formula	C6-H8-O7
Product name	--
Molecular weight	192.124
Solubility in water	1000000 mg/L
pH	2 to 2.2
Melting point	Decomposition > 175 C
Boiling point	152 to159 C
Vapour pressure	White powder or granules
Henrys law constant	1.7 $x10^{-8}$ mm Hg at 25 deg C
Explosive potential	4.39 x 10^{-09} $Pa.m^3/mol$
Flammability potential	Dust explosion possible if powder or granular form, mixed with air
Colour/Form	Melts and decomposes in fire, a non-hazardous reaction.
Overview	Citric acid is a water soluble organic solid. It is a natural substance that appears as an intermediate in the basic physiological citric acid or Krebs cycle in every eukaryote cell. Citric acid has been produced for many years in high volumes. It has wide dispersive use, being added to processed food and beverages, used in pharmaceutical preparations and in household cleaners as well as in special technical applications. Citric acid is recognised by Food Standards Australia New Zealand (FSANZ) and the WHO JECFA as safe as a multipurpose food additive. No upper limit of concentrations has been established in food products. This chemical has been identified by NICNAS to be of low concern to human health based on an initial screening approach and thus required no further assessment.
Environmental Fate[2,5]	
Soil/Water/Air	Citric acid is highly mobile in the environment and is extremely soluble in water. The pKa of citric acid is 2.79, indicating that this compound will exist almost entirely in the anion form in the environment. The compound does not sorb to soil or particles in the water column and is readily and rapidly degraded in surface waters and in soil. (OECD, hsdb)

Human Health Toxicity Summary [1,2,4,5]	
Chronic Repeated Dose Toxicity	A 2-year chronic oral study in rats being given 5% or 3% citric acid in feed (approx. 2 resp. 1.2 g/kg/d) found slightly decreased growth in the higher dosage group but no tissue abnormalities in the major organs. From the lower dosage a NOAEL of 1200 mg/kg/d results. Similarly, NOAELs of 1500 mg/kg/d (rabbit) and of 1400 mg/kg/d (dog) have been determined. In general, citric acid is a strong chelating agent, the dietary uptake of which may interfere with biological availability, absorption and excretion of metals. Further, loss of superficial enamel and erosion of teeth as well as local irritation result from frequent ingestion of citric acid in beverages including natural fruit juices; citric acid fumes were reported to apparently affect the teeth of exposed workers. The average daily intake of citric acid from natural sources in the diet and food additives was estimated at about 40 mg/kg for women, 130 mg/kg for infants and 400 mg/kg for individuals on slimming diets; maximum daily intake is reported to reach levels of 500 mg/kg. No formal ADI (acceptable daily intake) level has been specified for citric acid and its common salts by the Joint FAO/WHO Expert Committee on Food Additives nor by the EC Scientific Committee for Food.
Carcinogenicity	Citric acid has not been classified by the IARC.
Mutagenicity/ Genotoxicity	In several in vitro and in vivo tests citric acid was not mutagenic. The substance was not mutagenic either in bacterial tests with Salmonella typhimurium (Ames test, 2 studies) and Escherichia coli, with and without metabolic activation.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	In a two-generation 90 days study with male and female rats fed 1.2 % citric acid no adverse effect on reproductive parameters nor any teratogenicity of dietary citric acid was seen. There were no indications of teratogenic or other adverse effects in three shorter term reproductive studies in rats with dietary dosage of either 5% citric acid (approx. 2.5 g/kg/d) previous, during and after mating (NOEL = 2500 mg/kg/d), or 295 mg/kg/d (route unspecified) during days 6–15 of pregnancy
Acute Toxicity	Citric acid has a low acute toxicity by oral application in both rat (LD50 = 3,000–12,000 mg/kg, 3 different values) and mouse (LD50 = 5,400 mg/kg). General effects comprised physiological disturbances (acidosis and calcium deficiency), while “high” doses caused nervous system effects as well as severe damage to the stomach mucosa.
Irritation	Local effects of citric acid to the skin (rabbit) are reported as slightly irritating in two studies and as not irritating in a third study using a 30% aqueous solution. In an acute eye irritation/corrosion test in rabbits according to OECD 405 citric acid was highly irritating.
Sensitisation	The sensitising potential is low.
Key Study/Critical Effect for Screening Criteria	A 2-year chronic oral study in rats being given 5% or 3% citric acid in feed resulted in a NOAEL of 1200 mg/kg/d. Uncertainty factors: 10 (interspecies variability) and 10 (intraspecies variability). Drinking water guideline = 4.7 ppm
Ecological Toxicity [1,5]	
Aquatic Toxicity	The 96-hour LC50 values for citric acid to fish are from 440 to 1,516 mg/L. The acute toxicity 24 hour EC50 value for invertebrates is 85 mg/L. The 7 day toxic limit concentration (TLC) values for algae range from 300 to 640 mg/L. In an 8 day freshwater static test for the algae Scenedesmus quadricauda, the NOEC is 425 mg/L. In freshwater, citric acid appears to be of low toxicity to aquatic acute test standard organisms, fish, daphnia and algae, with consistent LC50/EC50 values of several hundred milligrams per litre.

Determination of PNEC aquatic	$PNEC_{aquatic}$: Experimental results are available for three trophic levels. Acute $E(L)C_{50}$ values are available for fish (440 mg/L), Daphnia (85 mg/L). A TLC value of 300 mg/L was obtained for algae from which no dependable EC50 can be derived. Even though a NOEC was obtained from the algae study, there were no chronic studies conducted on fish or Daphnia. On the basis that the data consists of short-term results from three trophic levels, an assessment factor of 1,000 has been applied to the lowest reported effect concentration of 85 mg/L for Daphnia Magna. The $PNEC_{aquatic}$ was calculated to be 0.085 mg/L.
Current Regulatory Controls	
Australian Hazard Classification	
Australian Occupational Exposure Standards	
International Occupational Exposure Standards	
Australian Food Standards	
Australian Drinking Water Guidelines	No data found
Aquatic Toxicity Guidelines	No data found
Australian Hazard Classification	
PBT Assessment[1]	
P/vP Criteria fulfilled?	Citric acid is expected to be readily biodegradable and does not persist in the environment
B/vB criteria fulfilled?	Based on the low Log Kow and widespread natural occurrence, citric acid is not expected to have potential for bioaccumulation.
T criteria fulfilled?	Long term data not available (acute data >0.1 mg/L); potentially not toxic.
Overall conclusion	Not a PBT substance (based on screening data).

References

1. ECHA REACH, Citric Acid, Retrieved 2015: http://apps.echa.europa.eu
2. HSDB (n.d.). *Hazardous Substances Data Bank*. Retrieved 2015, from Toxnet, Toxicology Data Network, National Library of Medicine: http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB
3. IPCS Citric Acid, Retrieved 2015: http://www.inchem.org
4. JECFA http://apps.who.int/ipsc/database/evaluations/chemical.aspx?chemID=4785
5. OECD, Citric Acid, Retrieved 2015: http://www.echemportal.org

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Toxicity Summary - Crystalline silica-cristobalite, crystalline silica-quartz

Chemical and Physical Properties[1,3]	
CAS number	Crystalline Silica (Cristobalite) : 14464-46-1 Crystalline Silica (Quartz): 14808-60-7 Diatomacous Earth (Calcined silica): 91053-39-3
Molecular formula	Crystalline Silica (Cristobalite): SiO_2 Crystalline Silica (Quartz): SiO_2 Diatomacous Earth (Calcined silica): SiO_2
Molecular weight	60.09 g/mol
Solubility in water	Insoluble/negligible
pH	-
Melting point	1713◦C (Cristobalite) 1610◦C (Quartz)
Boiling point	2230 ◦C
Vapour pressure	NA
Henrys law constant	NA
Explosive potential	Not explosive
Flammability potential	Not flammable
Colour/Form	Transparent crystals
Overview	Silica is an off-white granule that occurs naturally in various crystalline and amorphous or other non-crystalline forms. Crystalline silica is characterized by silicon dioxide (SiO2) molecules oriented in fixed, periodic patterns to form stable crystals. The primary crystalline form of silica is quartz. Other crystalline forms of silica include cristobalite, tripoli and tridymite. Particle size is a key determinate of silica toxicity, since toxicity is restricted to particles that are small enough to be deposited into the target regions of the respiratory tract. Uncalcined diatomaceous earth typically contains around 1%crystalline silica. When diatomaceous earth is subjected to pressure or is processed ("calcined") at temperatures above 1000°C some of the amorphous silica is converted to crystalline silica in the form of cristobalite. Calcined diatomaceous earth can contain anywhere from 1% to 75% cristobalite.
Environmental Fate [1,2]	
Soil/Water/Air	Crystalline Silica consists of diatomaceous earth, a naturally occurring material. Its primary component, silica, is found in common materials like quartz, sand and agate. The materials are ubiquitous and unlikely to react chemically with any other substance in the environment.

Human Health Toxicity Summary [1,2,3]	
Chronic Repeated Dose Toxicity	A number of animal studies have found that cristobalite is more toxic to the lung than quartz, and more tumorigenic (e.g., King et al. 1953; Wagner et al. 1980). However, several other authors concluded that this is not the case (Bolsaitis and Wallace 1996; Guthrie and Heaney 1995). OSHA (2013) has examined evidence on the comparative toxicity of the silica polymorphs (quartz, cristobalite, and tridymite) and found no difference in toxicity effects between cristobalite and quartz. Furthermore, no difference in toxicity between cristobalite and quartz has been observed in epidemiologic studies (NIOSH 2002). There is no information on the repeat dose oral, inhalation or dermal effect of calcined silica. However, since calcined diatomaceous earth contains varying amounts of crystalline silica in the form of cristobalite, and may also contain small amounts of quartz and tridymite, it is expected that any long-term health hazards associated with diatomaceous earth would mainly be due to the effects of crystalline silica. In humans, the most prevalent effect identified from long term exposure in occupational settings is silicosis, a diffused nodular pulmonary fibrosis (US EPA 1996).
Carcinogenicity	IARC (2012) concluded that there is sufficient evidence in humans for the carcinogenicity of inhaled crystalline silica in the form of quartz or cristobalite from occupational sources. There is sufficient evidence in experimental animals for the carcinogenicity of quartz and cristobalite. The IARC has also concluded that inhaled crystalline silica in the form of cristobalite or quartz from occupational sources is carcinogenic to humans (Group 1) (IARC 2012).
Mutagenicity/ Genotoxicity	Conflicting results have been reported in genotoxicity studies with crystalline quartz or cristobalite, and a direct genotoxic effect for crystalline silica has not been confirmed or ruled out. Studies on genotoxicity of calcined diatomaceous silica are not available.
Reproductive Toxicity Developmental Toxicity/Teratogenicity	No data available.
Acute Toxicity	No data available.
Irritation	No data available. Most acute toxicity studies for quartz or cristobalite were conducted using intratracheal instillation. Single intratracheal instillation of quartz caused inflammatory effects and formation of discrete silicotic nodules in rats, mice and hamsters (IARC 2012; WHO 2000). Other effects like oxidative stress, cellular proliferation and increases in water, protein, and phospholipid content of rat lungs, apoptosis (programmed cell death) and lung cancer were also noted. In general, exposure to high concentrations of dust may cause coughing and mild, temporary irritation (CCOHS 2001).
Sensitisation	No data available. However, based on the structure and physico-chemical properties, the three forms of crystalline silica or the calcined diatomaceous silica are not expected to cause skin sensitisation.
Health Effects Summary	The substances are not skin or eye irritants but acute inhalation of dust may cause discomfort and stress as well as signs of local irritation to nasal, bronchiolar and ocular mucous membranes. Based on the evaluation of the epidemiological data it is concluded that inhalation exposure to crystalline silica results in lung cancer. This conclusion is also supported by animal studies in which inhalation and intratracheal exposure to crystalline silica resulted in lung tumours. The most common types of lung tumour observed in rats were lung adenocarcinomas.
Key Study/Critical Effect for Screening Criteria	Not applicable.

Ecological Toxicity [1,2,3]	
Aquatic Toxicity	Aquatic toxicity studies performed at saturation concentrations of synthetic amorphous silica showed no acute toxicity to fish, Daphnia, or algae, though some physical effects were observed with loading rates of greater than or equal to 10 g/L (OECD 2004). Any harmful effects to aquatic ecosystems are therefore not ecotoxicological in nature. No chronic toxicity data were identified.
Determination of PNEC aquatic	Not applicable.
Current Regulatory Controls [3]	
Australian Hazard Classification	Quartz and cristobalite are listed in the Hazardous Substances Information System (HSIS) (Safe Work Australia 2014a) as hazardous substances. Calcined silica is not listed in the HSIS.
Australian Occupational Exposure Standards	Time Weighted Average (TWA) occupational exposure standard of 0.1 mg/m³ for quartz and cristobalite are recommended in Australia (Safework Australia 2013). A Short-Term Exposure Limit (STEL) is not recommended for any of the compounds.
International Occupational Exposure Standards	TWA for quartz, cristobalite: Canada: 0.025 mg/m³ France: 0.05 mg/m^3 Japan: 0.03 mg/m³ Sweden: 0.05 mg/m^3 US (ACGIH): 0.025 mg/m^3 US (NIOSH): 0.05 mg/m^3 US (OSHA): 0.1 mg/m^3 US: 0.3, 0.9, 1.5, 500 mg/m^3 Temporary Emergency Exposure Limits (TEEL) (Diatomaceous silica, calcined)
Australian Food Standards	No data found.
Australian Drinking Water Guidelines	The Australian Drinking Water Guidelines state: 'To minimise an undesirable scale build up on surfaces, silica (SiO¬2) within drinking water should not exceed 80 mg/L' (National Health and Medical Research Council (NHMRC) 2001).
Aquatic Toxicity Guidelines	No data found.
PBT Assessment [3]	
P/vP Criteria fulfilled?	No. Not applicable, inorganic substance, ubiquitous in environment.
B/vB criteria fulfilled?	No. Not applicable, inorganic substance, ubiquitous in environment.
T criteria fulfilled?	No. Long term data not available (acute data >0.1 mg/L).
Overall conclusion	It is not currently possible to categorise the environmental hazards of metals and other inorganic chemicals according to standard persistence, bioaccumulation and toxicity (PBT) hazard criteria. These criteria were developed for organic chemicals and do not take into account the unique properties of inorganic substances and their behaviour in the environment (UNECE 2007; US EPA 2007). Further assessment of the environmental risks from the use of this chemical is not required as identified by DoEE
Revised	April 2018

References

1. HSDB. Hazardous Substances Data Bank. Retrieved 2015, from Toxnet, Toxicology Data Network, National Library of Medicine: http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB
2. OECD-SIDS Initial Targeted Assessment Profile on Quartz and Cristobalite, SIAM 32, 19-21 April 2011.
3. Department of the Environment and Energy 2017 , National assessment of chemicals associated with coal seam gas extraction in Australia, prepared by the National Industrial Chemicals Notification and Assessment Scheme

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Toxicity Summary - Diethanolamine

Chemical and Physical Properties [1,2,4]	
CAS number	111-42-2
Molecular formula	C4H11NO2
Molecular weight	105.14
Solubility in water	1,000 g/L @ 20 °C
Melting point	27 °C at 101.3 kPa
Boiling point	269.9 °C at 101.325 kPa
Vapour pressure	0.0028 hPa (25 °C)
Henrys law constant	3.97 x 10-6 Pa*m^3/mol
Explosive potential	Non explosive
Flammability potential	Non flammable
Colour/Form	Colourless crystals or a white syrupy liquid with a mild ammonical odour.
Overview	2,2'-Iminodiethanol (diethanolamine, DEA) belongs to the ethanolamines group that includes monoethanolamine (MEA), diethanolamine (DEA) and triethanolamine (TEA). Large-scale production of DEA is carried out by the reaction of ethylene oxide and excess ammonia, followed by fractionation of the three ethanolamines (mono-, di- and triethanolamine). Ethanolamines are used widely as intermediates in the production of anionic and non-ionic surfactants, which have become commercially important as detergents, textile and leather chemicals, and emulsifiers. Their uses range from drilling and cutting oils to medicinal soaps and high-quality toiletries. DEA is an important additive of corrosion inhibitors, particularly in coolants for automobile engines. DEA is also employed as an additive in lubricants and in cement/concrete production. Large amounts of DEA are used as such in closed systems for absorptive gas purification to remove weakly acidic components. In the production of detergents, cleaners, fabric softeners and metalworking fluids DEA is used for acid neutralization and to prevent soil deposition. DEA is also used as an intermediate in the production of morpholine, photographic chemicals and polyurethanes. In addition, DEA is used as a building block for agrochemicals.
Environmental Fate[4]	
Soil/Water/Air	The colourless solid DEA is completely miscible with water at ambient temperature and has a negligible vapour pressure of 0.0028 hPa (25 °C). The measured log KOW of -2.18 (25 °C) and the calculated BCF of 3.16 indicate a low potential for bioaccumulation. The Henry's law constant of 3.97 x 10-6 Pa*m^3/mol (uncharged) is considered as an indication for low volatility. The calculated Koc of uncharged DEA is 1 (corrected log Koc = 0). Thus, the potential for adsorption to soil, sediment, and suspended solid may be low. However, binding of the substance to the matrix of soils (and sediments) with high capacities for cation exchange (e.g. clay) cannot be excluded for the charged molecule. The measured pKa value of 8.92 (23 °C) indicates that at environmentally relevant conditions of pH 6 – 8, the molecule will predominantly occur in the charged (cationic) form. At pH values > 9, DEA will predominantly be present as the uncharged species. According to Mackay Level I modelling, uncharged DEA will distribute almost completely into water (99.99 %). DEA is readily biodegradable according to OECD criteria. Potential for anaerobic degradation of DEA was also observed. In the atmosphere, it will be photodegraded by reactions with OH radicals (calculated half-life of the uncharged molecule for a 12-hour day and 1.5E06 OH/cm^3: 2.4 hours = 0.1 day; for a 24-h day and 0.5E06 OH/cm^3: 4.2 hours = 0.2 days). At environmental pH conditions hydrolysis is not expected to be a relevant degradation process due to the absence of hydrolysable groups
Human Health Toxicity Summary [1,2]	

Chronic Repeated Dose Toxicity	In a 90 day oral gavage study conducted similarly to OECD TG 408 in F344 rats, lowest observed adverse effect levels (LOAEL) of 320 and 160 ppm (equivalent to 25 and 14 mg/kg bw/day, respectively) was reported in male and female rats, respectively. These were the lowest doses tested. Mortality was observed in males (2/10 animals) at the highest dose (5000 ppm) before the completion of the study (REACH; OECD, 2008). Signs of toxicity were observed across all dose groups (160 - 2500 ppm), and included tremors, extreme weight loss, abnormal posture and a dose dependent increase in microcytic anaemia. Dose related (≥ 320 ppm in males and ≥ 160 ppm in females) changes in kidney weights were associated with an increase in nephropathy and renal cell necrosis. Dose related (≥ 320 ppm in males and ≥ 630 ppm in females) increase in liver weight was associated with a moderate increase in serum bile acid concentration (REACH; OECD, 2008). Based on treatment-related effects reported with a LOAEL of 32 and 80 mg/kg bw/day in rat and mouse studies, respectively, the chemical is considered to cause serious damage to health from repeated oral exposure. In a 90 day dermal application study conducted similarly to OECD TG 411 in F344 rats, a LOAEL of 32 mg/kg bw/day was reported in male and female rats. Mortality occurred in one male and two female rats administered the highest dose of 500 mg/kg bw/day (REACH; OECD, 2008). Ulceration, inflammation, hyperkeratosis, and acanthosis occurred at all administered doses (32 - 500 mg/kg bw/day). Other signs of toxicity included reductions in body weight gain, anaemia, renal function changes and liver weight increases. Demyelination in the brain, nephropathy and renal tubular necrosis were also observed (REACH; OECD, 2008). In a similar study conducted similarly to OECD TG 411 in B6C3F1 mice, a LOAEL of 80 mg/kg bw/day was reported in male and female mice. Effects on the skin were noted at all doses (80 - 1250 mg/kg bw/day) and consisted of acanthosis at the lower doses and a dose-dependent increase in ulcerations, inflammation and hyperkeratosis at higher dose levels (630 and 1250 mg/kg bw/day in males and females, respectively) (REACH; OECD, 2008). Further signs of toxicity included dose dependent increases in liver and kidney weights. The increase in liver weight was associated with hepatocellular changes consisting of enlarged hepatocytes and, at the higher dose levels, the presence of multinucleated, giant hepatocytes. Liver damage (hepatocellular necrosis) was observed in male mice only (REACH; OECD, 2008). Based on the available data no adverse systemic toxicity was evident. Local effects were observed at a lowest observed adverse effect concentration (LOAEC) of 0.15 mg/L in one study. The available data do not warrant a hazard classification for repeated dose inhalation toxicity. However, a classification for respiratory irritation is warranted. In a 90 day inhalation study conducted according to OECD TG 413 in Wistar rats, a LOAEC of 0.15 mg/L was reported in male and female rats. Local inflammation (focal squamous metaplasia and hyperplasia) was evident in the larynx (0.15 mg/L) and trachea (0.4 mg/L) in a concentration dependent manner (REACH, SIDS, 2008). Marginal increases in liver weight and serum alkaline phosphatase levels occurred at the mid - high doses (0.15 and 0.4 mg/L, respectively), although, no histopathological changes were noted. In females, erosions of the glandular stomach occurred in a dose dependent manner (0.15 mg/L and 0.4 mg/L) (REACH; OECD, 2008). A further study conducted according to OECD TG 413 in male and female Wistar rats using lower doses (0.0015, 0.003 or 0.008 mg/L) showed similar local irritation effects (focal squamous metaplasia) after 90 days of exposure. After 90 days of exposure to the chemical, a group of 10 animals were given three months of recovery. At the end of the recovery period, no treatment related systemic effects were observed, indicating reversibility in the laryngeal epithelium up to the highest dose administered (0.008 mg/L) (REACH, OECD, 2008).

Carcinogenicity	Limited data are available on the carcinogenicity of DEA. A two-year carcinogenicity study was conducted by the United States National Toxicology Program (NTP, 1999). Based on the pattern of occupational and consumer exposure, dermal administration was considered the most appropriate route for the carcinogenicity study in rats and mice. Groups of 50 male F344/N rats were administered dermal doses of 0, 16, 32, or 64 mg/kg bw DEA in ethanol solutions, 5 days per week for 103 weeks. Female rats were administered 0, 8, 16, or 32 mg/kg bw, and male and female B6C3F1 mice were administered 0, 40, 80, or 160 mg/kg bw DEA dermally, 5 days per week for 103 weeks. Mean body weights of treated rats were generally lower than those of the control rats. The only clinical finding attributed to DEA administration was irritation of the skin at the site of application. This effect was dose-related. Exudate, consisting of focal accumulations of serum and cellular debris on the epidermal surface, occurred at significantly increased incidences in 64 mg/kg bw males and in all dosed female groups. In rats, the main histopathological effects were noted in kidneys of female rats with nephropathy, renal tubular epithelial cell necrosis and/or mineralisation, which increased in incidence and/or severity in a dose-dependent manner. The incidence of nephropathy in dosed female groups was significantly greater than that in the vehicle controls; but no such effects were seen in male rats. There was no neoplastic response in the skin or any organ associated with DEA exposure during the two-year study. The incidence of basophilic foci was significantly decreased in all dosed groups of males and females. The incidence of fibroadenoma in mammary glands in female rats occurred with a negative trend, being lower in all dosed groups compared to the historical control range. In mice, mean body weights of treated groups were depressed, more so in female mice than in male mice. The liver was clearly the most affected organ, and female mice were more sensitive than males. Exposure to diethanolamine for two years produced a marked neoplastic response in the liver characterised by significant increases in the incidences and multiplicity of hepatocellular adenomas (males: 31/50, 42/50, 49/50, 45/50 and females: 32/50, 50/50, 48/50, 48/50) and hepatocellular carcinoma (males: 12/50, 17/50, 33/50, 34/50 and females: 5/50, 19/50, 38/50, 42/50) at 0, 40, 80 and 160 mg/kg bw/day, respectively. The microscopic appearance of these liver neoplasms was typical of those usually observed spontaneously in B6C3F1 mice. There was a morphologic continuum from adenoma to carcinoma, with less differentiation and typical trabecular formations in the carcinomas. Increased mortality was noted in female mice and this, along with reduced body weights, was considered to be a consequence of the presence of liver neoplasms. The incidence of hepatoblastomas, uncommon phenotypic variants of hepatocellular carcinoma, was significantly increased in male mice, but not in females. In addition, the incidence of syncytial alteration, a non-neoplastic lesion characterised by the presence of hepatocytes containing multiple (three or more) nuclei, was increased in all groups of dosed mice; this lesion was not present in the controls. Centrilobular cytoplasmic alteration was increased in treated males but was not present in females. There were no neoplasms of the skin in mice. Effects in the kidneys included increased organ weights and increased incidence of tubular epithelial cell necrosis. The incidences of renal tubule adenoma and renal tubule adenoma or carcinoma (combined) occurred with a positive trend in male mice, but renal tubule carcinoma did not follow the same pattern. Detailed evaluation of the renal neoplasms indicated a treatment- and dose-related increase in the incidences of renal tubule adenoma (1/50, 4/50, 6/50 and 6/50) and adenoma or carcinoma (combined) (3/50, 5/50, 6/50 and 8/50 at 0, 40, 80 and 160 mg/kg, respectively). Diethanolamine is eliminated in urine as the parent compound. The data on the mode of action are insufficient to conclude that diethanolamine-induced tumours in mice are relevant for humans and, therefore, based on the available information, diethanolamine is not classified for carcinogenicity.

Mutagenicity/ Genotoxicity	The chemical tested negative in several in vitro (Ames test with and without metabolic activation, reverse mutation assay, cytogenic assay and the mouse lymphoma assay) and in vivo (micronucleus assay and the alkaline elution assay) tests for gene mutation and clastogenicity (NICNAS; OECD, 2008).
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	No reproductive toxicity studies are available for diethanolamine. Repeated dose studies were conducted in F344/N rats and B6C3F1 mice of both sexes for 13 weeks (10/sex/species/dose) to characterise the effects of oral and dermal exposure (NTP, 1992). No reproductive toxicity in male or female rats was reported following dermal administration of the chemical for 13 weeks. There were no morphological effects on male or female reproductive organs or in sperm parameters (NTP, 1992). It is likely that testicular degeneration in a 90-day drinking water study is a direct toxic effect of diethanolamine. However, no effect on the reproductive organs of the female rats was noted. The NOAEL for reproductive effects in males is 630 ppm (48 mg/kg bw/day). In an inhalation study, conducted according to OECD TG 413, male and female Wistar rats were exposed to the chemical via inhalation (0.015, 0.15 or 0.4 mg/L), five times a week for 90 days. Reproductive effects in males were reported at the highest concentration (0.4 mg/L) and these included testicular atrophy and slight atrophy of the prostate. No changes were observed in female rats (OECD, 2008). The effects of diethanolamine on the male reproductive system are indicative of a potential to impair reproductive capability. However, more detailed reproductive toxicity studies are needed to confirm the potential effects on fertility observed in male rats. The current information is insufficient to classify diethanolamine for reproductive toxicity. Developmental effects were tested following exposure of dams to diethanolamine by oral, dermal and inhalation routes. In almost all the rodent studies, developmental effects were seen only at higher doses, at which maternal effects were also noted. In a dermal study in rabbits, the overall incidence of malformation was similar to the incidence seen in control animals. The current data therefore do not allow for a clear delineation of reproductive and developmental toxicity of diethanolamine in experimental animals. Classification of diethanolamine for reproductive and developmental toxicity is, therefore, not recommended at this stage.

Acute Toxicity	The reported oral median lethal dose (LD50) values in rats ranged from 780 - 3540 mg/kg bw (OECD, 2008). In one study male Sprague Dawley (SD) rats administered a single oral dose of aqueous DEA (100 – 6400 mg/kg bw) resulting in 90 % mortality at the highest dose. Doses greater than 100 mg/kg bw resulted in an increase in liver weight. An increase in the relative kidney weight was observed at doses greater than 1600 mg/kg bw. Clinical chemistry changes were reported for the liver at doses greater than 200 mg/kg bw and for the kidney at greater than 400 mg/kg bw (OECD, 2008). The chemical was of low acute toxicity in animal tests following dermal exposure. The median lethal dose (LD50) in rabbits is greater than 12000 mg/kg bw (IUCLID, 2000). The chemical was of low acute toxicity in animal tests following inhalation exposure. The median lethal concentration (LC50) in rats is 6.4 mg/L. The available data do not warrant hazard classification. Acute inhalation exposure to the chemical for 1.5 – 4 hours at concentrations between 30 – 1476 ppm (0.13 - 6.4 mg/L) caused mortality in 5/8 rats after 105 minutes of exposure to 6.4 mg/L. Exposure to 3.35 mg/L (768 ppm) for up to 4 hours resulted in no mortality. It was reported that the exposure was to vapours or aerosols (most likely at the higher concentration). Observed sub-lethal effects included lethargy, increased breathing, increased blood pressure, congestion in the lung and discolouration in the kidney and thymus (REACH; OECD 2008).
Irritation	The chemical on unabraded rabbit skin produced skin irritation after 1 - 15 minutes and marked irritation after 20 hours. Over 72 hours, erythema increased and oedema decreased (REACH). After 20 hours of exposure the mean Draize scores for erythema and oedema formation were 2 and 1.33, respectively. While the Draize scores for erythema and oedema returned to normal after 8 days, severe desquamation of the skin persisted. The chemical is also reported to cause ulceration, inflammation and hyperkeratosis following repeated exposure. In an eye irritation study in Vienna White rabbits, 0.05 mL of the chemical was instilled into the rabbit's eyes and observed for eight days. The chemical caused signs of severe irritation consisting of superficial corrosion, corneal opacity, conjunctival bleeding, conjunctivitis and oedema (OECD, 2008; REACH). Extensive corrosion was evident at the end of the observation period. In a further study, 0.1 g of the chemical was applied into the conjunctival sac of New Zealand White rabbits. This resulted in strong irritation of the cornea, iris and conjunctiva, which did not completely resolve over seven days of observation (OECD, 2008).
Sensitisation	The chemical was not found to induce dermal sensitisation in the Guinea pig maximization test conducted according to OECD Test Guideline (TG) 406 (OECD, 2008).
Health Effects Summary	The critical health effects for risk characterisation include systemic acute effects (acute toxicity by the oral route of exposure) and local effects (skin, eye and respiratory irritation). The chemical may also cause harmful effects following repeated exposure through oral and dermal routes.
Key Study/Critical Effect for Screening Criteria	The lowest observed adverse effect levels (LOAEL) of 320 and 160 ppm (equivalent to 25 and 14 mg/kg bw/day, respectively) were reported in male and female rats, respectively, based on kidney and liver weights in the drinking water study (US NTP, 1992). In mice, the LOAEL was 630 ppm (104 mg/kg bw/day for males and 142 mg/kg bw/day for females) based on liver weight changes. It is reported that the fatal oral dose of the chemical is 20g in humans (HSDB).
Ecological Toxicity [3,4]	

Aquatic Toxicity	The lowest reliable acute toxicity values for aquatic species were as follows: Pimephales promelas (fish) 96-h LC50 = 1370 mg/l (nominal) Daphnia magna (invertebrates) 48-h EC50 = 55 mg/l (nominal) Pseudokirchneriella subcapitata 96-h ErC50 = 2.2 mg/l (nominal) Pseudomonas sp. (microorganisms) 16-h TTC = 16 mg/l (nominal) In a chronic toxicity test on reproduction of the water flea Daphnia magna, the NOEC (21 days) was 0.78 mg/l (nominal, based on analytical verification).
Determination of PNEC aquatic	Using an uncertainty factor of 50 on the lowest NOEC to Daphnia a PNEC (Predicted No Effect Concentration) of 0.02 mg/L is calculated, for aquatic organisms.
Current Regulatory Controls [1]	
Australian Hazard Classification	The chemical is classified as hazardous, with the following risk phrases for human health in the Hazardous Substances Information System (HSIS) (Safe Work Australia): Xn; R22 (Acute toxicity) Xi; R38/41 (Irritation) Xn; R48/22 (Repeated dose toxicity)
Australian Occupational Exposure Standards	The chemical has an exposure standard of 13 mg/m³ (3 ppm) time weighted average (TWA).
International Occupational Exposure Standards	The following exposure standards are identified (Galleria Chemica): An exposure limit (TWA) of 2 - 15 mg/m³ (0.46 – 3 ppm) in different countries such as USA (Alaska, Hawaii), Canada (Yukon), Norway and Switzerland.
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	No data available.
PBT Assessment [4]	
P/vP Criteria fulfilled?	No. DEA is readily biodegradable according to OECD criteria.
B/vB criteria fulfilled?	No. Based on a measured log Kow of -2.18 and a calculated BCF of 3.16, this chemical does not meet the screening criteria for bioaccumulation.
T criteria fulfilled?	No. The chronic aquatic toxicity of the chemical is > 0.01 mg/L. Hence the substance does not fulfil the screening criteria for toxicity.
Overall conclusion	Not PBT
Revised	January 2019

References

1. National Industrial Chemicals Notification and Assessment Scheme (NICNAS). Human Health Tier II Assessment for Ethanol, 2,2'-iminobis-, Retrieved 2019: https://www.nicnas.gov.au
2. National Industrial Chemicals Notification and Assessment Scheme (NICNAS). Human Health Tier III Assessment for Ethanol, 2,2'-iminobis-, Retrieved 2019: https://www.nicnas.gov.au
3. ECHA REACH, 2,2'-iminodiethanol, Retrieved 2019: https://echa.europa.eu/
4. OECD (2002) SIDS Initial Assessment Profile for 2,2'-iminodiethanol (diethanolamine, DEA)

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Toxicity Summary - 2,2''-oxydiethanol (Diethylene glycol)

Chemical and Physical Properties[1,2,3,4]	
CAS number	111-46-6
Molecular formula	$C_4H_{10}O_3$
Molecular weight	106.1 g/mol
Solubility in water	Miscible
Melting point	-10°C
Boiling point	245°C
Vapour pressure	It has a low vapour pressure (<0.01 kPa at 25°C).
Henrys law constant	$2.0X10^{-9}$ atm-cu m/mol at 25 °C
Explosive potential	Not explosive
Flammability potential	Combustible
Colour/Form	Odourless, colourless, viscous and hygroscopic liquid with a sharply sweetish taste
Overview	Diethylene glycol (DEG) is produced via a non-catalytic reaction between ethylene oxide and water at high pressure temperature. The resulting crude ethylene glycols (EG) are dried. The water-free glycol mixture is subsequently fractionated by vacuum distillation into mono, di and triethylene glycol. Biodegradation of polyethylene glycols results in chain shortening with concomitant formation of ethylene glycol and diethylene glycol in nature DEG is a widely used chemical in industrial and household applications. It is also used in cosmetics for topical use. DEG is not an approved food additive in Australia. However, DEG is allowable in food in Australia as an impurity in polyethylene glycol (PEG) used as a processing aid or miscellaneous food additive. PEG used for this purpose must contain no more than 0.25% w/w DEG.
Environmental Fate[1,4]	
Soil/Water/Air	EGs emitted to the atmosphere readily undergo hydroxyl radical induced photodegradation, with half-lives ranging from about 2 to 15 hours. Particulate-phase EGs may be physically removed from the atmosphere by wet deposition (SRC, 2003). EGs have limited volatility, decreasing with increasing molecular weight. Level III fugacity modelling and Henry's Law constants ranging from 1.31×10^{-7} to 7.62×10^{-15} atm-m^3/mole indicate that volatilization from water to the atmosphere is limited. EGs are inherently to readily biodegraded in water. Since these substances are resistant to water hydrolysis, abiotic degradative processes in water are not major elimination pathways. Fugacity modelling indicates that EGs have a high affinity for soil as well as water. Low soil/sediment coefficients (Koc = 1 to 10) suggest that these substances are highly mobile in soil, have limited tendency to adsorb onto suspended solids and sediment, and are therefore subject to biodegradative elimination in either soil or water. Overall, the data suggest that EGs do not persist in the environment and that they have limited potential for bioaccumulation.

Human Health Toxicity Summary [1,2,3,4,5]	
Chronic Repeated Dose Toxicity	Two well-conducted studies were identified from which effect levels from long-term oral DEG administration could be derived (OECD, 2004; Health Council of the Netherlands 2007). In these two studies by Gaunt et al. (1976*) using DEG doses in food of 0%-4% (0.3-3.7 g/kg bw/d) for 98 days and 0%-2% (0.05-1.5 g/kg bw/d) for 225 days in Wistar rats (10-15/sex/dose), kidney effects were reported consisting of oxalate crystalluria, increased urine volumes and histopathological evidence of hydropic degeneration and tubular necrosis. For the crystalluria and increased urine volumes, there were inconsistent findings between male and female rats and questionable dose-response relationships. For example, the number of male rats with urinary oxalate crystals was not increased at the highest male dose of 1.2 g/kg bw/d in the 225 day study. In addition, the observed increase in urinary volumes was possibly caused by the osmotic diuretic effect of DEG and the oxalate crystalluria could not be explained in view of oxalic acid being a minor metabolite of DEG in rats. Therefore, the significance of elevated production of oxalate was regarded as unclear (Health Council of the Netherlands, 2007) and was viewed as a biomarker and not an indication of toxicity (OECD, 2004). OECD (2004) identified a LOAEL for kidney effects of 230 mg/kg bw/d from the 225 day study based on increases in urine volume. The NOAEL was 100 mg/kg bw/d. Health Council of the Netherlands (2007) regarded a NOAEL based on renal histopathological findings as more relevant than a NOAEL based on increased urine volumes. From the 98 day study, a LOAEL based on renal hydropic degeneration was established at 1.6 g/kg bw/day with the NOAEL at 300 mg/kg bw/d (Health Council of the Netherlands, 2007).
Carcinogenicity	The International Agency for Research on Cancer (IARC) has not evaluated DEG as a carcinogen. Urinary bladder calculus and tumour responses were recorded in some long-term oral studies in the rat. Bladder tumours were found associated with the formation of oxalate containing bladder stones in a 2-year feeding study by Fitzhugh and Nelson (1946*). On the other hand, Weil et al. (1965*, 1967*) found that DEG did not induce bladder tumours in rats unless a foreign body or lesion was present, such as an oxalate- containing bladder stone or a surgery-induced bladder lesion. These authors concluded that the bladder tumours seen were due to mechanical irritation by oxalate-containing bladder stones rather than the carcinogenic response to DEG. In more recent studies such as Ito et al. (1988*), Masui (1988*) and Hiasa et al. (1990* and 1991*), DEG did not demonstrate any evidence of carcinogenic effects after oral administration. Several studies in mice also showed that DEG is not carcinogenic after dermal application. No information was found in the literature concerning the occurrence of bladder stones in humans after ingestion of DEG. Overall, although some human carcinogenicity information are available, data are insufficient (e.g. lack of a quantitative estimate of DEG exposure and sound methodology) to evaluate the carcinogenic potential of DEG.
Mutagenicity/ Genotoxicity	DEG was shown to be negative in the majority of gene mutation and chromosome aberration studies in vitro. Some indications of chromosomal damage were seen in vivo only at high doses. Taken together, DEG is considered non-genotoxic.

Reproductive Toxicity / Developmental Toxicity/Teratogenicity	In oral studies, adverse effects on fertility were seen in mice and foetal abnormalities occurred in rats and mice. Inhalation and injection studies in rabbits and hamsters also revealed foetal abnormalities and other adverse effects on the foetus. However, reduced fertility was observed only at high doses of DEG, up to 6.1 g/kg bw/d in mice with maternal toxicity. With regard to developmental toxicity, a significant decrease in mean foetal body weight in mice was seen at 10 g/kg bw/d in the presence of maternal toxicity. In addition, at an oral dose of 6.1 g/kg bw/d in a 2-generation study in mice, craniofacial malformations, including exencephaly and cleft palate, and related mortality were observed in the presence of maternal toxicity. In rats, a decreased foetal body weight with increased skeletal variations was seen at 4.5 g/kg bw/d in the presence of maternal toxicity. Foetal malformations were not observed at dose levels up to 8.9 g/kg bw/d. From these studies, the NOAEL for fertility and developmental effects is established at 3.1 g/kg bw/d with a LOAEL of 6.1 g/kg bw/d based on reductions in litters/pair, live pups/litter and live pup weight
Acute Toxicity	In animals, the acute oral, dermal and inhalational toxicity of DEG are low. Oral toxicity is similar for both rats and mice with LD50 values ranging 13-30 g/kg bw across both species. A single study of dermal toxicity in rabbits derived an LD50 value of 12.5 or 13.3 g/kg bw . Acute inhalational toxicity has also been tested in rats and mice. The 4-hour LC50 in rats was 4600 mg/m^3. In humans, mortality and morbidity are high in cases of inadvertent DEG ingestion, with most deaths occurring within the first 2 weeks post exposure. Neurological impairments observed after exposure include encephalopathy, demyelinating neuropathy, optic neuritis, facial paralysis, cerebral oedema and haemorrhages. Acute anuric renal failure with metabolic acidosis and concomitant severe neurological abnormalities progressing to coma and finally death were also noted during severe intoxications after uptake of DEG in patients with burns. A median lethal oral dose of 1.49 g/kg bw DEG (range 0.25-4.9 g/kg bw) was estimated from large-scale intoxication of Haitian children with a paracetamol syrup contaminated with DEG. However, large overlaps in ranges of lethal and non-lethal doses have been observed for adults and children. Accidents in humans following acute DEG exposure have been recorded. A large number of mass poisonings in humans involving substitution of DEG for more expensive, non-toxic, glycols in medicinal preparations have been documented over the past 70 years. Typical features of acute toxicity include neurological impairment, metabolic acidosis and acute renal failure. Early mortality and morbidity are high, with most deaths occurring within the first two weeks following DEG exposure. Humans appear to be 10 times more susceptible to acute oral toxic effects of DEG compared with experimental animals, with median lethal dose of 1490 mg/kg bw in humans compared with > 15000 mg/kg bw in rats (NICNAS, 2009).
Irritation	Overall, available data indicate that DEG causes no or only minimal skin and eye irritation in laboratory animals. Respiratory depression was reported in mice although the characteristics were reported as not typical of a pure airway irritant (OECD, 2004). No other information on respiratory irritation was available. Similar to experimental animals, DEG causes no or only minimal skin irritation in humans. Data for eye irritation in humans were not available.
Sensitisation	DEG does not cause skin sensitisation in guinea pigs. In humans, there is a single case study reporting skin sensitisation 2-4 weeks after a man had started smoking a brand of cigarettes containing DEG. However, overall, available data indicate that DEG is not a skin sensitiser in humans.
Health Effects Summary	The critical health effects for risk characterisation include systemic acute effects (acute toxicity from oral exposure).

Key Study/Critical Effect for Screening Criteria	The effects of diethylene glycol on the liver and kidneys after prolonged oral exposure are considered as the critical effects. Key study is the oral exposure study in rats carried out by Gaunt *et al.* (1976). the NOAEL for hydropic degeneration is 300 mg/kg bw/day (0.4% diethylene glycol in food) in the male rats (Health Council of the Netherlands, 2007). Uncertainty factors: 10 (interspecicies variability); 10 (intraspecies variability); 10 (sub-chronic to chronic) Oral RfD = 300/1000 = 0.3 mg/kg/day Drinking water guidance value = 1.17 mg/L
Ecological Toxicity [1,4]	
Aquatic Toxicity	Fish acute toxicity (measured as LC50 in mg/L) for DEG ranges from >1000 mg/L to 77900 mg/L. The lowest acute toxicity (LC50) to invertebrates (Daphnia) value was >100 mg/L (48hr LC50) . Algal toxicity has been tested for DEG with an EC50 of >1000 mg/L. Chronic toxicity to fish was also tested which resulted in a 7 day LC50 of 61,000 mg/L and chronic toxicity data on pentaEG are available for algae (NOEC – 100 mg/L)
Determination of PNEC aquatic	On the basis that short term results from three trophic levels and long term results from two trophic levels, an assessment factor of 50 has been applied to the lowest reported NOEC for algae (100 mg/L). The PNEC aquatic is 2.0 mg/L.
Current Regulatory Controls[6]	
Australian Hazard Classification	The chemical is classified as hazardous with the following risk phrase for human health in HSIS (Safe Work Australia): Xn; R22 (Harmful if swallowed)
Australian Occupational Exposure Standards	TWA (time weighted average) = 100 mg/m^3 (Safe Work Australia).
International Occupational Exposure Standards	TWA = 101 mg/m^3 [UK] (HSE, 2013).
Australian Food Standards	No data available
Australian Drinking Water Guidelines	No data available
Aquatic Toxicity Guidelines	No data available
PBT Assessment[1,4]	
P/vP Criteria fulfilled?	DEG is readily biodegradable and as such not persistent in the environment.
B/vB criteria fulfilled?	An estimated BCF of 3 suggests the potential for bioconcentration in aquatic organisms is low.
T criteria fulfilled?	The acute aquatic toxicity of DEG is > 0.01 mg/L. Hence the substance does not fulfill the screening criteria for toxic (T).
Overall conclusion	Not a PBT substance (based on screening data).
Revised	December 2018

References

1. HSDB (n.d.). *Hazardous Substances Data Bank*. Retrieved 2017, from Toxnet, Toxicology Data Network, National Library of Medicine: http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB
2. National Industrial Chemicals Notification and Assessment Scheme (NICNAS), 2009. Diethylene glycol (DEG)—hazard assessment
3. National Industrial Chemicals Notification and Assessment Scheme (NICNAS). Human Health Tier II assessment for Ethanol, 2,2'-oxybis-, CAS Number: 111-46-6, Retrieved 2018: https://www.nicnas.gov.au

4. OECD (2004) SIDS Initial Assessment Profile for Ethylene Glycols Category, CAS Number 107-21-1, 111-46-6, 112-27-6, 112-60-7, 4792-15-8
5. Health Council of the Netherlands. 2007. Diethylene glycol; Health based recommended occupational exposure limit. The Hague; Health Council of the Netherlands; publication no 2007/03OSH. Accessed 2017 at https://www.gezondheidsraad.nl/sites/default/files/200703osh_diethylene_glycol.pdf
6. Safe Work Australia 2011. Workplace Exposure Standards for Airborne Contaminants.

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Toxicity Summary - Boric acid/sodium tetraborate / boronatrocalcite / boron sodium oxide

Chemical and Physical Properties[1,3,5,8]	
CAS number	Boric Acid: 10043-35-3 Sodium Tetraborate: 1330-43-4 Boronatrocalcite: 1319-33-1 Boron sodium oxide: 12008-41-2
Molecular formula	Boric acid: H_3BO_3 Sodium Tetraborate: $Na_2B_4O_7$ Boronatrocalcite: $CaNaH_{12}(BO_3)5.2H_2O$ Boron sodium oxide: $B_8Na_2O_{13}$
Molecular weight	Boric acid: 61.833 g/mol Sodium Tetraborate: 201.220 g/mol Boronatrocalcite: 405.23 g/mol Boron sodium oxide: 340.47
Solubility in water	Boric acid: 49.20 g/l @ 20± 0.5 °C Sodium Tetraborate: 3.1% at 25 °C Boronatrocalcite: no data found Boron sodium oxide: 223.65 g/L @ 20 °C
pH	Boric acid: 6.1 in a 0.1% (wt) solution Sodium Tetraborate: 9.3 at 20 °C (3% solution) Boronatrocalcite: no data found Boron sodium oxide: no data found
Melting point	Boric Acid: 170.9 °C Sodium Tetraborate: 743 °C Boronatrocalcite: no data found Boron sodium oxide: 813 °C
Boiling point	Boric Acid: 300 C Sodium Tetraborate: 1,575 °C (decomposes) Boronatrocalcite: no data found Boron sodium oxide: no data found
Vapour pressure	Boric acid: 9.9×10^{-6} Pa @ 25 °C Sodium Tetraborate: Negligible at 20 °C Boronatrocalcite: no data found Boron sodium oxide: no data found
Henrys law constant	No data found
Explosive potential	Not explosive
Flammability potential	Not flammable
Colour/Form	Boric Acid: Colourless, transparent crystals or white granules or powder. Sodium Tetraborate: Colourless, monoclinic crystalline salt; also occurs as a white powder. Boronatrocalcite: Silky white rounded crystalline masses or parallel fibres. Boron sodium oxide: Solid white powder. Odourless.

Overview	Limited toxicity data is available for sodium tetraborate (Borax anhydrous) and boronatrocalcite (Ulexite) as such; this toxicity profile includes data on boron and boric acid. Boric acid and borate salts exist naturally in rocks, soil, plants and water as forms of the naturally occurring element boron. Anhydrous Borax is a free flowing mixture of clear, glass-like particles and white granules formed by the crushing of relatively large masses of fused materials. Borax is a salt of boric acid. Borax occurs naturally in evaporite deposits produced by the repeated evaporation of seasonal lakes and has many applications in chemistry, mining and pharmaceuticals. Ulexite is a sodium-calcium-hydroborate and, like other borates, is a structurally complex mineral. It is composed of hydrogen (3.98 %), sodium (5.67 %), calcium (9.89 %), boron (13.34 %), and oxygen (67.12 %) There is a lack of data available in the literature to directly assess the toxicity of the chemical. The major component of the chemical is a borate ion, which is likely to be associated with human health hazards of the chemical. The other constituents are considered to be of low concern to human health (NICNAS, 2013). As the chemical will readily break down in the stomach pH to boric acid (H_3BO_3) following ingestion, the toxicokinetics and toxicity of the chemical will be driven predominantly by borate ions. Boron is a naturally occurring element that is found in the form of borates in the oceans, sedimentary rocks, coal, shale, and some soils. Boron is widely distributed in nature, with concentrations of about 10 mg/kg in the earth's crust (range 5 mg/kg in basalts to 100 mg/kg in shales) and about 4.5 mg/L in the ocean. Borates are used in glass, ceramics, detergents, wood treatment and insulation fiberglass industries. Boric acid and other borates are also used in a range of consumer products including cosmetic and personal care products and also in detergents. Moreover, borates are essential for all plants – their use as fertilizers increases crop yields (including grapes, potatoes, sugar beets, alfalfa and olives) and quality. Boron occurs in foods as borate and boric acid. Boron has not been established to be an essential nutrient for humans and no specific biochemical function for boron has been identified in higher animals or man. There is some evidence that, in humans, boron intake within the usual dietary range may influence the metabolism and utilisation of other nutrients, particularly calcium, and may have a beneficial effect on bone calcification and maintenance.
Environmental Fate[2,4]	
Soil/Water/Air	All of the chemical in this group will transform into boric acid in the aquatic environment. This simple mononuclear boron compound is highly water soluble and is the predominant form of dissolved boron in surface waters. It is a mobile species in the environment and is to be found in all major environmental compartments.

Human Health Toxicity Summary [2,3,4,8,9]	
Chronic Repeated Dose Toxicity	The haematological system and the testes have been identified as the major targets after oral repeat dose exposure to Boric acid. Studies after repeated dermal or inhalation exposure to boric acid are not available. A NOAEL for effects on testes and the blood system of 17.5 mg boron/kg bw/day can be derived (with a LOAEL of 58.5 mg boron/kg bw/day) from two 2-year studies in rats on boric acid. Results obtained with boric acid can be supported by findings obtained from other borates thus indicating that the boron ion is the toxicologically relevant species
Carcinogenicity	Boric acid is not listed as an IARC carcinogen. In long term feeding studies on boric acid and disodium tetraborate decahydrate in both rats and dogs, no carcinogenic effects were observed.
Mutagenicity/ Genotoxicity	Boric acid is not mutagenic either in vitro or in vivo.
Reproductive Toxicity Developmental Toxicity/Teratogenicity	Results from animal experiments demonstrate that boric acid adversely effects fertility and development. Feeding studies in different animal species (rats, mice and dogs) have consistently demonstrated that the male reproductive system is the principle target in experimental animals, although effects on the female reproductive system have also been reported. Testicular damage ranging from mildly inhibited spermiation to complete atrophy has been demonstrated following oral administration of boric acid. Effects on fertility were observed at lower dose levels compared to dose levels, where signs of general toxicity appeared. Based on data from the two-year feeding studies with boric acid and borax in rats, 17.5 mg boron /kg bw/day (equivalent to 100 mg boric acid/kg bw/day)_was derived as a NOAEL for male and female fertility. Developmental effects have been observed in three species, rats, mice and rabbits. The most sensitive species appears to be rats, in which the effects observed at non maternally toxic doses include a reduction in foetal body weight and minor skeletal variations which, with the exception of short rib XIII, had reversed by 21 days post-natal. The NOAEL for developmental effects is 9.6 mg boron/kg bw/day (55 mg boric acid/kg/day).
Acute Toxicity	Boric acid is of low acute toxicity. LD50 oral rat > 3765 mg/kg bw (659 mg boron/kg/bw); LD50 dermal rabbits > 2000 mg/kg bw/day; 4 hour LC50 inhalation rat ≥ 2.03 mg/L.
Irritation	In rabbits, boric acid caused no/mild skin irritation, induced reversible conjunctival redness and chemosis with minor effects on the iris. In rats and mice, boric acid acts as a sensory irritant. The substance may irritate the eyes, nasal mucous membranes, skin and the respiratory tract, and may cause effects on the gastrointestinal tract, liver and kidneys.
Sensitisation	No borate tested has displayed skin sensitisation in Bheuler studies. No evidence of skin sensitisation has been seen in humans exposed occupationally to sodium borates, or in a human patch test with a 3% aqueous boric acid solution.
Health Effects Summary	Borates are of low acute toxicity and low skin irritation potential. It may cause sensory irritant effects on animals and humans with acute exposure. Borates were shown not to be skin sensitisers, genotoxic or carcinogenic. Repeated exposures to boron as boric acid induced effects on fertility (testes), development and the blood system.
Key Study/Critical Effect for Screening Criteria	The critical lowest No Observed Adverse Effect (NOAEL) level for the purposes of risk assessment is 9.6 mg boron/kg bw/day. This NOAEL was the equivalent of 55 mg boric acid/kg bw/day; 38 mg disodium octaborate anhydrate/kg bw/day and 85 mg borax/kg bw/day), from feeding (dietary intake) studies based on developmental effects. Uncertainty factors: 10 (interspecies variability); 10 (intraspecies variability); 10 (subacute to chronic). Drinking water guideline for boron: 3.5 ppm

Ecological Toxicity [3,9]	
Aquatic Toxicity	The most sensitive tests report that acute effects on fish are in the range of 10-20 mg-B/L although the quality of these studies was rated low. The lowest daphnid acute value is 133 mg-B/L. Algal and microbial inhibition studies suggest less toxicity: Selenastrum growth was not affected at 93 mg-B/L and activated sludge respiration showed minimal effects at 683 mg/L boric acid (119 mg-B/L). Chronic endpoints for Boric acid were available for Daphnia (6 mg/L) and Fish (2.1 mg/L).
Determination of PNEC aquatic	Canadian Water Quality Guidelines for the Protection of Aquatic Life: Long–term Exposure to Boron is 1.5 mg/L (2009). An assessment factor of 100 has been applied to the lowest reported chronic effect concentration of 2.1 mg/L for Fish. The PNECaquatic is 0.021 mg/L.
Current Regulatory Controls [9]	
Australian Hazard Classification	Boric acid and borax are classified as hazardous for human health in the Hazardous Substances Information System (HSIS) (Safe Work Australia 2013) with the following risk phrases: · Toxic to reproduction (Repr.) Cat. 2; R60 (May impair fertility) · Repr. Cat. 2; R61 (May cause harm to the unborn child) Mixtures containing boric acid and borax are classified as hazardous with the following risk phrases based on the concentration (conc) of the chemicals in the mixtures. · Boric acid: Conc ≥5.5%: Toxic (T); R60; R61 · Borax: Conc ≥8.5%: T; R60; R61.
Australian Occupational Exposure Standards	There are no specific exposure standards for boric acid or disodium octaborate anhydrate. However, the permissible exposure limits (as the time weighted average (TWA)) for dusts apply (10 mg/m^3 measured as inspirable dust) (Safe Work Australia 2013b). The exposure standard for borax is 5 mg/m^3 TWA (Safe Work Australia 2013a).
International Occupational Exposure Standards	The following exposure standards were identified (Galleria Chemica 2013): · Boric acid − Canada 2 mg/m^3 TWA, 6 mg/m^3 Short-term exposure limit (STEL) (borate compounds) − Germany 10 mg/m^3 TWA; 1 mg/m^3 STEL − Spain 10 mg/m^3 TWA (insoluble particles) − US 2 mg/m^3 TWA; 6 mg/m^3 STEL (borate compounds), 5 mg/m^3 TWA (particulates, respirable fraction) · Disodium octaborate anhydrate − Canada 10 mg/m^3 TWA, (insoluble particles) − Spain 10 mg/m^3 TWA (particulates, inhalable fraction) − US 5 mg/m^3 TWA (particulates, respirable fraction) · Borax − Canada 1 to 5 mg/m^3 TWA, 6 mg/m^3 STEL (inorganic borate compounds) − Denmark 1 to 2 mg/m^3 TWA − Germany 0.5 mg/m^3 TWA − Spain 5 mg/m^3 TWA − Sweden and UK 2 mg/m^3 TWA − US 2 mg/m^3 TWA (inorganic borate compounds); 5 to 10 mg/m^3 TWA.
Australian Food Standards	No data found.
Australian Drinking Water Guidelines	No aesthetic or health-related guidance values exist specifically for boric acid, disodium octaborate anhydrate or borax. However, the guidelines note that boron in the environment is likely to be predominantly in the form of boric acid and that based on health considerations, the concentration of boron in drinking water should not exceed 4 mg/L (NHMRC 2011).
Aquatic Toxicity Guidelines	For boron: 90 µg/L (ANZECC 2000 99% Freshwater)
PBT Assessment [9]	
P/vP Criteria fulfilled?	For the purposes of this PBT assessment, the persistent criteria is not considered applicable to this inorganic substance.

B/vB criteria fulfilled?	For the purposes of this PBT assessment, the bioaccumulation criteria is not considered applicable to this inorganic substance.
T criteria fulfilled?	No. The chronic toxicity data is >1 mg/L.
Overall conclusion	Not PBT
Revised	April 2018

References

1. HSDB (n.d.). *Hazardous Substances Data Bank*. Retrieved 2015, from Toxnet, Toxicology Data Network, National Library of Medicine: http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB
2. ECHA REACH, Acetic Acid, Retrieved 2015: http://apps.echa.europa.eu
3. Human and Environmental Risk Assessment (HERA) on Ingredients of Household Cleaning Products: Boric Acid, 10043-35-3, 2005. http://www.heraproject.com
4. EFSA, Opinion of the Scientific Panel on Dietetic Products, Nutrition and Allergies on a request from the Commission related to the Tolerable Upper Intake Level of Boron (Sodium Borate and Boric Acid), 2004
5. Draft European Union Risk Assessment Report. Disodium tetraborate, Anhydrous Boric Acid, Boric Acid, Crude natural (1) Risk Assessment. 2007
6. IPCS Sodium Tetraborate, Retrieved 2016: http://www.inchem.org
7. EFSA, European Food Safety Authority, Scientific Opinioni on the re-evaluation of boric acid (E284) and sodium tetraborate (borax) (E285) as food additives. 2013
8. NICNAS, National Industrial Chemicals Notification and Assessment Scheme, Human Health Tier II Assesssment for Ulexite, CAS Number: 1319-33-1, 2015
9. National Industrial Chemicals Notification and Assessment Scheme (NICNAS, 2017). National assessment of chemicals associated with coal seam gas extraction in Australia. Human health hazards of chemicals associated with coal seam gas extraction in Australia.
10. Department of the Environment and Energy 2017 , National assessment of chemicals associated with coal seam gas extraction in Australia, prepared by the National Industrial Chemicals Notification and Assessment Scheme

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Toxicity Summary - Ethanol

Chemical and Physical Properties[1,2,3]	
CAS number	64-17-5
Molecular formula	C2H6O
Molecular weight	46.07
Solubility in water	1 x 10_3 g/L at 25 °C
Melting point	114.14 °C
Boiling point	78.3 °C
Vapour pressure	57.3 hPa at 20°C
Henrys law constant	0.000252
Explosive potential	Non explosive
Flammability potential	Highly flammable (100%)
Colour/Form	Clear, colourless liquid with a characteristic pleasant odour and burning taste.
Overview	Ethanol, also known as grain alcohol, is a clear, colourless liquid. It has an alcohol odour a burning taste. Ethanol mixes easily with water. Ethanol is present in emissions from plants, fires, volcanoes, animal wastes, insects and natural fermentation of sugars. Ethanol is an important commercial chemical used in alcoholic beverages, which may contain up to 50% ethanol. It is also used as a solvent in cleaners and as a fuel additive. Ethanol is used in the production of other chemicals, pharmaceuticals, perfumes, and cosmetics. It is also used as a fungicide and to regulate plant growth. It is an ingredient in many consumer products, such as cleaners, sprays, inks, mouthwash, perfume and aftershave, and human and veterinary medicines. Ethanol is a food additive.
Environmental Fate[3]	
Soil/Water/Air	Ethanol is stable to hydrolysis but is readily biodegradable (74% after 5 days) and is not likely to bioaccumulate (calculated logBCF=0.5). Ethanol is not persistent in the environment. Fugacity-based modelling shows that ethanol released into the environment will become distributed mainly into air and water. Relative distributions between compartments based on an emission pattern of 1000:100:10 were 57 % in air, 34 % in water, and 9 % in soil. These predictions are supported by the limited data available on prevailing concentrations, which shows that ethanol has been detected in outdoor air and in river water. The total tropospheric half-life of ethanol is estimated to be 10-36 hours, with degradation due to hydroxyl, NOx and SOx radical-mediated photooxidation. As a volatile organic compound in the atmosphere, ethanol is a potential contributor to tropospheric ozone formation under certain conditions, however its photochemical ozone creation potential is considered to be moderate to low (40-45 relative to ethylene as 100).
Human Health Toxicity Summary [1]	

Chronic Repeated Dose Toxicity	Many repeated dose studies of chemical have been conducted in many species, predominantly with the aim of assessing adverse effects associated with the consumption of alcoholic beverages. Consequently, these are mostly conducted through oral exposure and with doses well in excess of those that might be encountered in occupational exposure or consumer products (OECD, 2005), or unintentional public exposures from environmental contamination. Considering the lowest observed adverse effect level (LOAEL) available from a 90-day rat study (3600 mg/kg bw/day), and based on the treatment-related effects reported in various repeated dose toxicity studies, the chemical is not considered to cause serious damage to health from repeated oral exposure, except from exposure to high doses. In a well-conducted repeated dose toxicity study, the chemical was administered (in a liquid diet) to Sprague Dawley (SD) rats at a 1, 2, 3, 4, 5, and 10 % concentration for 90 days. Water consumption in the 10 % group was reduced relative to controls. There were no adverse clinical signs or mortality during the study. Serum liver enzymes were unaffected by treatment and kidney findings were reported to be minimal. A LOAEL was established at 3 % (approximately 3600 mg/kg bw/day), based on dose-related hepatic yellowing, centrilobular steatosis, increased frequency and severity of Mallory bodies (hyaline), and acidophilic degeneration and necrosis. The no observed adverse effect level (NOAEL) was 2 % (approximately 2400 mg/kg bw/day) (OECD, 2005; REACH). In another repeated dose toxicity study conducted in accordance with national test guidelines of USA (EPA OPPTS 870.3100), the chemical was administered in drinking water to Fischer 344 (F344) rats and B6C3F1 mice at a single dose of 5 % concentration for 90 days. Even though male rats showed minor changes in thymus weights, and some slight but inconsistent changes in haematology and clinical chemistry, these effects were not considered adverse. Based on water consumption data, this single dose study established a 5 % nominal NOAEL for male rats (approximately 3250 mg/kg bw/day). Although minor changes in clinical chemistry were also seen in female rats, some female rats (4/10) also exhibited liver nodules (diaphragmatic nodules) and small increases in liver weights. As no NOAEL could be established for female rats, a LOAEL of 4400 mg/kg bw/day was established. For male mice, a LOAEL at 9700 mg/kg bw/day was established, based on increased organ weights (liver, heart, kidney and lung) and decreased sperm counts in the cauda epididymis. Although female mice showed small changes in the length of dioestrus and pro-oestrus, the overall cycle length was unchanged. As biological significance of these changes was unclear, a NOAEL for female mice was established at 5 % (9400 mg/kg bw/day) (OECD, 2005; REACH). As properly conducted studies in animals are not available, there are no valid data on the effects of repeated inhalation exposure to the chemical. However, limited information is presented below to indicate that the chemical is likely to be of low toxicity following repeated inhalation exposure. In a repeated dose toxicity study, SD male rats (10/dose) were exposed to the chemical through inhalation (whole body exposure) continuously at 20 mg/L for three, six, nine, and 26 days. Although initial exposure to the chemical produced a number of transient effects (lethargy, ataxia and intoxication, mild hepatic vacuolisation and changes to clinical chemistry parameters), animals adapted and appeared normal at the end of the study. Induction of metabolic tolerance to the chemical was also indicated as it was noted that the levels of the chemical in the blood of animals exposed for 26 days were much lower than those exposed for shorter periods (REACH). In another repeated dose toxicity study, the chemical was administered through inhalation at 0 or 6300 ppm (1 ppm = 1.92 mg/m^3) to SD rats (10/sex/dose) for six hours/day, five days/week, for four weeks (total of 20 days exposure). Additional groups of animals (five/sex/dose) were also included in the study to determine reversibility of effects for a further four weeks following cessation of treatment. There were no treatment-related clinical signs of toxicity and there were also no gross pathological or histological changes reported of the major organs. Body weights, liver enzyme levels, haematology, and clinical chemistry parameters were otherwise normal (REACH).

Carcinogenicity	The International Agency for Research on Cancer (IARC) has concluded that there is sufficient evidence in humans and experimental animals to establish carcinogenicity of alcohol consumption and ethanol, respectively. It was also concluded that there is sufficient evidence in experimental animals to establish carcinogenicity of acetaldehyde (major metabolite of ethanol). Consequently, IARC has classified that 'alcohol consumption is carcinogenic to humans (Group 1)' and that 'ethanol in alcoholic beverages is carcinogenic to humans (Group 1)'. This conclusion was supported by an analysis of the expanded human dataset that carcinogenic effects appeared independent of the type of alcoholic beverage (IARC, 2010; IARC, 2012). As the use of the chemical in alcoholic beverages is not considered in this report, the above assessment of carcinogenicity of alcohol beverages may not be relevant to occupational exposure to the chemical or from using the chemical in consumer products (OECD, 2005). Furthermore, studies in animals conducted mostly through oral exposure at very high doses, exceeding the 'maximum tolerated dose', may be of little relevance when assessing risks associated with occupational exposure or using consumer products containing the chemical (OECD, 2005). Thus, classification is not considered appropriate.
Mutagenicity/ Genotoxicity	Overall, the data indicate that the chemical has no mutagenic or genotoxic potential (OECD, 2005; REACH). The results from numerous bacterial mutation assays of the chemical have generally been negative. A very weak positive effect of the chemical was found in an Escherichia coli DNA repair test but not in Ames tests with Salmonella typhimurium conducted by the same authors. In separate studies, there have been positive results reported in Ames tests, but only at concentrations of the chemical significantly greater than those specified in test guidelines. The chemical is therefore not considered mutagenic in bacteria.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	The chemical does not show specific reproductive or developmental toxicity. Any reproductive and developmental effects were only observed secondary to maternal toxicity. As results of inhalation studies showed no developmental toxicity from chemical exposures even at maternally toxic doses, it can be concluded that deliberate oral consumption of alcoholic beverages is required for any reproductive or developmental toxicity (OECD, 2005).
Acute Toxicity	The chemical has low acute toxicity by oral exposure in animal tests. The median lethal dose (LD50) in rats is >2000 mg/kg bw. Observed sub-lethal effects included central nervous system depression, e.g. inebriation, disturbances of gait, dose-related decreases in responses to painful stimuli, respiratory depression, and coma. Deaths were reported due to cardiorespiratory failure (OECD, 2005; HSDB; REACH). Few studies are available on the dermal toxicity of the chemical. A poorly documented rabbit study reported death in one of four animals following a dose of 20000 mg/kg bw. Although limited data are available, the apparent low dermal toxicity from this study is regarded as consistent with low uptake of ethanol through intact skin. The median lethal dose (LD50) in rats is greater than 2000 mg/kg bw. Observed sub-lethal effects were not reported for the study (OECD, 2005; REACH). The chemical has low acute toxicity by inhalation exposure in animal tests. The lowest reported median lethal concentration (LC50) is 124.7 mg/L/four hours in rats. Observed sub-lethal effects included attempts to escape, reddish-watery eyes, nasal secretions, closing of eyelids, snout wiping, intermittent respiration, loss of pain reflex, abdominal position, and apathy (OECD, 2005; REACH).

Irritation	The chemical is not regarded as irritating to skin. In a skin irritation study conducted in accordance with OECD Test Guideline (TG) 404, the chemical was applied to six New Zealand White rabbits for four hours using exposure chambers. The mean score for erythema was one at 24 hours and remained zero at all other time points (48, 72 hours); the mean score for oedema remained zero at all time points (24, 48, 72 hours). The chemical was concluded not to be irritating to the skin of rabbits. Another skin irritation study in rabbits, where the chemical was applied under occlusion for 24 hours, also showed only very slight skin irritation (OECD, 2005; REACH). The chemical produced irritant effects in several eye irritation studies in rabbits. In an eye irritation study conducted in accordance with US Federal guideline (Fed. Reg. Vol. 38, No. 187, 1973), the chemical (0.1 mL) was applied on the conjuctival sac of one eye of each of three New Zealand White rabbits. Irritation responses were observed at 24, 48 and 72 hours and eight days following application. Mean Draize scores following grading at 24, 48 and 72 hours for three rabbits were 1 for corneal opacity, 0.22 for iritis, 2.45 for conjunctivitis, and 1.89 for chemosis. Mean Draize scores following grading at day eight were 0.67 for corneal opacity, 1.67 for conjunctivitis, and 1.33 for chemosis. While iris lesions were fully reversible by day eight, other eye lesions were not fully reversible at this time. Given the observation period did not extend to 21 days, it is difficult to conclude any findings on the reversibility of the irritation. The average response of 2/3 animals was sufficiently severe in terms of conjunctival effects (>2.5) and chemosis (³2) observed, that classification as an eye irritant is warranted (REACH). In another eye irritation study (OECD TG 405), the chemical (0.1 mL) was applied to the eyes of three rabbits (strain not specified) and observed up to 14 days. Mean Draize scores at 24, 48 and 72 hours were 2.11 for conjunctivitis, 1.33 for chemosis, 0.44 for iritis, and 1.11 for corneal opacity. Although all symptoms subsided by day 14, conjunctivitis was still present at day seven. As positive responses for corneal opacity (mean score >1 for 2/3 animals) and conjunctival redness (mean score >2 for 2/3 animals) were noted in the study, the chemical is considered to be an eye irritant (category 2A) (OECD, 2005; REACH). In an eye irritation study (OECD TG 405), the chemical (0.1 mL) was applied into the lower conjunctival sac of one eye of six New Zealand White rabbits and observed up to 72 hours. Reported average Draize scores at 24, 48 and 72 hours were 2.39 for redness of the conjunctivae, 1.2 for chemosis, 0.28 for iritis, and 1.2 for corneal opacity. As conjuctival redness persisted for 24 hours with a mean score of >2 and corneal opacity was noted with a mean score >1, the chemical is considered to be an eye irritant (category 2A) (OECD, 2005; REACH). In an eye irritation study conducted in accordance with US Federal guideline (Fed. Reg. 28 (119), 5582, 1963), the chemical (0.1 mL) was applied on the lower lid of one eye of six New Zealand White rabbits. The eyes were examined at 24, 48, and 72 hours and at day seven following administration of the chemical. Mean Draize scores following grading at 24, 48 and 72 hours were 1.72 for conjunctivitis, 1.78 for chemosis, 0.83 for iritis, and 1.28 for corneal opacity. While iris lesions were fully reversible at day seven, other eye lesions were not. Mean Draize scores following grading at day seven were 0.83 for conjunctivitis, 0.83 for chemosis, and 1.17 for corneal opacity. As corneal opacity was noted with a mean score >1, the chemical is considered an eye irritant (category 2A). In addition, whilst mean scores for conjunctival redness and chemosis were <2, scores ³2 were noted in four out of six animals (OECD, 2005; REACH).

Sensitisation	The available data indicate that the chemical does not induce skin sensitisation in animals. The chemical, at 75 % concentration, was used as a solvent in a Magnusson and Kligman guinea pig maximisation test of a polyalkalene glycol. Skin reactions were not observed at challenge with the polyalkalene glycol in 75 % ethanol in either the test or negative control animals (OECD, 2005). In a mouse ear swelling test, no increase in ear thickness was observed following a challenge application of the chemical at 95 % (OECD, 2005; REACH). In a mouse local lymph node assay (LLNA) (OECD TG429) the chemical, or diethyl phthalate, were used as vehicles to examine the skin sensitisation potential of four test fragrance materials. The concentration of the chemical in this study varied from 0–100 %. The level of induced T-lymphocyte proliferation was low for the chemical compared with that for fragrance materials known to be mild to moderate skin sensitisers, and comparable with the other negative control vehicle (diethyl phthalate). On the basis of a lack of sensitising potential up to a concentration of 100 %, the test concluded that the chemical is an appropriate vehicle for use in a local lymph node assay (REACH).
Health Effects Summary	While exposure to the chemical through consuming alcoholic beverages is associated with an increased risk of carcinogenicity and reproductive and developmental toxicity, these risks increase in a dose-dependent manner and are not considered relevant at doses relating to occupational exposure and using consumer products containing the substance such as mouthwash. Therefore the critical health effect for risk characterisation from industrial use of the chemical is a local effect: eye irritation.
Key Study/Critical Effect for Screening Criteria	Overall, the most sensitive endpoint for ethanol is repeat dose toxicity. The oral NOAEL was 2,400 mg/kg bw/day. This NOAEL is used in this human health risk assessment.
Ecological Toxicity [2,3]	
Aquatic Toxicity	The aquatic toxicity data in fish, invertebrates, and algae indicate a low order of acute toxicity with LC50/EC50 values greater than 1000 mg/L. The most sensitive species were algae Chlorella vulgaris with a 96hr EC50 of 1000 mg/L and the invertebrate Artemia Salina with a 24hr LC50 of 1833 mg/L. Valid chronic toxicity data are available for two trophic levels. NICNAS (2017) reported a measured chronic endpoint of 7800 mg/L for Daphnia.
Determination of PNEC aquatic	A PNECaqua = 780 mg/L can be calculated based on the chronic toxicity value (NOEC = 7800 mg/L) for aquatic invertebrates (Daphnia) with the assessment factor of 10.
Current Regulatory Controls [1,4]	
Australian Hazard Classification	The chemical is not classified for health hazards on the Hazardous Substances Information System (HSIS) (Safe Work Australia).
Australian Occupational Exposure Standards	The chemical has an exposure standard of 1880 mg/m³ (1000 ppm) time weighted average (TWA).
International Occupational Exposure Standards	The following exposure standards are identified (Galleria Chemica): An exposure limit (TWA) of 960–1920 mg/m³ (500-1000 ppm) in countries such as Canada, Denmark, Germany, Sweden, South Africa, Switzerland, United Kingdom, and the United States of America. An exposure limit (STEL) of 1900–1920 mg/m³ (1000 ppm) in countries such as Canada, Sweden, and Switzerland.

Australian Food Standards	Ethanol has the following listings in the Australia New Zealand Food Standards Code (Food Standards Australia and New Zealand 2013): · as a permitted food additive subject to GMP (ethanol) (Standard 1.3.1 Food additives) · as a generally permitted processing aid (ethyl alcohol) (Standard 1.3.3 Processing aids) · as a permitted component of wine (alcohol) (Standard 2.7.3 Fruit wine and vegetable wine) · as subject to a composition limit in brewed soft drinks (no more than 1.15% alcohol/volume) (Standard 2.6.2 Non-alcoholic beverages and brewed soft drinks) · As subject to a composition limit in: − wine and sparkling wine (no less than 45mL ethanol/L and not to contain added ethanol) − fortified wine (no less than 150 mL ethanol/L and no more than 220 mL ethanol/L) − brandy (must contain no less than 250 mL/L of the spirit distilled at a strength of no more than 830 mL ethanol/L at 20°C (Standard 4.5.1 Wine production requirements).
Australian Drinking Water Guidelines	No aesthetic or health-related guidance values were identified for this chemical in the Australian Drinking Water Guidelines (NHMRC 2011).
Aquatic Toxicity Guidelines	1400 µg/L (95% protection level) (ANZECC & ARMCANZ, 2000)
PBT Assessment [2]	
P/vP Criteria fulfilled?	No. Ethanol is readily biodegradable (74% after 5 days).
B/vB criteria fulfilled?	No. Ethanol is not likely to bioaccumulate (calculated logBCF=0.5).
T criteria fulfilled?	No. Chronic aquatic toxicity (NOEC) >1mg/l, thus ethanol does not meet the screening criteria for toxicity.
Overall conclusion	Not PBT
Revised	January 2019

References

1. National Industrial Chemicals Notification and Assessment Scheme (NICNAS). IMAP, Human Health Tier II Assessment for Ethanol: Retrieved 2019: https://www.nicnas.gov.au
2. National Industrial Chemicals Notification and Assessment Scheme (NICNAS, 2017). National assessment of chemicals associated with coal seam gas extraction in Australia. Human health hazards of chemicals associated with coal seam gas extraction in Australia.
3. ECHA REACH, Ethanol, Retrieved 2019: https://echa.europa.eu/
4. OECD (2005) SIDS Initial Assessment Profile for Ethanol
5. ANZECC & ARMCANZ (2000), Australian and New Zealand Guidelines for Fresh and Marine Water Quality

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Toxicity Summary - Ethylene glycol

Chemical and Physical Properties [1,2]	
CAS number	107-21-1
Molecular formula	C2H6O2
Molecular weight	62.07 g/mol
Solubility in water	Miscible with water.
pH	No data found
Melting point	-12.69 ºC
Boiling point	197.3 ºC
Vapour pressure	0.092 mm/Hg at 25C
Henrys law constant	Low. 6.00X10-8 atm-cu m/mol at 25 deg C
Explosive potential	Not explosive
Flammability potential	Lower flammable limit of 3.2% by volume; Flashpoint of 232 deg F (111 deg C). Not combustible.
Colour/Form	Colourless odourless liquid
Overview	Ethylene glycol is a clear, colourless, syrupy liquid with a sweet taste but no odour. It has low volatility. It is miscible with water and some other solvents, slightly soluble in ether, but practically insoluble in benzene, chlorinated hydrocarbons, petroleum ethers, and oils. As a small molecular weight alcohol, ethylene glycol readily passes through biological membranes and will be effectively absorbed from the gastrointestinal tract and via inhalation exposure. It is rapidly distributed in body water. The chemical has numerous domestic and commercial uses, and is found in cleaning products, cosmetics, hydraulic brake fluids, anti-freeze agents and corrosion inhibitors. Ethylene glycol has been assessed by NICNAS to be of low environmental concern when used in coal seam gas extraction.
Environmental Fate [1,3,5]	
Soil/Water/Air	Ethylene glycol released to the atmosphere will be degraded by reaction with hydroxyl radicals; the half-life for the compound in this reaction has been estimated at between 0.3 and 3.5 days. No hydrolysis of ethylene glycol is expected in surface waters. The compound has little or no capacity to bind to particulates and will be mobile in soil. The low octanol/water partition coefficient and measured bioconcentration factors indicate low capacity for bioaccumulation Ethylene glycol is readily biodegradable in standard tests using sewage sludge. Rapid degradation has been reported in surface waters (less in salt water than in fresh water), groundwater, and soil.

Human Health Toxicity Summary [1,2,3,4,6,7]	
Chronic Repeated Dose Toxicity	Considering the lowest observed adverse effect levels (LOAELs) available from 13–104 week studies (300–3000 mg/kgbw/d) (ATSDR, 2010), and based on the treatment-related effects reported in various repeated dose toxicity studies, the chemical is not considered to cause serious damage to health from repeated oral exposure. However, there is evidence of cumulative effects, as the nephropathy observed at high doses in acute toxicity studies also occurs after repeated exposure at lower doses. The National Toxicology Program (NTP) conducted a 13 week and a two year study in B6C3F1 mice. In the 13 week study, 10 male and 10 female mice were administered 0, 3200, 6300, 12500, 25000 or 50000 ppm ethylene glycol incorporated into feed. There were no reported deaths and no chemical-related clinical findings were reported. Histopathology showed chemical-related kidney and liver lesions, which were significantly elevated in the 25000 and 50000 ppm male mice. These lesions included nephropathy and centrilobular hepatocellular hyaline degeneration (NTP, 1993). The two year study used 60 male mice dosed with the chemical at 0, 6250, 12500 or 25000 ppm and 60 females dosed at 0, 12500, 25000 or 50000 ppm in feed. The doses in ppm were reported as being equivalent to: males - 0, 1500, 3000 or 6000 mg/kg bw/d and females - 0, 3000, 6000 or 12000 mg/kg bw/d. There were no significant differences in survival although male mice in the high dose (6000 mg/kg bw/d) group had to be housed separately after week 54 due to excessive fighting. Survival of mice was not affected by ethylene glycol administration at all doses. As with the 13 week study, mice did not show any adverse clinical signs. Histopathology showed hepatocellular degeneration in the mid and high dose male and high dose female mice. Pulmonary arterial hyperplasia occurred at a higher incidence in female mice than male mice exposed to the chemical. Some male mice in the high dose group had oxalate-like crystals and/or calculi in the renal system (NTP, 1993). Mice appear to be less sensitive than rats to ethylene glycol. A two-year study conducted in Fischer-344 (F344) rats found that administration of the chemical (40, 200 or 1000 mg/kg bw/d) resulted in excessive mortality in male rats in the high dose group after nine months. All male rats in the high dose group (1000 mg/kg bw/d) were reported dead by 15 months of the study. Survival was significantly reduced in male rats in the 1000 mg/kg bw/d group only. (Cruzan et al., 2004; DePass et al., 1986). Pathology investigation of the male rats concluded that extensive kidney damage was the reason for increased mortality in the 1000 mg/kg bw/d group. The NOAEL for male rats was reported as 200 mg/kg bw/d in this study (DePass et al., 1986). A further study indicates that the Wistar rat strain is more sensitive than the F344 strain. In a 16-week study, 10 male rats of each strain were exposed to the chemical (0, 50, 150, 500 or 1000 mg/kg bw/d) by incorporation in a normal diet. Mortality was reported in two Wistar rats at the highest dose and significant weight loss was observed in Wistar rats administered 500 and 1000 mg/kg bw/d, respectively. Both strains of rats treated with ≥ 500 mg/kg bw/d had increased calcium oxalate crystals in the kidney tubules as well as crystal associated nephropathy; this was reported as being more severe in the Wistar rat strain (Cruzan et al., 2004). Further repeated dose studies conducted in rodents have reported no observed adverse effect levels (NOAELs) in the range of 150–2000 mg/kg bw/d depending on species and strain studied. Overall, repeated oral exposure to ethylene glycol is consistently associated with adverse effects on the kidney such as crystal nephropathy in rodents (ATSDR, 2010).

	In a study conducted according to OECD TG 410, five male Beagle dogs per group were dermally exposed (60 % of the total body surface area) to 0.5, 2.0 or 8 mL/kg bw/d Glysantin G 105 (automotive coolant which contains ≥ 92.5 % ethylene glycol and ≥1.4 % p-tert.-butyl benzoate (PTBBA)) daily for four weeks. Mortality (4/5 animals) was reported at the highest dose (8 mL/kg). Prior to death, animals showed signs of toxicity including staggering gait, vomiting, diarrhoea and reduced food intake. Clinical analysis showed increased creatinine and urea levels and increased incidence of calcium oxalate crystals. Pathology investigation reported oxalate nephrosis, testicular atrophy and uraemic gastroenteritis. Similar pathology findings were reported at the mid dose (2 mL/kg), but only in one animal. No mortality or any further clinical or pathological adverse effects were reported at the mid and lower doses. Further studies conducted comparing pure ethylene glycol to Glysantin G105 showed that the testicular atrophy was associated with the presence of PTBBA in Glysantin G105 and not ethylene glycol (REACH). PTBBA has known testicular toxicity (NICNAS). Mortality was reported in 1/15 rats, 3/15 guinea pigs, 1/3 rabbits, 0/3 dogs and 0/3 monkeys after exposure to 12 mg/m3 of ethylene glycol aerosol for 90 days. Apart from mortality, no specific signs of clinical toxicity were reported. In a further study, no mortality or toxicity was observed in the same range of animal species exposed to either 10 or 57 mg/m3 ethylene glycol. The authors noted that as the exposure was whole body, further oral intake from grooming may have occurred, and therefore a reliable LOAEL could not be established (ATSDR, 2010).
Carcinogenicity	Based on the available data, ethylene glycol is not considered to be a carcinogen. Histopathological investigations showed no evidence of carcinogenicity in studies conducted in various rodent species. No tumours were reported in SD rats administered up to 3000 mg/kg bw/day in the diet for two years, F344 rats administered 1000 mg/kg bw/day in the diet for one year, B6C3F1 mice administered up to 12000 mg/kg bw/day in the diet for two years and CD-1 mice administered up to 1000 mg/kg bw/day in the diet for two years (NTP, 2004; WHO, 2002). A limited number of epidemiological studies have reported that exposure to the chemical does not increase the risk of cancer. Ethylene glycol exposure (inhalation) in 1666 chemical plant employees was not found to increase the odds ratio (OR) for any type of cancer (ATSDR, 2010).
Mutagenicity/ Genotoxicity	Based on the weight of evidence from the available in vitro and in vivo genotoxicity studies the chemical is not considered to be genotoxic. An Ames assay conducted according to OECD TG 471 reported that the chemical did not induce bacterial mutations in Salmonella typhimurium strains TA 1535, TA 1537, TA 98, TA 100 and Escherichia coli WP2 at a concentration up to 5000 □g/plate with or without metabolic activation (REACH). Further in vitro genotoxicity tests conducted with bacterial and mammalian cell lines were all negative for gene mutations and DNA strand breaks respectively (ATSDR, 2010). An in vivo study in mice reported no chromosomal aberrations in Swiss mice exposed to 638 mg/kg bw/day for two days (WHO, 2002). Negative results were found for dominant lethal mutations in F344 rats after administration of up to 1000 mg/kg bw/d ethylene glycol in a 155-day multi-generational study.

Reproductive Toxicity Developmental Toxicity/Teratogenicity	The available data from rat studies suggest that developmental effects were only observed secondary to maternal toxicity, so the chemical does not show specific developmental toxicity. The chemical is not toxic to reproduction. Having reviewed the available data the Centre for the Evaluation of Risks to Human Reproduction (CERHR) expert panel concluded that there are sufficient data to conclude that the chemical is not toxic to reproduction in rats orally exposed to 1000 mg/kg bw/day in diet (NTP, 2004). A study in mice gave negative results at doses up to 2826 mg/kg bw/day via drinking water. The expert panel also concluded that exposure of CD-1 mice to the chemical by the dermal route for 6 hours/d on gestation days (GD) 6-15 resulted in no evidence of developmental toxicity up to a dose of 3549 mg/kg bw/d. Developmental toxicity was also not observed in rabbits exposed orally via gavage on GD 6-19 to doses as high as 2000 mg/kg bw/d. Severe maternal toxicity was observed at the high dose with maternal deaths as well as oxalate crystals in the kidney. Data suggested that oral exposure to high doses of the chemical (≥500 mg/kg bw/d in CD-1 mice and ≥1000 mg/kg bw/d in SD rats) on GD 6-15 causes developmental effects in mice and rats such as axial skeletal malformations, external malformations, reduced body weights and increased post-implantation loss (NTP, 2004). The CERHR expert panel concluded that developmental toxicity may not be attributed directly to the chemical but from the accumulation of glycolic acid, which is a metabolic breakdown product of ethylene glycol. The developmental effects are seen at doses that exceed saturation of glycolic acid metabolism. Observations from rat studies suggest that oral doses resulting in developmental toxicity (1000 mg/kg bw/d) are greater than those associated with maternal and renal toxicity at 500 mg/kg bw/d.
Acute Toxicity	Ethylene glycol has low acute toxicity via oral, inhalation, or dermal exposure. LD50s for the oral administration of ethylene glycol in rats range from 4000 to 10 020 mg/kg body weight, while reported values in guinea-pigs and mice are 6610 mg/kg body weight and 5500–8350 mg/kg body weight, respectively. The minimum lethal oral dose in rats is 3.8 g/kg body weight (Clark et al., 1979). Oral LD50s of 5500 and 1650 mg ethylene glycol/kg body weight have also been reported in dogs and cats, respectively. A dermal LD50 of 10 600 mg/kg body weight has been reported for rabbits. In rats and mice, the lethal concentration following 2-h inhalation exposure has been reported to be >200 mg/m3.
Irritation	The available data show that the chemical is a mild skin irritant in animals. Mild dermal irritation was reported in rabbits and guinea pigs. No dermal effects were reported in female CD-1 mice exposed to 3549 mg/kg bw/day ethylene glycol under occlusive conditions for 6 hours/day on gestation days 6-15 (NTP, 2004; WHO, 2002). The available data indicate that the chemical is a mild eye irritant in animals. In a study conducted in six New Zealand White rabbits, 0.05 mL of the chemical (4 or 40 %) applied to one eye (while the other eye served as a control) at 10 minute intervals for a total of 35 applications in a six hour period was reported to cause chemosis, swelling and conjunctival redness. All eyes exposed to the chemical were reported to be normal on day seven of observation and no evidence of systemic toxicity was reported (REACH).
Sensitisation	The chemical was not found to induce dermal sensitisation when tested according to OECD Test Guideline (TG) 406 (REACH).
Health Effects Summary	Ethylene glycol demonstrates acute oral toxicity, is a mild skin and eye irritant and a respiratory irritant in humans. The chemical is not a skin sensitiser. Consistent adverse effects associated with repeated exposure to ethylene glycol in animals are the kidney effects, characterised by calcium oxalate crystal deposition and consequent renal lesions.

Key Study/Critical Effect for Screening Criteria	The key study chosen for the determination of a drinking water guidance value is the one-year rat feeding study by Wilson et al. (2005). No adverse chronic renal effects from ethylene glycol dosing were seen in animals exposed below 150 mg/kg/day. The oral RfD for ethylene glycol is thus based on the NOAEL of 150 mg/kg/day. Uncertainty factors: 10 (interspecies variability); 10 (intraspecies variability) Oral RfD = 150/100 = 1.5 mg/kg/dayDrinking water guideline value = 0.59 ppm
Ecological Toxicity [3,8]	
Aquatic Toxicity	The aquatic toxicity of the 'ethylene glycol and higher glycols' (mono-, di-, tri-, tetra- and pentaethylene glycol) is evaluated as a category. Fish acute toxicity (measured as LC50 in mg/L) has been tested for all category members and ranges from 22800 for EG to greater than 50000 for pentaEG. Toxicity to Daphnia (measured as LC50 in mg/L) is greater than 20,000 for all category members except tetraEG (LC50=7800 mg/L) indicating low toxicity, but the toxicity was not as uniform as in fish. Toxicity evaluations in another invertebrate, brine shrimp (Artemia salina) were imprecise, but appear to be more consistent than the measured Daphnia toxicity values (no toxicity observed at the highest tested dose, 20g/l for EG, 10 g/l for DEG, TEG and tetraEG). Algal toxicity has been tested for EG, DEG, TEG, and PentaEG, and no toxicity was found at concentrations less than or equal to 100 mg/L. As a worst case assumption the limit test concentration of 100 mg/L was used as NOEC value for the PNEC derivation.
Determination of PNEC aquatic	PNECaquatic: An assessment factor of 10 has been applied to the lowest reported effect concentration of 100 mg/L. The PNECaquatic is determined to be 10 mg/L.
Current Regulatory Controls [7]	
Australian Hazard Classification	Xn (Harmful); R22 (Harmful if swallowed) (Safe Work Australia 2013) Acute Toxicity: Harmful if swallowed – Cat 4 (H302) (NICNAS)
Australian Occupational Exposure Standards	Ethylene glycol has an exposure standard of 10 mg/m^3 time weighted average (TWA). A further exposure standard for ethylene glycol (vapour) is 52 mg/m^3 (20 ppm) TWA and a short-term exposure limit (STEL) of 104 mg/m^3 (40 ppm) (Safe Work Australia 2013)
International Occupational Exposure Standards	TWA: 50 mg/m3 (20 ppm) [Belgium, Hungary, UK, Finland] 26 mg/m³ (10 ppm) [Denmark, Iceland, Sweden] 25 to 50 mg/m³ (63 to 125 ppm) [Mexico, Norway] 5 mg/m³ [Russia] STEL: 20 to 40 mg/m3 (50 to 104 ppm) [Belgium, Hungary, UK, Finland, Peru, Sweden] 10 mg/m³ [Russia]
Australian Food Standards	No data found.
Australian Drinking Water Guidelines	No data found
Aquatic Toxicity Guidelines	No data found
PBT Assessment [1,3,5]	
P/vP Criteria fulfilled?	Ethylene glycol is readily biodegradable both aerobically and anaerobically and as such not persistent in the environment.
B/vB criteria fulfilled?	Based on the measured log Kow of -1.36 and a measured BCF of 10, Ethylene glycol is not bioaccumulative.
T criteria fulfilled?	The acute aquatic toxicity of Ethylene glycol is > 0.01 mg/L. Hence the substance does not fulfill the screening criteria for toxic (T)
Overall conclusion	Not a PBT substance (based on screening data).
Revised	April 2018

References

1. HSDB (n.d.). *Hazardous Substances Data Bank*. Retrieved 2016, from Toxnet, Toxicology Data Network, National Library of Medicine: http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB
2. National Industrial Chemicals Notification and Assessment Scheme (NICNAS), 2014. Inventory Multi-Tiered Assessment and Prioritisation (IMAP), Human Health Tier II Assessment for 1,2 – Ethanediol, CAS Number 107-21-1.
3. OECD (2004). Screening Information Dataset (SIDS) Initial Assessment Profile for Ethylene Glycols Category (CAS No.107-21-1, 111-46-6, 112-27-6, 112-60-7, 4792-15-8)
4. US Environmental Protection Agency, Integrated Risk Information System (IRIS), Chemical Assessment Summary, Ethylene Glycol, CASRN 107-21-1
5. World Health Organisation (2000), Concise International Chemical Assessment Document (CICAD) 22, Ethylene Glycol: Environmental Aspects
6. World Health Organisation (2002), Concise International Chemical Assessment Document (CICAD) 45, Ethylene Glycol: Human Health Aspects
7. Department of the Environment and Energy 2017 , National assessment of chemicals associated with coal seam gas extraction in Australia, prepared by the National Industrial Chemicals Notification and Assessment Scheme
8. ECHA REACH, Ethane-1,2-diol, Retrieved 2019: https://echa.europa.eu/

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Toxicity Summary - Fatty acids, tall-oil, ethoxylated

Chemical and Physical Properties[1]	
CAS number	61791-00-2
Molecular formula	C(18-50)H(34-98)O(3-8)
Molecular weight	UVCB
Solubility in water	No data available.
Melting point	-85 °C at 101.3 kPa
Boiling point	No data available.
Vapour pressure	No data available.
Henrys law constant	No data available.
Explosive potential	Non-explosive (100%)
Flammability potential	Not classified
Colour/Form	Liquid
Overview	This substance is used by consumers, in articles, by professional workers (widespread uses), in formulation or re-packing, at industrial sites and in manufacturing.
Environmental Fate[1]	
Soil/Water/Air	One study investigating the adsorption/desorption behaviour of Fatty acids, tall-oil, ethoxylated (CAS 61791-00-2) is available. The study was performed according to GLP and OECD guideline 121 (BASF 2017). 6 different peaks were observed with log Koc values ranging from < 1.8 to > 5.63. The two main components (> 85%) show log Koc values > 4. Thus, adsorption of Fatty acids, tall-oil, ethoxylated to solid soil is expected. The test with the source substance was conducted according to OECD Guideline 301B, under GLP conditions (BASF 2005). Domestic, non-adapted activated sludge was exposed to the test substance for 28 days at 22°C, and biodegradation was measured by CO2 consumption. After 28 days, the test substance reached a biodegradation of 90 - 100 %. Based on the results for the read-across substance, Fatty acids, tall oil, ethoxylated (EO > 1 < 2.5) (CAS 61791-00-2) is considered to be readily biodegradable. The test substance consists of components with log Kow values in the range of 5 to > 10 (KOWWIN v1.68) indicating a potential for bioaccumulation. But due to rapid environmental biodegradation, metabolisation via enzymatic hydrolysis (monoesters and diesters) as well as sterical hindrance of crossing biological mebranes (high molecular weight of diesters) a relevant uptake and bioaccumulation in aquatic organisms is not expected. This is supported by low BCF values of < 100 L/kg ww (BCFBAF v3.01, Arnot-Gobas, including biotransformation, upper trophic) calculated for different components of the UVCB (mono- and diester EO1 to EO5). Thus, taking all information into account, the test substance is not considered to be bioaccumulative.
Human Health Toxicity Summary [1]	
Chronic Repeated Dose Toxicity	Under the conditions of this Combined Repeated Dose Toxicity Study with the Reproduction/Developmental Toxicity Screening Test, the oral administration by gavage of test substance to Wistar rats revealed no adverse signs of toxicity in male and female animals at a dose level of 1000 mg/kg bw/d. Thus, the no observed adverse effect level (NOAEL) for general systemic toxicity was 1000 mg/kg bw/d for male and female Wistar rats.
Carcinogenicity	No data available.

Mutagenicity/ Genotoxicity	The test substance is not mutagenic in bacteria, as determined in an OECD 471 study. The test substance is not chromosome damaging, as determined in an OECD 487 study. The test substance is not mutagenic in mammalian cells, as determined in an OECD 476 study.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	Under the conditions of this Combined Repeated Dose Toxicity Study with the Reproduction/Developmental Toxicity Screening Test, the oral administration by gavage of the test substance to Wistar rats revealed no adverse signs of toxicity in male and female animals at a dose level of 1000 mg/kg bw/d. Thus, the no observed adverse effect level (NOAEL) for general systemic toxicity was 1000 mg/kg bw/d for male and female Wistar rats. The NOAEL for reproductive performance and fertility was set to 1000 mg/kg bw/d for male and female Wistar rats.
Acute Toxicity	In an acute oral toxicity study performed similar to OECD guideline 401 (BASF 1971), three groups of rats consisting of 10 animals/sex/dose were treated by single gavage application with an aqueous solution of the test substance (10000, 8000, 6400 mg/kg bw). The animals were observed for mortality and for clinical symptoms of toxicity over a period of 7 days. At the end of the observation period, the surviving animals were sacrificed for the purpose of necropsy. No mortality occurred at the tested concentrations. At all doses mastication, irregular breathing, redness of the eyes and closed eyes were seen immediately after dosing. The next morning mastication and irregular breathing was observed. On the following days, no clinical sings were observed. Pathological examination revealed hydrometra in 3 animals exposed to 10000 mg/kg bw, 2 animals exposed to 8000 mg/kg bw, and 3 animals exposed to 6400 mg/kg bw. Based on the results obtained under the test conditions of this study, the acute oral LD50 was determined to be > 10000 mg/kg bw. To evaluate the potential acute inhalation toxicity of the test substance an Inhalation Risk Test conducted according to a BASF internal testing method (BASF 1971). The test demonstrates the toxicity of an atmosphere saturated with vapours of the volatile components of a test substance at the temperature chosen for vapour generation (20 °C). Rats were exposed sequentially to the vapours, generated by bubbling 200 l/h air through a substance column of about 5 cm above a fritted glass disc in a glass cylinder. The animals were exposed for 8 hour. The exposure concentration was estimated to be 0.28 mg/L based on evaporated substance. In addition to mortality, clinical signs were recorded and necropsy on surviving animals performed. No mortality occurred and no clinical sign were noted during exposure and observation period. In one animal exposed for 8 hours hydrometra was observed after necropsy. Since no mortality occurred at the concentrations tested an LC50 estimation cannot be made. In another Inhalation Risk Test of similar design, Rats (12 animals) were exposed sequentially to the vapours, generated by bubbling 200 l/h air through a substance column of about 5 cm above a fritted glass disc in a glass cylinder. This time vapours were generated at 20 °C as well as 50 °C. The exposure concentrations were 0.04 mg/L and 0.34 mg/L. Rats were exposed for 8 hour. As in the previous study, no mortality occurred after exposure up to 8 hours. Clinical sings observed in the animals exposed to the vapour generated at 20°C included mild escape attempts when exposure began and at the end of the exposure period slight eye irritation was observed. The next day, the animals were without symptoms. In the animals exposed to the vapour generated at 50 °C escape attempts were noted in the first 60 minutes of exposure. Exposure to the saturated atmosphere caused slight eye irritation. At the end of the exposure period, all clinical signs were resolved. Since no mortality occurred at the concentrations tested an LC50 estimation cannot be made. Based on the inhalation studies, no conclusion on LC50 can be drawn, because the tested concentrations are too low in relation to the classification criteria.

Irritation	The test substance was not irritant or corrosive to the skin in a GLP-compliant OECD 431 and 439 study. The test substance was not irritant to the eyes in a GLP-compliant OECD 492 study. Based on the available information, classification for skin and eye irritation is not warranted, in accordance with EU Classification, Labelling and Packaging of Substances and Mixtures (CLP) Regulation No. (EC) 1272/2008.
Sensitisation	The test substance did not show an indication of skin sensitising potential in an OECD 429 (LLNA) study. However, an earlier Buehler test (OECD 406) did indicate skin sensitising potential of the substance.
Health Effects Summary	Possible sensitiser.
Key Study/Critical Effect for Screening Criteria	
Ecological Toxicity [1]	
Aquatic Toxicity	Short-term toxicity tests with the target substance for all trophic levels (fish, daphnia, algae) are available. The test substance did not indicate to be harmful to freshwater fish (96h-LL50 > 100 mg/L), but showed to be toxic to aquatic invertebrates (48h-EL50 = 12.41 mg/L) and harmful to algae (72h-EL50 = 39.7 mg/L). Hence, aquatic invertebrates were most susceptible to the test substance and this effect value was used for the PNEC derivation. Long-term toxicity data with the source substance are only available for algae. The algal test revealed the substance to be of low toxicity to algae (72h-EL10 = 7.08 mg/L). In addition, data are available for toxicity to microorganisms. A test on respiration inhibition with activated sludge resulted in an 3h-EC10 of > 10000 mg/L indicating that detrimental effects in STPs are not to be expected.
Determination of PNEC aquatic	A PNECaqua = 0.012 mg/L can be calculated based on the lowest acute toxicity value (EL50 = 12.41 mg/L) for aquatic invertebrates (Daphnia) with the assessment factor of 1000.
Current Regulatory Controls	
Australian Hazard Classification	No data available.
Australian Occupational Exposure Standards	No data available.
International Occupational Exposure Standards	No data available.
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	No data available.
PBT Assessment[1]	
P/vP Criteria fulfilled?	No. Based on the results from the read-across substance, Fatty acids, tall oil, ethoxylated (EO > 1 < 2.5) (CAS 61791-00-2) is considered to be readily biodegradable.
B/vB criteria fulfilled?	No. The test substance consists of components with log Kow values in the range of xx to > 10 (KOWWIN v1.68) indicating a potential for bioaccumulation. But due to rapid environmental biodegradation, metabolisation via enzymatic hydrolysis (monoesters and diesters) as well as sterical hindrance of crossing biological membranes (high molecular weight of diesters) a relevant uptake and bioaccumulation in aquatic organisms is not expected. This is supported by low BCF values of < 100 L/kg ww (BCFBAF v3.01, Arnot-Gobas, including biotransformation, upper trophic) calculated for different components of the UVCB (mono- and diester

	EO1 to EO5). Thus, taking all information into account, the test substance is not considered to be B or vB.
T criteria fulfilled?	No. Available short-term and long-term toxicity tests with aquatic organisms resulted in effect values > 1 mg/L. Thus, this substance does not meet the screening criteria for toxicity.
Overall conclusion	Not PBT
Revised	January 2019

References

1. ECHA REACH, Fatty acids, tall-oil, ethoxylated, Retrieved 2019: https://echa.europa.eu/

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Toxicity Summary - Glutaraldehyde

Chemical and Physical Properties [1,2,3]	
CAS number	111-30-8
Molecular formula	C5H8O2
Molecular weight	100.11
Solubility in water	Soluble in all proportions in water and ethanol; soluble in benzene and ether.
Melting point	-14°C
Boiling point	188°C
Vapour pressure	2.03 x 10^{-3} kPa at 25 °C (50% solution)
Henrys law constant	0.011 Pa m³/mol @ 25 °C
Explosive potential	Non explosive
Flammability potential	Non flammable
Colour/Form	Colourless oily liquid. In the vapour state, glutaraldehyde has a pungent odour, with an odour threshold of 0.04 ppm.
Overview	Glutaraldehyde is manufactured in Germany by BASF and in the USA by Union Carbide Corporation. It is usually sold commercially as a 45% or 50% aqueous solution. Glutaraldehyde has a wide variety of uses throughout the world with its use spread over a number of different industries. It is used primarily as a biocide but it also has wide use as a fixative, and some use as a therapeutic agent. The principal health effects of glutaraldehyde are irritation of the skin, eye and respiratory tract, skin sensitisation and occupational asthma. Exposure data indicated that, in some situations, particularly the health care industry (disinfection), x-ray film processing and the animal health industry (spray use), health concerns may arise where available control measures such as ventilation have not been implemented to minimise exposure. Due to low and intermittent exposure, the public health risk from the industrial use of glutaraldehyde is minimal. For the use of glutaraldehyde in cosmetics, a safety margin of >400 for extensive use indicated low concern.
Environmental Fate[1]	
Soil/Water/Air	Glutaraldehyde is a hydrophilic substance that will be mainly associated with the aquatic compartment, with minor amounts partitioning to the atmosphere, following release to the environment. Hydrolysis is slow, but glutaraldehyde, like other aldehydes, undergoes aerial oxidation in solution. It biodegrades rapidly in aerobic and anaerobic aquatic environments at subcidal concentrations (below 10 mg/L) and will not bioaccumulate. Tropospheric degradation is also rapid.
Human Health Toxicity Summary [1,2,3]	

Chronic Repeated Dose Toxicity	A two-year chronic study was conducted in male and female Fischer 344 rats (NICNAS 1994). Groups of 100 male and 100 female rats were administered 0, 50, 250, or 1000 ppm w/v glutaraldehyde in drinking water (4, 17 and 64 mg/kg bw/day for the males and 6, 25 and 86 mg/kg/day for the females). The mortality rate over the treatment period was 25 to 30% for males and 19 to 23% for females with no dose-related increase. The major cause of death in all rats (control and dose groups) was large granular cell lymphatic leukaemia (LGLL). Small dose-related decreases in absolute body weight and body weight gain occurred at 250 and 1000 ppm in males and at 1000 ppm in females. Dose-related decrease in urine volumes and associated increase in osmolality were observed in higher dose animals. At necropsy at 52, 78 and 104 weeks, the only statistically significant changes in organ weights were for the kidney. Relative kidney weights were increased for males and females at 52 and 78 weeks. A significant dose-related increase in kidney weight relative to final body weight occurred for males and females in the 250 and 1000 ppm groups, including an increase in absolute kidney weight for the female rats. Changes in final body weights and the weights of other organs were minor and / or sporadic and were unlikely to be related to glutaraldehyde exposure. The total leucocyte count was significantly increased at week 104 in males at 250 and 1000 ppm, and in females at 250 ppm only. The variation in counts was large, possibly due to the large monocyte count at 250 and 1000 ppm. Changes in clinical chemistry parameters included decreases in the activities of some enzymes at 250 and 1000 ppm and occasional decreases in total protein, globulin and phosphorous; these were probably due to reduced food consumption and body weight. Gross pathology showed evidence of gastric inflammation, particularly in rats sacrificed at the end of the study, with irritation observed as ulceration, a multifocal colour change and thickening of the mucosa (dose groups not specified). Histologic examination of the tissues revealed squamous epithelial hyperplasia and keratinised cysts and oedema. Based on the observations, a NOAEL of 4 mg/kg bw/day for males and 6 mg/kg bw/day for females was established in this study. For the purpose of human health risk assessment, the lowest NOAEL (4 mg/kg bw/day) established in the two-year chronic study in rats will be used.
Carcinogenicity	In a two-year chronic/carcinogenicity study by Van Miller et al. (2002), groups of 100 male and 100 female Fischer 344 rats were treated with 0, 50, 250, or 1000 ppm w/v glutaraldehyde in drinking water. The mean glutaraldehyde consumption for each of the three groups was 4, 17 and 64 mg/kg bw/day for the males and 6, 25 and 86 mg/kg bw/day for the females. The mortality rate during the study period was 25 to 30% for males and 19 to 23% for females and was not dose-related. Gross pathology showed evidence of gastric inflammation. The main finding of the study was an increased incidence of large granular lymphocytic leukaemia (LGLL) in the spleen and liver of male and female rats in all groups, including the control group. Treated females showed a significantly increased incidence of LGLL and analysis for dose-response trend for the severity of LLGL revealed an increased severity in females at the higher dosages (53% in spleen and 54% in liver versus respectively 20% and 23% in untreated females) while no such observation were made for the males. No other significant oncogenic effects were observed during the study. Occurrence of LGLL was seen in all groups including controls; the incidence of LGLL in the 1000 ppm group was high compared to controls but no clear dose-response relationship was evident, and LGLL mainly affected treated females whereas the incidence in treated males was within the control range (REACH 2013). Historical control data for untreated Fischer 344 rats in NTP studies also indicates that the ranges for this tumour are 10 to 72% in males and 6 to 31% in females (REACH 2013). The control data in the Van Miller et al. study fitted in with the historical control data reported from NTP studies. The variability in control data for LGLL and the wide variation reported in the literature makes a definitive conclusion difficult. Base on this study, glutaraldehyde was considered not to be carcinogenic.

Mutagenicity/ Genotoxicity	Glutaraldehyde has been extensively tested for genetic activity in vitro and in vivo, however there is disagreement in the literature regarding glutaraldehyde's genetic activity (Zeiger et al. 2005). While all in vivo genotoxicity tests with glutaraldehyde gave negative results, mixed results were reported for in vitro mutagenicity tests. Early in vitro tests were negative (Watts 1984), but some recent bacterial assays and tests in mammalian cells indicated that glutaraldehyde could be mutagenic in vitro. A series of reverse mutation assays was carried out with various Salmonella typhimurium strains, with and without metabolic activation (REACH 2013). All assays with TA 100, 1535, 1537 and 98 were negative. Some assays with TA 102 and 104 gave positive results. Tests with Escherichia coli also yielded both positive as well as negative results. Glutaraldehyde induced sister chromatid exchanges in CHO cells with and without S9 metabolic activation in one laboratory, but was negative without S9 and only weakly positive with S9 in the second laboratory (NICNAS 1994). The difference in the results was attributed to slight differences between the data evaluation systems used in the two laboratories. Glutaraldehyde was not mutagenic in any of the in vivo assays such as peripheral blood micronucleus test, rat bone marrow chromosomal aberration assay and the Drosophila melanogaster sex-linked recessive lethal test (NICNAS 1994; REACH 2013). Chromosome aberrations in bone marrow cells were reported in only one out of eight studies using rats and mice, micronuclei were not induced in bone marrow cells of mice, and dominant lethal mutations were not induced in mice. Glutaraldehyde did not induce cell transformation in Syrian hamster embryo cells in vitro (Zeiger et al. 2005). In vivo, inhalation of glutaraldehyde induced cell proliferation in nasal tissue in rats and mice, but did not induce DNA damage at these sites. Based on these observations, it is concluded that glutaraldehyde is not a genotoxin.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	Studies on the incidence of miscarriage in pregnant women have shown no difference between those exposed to glutaraldehyde and those not exposed to the chemical. Studies in female rats and mice have resulted in embryotoxicity/foetotoxicity for glutaraldehyde, but only at doses which are maternally toxic. A number of studies have found no evidence of teratogenicity.

Acute Toxicity	Several acute oral toxicity studies with glutaraldehyde have been reported in rats and other species. In one reliable study, administration of 0.2, 0.3, 0.5, 1.0, 1.7 mL/kg bw glutaraldehyde (corresponding to 226, 339, 565, 1130 and 1921 mg/kg bw, respectively) to male/female Wistar rats by gavage gave a median lethal dose (LD50) of 226 mg/kg bw (REACH 2013). Necropsy of animals that died during the observation period revealed congestion of the lungs and the abdominal viscera. In another study in Sprague-Dawley rats, the oral LD50 was 316 mg/kg bw for males and 285 mg/kg bw for females, when 10 mL of 2.15, 3.16, 4.64, 14.7% glutaraldehyde (corresponding to 215, 316, 464 and 1470 mg/kg bw) was administered by oral gavage (REACH 2013). In a separate study using different strengths of glutaraldehyde, Ballantyne (1986) showed that the oral LD50 for glutaraldehyde in rats varied with the concentration of the glutaraldehyde used. By using different concentrations of glutaraldehyde solutions (1% to 50%) and varying the administration volume to maintain a constant dose, oral LD50 in the range 66 to 733 mg/kg bw were obtained. These studies indicate that glutaraldehyde has high acute oral toxicity. Of the 18 acute dermal toxicity studies reported in REACH (2013) dossiers, results from 14 studies indicated LD50 higher than 2000 mg/kg bw. In four other studies, LD50 ranged between 250 and 1432 mg/kg bw. These studies however did not follow international guidelines and have low reliability. Based on these studies, glutaraldehyde is considered to have low acute dermal toxicity. In a well-defined study, 10 male and 10 female Sprague-Dawley rats per dose group were exposed to glutaraldehyde as liquid aerosol at 0.22, 0.31 and 0.63 mg/L for 4 hours (REACH 2013). Exposure was followed by an observation period of 14 days. During the exposure period slight nasal discharge, snout wiping, flank respiration and irregular to intermittent respiration were reported in rats. During the post-exposure period, bloody nasal discharge, red crusts surrounding the nose, whooping or gasping respiration with rasping sounds and a tremulous gait were observed. These symptoms disappeared in the surviving animals within 5 to 9 days post-exposure. Mortalities were noted in all treated groups. The determination of the LC50 values was based on the Probit Analysis. An LC50 of 0.48 mg/L was calculated for both male and female rats. In another acute inhalation study conducted in a similar manner to the above study, Sprague-Dawley rats, 10 rats per sex per dose group, were exposed to 0.1, 0.18, 0.28, 0.39 and 0.44 mg/L glutaraldehyde as liquid aerosol for 4 hours (REACH 2013). During and after exposure, mortality and clinical signs of toxicity were recorded at regular time intervals. The LC50 in this study was established as 0.28 mg/L for females and 0.39 mg/L for males. Based on the above studies, glutaraldehyde is considered to have high acute inhalation toxicity.
Irritation	Glutaraldehyde is corrosive to the skin and eyes of rabbits at high concentrations, with signs of skin irritation evident at 2%, and eye irritation at 0.2%. Exposure to glutaraldehyde vapours in acute inhalational studies resulted in nasal irritation and respiratory difficulties. Joint irritation was seen in rabbits after intra-articular administration.
Sensitisation	The skin sensitisation effect of glutaraldehyde was demonstrated in tests with guinea pigs.
Health Effects Summary	Glutaraldehyde has high acute oral and inhalation toxicity and low to moderate acute dermal toxicity. Based on human and animal data, it is corrosive, the vapours are irritating to the respiratory tract, and it has skin and respiratory sensitisation potential. Glutaraldehyde has high repeat dose oral and inhalation toxicity, with an oral No-Observed-Adverse-Effect Level (NOAEL) of 4 mg/kg bw/day based on changes in liver and kidney weights and clinical chemistry parameters. Glutaraldehyde is not genotoxic or carcinogenic. It did not have any adverse effects on the reproductive system of adult rats or on the development of foetuses. The critical adverse health effects of glutaraldehyde are corrosivity, skin and respiratory tract sensitisation and acute and repeat dose oral and inhalation toxicity.
Key Study/Critical Effect for Screening Criteria	From the hazard characterisation, the critical (most sensitive) adverse health effects for repeated exposures to the chemical are changes in clinical chemistry parameters and relative organ (liver and kidney) weights. Glutaraldehyde has high repeat dose oral toxicity with an oral NOAEL of 4 mg/kg bw/day. This NOAEL is used in this human health risk assessment.
Ecological Toxicity [1,2,3,4]	

Aquatic Toxicity	96 h acute Bluegill sunfish LC50 = 11.2 mg/L 48 h acute Oyster larvae LC550 = 2.1 mg/L 96 h acute Green crabs LC50 = 465 mg/L 96 h acute Grass shrimp LC50 = 41 mg/L 48 acute Daphnia magna LC50 = 0.35 mg/L 48 acute Daphnia magna LC50 = 16.3 mg/L 21 d reproduct'n Daphnia magna LOEC = 4.3 mg/L, NOEC = 2.1 mg/L 96 h algal growth inhibition Selenastrum capricornutum ILm = 3.9 mg/L (median inhibitory limit) 96 h algal growth inhibition Scenedesmus subspicatus EC50 = 1.0 mg/L Bacterial inhibition Sewage microbes IC50 = 25-34 mg/L In summary, the test results indicate that glutaraldehyde is slightly to moderately toxic to aquatic fauna and moderately to highly toxic to algae. In some instances, glutaraldehyde appeared to be rapidly lost from test waters in the laboratory. Such behaviour in aquatic toxicity tests generally means that their results will underestimate the inherent toxicity of a substance. However, the toxicity that will prevail under environmental conditions is likely to be lower than that recorded in the laboratory in view of the rapid degradation that would be expected to occur in natural surface waters.
Determination of PNEC aquatic	As a wide selection of species is available, applying a safety factor of 10 to the NOEC (2.1 mg/L) derived from Daphnia seems most appropriate, giving a PNEC of 2100/10 = 0.21 mg/L for faunal species
Current Regulatory Controls [1,2,4]	
Australian Hazard Classification	Glutaraldehyde is classified as hazardous in the Hazardous Substances Information System (HSIS) with the following risk phrase (Safe Work Australia 2013): · T (Toxic); R23/25 (Toxic by inhalation and if swallowed) · C (Corrosive ; R34 (causes burns) · R42/43 (May cause sensitisation by inhalation and skin contact). Mixtures containing the chemical are classified as hazardous with the following risk phrases based on the concentration (Conc) of the chemical in the mixtures. The risk phrases for this chemical are: · Conc ≥50%: T; R23/25; R34; R42/43 (Toxic; toxic by inhalation and if swallowed; causes burns; may cause sensitisation by inhalation and skin contact) · ≥25% Conc <50%: T; R23; R22; R34; R42/43 (Toxic; toxic by inhalation, harmful if swallowed, causes burns; may cause sensitisation by inhalation and skin contact) · ≥10% Conc <25%: C; R20/22; R34; 42/43 (Corrosive; harmful by inhalation and if swallowed; causes burns; may cause sensitisation by inhalation and skin contact) · ≥2% Conc <10%: Xn; R20/22; R37/38; R41; R42/43 (Harmful; harmful by inhalation and if swallowed; irritating to respiratory system and skin; risk of serious eye damage; may cause sensitisation by inhalation and skin contact) · ≥1% Conc <2%: Xn; R36/37/38 R42/43 (Harmful; Irritating to eyes, respiratory system and skin; may cause sensitisation by inhalation and skin contact) · ≥0.5% Conc <1%: Xi; R36/37/38; R43 (Irritating; irritating to eyes, respiratory system and skin; may cause sensitisation by skin contact)
Australian Occupational Exposure Standards	The chemical has an exposure standard of 0.41 mg/m³, 0.1 ppm; Time Weighted Average (TWA).
International Occupational Exposure Standards	The following exposure standards are identified in Galleria Chemica (2013): · Occupational Exposure limit (TWA) of 0.2 mg/m3 [Canada, China, Denmark, Japan, Korea, UK] · 0.4 mg/m3 TWA [Sweden] · 0.8 mg/m3 TWA [US (NIOSH), Greece]
Australian Food Standards	No Australian food standards relating to the chemical have been identified (Food Standards Australia New Zealand 2013).
Australian Drinking Water Guidelines	No aesthetic or health-related guidance values were identified for this chemical in the Australian Drinking Water Guidelines. (National Health and Medical Research Council (NHMRC) 2011).

Aquatic Toxicity Guidelines	No data available.
PBT Assessment	
P/vP Criteria fulfilled?	No. Readily biodegradable and as such not persistent in the environment.
B/vB criteria fulfilled?	No. As the Log Pow is -0.01 (Log Pow < 4.5), it is not expected to be bioaccumulative.
T criteria fulfilled?	No. Chronic toxicity data >1 mg/L in invertebrates, thus glutaraldehyde does not meet the screening criteria for toxicity.
Overall conclusion	Not PBT
Revised	January 2019

References

1. NICNAS (1994) Priority Existing Chemical 3, Glutaraldehyde: Retrieved 2019: https://www.nicnas.gov.au
2. National Industrial Chemicals Notification and Assessment Scheme (NICNAS, 2017). National assessment of chemicals associated with coal seam gas extraction in Australia. Human health hazards of chemicals associated with coal seam gas extraction in Australia.
3. OECD (1995) SIDS Initial Assessment Profile on Glutaraldehyde
4. ECHA REACH, Glutaral, Retrieved 2019: https://echa.europa.eu/
5. Hazardous Chemical Information System (HCIS), Safe Work Australia. Retrieved 2019: http://hcis.safeworkaustralia.gov.au/
6. National Occupational Health and Safety Commission, Approved Criteria for Classifying Hazardous Substances [NOHSC:0006(1993)], AGPS, Canberra, 1993.

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Toxicity Summary - Guar gum

Chemical and Physical Properties[1,2,7]	
CAS number	9000-30-0
Molecular formula	NA.
Product name	
Molecular weight	220,000 g/mol
Solubility in water	Completely soluble in water
pH	No data were found.
Melting point	No data were found.
Boiling point	No data were found.
Vapour pressure	solid
Henrys law constant	NA
Explosive potential	NA
Flammability potential	NA
Colour/Form	NA
Overview	Guar gum is a yellowish-white free-flowing powder. It is completely soluble in water and practically insoluble in oils, greases, hydrocarbons, ketones and esters. Water solutions are tasteless, odourless and a pale, translucent grey colour and neutral. The powder has 5 to 8 times the thickening power of starch. Water solution may be converted to a gel by adding a small amount of borox and are stable to heat. Guar gum is extensively used, eg typically used as a protective colloid, stabilizer, thickening and film forming agent for cheese, salad dressing, milk products including ice cream and soups; disintegration agent in tablet formulations; in pharmaceutical jelly formulations; in suspension, emulsions, lotions, creams and toothpastes; in bulk laxatives and appetite depressants; in mining industry as a flocculent, for hydraulic fracturing aid in oil well recovery and as a filtering ages; gelling and waterproofing agent in explosive and in water treatment as a coagulant. Guar gum is approved for use as a food additive by the U.S. Food and Drug Administration and is on the list of substances "generally recognized as safe" (CFR 1974). This chemical has been identified by NICNAS to be of low concern to human health based on an initial screening approach and thus required no further assessment.
Environmental Fate[1]	
Soil/Water/Air	No information was found. Guar gum, being a polysaccharide composed of galactomannan, would be expected to be readily biodegradable

Human Health Toxicity Summary [1,2,3,5,6,7,8,9]	
Chronic Repeated Dose Toxicity	F344 rats and B6C3F1 mice were given diets containing 0, 6,300, 12,500, 25,000, 50,000 or 100,000 ppm guar gum for 13 weeks (NTP, 1982). Mean body weights were decreased in male rats (100,000 ppm group) and in female mice (50,000 and 100,000 ppm). A dose-related decrease in feed consumption was observed for male and female rats; male and female mice were comparable or higher than that of controls. There were no compound-related clinical signs or histopathological effects. F344 rats and B6C3F1 mice were given diets containing 0, 25,000 ppm or 50,000 ppm guar gum for 103 weeks (NTP, 1982). Mean body weights of the high-dose females were lower than those of the controls after week 20 for mice and week 40 for rats. No compound-related clinical signs or adverse effects on survival were observed. Feed consumption by dosed rats and mice of either sex was lower than that of controls. There were no non-neoplastic histopathological effects in either rats or mice that were treatment-related.
Carcinogenicity	F344 rats and B6C3F1 mice were given diets containing 0, 25,000 ppm or 50,000 ppm guar gum for 103 weeks (NTP, 1982). There were increased incidences of adenomas of the pituitary in male rats and pheochromocytomas of the adrenal in female rats that were statistically significant, but these differences were considered to be unrelated to guar gum administration. When pituitary adenomas or carcinomas and when pheochromocytomas or malignant pheochromocytomas are combined, the statistical differences disappear. Hepatocellular carcinomas occurred in treated male mice at incidences that were significantly lower than that in controls. The combined incidence of male mice with either hepatocellular adenomas or carcinomas was also significantly lower in the highdose group. It was concluded that under conditions of this bioassay, guar gum was not carcinogenic for F344 rats or B6C3F1 mice.
Mutagenicity/ Genotoxicity	Guar gum induced no consistent responses in dominant lethal gene tests to suggest that it was mutagenic to the rat. Guar gum was not mutagenic to Salmonella typhimurium TA 1530 or G-46 when tested without metabolic activation; however, it was mutagenic to Saccharomyces cerevisiae D- 3 (Green, 1977). Guar gum also was reported to cause chromosomal aberrations in human embryonic lung cells WI-38 (Green, 1977). No in vivo genotoxicity studies have been conducted on guar gum.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	The developmental effects of guar gum were evaluated in groups of 20 rabbits by daily dermal administration of the test substance for 6 hours/day at dose levels of 0, 2, 10 and 50 mg/kg/day on days 6 through 18 of gestation. The number of early resorptions was significantly increased and the number of viable foetuses was correspondingly decreased at 50 mg/kg/day ($p<0.05$). The NOEL was 2 mg/kg/day. The frequency of foetal malformations and variations in the treated groups was comparable to that of the control group at all dose levels. Female rabbits were given daily (6 hours/day) dermal administration of 0, 2, 10 and 50 mg/kg guar gum during gestational days 6 through 18 (IRDC, 1988). Mortalities included 2 deaths at 50 mg/kg and 1 death at 10 mg/kg. A single animal was killed in extremis. A dose-related increase in dermal irritation (including erythema, edema, and desquamation) was observed in animals receiving 10 and 50 mg/kg. The number of early resorptions was significantly increased and the number of viable fetuses was correspondingly decreased at 50 mg/kg/day ($p<0.05$). The frequency of fetal malformations and variations in the treated groups was comparable to that of the control group at all dose levels. The NOEL for this study is 2 mg/kg/day.
Acute Toxicity	Guar gum has been blamed for causing esophageal obstruction. A death has the use of one guar gum tablet product, which apparently swelled in the esophagus, resulting in complications that caused the fatality. Mildly toxic by ingestion. The oral LD50 is 8,100 mg/kg for mice and 9,400 mg/kg for rats.
Irritation	No data were found.
Sensitisation	Occupational asthma has been reported in subjects of guar gum. A respiratory sensitizer There are reports of respiratory sensitization in workers exposed occupationally to guar gum dusts (Maio, 1986).

Key Study/Critical Effect for Screening Criteria	The key studies for the determination of a drinking water guidance value is the NTP two year chronic bioassays. The LOAELs are based on decreased mean body weights in female mice and rats fed 50,000 ppm guar gum in diet for 103 weeks. The NOAELs for these studies are 25,000 ppm guar gum. Rat: NOAEL (mg/kg/day) = 25,000 ppm * 0.05 = 1,250 mg/kg/day Mouse: NOAEL (mg/kg/day) = 25,000 ppm * 0.13 = 3,250 mg/kg/day Where 0.05 and 0.13 are the fraction of body weight that rats and mice, respectively, consume per day as food (U.S. EPA). The lowest NOAEL of 1,250 mg/kg/day for the rat will be used to derive a drinking water guidance value. Uncertainty factors: 10 (interspecies variability); 10 (intraspecies variability) Oral RfD = 1,250/100 = 12.5 mg/kg/day Drinking water guideline = 49 ppm
Ecological Toxicity [1,7]	
Aquatic Toxicity	The lowest measured ecotoxicity endpoint for fish was reported to be 218 mg/L.
Determination of PNEC aquatic	PNECaquatic: On the basis that the data consists of only one short-term result from one trophic level, an assessment factor of 1,000 has been applied to the reported effect concentration of 218 mg/L for Fish. The PNECaquatic is 0.218 mg/L.
Current Regulatory Controls	
Australian Hazard Classification	No data available.
Australian Occupational Exposure Standards	No data available.
International Occupational Exposure Standards	No data available.
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	No data available.
Australian Hazard Classification	No data available.
PBT Assessment	
P/vP Criteria fulfilled?	No biodegradation information was found on guar gum. However, guar gum is a naturally occurring polysaccharide which would be expected to readily biodegrade. Thus, it is not expected to meet the screening criteria for persistence
B/vB criteria fulfilled?	The molecular weight of guar gum ranges from 200,000 to 300,000 daltons, and it is also water soluble. Thus, guar gum is not expected to meet the criteria for bioaccumulation
T criteria fulfilled?	The acute aquatic toxicity of guar gum is >0.1 mg/L. Thus, guar gum is not expected to meet the screening criteria for toxicity
Overall conclusion	Not a PBT substance.

References

1. Hazardous Substances and New Organisms (HSNO) 2013, Chemical Classification and Information Database (CCID). Guar Gum. New Zealand Environmental Protection Authority, New Zealand Government.
2. Glicksman M. (1969). Gum technology in the Food Industry, pp. 590, Academic Press, New York; cited in Yoon, S.-J., Chu, D.-C., and Juneja, L.R. (2008) Chemical and physical properties, safety and application of partially hydrolyzed guar gum as dietary fiber. J. Clin. Biochem. Nutr. 42: 1-7.
3. Green, S. (1977). Present and future uses of mutagenicity tests for assessment of the safety of food additives. J. Environ. Pathol. Toxicol. 1: 49-54.

4. International Research and Development Corp (1988). Teratology Study of Guar Gum in Rabbits. TSCATS database, EPA Doc. No. 88-920004924, Fiche No. OTS0542101; cited in NZ HSNO CCID. http://www.epa.govt.nz/search-databases/Pages/cciddetails. aspx?SubstanceID=1930

5. Maio, J.L., Cartier, A., L'Archevêque, J., Ghezzo, H., Soucy, F., Somers, J., and Dolovich, J. (1990). Prevalence of occupational asthma and immunologic sensitization to guar gum among employees at a carpet-manufacturing plant. J. Allergy Clin. Immunol. 86: 562-569.

6. NTP (1982). NTP Technical Report on the Carcinogenesis Bioassay of Guar Gum (CAS No. 9000-30-0) in F344 Rats and B6C3F1 Mice (Feed Study), National Toxicology Program, Research Triangle Park, NC

7. Department of the Environment and Energy 2017 , National assessment of chemicals associated with coal seam gas extraction in Australia, prepared by the National Industrial Chemicals Notification and Assessment Scheme

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Toxicity Summary - Hydrochloric acid

Chemical and Physical Properties [1,2]	
CAS number	7647-01-0
Molecular formula	HCl
Molecular weight	36.46 g/mol
Solubility in water	Soluble
Melting point	-114.22 °C
Boiling point	-85.05°C
Vapour pressure	35,424 mm Hg at 25 deg C
Henrys law constant	2.04 x106 mol/L atm
Explosive potential	Reacts with most metals producing explosive hydrogen gas
Flammability potential	Not combustible
Colour/Form	liquid
Overview	CAS Registry number. Since the gas becomes the acid in aqueous systems and volatilization of the gas can occur from aqueous systems, it is often difficult to determine which is being considered in a specific item in the literature. If released to water, hydrogen chloride dissociates readily in water to chloride and hydronium ions, decreasing the pH of the water. The solution in water is a strong acid, it reacts violently with bases and is corrosive. Reacts violently with oxidants forming toxic gas (chlorine). Attacks many metals in the presence of water forming flammable/explosive gas (hydrogen). Hydrochloric acid is one of the most widely used industrial chemicals. Uses include pickling and cleaning metals, food process, and cleaning of industrial equipment.
Environmental Fate [3,4]	
Soil/Water/Air	Hydrochloric acid is readily dissociated in water into hydrated protons and chloride ions. The increase in the concentration of hydrochloric acid in water decreases the pH in the aquatic ecosystem. Generally, the buffer capacity to maintain the pH in the aquatic ecosystem is important and the equilibrium between CO2, HCO3 - and CO3 2- in the aquatic ecosystem is mainly responsible for the buffer capacity of receiving water.

Human Health Toxicity Summary [1,2,3,8]	
Chronic Repeated Dose Toxicity	Frequent contact with aqueous solutions of hydrochloric acid may lead to dermatitis. For repeated dose toxicity, local irritation effects were observed in the groups of 10 ppm and above in a 90-day inhalation study. Rats were fed diets containing 280 to 1,250 mmol/kg hydrochloric acid (10.2 to 45.6 mg/kg) for 7-12 weeks. There was increased water intake in all treated groups. All animals fed diet containing 937 mmol/kg and above for 9 weeks, and half of the animals fed diet containing 900 mmol/kg for 12 weeks died. Also at doses >937 mmol/kg, there was decreased body weight, food consumption, blood pH, femur length, rate of ash in bone (Upton and L'Estrange, 1977). In another study with rats, hydrochloric acid was administered via drinking water at pH 2-3 (study duration not provided). Decreased protein levels in urine and decreased urine volumes were observed in the treatment groups (Clausing and Gottschalk, 1989).
Carcinogenicity	HCl is not classifiable as a human carcinogen. No evidence of treatment related carcinogenicity was observed either in other animal studies performed by inhalation, oral or dermal administration. In three industry-based human case studies conducted in the U.S, no association between hydrogen chloride exposure and cancers of the lung, brain, or kidney was observed. In one U.S study of steel-pickling workers an excess risk for cancer of the lung was identified in workers exposed primarily to hydrochloric acid. Under IARC definitions, HCl is not classifiable as to its carcinogenicity to humans (Group 3).
Mutagenicity/ Genotoxicity	In single studies, HCl induced mutation and chromosomal aberrations in mammalian cells and induced chromosomal aberrations in insects and in plants. It did not induce mutation in bacteria. For genetic toxicity, a negative result has been shown in the Ames test. A positive result, which is considered to be an artefact due to the low pH, has been obtained in a chromosome aberration test using Hamster ovary cells. The effects of low pH in in vitro studies are not a problem in vivo as the proton level is regulated systemically. Hydrochloric acid is not considered to be genotoxic.
Reproductive Toxicity Developmental Toxicity/Teratogenicity	No reliable studies have been reported regarding toxicity to reproduction and development in animals after oral, dermal or inhalation exposure to hydrogen chloride/hydrochloric acid. As protons and chloride ions are normal constituents in the body fluid of animal species, low concentrations of hydrogen chloride gas/mist or solution do not seem to cause adverse effects to animals. The cells of gastric glands secrete hydrochloric acid into the cavity of the stomach. No reliable conclusion could be drawn on the potential reproductive toxicity of hydrogen chloride/hydrochloric acid.

Acute Toxicity	Rapid evaporation of the liquid may cause frostbite. The substance is corrosive to the eyes, the skin and the respiratory tract and can cause serious skin burns and blurred/reduced vision or blindness. Inhalation of high concentrations of the gas may cause pneumonitis and lung oedema, resulting in reactive airways dysfunction syndrome. The effects may be delayed. Exposure to hydrochloric acid can produce burns on the skin and mucous membranes, with severity related to the concentration of the solution. Subsequent ulceration may occur, followed by keloid and retractile scarring. Dental decay, including yellowing, softening and breaking of teeth, and related digestive diseases have been recorded after exposures to hydrochloric acid. Mortality has been observed following ingestion of hydrochloric acid. Female rats orally administered 3.3% hydrochloric acid yielded an acute oral median lethal dose (LD50) in a range from 238 to 277 mg/kg bw (Hoechst 1966). No details of the study were available. In another study in rats, administration of a solution of undisclosed concentration induced stomach ulceration, inflammation of the intestine, discolouration of the liver and hyperaemia of the lung (Monsanto 1976). An LD50 of 700 mg/kg bw was reported. An acute dermal LD50 was established as >5010 mg/kg bw in rabbits however the dose levels administered were not reported (Monsanto 1976). Acute median lethal concentration (LC50) values of 8.3 mg/L and 3.2 mg/L were observed in rats and mice respectively after a 30 minute inhalation exposure to aerosolised hydrochloric acid (Darmer et al. 1974).
Irritation	In a skin irritation test in rabbits performed according to OECD TG 404, 37% hydrochloric acid (0.5 mL) was applied by both semi-occlusion and occlusion (Potokar 1985). The chemical was found to be corrosive under both conditions after one hour exposure. Concentrations >17% also caused corrosion in rabbits. Concentrations >3.3% caused skin irritation to rabbits after application for 5 days. Hydrochloric acid caused mild to severe eye irritation in animal studies. There were no data available for respiratory irritation however; inhalation of hydrochloric acid vapours is expected to cause irritation. In humans, the chemical was determined to be 'irritating to skin' (York et al. 1996).
Sensitisation	May cause dermatitis with frequent contact of aqueous solutions of hydrochloric acid.
Health Effects Summary	Hydrochloric acid has demonstrated acute oral toxicity, corrosive effects to the skin and eye, and irritant effects to the respiratory system. Hydrochloric acid is not a skin sensitiser based on the available studies. Only limited information on the repeated oral toxicity of hydrochloric acid is available. However, as the component ions are normal constituents of the human body (particularly the stomach), only localised effects are expected. No systemic effects from repeated exposures are expected. The chemical is not genotoxic. No evidence of treatment-related carcinogenicity was observed in animal studies performed by inhalation or dermal administration. In humans, no association between hydrogen chloride exposure and tumour incidence was observed. No reliable studies were identified regarding specific toxicity to reproduction and development in animals after exposure to hydrochloric acid/hydrogen chloride. Because protons and chloride ions are normal constituents in the body fluids, low concentrations of hydrochloric acid/hydrogen chloride would not be expected to cause adverse reproductive effects to animals. This conclusion is supported by the 90-day inhalation study of hydrogen chloride where no effects on the gonads of rodents were observed.
Key Study/Critical Effect for Screening Criteria	The Australian drinking water guideline value for pH may apply to hydrochloric acid.

Ecological Toxicity [1,3,4,8]	
Aquatic Toxicity	The measured acute endpoint for: Algae = 0.492 mg/L Daphnia = 0.492 mg/L Fish = 4.92 mg/L The measured chronic endpoint for Daphnia is 62 mg/L
Determination of PNEC aquatic	On the basis that the data consists of short-term and long-term results from three trophic levels, an assessment factor of 10 has been applied to the lowest reported Chronic endpoint of 62 mg/L for Daphnia. The PNECaquatic is 6.2 mg/L.
Current Regulatory Controls [8]	
Australian Hazard Classification	C (Corrosive); R34 (Causes burns) Xi (Irritant); R37 (Irritating to respiratory system).
Australian Occupational Exposure Standards	There are no specific exposure standards for hydrochloric acid. However, the permissible exposure limits for hydrogen chloride gas apply (Safe Work Australia 2013): Time Weighted Average (TWA) of 7.5 mg/m^3 (5 ppm).
International Occupational Exposure Standards	The following exposure standards were identified for hydrogen chloride (Galleria Chemical 2013). TWA: 7 to 8 mg/m³ (5 ppm) [Austria, Belgium, Denmark, EU, Hungary, Japan, Korea, Mexico, The Netherlands, New Zealand, Norway, Sweden, Turkey] 2 to 5 mg/m³ (1-2 ppm) [Germany, Poland, Switzerland, UK]. Short Term Exposure Limit (STEL): 15 mg/m^3 (10 ppm) [Austria, Belgium, EU, Hungary]
Australian Food Standards	Hydrochloric acid is an additive permitted in accordance with Good Manufacturing Practice (GMP) in processed foods specified in Schedule 1 of the Australia New Zealand Food Standards Code – Standard 1.3.1 – Food Additives (Food Standards Australia New Zealand 2013).
Australian Drinking Water Guidelines	Hydrochloric acid is listed as an endorsed drinking water treatment chemical in the Australian Drinking Water Guidelines (National Health and Medical Research Council (NHMRC) 2011).
Aquatic Toxicity Guidelines	No data found
PBT Assessment	
P/vP Criteria fulfilled?	Hydrochloric acid is an organic salt that dissociates completely to hydrogen and chloride ions in aqueous solutions. Biodegradation is not applicable to these inorganic ions; both hydrogen and chloride ions are also ubiquitous and are present in most water, soil and sediment. Thus, the persistent criteria is not considered applicable to this inorganic salt.
B/vB criteria fulfilled?	Hydrogen and chloride ions are essential to all living organisms and their intracellular and extracellular concentrations are actively regulated. Thus, hydrochloric acid is not expected to bioaccumulate.
T criteria fulfilled?	No chronic toxicity data exist on hydrochloric acid; however, the acute EC(L)50s are >0.1 mg/L in fish, invertebrates and algae. Thus, hydrochloric acid does not meet the screening criteria for toxicity.
Overall conclusion	Not PBT
Revised	April 2018

References

1. U.S. National Library of Medicine, Toxicology Data Network HSDB (Hazardous Substances Data Bank) http://toxnet.nlm.nih.gov/
2. OECD SIDS. (1992), *UNEP Publications 5; Hydrochloric Acid (IARC Summary & Evaluation, Volume 54*). Obtained from IPCS INCHEM http://www.inchem.org/documents/iarc/vol54/03-hydrochloric-acid.html
3. IARC (International Agency for Research on Cancer). (2011), *Agents Classified by the IARC Monographs, Volumes 1 -102.*

4. IARC (International Agency for Research on Cancer). (1992), *Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man* (Multi-volume work).
5. OECD (2002). IUCLID Data Set for Hydrogen chloride (CAS No. 7647-01-0), UNEP Publications.
6. OECD (2002). Screening Information Dataset (SIDS) Initial Assessment Report for Hydrogen chloride (CAS No. 7647-01-0), UNEP Publications.
7. Safe Work Australia Workplace Exposure Standards for Airborne Contaminants, 2013.
8. Department of the Environment and Energy 2017 , National assessment of chemicals associated with coal seam gas extraction in Australia, prepared by the National Industrial Chemicals Notification and Assessment Scheme

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Toxicity Summary - Distillates, Hydrotreated Light

Chemical and Physical Properties [1,2,3,4]	
CAS number	64742-47-8
Molecular formula	C48H94
Molecular weight	Not applicable - unknown or variable composition, complex reaction products or biological materials (UVCB)
Solubility in water	0.009 to 6.45 mg/L (at 25°C)
Melting point	-49 °C
Boiling point	146 to 299 °C
Vapour pressure	1 to 3.7 kPa at 37.8 °C
Henrys law constant	No data found.
Explosive potential	Above 66°C explosive vapour/air mixtures may be formed
Flammability potential	Combustible
Colour/Form	Liquid at room temperature
Overview	Distillates, hydrotreated light (also called deodorised kerosene) is a petroleum substance. The C_9-C_{14} Aliphatic [< 2% Aromatic] Hydrocarbon Solvents Category is comprised of complex aliphatic hydrocarbon solvents that contain >98% aliphatic constituents with carbon numbers in the range of C9-C14 and less than 2% aromatic constituents. The chemical is used as a component of a drilling fluid formulation for coal seam gas extraction.
Environmental Fate[1]	
Soil/Water/Air	Members of the C_9-C_{14} Aliphatic [≤2% aromatics] Hydrocarbon Solvents Category have the potential to volatilize from surface waters, based on Henry's Law constants (HLC) representing volatility for category members that range from 4.76×10^4 to 1.67×10^6 Pa-m^3/mole (at 25°C). In the air, category members have the potential to rapidly degrade through indirect photolytic processes mediated primarily by hydroxyl radicals (•OH) with calculated degradation half-lives ranging from 0.42 to 1.10 days or 10.8 to 26.4 hours based on a 12-hr day and an •OH concentration of 1.5×10^6 •OH/cm^3. These chemicals are unlikely to degrade by hydrolysis as they lack a functional group that is hydrolytically reactive.

Human Health Toxicity Summary [1,2,3]	
Chronic Repeated Dose Toxicity	In a 90-day study conducted in accordance with OECD TG 408, Sprague-Dawley rats were administered deodorized kerosene by gavage at doses of 0, 100, 500 or 1000 mg/kg bw/day (REACH 2013). Microscopic changes, such as incidence of a2µ-globulin, were seen in male kidneys. These effects are not considered relevant to humans. No other treatment-related effects were observed. No Lowest Observed Adverse Effect Level (LOAEL) or No Observed Adverse Effect Level (NOAEL) could be established in this study. Repeated dermal exposures to members of the kerosene/jet fuel category showed minimal systemic effects (API 2010). Animal data on repeat dermal toxicity of kerosene (petroleum) are summarised from REACH (2013) and presented in Table A29.2. The LOAELs and NOAELs are indicated for each study. Prolonged skin exposure to kerosene (petroleum) in rats and rabbits were consistently associated with local irritation. In rabbits only, systemic effects included changes in bodyweight and organ weights. It is expected that deodorized kerosene would have similar effects in the animals. In a 13-week study, rats (strain not specified) were exposed to deodorized kerosene vapour at concentrations of 0, 0.02, 0.048 or 0.10 mg/L for six hours/day, five days/week. No treatment-related effects were reported (REACH 2013).
Carcinogenicity	A study for deodorized kerosene is available in the REACH Dossier (REACH 2013) but was not reported in enough detail to be able to determine the carcinogenicity of the substance. In a study conducted similarly to OECD TG 451, B6C3F1 mice were applied 0, 250 or 500 mg/kg bw/day kerosene (petroleum) in the interscapular region (type of wrapping not specified) for 103 weeks (REACH 2013). At the end of the study, less than 10% decrease in bodyweight gain was observed at the top dose in both sexes. Mortality in females was significantly higher at the two doses compared to controls. Increased incidence and severity of chronic dermatitis was seen in all treatment groups. At the top dose, increased incidence of the following non-neoplastic lesions was reported: amyloid in the liver, kidney, adrenal cortex (males only), spleen; granulocytic hyperplasia in the bone marrow; and hyperplasia of the axillary lymph nodes (females only). The only indication of neoplastic lesions was an increased incidence of malignant lymphomas observed in treated female animals but the values were within the range of historical controls. Under the conditions of the test, kerosene (petroleum) was not carcinogenic. The LOAEL for systemic effects is 250 mg/kg bw/day. The International Agency for Research on Cancer (IARC) concluded that there is inadequate evidence for the carcinogenicity of kerosene (petroleum) in experimental animals and humans, placing the chemical in Group 3 (Not classifiable as to its carcinogenicity to humans) (IARC 1989). Deodorized kerosene is not carcinogenic, based on reading across the information available for kerosene (petroleum).
Mutagenicity/ Genotoxicity	In vitro tests reported deodorized kerosene as negative both with and without metabolic activation in Ames tests conducted in accordance with OECD TG 471 (REACH 2013; OECD 2011) and in chromosomal aberration tests conducted in accordance with OECD TG 473 (OECD 2011, 2012). In an in vivo study, deodorized kerosene was negative in a dominant lethal assay, conducted in accordance with OECD TG 478, in male Swiss mice and Long Evans rats administered 10% deodorized kerosene intraperitoneally (REACH 2013). These studies demonstrate that deodorized kerosene is not genotoxic.

Reproductive Toxicity / Developmental Toxicity/Teratogenicity	C9-C14 aliphatic (≤2% aromatic) hydrocarbon solvents and C14-C20 aliphatic (≤2% aromatic) hydrocarbon solvents are not toxic to fertility (OECD 2011, 2012). Members of the kerosene/jet fuel category are not toxic to fertility (API 2010). Sprague-Dawley rats were administered undiluted kerosene (petroleum) by gavage at doses of 0, 750, 1500 or 3000 mg/kg bw/day in males treated for 70-90 days and 0, 325, 750 or 1500 mg/kg bw/day in females treated for 21 weeks. At 750 and 1500 mg/kg bw/day, increased absolute liver weight was observed in females but with no corresponding changes in clinical chemistry or histopathology. In females only, other effects included perianal dermatitis at 1500 mg/kg bw/day and stomach hyperplasia at 750 and 1500 mg/kg bw/day. These parameters were not measured in males. In males, the study indicated dose dependent decrease in male bodyweight that was linked to nephropathy specific to male rats. Data for this effect were not provided in the study description. There were no treatment related effects on fertility in both sexes (REACH 2013). The NOAEL for systemic effects in females only was 325 mg/kg bw/day. No NOAEL can be established for fertility effects. C9-C14 aliphatic (≤2% aromatic) hydrocarbon solvents and C14-C20 aliphatic (≤2% aromatic) hydrocarbon solvents are not developmental toxicants (OECD 2011, 2012). Members of the kerosene/jet fuel category are not developmental toxicants (API 2010). In a study conducted in accordance with OECD TG 414, Sprague-Dawley rats were administered kerosene (petroleum) by gavage on gestation days (GD) 6 to 15 at doses of 0, 500, 1000, 1500 or 2000 mg/kg bw/day (REACH 2013). Bodyweight gain was decreased at 1500 and 2000 mg/kg bw/day. Foetal weight was decreased at 1500 and 2000 mg/kg bw/day which may be attributed to decreased maternal bodyweight gain. No malformations were reported. The maternal NOAEL is 1000 mg/kg bw/day. In another study, Sprague-Dawley rats were exposed (whole body) to kerosene (petroleum) in air at concentrations of 0, 106 or 364 ppm on GD 6-15. There were no treatment-related effects observed in the dams and offspring (REACH 2013). Deodorized kerosene is not considered a developmental toxicant, based on reading across data available for kerosene (petroleum).
Acute Toxicity	The chemicals have low acute toxicity based on results from animal tests following oral exposure. The median lethal dose (LD50) in rats is >2000 mg/kg bw (OECD, 2011; US EPA, 2011; OECD, 2012a; OECD, 2012b; OECD, 2012c). The chemicals have low acute toxicity based on results from animal tests following dermal exposure. The LD50 in rats and rabbits is >2000 mg/kg bw (OECD, 2011; US EPA, 2011; OECD, 2012a; OECD, 2012b; OECD, 2012c). The chemicals have low acute toxicity based on results from animal tests following inhalation exposure.
Irritation	Semi-occlusive applications of commercial grade deodorized kerosene produced slight irritation in New Zealand White and SPF rabbits in dermal irritation studies conducted in accordance with OECD TG 404. The studies reported the range of erythema and oedema scores to be 0.3-0.9 and 0.2-1.0, respectively, based on Draize scoring at 24, 48 and 72 hours. Deodorized kerosene is slightly irritating to rabbit skin. Several studies conducted similarly to OECD TG 405 showed minimal effects to the eye with the reported range of conjunctival redness score to be 0-0.2 from instillation of undiluted deodorized kerosene in the eyes of New Zealand White and SPF rabbits (OECD 2011). Deodorized kerosene is slightly irritating to rabbit eye.
Sensitisation	The C9-C14 aliphatic (≤2% aromatics) Category members do not cause skin sensitization.

Health Effects Summary	Deodorised kerosene is an aspiration hazard since it has low viscosity and is composed of aliphatic and aromatic hydrocarbons up to 10%. Deodorised kerosene has low acute oral, dermal and inhalation toxicity, and is slightly irritating to the skin and eyes. The substance is not a skin sensitiser, based on reading across data available for kerosene (petroleum). No treatment-related effects were reported in repeated oral and inhalation exposures to deodorised kerosene. Prolonged dermal exposure to kerosene (petroleum) reported local irritation in rats and rabbits, and changes in bodyweight and organ weights in rabbits. It is expected that these effects would be similar for deodorised kerosene. Based on the absence of adverse effects observed in repeat dose toxicity studies, for the purposes of quantifying the health risk to the general worker and public, the highest dose tested in the study conducted in rats (1 000 mg/kg bw/day) is used in this risk assessment. The substance is not genotoxic. It is neither a carcinogen nor a reproductive toxicant, based on reading across data available for kerosene (petroleum).
Key Study/Critical Effect for Screening Criteria	The most appropriate No-Observed-Adverse-Effect Level (NOAEL) for risk assessment is 1 000 mg/kg bw/day based on maternal toxicity (decreased bodyweight gain) at the Lowest- Observed-Adverse-Effect Level (LOAEL) of 1 500 mg/kg bw/day from a developmental toxicity study on kerosene (petroleum).
Ecological Toxicity [2]	
Aquatic Toxicity	Lowest acute endpoint for Daphnia = 0.018 mg/L (modelled)
Determination of PNEC aquatic	Based on the lowest acute endpoint for Daphnia (0.018 mg/L), an assessment factor of 100 has been applied, resulting in a PNECaquatic of 1.80E-04 mg/L.
Current Regulatory Controls [2]	
Australian Hazard Classification	All of the chemicals are classified as hazardous, with the following risk phrase for human health in the Hazardous Substances Information System (HSIS) (Safe Work Australia): Xn; R65 (acute toxicity) Mixtures containing the substance are classified as hazardous with the following risk phrase based on the concentration (Conc) of the substance in the mixtures: Conc ≥10%: Xn; R65 (May cause lung damage if swallowed)
Australian Occupational Exposure Standards	No specific exposure standards are available.
International Occupational Exposure Standards	No specific exposure standards are available for this chemical.
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	Oils and greases (including petrochemicals) for freshwater production: <300[6] µg/L (ANZECC 2000)
PBT Assessment	
P/vP Criteria fulfilled?	No. This chemical is expected to be biodegradable. The ready biodegradability of SHELLSOL NF a solvent naphtha (petroleum), heavy aromatics (consists predominantly of C9 aromatics 25%m/m; C10 aromatics 65%, and indanes 10%) was studied in mineral nutrient medium inoculated with activated sludge (mixed liquor suspended solids 100-101 mg/L, pH 6.9) and incubated for 28 days at 20°C. SHELLSOL NF is readily biodegrade after 28 days but not within the 10 day window.
B/vB criteria fulfilled?	Category members have a potential to bioaccumulate, based on calculated log BCF values for constituents that range from 2.78 to 4.06, and calculated BCF values of 598 to 11,430 L/kg wet-weight, based on the Arnot and Gobas model, that take into account biotransformation of the chemicals in fish tissue. This chemical also has a log Kow of 6.025.

T criteria fulfilled?	Yes. The lowest acute endpoint is <1 mg/L.
Overall conclusion	Not PBT
Revised	January 2019

Human Health Risk Assessment

Occupational Exposure

Table 2 presents the calculated internal doses for adult workers associated with drilling chemical exposure/hydraulic fracturing chemical exposure.

Table 2 Calculated Internal Doses for Adult Workers

Occupational Activity	E_{derm} (mg/kg bw/day)	E_{inh} (mg/kg bw/day)	E_{total} (mg/kg bw/day)
Transport and storage	Negligible*	Negligible*	Negligible*
Mixing/blending drilling of hydraulic fracturing chemicals	0.06	0.750	**0.810**
Injection of drilling chemicals	Negligible*	Negligible*	Negligible*
Cleaning and maintenance (hydraulic fracturing)	0.012	0.150	**0.162**
Combined exposure Mixing/blending and cleaning and maintenance			**0.972**
Transport and storage of drilling muds	Negligible*	Negligible*	Negligible*

Ederm - Internal dose from dermal exposure; Einh – Internal dose from inhalation exposure; Etotal – Total internal dose from all routes.

* In the absence of accidents/incidents, repeated occupational exposures during transport and storage, or during injection of mixed/blended chemicals, are negligible. Similarly, repeated occupational exposures to the chemical via the transport and storage of drilling muds are negligible (NICNAS 2017).

Human Health Risk Characterisation

Uncertainty Factors

Using the Margin of Exposure (MOE) approach, conservative default uncertainty factors for intra- and inter-species variability are assumed to be 10 each. A MOE of less than 100 is considered a concern (NICNAS 2017).

Acute Health Risks

Acute exposure to the chemical is unlikely to result in adverse health effects. In addition, given the low concentration in the drilling fluids, exposure to the chemical via these fluids is of low concern for workers.

Chronic long-term health risks

The critical (most sensitive) adverse health effect is maternal toxicity (decreased bodyweight gain). The NOAEL established for this effect is 1000 mg/kg bw/day from a reproductive toxicity study. There are no adverse effects observed from repeated exposures to the chemical at any dose tested, up to 1000 mg/kg bw/day. This highest no-effect dose is applicable for a general worker. Margins of Exposure (MOE) for adverse health effects from repeated occupational exposures are calculated by comparing the NOAEL with exposures estimated for different occupational activities and combined activities. **Table 3** presents Margin of Exposure calculated for Adult Workers associated with drilling

chemical exposure/hydraulic fracturing chemical exposure. Risk characterisation calculations are presented in **Attachment A**.

Table3 Margins of exposure calculated for adult workers

Adult worker exposure scenario	E_{total} (mg/kg bw/day)	NOAEL (mg/kg bw/day)	Critical effect	MOE (NOAEL / E_{total})	Chemical is of concern? (MOE < 100)
Occupational Activity					
Mixing/blending drilling of hydraulic fracturing chemicals	0.810	1000	Maternal toxicity in rats	1235	No
Cleaning and maintenance (hydraulic fracturing)	0.162			6173	
Combined exposure Mixing/blending and cleaning and maintenance	0.972			1029	

Based on uncertainty factors derived for this risk characterisation, the MOEs indicate that the chemical is of low concern for workers from repeated exposures during certain operations.

References

1. OECD (2012) SIDS Initial Assessment Profile on C_9-C_{14} Aliphatic [≤2% aromatic] Hydrocarbon Solvents Category. Available at: http://webnet.oecd.org/HPV/UI/SIDS_Details.aspx?id=476560b6-e2b7-4466-9c52-0b278c8b71a7
2. National Industrial Chemicals Notification and Assessment Scheme (NICNAS, 2017). National assessment of chemicals associated with coal seam gas extraction in Australia. Human health hazards of chemicals associated with coal seam gas extraction in Australia.
3. National Industrial Chemicals Notification and Assessment Scheme (NICNAS). IMAP, Human Health Tier II Assessment for Kerosene, Retrieved 2019: https://www.nicnas.gov.au
4. ECHA REACH, Distillates (petroleum), hydrotreated light, Retrieved 2017: https://echa.europa.eu/information-on-chemicals/registered-substances
5. ICSC Distillates (petroleum), hydrotreated light, Retrieved 2017: http://www.inchem.org
6. ANZECC (2000) Australian and New Zealand Guidelines for Fresh and Marine Water Quality for protection for aquatic ecosystems

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Toxicity Summary - Methanol

Chemical and Physical Properties[1,3,4]	
CAS number	67-56-1
Molecular formula	CH4O
Molecular weight	32.04
Solubility in water	1,000 g/L at 20 °C
Melting point	-98 °C
Boiling point	65 °C
Vapour pressure	16.927 kPa at 25 °C
Henrys law constant	0.461 Pa m³/mol
Explosive potential	Vapour/air mixtures are explosive
Flammability potential	Highly flammable
Colour/Form	Clear colourless liquid
Overview	Methanol occurs naturally in humans, animals and plants. The general population is exposed to methanol mainly through consumption of food and beverages and through use of consumer products such as paints, sealers and adhesives that contain methanol as a solvent.
Environmental Fate [1,3]	
Soil/Water/Air	Air is the main target compartment, based on a fugacity model calculation (Mackay Level III) with about 73 % of environmental methanol distributing to air and 16 % to water. Methanol is degraded in the atmosphere by photochemical, hydroxyl-radical dependent reactions. The estimated elimination half-life is calculated to be about 17-18 days with a rate constant of 0.93 x 10-2 cm3/molecule-sec. Methanol is completely miscible in water and has a low octanol/water partition coefficient. These properties are indicative of high mobility in soil.
Human Health Toxicity Summary [1,2,3]	
Chronic Repeated Dose Toxicity	Considering the no observed adverse effect level (NOAEL) available from a 90-day rat study (500 mg/kg bw/day), the chemical is not considered to cause serious damage to health by repeated oral exposure. In a 20-day inhalation study in monkeys, 3.9 mg/L (3000 mL/m3) was identified as the LOAEL (continuous exposure) where neurotoxic lesions appeared to progress in monkeys (according to NEDO 1987). This exposure concentration correlated with methanol blood levels 80 mg/L and formate levels 30 mg/L. There was no evidence of adverse effects in rats exposed to methanol up to 6.6 mg/L, six hours/day for 28 days, except local nasal irritation and increased relative spleen weights, which were observed only at the middle dose and not considered treatment-related (Andrews et al. 1987). A NOAEL could not be established in this study. In the chronic exposure studies in rats and mice, slight treatment-related decreases in body and organ weights were reported at the highest dose. These are however not considered as 'adverse' effects. In monkeys, slight degeneration of the inside nucleus of the thalamus was observed at 0.13 and 1.3 mg/L after seven months or more (NEDO 1987). One monkey at 0.13 mg/L and two at 1.3 mg/L showed slight but clear changes in peroneal nerves indicating damage to peripheral nerves. Some signs of fibrosis at 1.3 mg/L, which were considered borderline. There were mild but significant effects on heart and kidney at 0.13 and 1.3 mg/L. Histologically, a significant increase of Sudan positive granules was noted in the 1.3 mg group without pathological manifestations (e.g. fibrosis). Although the authors considered the lowest dose (0.013 mg/L) as the LOAEL, it was observed that effects at this dose were very mild and reversible and therefore not considered to be adverse effects. Based on these observations, a NOAEL of 0.013 mg/L was established in this study.

Carcinogenicity	The chemical is not likely to be a carcinogen. In a chronic inhalation study, Fisher rats and B6C3F1 mice were exposed to 0.013, 0.13, and 1.3 mg/L methanol for 24 and 18 months, respectively (NEDO 1987). No differences in survival were noted in the treatment groups compared with the control group. There was no evidence of an increase in liver tumours in rats or in the spontaneous liver tumour rate in mice. In the rats, some tumours such as papillary lung adenomas (males only), adrenal phaeochromocytomas (females only) and metastatic (transition) tumours appeared at a somewhat higher incidence in high-dose group rats after week 79 and 104 without clear dose-response relationship. However these tumour incidences were not statistically significantly different from those in the control group. In the mice, there were no appreciable differences from the control in either numbers of animals with tumours or in degree of malignancy observed. Proliferative effects on the astroglia cells were observed in monkeys continuously exposed to 0.013, 0.13 and 1.3 mg/L methanol by the inhalation route (NEDO 1987). These effects however were of a transient nature and disappeared after a six-month recovery period. There were no signs of histological degeneration.
Mutagenicity/ Genotoxicity	Methanol has been examined in numerous in vitro and in vivo test systems, including bacterial, mammalian and fungal test systems. Most in vitro studies did not demonstrate mutagenic activity. A small number of studies gave ambiguous results. All other studies produced negative results consistently. The majority of in vivo assays were negative for mutagenicity and clastogenicity (OECD 2004). Methanol was therefore concluded to be not mutagenic.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	No impairment of fertility or reproductive performance was reported in male and female rats exposed to the chemical, except at very high doses. Male mice had morphological anomalies in spermatozoa after repeated oral dosing at 1000 mg/kg bw/day (blood level > 500 to 1000 mg/L in mice) (OECD 2004). Rodent studies indicate that methanol has developmental toxicity effects. The rodent data on developmental toxicity are relevant for humans despite the known differences in methanol metabolism between the two species. However, rodents are considered adequate models for humans only at levels where formate does not accumulate (NTP 2003). Blood methanol levels associated with serious developmental effects in rodents were in the range associated with formate accumulation (1000 to 2000 mg methanol per litre of blood), which is likely to result in metabolic acidosis, and visual and clinical effects in humans (NTP 2003; OECD 2004). The limited data available in humans do not show an association between reproductive and developmental toxicity and methanol (NTP 2003). Following a review of the developmental toxicity studies, the NTP concluded that there is evidence to suggest that females with low folate levels may be more susceptible to the adverse developmental effects of methanol, but more information was necessary to clarify this issue (NTP 2003). Based on the data available, the chemical is not considered to have reproductive or developmental toxicity in humans.

Acute Toxicity	In rats, mice, rabbits and dogs, the LD50 values after single oral administration range from about 5600 to 14 400 mg/kg bw (EHC 1997). Adverse effects noted in these animals were ataxia, narcosis and coma after high methanol doses. The animals did not exhibit acidosis and ophthalmologic changes typically seen in humans at high lethal and sub-lethal doses In rhesus monkeys, no deaths were reported at doses of 1000 to 2000 mg/kg bw, while animals receiving 3000 to 8000 mg/kg bw died within two days (OECD 2004). Treated animals showed acidosis, and some exhibited semi-coma and ophthalmologic changes. Human data, however, indicate acute oral toxicity at comparatively lower doses of 300 to 1000 mg/kg bw (EHC 1997). The reported median lethal doses (LD50) for experimental animals are 7300 mg/kg bw (mouse), 5628 mg/kg bw (rat), 14 200 mg/kg bw (rabbit) and 7000 mg/kg bw (monkey). The lowest lethal dose (LDLo) for humans ranges from 143 to 428 mg/kg bw (ChemIDplus 2012). There are limited available dermal toxicity studies in animals. In one dermal exposure study all the rats survived after application of 35 000 mg/kg bw methanol to the skin under occlusive conditions, while deaths were reported at 45 000 mg/kg bw (Eulner and Gedicke 1955). In rabbits, a dermal LD50 of 17 000 mg/kg bw was reported although no details of the study were provided (Carnegie-Mellon 1981). Limited data in monkeys indicate that the chemical is toxic via the dermal route (McCord 1931). Humans have been found to be more susceptible to methanol as compared to monkeys. Therefore, acute dermal toxicity with methanol is expected in humans (OECD 2004). The lowest reported dermal LD50 is 17 000 mg/kg bw, which was recorded in rabbits. Median lethal concentrations (LC50) of 87.5 and 128.2 mg/L were reported in rats following six and four hour inhalation exposures to methanol, respectively (BASF 1980a, 1980b). Clinical signs of toxicity were secretions from eyes and nose, laboured breathing, staggering, apathy and narcosis. A similar LC50 value (79 mg/L) was reported for mice following 2.25 hours exposure (Von Burg 1994). In cats, LC50 values after six-hour exposures ranged from 26 to 48 mg/L. A shorter duration of 4.5 hours led to an LC50 of 85.4 mg/L (Von Burg 1994). Studies in Rhesus monkeys indicated lethal concentrations (percent mortality not reported) at 13 mg/L after 18 hour exposure and 52 mg/L after one to four hour exposure (OECD 2004).
Irritation	The chemical is not a skin irritant. The chemical is a slight eye irritant in rabbits. High concentration of methanol vapours may cause irritation of the respiratory tract. In a short-term exposure study (details not available), exposure of rats to an atmosphere saturated with methanol vapours produced severe irritation of mucous membranes and milky corneal opacity (BASF 1975). All animals died after eight hours (BASF 1975).
Sensitisation	The chemical is not a skin sensitiser.
Health Effects Summary	Methanol has low acute oral, dermal and inhalation toxicity in experimental animals but moderate to high acute oral and dermal toxicity in humans. A Lowest Lethal Dose (LDLo) of 143 - 428 mg/kg bw (humans) has been reported. It is not a skin or eye irritant but is expected to be a moderate respiratory irritant, based on its effect on the mucous membrane in rats exposed to methanol vapours and on the effects observed in repeat dose inhalation studies. Tests with guinea pigs indicated that methanol is not a skin sensitiser. The critical effects to human health are acute toxicity from inhalation, skin contact and swallowing, and possible irreversible effects from acute oral exposure. No deaths were reported in Rhesus monkeys dosed at 2 000 mg/kg bw, but treated animals showed acidosis, and some exhibited semi-coma and ophthalmic changes. Human data, however, indicate acute oral toxicity and ophthalmic changes at comparatively lower doses of 300 - 1 000 mg/kg bw. Information on repeated dose toxicity by the dermal route is not available. Methanol was not genotoxic or carcinogenic. Reproductive and developmental toxicity studies did not show any significant effects of relevance to humans.

Key Study/Critical Effect for Screening Criteria	A No-Observed-Adverse-Effect-Concentration (NOAEC) of 0.013 mg/L (13 mg/m3) is used for this risk assessment. This NOAEC is derived from a chronic inhalation study in monkeys, in which degenerative effects in the brain and slight damage to the optic and peripheral nerves were noted at 0.13 mg/L and above. Changes in peroneal nerves were also noted in higher dosed animals, indicating damage to peripheral nerves. An oral No Observed Adverse Effect Level (NOAEL) of 500 mg/kg bw/day was also established in rats in a 90-day oral study based on increased liver enzymes (enzymes not specified) and decreased absolute brain weights at the highest dose. This value is not used in this risk assessment because acute oral data indicate that humans are more sensitive to methanol toxicity than rodents.
Ecological Toxicity [2,3]	
Aquatic Toxicity	In several 96-hour studies in fish in which methanol concentrations were measured during the tests, LC50s ranged from 15,400 to 29,400 mg/L. In the chronic toxicity study to invertebrates, the NOEC was 32,000 mg/L.
Determination of PNEC aquatic	A PNECaqua = 3.20E+03 mg/L can be calculated based on the lowest chronic toxicity value for aquatic invertebrates (Daphnia) with the assessment factor of 10.
Current Regulatory Controls[4]	
Australian Hazard Classification	The chemical is classified as hazardous with the following risk phrases for human health in the Hazardous Substances Information System (HSIS) (Safe Work Australia): T; R23/24/25 (acute toxicity) T; R39/23/24/25 (irreversible effects from acute exposure) Mixtures containing the chemical are classified as hazardous based on the concentration (Conc) of the chemical in the mixtures. The risk phrases for this chemical are: Conc ≥20%: T; R23/24/25; (Toxic: Toxic by inhalation, in contact with skin and if swallowed); R39/23/24/25; (Toxic: danger of very serious irreversible effects through inhalation, in contact with skin and if swallowed) 10% ≤Conc <20%: T; R20/21/22; (Toxic: Harmful by inhalation, in contact with skin and if swallowed); R39/23/24/25; (Toxic: danger of very serious irreversible effects through inhalation, in contact with skin and if swallowed) 3% ≤Conc <10%: Xn; R20/21/22; (Harmful: Harmful by inhalation, in contact with skin and if swallowed); R68/20/21/22; (Harmful: possible risk of irreversible effects through inhalation, in contact with skin and if swallowed).
Australian Occupational Exposure Standards	The chemical has an exposure standard of 262 mg/m³ (200 ppm) Time Weighted Average (TWA) and 328 mg/m³ (250 ppm) Short-Term Exposure Limits (STEL) (Safe Work Australia).

International Occupational Exposure Standards	The following were identified (Galleria Chemica): 250-270 mg/m³ (200 ppm) TWA in USA, Canada, Denmark, United Kingdom, Germany, France, Estonia, Greece, Hungary, South Africa, Spain, Singapore, Taiwan, Sweden, Malta, Malaysia, Latvia, Japan, Indonesia, India, Iceland, Egypt, Ireland, Mexico, Philippines and Switzerland; 250-350 mg/m³ (250-328 ppm) STEL in USA, Canada, United Kingdom, Greece, South Africa, Singapore, Sweden, India, Egypt and Mexico; 50 mg/m³ TWA in Bulgaria; 100 mg/m³ TWA and 300 mg/m³ STEL in Poland; 133 mg/m³ TWA in Netherlands; 25 mg/m³ TWA and 50 mg/m³ STEL in China; 1300 mg/m³ (1000 ppm) STEL in France; and 1040 mg/m³ STEL in Hungary and Switzerland.
Australian Food Standards	No Australian food standards were identified (FSANZ 2013)
Australian Drinking Water Guidelines	No aesthetic or health-related guidance values were identified for methanol in the Australian Drinking Water Guidelines (National Health and Medical Research Council (NHMRC) 2011).
Aquatic Toxicity Guidelines	No data available.
PBT Assessment	
P/vP Criteria fulfilled?	No. Methanol is expected to be readily biodegradable.
B/vB criteria fulfilled?	No. The Log Kow for methanol is -0.82 to -0.64. Thus, methanol does not meet the screening criteria for bioaccumulation.
T criteria fulfilled?	No. The EC50s from the acute aquatic toxicity data on methanol are >1 mg/L, hence does not meet the screening criteria for toxicity.
Overall conclusion	Not PBT
Revised	January 2019

References

1. NICNAS (2017) Human Health Tier II Assessment for Methanol
2. National Industrial Chemicals Notification and Assessment Scheme (NICNAS, 2017). National assessment of chemicals associated with coal seam gas extraction in Australia. Human health hazards of chemicals associated with coal seam gas extraction in Australia.
3. OECD (2008) SIDS Initial Assessment Profile on Methanol
4. ECHA REACH, Methanol, Retrieved 2017: https://echa.europa.eu/information-on-chemicals/registered-substances
5. IPCS Acetic Acid, Retrieved 2015: http://www.inchem.org

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Toxicity Summary - Polyethylene glycol

Chemical and Physical Properties	
CAS number	25322-68-3
Molecular formula	(C2H4O)nH2O
Molecular weight	UVCB
Solubility in water	40 g/L @ 30 °C
Melting point	-10 °C at 101.3 kPa
Boiling point	870 °C at 101.3 kPa
Vapour pressure	0 Pa @ 25 °C
Henrys law constant	
Explosive potential	Non explosive
Flammability potential	Non flammable
Colour/Form	Odourless, viscous transparent organic liquid
Overview	Polyethylene glycols, also known as PEGs, are clear, colourless, thick liquids to waxy solids, depending on the molecular weight. The molecular weight of PEGs ranges from 200 to over 6000. Some may have a faint odour and bitter taste. PEGs mix easily with water. PEGs are important commercial chemicals. They are used to make other chemicals, paper coatings, solvents, plasticizers and used in many household products, cosmetics and pharmaceuticals. One formulation, PEG 3500, is used as a laxative. PEGs are also used as food and animal feed additives.
Environmental Fate[1]	
Soil/Water/Air	Koc value of PEG was estimated as 10 L/kg by means of MCI method. This indicates that PEG will have a negligible tendency of sorption to soil and sediment and therefore have rapid migration potential to groundwater. The estimated half-life of the substance indicates that the substance is rapidly hydrolysable.

Human Health Toxicity Summary [1]	
Chronic Repeated Dose Toxicity	The substance PEG exhibits repeated dose toxicity by oral, dermal and inhalation route. A study was designed to investigate the subacute repeated dose toxicity effects of Polyethylene Glycols (PEG 400) in Wistar rats (male/female) by oral route, in an overall study period of 90 days. Dose group (5 animals per group) was fed a solution ofPEG400 equivalent to 0, 2000, 4000, 8000, 16000 or 24000 mg/kg/day in the diet. The control group received no polyethylene glycol. During the study period, body weight as a ratio to the amount of nutrient consumed, body weight, liver weight, kidney weight, micro pathology of liver and kidneys were examined. No effects upon male and female rats were observed when PEG 400 was present in the diet at a level up to 8000 mg/kg/day (8%concentration) for 90 days study period. But at 16000 mg/kg/day it showed effects on organ weight (liver and kidney heavier than that of control rats); and a decrease in weight gain was observed. Thus, from overall conclusion of the study the NOAEL (no observed adverse effect level) for repeated dose oral toxicity was considered to be 8000 mg/kg/day. And the LOAEL (low observed adverse effect level) for subacute repeated dose toxicity was considered to be 16000 mg/kg/day. Rats were exposed to airborne concentrations of 100 mg/m^3 and 1000 mg/m^3 of PEG-200 for periods up to 13 weeks. Toxicological, physiological, hematological, blood chemical, and pathological effects were evaluated during the course of the exposures. No significant lesions observed in this study occurred exclusively in exposed animals and the severity of lesions which were found was not dose-related. It is our impression that there were no PEG 200 induced lesions in rat tissue at the dosage level and exposure/post exposure periods evaluated in this study. Organ:body weight ratios in rats at all concentrations and for the 6- and 13-week exposure periods and the 30-day post exposure period showed no pattern of significance that could be related to PEG 200. The mice organ:body weights for the 6-week·exposure period are unavailable. No pattern of significance could be related to PEG 200 exposure for the 13-week or the 30-day post exposure periods. There were no consistently significant changes in rat blood chemistry at the end of the 6- or 13-week exposures or the 30-day post exposure period. It appears that PEG-200 produced no positive effects in the rodents at the Inn and 1000 mg/m3 PEG 200 concentrations over the 13 weeks of exposure used in this study. Thus it is concluded that the NOAEC value of PEG-200 in rats was observed at dose level of 1000 mg/m^3. The NOAEL value of PEG in rabbit was observed at dose level of 760 mg/kg bw/day. The supporting study indicates the TDLo (TDLo - Lowest published toxic dose) of PEG was observed at a dose concentration of 30 mL/kg (30000 mg/kg) in a 30 days study period where the dosage of PEG was intermittently given to rodent-rabbit by the dermal route(full study is not available). Considering the above results it is concluded that PEG is non-toxic by dermal route.
Carcinogenicity	No data available.
Mutagenicity/ Genotoxicity	PEG was found to be non-genotoxic.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	The one generation reproductive toxicity NOAEL (no observed adverse effect level) of PEG in rat was observed at a dose concentration of 1698.09 mg/kg bw/day. On the basis of this NOAEL value it indicates that PEG does not exhibit toxic effects to rat below the above mention dose.
Acute Toxicity	Acute toxicity of PEG to mouse by the oral route indicates that the substance does not exhibits acute toxicity by the oral route. Similarly the acute values of inhalation also indicate that the substance does not exhibits acute toxicity by the inhalative route. Thus, it can be inferred that the target substance is non-toxic to any of the oral, dermal and inhalation route of exposure.
Irritation	The available studies indicate that the substance PEG is not classified as a skin and eye irritant according to CLP regulation within the dose levels mentioned in the study.
Sensitisation	In the human repeat insult patch test 216 subjects were enrolled and 200 subsequently completed the study. PEG 200 caused some degree of sensitization response in 1 of the 200 subjects. This subject was a 61 year old white woman.

Health Effects Summary	PEG is non acute toxic to oral, dermal and inhalation route, shows no irritation effect to skin and eye, is not genotoxic and is not developmental and reproductive toxic.
Key Study/Critical Effect for Screening Criteria	Oral: In chronic repeated dose toxicity study by polyethylene glycols (PEG) 400 showed no effect upon male and female dogs when present in the diet at a level of 500 mg/kg/day (2% concentration) for one year. Thus NOAELs (no observed adverse effect level) for repeated dose oral toxicity was considered to be 500 mg/kg/day. Inhalation: The NOAEC value of PEG-200 in rats was observed at dose level of 1000 mg/m^3. Dermal: The NOAEL value of PEG in rabbit was observed at dose level of 760 mg/kg bw/day.
Ecological Toxicity [1]	
Aquatic Toxicity	The toxicity values of fish, invertebrates and algae are LC50 = 100 mg/L, LC50 = 1000 mg/L and EC 50 = 15.91 mg/L, respectively.
Determination of PNEC aquatic	Acute LC50 values are reported for fish, aquatic invertebrates, and freshwater algae. Since there is valid acute toxicity data for three trophic levels, an assessment factor of 1000 is used (in accordance with EU guidance). Based on the EC50 for freshwater algae (the most sensitive species in short term tests), the aquatic PNEC is 15.91 µg/L.
Current Regulatory Controls	
Australian Hazard Classification	No data available.
Australian Occupational Exposure Standards	No data available.
International Occupational Exposure Standards	No data available.
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	No data available.
PBT Assessment [1]	
P/vP Criteria fulfilled?	No. PEG is non persistent in nature and so is considered to have rapid biodegradation in the environment.
B/vB criteria fulfilled?	No. The calculated BCF of PEG is 3.2 dimensionless and below the threshold of 2000.
T criteria fulfilled?	No. Acute toxicity data >1 mg/L in fish, invertebrates and algae, thus PEG does not meet the screening criteria for toxicity.
Overall conclusion	Not PBT
Revised	January 2019

References

1. ECHA REACH European Chemicals Agency Database: http://apps.echa.europa.eu

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Toxicity Summary - Sodium bisulfite

Chemical and Physical Properties [1]	
CAS number	7631-90-5
Molecular formula	H2O3S.Na
Molecular weight	104.06
Solubility in water	724 g/L @ 20 °C
Melting point	No data available.
Boiling point	No data available.
Vapour pressure	No data available.
Henrys law constant	No data available.
Explosive potential	No data available.
Flammability potential	No data available.
Colour/Form	No data available.
Overview	Sulfites in aqueous solutions involve complex equilibria among the different species of sulfur oxidation state IV. The composition of their mixture in solutions depends on the pH and temperature. Sulfur dioxide may be produced from sulfites at low pH. At a pH closer to 7, the concentration ratio of bisulfite ($HSO3^-$) to sulfur dioxide (SO2) is very high (Gunnison and Jacobsen, 1987). Sulfites occur naturally in some foods and beverages as a result of fermentation (e.g. in beer and wine). A small percentage of the population (up to 1 %) is sensitive to sulfites (FDA, cited in Grotheer et al., 2005), as sulfur dioxide may be generated from sulfites in the stomach at low pH (Simon, 1986). The sensitivity to sulfur dioxide can cause a wide range of reactions in humans ranging from mild to severe dermatological, pulmonary, gastrointestinal, or cardiovascular symptoms (Grotheer et al., 2005).
Environmental Fate[1]	
Soil/Water/Air	The substance has a very low vapour pressure, and also does not sublime. Therefore, the substance will not be present as a gas and no radical reactions can be expected. According to its chemical properties, hydrolysis is not expected/probable. Photodegradation in water is not relevant because it dissociates rapidly into ions and decomposes in water, and it not susceptible to visible light. The substance is an inorganic compound which does not undergo biodegradation. The substance readiliy dissociates in aqueous solution, as with soil moisture. Bioaccumulation is not to be expected. a low log Kow underlines this statement. Due to the ionic salt-character and other physico-chemical properties (negligible vapour pressure, very high water solubility and decomposition in water), the Henry constant is near to zero. Because of its ionic nature, sodium hydrogensulfite as well as its dissociation products are not volatile from aqueous solutions. Relevant adsorption onto soils, sediments or suspended matter is not expected.

Human Health Toxicity Summary [1]	
Chronic Repeated Dose Toxicity	Based on the data available for sodium metabisulfite, Sulfites are not considered to cause serious damage to health by repeated oral and inhalation exposure. In an 8-week study, SD rats (normal and sulfite oxidase enzyme—which oxidises sulfite to sulfate—deficient) were exposed to sodium metabisulfite (CAS No. 7681-57-4) or a mixture containing sodium metabisulfite and acetaldehyde hydroxysulfonate, in drinking water at doses of 0, 7, 70 or 175 mg/kg bw/day (as SO2). A no observed effect level (NOEL) for sodium metabisulfite was established as 70 mg/kg bw/day (as SO2) for all treated rats (normal and enzyme deficient), based on severe gastric lesions, significant body weight reduction and increased urine excretion with sulfites observed at the highest dose. The NOEL for the mixture was 7 mg/kg bw/day (as SO2) for enzyme-deficient rats, based on severe gastric and hepatic lesions at higher doses. At necropsy, lung oedema was observed in sodium metabisulfite treated, enzyme-deficient rats (Hui et al., 1989 cited in CIR, 2003). Groups of six rats (Sprague Dawley) were exposed to sodium sulfite (CAS No: 7757-83-7) aerosols with a particle size of approximately 1 µm at concentrations of 0.1, 1, 5 or 15 mg/m3 for three days. Mild pulmonary oedema at 5 mg/m3 and irritation of the tracheal epithelium at 15 mg/m^3 were observed (CIR, 2003). In a repeated dose study, eight dogs (beagle) were exposed to 1 mg/m3 of sodium metabisulfite (CAS No: 7681-57-4) aerosols with a mass median aerodynamic diameter (MMAD) of 0.63 µm for 290 days. Severe epithelial changes were observed with hyperplastic foci in the respiratory region of the nasal cavity. An increase in the nonciliated cell numbers in the membranous portion of the trachea of the animals was also observed. No other effects were reported (CIR, 2003).
Carcinogenicity	Based on a 104-week repeated dose toxicity study in rats, with up to 2 % sodium bisulfite in the diet, sodium bisulfite is not considered carcinogenic to rats (OECD, 2001).
Mutagenicity/ Genotoxicity	Based on the data available, Sulfites are not considered to be genotoxic. A mixture of sodium bisulfite (CAS No. 7631-90-5) and sodium sulfite (1:3) was tested at concentrations of 0.05–1 mmol/L in human peripheral lymphocytes. Positive results were obtained for chromosomal aberrations: micronucleus formation, and sister chromatid exchange (WHO, 1999). In an in vitro unscheduled DNA synthesis test with rat hepatocytes (OECD TG 486), and in an in vivo micronucleus test (OECD TG 474), sodium bisulfite (CAS No. 7631-90-5) did not show any evidence of mutagenicity (SCCNFP, 2003). Sodium bisulfite gave both positive and negative results in the mutagenicity testing. The positive results in Salmonella typhimurium strains containing his-G46 and his-D6610 mutations, and in some E.coli strains were suggested to be due to the presence of sulfurous acid under acidic conditions. At a neutral pH and lower concentrations, sodium bisulfite was not mutagenic to these strains. However, sodium bisulfite alone gave negative results in all in vivo studies with mammalian systems (rats and mice) (CIR, 2003).
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	Based on the data available, Sulfites are not considered to cause reproductive or developmental toxicity. Pregnant rats (Wistar) were exposed by gavage to sodium bisulfite (CAS No. 7631-90-5) at 0, 1, 5, 24, or 110 mg/kg bw/day on days 6–15 of gestation. The NOAEL for maternal toxicity or embryo foetotoxicity was 110 mg/kg bw/day. A NOAEL of 123 mg/kg bw/day was established in a study with pregnant rabbits (Dutch belted) exposed to sodium metabisulfite (CAS No. 7681-57-4) at 0, 1.23, 5.71, 26.5 or 123 mg/kg bw/day on days 6–18 of gestation. In both these studies, there were no treatment related effects reported on nidation (nesting behaviour), maternal or foetal survival. The number of abnormalities in soft or skeletal tissues of the treated groups were similar to controls (OECD, 2001).

Acute Toxicity	Sodium bisulfite has an oral LD50 of 2000 mg/kg bw in rats (ChemIDplus). Based on the limited data available, sulfites are considered to be of low acute dermal toxicity. The LD50 for sodium metabisulfite in rats is >2000 mg/kg bw. Sulfites exhibit low acute toxicity in animal tests (US EPA, 2007). Based on the limited data available, no conclusion can be made on the acute inhalation toxicity of the chemicals in this group. A group of guinea pigs was exposed (whole body) for one hour to 0.204, 0.395 or 1.152 mg/m^3 of sodium sulfite (CAS No. 7757-83-7) aerosols with a mass median aerodynamic diameter (MMAD) of 0.36 µm. The chemical caused dose-related changes in the lung capacity parameters (bronchoconstriction) with a lowest observed adverse effect concentration (LOAEC) of 0.204 mg/m^3 (Chen et al., 1987 cited in CIR, 2003). Sodium bisulfite are classified as hazardous with the risk phrase 'Contact with acid liberates toxic gas' (Xi; R31) in the Hazardous Substances Information System (HSIS) (Safe Work Australia).
Irritation	No data are available on respiratory tract irritation from a single exposure. A 3-day repeated dose study indicated irritation of the tracheal epithelium in rats from exposure to sodium sulfite (CAS No. 7757-83-7) aerosols at 15 mg/m^3 (CIR, 2003). In acute dermal irritation studies (OECD TG 404) with sodium sulfite, sodium bisulfite and potassium sulfite, no skin irritation was observed in albino rabbits (SCCNFP, 2003). In acute eye irritation studies (OECD TG 405) with sodium sulfite and sodium bisulfite in rabbits, slight to severe effects in the cornea and the iris in most of the exposed animals persisted during the observation periods (eight and 15 days, respectively). Slight to moderate conjunctival effects (erythema and oedema) were also observed up to the end of the observation periods. Due to the persistency of eye effects, especially of increased corneal opacity, both chemicals were considered as severe eye irritants (SCCNFP, 2003).
Sensitisation	Based on the available data, Sulfites are not likely to be skin sensitisers.
Health Effects Summary	Severe eye irritation effects; acute oral toxicity; and the possibility of liberating toxic gas when the chemical is in contact with acids. Sensitivity to sulfites that causes allergic reactions in a small percentage of the population should also be considered.
Key Study/Critical Effect for Screening Criteria	The main critical effects to human health are severe eye irritation and acute oral toxicity. The chemicals in this group will liberate toxic gas when in contact with acid and therefore may cause effects in individuals with a high acid content in the stomach. A small percentage of the population (up to 1 %) are sensitive to sulfites (FDA, cited in Grotheer et al., 2005). Those who have asthma are most at risk to sulfite sensitivity and other forms of sulfite reactions. This sensitivity can cause a wide range of allergic reactions ranging from mild to severe.
Ecological Toxicity [2]	
Aquatic Toxicity	Acute and chronic toxicity data were available for the three main aquatic trophic levels that are considered for classification purposes. Classification is based on the lowest acute and chronic value, referred to as the acute and chronic toxicity reference value (TRV). The lowest acute effect concentration was observed for the alga S. subspicatus (72h-EC50), and was 36.8 mg sodium sulfite/L. Translating this value to HNaSO3 results in an acute TRV of 47.9 mg/L for this substance. For sulfite/disulfite compounds, the lowest chronic value was a NOEC of >8.41 mg sodium sulfite/L for the invertebrate D. magna. Translating this value to HNaSO3 results in a chronic TRV of 10.9 mg/L for this substance, i.e., > 1 mg/L.

Determination of PNEC aquatic	The lowest value for chronic toxicity was and unbounded NOEC of 8.41 mg sodium sulfite/L. Applying the AF of 10 results in a PNECaquatic of 0.84 mg sodium sulfite/L.Translating this value to HNaSO3 gives a PNECaquatic of 1.09 mg test substance/L. As the lowest NOEC-value is an unbounded value (i.e., no effect was noted at the highest test concentration), this value can be considered as a worst-case estimate. Further refinement of the NOEC-value for daphnids could increase the PNECaquatic up to a maximum value of 2.8 mg sodium sulfite/L (i.e., an assessment factor of 10 on the algal 72h-EC10 value), which is equivalent to 3.64 mg test substance/L.
Current Regulatory Controls [1]	
Australian Hazard Classification	Sodium bisulfite is classified as hazardous with the following risk phrases for human health in the Hazardous Substances Information System (HSIS) (Safe Work Australia): Sodium bisulfite (CAS No. 7631-90-5): Xn; R22 (acute toxicity) Xi; R31 (contact with acid liberates toxic gas)
Australian Occupational Exposure Standards	Sodium bisulfite has an exposure standard of 5 mg/m^3 time weighted average (TWA). The exposure standard for sulfur dioxide of 5.2 mg/m^3 (2 ppm) (TWA) is also relevant to uses of these chemicals that may generate sulfur dioxide.
International Occupational Exposure Standards	An exposure limit (OEL, TWA, STEL, PEL or STV) of 5–10 mg/m^3 in different countries such as USA, United Kingdom, Canada, Ireland, Spain, Norway and Switzerland.
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	No data available.
PBT Assessment [2]	
P/vP Criteria fulfilled?	Not applicable (inorganic substance)
B/vB criteria fulfilled?	Not applicable (inorganic substance)
T criteria fulfilled?	Not applicable (inorganic substance)
Overall conclusion	Not PBT
Revised	January 2019

References

1. National Industrial Chemicals Notification and Assessment Scheme (NICNAS). IMAP, Human Health Tier II Assessment for Ethoxylates of aliphatic alcohols (>C6): Retrieved 2019: https://www.nicnas.gov.au
2. ECHA REACH, Sodium hydrogensulfite, Retrieved 2019: https://echa.europa.eu/

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Toxicity Summary - Sodium chloride

Chemical and Physical Properties [1,4]	
CAS number	7647-14-5
Molecular formula	NaCl
Molecular weight	58.44 g/mol
Solubility in water	3.57 x 10 5 g/m3 at 25oC
pH	In aqueous solution is neutral
Melting point	1 mm Hg at 865oC
Boiling point	1670 ^{o}C
Vapour pressure	No data found
Henrys law constant	No data found
Explosive potential	Not explosive
Flammability potential	Not flammable
Colour/Form	light brown liquid or colourless crystals
Overview	Sodium, together with potassium is an essential mineral for the regulation of body fluid balance. Sodium is the most abundant cation in the extracellular fluid and sodium salts account for more than 90% of the osmotically active solute in the plasma and interstitial fluid. Consequently, sodium load is the major determinant of extracellular volume. Chloride is also important in maintaining the fluid balance and is an essential component of the gastric and intestinal secretions Sodium chloride occurs naturally as rock salt which comprises 95% to 99% NaCl. It is also widely used in food products. The NHMRC has established dietary guidelines for the intake of sodium per day (adults should consume less than 2300 mg sodium per day). This chemical has been identified by NICNAS to be of low concern to human health based on an initial screening approach and thus required no further assessment.
Environmental Fate [2,3]	
Soil/Water/Air	Due to its high solubility, sodium chloride is highly mobile in the environment. Once dissociated, chloride ions will migrate readily, however sodium ions will sorb to clay-rich materials limiting mobility. If released into the environment, sodium chloride is not likely to sorb to solid particles in the water column, is readily dissociated to form chloride and sodium ions, is not bioaccumulative in aquatic species or the food chain.

Human Health Toxicity Summary [2,3]	
Chronic Repeated Dose Toxicity	High sodium chloride intakes increase calcium excretion and may increase the risk of kidney stone formation. There is evidence for a causal relationship between the consumption of sodium (mainly from common salt) and both blood pressure and the age-related rise in blood pressure. Data suggest that30% of a normotensive population may be salt sensitive. Sodium chloride has been demonstrated to be a gastric tumour promoter in experimental animals and high sodium chloride intakes have been associated with incidence of stomach cancer in human populations with traditional diets of highly concentrated, salted foods.
Carcinogenicity	Not listed with IARC.
Mutagenicity/ Genotoxicity	No data available.
Reproductive Toxicity Developmental Toxicity/Teratogenicity	No data available.
Acute Toxicity	No data available.
Irritation	Although rare, acute toxicity may be caused by ingestion of 500 – 1000 mg sodium chloride/kg body weight. Symptoms include vomiting, ulceration of the gastrointestinal tract, muscle weakness and renal damage, leading to dehydration, metabolic acidosis and severe peripheral and central neural effects.
Sensitisation	No data available.
Health Effects Summary	Sodium is an essential mineral for the regulation of body fluid balance. This chemical has been identified by NICNAS to be of low concern to human health.
Key Study/Critical Effect for Screening Criteria	The Australian drinking water guideline value for sodium and chloride may apply.
Ecological Toxicity [2,3,4]	
Aquatic Toxicity	A large number of studies are available in relation to the aquatic toxicity of sodium chloride with the USEPA ECOTOX database identifying 1712 records. The evaluation of ecological effects of sodium chloride has been evaluated in detail for the assessment of the use of rock salt in the US on roadways during the winter months. The following has been summarised from the US review: The presence of sodium chloride may result in the increased mobilisation of other contaminants (metals, nutrients etc) and a shift in the acid buffering capacity may compromise aquatic ecosystems. Most sensitive species are birds where a safe concentration of 1000 mg/L sodium chloride can be established. Salt tolerance of aquatic species varies significantly with EC50 concentrations ranging from 400 to 30000 mg/L. The measured acute endpoint for Fish was reported at 1290 mg/L. The measured NOEC for Daphnia is 314 mg/L.
Determination of PNEC aquatic	PNECaquatic: On the basis of the chronic results for Daphnia, an assessment factor of 100 has been applied to the lowest reported effect concentration of 314 mg/L. The PNECaquatic is determined to be 3.14 mg/L.
Current Regulatory Controls	
Australian Hazard Classification	No data available
Australian Occupational Exposure Standards	No data available
International Occupational Exposure Standards	No data available
Australian Food Standards	No data available

Australian Drinking Water Guidelines	No data available
Aquatic Toxicity Guidelines	No data available
PBT Assessment [4]	
P/vP Criteria fulfilled?	Sodium chloride is an organic salt that dissociates completely to sodium and chloride ions in aqueous solutions. Biodegradation is not applicable to these inorganic ions; both sodium and chloride ions are also ubiquitous and are present in most water, soil and sediment. The persistent criteria is not considered applicable to this inorganic salt.
B/vB criteria fulfilled?	Sodium and chloride ions are essential to all living organisms and their intracellular and extracellular concentrations are actively regulated. Thus, sodium chloride is not expected to bioaccumulate.
T criteria fulfilled?	The measured chronic toxicity data for sodium chloride was 314 mg/L for Daphnia Thus, sodium chloride does not meet the screening criteria for toxicity.
Overall conclusion	Not PBT
Revised	April 2018

References

1. HSDB (n.d.). *Hazardous Substances Data Bank*. Retrieved 2015, from Toxnet, Toxicology Data Network, National Library of Medicine: http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB
2. UK 2003. Expert Group on Vitamins and Minerals, Risk Assessment - Sodium Chloride
3. US, 2007. Hazard Identification for Human and Ecological Effects of Sodium Chloride Rock Salt. Prepared by the New Hampshire Department of Environmental Services
4. Department of the Environment and Energy 2017 , National assessment of chemicals associated with coal seam gas extraction in Australia, prepared by the National Industrial Chemicals Notification and Assessment Scheme

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Toxicity Summary - Sodium hydroxide

Chemical and Physical Properties	
CAS number	1310-73-2
Molecular formula	Na-O-H
Product name	40 g/mol
Molecular weight	1.11E+06 mg/L at 20C
Solubility in water	13
Melting point	318 °C
Boiling point	1388 °C
Vapour pressure	Negligible at 25 deg C
Henrys law constant	No data found.
Explosive potential	No
Flammability potential	No
Colour/Form	Anhydrous (pure) NaOH is a solid – *refer melting point above*. However it is a hygoscopic, ionic solid, and will absorb water from air and is highly soluble
Incompatibility	Avoid contact of solid NaOH with water due to strong exothermic reaction, leather, wood, acids, organic halogen compounds or organic nitro compounds. Carbon monoxide gas can form upon contact with reducing sugars, food and beverage products in enclosed spaces. NAoH is neither explosive, flammable, nor oxidising.
Overview	Vegetable oil refining, regenerating iron exchange resins, organic fusions, peeling of fruits and vegetables in the food industry, etching and electroplating.
Environmental Fate[1]	
Soil/Water/Air	Sodium hydroxide is highly soluble, not volatile and unlikely to materially adsorb to soil and is therefore predominately found in the aquatic environment if released to the environment. NaOH will readily dissociate to be present in the environment as sodium and hydroxyl ions, both being ubiquitous in the environment. NaOH is a strong alkali, so it's dissolution in water may locally raise the pH of the affected environment. The dissolution reaction is also strongly exothermic.

Human Health Toxicity Summary [1,2,,3]	
Chronic Repeated Dose Toxicity	No animal data are available on repeated dose toxicity studies by oral or dermal routes for sodium hydroxide. In a repeat dose inhalation study, twenty seven white rats died within a month, mostly from bronchopneumonia, after being exposed twice weekly to an aerosol of unknown airborne concentration of sodium hydroxide, generated from an aqueous 40% sodium hydroxide solution (NIOSH 1975). When exposed to an aerosol generated from a 20% sodium hydroxide solution, the bronchi were dilated, the epithelial cover was thin and frequently desquamated, and the septa were dilated and cracked. A light round cell infiltration of the sub-mucus membrane tissue was also observed. Few changes occurred in a group of rats exposed to aerosols from 10% sodium hydroxide, but rats exposed to an aerosol of 5% sodium hydroxide had dilation of the bronchi and a slight degeneration of the mucus membrane and thickened strata of lymphadenoid tissue surrounding the bronchi. A NOAEL could not be established in this study. Workers exposed to 0.24 to 1.86 mg/m^3 sodium hydroxide for 2 to 15 minutes reported throat irritation and watery eyes (NIOSH 1975). Based on the observations of the irritant effects on workers exposed to 1 to 40 mg/m^3 sodium hydroxide, it was concluded that 2 mg/m^3 represented a concentration that is 'noticeably but not extensively irritant' (NIOSH 1975). Obstructive airway disease has been reported following chronic occupational exposure to sodium hydroxide mist (IPCS 1996). The patient developed cough, dyspnoea and tachypnoea after a 20-year exposure to sodium hydroxide.
Carcinogenicity	IARC Category 3 - not classifiable as to human carcinogenicity
Mutagenicity/ Genotoxicity	In vitro and vivo genetic toxicity testing reported no evidence of mutagenic activity.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	No valid studies were identified regarding reproduction toxicity after oral, dermal or inhalation exposure to NaOH. Sodium hydroxide is not expected to be systemically available to the body under normal handling and use conditions.
Acute Toxicity	Exposure to the solid or concentrated liquid can cause severe burns to the eyes, skin and gastrointestinal tract which may cause death. An oral LD50 of a 1-10% solution of NaOH in rabbits was 325 mg/kg bw (as 100% NaOH). An oral LD50 of 140 to 340 mg/kg in rats has also been reported (National Research Council 2011), however details of the study are not available. In an acute dermal study, mice were treated dermally with 50% sodium hydroxide, and the treated area was irrigated with water at various intervals (OECD 2002). The mortality of mice was 20, 40, 80 and 71% when they were irrigated at 30 minutes, one hour, two hours or not at all after the application. All animals developed rapidly progressive burns. No mortality or burns were observed when the treated area was irrigated immediately after the application. A 5% aqueous solution of sodium hydroxide produced severe necrosis when applied to the skin of rabbits for four hours (Clayton and Clayton 1993). A dermal LD50 of 1350 mg/kg has been reported in rabbits (National Research Council 2011), however details of the study are not available. Caustic dusts are irritating to the upper respiratory system. Prolonged exposure to high concentrations may cause discomfort and ulceration of nasal passages. Cases of fatality due to ingestion of liquid sodium hydroxide have been reported in humans.
Irritation	Sodium hydroxide is a corrosive irritant to skin, eyes and mucous membranes. A NaOH solution of 8% can be considered corrosive based on animal data. Human data indicate that concentrations of 0.5 to 4% were irritating.
Sensitisation	Sodium hydroxide has no skin sensitisation potential.

Health Effects Summary	An oral LD50 of 325 mg/kg in rats and a dermal LD50 of 1350 mg/kg in rabbits were reported for sodium hydroxide. Lethality has been reported in animals at oral doses of 240 mg/kg bw. Inhalational LC50 is not available. Sodium hydroxide is corrosive to skin, eyes and gastrointestinal and respiratory tracts. Based on human data, concentrations of 0.5 to 4.0% are irritating to the skin, while a concentration of 8.0% is corrosive. Sodium hydroxide is not a skin sensitiser. No animal data were available on repeated dose toxicity by oral or dermal routes for sodium hydroxide. In the single reported repeat dose inhalation study, a NOAEL could not be established. Both in vitro and in vivo genetic toxicity tests indicated no evidence of a mutagenic activity. Information is not available on reproductive and developmental toxicity and carcinogenicity of sodium hydroxide. Due to dissociation into ions which are subject to homeostatic controls in the human body, systemic effects from repeated exposures to sodium hydroxide are not expected. The critical health effect of sodium hydroxide is its corrosive effect.
Key Study/Critical Effect for Screening Criteria	No oral TRV apply. Acute toxicity only (irritant and corrosive), not systemically available in body. The Australian drinking water guideline value for pH may apply to sodium hydroxide.
Ecological Toxicity [1,2,3]	
Aquatic Toxicity	Measured acute endpoints were available for fish (196 mg/L). Measured chronic endpoint were available for Daphnia (240 mg/L)
Determination of PNEC aquatic	An assessment factor of 10 has been applied to the lowest reported NOEC of 240 mg/L for Daphnia. The PNECaquatic is 24 mg/L.
Current Regulatory Controls[4]	
Australian Hazard Classification	C: R35 (Corrosive, causes severe burns)
Australian Occupational Exposure Standards	Sodium hydroxide has an exposure standard of 2 mg/m³, Time Weighted Average (Safe Work Australia 2013).
International Occupational Exposure Standards	Occupational Exposure Limit (OEL) or limit values in working environment of 2 mg/m³ [Argentina, Belgium, Bulgaria, Canada, China, India, Japan and the US (NIOSH 1975)]. Occupational exposure standard: 2 mg/m³ [Korea] Occupational exposure limit values: 0.5 mg/m³ [Latvia] Short Term Exposure Limit (STEL): 2 mg/m³ [UK] US Department of Energy Temporary Emergency Exposure Limits (TEELs) = 0.5 mg/m³ (TEEL-0 and TEEL-1), 5 mg/m³ (TEEL-2) and 50 mg/m³ (TEEL-3).
Australian Food Standards	Processing aids - Generally permitted - permitted for use as acidity regulator (FSANZ 2013). Sodium hydroxide is allotted an International Numbering System (INS) of food additives number: INS 524 (Food Standards Australia New Zealand 2013).
Australian Drinking Water Guidelines	No data found. However, since sodium hydroxide readily dissociates in water into sodium and hydroxyl ions, the Australian Drinking Water Guidelines for sodium state that, based on aesthetic considerations (taste), the concentration of sodium in drinking water should not exceed 180 mg/L (National Health and Medical Research Council (NHMRC) 2011). No health-based guideline value is proposed for sodium.
Aquatic Toxicity Guidelines	No data found.
Occupational Exposure Limits	Peak limitation – 2 mg/m^3
PBT Assessment	
P/vP Criteria fulfilled?	Not applicable (inorganic salt, ionic species ubiquitous in environment)
B/vB criteria fulfilled?	Not applicable. Bioaccumulation is not applicable to these inorganic ions; sodium and hydroxide ions are ubiquitous and are present in most water, soil and sediment.

T criteria fulfilled?	Not applicable. Chronic toxicity data >1 mg/L in invertebrates, thus sodium hydroxide does not meet the screening criteria for toxicity.
Overall conclusion	Not PBT

References

1. OECD SIDS Sodium Hydroxide, UNEP Publications, March 2002
2. HSDB (n.d.). *Hazardous Substances Data Bank*. Retrieved March 2015, from Toxnet, Toxicology Data Network, National Library of Medicine: http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB
3. European Commission (EC) Joint Research Centre (JRC) Institute for Health and Consumer Protection - European Chemical Substances Information System (ESIS), Sodium Hydroxide, Summary Risk Assessment Report, 2008
4. Safe Work Australia, Hazardous Substances System, sodium hydroxide

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Toxicity Summary - Sodium iodide

Chemical and Physical Properties [1,2,3]	
CAS number	7681-82-5
Molecular formula	INa
Molecular weight	149.92
Solubility in water	165 – 1,800 g/L @ 25 °C
Melting point	651 - 659 °C at 101.3 kPa
Boiling point	1,304 °C at 101.3 kPa
Vapour pressure	-1.301 @ 25 °C
Henrys law constant	0.015 Pa.m³.mol-1 @ 25 °C
Explosive potential	Non explosive
Flammability potential	Non flammable
Colour/Form	Solid, colourless cubic crystals, odourless
Overview	Iodides are used by the thyroid gland in hormone production. Iodides have been utilized to treat iodine disorders, hyperthyroidism, bacterial, fungal or protozoal infections and also were traditionally as expectorants because of their stimulatory effects on bronchial secretions. A Tier 1 Human Health Assessment for this chemical has been conducted by NICNAS which concluded that it was low concern to human health.
Environmental Fate [2]	
Soil/Water/Air	Sodium iodide is very stable under ordinary conditions of use and storage. The phototransformation in air is irrelevant to sodium iodide, because few sodium iodide can be distributed in air for the low vapour pressure and high water solubility. Hydrolysis is not a concern to such inorganic substance which can be completely ionized in water phase. sodium iodide will completely dissociate in water giving sodium ion and iodide anion. The sodium iodide is readily absorbed by organisms as Na+ and I-, which are both small (an)ions and well known to not likely to be bioaccumulative. Based on the intrinsic prosperities of sodium iodide, the substance can be expected to have a low potential for adsorption (completely ionized to small ions in water phase). The sodium ion and iodide anion are uniformly distributed in water phase. In the air, these two basic (an)ions is negligible, due to high water solubility and low vapour pressure. To sediment and soil phases, these two (an)ions are mostly distributed in the pore water.
Human Health Toxicity Summary [1]	

Chronic Repeated Dose Toxicity	The most likely route for human exposure is via digestion, so the dermal and inhalation route are irrelevant in the repeated toxicity assessment. Boyages et al. (1989) compared thyroid status in groups of children 7–15 years of age who resided in two areas of China where drinking-water iodide concentrations were either 462.5 µg/l (n = 120) or 54 µg/l (n =51). Urinary iodine concentrations were 1236 µg/g creatinine in the high-iodine group and 428 µg/g creatinine in the low-iodine group. Although the subjects were all euthyroid, with normal values for serum thyroid hormones and TSH concentrations, TSH concentrations were significantly higher ($P < 0.05$) in the high-iodine group. The high-iodine group had a 65% prevalence of goitre and a 15% prevalence of Grade 2 goitre compared with 15% for goitre and 0% for Grade 2 goitre in the low-iodine group. To transform the measured urinary iodine levels into estimates of iodine intakes, steady state baseline dietary intakes of iodide were assumed to be equivalent to the reported 24 h urinary iodine excretion rates. Assuming a body weight of 40 kg and lean body mass of 85% of body weight, the urinary iodine/creatinine ratios reported by Boyages et al. (1989) can be converted to approximate equivalent intake rates of 1150 µg/day (0.029 mg/kg body weight per day) and 400 µg/day (0.01 mg/kg body weight per day) for the high- and low-iodine groups, respectively. Thus, the NOAEL for this study is considered to be 0.01 mg/kg body weight per day. From the Boyages et al. (1989) study, supported by the studies of Gardner et al. (1988), Paul et al. (1988), and others, a TDI of 0.01 mg/kg body weight, based upon reversible subclinical hypothyroidism, can be established by dividing the NOAEL of 0.01 mg/kg body weight per day by an uncertainty factor of 1.
Carcinogenicity	A chronic toxicity and carcinogenicity study, in which male and female F344/DuCrj rats were administrated iodide (KI) in the drinking water at concentrations of 0, 10, 100 or 1000 ppm for 104 weeks was conducted. In the test, neither focal hyperplasias, adenomas nor carcinomas derived from the follicular epithelium were increased, despite the fact that iodide was administered for 2 yr. It was therefore concluded that long-term treatment of iodide per se does not result in thyroid tumour induction in rats. In contrast, SCCs were observed in the submandibular gland in the 1000 ppm groups of both sexes, along with focal acinar atrophy and/or ductular proliferation, frequently accompanied by squamous metaplasia. Based on the fact that the cell proliferation of these proliferating ductules was higher in cases with metaplasia, and the evidence of a morphological continuum from meta-plasias to squamous cell carcinomas, a histogenetic relationship is suspected, which was also described in previous investigation (Takegawa et al., 1998). Based on these findings, it suggests that excess iodide has a thyroid tumour-promoting effect, but iodide per se does not induce thyroid tumours in rats. In the salivary gland, iodide was suggested to have carcinogenic potential via an epigenetic mechanism, only active at a high dose (1000 ppm in drinking water). The default value of volume of drinking water for rat is well accepted of 10 ml/100g bw·day, and the average body weight for rat is 250g. Based on these the LOAEL for salivary glands for carcinogenicity is proposed to be 100 mg/kg bw·day of iodide by drinking water

Mutagenicity/ Genotoxicity	The mutagenic potential for iodide (in potassium iodide) was studied using the L5178Y mouse (TK+/-) lymphoma assay (Kessler et al., 1980), The established mutagens ethylmethanesulphonate (EMS) and dimethylnitrosamine (DMN)were highly active in this assay, whereas iodide (KI) was inactive. Using the BALB/c 3T3 transformation assay well assessed the transformational capacities of these same agents and the positive mutagen N-ethyl-N-nitro-N-nitrosoguanidine (MNNG). All concentrations of the iodide tested were inactive in this assay it can be concluded that KI did not possess any biologically significant mutagenic cell transforming ability. Another study (J.M. Poul, and P. Sanders, 2004) on genotoxic effects of potassium iodide was conducted in vitro using the alkaline comet assay at concentration of 0.625, 1.25, 2.5, 5 and 10 mM. Additionally in the test cell viability was also measured using the Trypan blue exclusion method and expressed as proportion of total cells. The test results showed that potassium iodide did not induced DNA damage or cytotoxicity in the alkaline comet assay for doses up to 10 mM. In the same study, the chromosome damage effects of potassium iodide were evaluated in vitro using cytokinesis-block micronucleus test at concentration of 0.625, 1.25, 2.5, 5 and 10 mM. Additionally in the test cytotoxicity was also measured by the binucleated (BN) cell ratio between treated and control slides. The test results showed that potassium iodide did not induce chromosome damage or cytotoxicity in the alkaline comet assay for doses up to 10 mM. In an in vivo chromosome aberration test on embryonic hepatocytes, Stable iodine of 10 mg/kg is administered to the rats 7 days after fertilization. Then the embryonic liver was homogenated and the cells in metaphase were stained and checked under metaphase. The chromosome aberration cells were counted respectively for the concentration group and control group. The chromosome aberration rate in the concentration group was compared with that in the control group. The result showed there was no significant difference between iodide dosed group with the control group. Therefore, it can be concluded that the iodide has neither genetic toxicity nor cytotoxicity to mammalian cells.

Reproductive Toxicity / Developmental Toxicity/Teratogenicity	Iodide (KI) was fed to male and female rats before and during breeding, to females only during gestation and lactation, and to their offspring after weaning (day 21 after birth) through to day 90, at levels of 0, 0.025, 0.05 or 0.1% (w/w) of the diet. There was no evidence suggesting that potassium iodide was embryotoxic. Litter size was significantly reduced, but birth weights and external morphology among those born alive were not significantly altered. No change in thyroid weight was observed indicating that these doses were not overtly thyrotoxic. Thyroid hormones were not assessed, however, and it is possible that thyroid function could have been altered in these animals. Nevertheless, the data are consistent with a picture of impaired thyroid function. Several tests of post-weaning behaviour showed effects at the lowest dose, 0.025 % potassium iodide. M-maze errors were increased at this dose and rotorod performance decreased. However, because these effects were not found at the higher doses it appears unlikely that they were related to potassium iodide. At present, these effects can only described as 'false positives'. The only effect on post-weaning behaviour that appeared to be consistently related to potassium iodide exposure was the reduction in nocturnal running-wheel activity found among the tested females. It may be that female cyclicity makes them more sensitive to the influence of chronic moderate iodide exposure than males and this could explain the contrast with the results of an acute test of activity and exploration, the open-field test, on which no consistent iodide-related effects were found. According to REACH guidance “R 10.8 of Guidance on information requirements and chemical safety assessment Chapter R.10: Characterisation of dose [concentration]-response for environment” The NOAEL can be calculated with the equation R 10-7:NOAEL(mg/kg bw day) = NOEC (mg/kg food)/CONV Where NOEC (mg/kg food) is 0.1, and CONV for Rattus norvegicus (> 6 weeks) is 20, and 10 for Rattus norvegicus (≤6 weeks). Therefore under this study the NOAEL for rats is 50 mg/kg bw day (developmental). In another study, twenty-five thyroiditis-prone BB/W rats were prenatally and postnatally exposed to iodine in drinking-water at dosages equivalent to 0, 0.059, or 59 mg/kg body weight per day for about 12 weeks. An increase in the number of lysosomes and lipid droplets was observed in the treated animals, especially in the higher exposure group. However, the test organism is not healty, as well as not enough information in the study, the effects cannot be considered to be dose related. Additionally, old studies were conducted with rabbits hamsters, rats and swine (Arrington LR, et al., 1965) to determine the effects of excess iodine intake. Females were bred to normal males, potassium or sodium iodide was added to the diet during the latter portion of gestation and the females were permitted to litter normally. Observations were made for length of gestation, parturition time, lactation and survival of young. 250 to 1000 ppm iodide fed for 2 to 5 days caused increasing mortality of new born rabbits. Hamsters were not affected by 2500 ppm iodine except for slightly re duced feed intake and decreased weaning weight of the young. Gestation time for rats and hamsters was not affected by iodine. Female rats and rabbits re-bred after removal from dietary iodine produced and nursed litters normally. Swine were not affected by dietary levels of iodine which were toxic to rabbits and rats. In conclusion, the iodide is not reproductive, embryonic toxicity, but the developmental toxicity was showed under concentration of 0.1% in diet, corresponding NOAEL as 50 mg/kg bw day (developmental).

Acute Toxicity	The most relevant study on vertebrates by oral route is a company study (A. Hausner, G. Weise, and A. Hofmann, 1980). In the test the effects of iodide were studied in male and female Wistar rats. 10 male and 10 female in each dose and control groups were administrated with potassium iodide for 14 days at dose of 0 (control), 2000, 2500, 2800 3200, 3600, and 4000 mg/kg body weight mg/kg bw respectively. The key value of LD50 was calculated by Probit-analysis (Fink und Hund 1965). It shows the 24 hour and 7-14 days of LD50 to rats (male/female) was respectively 3118 and 2779 mg/kg bw under test conditions. Therefore the key value which is used in the hazard classification and chemical safety assessment is 3118 mg/kg bw.
Irritation	Iodine has been used for dermal application in human as disinfectant (as Iodine and Povidine Iodine) for long time. The mechanism of disinfecting is oxidizing bactericide by iodine; meanwhile the iodine is reduced to iodide. It means after application of iodine on skin, the iodide is left on skin. In addition, based on information from assessment report of WHO, in a human assay, five patients were applied with potassium iodide in concentrations ranging from 5% to 20% in petrolatum, the reactions were negative. With such evidence, it can be concluded that iodide has no effect to the human skin.
Sensitisation	No adverse effect observed (not sensitising) for skin and respiratory sensitisation.
Health Effects Summary	This chemical has been identified by NICNAS to be of low concern to human health
Key Study/Critical Effect for Screening Criteria	TDI of iodide is 0.01 mg/kg body weight.
Ecological Toxicity [2]	
Aquatic Toxicity	The 96 hours acute toxicity test to Rainbow Trout (Laverock, M.J., M. Stephenson, and C.R. MacDonald, 1995) was conducted according to Protocol to determine the acute lethality of liquid effluents to fish, which was established by Ontario Ministry of the Environment. The results showed that the 96 hour LC50 is over 860 mg/l. The acute toxicity to daphnia of iodide was determined (INERIS Parc Technologique ALATA, 2012) according to OECD test guideline 202 following GLP procedure to give a result of 48hrs-EC50 as 1.27 mg/L (95%CL, 1.19 -1.38 mg/L). There is another data on daphnia acute toxiciy (Laboratoire d'Ecotoxicologie Parc technologique ALATA, 1996) of KI according to method of “French standard”, which was similar to OECD test guideline 202, which is 48 hrs- EC50 as 7.5 mg/l. As the study for NaI gives lower tolerance value for daphnia and the test itself is more reliable (Klimisch score 1), the 48 hrs- EC50 of 1.27 mg/l is taken as the key value. One study of acute toxicity of iodide to algae was published in well-known journal “water research” (Bringmann, G., and R. Kuhn, 1980). It was not a standard test and without declaration of GLP compliance, and in the test the 7 days cell multiplication inhibition test was applied to the model organism, Scenedesmus quadricauda (green algae) for iodide, but fulfilled basically scientific principles. The results showed the toxicity threshold (≥3% inhibition of the biomass of green algae) of iodide to green algae is 2370 mg/l.
Determination of PNEC aquatic	PNECaquatic: On the basis of the acute results for Daphnia, an assessment factor of 100 has been applied to the lowest reported effect concentration of 1.27 mg/L. The PNECaquatic is determined to be 1.27 µg/L.
Current Regulatory Controls	
Australian Hazard Classification	No data available.
Australian Occupational Exposure Standards	No data available.

International Occupational Exposure Standards	No data available.
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	No data available.
PBT Assessment [2]	
P/vP Criteria fulfilled?	Not applicable (inorganic salt, ionic species ubiquitous in environment).
B/vB criteria fulfilled?	Not applicable. Bioaccumulation is not applicable to these inorganic ions; sodium and iodide ions are ubiquitous and are present in most water, soil and sediment.
T criteria fulfilled?	Not applicable. Acute toxicity data >0.01 mg/L in invertebrates, thus sodium iodide does not meet the screening criteria for toxicity.
Overall conclusion	Not applicable.
Revised	January 2019

References

1. National Industrial Chemicals Notification and Assessment Scheme (NICNAS). IMAP, Human Health Tier 1 Assessment. Retrieved 2019: https://www.nicnas.gov.au
2. ECHA REACH, Sodium iodide, Retrieved 2019: https://echa.europa.eu/
3. HSDB (n.d.). Hazardous Substances Data Bank. Retrieved 2015, from Toxnet, Toxicology Data Network, National Library of Medicine: http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB

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Toxicity Summary - Sodium Persulfate

Chemical and Physical Properties[1,2,3,4]	
CAS number	7775-27-1
Molecular formula	Na2O8S2
Molecular weight	238
Solubility in water	730 g/l at 25 °C
Melting point	Decomposes at > 180°C
Boiling point	No data available
Vapour pressure	0 Pa at 25 °C (negligible)
Henrys law constant	No data available
Explosive potential	Non-explosive
Flammability potential	Non-flammable
Colour/Form	White crystals or powder
Overview	The persulfates category includes molecules with similar chemical structure and similar physical-chemical properties. Substances of the persulfate category are inorganic salts sharing the persulfate anion moiety. The inorganic substances differ only by the cationic portion of the salt, which is not expected to influence the hazardous properties of the molecule. The anionic part is identical and is expected to display the same environmental, ecotoxicological and toxicological behaviour based on the available data.
Environmental Fate[1,3]	
Soil/Water/Air	Substances of the persulfate category are not stable in the environment. Persulfates are not expected to adsorb to soil due to their dissociation properties, instability (hydrolysis) and high water solubility. They should behave as free ions or decompose into sulfate ions. In soils, upon decomposition, the cation could form more stable sulfate or bisulfate salts. Persulfates are not expected to bioaccumulate in the soil or in aqueous solution. They will decompose into inorganic sulfate or bisulfate.
Human Health Toxicity Summary [1]	
Chronic Repeated Dose Toxicity	The persulfates have low repeat dose toxicity. Twenty-eight-day repeated dose oral (dietary) toxicity studies were conducted in rats with three persulfate salts. The oral doses for the three salts were 0, 100, 316, 1000 ppm (equivalent to 0, 12.6, 41.2, 131.5 mg/kg bw/day for the potasium salt). Tests were performed in male rats only. The no observed adverse effect levels (NOAEL) for sodium and potassium salts were 137 and 131.5 mg /kg bw/day, respectively (the highest doses tested), while the NOAEL for ammonium persulfate was 41 mg/kg bw/day, based on decreased relative adrenal weight at the highest dose (FMC, 1979a; FMC, 1979b; FMC1979c). Another oral (dietary) subchronic toxicity study using sodium persulfate was conducted in rats. Rats (20/sex/group; strain not provided) were fed rodent chow containing 0, 300, 1000 or 3000 ppm sodium persulfate (0, 23, 100 or 225 mg/kg bw/day) for 90 days. On day 48 of the study, the concentration of the group receiving 1000 ppm was increased to 5000 ppm for the remainder of the study. At the two high dose levels body weight was decreased during the last 6 weeks of treatment (FMC 1979e).
Carcinogenicity	Based on the limited data available, there is no evidence of carcinogenicity of any of the persulfate salt. In a non-guideline study, female SENCAR mice were exposed dermally twice weekly to 0.2 mL of a 200 mg/mL solution of ammonium persulfate for 51 weeks. The investigators concluded that ammonium persulfate is neither a tumour promoter nor a complete carcinogen when applied to the skin (Kurokawa et al., 1984).

Mutagenicity/ Genotoxicity	Based on the limited available data, sodium persulfate was not mutagenic. An in vitro unscheduled DNA synthesis test was also negative for sodium persulfate (FMC, 1990d). The ammonium salt was not clastogenic in Chinese hamster fibroblasts in the absence of metabolic activation in a chromosome aberration test (Ishidate et al., 1988). Sodium persulfate was negative in two in vivo genotoxicity studies. Doses of sodium persulfate up to 338 mg/kg injected into mice intraperitoneally did not increase the incidence of micronuclei in bone marrow polychromatic erythrocytes (FMC, 1990c). Sodium persulfate was found to be non-genotoxic when tested up to 820 mg/kg in an in vivo unscheduled DNA synthesis test in rats (FMC, 1991c).
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	Based on the limited data available for ammonium persulfate, the sodium persulfate is not toxic to reproduction or development. In a well conducted fertility/developmental study (OECD 421), groups of rats (Crl:CD (SD)IGS BR, 12/sex/group) were administered ammonium persulfate in the diet at doses of 0, 40, 100 and 250 mg/kg bw/day (Weaver, 2004). Animals (both sexes) were dosed two weeks prior to and during mating. Females were administered the substance following mating, throughout gestation and until lactation day 4. In the parental generation group, there were no treatment related clinical signs, effects on body and organ weights or gross lesions. There were no significant adverse effects on the gonads and progression of spermatogenesis, although a non-significant decrease in pregnancy rates was reported at = 100 mg /kg bw/day. On this basis, it was concluded that the NOAEL for fertility indices and reproductive performance was the top dose of 250 mg /kg bw/day. There were no treatment-related clinical signs, mortality or necropsy findings among pups (live birth and viability indices were similar across all groups). There was a slight transient depression in mean pup body weight; however it was not considered adverse. The developmental toxicity NOAEL determined was the highest dose of 250 mg /kg bw/day (Weaver, 2004).
Acute Toxicity	Persulfate salts are considered to have moderate acute toxicity by the oral route. The acute oral median lethal dose (LD50) values for soidum persulfate (in rats) was reported as 895-930 mg/kg bw (Degussa AG, 1979). Clinical signs were ocular and oral discharge, irregular breathing and loss of muscle control. Persulfate salts have low acute dermal toxicity. The acute dermal LD50 was greater than 10,000 mg/kg bw (rabbits) for sodium persulfates (FMC, 1979c). Ocular and nasal discharge and slight irritation were reported in animals dermally exposed to high levels of persulfates (FMC, 1979b). Persulfates have low acute inhalation toxicity. Acute inhalation studies with sodium persulfates performed according to OECD guidelines in rats, indicated median lethal concentration (LC50) values of greater than the maximum attainable concentrations, 5.1 mg/L. Following exposure to high concentrations of persulfates, animals exhibited dyspnoea, respiratory distress and increased nasal, ocular and oral secretion (FMC 1987, FMC, 1979b; FMC 1995).

Irritation	The chemicals are classified as hazardous with the risk phrase 'Irritating to Respiratory system' (Xi; R37) in the HSIS (Safe Work Australia). Groups of male ND4 Swiss Webster mice were exposed, head-only, to sodium persulfate dust for 30 minutes at concentrations of 0.26 to 3.22 mg/L. Mortality was observed in all except the lowest exposure group during the 7-day post-exposure period with clinical signs that included ocular and nasal discharge and decreased respiratory rate. Abnormal gait and whole body tremors were observed in animals exposed to the highest concentration of dust. The concentration of dust which produced a 50 % decrease in respiratory rate (RD50) was 2.25 mg/L, indicating that sodium persulfate was a respiratory system irritant (FMC, 1994). Sodium persulfates were not found to be skin irritants in animal studies. However human observations support the existing classification as skin irritants. Three brief study reports submitted by industry on sodium persulfate showed at most a slight skin irritant potential in rabbits (FMC, 1979d; FMC, 1980). The chemicals are classified as hazardous with the risk phrase 'Irritating to eyes' (Xi; R36) in the HSIS (Safe Work Australia). In a single unpublished study, sodium persulfate was instilled into the eyes of 8 rabbits. Eye irritation was scored by the Draize method at 24, 48 and 72 h. Slight conjunctivitis was noted at 48 h (FMC, 1979c).
Sensitisation	There was evidence of delayed contact hypersensitivity in two maximisation tests (OECD TG 406) using ammonium and sodium persulfate in guinea pigs. All test animals reacted positively following challenge by intradermal injection of 0.1 % ammonium persulfate and 80 % of animals were positive following dermal challenge with 1 % ammonium persulfate 14 days later. The corresponding figures for sodium persulfate were 90 % positive for test animals positive following an (non-standard) intracutaneous challenge and 60 % of the test animals were positive following topical challenge (CIR, 2001; BIBRA International, 1997). Sodium persulfate was not sensitising when applied to the skin of guinea pigs in an unpublished Buehler Test, conducted to guideline standards (FMC, 1990b). In a murine local lymph node assay (LLNA), investigators concluded that both ammonium and sodium persulfate were moderate to strong sensitisers with EC3 values (amount of chemical required to elicit a stimulation index of 3) calculated to be 1.9 % and 0.9 % respectively (Cruz et al., 2009 cited in HSDB).
Health Effects Summary	Although the persulfate salts are harmful by the oral route, potential for acute toxicity was generally not demonstrated via the dermal or inhalation routes. The persulfate salts were irritating to eyes and respiratory system but not skin irritants in animal studies, while studies in humans indicate that persulfates can cause skin irritation. The persulfates are capable of inducing skin and respiratory sensitisation in animals and these are also the major chronic effects observed in humans. Mouse LLNA results for ammonium and sodium persulfate suggest that persulfates are moderate to strong sensitisers. Overall, the main critical effects to human health are skin and respiratory sensitisation and irritation.
Key Study/Critical Effect for Screening Criteria	
Ecological Toxicity [2]	
Aquatic Toxicity	The LC50 values for acute toxicity to fish ranged between 163 to 771 mg/L for sodium persulfate. The acute toxicity EC50 values for invertebrates were between 133 and 519 mg/L for sodium persulfate. In algae, the EC50 for sodium persulfate 116 mg/L.
Determination of PNEC aquatic	A PNECaquatic of 116 µg/L was calculated using the lowest endpoint of EC50 of 116 mg/L for algae. An assessment factor of 1000 was used.
Current Regulatory Controls	

Australian Hazard Classification	No data available.
Australian Occupational Exposure Standards	No data available.
International Occupational Exposure Standards	No data available.
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	No data available.
PBT Assessment	
P/vP Criteria fulfilled?	No. Biodegradation is not applicable to substances of the Persulfate Category, as the substances are inorganic. Upon contact with water or water vapour substances of the persulfate category hydrolyse into cation and persulfate anion. The persulfate anion, independent of the cation, undergoes further decomposition in normal water or acid conditions, readily oxidizing water to oxygen, producing sulphate and hydrogen ions. All final persulfate degradation products are ubiquitous to the environment.
B/vB criteria fulfilled?	No. Persulfates are very soluble in water and are not expected to bioaccumulate in soil or aqueous solutions.
T criteria fulfilled?	Based on measured acute toxicity endpoints of greater than 1 mg/L, sodium persulfate does not meet the screening criteria for toxicity.
Overall conclusion	Not PBT
Revised	January 2019

References

1. NICNAS (2017) Human Health Tier II Assessment for Persulfates
2. OECD (2005) SIDS Initial Assessment Profile on Persulfates
3. ECHA REACH, Disodium peroxodisulphate, Retrieved 2017: https://echa.europa.eu/information-on-chemicals/registered-substances
4. ICSC Sodium Persulfates, Retrieved 2017: http://www.inchem.org

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Toxicity Summary - Sodium sulphate

Chemical and Physical Properties[1,3,4,5]	
CAS number	7757-82-6
Molecular formula	Na2SO4
Product name	142.04 g/mol
Molecular weight	161 g/l at 20 °C
Solubility in water	No data found.
Melting point	884 °C
Boiling point	Decomposition occurs above 884°C.
Vapour pressure	Solid
Henrys law constant	Expected to be extremely low
Explosive potential	No data found.
Flammability potential	No data found.
Colour/Form	Not combustible. Gives off irritating or toxic fumes/gases in a fire.
Overview	Sodium sulfate is widely distributed in nature; it occurs as mineral salts (e.g. thenardite, mirabilite), it is present in almost all fresh and salt waters and sulfate as such is normally present in almost all natural foodstuffs. Both sodium and sulfate ions are among the most common ions found in all living organisms. In mammals, sulfate is an normal metabolite of sulfur-containing amino-acids, it is normally incorporated in a variety of body compounds and it plays an important role in detoxification/ excretion processes due to sulfoconjugation Sodium sulfate has been produced for many years in high volumes for use in detergents, glass and paper manufacture and a variety of smaller industrial uses National Industrial Chemicals Notification and Assessment Scheme (NICNAS) has performed an IMAP environment Tier 1 summary which concluded that sodium sulphate is an inorganic substance comprising ions of low ecotoxicological concern. This chemical is not expected to pose an unreasonable risk to the environment provided that ANZECC water quality guidelines for physical and chemical stressors are not exceeded.
Environmental Fate[1,4,5]	
Soil/Water/Air	Sodium sulphate is a solid inorganic salt well soluble in water. In water solutions it is fully dissociated to sodium and sulfate ions. In anaerobic environments sulfate is biologically reduced to (hydrogen) sulphide by sulfate reducing bacteria, or incorporated into living organisms as source of sulphur, and thereby included in the sulphur cycle. The BCF of sodium sulfate is very low (0.5) and therefore bioconcentration is not expected. Sodium and sulfate ions are essential to all living organisms and their intracellular and extracellular concentrations are actively regulated. However some plants (e.g. corn and *Kochia Scoparia*), are capable of accumulating sulfate to concentrations that are potentially toxic to ruminants.
Human Health Toxicity Summary [1,2,4,5]	
Chronic Repeated Dose Toxicity	Valid oral repeated dose toxicity studies with 21, 28 and 35 day studies in hens and pigs are available. Toxicity was confined to changes in bodyweight, water and feed intake and diarrhoea. These changes occurred only at very high doses of sodium sulfate. In ruminants, high concentrations of sulfate in food may result in the formation of toxic amounts of sulfites by bacterial reduction the rumen, leading to poly-encephalomalacia. The available data do not allow the derivation of a NOAEL. Based on available consumer data, a daily dose of around 25 mg/kg/day is well tolerated by humans

Carcinogenicity	There is no valid oral carcinogenicity study. Limited data from experimental studies support the notion that a substance that is abundantly present in and essential to the body is unlikely to be carcinogenic.
Mutagenicity/ Genotoxicity	Sodium sulfate has been shown to be without effect in the Ames test using various strains of *S. typhimurium* (TA1535, TA1537, TA100, TA98) both with and without S9 activation in a GLP standardised test Based on the natural intra- and extracellular occurrence of the substance it can be concluded that sodium sulfate is highly unlikely to be mutagenic
Reproductive Toxicity	Limited data of poor validity did not provide an indication of toxicity to reproduction.
Developmental Toxicity/Teratogenicity	No data were found.
Acute Toxicity	The acute toxicity (LD50) of sodium sulfate has not been reliably established but is probably far in excess of 5000 mg/kg. In an inhalation study with an aerosol, no adverse effects were found at 10 mg/m3. Also human data indicate a very low acute toxicity of sodium sulfate. Human clinical experience indicates that very high oral doses of sodium sulfate, 300 mg/kg bw up to 20 grams for an adult, are well tolerated, except from (intentionally) causing severe diarrhoea. WHO/FAO did not set an ADI for sodium sulfate. There is no data on acute dermal toxicity, but this is probably of no concern because of total ionisation in solution.
Irritation	Sodium sulfate is not irritating to the skin and slightly irritating to the eyes. Respiratory irritation has never been reported.
Sensitisation	Sodium sulphate is not a skin or respiratory sensitiser
Key Study/Critical Effect for Screening Criteria	The Australian Drinking Water Guidelines for sodium and sulphate may apply to sodium sulphate.
Ecological Toxicity [3,4,5]	
Aquatic Toxicity	Algae were shown to be the most sensitive to sodium sulfate; EC50 120h = 1,900 mg/l. For invertebrates *(Daphnia magna)* the EC50 48h = 4,580 mg/l and fish appeared to be the least sensitive with a LC50 96h = 7,960 mg/l for *Pimephales promelas*. No data were found for long term toxicity. The acute studies all show a toxicity of sodium sulfate higher than 100 mg/l, no bioaccumulation is expected
Determination of PNEC aquatic	An assessment factor of 1000 has been applied to the lowest reported effect concentration of 1900 mg/L for Daphnia. The PNEC aquatic is 1.9 mg/L.
Current Regulatory Controls	
Australian Hazard Classification	The chemical is not listed in the Hazardous Substance Information System (HSIS) (Safe Work Australia 2013).
Australian Occupational Exposure Standards	No data found
International Occupational Exposure Standards	No data found
Australian Food Standards	No data found
Australian Drinking Water Guidelines	The Australian Drinking Water Guideline for sulphate is 250 mg/L (aesthetic) and sodium is 180 mg/L (aesthetic).
Aquatic Toxicity Guidelines	No data found
PBT Assessment	
P/vP Criteria fulfilled?	Sodium sulphate is an inorganic salt that dissociates completely to sodium and sulphate ions in aqueous solutions. The persistent criterion is not considered applicable to this inorganic salt.
B/vB criteria fulfilled?	The BCF of sodium sulfate is very low (0.5) and therefore bioconcentration is not

	expected.
T criteria fulfilled?	The acute aquatic toxicity of sodium sulfate is > 0.01 mg/L. Hence the substance does not fulfill the screening criteria for toxic (T)
Overall conclusion	Not a PBT substance (based on screening data).

References

1. HSDB (n.d.). *Hazardous Substances Data Bank*. Retrieved 2017, from Toxnet, Toxicology Data Network, National Library of Medicine: http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB
2. National Health and Medical Research Council, Natural Resources Management Ministerial Council, national Water Quality Management Strategy, Australian Drinking Water Guidelines 6, 2011, Version 3.3 Updated November 2016.
3. National Industrial Chemicals Notification and Assessment Scheme (NICNAS), IMAP Environment Tier I Summary all tranches, 2016.
4. OECD (2005a) Screening Information Dataset (SIDS) Initial Assessment Report for Sodium Sulfate, CAS Number 7757-82-6, UNEP Publications
5. OECD (2005b) SIDS Initial Assessment Profile for Sodium Sulfate, CAS Number 7757-82-6, UNEP Publications

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Toxicity Summary - Tributyl tetradecyl (TTPC)

Chemical and Physical Properties	
CAS number	81741-28-8
Molecular formula	C26-H56P.Cl
Product name	BE9
Molecular weight	435.15 g/mol
Solubility in water	miscible
Melting point	45 °C
Boiling point	439 °C (estimated)
Vapour pressure	Solid
Henrys law constant	1.04 x 10-8 kPa at 25 °C (estimated)
Explosive potential	No data found
Flammability potential	No data found
Colour/Form	No data found
Overview	Limited toxicity information was located for this alkyl phosphonium salt.
Environmental Fate[1]	
Soil/Water/Air	No data found
Human Health Toxicity Summary [1,2]	
Chronic Repeated Dose Toxicity	No data were found.
Carcinogenicity	No data were found.
Mutagenicity/ Genotoxicity	No data were available for TTPC. A brief report for TBPB noted that the chemical tested negative in an Ames bacterial mutagenicity assay, a Chinese hamster ovary (CHO) chromosome aberration test and a cell transformation test using Hamster Embryo Cells (HEC) although further details were not provided (Dunn et al. 1982). Therefore, TBPB is not mutagenic under the conditions tested and, on the basis of this limited evidence; it is assumed that TTPC is not genotoxic.
Reproductive Toxicity	No data were found.
Developmental Toxicity/Teratogenicity	No data were found.
Acute Toxicity	An inhalation study (EPA Office of Prevention, Pesticides and Toxic Substances (OPPTS) 870.1300) in rats exposed nose-only to TTPC (particle size 1.7 to 2.1 µm) reported hypoactivity, gasping, irregular respiration, red nasal discharge, ano-genital staining and abdominal distension at 0.05 mg/L (US EPA 2012b). Six of the 10 animals died within three days of a four-hour exposure. Gross necropsy revealed red coloured lungs, distension of stomach and / or intestines and / or mottled liver. The single exposure acute inhalation LC50 for this study was identified as <0.05 mg/L. This study shows that TTPC is highly toxic by the inhalation route in rats. No oral or dermal information was available for TTPC. However, based on analogue data available for THPB, TBPC and TBPB from animal studies, acute toxicity of TTPC by oral and dermal route is likely to be moderate

Irritation	No information was available for TTPC but data were available for the analogues THPB and TBPC.for skin irritation. Overall, the effects observed with the analogues THPB and TBPC, albeit after a 24-hour exposure period compared with the four-hour exposure specified by the equivalent OECD TG, demonstrate the likely corrosive potential of TTPC to the skin. No information was available for TTPC but data were available for the analogues THPB, TBPC and TBPB for eye irritation. The effects observed in all tests with the analogues THPB, TBPC and TBPB demonstrate the likely corrosive potential of TTPC to the eyes. In an inhalation study with TTPC in rats, a red nasal discharge and facial staining was noted (US EPA 2012b). While the information in the study is limited based on the analogues being corrosive to the skin it is likely that the chemicals are also irritant to the respiratory mucosa. TTPC is therefore likely to be a respiratory irritant.
Sensitisation	No data were available for TTPC. TBPC at 0.1% concentration in normal saline solution was determined as not sensitising to the skin following dermal applications (undisclosed induction and one challenge treatment) in guinea pigs (US EPA 1978). TBPC is not a skin sensitiser in guinea pigs and therefore a sensitisation potential for TTPC is not expected. No data were available for respiratory sensitisation.
Health Effects Summary	TTPC demonstrates high acute toxicity by the inhalation route. Based on read across data available from THPB, TBPC and TBPB, the chemical has moderate acute toxicity by oral and dermal routes and is corrosive to the skin and eye and is a respiratory irritant. Data available for TBPC and TBPB indicate that the chemical is not a skin sensitiser or genotoxic, respectively. No repeat dose, carcinogenicity or reproductive toxicity data were available for the chemical or suitable analogues. Chronic exposure may be considered as inappropriate given the nature of TTPC and analogues as direct acting corrosives mediating severe adverse effects at the site of contact. In conclusion, the critical health effect of TTPC is its acute inhalation toxicity.
Key Study/Critical Effect for Screening Criteria	No data are available for determining the critical effect and the LOAEL/NOAEL for an oral reference dose.
Ecological Toxicity [1,2]	
Aquatic Toxicity	The modelled acute endpoint for Daphnia is 16.788 mg/L and Fish is 1059.2530 mg/L.
Determination of PNEC aquatic	PNECaquatic: On the basis that the modelled data consists of short-term results from two trophic levels, an assessment factor of 1,000 has been applied to the lowest reported effect concentration of 16.788 mg/L for Daphnia. The PNECaquatic is calculated to be 0.0168 mg/L.
Current Regulatory Controls	
Australian Hazard Classification	The chemical is not listed in the Hazardous Substance Information System (HSIS) (Safe Work Australia 2013).
Australian Occupational Exposure Standards	No data found
International Occupational Exposure Standards	No data found
Australian Food Standards	No data found

Australian Drinking Water Guidelines	No data found
Aquatic Toxicity Guidelines	No data found
PBT Assessment	
P/vP Criteria fulfilled?	No information is available on biodegradation.
B/vB criteria fulfilled?	Not Bioaccumulative (Based on an estimated log Kow value of 6.26)
T criteria fulfilled?	No chronic toxicity data are available for TTPC. The lowest modelled acute endpoint of TTPC is 16.788 mg/L in invertebrates. Since this value is >0.1 mg/L, TTPC does not meet the screening criteria for toxicity.
Overall conclusion	Inconclusive.

References

1. Material Safety Data Sheet for Bellacide 350, BWA Water Additives, SDS No. 10794
2. National Information System of the Regional Integrated Pest Management (IPM) Centers, U.S. Department of Agriculture and National Institutes of Food and Agriculture (www.ipmcenters.org).

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Toxicity Summary - 2,2`,2"- Nitrilotriethanol

Chemical and Physical Properties [1,2, 3,6]	
CAS number	102-71-6
Molecular formula	C6H15NO3
Molecular weight	149.19 g/mol
Solubility in water	Miscible with water.
pH	10.5
Melting point	17-21.6 °C
Boiling point	153 °C at 0.1007 kPa 192.87 °C at 0.7996 kPa 236.69 °C at 5.01 kPa 320 °C at 101 kPa
Vapour pressure	$3.59x10^{-6}$ mm Hg at 25 °C
Henrys law constant	$7.05x10^{-13}$ atm-cu m/mole at 25 °C
Explosive potential	No data found.
Flammability potential	Combustible, when exposed to heat or flame. Gives off irritating or toxic fumes (or gases) in a fire.
Colour/Form	Pale yellow to colourless viscous liquid with a slight ammonia odour.
Overview	Triethanolamine is a member of the ethanolamines family that combines the properties of amines and alcohols. Triethanolamine is typically supplied as a pale colourless to yellow liquid with an ammonia-like odor. Triethanolamine is primarily used in detergents, personal-care products, and textile finishing. Triethanolamine may also be used as in other applications including adhesives, agricultural products, concrete additives, gas treating processes, rubber, surfactants, photographic chemicals, and urethane foams. Contact with triethanolamine may cause slight to severe eye irritation. Brief contact is essentially nonirritating to the skin, but repeated exposure may cause irritation and burns. Skin contact may cause an allergic skin reaction. At room temperature, exposure to vapour is minimal due to low volatility; single exposure is not likely to be hazardous. This product has very low toxicity if swallowed. Harmful effects are not anticipated from swallowing small amounts, but swallowing larger amounts may cause injury. This product has been toxic to the fetus in laboratory animals at doses toxic to the mother. Findings from a study by the National Toxicology Program suggest an increased incidence of liver tumors in mice, but their relevant to humans is not clear. Triethanolamine is water soluable and biodegradable according to the OECD 301A test for biodegradation. It is not expected to bioaccumulate or persist in the environment. Triethanolimine is practically non-toxic to aquatic organisms on an acute basis. However large releases may increase the pH of aquatic systems to levels that may be toxic to aquatic organisms.

Environmental Fate [1,3,4,6]	
Soil/Water/Air	If released to soil, triethanolamine is expected to have very high mobility based upon an estimated Koc of 7. However, the pKa of triethanolamine is 7.8, indicating that this compound will primarily exist in cation form; and cations generally adsorb to organic carbon and clay more strongly than their neutral counterparts. Volatilization from moist soil surfaces is not expected to be an important fate process based upon an estimated Henry's Law constant of 7.1X10-13 atm-cu m/mole. If released into water, triethanolamine is not expected to adsorb to suspended solids and sediment based upon the estimated Koc. Triethanolamine biodegraded in a biochemical oxygen demand (BOD) test at an initial concn 50 ppm. After 10 days, the ThOD (theoretical oxygen demand) was 70% using acclimated water as seed and sewage as inoculum. Volatilization from water surfaces is not expected to be an important fate process based upon this compound's estimated Henry's Law constant. An estimated BCF of 3 suggests the potential for bioconcentration in aquatic organisms is low. Hydrolysis is not expected to be an important environmental fate process since this compound lacks functional groups that hydrolyze under environmental conditions

Human Health Toxicity Summary [1,2,3,4,5,6]	
Chronic Repeated Dose Toxicity	Fischer 344 rats and B6C3F1 mice were administered 0, 500, 1000, 2000, 4000 or 8000 mg/100 mL triethanolamine in drinking water (NTP 1990). Water consumption was reduced at the top two doses. No other details were provided. In a 91-day study conducted in accordance with OECD TG 408, Cox CD rats were administered 88.5% triethanolamine in the diet at doses of 0, 250, 500 or 1000 mg/kg bw/day (REACH 2013). There were no significant dose-dependent changes in bodyweight, organ weight, histopathology, pathology and haematology. No Lowest Observed Adverse Effect Level (LOAEL) or No Observed Adverse Effect Level (NOAEL) can be established for this study. In a 90-day study, rats (strain not specified) were administered doses of 5 to 2610 mg/kg bw/day triethanolamine in the diet (Smyth et al. 1951). The study reported microscopic lesions and mortality at doses of 730 mg/kg bw/day and above. The authors indicated the NOAEL as 80 mg/kg bw/day. No other details were provided. In 60- and 120-day studies in rats (strain not specified) given 200 to 1800 mg/kg bw/day triethanolamine, effects observed included liver changes at all treatment doses after 60 and 120 days administration, kidney changes at 400 mg/kg bw/day after 60 and 120 days administration, and kidney damage at >800 mg/kg bw/day after 60 and 120 days administration (Kindsvatter 1940). The specific changes in the liver and kidney were not described. No other details were provided. The LOAEL for this study was 200 mg/kg bw/day. Repeated dermal dose toxicity with triethanolamine application was consistently associated with inflammation at the treatment site. Systemic effects included changes in bodyweight and organ to bodyweight ratios. The critical study for determining the effects of repeated dermal exposures to the chemical is the 90-day study cited in REACH (2013) conducted similarly to OECD TG 411. The NOAELs for this study are 125 mg/kg bw/day for males and 250 mg/kg bw/day for females. In an inhalation study, Fischer 344 rats were exposed to 0, 125, 250, 500, 1000 or 2000 mg/m3 triethanolamine for 16 days (NTP 1985b). The effects observed included decreased bodyweight at 2000 mg/m3 for both sexes, increased liver weight in males at 2000 mg/m3, increased kidney weight in males at concentrations ≥500 mg/m3, and increased kidney weight in females at concentrations ≥250 mg/m3. Minimal to slight acute inflammation of the larynx was reportedbut the doses for which this effect was seen were not specified. The LOAECs are 500 mg/m3 in males and 250 mg/m3 in females. The NOAECs are 250 and 125 mg/m3 in males and females, respectively. Wistar rats were exposed through the head and nose to 0, 0.02, 0.1 or 0.5 mg/L aerosolised triethanolamine in a 28-day study conducted in accordance with OECD TG 412 (Gamer et al., 2008). There were no treatment-related effects seen on bodyweight, haematology, clinical chemistry and neurobehavioural parameters. Local effects, such as minimal to moderate focal inflammation in the submucosa of the larynx region, were reported at all treatment concentrations. The LOAEC and NOAEC for systemic effects cannot be established. The LOAEC for local effects is 0.02 mg/L. B6C3F1 mice exposed to 0, 125, 250, 500, 1000 or 2000 mg/m3 triethanolamine for 14 days showed minimal acute inflammation of the laryngeal submucosa (NTP 1985a). The doses for which this effect was seen were not specified.
Carcinogenicity	The International Agency for Research on Cancer (IARC) has classified the chemical as ‘not classifiable as to its carcinogenicity to humans’ (Group 3), based on inadequate evidence for carcinogenicity in humans and experimental animals (IARC, 2000). There was no evidence of carcinogenicity by oral (up to 1000 mg/kg/day for 104 weeks, and up to 3334 mg/kg/day for 82 weeks amongst rats and mice respectively) or dermal routes (dose unknown) in studies of 14-18 months duration using rats and mice. No inhalation data were available.

Mutagenicity/ Genotoxicity	Triethanolamine was not genotoxic in a number of in vitro studies (bacterial reverse mutation, mammalian cell cytogenetics, and unscheduled DNA synthesis). On the basis of the negative results observed in a range of in vitro studies, in vivo genotoxicity is not anticipated.
Reproductive Toxicity Developmental Toxicity/Teratogenicity	Triethanolamine is not considered to be toxic to fertility and not considered to be a developmental toxicant. There were no effects observed in the reproductive organs of the animals treated with the chemical from repeated oral, dermal and inhalation toxicity studies. In a reproduction/developmental toxicity screening test conducted in accordance with OECD TG 421, Wistar rats were administered 0, 100, 300 or 1000 mg/kg bw/day triethanolamine by gavage (REACH 2013). The animals were treated during pre-mating (two weeks for both sexes), mating (maximum of two weeks for both sexes), post-mating (one week in males), and the entire gestation period and four days of lactation in females. There were no parental systemic effects reported in all of the treated animals. Most of the animals treated at the top dose showed transient salivation, which could be attributed to the unpalatability of the chemical or local irritation of the upper digestive tract. There were no effects on fertility observed in any of the treated animals. The parental LOAEL and NOAEL for local effects are 1000 and 300 mg/kg bw/day, respectively. The developmental LOAEL and NOAEL are 1000 and 300 mg/kg bw/day, respectively. The LOAEL and NOAEL for fertility cannot be established. A dye formulation containing 0.15, 1.5 or 2% triethanolamine was applied to the shaved skin of CD-1 rats (Burnett et al. 1976). The application occurred seven times during the gestation period. There were no systemic or local effects observed. No developmental effects were reported.
Acute Toxicity	The chemical was of low acute toxicity in animal tests following oral exposure. The median lethal dose (LD50) in experimental rats studies ranged from is 4190–11300 mg/kg bw triethanolamine. Two studies in mice (strain not specified), two studies in rabbits (strain not specified), and three studies in guinea pigs (strain not specified) reported acute oral LD50s of 5400 to 7800, 2200 to 5200, and 2200 to 8000 mg/kg bw, respectively.Observed sub-lethal effects included agitation, elevated respiration and reduced grooming (NIWL, 2003; CIR, 2011). The chemical was of low acute toxicity in animal tests following dermal exposure. The median lethal dose (LD50) in rabbits is greater than 2000 mg/kg bw. Observed sublethal effects included mild erythema 24 hours after exposure, resolving after 6 –10 days (REACH; CIR, 2011). Due to the low vapour pressure of the chemical, the highest attainable vapour concentration is 1.8 mg/m^3. In a study conducted in rats (strain not specified) exposed to the chemical (1.8 mg/m^3), no deaths were reported. One out of 12 rats exposed showed signs of chronic bronchitis (REACH).
Irritation	Based on the available data, the chemical is considered a respiratory and eye irritant. In two studies conducted similarly to OECD TG 405 the average Draize scores for corneal opacity, redness of the conjunctivae and chemosis were 1, 2 and 1.75 respectively (REACH). In one study, the corneal opacity in one animal had not fully resolved by day eight of the observation period. However, based on the results seen in the other animals, it is expected that the corneal opacity would fully resolve had the observation period continued for 21 days. The chemical was not irritating to skin in studies that were performed in accordance with OECD Test Guideline (TG) 404 (REACH). In one study, three Vienna White Rabbits were dermally exposed to the chemical (85 % concentration of triethanolamine and 15 % diethanolamine) through a occlusive patch for four hours. Neither oedema nor erythema was observed throughout the observation period (REACH). In animal studies with repeated exposures, the chemical was applied to rabbit ears over 10 open applications, with 10 unoccluded applications to abdominal intact skin, or with three semi-occluded 24-hour applications to abraded skin. These exposures resulted in slight to moderate irritation (CIR, 2013). In a two-year repeated dose dermal study, the chemical caused lesions consisting of acanthosis (thickened skin), ulceration and chronic active inflammation at the application site. In the repeated dose inhalation studies, minimal to slight acute inflammation of the larynx was observed in rats and mice (NTP 1985a, 1985b). In a more recent 28-day inhalation study, minimal to moderate focal inflammation in the submucosa of the larynx was observed in rats (Gamer et al. 2008).

Sensitisation	Triethanolamine is not a skin sensitizer in animals. The negative results observed for the chemical in several guinea pig maximisation tests and one local lymph node assay support a conclusion that the chemical is not a skin sensitiser (REACH; CIR, 2013).
Health Effects Summary	Triethanolamine has low acute oral and dermal toxicity but may cause eye and respiratory irritation. Triethanolamine was non-irritating to the skin in rabbit studies, whilst studies in humans indicate that the chemical can cause skin irritation. The chemical is not a skin sensitiser. The chemical is neither genotoxic, carcinogenic nor a reproductive toxicant.
Key Study/Critical Effect for Screening Criteria	The most appropriate NOAELs for risk assessment, determined from the 90-day repeat dermal dose toxicity study cited in REACH (2013) are 125 (males) and 250 (females) mg/kg bw/day based on systemic effects. Uncertainty factors: 10 (interspecies variability); 10 (intraspecies variability); 10 (subchronic to chronic) Oral RfD = 125/1000 = 0.125 mg/kg/day Drinking water guideline value = 0.49 ppm

Ecological Toxicity [1,3, 4,6]	
Aquatic Toxicity	Triethanolamine is of low acute toxicity to fish and aquatic invertebrates. The most sensitive fish species tested was the fathead minnow Pimephales promelas for which a 96h-LC50 of 11,800 mg/l was determined. Triethanolamine was slightly more toxic to Daphnia, which had a 24h-EC50 of 1,390 mg/l. In a 21 day reproduction test with Daphnia magna, a NOEC of 16 mg/l and an EC50 of 2,038 mg/l were determined in a semi-static test (concentrations measured twice during the test). Triethanolamine appears to be more toxic to algal species. Toxicity tests have been carried out at both constant pH and allowing the pH to increase with increasing triethanolamine concentration. In two cases triethanolamine appears to be more toxic when the test is carried out allowing the pH to increase. In one case, using the green algae Scenedesmus quadricauda, the 7-8 day toxicity threshold (defined as the concentration which just caused an effect of cell multiplication of around 3% compared with controls - can be considered as a NOEC) for triethanolamine was found to be much lower at constant pH (toxicity threshold = 1.8 mg/l) than when the pH was allowed to vary (toxicity threshold = 715 mg/l). The EC50 was reported as 910 mg/l for Scenedesmus subspicatus (algae) for 96 hour exposure under test conditions where the test media was neutralised.
Determination of PNEC aquatic	PNECaquatic: On the basis that the data consists of short-term and long-term results from three trophic levels, an assessment factor of 10 has been applied to the lowest reported NOEC of1.8 mg/L for Scenedesmus quadricauda mg/L for invertebrates. The PNECaquatic is 0.18 mg/L.
Current Regulatory Controls [2]	
Australian Hazard Classification	Triethanolamine is listed on the Hazardous Substances Information System (HSIS) (Safe Work Australia 2013) with a recommended Exposure Standard.
Australian Occupational Exposure Standards	Time Weighted Average (TWA) of 5 mg/m^3 (Safe Work Australia 2013).
International Occupational Exposure Standards	TWA: 5 mg/m^3 [Belgium, Finland, Iceland, New Zealand, Peru] 0.5 mg/m^3 [Denmark].
Australian Food Standards	Triethanolamine is listed as a permitted processing aid in bleaching agents, washing and peeling agents, water used as an ingredient in other foods, and miscellaneous functions under the conditions of Good Manufacturing Practice (GMP) (Food Standards Australia New Zealand 2013).
Australian Drinking Water Guidelines	No data found
Aquatic Toxicity Guidelines	No data found
PBT Assessment [1,3,4,6]	
P/vP Criteria fulfilled?	There are conflicting findings from standard ready biodegradability tests regarding the rate of biodegradation of triethanolamine. Some studies indicate relative rapid biodegradation, whereas some closed bottle studies indicate slow biodegradation under the test conditions (OECD 1995). However, the chemical is inherently biodegradable. The results of a test using OECD test guideline 302B showed that 89% of the chemical is degraded after 14 days (OECD 1995). Thus, Triethanolamine is categorised as Persistent.
B/vB criteria fulfilled?	Based on the measured log Kow of -1.0 and a measured BCF of <3.9 L/kg in fish, triethanolamine has low bioaccummulation potential and is considered not bioaccumulative.
T criteria fulfilled?	The acute aquatic toxicity of triethanolamine is > 0.01 mg/L. Hence the substance does not fulfill the screening criteria for toxic (T)
Overall conclusion	Not a PBT substance (based on screening data). Further assessment of the environmental risks from the use of this chemical is not required as identified by DoEE.
Revised	April 2018

References

1. HSDB (n.d.). *Hazardous Substances Data Bank*. Retrieved 2016, from Toxnet, Toxicology Data Network, National Library of Medicine: http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB
2. National Industrial Chemicals Notification and Assessment Scheme (NICNAS), 2014. Inventory Multi-Tiered Assessment and Prioitisation (IMAP), Human Health Tier II Assessment for Ethanol, 2,2',2''- nitrilotris-, CAS Number 102-71-6.
3. OECD (1995) SIDS Initial Assessment Report for Triethanolamine, CAS Number 102-71-6
4. DOW Product Safety Assessment Triethanolamine, 2014
5. International Agency for Research on Cancer (IARC) – Summaries & Evaluations, Triethanolamine, 2000
6. Department of the Environment and Energy 2017 , National assessment of chemicals associated with coal seam gas extraction in Australia, prepared by the National Industrial Chemicals Notification and Assessment Scheme

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Toxicity Summary - Sodium perborate tetrahydrate

Chemical and Physical Properties	
CAS number	10486-00-7
Molecular formula	NaBO3. 4H2O / NaBO2. H2O2. 3H2O
Molecular weight	153.9
Solubility in water	g/100ml at 20°C: 2.3
Melting point	ca. 60-65.5°C
Boiling point	Decomposes.
Vapour pressure	No data available.
Henrys law constant	No data available.
Explosive potential	No data available.
Flammability potential	No data available.
Colour/Form	No data available.
Overview	Perborates are salts of perboric acid. Sodium perborate degrades into sodium metaborate and water with the generation of hydrogen peroxide and oxygen. Sodium metaborate is the salt of a strong base (sodium hydroxide) and a weak acid (boric acid). Undissociated boric acid is the main species present in the blood of mammals following exposure to these chemicals. Sodium perborate tetrahydrate (CAS No. 10486-00-7) have reported domestic use as bleaching agents.
Environmental Fate[1]	
Soil/Water/Air	Perborates have high water solubility. Perborates dissociate to borates and hydrogen peroxide in aqueous environments. The most important borate species, which will be formed in aqueous solutions, is boric acid (H3BO3). At relevant environmental pH values of ≤ 7 no significant adsorption of boron compounds in soil and the aquatic compartments are to be expected (EPA, 1975; Koehnlein, 1972).
Human Health Toxicity Summary [1,2,3]	
Chronic Repeated Dose Toxicity	In a repeated dose toxicity study, sodium perborate tetrahydrate (CAS No. 10486-00-7) was administered (by gavage) to rats at 1000 mg/kg bw/day (70 mg boron/kg bw/day) for 28 days. Acanthosis and hyperkeratosis in the forestomach, and hyperplasia of the fundic mucosa were noted. At the end of the study, the red blood cell count, haemoglobin, haematocrit and number of lymphocytes were significantly decreased; the number of platelets was significantly increased. The spleen size and splenic parenchyma were reduced. Although a significant (18 %) decrease in absolute testicular weights was recorded, the authors attributed this to a generalised weight reduction of 15 %; histological examination of the testes revealed no adverse effects. The lowest observed adverse effect level (LOAEL) was 1000 mg/kg bw/day (70 mg boron/kg bw/day), based on effects on the stomach, spleen and the haematopoietic system. It was concluded that the no observed adverse effect level (NOAEL) for males or females was below 1000 mg/kg bw/day (EU RAR, 2007; SCCS, 2010; REACH). In a repeated dose toxicity study, sodium perborate tetrahydrate (CAS No. 10486-00-7) was applied at 200 mg/kg bw/day (as a 10 % aqueous solution) to the abraded skin of New Zealand White rabbits for three weeks. After exposure, the skin was near normal (signs of mild irritation in some cases) and there were no adverse microscopic findings in different organs. A NOAEL of 200 mg/kg bw/day was established, being the highest tested dose (EU RAR, 2007; SCCS, 2010; REACH). In another repeated dose toxicity study, sodium perborate tetrahydrate (CAS No. 10486-00-7) was applied at 50 mg/kg bw (as a 2.5 % aqueous solution) to the

	intact skin of New Zealand White rabbits (three/sex), five days/week for 13 weeks. The treatment caused no skin irritation and there were no adverse effects on blood parameters or on the gross histopathology of selected organs. An NOAEL of 50 mg/kg bw/day was established, being the highest tested dose (EU RAR, 2007; SCCS, 2010; REACH).
Carcinogenicity	Not likely to have any carcinogenic potential.
Mutagenicity/ Genotoxicity	Not considered to have mutagenic or genotoxic potential.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	In a repeated dose toxicity study, sodium perborate tetrahydrate (CAS No. 10486-00-7) was administered (by gavage) to rats at 1000 mg/kg bw/day (70 mg boron/kg bw/day) for 28 days. The authors recorded a significant (18 %) decrease in absolute testicular weights but this was attributed to a generalised weight reduction of 15 %. A histological examination of the testes revealed no adverse effects. It has also been argued that more sensitive methods of histopathology than used in this study (fixed with formalin) could have revealed more subtle effects. Therefore, using reduced testes weights as early signs of testicular toxicity cannot be dismissed in view of the known testicular toxicity of the borates. It was concluded that the NOAEL for males or females was below 1000 mg/kg bw/day (EU RAR, 2007; SCCS, 2010; REACH). In a developmental toxicity study, sodium perborate tetrahydrate (CAS No. 10486-00-7) was administered (by gavage) to 25 pregnant Crl:Cd (SD) rats on gestation days (GD) 6–15 at doses of 0, 100, 300 and 1000 mg/kg bw/day. The NOAEL for maternal toxicity was established as 100 mg/kg bw/day (7 mg boron/kg bw/day), based on significant reductions in body weight gain at the two highest doses. It is also noted that even though reduced maternal weight gain might partly be due to an increased number of resumptions and reduced foetal weights, other toxicological studies have supported the view that doses above 100 mg/kg bw/day administered via gavage are toxic to the dams. A dose-related effect was found on the ossification and bone system. While various incomplete ossifications and wavy ribs occurred at 300 mg/kg bw/day, malformations (fused ribs) were observed at 1000 mg/kg bw/day. The NOAEL for developmental toxicity was established as 100 mg/kg bw/day (7 mg boron/kg bw/day) (EU RAR, 2007; SCCS, 2010; REACH).
Acute Toxicity	The reported oral LD50 for sodium perborate tetrahydrate is 2567 mg/kg bw (CAS No. 10486-00-7). The chemical is likely to have low acute toxicity following dermal exposure. It is also noted that the dermal absorption through intact skin is very low. The available data (median lethal concentration—LC50, inhalation) for sodium perborate tetrahydrate is 1.65 mg/L. Reported signs of toxicity included gasping, red nasal discharge, and compound-covered faeces (EU RAR, 2007; SCCS, 2010; REACH).
Irritation	The chemicals in the group are classified as hazardous, with hazard category Specific Target Organ Toxicity (Single Exposure) – Category 3 and hazard statement 'May cause respiratory irritation' (H335) in the HCIS (Safe Work Australia). Although slight skin irritant effects were reported in animal studies, the effects were not sufficient to warrant a hazard classification for the chemicals in this group. The sodium perborates are classified as hazardous with hazard category 'Eye Damage – Category 1' and the hazard statement 'Causes serious eye damage' (H318) in the HCIS (Safe Work Australia). In an eye irritation study conducted according to Federal Hazardous Substances Act Regulations 191.12 (1964-09) of the USA, 0.1 mL of sodium perborate tetrahydrate (CAS No. 10486-00-7) was placed once into the right eyes of six albino rabbits. The chemical was judged to be corrosive as severe corneal damage, severe iritis and severe conjunctivitis were observed in all animals (EU RAR, 2007; SCCS, 2010; REACH).
Sensitisation	Not likely to be skin and respiratory sensitisers.
Health Effects Summary	The critical health effects for risk characterisation include systemic long-term effects (reproductive toxicity, developmental toxicity), systemic acute effects

	(acute toxicity from oral/inhalation exposure) and local effects (respiratory and eye irritation).
Key Study/Critical Effect for Screening Criteria	The lowest NOAEL of 50 mg/kg bw/day from the repeated dose dermal study will be used for risk assessment.
Ecological Toxicity[3]	
Aquatic Toxicity	The following aquatic toxicity endpoints are based on modelled estimates of sodium perborate (CAS 7632-04-4) from ECOSAR: The 96hr LC50 for fish is estimated to be 2610 mg/L The 48 hr LC50 for daphnids is estimated to be 1241 mg/L The 14 day LC50 for earthworms is estimated to be 164.5 mg/L The 96 hr EC50 for algae is estimated to be 444 mg/L
Determination of PNEC aquatic	In a recent publication Dyer (2001) used a probabilistic approach to derive a PNEC0.05 (Predicted No Effect Concentration for 95% of the species) from chronic studies that were available for boron for all trophic levels. Mean toxicity levels per taxa were determined and then converted to a cumulative probability term and curve-fit assuming a log-logistic distribution. The PNEC 0.05 derived from this analysis was 3.45 mg B/l when all species data with uniform chronic toxicity endpoints (NOEC, LC10) were considered.
Current Regulatory Controls[4]	
Australian Hazard Classification	Reproductive toxicity – category 1B Acute toxicity – category 4 Specific target organ toxicity (single exposure) – category 3 Eye damage – category 1
Australian Occupational Exposure Standards	No data available.
International Occupational Exposure Standards	No data available.
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	No data available.
PBT Assessment	
P/vP Criteria fulfilled?	No. Expected to be biodegradable based on Ecosar prediction using sodium perborate.
B/vB criteria fulfilled?	No. Estimated log Kow for sodium perborate: 0.08 (Log Kow < 4.5)
T criteria fulfilled?	No. Acute toxicity values > 1 mg/L.
Overall conclusion	Not PBT
Revised	October 2019

References

1. IPCS INCHEM, Sodium perborate tetrahydrate. Retrieved 2019: http://www.inchem.org/documents/icsc/icsc/eics1046.htm
2. National Industrial Chemicals Notification and Assessment Scheme (NICNAS). IMAP, Human Health Tier II Assessment for Perborates: Retrieved 2019: https://www.nicnas.gov.au

3. HERA Risk Assessment of Sodium Perborate mono- and tetrahydrate. Retrieved 2019: https://www.heraproject.com/files/7-F-04-HERA%20sodium%20perborate%20full%20web%20wd.pdf
4. Hazardous Chemical Information System (HCIS), http://hcis.safeworkaustralia.gov.au/

Colour/Form	Boric Acid: Colourless, transparent crystals or white granules or powder. Sodium Tetraborate: Colourless, monoclinic crystalline salt; also occurs as a white powder. Boronatrocalcite: Silky white rounded crystalline masses or parallel fibres. Borax: White crystalline solid. Odourless.
Overview	Limited toxicity data is available for sodium tetraborate (Borax anhydrous) and boronatrocalcite (Ulexite) as such; this toxicity profile includes data on boron and boric acid. In physiological conditions, aqueous solutions of simple borates will exist predominantly as un-dissociated boric acid. Therefore, the chemical and toxicological properties of simple borates such as boric acid, boric acid disodium salt and borax are expected to be similar on a mol boron/L equivalent basis when dissolved in water or biological fluids at the same pH and low concentration. Accordingly, read-across of toxicity testing results between these borate species and from other similar borate species differing only in extent of hydration was applied and testing results were expressed as boron equivalents. Boric acid and borate salts exist naturally in rocks, soil, plants and water as forms of the naturally occurring element boron. Anhydrous Borax is a free flowing mixture of clear, glass-like particles and white granules formed by the crushing of relatively large masses of fused materials. Borax is a salt of boric acid. Borax occurs naturally in evaporite deposits produced by the repeated evaporation of seasonal lakes and has many applications in chemistry, mining and pharmaceuticals. Ulexite is a sodium-calcium-hydroborate and, like other borates, is a structurally complex mineral. It is composed of hydrogen (3.98 %), sodium (5.67 %), calcium (9.89 %), boron (13.34 %), and oxygen (67.12 %). There is a lack of data available in the literature to directly assess the toxicity of the chemical. The major component of the chemical is a borate ion, which is likely to be associated with human health hazards of the chemical. The other constituents are considered to be of low concern to human health (NICNAS, 2013). As the chemical will readily break down in the stomach pH to boric acid (H_3BO_3) following ingestion, the toxicokinetics and toxicity of the chemical will be driven predominantly by borate ions. Boron is a naturally occurring element that is found in the form of borates in the oceans, sedimentary rocks, coal, shale, and some soils. Boron is widely distributed in nature, with concentrations of about 10 mg/kg in the earth's crust (range 5 mg/kg in basalts to 100 mg/kg in shales) and about 4.5 mg/L in the ocean. Borates are used in glass, ceramics, detergents, wood treatment and insulation fiberglass industries. Boric acid and other borates are also used in a range of consumer products including cosmetic and personal care products and also in detergents. Moreover, borates are essential for all plants – their use as fertilizers increases crop yields (including grapes, potatoes, sugar beets, alfalfa and olives) and quality. Boron occurs in foods as borate and boric acid. Boron has not been established to be an essential nutrient for humans and no specific biochemical function for boron has been identified in higher animals or man. There is some evidence that, in humans, boron intake within the usual dietary range may influence the metabolism and utilisation of other nutrients, particularly calcium, and may have a beneficial effect on bone calcification and maintenance.
Environmental Fate[2,4]	
Soil/Water/Air	These forms of boron are highly soluble and not easily removed from solution by natural mechanisms. Borate and boric acid are in equilibrium depending on the pH of the water. At an acidic pH, boron exists in solution mainly as undissociated boric acid, whereas at alkaline pH it is present as borate ions. Boric acid is a persistent molecule, mobile in soil and sediment, not subject to hydrolysis, photodegradation or biodegradation. Other borates yield boric acid upon dissolution in water (or borate anion in higher pH conditions).

Human Health Toxicity Summary [2,3,4,8,9]	
Chronic Repeated Dose Toxicity	The haematological system and the testes have been identified as the major targets after oral repeat dose exposure to Boric acid. Studies after repeated dermal or inhalation exposure to boric acid are not available. A NOAEL for effects on testes and the blood system of 17.5 mg boron/kg bw/day can be derived (with a LOAEL of 58.5 mg boron/kg bw/day) from two 2-year studies in rats on boric acid. This NOAEL was the equivalent of 155 mg borax/kg bw/day. Results obtained with boric acid can be supported by findings obtained from other borates thus indicating that the boron ion is the toxicologically relevant species
Carcinogenicity	In two-year dietary studies on boric acid and borax in rats (Weir 1966a; Weir 1966b) (described under Section A1.6.5) no signs of carcinogenicity were observed. It has been noted that less than one third of treated animals (10 animals per sex) were used for macroscopic and histopathological examination in these studies (ECHA 2009; RIVM 2013). In a subsequent two-year dietary carcinogenicity study of boric acid in mice, animals received 0, 446 or 1150 mg boric acid (0, 75 or 200 mg boron)/kg bw /day (NTP 1987). High dose males showed testicular atrophy and interstitial cell hyperplasia. No signs of carcinogenicity were observed.
Mutagenicity/ Genotoxicity	Boric acid is not mutagenic either in vitro or in vivo. Overall, it was concluded that boric acid is unlikely to be genotoxic.
Reproductive Toxicity Developmental Toxicity/Teratogenicity	Results from animal experiments demonstrate that boric acid adversely effects fertility and development. Feeding studies in different animal species (rats, mice and dogs) have consistently demonstrated that the male reproductive system is the principle target in experimental animals, although effects on the female reproductive system have also been reported. Testicular damage ranging from mildly inhibited spermiation to complete atrophy has been demonstrated following oral administration of boric acid. Effects on fertility were observed at lower dose levels compared to dose levels, where signs of general toxicity appeared. Based on data from the two-year feeding studies with boric acid and borax in rats, 17.5 mg boron /kg bw/day (equivalent to 100 mg boric acid/kg bw/day)_was derived as a NOAEL for male and female fertility. Developmental effects have been observed in three species, rats, mice and rabbits. The most sensitive species appears to be rats, in which the effects observed at non maternally toxic doses include a reduction in foetal body weight and minor skeletal variations which, with the exception of short rib XIII, had reversed by 21 days post-natal. The NOAEL for developmental effects is 9.6 mg boron/kg bw/day (55 mg boric acid/kg/day).

Acute Toxicity	Borates are of low acute toxicity in mammals, including rats and mice. For boric acid, an oral median lethal dose (LD50) of 3765 mg/kg bw (659 mg boron/kg bw) was reported in Sprague-Dawley rats (Keller 1962; Weir and Fisher 1972). An acute oral toxicity study in rats conducted according to the Organisation for Economic Cooperation and Development (OECD) Test Guideline (TG) 401 of disodium octaborate tetrahydrate reported an LD50 of 2550 mg/kg bw (535 mg boron/kg bw) (Doyle 1988). In an acute dermal toxicity study in rats performed with disodium octaborate tetrahydrate the LD50 value was >2000 mg/kg bw (European Commission 2000). The other borates also appear to have low acute dermal toxicity. In a study in rabbits, the dermal LD50 value for boric acid was >2000 mg/kg bw/day (Weiner et al. 1982). Acute dermal toxicity studies with disodium tetraborate decahydrate (borax) and disodium tetraborate pentahydrate revealed no deaths at a limit dose of 2000 mg/kg bw/day (Reagan and Becci 1985a,c). It was noted that these studies may be flawed since the test material was not moistened, so good contact with the skin was not ensured. The four-hour acute median lethal concentration (LC50) for boric acid, borax and disodium borates is reported to be >2 mg boron/m3 (Hubbard 1998). An inhalation study in rats conducted to OECD TG 403 with boric acid reported an oralmedian lethal concentration (LC50) of ≥2.03 mg/L (Wnorowski 1994a). A similar study with disodium octaborate anhydrate reported an LC50 of ≥2.01 mg/L (Wnorowski 1994b).
Irritation	Borates have low skin irritation potential. In rabbits, boric acid caused no/mild skin irritation, induced reversible conjunctival redness and chemosis with minor effects on the iris. In rats and mice, boric acid acts as a sensory irritant. The substance may irritate the eyes, nasal mucous membranes, skin and the respiratory tract, and may cause effects on the gastrointestinal tract, liver and kidneys.
Sensitisation	Boric acid and borax were tested in a Buehler skin sensitisation test conducted according to OECD TG 406 (Wnorowski 1994c, 1994d). Test substances were applied at a concentration of 95% in water during both induction and challenge. No signs of skin sensitisation were seen.
Health Effects Summary	Borates are of low acute toxicity and low skin irritation potential. It may cause sensory irritant effects on animals and humans with acute exposure. Borates were shown not to be skin sensitisers, genotoxic or carcinogenic. Repeated exposures to boron as boric acid induced effects on fertility (testes), development and the blood system.
Key Study/Critical Effect for Screening Criteria	The critical lowest No Observed Adverse Effect (NOAEL) level for the purposes of risk assessment is 9.6 mg boron/kg bw/day. This NOAEL was the equivalent of 55 mg boric acid/kg bw/day; 38 mg disodium octaborate anhydrate/kg bw/day and 85 mg borax/kg bw/day), from feeding (dietary intake) studies based on developmental effects. Uncertainty factors: 10 (interspecies variability); 10 (intraspecies variability); 10 (subacute to chronic). Drinking water guideline for boron: 3.5 ppm
Ecological Toxicity [3,9]	
Aquatic Toxicity	The most sensitive tests report that acute effects on fish are in the range of 10-20 mg-B/L although the quality of these studies was rated low. The lowest daphnid acute value is 133 mg-B/L. Algal and microbial inhibition studies suggest less toxicity: Selenastrum growth was not affected at 93 mg-B/L and activated sludge respiration showed minimal effects at 683 mg/L boric acid (119 mg-B/L). Chronic endpoints for Boric acid were available for Daphnia (6 mg/L) and Fish (2.1 mg/L).
Determination of PNEC aquatic	Canadian Water Quality Guidelines for the Protection of Aquatic Life: Long–term Exposure to Boron is 1.5 mg/L (2009). An assessment factor of 100 has been applied to the lowest reported chronic effect concentration of 2.1 mg/L for Fish. The PNECaquatic is 0.021 mg/L.
Current Regulatory Controls[9]	

Australian Hazard Classification	Boric acid and borax are classified as hazardous for human health in the Hazardous Substances Information System (HSIS) (Safe Work Australia 2013) with the following risk phrases: - Toxic to reproduction (Repr.) Cat. 2; R60 (May impair fertility) - Repr. Cat. 2; R61 (May cause harm to the unborn child) Mixtures containing boric acid and borax are classified as hazardous with the following risk phrases based on the concentration (conc) of the chemicals in the mixtures. - Boric acid: Conc ≥5.5%: Toxic (T); R60; R61 - Borax: Conc ≥8.5%: T; R60; R61.
Australian Occupational Exposure Standards	There are no specific exposure standards for boric acid. However, the permissible exposure limits (as the time weighted average (TWA)) for dusts apply (10 mg/m^3 measured as inspirable dust) (Safe Work Australia 2013b). The exposure standard for borax is 5 mg/m^3 TWA (Safe Work Australia 2013a).
International Occupational Exposure Standards	Boric Acid: Canada 2 mg/m^3 TWA, 6 mg/m^3 Short-term exposure limit (STEL) (borate compounds) Germany 10 mg/m^3 TWA; 1 mg/m^3 STEL Spain 10 mg/m^3 TWA (insoluble particles) US 2 mg/m^3 TWA; 6 mg/m^3 STEL (borate compounds), 5 mg/m^3 TWA (particulates, respirable fraction) Disodium octaborate anhydrate: Canada 10 mg/m^3 TWA, (insoluble particles) Spain 10 mg/m^3 TWA (particulates, inhalable fraction) US 5 mg/m^3 TWA (particulates, respirable fraction) Borax: Canada 1 to 5 mg/m^3 TWA, 6 mg/m3 STEL (inorganic borate compounds) Denmark 1 to 2 mg/m^3 TWA Germany 0.5 mg/m^3 TWA Spain 5 mg/m^3 TWA Sweden and UK 2 mg/m^3 TWA US 2 mg/m^3 TWA (inorganic borate compounds); 5 to 10 mg/m3 TWA.
Australian Food Standards	No data found.
Australian Drinking Water Guidelines	No data found. However, boron in the environment is likely to be predominantly in the form of boric acid and that based on health considerations, the concentration of boron in drinking water should not exceed 4 mg/L (NHMRC 2011).
Aquatic Toxicity Guidelines	For boron: 90 µg/L (ANZECC 2000 99% Freshwater)
PBT Assessment[9]	
P/vP Criteria fulfilled?	For the purposes of this PBT assessment, the persistent criteria is not considered applicable to this inorganic substance.
B/vB criteria fulfilled?	For the purposes of this PBT assessment, the bioaccumulation criteria is not considered applicable to this inorganic substance.
T criteria fulfilled?	No. The chronic toxicity data is >1 mg/L.
Overall conclusion	Not PBT

References

1. HSDB (n.d.). *Hazardous Substances Data Bank*. Retrieved from Toxnet, Toxicology Data Network, National Library of Medicine: http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB
2. ECHA REACH, Acetic Acid, Retrieved http://apps.echa.europa.eu
3. Human and Environmental Risk Assessment (HERA) on Ingredients of Household Cleaning Products: Boric Acid, 10043-35-3, 2005. http://www.heraproject.com

4. EFSA, Opinion of the Scientific Panel on Dietetic Products, Nutrition and Allergies on a request from the Commission related to the Tolerable Upper Intake Level of Boron (Sodium Borate and Boric Acid), 2004
5. Draft European Union Risk Assessment Report. Disodium tetraborate, Anhydrous Boric Acid, Boric Acid, Crude natural (1) Risk Assessment. 2007
6. IPCS Sodium Tetraborate, Retrieved http://www.inchem.org
7. EFSA, European Food Safety Authority, Scientific Opinioni on the re-evaluation of boric acid (E284) and sodium tetraborate (borax) (E285) as food additives. 2013
8. NICNAS, National Industrial Chemicals Notification and Assessment Scheme, Human Health Tier II Assesssment for Ulexite, CAS Number: 1319-33-1, 2015
9. Department of the Environment and Energy 2017, National assessment of chemicals associated with coal seam gas extraction in Australia, prepared by the National Industrial Chemicals Notification and Assessment Scheme

Appendix H

Toxicity Profiles for Chemical Tracers

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Toxicity Summary - Water Flow Assurance Tracer (WFT)

Chemical and Physical Properties[1,2,3,4]	
CAS number	One chemical (proprietary)
Molecular formula	Proprietary
Molecular weight	534.36
Solubility in water	167.05 g/L at 20 °C and pH 7
Melting point	347.1 °C
Boiling point	909.54 °C at 101.325 kPa
Vapour pressure	7.43 X 10-22 mm Hg at 25°C (calculated)
Henrys law constant	10-15 atm-m^3/mol (estimated)
Explosive potential	Non-explosive (100%)
Flammability potential	Non-flammable (100%)
Colour/Form	Bright, odourless, orange-yellow powder
Overview	This chemical is used as a food, drug, and cosmetic colorant. It is used to colour confectionary, bakery goods, animal feeds, aqueous drug solutions, toothpastes, bath salts, hair rinses, and printing inks for use in and on foods, drugs, and cosmetics and on food, drug, and cosmetic packaging materials. This chemical is an azo dye. Azo compounds are formed from arenediazonium ions reacting with highly reactive aromatic compounds, in what is called a diazo coupling reaction. Azo compounds are generally deeply coloured because the azo linkage brings the two aromatic rings into conjugation (Solomon, 1996).
Environmental Fate[2]	
Soil/Water/Air	This chemical's production as a dye for wool, silks and as a colorant in food, drugs and cosmetics may result in its release to the environment through various waste streams. If released to air, this chemical will exist solely in the particulate phase in the atmosphere since it is a salt and will be non-volatile. Particulate-phase this chemical will be removed from the atmosphere by wet or dry deposition. This chemical may be susceptible to direct photolysis by sunlight; after exposure to sunlight, This chemical in distilled water exhibited a first order rate constant of $2.31X10^{-3}$ per day, corresponding to a half-life of 300 days. If released to soil, this chemical is expected to be mobile since this compound is expected to exist almost entirely in anion form in the environment and anions generally do not adsorb more strongly to soils containing organic carbon and clay than their neutral counterparts. Volatilization from moist soil surfaces is not expected to be an important fate process because the compound exists as an anion and anions do not volatilize. If released into water, this chemical is not expected to adsorb to suspended solids and sediment based upon this compound's ionic nature in the environment. This chemical passed through pilot scale treatment activated sludge processes relatively unchanged, indicating that biodegradation is not expected to be an important environmental fate process. This chemical will exist almost entirely in the anion form at pH values of 5 to 9 and therefore volatilization from water surfaces is not expected to be an important fate process. Measured BCF values of <0.29 and <3.0 in carp suggests bioconcentration in aquatic organisms is low. Hydrolysis is not expected to be an important environmental fate process since this compound lacks functional groups that hydrolyse under environmental conditions.

Human Health Toxicity Summary [1,2,3,4]	
Chronic Repeated Dose Toxicity	Two separate but concurrent studies in rats given 0%, 0.1%, 1% or 2% in the diet or 0% or 5% in the diet for between 113 and 125 weeks showed decreases in body weight in females at 1% in the diet and in males (12.2% decrease) and females (16.9% decrease) at 5% in the diet, but there were no effects at 2% in the diet. The FAO/WHO Expert Committee on Food Additives concluded that 2% in the diet, equal to 984 mg/kg bw per day, was the NOAEL for this study. During a 2-year study in Fischer 344 rats given This chemical in the drinking water at a concentration of 0%, 1% or 2%, statistically significant increases in mesothelioma in the abdominal cavity in males and endometrial stromal polyps in females in the 1% concentration groups were reported. The incidences of these tumours were not dose dependent, and the authors noted that the incidences were within the historical control range for these tumours in this rat strain.
Carcinogenicity	A 104-week carcinogenicity study in mice given 0%, 0.5%, 1.5% or 5% This chemical in the diet showed no effects other than reductions in body weight at various time points in both sexes at 5% in the diet and slight, but statistically significant, increases in feed consumption in males at 5% in the diet. Although the authors considered the NOAEL to be the highest dose tested, the FAO/WHO Expert Committee on Food Additives concluded that 1.5% in the diet, equal to 2173 mg/kg bw per day, was the NOAEL for this study, on the basis of a body weight reduction concurrent with an increase in feed consumption at the higher dose in males.
Mutagenicity/ Genotoxicity	The FAO/WHO Expert Committee on Food Additives concluded that the overall weight of evidence indicates that this chemical is not genotoxic.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	Reproductive and developmental parameters were assessed in the rat chronic toxicity studies that included an in utero exposure phase. No significant effects on reproduction or body weights of the offspring were observed. The FAO/WHO Expert Committee on Food Additives concluded that 5% in the diet, equal to 2641 mg/kg bw per day, the highest dose tested, was the NOAEL for reproductive end-points in this study. No reproductive effects were observed in two developmental neurotoxicity studies. Also, no effects on reproductive parameters were observed in several other developmental neurotoxicity studies in rats using a mixture of colours, including This chemical, as the test substance. Two developmental toxicity studies were available in rats, one with dietary administration and one with drinking-water administration of This chemical during gestation days 0–19; these showed no adverse effects at doses up to 1000 mg/kg bw per day.
Acute Toxicity	In reports submitted to the World Health Organization, the acute oral LD50 in mice was reported to be 12,750 mg/kg bw [National Institute of Hygienic Sciences of Japan, 1964]. In rats, the LD50 by intraperitoneal injection was reported to be 2,000 mg/kg bw and the LD50 by intravenous injection was reported to be 1,000 mg/kg bw [Deutsche Forschungsgemeinschaft, 1957].
Irritation	No irritating effects were observed both for skin and for eye.
Sensitisation	The results of the available tests about the evaluation of dermal effects on human showed no sensitizing effects.
Health Effects Summary	A number of case reports have been published showing intolerance or hypersensitivity reactions to This chemical. Although some of these reactions have been shown to be quite severe, their prevalence appears to be very low (0.12% in the general population).
Key Study/Critical Effect for Screening Criteria	An average daily intake (ADI) of 0-10 mg/kg bw per day was assigned by JECFA in 2016.

Ecological Toxicity [1]	
Aquatic Toxicity	Acute short-term administration on fish: LC50 fish (96 h) > 120 mg/L Acute short-term administration on invertebrates: Both of the acute toxicity to Daphnia magna studies does not show any toxic effects. EC50(48h) > 125 mg/L Acute short-term administration on aquatic plants: Both of the acute toxicity to aquatic plants studies does not show any toxic effects. EC50(48h) > 125 mg/L
Determination of PNEC aquatic	On the basis of the three acute toxicity data points, an assessment factor of 1000 has been applied to the lowest reported effect concentration of 120 mg/L. The PNECaquatic is determined to be 0.12 mg/L.
Current Regulatory Controls[3,4]	
Australian Hazard Classification	This chemical is a permitted food colour in both Australia and New Zealand.
Australian Occupational Exposure Standards	No data available.
International Occupational Exposure Standards	This chemical is a certified colour additive approved by the FDA in the United States to colour food, drugs and cosmetics.
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	No data available.
PBT Assessment	
P/vP Criteria fulfilled?	Not readily biodegradable. Thus, it is expected to meet the screening criteria for persistence.
B/vB criteria fulfilled?	As the estimated Log Pow is -10.7 (Log Pow < 4.5), it is not expected to be bioaccumulative.
T criteria fulfilled?	The acute aquatic toxicity of this chemical is >0.01 mg/L. Thus, it is not expected to meet the screening criteria for toxicity.
Overall conclusion	Not PBT
Revised	April 2019

References

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Toxicity Summary - Water Flow Assurance Tracer (WFT)

Chemical and Physical Properties[3,4,8,9]	
CAS number	One chemical (proprietary)
Molecular formula	Proprietary
Product name	--
Molecular weight	194.19
Solubility in water	$2.16x10^{4}$ mg/L at 25 deg C
pH	6.9
Melting point	236.2 deg C
Boiling point	178 deg C
Vapour pressure	Odourless white crystals or crystalline powder
Henrys law constant	$9.0x10^{-7}$ mm Hg at 25 deg C
Explosive potential	$1.1X10^{-11}$ atm-cu m/mole at 25 deg C
Flammability potential	Combustible. Gives off irritating of toxic fumes in a fire.
Colour/Form	No data found
Overview	This WFT is a naturally occurring substance in various plant species. The use in food is the predominant way of human exposure and of exposure of the environment. It is generally recognised as safe (GRAS) as a food additive by the US FDA.
Environmental Fate[4,8,9]	
Soil/Water/Air	If released to air, a vapor pressure of 9.0X10-7 mm Hg at 25 deg C indicates this chemical will exist in both the vapor and particulate phases in the atmosphere. In vapor-phase the chemical will be degraded in the atmosphere by reaction with photochemically-produced hydroxyl radicals; the half-life for this reaction in air is estimated to be 20 hours. The Henry's law constant of 0.00000363 Pa m^3/mol indicates that the substance is non-volatile from water surfaces. If released to soil, this chemical is expected to have low to no mobility based upon Koc values of 741 and 7762 determined in silt and sandy loam soils. An approximated Koc of 71 suggests high mobility in sand which contains no clay and very low organic carbon content. Volatilization from moist soil surfaces is not expected to be an important fate process based upon an estimated Henry's Law constant of 1.1X10-11 atm-cu m/mole. Various biodegradation studies have found this chemical to be readily biodegradable. If released into water, this chemical is expected to adsorb to suspended solids and sediment based upon the Koc. Volatilization from water surfaces is not expected to be an important fate process based upon this compound's estimated Henry's Law constant. An estimated BCF of 3 (log Kow of -0.07) suggests the potential for bioconcentration in aquatic organisms is low. The hydrolysis half-life of this chemical in water is reported to be >1 year. Degradation in natural water can occur through photodegradation and biodegradation.

Human Health Toxicity Summary [1,2,3,5,6,7,8,9]	
Chronic Repeated Dose Toxicity	This chemical was tested for carcinogenicity in five studies in rats by oral administration. In two of these studies, no significant difference in the incidence of tumours at any site was found. The other three studies were found to be inadequate for evaluation. Studies on oral and intraperitoneal administration of this chemical to mice were found to be inadequate for evaluation. In one study, decaffeinated coffee to which this chemical was added was tested by oral administration to rats; overall, no increase in tumours at any site was observed as compared to appropriate controls. Administration of this chemical in combination with known carcinogens resulted in decreased incidences of lung tumours in mice treated with urethane, of mammary tumours in rats treated with diethylstilboestrol and of skin tumours in mice treated with either ultra-violet light or cigarette-smoke condensate. This chemical did not influence the incidence of bladder tumours induced in rats by N-nitroso-N-butyl(4-hydroxybutyl)amine in three experiments or of pancreatic tumours induced in rats by 4-hydroxyaminoquinoline-1-oxide in another study. Nawrot et al. (2003) concluded in their review of the effects of this chemical on human health that "for the healthy adult population, moderate daily this chemical intake at a dose level up to 400 mg/day (equivalent to 6 mg/kg body weight/day in a 65-kg person) is not associated with adverse effects such as general toxicity, cardiovascular effects, effects on bone status and calcium balance (with consumption of adequate calcium), changes in adult behaviour, increased incidence of cancer and effects on male fertility." It was indicated that habitual daily use of this chemical at greater than 500-600 mg/day (8.3 - 10 mg/kg) could be considered a health risk. For women, this chemical intake greater than 400 mg/day (6.7 mg/kg) "may increase the risk of detrusor instability (unstable bladder) development in women". The EFSA's panel on dietetic products, nutrition and allergies concluded that single doses of caffeine up to 200 mg (3 mg/kg/bw) from all sources do not raise safety concerns for the general healthy adult population. Intakes up to 400 mg per day (5.7 mg/kg bw) consumed throughout the day do not raise safety concerns for healthy adults in the general population, except pregnant women. A safety level of 3 mg/kg bw per day is also proposed for habitual caffeine consumption by children and adolescents.
Carcinogenicity	IARC evaluates that this chemical is not classifiable as to its carcinogenicity to humans (group 3).
Mutagenicity/ Genotoxicity	The potential for this chemical to induce genotoxicity has been evaluated in both in vitro an in vivo studies, with in vitro studies indicating both genotoxic and non-genotoxic results; in vivo studies have shown that, overall, this chemical is not genotoxic .
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	This chemical has been shown to cause adverse reproductive and developmental effects in mice, rats, rabbits and monkeys. Testicular atrophy was observed at high dose levels in rats. Reproductive studies in mice showed no effect on pregnancy but there was a decrease in litter size at birth. Teratogenic effects were usually associated with high, single, daily doses that were also associated with other signs of maternal toxicity. High daily levels given as divided doses were less toxic to the conceptus that when given as a single dose. Reduced fetal body weight was observed in rats. A reversible delay in ossification of the sternum was observed in rats at a relative low dose given by gavage. With administration in drinking-water, similar effects were seen, but at higher doses. One epidemiological study revealed no effect of this chemical on the sex ratio of their children. In lymphocytes of normal, this chemical-exposed people, chromosomal aberrations were not observed. An increased frequency of micronucleated blood cells was observed in otherwise healthy splenectomized people exposed to this chemical. Urine of this chemical-exposed persons was not mutagenic to Salmonella typhimurium.

Acute Toxicity	After oral application the LD50 for rats (10 animals/group/sex) was found to be 261-383 mg/kg bw; as clinical symptoms of toxicity, dyspnoea and staggering were seen after oral intake. In further reports the oral LD50 for rats was reported to be 200-400 mg/kg bw and for mice 185 mg/kg bw. The inhalation of the substance by rats as an aerosol for a period of 4 h resulted in an LC50-value of ca. 4.94 mg/l. Irregular and accelerated respiration were noted in this study. The LD50 for dermal application was >2000 mg/kg bw; no clinical symptoms of toxicity were observed. In animals studies this chemical showed moderate toxicity after oral uptake and inhalation and a low acute toxicity after dermal treatment .
Irritation	The undiluted substance was not irritating to the eyes of rabbits. Mean irritation indices were 0.9 (corneal opacity), 0 (iritis), 1.6 (conjunctival erythema) and 0.6 (conjunctival edema). The strongest signs of irritation were observed in 3/3 animals within the first 24h. By day 8 only one animal showed slight corneal opacity and conjunctival redness. The substance in a 50% aqueous dilution was not irritating to the skin of rabbits (Irritation index was 0) (OECD guideline 404 and 405). This chemical is not irritating to skin and eyes.
Sensitisation	No data available.
Key Study/Critical Effect for Screening Criteria	The American College of Obstetricians and Gynaecologists (2010) concluded that moderate chemical consumption (<200 mg/day) does not appear to be a major contributing factor in miscarriage or preterm birth. The EFSA's panel on dietetic products, nutrition and allergies concluded that single doses of caffeine up to 200 mg (3 mg/kg/bw) from all sources do not raise safety concerns for the general healthy adult population Thus, the acceptable daily intake of this chemical will be set at 200 mg/person/day for the derivation of a drinking water guidance value. Assuming that humans consume 2 litres of water a day, the drinking water guidance value for this chemical is determined to be 100 mg/L.
Ecological Toxicity [8,9]	
Aquatic Toxicity	Acute toxicity guideline studies have been conducted in fish, invertebrates and algae (OECD, 2002a,b; ECHA REACH database). A 96-hour LC50 in Leuciscus idus was reported to be 87 mg/L; the 48-hour EC50 in Daphnia magna was reported to be 182 mg/L. and the ErC50 in Scenedesmus subspicatus was reported to be >100 mg/L. .
Determination of PNEC aquatic	Based on the lowest acute toxicity value of 87 mg/L in fish and an assessment factor of 1,000, a PNECaquatic is determined to be 0.087 mg/L
Current Regulatory Controls	
Australian Hazard Classification	No data found
Australian Occupational Exposure Standards	No data found
International Occupational Exposure Standards	No data found
Australian Food Standards	No data found
Australian Drinking Water Guidelines	No data found
Aquatic Toxicity Guidelines	No data found
Australian Hazard Classification	No data found
Australian Occupational Exposure Standards	No data found

PBT Assessment	
P/vP Criteria fulfilled?	This chemical is expected to be readily biodegradable and thus would not be expected to meet the screening criteria for persistence.
B/vB criteria fulfilled?	This chemical is water-soluble and bioaccumulation is not expected according to the log Kow (0.07). Thus, this chemical is not likely to meet the screening criteria for bioaccumulation.
T criteria fulfilled?	Long term data not available (acute data >0.1 mg/L); potentially not toxic.
Overall conclusion	Not a PBT substance (based on screening data).

References

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Toxicity Summary - Water SoluableTracers (CFTs) - Benzoic acid used as analogue data

Chemical and Physical Properties[1]	
CAS number	20 chemicals (proprietary)
Molecular formula	Proprietary
Molecular weight	140 – 260 (approximate)
Solubility in water	3.5 g/L at 25 °C
Melting point	122.4 °C
Boiling point	249.2 °C
Vapour pressure	0.11 Pa at 20 °C
Henrys law constant	No data available.
Explosive potential	Non-flammable
Flammability potential	Non explosive
Colour/Form	A white crystalline powder with a pleasant odour.
Overview	CFTs are organic compounds. Benzoic acid has been used as analogue data.
Environmental Fate[1,2,3]	
Soil/Water/Air	If released to air, a vapor pressure of 7.0X10-4 mm Hg at 25 deg C indicates benzoic acid will exist solely as a vapor in the atmosphere. Vapor-phase benzoic acid will be degraded in the atmosphere by reaction with photochemically-produced hydroxyl radicals; the half-life for this reaction in air is estimated to be 9 days. Benzoic acid absorbs light at wavelengths >290 nm and, therefore, may be susceptible to direct photolysis by sunlight. If released to soil, benzoic acid is expected to have very high mobility based upon an estimated Koc of 15 (log Kow of 1.87). The pKa of benzoic acid is 4.20, indicating that this compound will exist almost entirely in the anion form in the environment and anions generally do not adsorb more strongly to soils containing organic carbon and clay than their neutral counterparts. Volatilization from moist soil is not expected because the compound exists as an anion and anions do not volatilize. Benzoic acid is not expected to volatilize from dry soil surfaces based upon its vapor pressure. If released into water, benzoic acid is not expected to adsorb to suspended solids and sediment based upon the estimated Koc. Biodegradation half-lives of 0.85 and 3.6 days using inoculum from a polluted river and a reservoir, respectively, suggest that biodegradation may be an important fate process in water. Measured BCF values of <10, 14, and 21 were reported for Golden ide (Leuciscus idus melanotus)(1), trout(2), and mosquito fish (Gambusia affinis)(3), respectively. This BCF range suggests the potential for bioconcentration in aquatic organisms is low.

Human Health Toxicity Summary [1]	
Chronic Repeated Dose Toxicity	Based on the weight of evidence the chemical is not considered to cause serious damage to health by repeated oral exposure (no observed adverse effect level (NOAEL) of 825 mg/kg bw/d). Effects observed at > 1000 mg/kg bw/d included increased mortality, reduced weight gain, and liver and kidney effects (OECD, 2004). Available animal data suggest that the chemical is not likely to cause serious damage to health via repeated dermal exposure. No treatment-related effects in rabbits at doses of up to 2500 mg/kg bw/d applied 5 d/wk for 3 weeks (OECD, 2004). Available animal data suggest that the chemical is not likely to cause serious damage to health via repeated inhalation exposure. The only available rat study for this chemical reported 2/20 mortalities at 1.2 mg/L 6 h/d (5 d/wk over 4 wk). Local reddish discharge around the nostrils and inflammatory cell infiltrates and interstitial fibrosis of the lung secondary to local irritant effects were also observed at ^{3} 0.25 mg/L. On the basis of systemic effects, the NOAEC is considered to be > 0.25 mg/L 6 h/d (ECHA, 2011).
Carcinogenicity	Based on the available data, the chemical is not considered carcinogenic. The chemical was not carcinogenic (NOAEL 500 mg/kg bw/d) in a lifetime 3-generation study in rats when given with the diet at doses up to 500 mg/kg bw/d. No increase in the lifetime tumour incidence, clinical abnormalities or histopathological changes were observed (OECD, 2004). A lifelong study using male/female Swiss Albino mice given the chemical (2 %) continuously in drinking water showed no carcinogenic effect (such as effect on survival or incidence of tumours) (CICAD, 2000).
Mutagenicity/ Genotoxicity	Based on the weight of the evidence of the in vitro and in vivo genotoxicity data, the chemical is not considered mutagenic or clastogenic. In vitro data using the reverse mutation assays with various strains of Salmonella typhimurium (with and without metabolic activation) and sister chromatid exchange assays (except one equivocal result) were negative. Weak genotoxic effects or equivocal results were observed in most of the chromosome aberration assays in three mammalian cell lines and two of the recombination assays in Bacillus subtilis (no further information available, only summary given) (REACH). No genotoxicity was observed in the in vivo cytogenetic, micronucleus, or other assays at either somatic or germ cell level (OECD, 2004).
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	No evidence of reproductive or developmental toxicity was observed for the chemical.

Acute Toxicity	The chemical is of low acute toxicity in animal tests following oral exposure. The median lethal dose (LD50) in rats and mice is greater than 2000 mg/kg bw/d. LD50 in rats ranged from 1700-3040 mg/kg bw/d and in mouse ranged from 1940-2370 mg/kg bw/d. However, the studies that reported the lower LD50s were all pre-guideline studies and no further information was available to critically assess the data. LD50s reported in two reliable studies were 2250 mg/kg bw/d (mice) and 2565 mg/kg bw/d (rats) (OECD, 2004). The chemical is of low acute toxicity in animal tests following oral exposure. The median lethal dose (LD50) in rats and mice is greater than 2000 mg/kg bw/d. LD50 in rats ranged from 1700-3040 mg/kg bw/d and in mouse ranged from 1940-2370 mg/kg bw/d. However, the studies that reported the lower LD50s were all pre-guideline studies and no further information was available to critically assess the data. LD50s reported in two reliable studies were 2250 mg/kg bw/d (mice) and 2565 mg/kg bw/d (rats) (OECD, 2004). The chemical exhibits low acute toxicity in animal tests as evidenced by reported dermal LD50 (median lethal concentration) in rats of greater than 2000 mg/kg bw (OECD, 2004). The chemical exhibits low acute toxicity in animal tests following inhalation exposure. No mortalities or toxic effects were observed in rats and mice with the reported median lethal concentration (LC50) > 12.2 mg/L/4-h (ECHA, 2011; OECD, 2004).
Irritation	Inhalation toxicity of the chemical was evaluated in one rat study (0, 0.025, 0.25 and 1.2 mg/L, 6 h/d 5 d/wk over 4 weeks) using fine benzoic acid dust (see Repeat dose toxicity - Inhalation). A reddish discharge around the nostrils was seen in the mid and high dose groups. An increased incidence and intensity of interstitial inflammatory cell infiltrate and interstitial fibrosis (indicating upper respiratory tract irritation) was noted at all doses. Observed histopathological changes were most likely due to a persistent irritating effect of the test substance on the lung. No changes in gross pathology were noted (REACH). The chemical was irritating (erythema and swelling of the ear lobe) in the guinea pig ear swelling test at ³ 1%, particularly when dissolved in ethanol, although it was not found irritating in the rabbit (OECD, 2004). The chemical was highly irritating in rabbit eyes, causing irreversible corneal opacity and chemosis in 2/3 animals, and increasing conjunctival redness severity with white/grey discoloration after 2-day observation. A Draize score of 35 was given based on the effects (REACH). In another rabbit study an irritation score of 65.0/110 was noted. No further details were available from this study (OECD, 2004).
Sensitisation	The negative results seen for the chemical from several skin sensitisation animal studies including guinea pig maximisation test (GPMT), Buehler test and local lymph node assay (LLNA) support a conclusion that the chemical is not a skin sensitiser (REACH). The chemical did not induce sensitisation in healthy volunteers although some allergic reactions were noted in 34/537 patients with suspected contact dermatitis (at 2 %) (SCCP, 2005) and 9/121 patients with dermatoses and 10/57 patients with chronic urticaria (at 5 %) (ECHA, 2011).
Health Effects Summary	The critical health effects associated with the chemical (but not the salts) are skin, eye and respiratory tract irritation. However, no systemic effects were seen with benzoic acid. The salts are expected to exist almost entirely as the benzoate ion under normal physiological conditions and will not have the local irritant properties that arise from the acidity of benzoic acid. Therefore, it is unlikely that any systemic effects will be observed with the salts of benzoic acid.
Key Study/Critical Effect for Screening Criteria	The critical lowest No Observed Adverse Effect (NOAEL) level for the purposes of risk assessment is 825 mg/kg bw/day from the repeated chronic oral toxicity study.

Ecological Toxicity [2]	
Aquatic Toxicity	Studies on three trophic levels are available with the lowest EC50 found in algae (33.1 mg/L). In this study the concentrations decreased significantly over the exposure period of 72 hours. The LC50 for fish is 44.6 mg/L and for daphnia an EC50 of > 100 mg/L was derived. The EC10 from the algae study is 3.4 mg/L, which is much lower than the NOEC for fish (120 mg/L in a 28 day study) and daphnia (25 mg/L in 21 day reproduction test).
Determination of PNEC aquatic	Long-term data was available for a fish, invertebrate and algae. An assessment factor of 10 was used on the lowest NOEC of 3.4 mg/L for algae for a resulting PNEC of 0.34 mg/L.
Current Regulatory Controls[1]	
Australian Hazard Classification	The chemical is not listed on the Hazardous Substances Information System (HSIS) (Safe Work Australia).
Australian Occupational Exposure Standards	No specific exposure standards are available.
International Occupational Exposure Standards	The following exposure standards are identified (Galleria Chemica): An exposure limit (TWA) of 5–10 mg/m^3 in different countries such as USA (California, Tennessee), Canada and England.
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	No data available.
PBT Assessment	
P/vP Criteria fulfilled?	Benzoic acid is readily biodegradable and as such not persistent in the environment.
B/vB criteria fulfilled?	Based on the measured BCF values of <10 to 21 and a log Kow of 1.87 benzoic acid is not expected to be bioaccumulative.
T criteria fulfilled?	The acute aquatic toxicity of this chemical is >0.01 mg/L. Thus, it is not expected to meet the screening criteria for toxicity.
Overall conclusion	Not PBT
Revised	April 2019

References

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Toxicity Summary - Gas Phase Frac Tracers (GFTs)

Chemical and Physical Properties[1,2,3]	
CAS number	15 chemicals (proprietary).
Molecular formula	Proprietary
Molecular weight	~300 – 500
Solubility in water	Insoluble
Melting point	~-37 °C
Boiling point	~76 °C
Vapour pressure	666 @ 25 °C
Henrys law constant	No data available
Explosive potential	Non explosive
Flammability potential	Non-flammable
Colour/Form	Colourless, odourless liquid
Overview	GFTs tracers are compounds that consist of a carbon and fluorine atoms joined by covalent bonds. GFTs are very stable because of the strength of the carbon–fluorine bond. GFTs are chemically inactive, nontoxic, and non-flammable compounds that are found in the atmosphere at very low levels. They are chemical inert, have no biological effects and are very safe. GFTs present no known danger to humans if inhaled or ingested. There are no regulatory restrictions on the use or emission of GFTs. Information for Perfluorocarbons (PFCs) used as analogue data.
Environmental Fate[1]	
Soil/Water/Air	GFTs as a class are extremely stable. They are not susceptible to hydrolysis, and not affected by light (including UV).
Human Health Toxicity Summary [1,2,3]	
Chronic Repeated Dose Toxicity	Two-week repeat dose preliminary inhalation toxicity (rat at a target concentration of 10,000 ppm (10%), no treatment-related effects were noted for clinical signs, body weight, food consumption, water consumption, macroscopic pathology or organ weights. 90 day inhalation study in rats: no treatment-related effects were observed in this study in which rats were exposed to 5,000 ppm, 15,000 ppm, and 50,000 ppm of the test material for 6 hours per day, 5 days per week for a total of 13 weeks. These results indicate that the toxicity of the test material following repeated inhalation exposure is very low and suggest that the gas can be treated as a simple asphyxiant. In a short term repeated Dose 28 Day oral toxicity study in rodents conducted in accordance to the OECD Guideline 407, the test subjects showed no toxic effect at a dosage of 1000 mg/kg/day over 28 days. The NOEL was determined to be 1000 mg/kg/day.
Carcinogenicity	Chromosomal aberration test in cultured mammalian cells: non-clastogenic
Mutagenicity/ Genotoxicity	Bacterial mutation assay salmonella typhimurium (strains ta 1535, ta 1537, ta 1538, ta 98 and ta 100): negative.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	No data available.

Acute Toxicity	Inhalation 4-hour LC50 : > 800,000 ppm in rats Effects observed in animals by inhalation include decreased growth rate, pulmonary changes, irregular respiration, increased urine volume and creatinine, reversible pathological changes in the kidneys, and increased urinary fluoride concentration. One study showed no arrhythmogenic effects in dogs at a concentration of 20 %, while another study did show some arrhythmogenic effects in both guinea pigs and dogs. Long-term inhalation exposures resulted in an initial decrease in growth rate, but no other adverse changes were noted. No animal test reports are available to define carcinogenic, developmental, or reproductive hazards. The compound does not produce genetic damage in bacterial cell cultures but has not been tested in animals. Acute inhalation toxicity study (rat): the 4-hour LC50 is above 110,000 ppm. These results suggest that on an acute inhalation basis the test material can be considered as a simple asphyxiant.
Irritation	Non-irritating
Sensitisation	Not sensitising
Health Effects Summary	The chemicals have been used in various medical applications, both in trials and in routine use, in human subjects, for some forty years, indicating these materials have zero toxicity to humans.
Key Study/Critical Effect for Screening Criteria	The NOEL level for the purposes of risk assessment is 1000 mg/kg bw/day from the repeated short term oral toxicity study.
Ecological Toxicity [1]	
Aquatic Toxicity	Fish 96h LC50 > 100 mg/L Invertebrates 48h EC50 > 0.1 mg/L Microorganism 3h EC50 > 100 mg/L Pimephales promelas (fathead minnow) 96 h NOEC = 1000 mg/L
Determination of PNEC aquatic	$PNEC_{aquatic}$ has not been calculated. The substance exhibits no toxicity.
Current Regulatory Controls	
Australian Hazard Classification	No data available.
Australian Occupational Exposure Standards	No data available.
International Occupational Exposure Standards	No data available.
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	No data available.
PBT Assessment	
P/vP Criteria fulfilled?	Yes, GFTs are not biodegradable. However, they are volatile and are quickly removed from the environment.
B/vB criteria fulfilled?	The estimated Log Kow is generally > 4.5 (EPI Suite), thus it is expected to be bioaccumulative.
T criteria fulfilled?	No. Fish 96 h NOEC = 1000 mg/L. Thus, it is not expected to meet the screening criteria for toxicity.
Overall conclusion	Not PBT

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Appendix I

Toxicological Profiles for Drilling and Packer Fluids

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Toxicity Summary - Sodium Erythorbate

Chemical and Physical Properties[1,2]	
CAS number	6381-77-7
Molecular formula	C6H7NaO6
Molecular weight	199.13
Solubility in water	Soluble; 146 g/L at 20 °C and pH 6
Melting point	160 °C at 101.3 kPa
Boiling point	No data available.
Vapour pressure	No data available.
Henrys law constant	No data available.
Explosive potential	No data available.
Flammability potential	Non-flammable (100%)
Colour/Form	White, free-flowing crystals
Overview	Sodium erythorbate is a synthetic antioxidant used in food and cosmetic formulations. Foliar application of sodium erythorbate sprays and dusts are used to control young tree decline in citrus trees and to reduce ozone damage to Thompson seedless grapes. It is also used in hydraulic fracturing mixtures to prevent precipitation of metal oxides (iron control). This chemical has been identified by NICNAS to be of low concern to human health based on an initial screening approach and thus required no further assessment.
Environmental Fate[1]	
Soil/Water/Air	The chemical is not expected to be readily biodegradable. The chemical achieved 56% degradation in 28 days according to test guidelines OECD 301E. However, the degradation after 28 d was not yet finished as a plateau is not yet visible in the degradation curve; thus, a further degradation of the product seems to be possible.
Human Health Toxicity Summary[1]	
Chronic Repeated Dose Toxicity	Male 6-week-old F344 rats were given doses of 5% Sodium Erythorbate in feed for 168 days. Parameters of urinary excretion were investigated and the urinary bladder epithelium was examined using light and scanning electron microscopy at weeks 8, 16, and 24. The urine of rats fed Sodium Erythorbate had increased pH, elevated content of crystals and sodium, and decreased osmolality; however, no morphological alterations such as hyperplasia were detected in the mucosa. The urine values and urinary bladder mucosa were similar to controls at doses below 5 g/kg/day.

Carcinogenicity	F344/DuCrj rats of both sexes (6-week-old) were given 1.25% or 2.5% Sodium Erythorbate in drinking water for 104 weeks and untreated water for 8 additional weeks. Rats of the control group were given untreated water only. Each group consisted of 52 male and 50 female rats. Cumulative consumption of Sodium Erythorbate by male rats was 217 g/rat (1.25%) and 430 g/rat (2.5%). Consumption by females was 206 g/rat (1.25%) and 583 g/rat (2.5%). Body weight of rats given 2.5% Sodium Erythorbate was reduced by 8.5% for males and 15.5% for females at weeks 88 and 85, respectively, compared to controls. Body weight gain was normal in rats of the low dose group. All male treated and control rats (except two of the high-dose group) had testicular interstitial cell tumours. Various tumours occurred in 80% of control males, 69% of males given the low dose, and 78% of males given the high dose. A 6-18% incidence of leukaemia, pheochromocytoma, mammary fibroadenoma, and mesothelioma was observed. Of the females of the control, 1.25%, and 2.5% dose groups, 94%, 88%, and 78% had tumours, respectively. Twenty to 43% of females (all groups) had leukaemia, mammary fibroadenoma, endometrial stromal polyp and/or pituitary adenoma. Females given 2.5% Sodium Erythorbate had significantly fewer tumours than control females. The pattern of occurrence of the various types of tumours was similar among the groups. Sodium Erythorbate did not enhance the development of rare spontaneous tumours or transform benign tumours (e.g., solid adenoma of the thyroid) to carcinomas. The investigators concluded that Sodium Erythorbate was not carcinogenic in F344 rats.
Mutagenicity/ Genotoxicity	Sodium Erythorbate (99.8% pure; 5.0 mg/plate) was non-mutagenic in S. typhimurium strains TA92, TA94, TA98, TA100, TA1535, and TA1537 with and without S9 activation. Sodium Erythorbate (0.25 mg/mL plate) was also negative in the chromosomal aberration assay using Chinese hamster fibroblasts; Sodium Erythorbate did not induce the formation of polyploid cells after 48 hours, and caused 1 % chromosomal breaks after 24 hours.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	Sodium erythorbate did not cause maternal or fetal toxicity when administered to female rats and mice during gestation by oral intubation at dosages up to 1,030 mg/kg/day. Developmental toxicity did not occur after pregnant rats were given up to 5% sodium erythorbate in feed during a 13-week teratogenesis study. It produced negative results in the Ames test, the host-mediated assay using S. typhimurium, chromosomal aberration tests using Chinese hamster ovary fibroblasts, the dominant lethal test using rats, and the B. subtilis rec assay.
Acute Toxicity	Sodium erythorbate powder was applied to the intact and abraded skin of six rabbits as a single 2 g/kg dose. A substantial amount of residual compound was observed 24 hours after dosing. No erythema, edema, or other signs of dermal irritation were observed at five of six test sites. One rabbit (abraded skin) had slight (1+) erythema at 24 hours that cleared by 48 hours.
Irritation	Sodium erythorbate powder did not cause signs of dermal irritation when applied to the intact and abraded skin of rabbits. Instillation of sodium erythorbate powder to the conjunctival sac of rabbits caused slight and transient reddening of the conjunctiva that cleared within 24 hours.
Sensitisation	In a dermal sensitization study (according to OECD 429) with Sodium erythorbate (5, 10, 25% w/w in propylene glycol), young adult female CBA/Ca (CBA/CaOlaHsd) mice (4/group) were tested using the local lymph node assay (LLNA). In this study, Sodium erythorbate was not considered a potential skin sensitizer.
Health Effects Summary	Sodium erythorbate did not show signs of toxicity, carcinogenicity, mutagenicity, irritation and sensitisation in the studies reported. This chemical has been identified by NICNAS to be of low concern to human health.
Key Study/Critical Effect for Screening Criteria	The Australian drinking water guideline value for sodium may apply.

Ecological Toxicity [1,2]	
Aquatic Toxicity	The acute toxicity of the sodium erythorbate to the freshwater fish rainbow trout (Oncorhynchus myldss) has been investigated and gave a 96-Hour LC50 of greater than 100 mg/L (semi-static). The acute toxicity of sodium erythorbate to Daphnia magna gave an EC50 (48 h) of 84 - 100 mg/L. The effect of the test item on the growth of Pseudokirchneriella subcapitata has been investigated over a 72-Hour period. The EC50 (72 h) was 160 mg/L while the NOEC (72 h) was 20 mg/L.
Determination of PNEC aquatic	A PNECaquatic of 84 µg/L was calculated using the lowest endpoint of EC50 of 84 mg/L for Daphnia magna. An assessment factor of 1000 was used.
Current Regulatory Controls[4]	
Australian Hazard Classification	No data available.
Australian Occupational Exposure Standards	No data available.
International Occupational Exposure Standards	No data available.
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	No data available.
PBT Assessment	
P/vP Criteria fulfilled?	Could potentially be persistent as it is not readily biodegradable.
B/vB criteria fulfilled?	No. The Log Pow is -3.29 (Log Pow < 4.5) which does not meet the screening criteria for bioaccumulation.
T criteria fulfilled?	No. Based on measured acute toxicity endpoints of greater than 1 mg/L Sodium erythorbate does not meet the screening criteria for toxicity.
Overall conclusion	Not PBT
Revised	April 2019

References

1. HSDB (n.d.). *Hazardous Substances Data Bank*. Retrieved 2015, from Toxnet, Toxicology Data Network, National Library of Medicine: http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB
2. ECHA REACH, 2,3-didehydro-3-O-sodio-D-erythro-hexono-1,4-lactone, Retrieved 2019: https://echa.europa.eu/
3. Department of the Environment and Energy 2017 , National assessment of chemicals associated with coal seam gas extraction in Australia, prepared by the National Industrial Chemicals Notification and Assessment Scheme

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Toxicity Summary - Starch

Chemical and Physical Properties[1,2,4,6]	
CAS number	9005-25-8
Molecular formula	(C6H10O5)n
Molecular weight	UVCB
Solubility in water	In cold water, starch absorbs water reversibly and swells slightly. In hot water, irreversible swelling occurs, producing gelatisation.
Melting point	No data available.
Boiling point	No data available.
Vapour pressure	No data available.
Henrys law constant	No data available.
Explosive potential	Combustible
Flammability potential	No data available.
Colour/Form	White powder, tasteless and has no smell
Overview	Starch is a high –polymeric carbohydrate material primarily composed of amylopectin and amylose. It is usually derived from cereal grains such as corn, wheat and sorghum and from roots and tubers such as potatoes and tapioca. It includes starch which has been pregelatinized by heating in the presence of water. This chemical has been identified by NICNAS to be of low concern to human health and thus required no further assessment.
Environmental Fate[7]	
Soil/Water/Air	Based on information from NICNAS (2006): In a ready biodegradation test, the notified polymer (Potato Starch Modified) showed an 86.87% degradation during a Modified Sturm Test (OECD Test Guideline 301B) indicating that it was readily biodegradable. The test was verified using a sodium benzoate standard which showed 93.77% degradation at the end of the study. In addition a toxicity control consisting of a mixture of the test substance and sodium benzoate showed 83.49% degradation at the end of the study period, indicating that the test material did not inhibit the microbial activity. The notified polymer does potentially contain cationic and anionic functional groups, however based on the typical dissociation constants for the functionalities and their ratio within the polymer it is expected to have a net anionic charge throughout most of the environmental pH range, becoming slightly cationic only at the low end of the range. In landfill and the sewer, the notified chemical is expected to be relatively readily degraded by biotic and abiotic pathways to ultimately yield water and oxides of carbon and nitrogen and salts of chlorine and sodium. Any incineration of the notified polymer would result in its destruction and the formation of carbon dioxide and water and ash containing salts of chlorine and sodium. The notified polymer has a high molecular weight not expected to bioaccumulate.

Human Health Toxicity Summary[2,3]	
Chronic Repeated Dose Toxicity	A long-term study was carried out on the effects of inoculating 1.5 g of starch powder into the peritoneal cavity of rats. After an initial considerable inflammatory reaction, the intense vascular reaction subsided, leaving firm adhesions that were still present in animals sacrificed at 18 months (Ell90). Feeding of unmodified cornstarch and potato starch to groups of rats at dietary levels up to 30% (equivalent to 27.4-33.6 g/kg bw/d) in a 2-year test and 10% (food intake not indicated) in a 3-generation test did not result in distinct toxicologically significant effects (Gro74). Rats fed a cooked diet containing 62% unmodified maize starch (equivalent to 51.1 g/kg bw/d*) for 2 years also did not show significant toxicological effects, including reproductive effects over 3 generations (Tru79). Slight growth retardation was seen in rats exposed for 4 weeks to raw potato starch at a dietary level of 40% (equivalent to 46.0-52.8 g/kg bw/d) (Fer73).
Carcinogenicity	Not classifiable as a human carcinogen (A4)
Mutagenicity/ Genotoxicity	There were no indications for significant toxicity, carcinogenicity or reproduction toxicity of starch in rats fed 27.4-52.8 g/kg bw/day.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	There were no indications for significant toxicity, carcinogenicity or reproduction toxicity of starch in rats fed 27.4-52.8 g/kg bw/day.
Acute Toxicity	Toxicity of starch given orally to albino rats were studied. Experiments were performed upon CBL albino rats weighing 140 ± 15 (mean ± S.D.). Starch was given daily for 14 consecutive days in total daily oral doses of 36, 72, 120 and 168 g/kg and in animals which did not succumb to gastric rupture in doses gradually increasing to 204, 240 and 288 g/kg. Gastric rupture appeared in 50 – 75% of rats given starch in amounts of 168 g/kg and over. Of the survivors of gastric rupture, 5% died of pneumonia and 20% from bowel obstruction during the 14 days of starch administration. Doses of one tenth body weight and above produced some inhibition of growth, doses of one fifth body weight and above increased the susceptibility to pneumonia and bowel obstruction owing to the inability of the animal to evacuate the starch calculi. It was noted that doses of this order could not readily be taken by humans and smaller doses had insignificant toxicity. Acute respiratory effects after exposure to dust from the refining process of potato starch have been described (personal sampling: 3.9-56.0 mg/m^3, total dust). The responsible agent could not be identified although the authors suspected endotoxin to be the causative agent (Hol94). Millers and bakers occupationally exposed to grain and flour dusts (personal sampling: 1.1-14.3 mg/m^3, total dust) showed significantly higher incidences of coughing and chronic bronchitis compared to a non-exposed reference group (Mas95, Mas96). A dose-response relationship was observed between dust exposure levels and chronic respiratory symptoms (Mas95). Although flour is a complex product that is mainly made up of starch (70%) and gluten (12%), it may also contain mite dust and endotoxins. The causative role of starch in the observed respiratory symptoms is therefore not clear. The intraperitoneal LD50 of starch in mice is 6600 mg/kg (ACG99).
Irritation	Skin contact with a total dose of 300 µg of starch, intermittently applied over a 3-day period, resulted in a mild erythema and slight oedema of the skin in humans (ACG99).
Sensitisation	No data available.
Health Effects Summary	This chemical has been identified by NICNAS to be of low concern to human health.
Key Study/Critical Effect for Screening Criteria	The intraperitoneal LD50 of starch in mice is 6600 mg/kg (ACG99).

Ecological Toxicity[7]	
Aquatic Toxicity	Based on QSAR modelling: Crassostrea virginica 96 h = 1000 mg/L Orthopristis chrysoptera 96 h = 5000 mg/L Bairdiella chrysoura 96 h = 5000 mg/L
Determination of PNEC aquatic	Based on the lack of ecotoxicity data, PNECaquatic was not determined.
Current Regulatory Controls[2,4]	
Australian Hazard Classification	No data available.
Australian Occupational Exposure Standards	TWA = 10 mg/m^3
International Occupational Exposure Standards	TLV: 10 mg/m^3, as TWA The current administrative occupational exposure limit (MAC) for starch in the Netherlands is 10 mg/m^3, 8-hour TWA, equal to the occupational exposure limit for nuisance dust.
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	No data available.
PBT Assessment	
P/vP Criteria fulfilled?	No. This substance is expected to be readily biodegradable.
B/vB criteria fulfilled?	No. This substance is not expected to be bioaccumulative.
T criteria fulfilled?	Based on QSAR modelling, this substance is not expected to meet the toxicity criteria.
Overall conclusion	Not PBT
Revised	April 2019

References

1. ECHA REACH, Starch, Retrieved 2019: https://echa.europa.eu/
2. IPCS Starch, Retrieved 2019: http://www.inchem.org
3. Boyd, E. M., & Liu, S. J. (1968). Toxicity of starch administered by mouth. Canadian Medical Association journal, 98(10), 492–499.
4. Health Council of the Netherlands: Committee on Updating of Occupational Exposure Limits. Starch; Health-based Reassessment of Administrative Occupational Exposure Limits. The Hague: Health Council of the Netherlands, 2002; 2000/15OSH/038.
5. Safe Work Australia, Hazardous Substances System, Starch, Retrieved 2019: http://hcis.safeworkaustralia.gov.au/
6. National Industrial Chemicals Notification and Assessment Scheme (NICNAS). IMAP, Human Health Tier 1 Assessment. Retrieved 2019: https://www.nicnas.gov.au
7. Daugherty,F.M.J Sewage Ind. Wastes 23(10):1282-1286. Effects of Some Chemicals Used in Oil Well Drilling on Marine Animals
8. NICNAS (2006) Potato Starch Modified, Full Public Report, File No PLC/639

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Toxicity Summary - Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione

Chemical and Physical Properties[1,2,3,5]	
CAS number	533-74-4
Molecular formula	C5H10N2S2
Molecular weight	162.28
Solubility in water	3.5 g/l at 20 °C at pH 5, pH 7and pH 9
Melting point	103.2 – 105.2 °C
Boiling point	No data available.
Vapour pressure	5.8 x 10-6 Pa at 20 °C (extrapolated)
Henrys law constant	2.66X10-10 atm-cu m/mole
Explosive potential	No data available.
Flammability potential	No data available.
Colour/Form	Off-white to yellowish solid of sulphurous odour
Overview	Dazomet (Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione) is a soil fumigant effective for the control of nematodes, insects, germinating weeds and soil fungi. Dazomet is strongly phytotoxic, acting by virtue of the chemical release of methylisothiocyanate (MITC).
Environmental Fate[1]	
Soil/Water/Air	Dazomet's production may result in its release to the environment through various waste streams; its use as a soil sterilant, nematicide, fungicide, slimicide in pulp and paper manufacture, and as a preservative in adhesives and glues will result in its direct release to the environment. If released to air, a vapour pressure of 2.80X10-6 mm Hg at 20 deg C indicates dazomet will exist in both the vapour and particulate phases in the atmosphere. Vapour-phase dazomet will be degraded in the atmosphere by reaction with photochemically-produced hydroxyl radicals; the half-life for this reaction in air is estimated to be 1.4 hours. Particulate-phase dazomet will be removed from the atmosphere by wet or dry deposition; hydrolysis of this compound during rain events or in clouds may occur. It has been suggested that dazomet may also undergo direct photolytic degradation and this process may contribute to atmospheric removal. If released to soil, dazomet is expected to have high mobility based upon an estimated Koc of 52; however it is expected to hydrolyse before extensive leaching occurs. Volatilization from moist soil surfaces is not expected to be an important fate process based upon a Henry's Law constant of 2.66X10-10 atm-cu m/mole. When dazomet is applied to soil, either to the surface or incorporated, it quickly hydrolyzes in the presence of moisture. The major degradate is methyl isothiocyanate, but formaldehyde, monomethylamine, hydrogen sulfide and (in acid soils) carbon disulfide, are also formed. The half-life of dazomet in soil has been reported as less than 1 day (pH >5). The rate of disappearance was found to be the same in both unamended and sterilized soils and in different soil types, indicating that chemical hydrolysis and not biodegradation is the primary removal process. Dazomet is not expected to volatilize from dry soil surfaces based upon its vapour pressure. If released into water, dazomet is not expected to adsorb to suspended solids and sediment based upon the estimated Koc. Volatilization from water surfaces is not expected to be an important fate process based upon this compound's Henry's Law constant. In water, dazomet is expected to undergo hydrolysis rapidly, forming methyl isothiocyanate and formaldehyde. Half-lives of 3.6, 2.4, 2.8, and 4.0 hours have been reported at pH values of 4.4, 5.7, 7.0, and 8.0, respectively. In salt water (0.15 M), a half-life of 6.1 hours was reported. An estimated BCF of 2.4 suggests the potential for bioconcentration in aquatic organisms is low.

Human Health Toxicity Summary[1]	
Chronic Repeated Dose Toxicity	In a 78 week study, mice were given dazomet in the diet at 0, 20, 80 and 320 ppm. Compound intakes were estimated as follows: males - 0, 4, 16 and 68 mg/kg/d; females - 0, 6, 22 and 93 mg/kg/d. Survival was not affected and there were no noteworthy clinical signs, or bodyweight or food consumption changes. There was a significant elevation of liver weight at the high dose and an increased number of mid-dose and high dose animals with liver discolouration, liver masses and centrilobular lipid deposition. At the high dose, females showed a slightly increased incidence of hepatocellular adenomas (3, 0, 1 and 7 females, out of 50, in the control, low dose, mid dose and high dose groups, respectively) and a significantly increased incidence of basophilic foci. Increased splenic haemosiderin deposition and extramedullary haematopoiesis were noted at the mid dose (males) and high dose. Three/60 females from each dose group had malignant lymphoma at one or more sites; because of the low incidence, lack of a dose-response, and lack of any effect in males, it was not considered to be directly compound-related. The NOEL was 20 ppm (about 4 mg/kg/d in males, 6 mg/kg/d in females).
Carcinogenicity	Rat studies showed no clear evidence of any carcinogenic effect of dazomet. In mice, there was a slight increase in hepatocellular adenomas (not carcinomas) following 78 weeks of treatment at the high dose (320 ppm). There was also an increase in malignant lymphoma in females, but because of the low incidence, the lack of effect in males and the lack of any dose-response, it was not considered to be directly compound-related. The lack of a carcinogenic effect of dazomet is consistent with the data for MITC.
Mutagenicity/ Genotoxicity	An acceptable package of mutagenicity tests has been conducted covering all three end points. The results are the genotoxicity tests are not clear cut. While the majority of tests gave negative results, there were sufficient positive results to indicate some genotoxic potential of dazomet. In summary, there were positive results in one gene mutation assay (HGPRT locus in Chinese hamster ovary cells), equivocal results in another gene mutation assay (TK locus in mouse lymphoma L5178Y cells), and positive results in two chromosome aberration assays (both in vitro assays in mouse lymphoma L5178Y cells), in one in vitro assay for of unscheduled DNA synthesis in primary rat hepatocytes and in one in vitro assay of sister chromatid exchange. In all cases, the positive findings were relatively weak. There were no positive in vivo studies and there was a trend for results to only be positive (or to be stronger) in the absence of metabolic activation than in its presence. This suggests that unchanged dazomet has greater genotoxic potential than the metabolites of dazomet. The unscheduled DNA synthesis assay was the only assay which gave results suggesting that the metabolites of dazomet may have some genotoxic potential, even if only weak.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	Dazomet was fed to rats at 0, 5, 30 and 180 ppm for at least 70 days prior to mating, throughout mating and lactation, during production of F_1a and F_1b litters. Selected F_1a pups were maintained on compound-containing diets post-weaning to produce F_2 litters. Hepatotoxicity was observed in both generations, mainly at the high dose, but to some extent at the mid dose. Liver weights were increased and there was an increased severity of liver fatty change. Some serum enzyme and serum protein changes also indicated effects on the liver. There was no impairment of mating or reproductive performance and no adverse effect on reproductive organs or pup development. The NOEL with respect to reproductive function in rats was 180 ppm (about 18 mg/kg/d), while that for systemic toxicity was 5 ppm (about 0.5 mg/kg/d). An oral (gavage) developmental study was conducted in rats at dazomet doses of 0, 3, 10 and 30 mg/kg/d. Food intake and body weight and also uterine weights were reduced at the high dose and to a lesser extent at the mid dose. There was a higher incidence of runts at 10 mg/kg and above, however, without a clear dose-response relationship. There was no evidence of teratogenic effects. The NOEL for maternal and foetal effects was 3 mg/kg/d.
Acute Toxicity	Dazomet is of moderate acute oral toxicity. The oral LD50 values for dazomet from two different studies in rats were about 600 - 900 mg/kg for males and 400 - 550 mg/kg for females. The LD50 of dazomet, given subcutaneously to mice, was 248 mg/kg. The LD50 of dazomet, given subcutaneously to rats, was 470 and 550 mg/kg in males and females, respectively. The dermal LD50 of dazomet in rats was greater than 2000 mg/kg. Symptoms associated with acute dazomet toxicity were shaking, salivation, tonic convulsions, trembling, dyspnoea and lassitude.

Irritation	In two studies, the introduction of 39 or 50 mg dazomet into the eye of rabbits caused slight irritation (moderate conjunctival erythema and slight oedema). Results of two acute dermal irritation studies employing 50% aqueous preparations of dazomet in rabbits were reported. No irritation was observed in the study employing a 4 h exposure period. After a 20 h exposure period, moderate erythema and oedema were observed. Application of the EUP, Basamid Granular (2 g coated on a cottonwool carrier), to the rabbit ear for 20 h caused slight inflammation.
Sensitisation	Skin sensitisation was not observed in two studies following the application of dazomet or Basamid Granular to the guinea pig. No justification was given for the doses / concentrations used in one of these studies and positive control compounds were not tested in these studies.
Health Effects Summary	Dazomet has moderate to low acute oral, dermal and inhalational toxicity. It appears that the toxicity of dazomet is somewhat greater by the oral route than by the dermal and inhalational routes. Dazomet is only a slight dermal and ocular irritant.
Key Study/Critical Effect for Screening Criteria	An ADI of 0.005 mg/kg/d is calculated based on a NOEL of 0.5 mg/kg (established in a 1-year dietary dog study and a 2-year dietary rat reproductive study) and a safety factor of 100.
Ecological Toxicity [1,2,3]	
Aquatic Toxicity	Daphnia magna (Water flea), 48 h, static, EC50 = 0.3 mg/L Salmo gairdneri (Rainbow trout), 96 h, static, LC50 = 0.16 mg/L Ankistrodesmus bribaianus (Green alga), 72 h, static, EC50 = 1.08 mg/L Colinus virginianus (Bobwhite quail), 21 d, LD50 = 415 mg/kg bw Colinus virginianus (Bobwhite quail), 25 weeks, NOEL = 100 mg/kg food
Determination of PNEC aquatic	An assessment factor of 10 has been applied to the lowest reported LC50 of 0.16 mg/L for Rainbow trout. The PNECaquatic is 0.016 mg/L.
Current Regulatory Controls[4]	
Australian Hazard Classification	Acute toxicity – category 4 Eye irritation – category 2 Hazardous to the aquatic environment (acute) – category 1 Hazardous to the aquatic environment (chronic) – category 1
Australian Occupational Exposure Standards	No data available.
International Occupational Exposure Standards	No data available.
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	No data available.
PBT Assessment[1,3,5]	
P/vP Criteria fulfilled?	The half-life of dazomet in soil has been reported as less than 1 day (half-life in soil < 6 months). Thus, it is not expected to be persistent.
B/vB criteria fulfilled?	As the Log Pow is 0.63 at 20 °C (Log Pow < 4.5) and estimated BCF is 2.4, it is not expected to be bioaccumulative.
T criteria fulfilled?	The acute aquatic toxicity of this chemical is >0.01 mg/L. Thus, it is not expected to meet the screening criteria for toxicity.
Overall conclusion	Not PBT
Revised	April 2019

References

1. National Registration Authority for Agricultural and Veterinary Chemicals, NRA Special Review of Metham Sodium, Dazomet and Methylisothiocyanate (MITC) Volume II, June 1997
2. ECHA REACH, 1-Butanol, Retrieved 2019: https://echa.europa.eu/
3. Food and Agriculture Organization of The United Nations (2001), FAO Specifications and Evaluations for Plant Protection Prducts, Dazoment
4. Safe Work Australia, Hazardous Substances System, Dazomet, Retrieved 2019: http://hcis.safeworkaustralia.gov.au/
5. HSDB (n.d.). Hazardous Substances Data Bank. Retrieved 2019, from Toxnet, Toxicology Data Network, National Library of Medicine: http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB

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Toxicity Summary - Trisodium Nitrilotriacetate

Chemical and Physical Properties[1,2,3]	
CAS number	5064-31-3
Molecular formula	C6H9NO6.3Na
Molecular weight	257.0
Solubility in water	640 g/l at 20 °C
Melting point	410 °C with decomposition above 200 °C
Boiling point	No data available
Vapour pressure	No data available
Henrys law constant	No data available
Explosive potential	Non-explosive (100%)
Flammability potential	Non-flammable (100%)
Colour/Form	colourless crystalline powder
Overview	The chemicals in this group are known as nitrilotriacetic acid (NTA) and its trisodium and tripotassium salts, trisodium nitrilotriacetate (trisodium NTA) and tripotassium nitrilotriacetate (tripotassium NTA). The trisodium salt also occurs as its monohydrate form (trisodium nitrilotriacetate monohydrate; CAS No. 18662-53-8). The chemical NTA is an aminocarboxylic acid with three functional carboxylate groups. The chemical forms water-soluble complexes with multivalent metal ions. The chemical NTA and trisodium NTA dissociate to form a common moiety, nitrilotriacetate ion. Thus the systemic toxicity of these chemicals is similar (Health Canada, 2010; SCCS 2010). Tripotassium NTA is considered to be functionally similar to trisodium NTA. The chemicals, NTA and trisodium NTA are used to soften water and to remove traces of heavy metals. These chemicals are commonly used as chelating and sequestering agents, and as builders in detergent and cleaning formulations for domestic and commercial use (EU RAR, 2008; SCCS, 2010).
Environmental Fate[1]	
Soil/Water/Air	Trisodium NTA was tested for ready biodegradability according to OECD 301 E (BASF, 1983b,c), OECD 301 F (in addition to a combined CO2/DOC test, see Strotmann et al., 1995), and Sturm Test (BASF, 1983d), and in a die away test (Takahashi et al, 1997) as well as for inherent biodegradability according to OECD 302 B (BASF, 1983a). These tests resulted in 75 -100 % degradation after 7 to 28 days with lag phases ranging between 1 and 16 days. According to results from ready biodegradation tests, trisodium NTA can be regarded as readily biodegradable. In accordance with column 2 of REACH Annex IX, trisodium NTA has a log octanol-water partition coefficient of -13.2 at pH 7, is highly water-soluble, and is unlikely, due to its polar nature, to be taken up by fish gills or across other biological membranes. Due to the ionic structure of the substance a relevant adsorption of trisodium NTA onto the organic fraction of soils, sediments or suspended solids is not expected. However, interaction with the mineral phase may be possible. This assumption is in line with available study results (Dunlap et al., 1971; Bolton et al., 1993) which demonstrate that trisodium NTA is neither strongly sorbed by loam, clay-loam and sandy soils or marine surface sediments (Kp sediment-water = 1.6 l/kg).

Human Health Toxicity Summary[1]	
Chronic Repeated Dose Toxicity	The available data suggest that the chemicals have harmful effects following repeated oral dosing, based on results from animal tests. However, the effects were not sufficient to warrant hazard classification. In a 4-week study, Charles River and Fischer 344 (F344/N) (five or ten animals/group) rats were fed either 0 % or 1.5 % NTA in the diet. Effects observed included reduced growth, increased relative kidney weight, urinary calcium, haematuria and hydronephrosis. A lowest observed adverse effect level (LOAEL) of 1.5 % NTA (equivalent to 750 mg/kg bw/day) was reported (EU RAR, 2008; Health Canada, 2010). In a 10-week study in male Sprague Dawley (SD) rats, trisodium NTA was administered to the rats in drinking water at 0 %, 0.01 %, 0.1 % or 1 % (equivalent to 0, 10, 100 or 1000 mg/kg bw/day). Increased kidney weights were observed in the rats treated at 0.1 % (100 mg/kg bw/day) and marked vacuolisation of the renal tubules was observed at 1 % trisodium NTA (1000 mg/kg bw/day dose) group. A LOAEL of 100 mg/kg bw/day (0.1 % trisodium NTA) was reported (EU RAR, 2008; Health Canada, 2010; SCCS, 2010). Trisodium NTA was administered to male SD rats by gavage at 0, 0.73 or 7.3 mmol/day (equivalent to 0, 187 or 1876 mg/kg bw/day) for 30 days. Cytoplasmic vacuolisation, focal haemorrhage, necrosis, erosion and hyperplasia of the epithelium of the proximal convoluted tubules were observed in all treated animals. An oral LOAEL of 0.73 mmol/day (187 mg/kg bw/day) was reported (EU RAR, 2008; Health Canada, 2010; SCCS, 2010; REACHb). In a 90-day study in rats (strain not reported), NTA was administered to male rats at 0, 100, 1000 or 5000 mg/L in drinking water. All treated animals showed reduced serum potassium levels (EU RAR, 2008; Health Canada, 2010). In two different studies (28-days and 91-days), New Zealand White (NZW) rabbits (six/group) were treated with either 0 or 2.5 % trisodium NTA on intact or abraded skin. No treatment-related effects were observed with or without abrasion (EU RAR, 2008; Health Canada, 2010; SCCS, 2010; REACHa & b). In a 4-week repeated dose inhalation toxicity study, NTA was administered in SD rats, trueblood albino guinea pigs and cynomolgus monkeys at 0, 10, 213 or 343 mg/m^3 concentrations for 6 hours/day by whole body exposure. No respiratory irritation or discomfort was observed at the highest tested concentration. The only treatment-related effects included diarrhoea in monkeys and dyspnoea in rats and guinea pigs. The no observed adverse effect concentration (NOAEC) of 213 mg/m^3 and the lowest observed adverse effect concentration (LOAEC) of 343 mg/m^3 were reported (EU RAR, 2008; Health Canada, 2010; REACHa & b). In another study, male albino rats were treated with NTA at 0, 2, 20, 200 or 2000 mg/m^3 concentrations for 6 hours/day for four consecutive days by inhalation exposure. All animals in the 2000 mg/m^3 showed signs of nasal, respiratory and eye irritation, which were fully reversed on day 14 (EU RAR, 2008; Health Canada, 2010).

Carcinogenicity	Trisodium NTA is classified as hazardous with hazard catergory 'Carcinogenicity – Category 2' and hazard statement 'Suspected of causing cancer' (H351) in the HCIS (Safe Work Australia). The available data support the classification for trisodium NTA. Additionally, the classification for carcinogenicity is considered appropriate for NTA. The International Agency for Research on Cancer (IARC) has classified NTA and its salts as 'Possibly carcinogenic to humans' (Group 2B), based on inadequate evidence for carcinogenicity in humans, but sufficient evidence for carcinogenicity in animal tests (IARC, 1990; IARC, 1995). In two-year carcinogenicity studies in Charles River (CD) rats and B6C3F1 mice, oral administration of Na3NTA induced benign and malignant tumours of the urinary system in both male and female rats at 80–100 mg/kg bw/day and haematopoietic tumours in male mice at 500–600 mg/kg bw. Trisodium NTA was reported to induce renal tubular adenomas and adenocarcinomas in male rats when administered orally (IARC, 1990; IARC, 1995; EU RAR, 2008; Health Canada, 2010; SCCS, 2010; REACHa & b).
Mutagenicity/ Genotoxicity	Based on the weight of evidence from the available in vitro and in vivo genotoxicity studies, the chemicals are not considered to be genotoxic. Several in vitro and in vivo micronucleus tests for gene mutation and clastogenicity were negative, although several positive results were reported (IARC, 1990; IARC, 1995; EU RAR, 2008; Health Canada, 2010; SCCS, 2010; REACHa & b).
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	Based on the available information, the chemicals do not cause specific reproductive or developmental toxicity. In different two-generation reproductive and developmental toxicity studies, oral administration of up to 0.5 % trisodium NTA (equivalent to 450 mg/kg bw/day) in the diet of Charles River rats, up to 250 mg/kg bw/day trisodium NTA by gavage in pregnant NZW rabbits, and up to 0.2 % NTA (equivalent to 570 mg/kg bw/day) in drinking water in Naval Medical Research Institute (NMRI) mice, caused no significant maternal, embryonic or foetal effects. No effect on neonatal development was seen in any of the above studies (NTP, 1977; IARC, 1995; EU RAR, 2008; Health Canada, 2010; SCCS, 2010; HSDB; REACHa & b). In a developmental study, female NZW rabbits (groups of 20) were treated by gavage with trisodium NTA in drinking water at 0, 2.5, 25, 100 or 250 mg/kg bw/day during gestation days 7–16. All animals were sacrificed on day 28 of gestation. No treatment-related effects were observed (EU RAR, 2008; Health Canada, 2010; SCCS, 2010; REACHa & b). A study was conducted in pregnant NMRI albino mice (10 animals/group) treated with 0 or 0.2 % trisodium NTA (equivalent to 0 or 570 mg/kg bw/day) in drinking water on 6–18 days of gestation. No significant differences in maternal weight gains and no developmental effects were observed (EU RAR, 2008; Health Canada, 2010; SCCS, 2010; REACHa & b).

Acute Toxicity	Trisodium NTA is classified as hazardous with hazard category 'Acute Toxicity – category 4' and hazard statement 'Harmful if swallowed' (H302) in the HCIS (Safe Work Australia). The available data (median lethal dose—LD50 of 1470 mg/kg bw in female rats and 750 mg/kg bw in monkeys) support this classification. Reported signs of toxicity include ataxia, tremors, hypopnoea, hypothermia, hypoactivity, prostration, staggering, twitching, opisthotonus, tonic convulsion, apathy, salivation and dyspnoea. Available data for NTA indicate an LD50 >6400 mg/kg in rats. The chemicals have low acute toxicity based on results from an animal test in rabbits following dermal exposure. In an acute dermal toxicity study, a 25 % aqueous solution of trisodium NTA monohydrate was applied occlusively to intact skin of rabbits (one animal/sex/dose) at 1000, 1580, 2510, 3980, 6310 or 10000 mg/kg bw. Mild muscle weakness and reduction in activity and appetite were seen in the higher dose groups. No local symptoms or muscular uncoordination were reported. An LD50 of >10,000 mg/kg bw was reported (EU RAR, 2008; REACHa & b). The chemicals have low acute toxicity based on results from animal tests following inhalation exposure. A median lethal concentration (LC50) in rats of >5.0 mg/L was reported for NTA (EU RAR, 2008; Health Canada, 2010; SCCS, 2010).
Irritation	Trisodium NTA is slightly irritating to the animal skin. The effects were not sufficient to warrant a hazard classification. Trisodium NTA is classified as hazardous with hazard category 'Eye Irritation – category 2A' and hazard statement 'Causes serious eye irritation' (H319) in HCIS (Safe Work Australia). The available data support this classification. In an eye irritation study in rabbits, trisodium NTA was found to be irritating. Conjunctivitis and marked corneal effects were observed at 24, 48 and 72 hours after application (ECHA, 2006). Effects were not reversible within the 7-day period. In a study, albino rabbits had considerable discomfort immediately after application of 100 mg of trisodium NTA monohydrate. Effects observed one hour after application included copious discharge, oedema with partial eversion of the lids, moderate redness and congestion with obscure iris. Discharge and oedema reduced on washing the eyes with saline solution after 24 hours. Complete reversal oedema occurred but mild redness and slight corneal dullness were observed on days 5 to 7 (EU RAR, 2008; Health Canada, 2010; SCCS, 2010; REACHb). In another study conducted according to OECD Test Guideline (TG) 405, trisodium NTA (0.1 mL of 38 % solution) applied to the conjunctival sac of three albino rabbits caused slight eye irritation. The average scores for conjunctival redness and chemosis after 24 hours were 2.0 and 0.7, respectively. The conjunctival redness score was 0.1 after 48 hours and no chemosis was present. The conjunctival redness was reversible within 8 days after application. No effects on the cornea and iris were reported (EU RAR, 2008; Health Canada, 2010; SCCS, 2010; REACHb).
Sensitisation	Based on the available data, the chemicals are not considered to be skin sensitisers.
Health Effects Summary	The critical health effects for risk characterisation include systemic long-term effects (carcinogenicity) for all three chemicals, and systemic acute effects (acute toxicity from oral exposure) and local effects (eye irritation) for trisodium NTA and tripotassium NTA only.
Key Study/Critical Effect for Screening Criteria	The Australian Drinking Water Guideline for NTA is 0.2 mg/L.

Ecological Toxicity[4]	
Aquatic Toxicity	Tests on acute toxicity to fish resulted in 96-hour LC50 values in the range of 98 – 487 mg/l. In a generation-cycle test over 224 days on Pimephales promelas (Arthur et al., 1974), there were no observable differences in survival, spawning activity, and egg hatchability at the highest tested concentration of 54 mg/l trisodium NTA (the active test substance was Ca- or Mg-NTA). Based in this study, the NOEC for fish is determined to 54 mg/L. All tests on acute toxicity to invertebrates showed effects only when the trisodium NTA concentration exceeded the stoichiometric metal levels of the medium. It is expected that effects are caused by the uncomplexed agent. This is supported by the increased effect values in hard water. In long-term tests, the most sensitive organism was the amphipod Gammarus pseudo limnaeus. In a generation-cycle test over 21 weeks exposure, the lowest tested concentration without significant effects was 9.3 mg/l trisodium NTA. Based in this study, the NOEC for invertebrates is determined to 9.3 mg/l. At this concentration, NTA is mainly complexed with Ca and Mg.
Determination of PNEC aquatic	Reliable long-term data was available for a fish, invertebrate and algae. The lowest NOEC of 9.3 mg/L was a result for testing with Gammarus pseudolimnaeus (Arthur et al. 1974). An assessment factor of 10 was used for a resulting PNEC for intermittent releases of 0.93 mg/L.
Current Regulatory Controls[1]	
Australian Hazard Classification	Trisodium NTA is classified as hazardous, with the following risk phrases for human health in the Hazardous Chemicals Information System (HCIS) (Safe Work Australia): Acute toxicity – category 4; H302 (Harmful if swallowed) Eye irritation – category 2; H319 (Causes serious eye irritation) Carcinogenicity – category 2; H351 (Suspected of causing cancer).
Australian Occupational Exposure Standards	The chemical NTA has an Australian drinking water guideline value of 0.2 mg/L (NHMRC, 2011; FSANZ).
International Occupational Exposure Standards	The following exposure standards are identified (Galleria Chemica; Protective Action Criteria (PAC)): Temporary Emergency exposure limits (TEELs) defined by the US Department of Energy (DOE): TEEL-1= 3.7 - 9.2 mg/m^3; TEEL-2= 40 - 100 mg/m^3; TEEL-3= 220 - 110 mg/m^3.
Australian Food Standards	The chemical NTA has an Australian drinking water guideline value of 0.2 mg/L (NHMRC, 2011; FSANZ).
Australian Drinking Water Guidelines	The chemical NTA has an Australian drinking water guideline value of 0.2 mg/L (NHMRC, 2011; FSANZ).
Aquatic Toxicity Guidelines	No data available.
PBT Assessment	
P/vP Criteria fulfilled?	NTA is readily biodegradable and as such not persistent in the environment.
B/vB criteria fulfilled?	Trisodium NTA has a log octanol-water partition coefficient of -13.2 at pH 7, is highly water-soluble. Thus, it is not expected to be bioaccumulative.
T criteria fulfilled?	The acute aquatic toxicity of NTA is > 0.01 mg/L. Hence the substance does not fulfil the screening criteria for toxic (T)

Overall conclusion	Not PBT
Revised	March 2019

References

1. National Industrial Chemicals Notification and Assessment Scheme (NICNAS). IMAP, Human Health Tier II Assessment for Nitrilotriacetic acid and salts: Retrieved 2019: https://www.nicnas.gov.au
2. ECHA REACH, Trisodium nitrilotriacetate, Retrieved 2019: https://echa.europa.eu/
3. HSDB (n.d.). Hazardous Substances Data Bank. Retrieved 2019, from Toxnet, Toxicology Data Network, National Library of Medicine: http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB

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Toxicity Summary - Xanthan Gum

Chemical and Physical Properties[1,3]	
CAS number	11138-66-2
Molecular formula	Unspecified
Molecular weight	high-molecular weight (of the order of 1000 kDa)
Solubility in water	Water-soluble
Melting point	No data available.
Boiling point	No data available.
Vapour pressure	No data available.
Henrys law constant	No data available.
Explosive potential	No data available.
Flammability potential	No data available.
Colour/Form	No data available.
Overview	Xanthan gum is a high molecular weight anionic polysaccharide secreted by the bacteria *Xanthomonas compestris*. It is used as a stabilizer and thickener for foods, pharmaceuticals, and cosmetics, for rheology control in water-based systems, and in oil and gas drilling. Xanthan gum is used for controlling the viscosity of drilling muds (DoE 2014). This chemical has been identified by NICNAS to be of low concern to human health based on an initial screening approach and thus required no further assessment.
Environmental Fate[1]	
Soil/Water/Air	Xanthan gum is expected to exhibit similar behaviour to that of guar gum because the two compounds are chemically similar. Thus, it is expected to adsorb strongly to soil and sediment and there is limited potential for it to reach surface waters via dissolved runoff and / or to leach into ground water. Volatilisation from soils and water is not considered to be a likely transport process in the environment (US EPA 2005). Xanthan gum is expected to readily undergo microbial biodegradation in the environment (on the bases that it is polysaccharide and expected to be readily biodegradable), and the potential to bioaccumulate in organisms is considered to be low.

Human Health Toxicity Summary[2]	
Chronic Repeated Dose Toxicity	Groups of 30 male and 30 female Charles River CD strain rats were fed diets for 104 weeks supplying O, 0.25, 0.5, or 1.0 g/kg b.w./day xanthan gum. No abnormalities which could be attributed to ingestion of these experimental diets were found with regard to survival, body-weight gain, food consumption, behaviour, or appearance. Ophthalmic and haematologic examination yielded normal results. Analysis of blood for glucose, SGOT, and prothrombin time showed no abnormalities in test groups. Organ weights were within normal limits and no lesions attributable to xanthan gum were found on gross and histopathological examination (Woodard et al., 1973). Xanthan gum was administered in the diet at levels supplying 0, 0.25, 0.37, or 1.0 g/kg b.w./day to groups of 4 male and 4 female beagle dogs for 107 weeks. No effects attributable to administration of the gum were seen in the treated animals with regard to survival, food intake, body-weight gain, electrocardiograms, blood pressure, heart rate, body temperature, or ophthalmic and neurological examinations. Haemoglobin, total and differential white cell counts, coagulation and prothrombin times, thrombocyte counts, serum alkaline phosphatase, blood urea nitrogen, blood glucose, SGOT, and SPGT were the same in control and treated animals. Urine pH, glucose concentrations, and sediment contents were comparable between test and control groups, but there was a dose-related increase in urine SG and a more frequent appearance of urinary albumin in dogs consuming 1.0 g/kg b.w./day of gum than in the other groups. Stool consistency was normal at the 0.37 g/kg level, but stools were loose at the top-dose level. The weight of the faeces showed a dose-related increase, as would be expected from feeding a non-absorbed hydrophilic gum at high-dose levels. The increased urinary SG is consistent with physiological adjustment for the extra water excreted in the faeces. Examination of the appearance and weights of organs and histopathological examinations failed to detect any adverse effects of treatment with xanthan gum at any dose level (Woodward et al.,1973).
Carcinogenicity	No data available.
Mutagenicity/ Genotoxicity	No data available.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	A three-generation reproduction study was carried out using groups of 10 male and 20 female rats in the first generation and 20 male and 20 female rats in subsequent generations. Dosage levels of 0, 0.25, and 0.5 g/kg/day were administered in the diet. Criteria evaluated were survival, body weight, general appearance, behaviour, the number of litters produced, number of live births and still births, physical condition of the young, weight at birth and weaning, and survival of the young. Females that had fewer than two litters were examined to determine whether there was foetal resorption. Malformations in offspring were recorded and gross and micropathological examinations were made on the offspring of the second and third generations. No adverse effects attributable to xanthan gum were found in this study (Woodard et al., 1973).
Acute Toxicity	A study was carried out on an unspecified number of rats fed diets containing 7.5 or 10% xanthan gum for 99-110 days. No adverse effects were observed in extensive investigatins on these animals (Booth et al., 1963). In a 91-day feeding study, a reduced rate of weight gain was found in groups of rats receiving 7.5 or 15% xanthan gum in the diet. Diets containing 3 or 6% gum did not reduce weight gain. No significant alterations in haemoglobin, red or white cell counts, or organ weights were observed in these rats. Histological examination of tissues from rats at the 15% level showed no pathological effects. At the highest-dose level the animals produced abnormally large faecal pellets, but diarrhoea did not occur. A paired-feeding test was used to compare the growth of rats ingesting a diet containing 7.5% xanthan gum and comparable rats restricted to the same intake of control diet. No differences in weight gain were found at the end of 18 days, indicating the absence of a growth-inhibiting factor (Booth et al.,1963). Groups of 3 male and 3 female beagle dogs were fed diets supplying 0, 0.25, or 0.5 g/kg b.w./day xanthan gum for 12 weeks. Animals in the high-dose group had softer stools than normal, but no diarrhoea. Growth was slightly retarded in the males and the serum cholesterol level was lowered in both sexes of the high-dose group. No other adverse effects were seen. The no-adverse-effect-level in this test was considered to be 0.25 g/kg b.w./day (USDA, 1964).

Irritation	Daily application of a 1% solution for 15 days to rat skin produced no signs of irritation. Daily application of a 1% solution for five days to rabbit conjunctiva produced no signs of irritation.
Sensitisation	Intradermal challenge tests in guinea-pigs did not produce evidence of sensitization (Hendrickson & Booth, sine data).
Health Effects Summary	A mild skin and eye irritant
Key Study/Critical Effect for Screening Criteria	The Joint FAO/WHO Expert Committee on Food Additives allocated an Acceptable Daily Intake (ADI) of "not specified".
Ecological Toxicity [1,2,3]	
Aquatic Toxicity	Acute Fish (measured) = 420 mg/L
Determination of PNEC aquatic	Based on acute fish toxicity of 420 mg/L, an assessment factor of 1000 was used for a resulting PNEC of 0.42 mg/L.
Current Regulatory Controls	
Australian Hazard Classification	No data available.
Australian Occupational Exposure Standards	No data available.
International Occupational Exposure Standards	No data available.
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	No data available.
PBT Assessment	
P/vP Criteria fulfilled?	No biodegradation information was found on xanthan gum. However, xantham gum is a naturally occurring polysaccharide which would be expected to readily biodegrade. Thus, it is not expected to meet the screening criteria for persistence
B/vB criteria fulfilled?	Xantham gum is not expected to meet the criteria for bioaccumulation.
T criteria fulfilled?	Not applicable. Acute toxicity data >1 mg/L in fish, thus xanthan gum does not meet the screening criteria for toxicity.
Overall conclusion	Not PBT
Revised	March 2019

References

1. Department of the Environment and Energy 2017, National assessment of chemicals associated with coal seam gas extraction in Australia, prepared by the National Industrial Chemicals Notification and Assessment Scheme
2. IPCS INCHEM, Xanthan Gum, Retrieved 2019: http://www.inchem.org/
3. Food and Agriculture Organization of the United Nations (FAO) 2016, 82nd JECFA - Chemical and Technical Assessment (CTA),XANTHAN GUM

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Toxicity Summary - Acrylamide polymers: Acrylamide, 2-acrylamido-2-methylpropanesulfonic acid, sodium salt polymer and Polymer of 2-acrylamido-2- ethylpropanesulfonic acid sodium salt and methyl acrylate

Chemical and Physical Properties [2, 3, 4]	
CAS number	38193-60-1 and 136793-29-8
Molecular formula	38193-60-1: $(C_7H_{13}NO_4S.C_3H_5NO.Na)_x$ 136793-29-8: $C_{11}H_{18}NNaO_6S$
Molecular weight	Likely >1000 MW
Solubility in water	No data available.
Melting point	No data available.
Boiling point	No data available.
Vapour pressure	No data available.
Henrys law constant	No data available.
Explosive potential	No data available.
Flammability potential	No data available.
Colour/Form	No data available.
Overview	No studies are available for the Acrylamide polymers. Information for 2-Acrylamido-2-methylpropanesulfonic acid, ammonium salt will be referenced in the following sections. 2-Acrylamido-2-methylpropanesulfonic acid, ammonium salts are generally incorporated into polymers. As such, the fate of the monomer is tied to the polymer and no hydrolysis, movement, biodegradation or bioaccumulation of the polymer is expected. A Tier 1 Human Health Assessment for Acrylamide, 2-acrylamido-2-methylpropanesulfonic acid, sodium salt polymer has been conducted by NICNAS which concluded that this chemical was identified as low concern to human health.
Environmental Fate [2]	
Soil/Water/Air	The polymers are not expected to be readily biodegradable. Biodegradation is limited due to the very high molecular weights and the low water solubilities of the polymers. Due to their high molecular weight, the polymers are not expected to bioaccumulate.
Human Health Toxicity Summary [2]	
Chronic Repeated Dose Toxicity	A repeat dose 28 day oral toxicity study carried out in rats with a 50% aqueous solution of 2-Acrylamido-2-methylpropanesulfonic acid, ammonium salt indicated no treatment related toxic effects.
Carcinogenicity	No information available.
Mutagenicity/ Genotoxicity	2-Acrylamido-2-methylpropanesulfonic acid, ammonium salt did not induce a mutagenic response in bacteria and no clastogenicity was observed when a 50% solution of the notified chemical was tested in albino mice cells in vitro.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	No data available.

Acute Toxicity	Aqueous solutions containing 50% of 2-Acrylamido-2-methylpropanesulfonic acid, ammonium salt exhibited low acute oral and dermal toxicity in rats (LD50 > 5 000 mg/kg, and 2 000 mg/kg respectively).
Irritation	2-Acrylamido-2-methylpropanesulfonic acid, ammonium salt was non-irritant to rabbit skin and a slight eye irritant in rabbits.
Sensitisation	A 50% aqueous solution of 2-Acrylamido-2-methylpropanesulfonic acid, ammonium salt showed minimal sensitisation potential when tested in guinea pigs.
Health Effects Summary	This chemical has been identified by NICNAS to be of low concern to human health.
Key Study/Critical Effect for Screening Criteria	No data available
Ecological Toxicity [2]	
Aquatic Toxicity	Limited information is available. The polymers are expected to be a low concern for toxicity to aquatic organisms. Due to their poor solubility and high molecular weights, they are not expected to be bioavailable. The polymers do not contain any reactive functional groups. Ecotoxicity data for 2-Acrylamido-2-methylpropanesulfonic acid, ammonium salt indicate that it is practically non-toxic to fish, water fleas and algae.
Determination of PNEC aquatic	No PNEC values were calculated.
Current Regulatory Controls[5]	
Australian Hazard Classification	No data available
Australian Occupational Exposure Standards	No data available
International Occupational Exposure Standards	No data available
Australian Food Standards	No data available
Australian Drinking Water Guidelines	Based on health considerations, the concentration of acrylamide in drinking water should not exceed 0.0002 mg/L.
Aquatic Toxicity Guidelines	No data available
PBT Assessment [1, 2]	
P/vP Criteria fulfilled?	The polymers are not readily biodegradable, hence they meet the screening criteria for persistence.
B/vB criteria fulfilled?	The polymers are expected to have very high molecular weights and poor water solubility. They are not expected to be bioavailable, hence the polymers do not meet the criteria for bioaccumulation.
T criteria fulfilled?	There are no aquatic toxicity studies on the polymers. They are expected to have low aquatic toxicity because of their very high molecular weights and poor water solubility. As such, the polymers do not meet the criteria for toxicity.
Overall conclusion	Not PBT substances
Revised	December 2018

References

1. Categorization Results from the Canadian Domestic Substance List, CAS# 38193-60-1

2. National Industry Chemicals Notification and Assessment Scheme. 2-Acrylamido-2-methylpropanesulfonic acid, ammonium salt, July 1997.
3. U.S National Library of Medicine, Toxicology Data Network, ChemIDplus, CAS#38193-60-1. Accessed 2017 at https://chem.nlm.nih.gov/chemidplus/rn/38193-60-1
4. National Industrial Chemicals Notification and Assessment Scheme (NICNAS). IMAP, Human Health Tier 1 Assessment. Retrieved 2018: https://www.nicnas.gov.au
5. National Health and Medical Research Council, Natural Resources Management Ministerial Council, national Water Quality Management Strategy, Australian Drinking Water Guidelines 6, 2011, Version 3.3 Updated November 2016.

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Toxicity Summary - Potassium chloride

Chemical and Physical Properties [1,2,3,8,9,10]	
CAS number	7447-40-7
Molecular formula	KCl
Molecular weight	74.55 g/mol
Solubility in water	34.20 at 20 ◦C
pH	7
Melting point	771.00 ◦C
Boiling point	1500 ◦C
Vapour pressure	No data found
Henrys law constant	No data found
Explosive potential	Not explosive
Flammability potential	Not flammable
Colour/Form	White crystals or crystalline powder
Overview	Potassium is an essential element in the body. It is the main intracellular cation with 98% of total body potassium located within the cells. It is mainly used in fertilisers, medicine, lethal injections, scientific applications, feedstock, food processing and as a sodium substitute in table salt. Potassium chloride is an essential element with homeostatic physiological processes regulating levels in the body. In cases of increased exposure to high levels of potassium significant health effects in people with kidney disease or other conditions, such as heart disease may result. Potassium chloride as an inorganic salt is not subjected to further degradation processes in the environment once it dissociates into its respective ions. In water, potassium chloride is highly water soluble, and readily undergoes dissociation. In soil, transport and leaching of potassium and chloride ions is affected by the clay minerals (type and content), pH, and organic matter. This chemical has been identified by NICNAS to be of low concern to human health based on an initial screening approach and thus required no further assessment.
Environmental Fate [1,3,8,9]	
Soil/Water/Air	KCl is a solid inorganic salt that is highly soluble in water (342 g/L at 20^{o} C). Potassium chloride fully dissociates in aqueous solutions to K+ and Cl- ions. Cl, either as an inorganic salt or as K+ and Cl- ions, is ubiquitous in the environment. There is no potential for bioaccumulation or bioconcentration. Potassium and chloride ions are essential to all living organisms and their intracellular and extracellular concentrations are actively regulated.

Human Health Toxicity Summary [1,3,8,9]	
Chronic Repeated Dose Toxicity	Fourteen female rats were given KCl in their drinking water (approximately 5,250 mg/kg/day) for 105 days. Ten rats were sacrificed after 105 days of exposure for examination of the heart, kidneys and the adrenals; four rats (recovery group) were kept for an additional month. KCl exposure resulted in decreased heart weight, increased kidney weight, and enlargement of part of the adrenals. All changes were reversible within one month of exposure (Bacchus, 1951).F344/Slc male rats were given 0, 110, 450 or 1,820 mg/kg/day KCl in feed for two years. At the end of the study, survival rates were 48%, 64%, 58% and 84% in the controls, 110, 45 and 1,820 mg/kg/day groups. Nephritis was reported to be predominant in all groups, including the controls. The only treatment-related effect observed was gastritis(inflammation of the stomach lining). The incidence of gastritis and ulcers were 6%, 18%, 18% and 30% in the controls, 110, 450 and 1,820 mg/kg/day groups (Imai *et al.*, 1968). Male and female Wistar rats were fed diets containing 0 or 3% KCl over a total period of 30 months: Examination after 13 weeks (10 rats/sex/group), after 18 months (15 rats/sex/group) and after 30 months (50 rats/sex /group). Due to the reduction of feed intake the mean test substance intake and mean body weight decreased in time. After 30 months of treatment, there was hypertrophy of the zona glomerulosa in the adrenals (24/50 treated rats versus 4/50 in controls); and cystitis in the urinary bladder (males: 3/59; females 3/50) and single epithelial hyperplasia of the bladder (males 3/50; females 2/50) (Lina *et al.*, 1994; Lina and Kuijpers, 2004)**.**
Carcinogenicity	Potassium chloride has not been evaluated and is not listed by the IARC as a carcinogen. In a long-term study, male rats (50 per group) were fed potassium chloride in the diet at levels of 110, 450 or 1820 mg/kg bw/day for 2 years. No carcinogenic effects were observed in male rats.
Mutagenicity/ Genotoxicity	No gene mutation ns were reported in bacterial tests, with and without metabolic activation. However, high concentrations of potassium chloride showed positive results in a range of genotoxic screening assays using mammalian cells in culture. The action of potassium chloride in culture seems to be an indirect effect therefore further *in vivo* studies were not considered necessary.
Reproductive Toxicity Developmental Toxicity/Teratogenicity	A developmental study revealed no foetotoxic or teratogenic effects of potassium chloridel in doses up to 235 mg/kg/day (mice) and 310 mg/kg/day (rats). No fertility study has been located. Further human and ecological assessment was not recommended by the OECD SIDS.
Acute Toxicity	Potassium chloride is an essential element with homeostatic physiological processes regulating levels in the body. In cases of increased exposure to high levels of potassium significant health effects in people with kidney disease or other conditions, such as heart disease may result. Adverse health effects due to consumption of potassium from drinking water are unlikely to occur in healthy individuals. Acute effects are rare in humans although under particular circumstances severe effects may occur. Lethal effects were observed in a 2 month old baby fed 15,000 mg potassium chloride for 2 days and in another case report where an adult woman had ingested slow released potassium chloride tablets (35, 000 mg). The most common form of ingestion is through drinking water. It is not considered necessary to establish a health-based guideline value for potassium in drinking water due to its lack of toxicity.
Irritation	Slight skin and eye irritant. A threshold concentration for skin irritancy of 60% was seen when potassium chloride in aqueous solution was in contact with skin of human volunteers. The threshold concentration when applied to broken skin was 5%.
Sensitisation	No data found.
Health Effects Summary	This chemical has been identified by NICNAS to be of low concern to human health and it is listed by the US Food and Drug Administration (FDA) as a Generally Recognised as Safe (GRAS) substance.

Key Study/Critical Effect for Screening Criteria	In a two-year rat feeding study, there was an increased incidence of gastritis and ulcers at dose levels of >110 mg/kg/day (Imai *et al.*, 1968). There was no NOAEL. Thus, the LOAEL for this study is 110 mg/kgday. Since the gastritis and ulcers are the result of a localized irritation effect of the test substance (site of contact) in the gastrointestinal tract, an uncertainty factor for interspecies variability is deemed unnecessary. For systemic effects, the NOAEL for the two-year rat feeding study is considered to be 1,820 mg/kg/day, the highest dose tested. Uncertainty factors: 10 (intraspecies variability); 10 (interspecies variability); 1 (intraspecies variability) Oral Reference Dose = 1,820/100 = 18.2 mg/kg/day Drinking water guideline: 71 ppm
Ecological Toxicity [1,3,8,9,10]	
Aquatic Toxicity	In a guideline study, the 96-hour LC50 in *Pimephales promelas* was reported to be 880 mg/L (Mount *et al.*, 1997). The 48-hour LC50 values from two studies on *Lepomis macrochirus* (Patrick *et al.*, 1968; Trama, 1954), and one study each on *Oncorhyncusmykiss* and *Ictalurus punctatus* (Waller *et al.*, 1993) ranged from 720 to 2,010 mg/L. In a guideline study, the 48-hour EC50s in *Daphnia magna* and *Ceriodaphnia dubia* were 660 and 630 mg/L, respectively (Mount *et al.*, 1997; ECHA REACH database). The 48-hour EC50 in *Daphnia magna* in another study was also reported to be 177 mg/L (Biesinger and Christensen, 1972).The toxicity of KCl has been investigated in one algae species (*Nitzschia linearis*), showing 120 hour-EC50 (growth rate) of 1,337 mg/L (Patrick *et al.*, 1968). The 72-hour EC50 to *Scenedesmus subspicatus* is >100 mg/L (growth rate), with a NOEC of >100 mg/L (ECHA REACH database). In a fish early-life-stage test with the fathead minnow (*Pimephales promelas*), the 7-day NOEC is 500 mg/L (ECHA REACH database). A long term (21-day) study has been performed on *Daphnia magna* where effects on reproduction were investigated for several metals. A 16% impairment of reproduction (LOEC) was observed at a concentration of 53 mg/L of K +, equal to KCl concentration of 101 mg/L (Biesinger and Christensen, 1972). The measured NOEC for Daphnia is 373 mg/L
Determination of PNEC aquatic	PNECaquatic: On the basis of the chronic results for Daphnia, an assessment factor of 100 has been applied to the lowest reported effect concentration of 373 mg/L. The PNECaquatic is determined to be 3.73 mg/L.
Current Regulatory Controls	
Australian Hazard Classification	No data available
Australian Occupational Exposure Standards	No data available
International Occupational Exposure Standards	No data available
Australian Food Standards	No data available
Australian Drinking Water Guidelines	No data available
Aquatic Toxicity Guidelines	No data available
PBT Assessment [1,8,9,10]	
P/vP Criteria fulfilled?	Potassium chloride is an organic salt that dissociates completely to potassium and chloride ions in aqueous solutions. Biodegradation is not applicable to these inorganic ions; both potassium and chloride ions are also ubiquitous and are present in most water, soil and sediment. For the purposes of this PBT assessment, the persistent criteria is not considered applicable to this inorganic salt.
B/vB criteria fulfilled?	Potassium and chloride ions are essential to all living organisms and their intracellular and extracellular concentrations are actively regulated. Thus, potassium chloride is not expected to bioaccumulate.

T criteria fulfilled?	The measured chronic toxicity data for potassium chloride was 373 mg/L for Daphnia. Thus, potassium chloride does not meet the screening criteria for toxicity
Overall conclusion	Not PBT
Revised	April 2018

References

1. WHO (2009). Potassium in drinking-water. Background document for development of Guidelines for Drinking-water Quality. World Health Organization WHO/HSE/WSH/09.01/7.
2. HSDB Hazardous Substance Databank (HSDB) Potassium Chloride. Toxnet http://toxnet.nlm.nih.gov U.S. National Library of Medicine.
3. IARC, 2009: IARC Monographs on the Evaluation of Carcinogenic Risks to Humans. International Agency for Research on Cancer. World Health Organisation.
4. Material Safety Data Sheet Potassium chloride. ScienceLabs.com Inc. http://www.sciencelab.com/msds.php?msdsId=9927402
5. WHO Poisons Information Monograph for Potassium Chloride. Electronic record accessed from www.inchem.org World Health Organization.
6. UNEP Potassium Chloride Screening Information Dataset (SIDS) Initial Assessment Report for 13th SIAM (Bern, 6-9 November 2001. United Nations Environment Programme (UNEP) http://www.inchem.org/documents/sids/sids/KCHLORIDE.pdf
7. ECHA REACH database: http://apps.echa.europa.eu/registered/registered-sub.aspx
8. IUCLID Data Set for Potassium chloride (CAS No. 7447-40-7), UNEP Publications.
9. OECD (2001b). OECD-Screening Information Assessment Report (SIAR) for Potassium chloride (CAS No. 7447-40-7), UNEP Publications.
10. Department of the Environment and Energy 2017 , National assessment of chemicals associated with coal seam gas extraction in Australia, prepared by the National Industrial Chemicals Notification and Assessment Scheme

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Toxicity Summary - 2-Propenoic acid, polymer with sodium phosphinate and 2-Propenoic acid, sodium salt, polymer with 2-propenamide

Chemical and Physical Properties[1,2,3]	
CAS number	129898-01-7 25085-02-3
Molecular formula	(C3H4O2.H3O2P.Na)x.xNa (C3H5NO.C3H4O2.Na)x
Molecular weight	Likely >1000 MW
Solubility in water	No data available.
Melting point	No data available.
Boiling point	No data available.
Vapour pressure	No data available.
Henrys law constant	No data available.
Explosive potential	No data available.
Flammability potential	No data available.
Colour/Form	No data available.
Overview	No studies are available. The polymer is not expected to be readily biodegradable. Biodegradation is limited due to the very high molecular weight and the low water solubility of the polymer. Due to its high molecular weight, the polymer is not expected to bioaccumulate. This chemical has been identified by NICNAS to be of low concern to human health and thus required no further assessment.
Environmental Fate[2]	
Soil/Water/Air	The polymer is not expected to be readily biodegradable. Biodegradation is limited due to the very high molecular weight and the low water solubility of the polymer. Due to its high molecular weight, the polymer is not expected to bioaccumulate.
Human Health Toxicity Summary	
Chronic Repeated Dose Toxicity	No data available.
Carcinogenicity	No data available.
Mutagenicity/ Genotoxicity	No data available.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	No data available.
Acute Toxicity	No data available.
Irritation	No data available.
Sensitisation	No data available.
Health Effects Summary	This chemical has been identified by NICNAS to be of low concern to human health.

Key Study/Critical Effect for Screening Criteria	No data available.
Ecological Toxicity[2]	
Aquatic Toxicity	Limited information is available. The polymer is expected to be a low concern for toxicity to aquatic organisms. Due to its poor solubility and high molecular weight, it is not expected to be bioavailable. It does not contain any reactive functional groups.
Determination of PNEC aquatic	No PNEC values were calculated.
Current Regulatory Controls	
Australian Hazard Classification	No data available.
Australian Occupational Exposure Standards	No data available.
International Occupational Exposure Standards	No data available.
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	No data available.
PBT Assessment	
P/vP Criteria fulfilled?	The polymer is not readily biodegradable, hence it meets the screening criteria for persistence.
B/vB criteria fulfilled?	The polymer is expected to have a very high molecular weight and poor water solubility. It is not expected to be bioavailable, hence this polymer does not meet the criteria for bioaccumulation.
T criteria fulfilled?	There are no aquatic toxicity studies on the polymer. It is expected to have low concern for aquatic toxicity because of its very high molecular weight and poor water solubility. As such, the polymer does not meet the critera for toxicity.
Overall conclusion	Not PBT
Revised	April 2019

References

1. National Industrial Chemicals Notification and Assessment Scheme (NICNAS). IMAP, Human Health Tier 1 Assessment. Retrieved 2019: https://www.nicnas.gov.au
2. Categorization Results from the Canadian Domestic Substance List, 2-Propenoic acid, polymer with sodium phosphinate
3. U.S National Library of Medicine, Toxicology Data Network, ChemIDplus, CAS#38193-60-1. Accessed 2017 at https://chem.nlm.nih.gov/chemidplus/rn/38193-60-1

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Toxicity Summary - Calcium Carbonate

Chemical and Physical Properties[1,2]	
CAS number	1317-65-3
Molecular formula	Not applicable
Molecular weight	Not applicable
Solubility in water	No data available
Melting point	Approximately 900°C (Oates 1998).
Boiling point	No data available
Vapour pressure	No data available
Henrys law constant	No data available
Explosive potential	No data available
Flammability potential	No data available
Colour/Form	Solid
Overview	Limestone is the name given to a type of rock mostly composed of calcium carbonate. It also contains minor impurities of iron, magnesium, quartz, clay, pyrite, phosphate, and organic matter (Pohl 2011). It is used widely in agriculture to increase calcium concentrations and the pH of soils (Upjohn et al. 2005). Limestone is used industrially on a very large scale as an ingredient in concrete production and in metallurgy (Oates 1998; Pohl 2011). In the Australian coal seam gas industry, it is used as a bridging agent in drilling fluid formulations. A Tier 1 Human Health Assessment for these chemicals has been conducted by NICNAS which concluded that these chemicals were identified as low concern to human health by application of expert validated rules.
Environmental Fate[2]	
Soil/Water/Air	Limestone dissolves slowly in water, releasing calcium and carbonate ions as well as other trace elements, such as iron and magnesium (Deer et al. 1992; Clair and Hindar 2005; Pohl 2011). These trace elements are naturally ubiquitous in the environment and are subject to natural biogeochemical processes. Calcium oxide reacts immediately upon exposure to water, forming calcium hydroxide, which itself reacts with carbon dioxide to form calcium carbonate. The final reaction products of both limestone and calcium oxide in the environment are therefore essentially the same, although calcium oxide typically has lower concentrations of magnesium and other inorganic chemicals than limestone and produces a higher initial concentration of hydroxide ions (Upjohn et al. 2005). Calcium and carbonate ions occur naturally in all environmental compartments, and are important nutrients for various organisms. Calcium is mobile in soil (ANZECC and ARMCANZ 2000) and, if released to the environment, should be expected to experience significant partitioning to the water compartment. However, calcium ions may also form insoluble precipitates with anions present in the environment, such as carbonate ions, and settle out of the aqueous phase. Carbonate is an important component of the global carbon cycle (Wetzel 2001).
Human Health Toxicity Summary[3]	
Chronic Repeated Dose Toxicity	No systemic toxicological findings could be detected in rats after repeated administration of uncoated nano calcium carbonate by the oral route for a period of 90 days. The results of this study are read across to bulk calcium carbonate. Several potential adverse effects have been reported following calcium supplementation e.g. effects on kidney function, milk-alkali syndrome, kidney stones and interactions with minerals. However, these effects are more prevalent in those people suffering from renal insufficiency and following the ingestion of high doses of calcium.

	No systemic toxicity was observed in a 90-day inhalation study where rats were exposed to uncoated calcium carbonate at a maximum concentration of 0.399 mg/L, stated as the NOEC. The local effects observed at this level were limited to increased lung weights accompanied by increases in BAL-derived inflammation and cytotoxicity biomarkers, which were reversible in males but were not fully reversible in females within a 4-week recovery period. Hence the NOAEC for local effects was established as 0.212 mg/L and the LOAEC at 0.399 mg/L. The results of this study are read across to bulk calcium carbonate.
Carcinogenicity	Uncoated nano calcium carbonate is not expected to pose a risk of carcinogenicity.
Mutagenicity/ Genotoxicity	Uncoated nano calcium carbonate was negative in the following assays: In vitro gene mutation study in bacteria (OECD TG 471) using Salmonella typhimurium strains TA 98, TA 100, TA 1535 and TA 1537 and Escherichia coli WP2 uvrA with and without metabolic activation (S9). In vitro chromosome aberration study in mammalian cells (OECD TG 473) using human lymphocytes in the presence and absence of metabolic activation. In vitro gene mutation study in mammalian cells (OECD TG 476) using mouse lymphoma L5178Y cells in the presence and absence of metabolic activation. The results of these studies are read across to bulk calcium carbonate.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	Under the conditions of the OECD TG 422 study, uncoated nano calcium carbonate administered to male and female rats up to a dose level of 1000 mg/kg bw/day for a period of up to 48 days is not toxic to reproduction and has no effect on fertility or development. No treatment-related effects were observed for reproduction; hence, a NOEL for reproductive toxicity was considered to be 1000 mg/kg bw/day. The results of this study are read across to bulk calcium carbonate. The prenatal developmental toxicity study also demonstrated that calcium carbonate was neither foetotoxic nor teratogenic at the concentrations used. Since no adverse effects were noted at the highest dose level tested (1.25% Ca in diet), the NOAEL for teratogenic and maternal toxic effects in rats is in excess of 1.25% Ca, equivalent to approximately 1963 - 2188 mg/kg bw/day of calcium carbonate.
Acute Toxicity	Bulk calcium carbonate is not considered to be acutely harmful by the oral, dermal or inhalation routes.
Irritation	Bulk calcium carbonate is not considered to be irritating to the skin or eyes.
Sensitisation	Based on the results of an OECD TG 429 study performed using nano calcium carbonate and read across to bulk calcium carbonate, where the Stimulation Index was < 3, bulk calcium carbonate is considered to be a non-sensitiser
Health Effects Summary	This chemical has been identified by NICNAS to be of low concern to human health.
Key Study/Critical Effect for Screening Criteria	In the repeated dose toxicity study, NOAEC for local effects was established as 0.212 mg/L and the LOAEC at 0.399 mg/L.
Ecological Toxicity[2]	
Aquatic Toxicity	Calcium carbonate has low toxicity to aquatic and terrestrial organisms. Ecotoxicological endpoint values for aquatic organisms generally greatly exceed 100 mg/L (LMC 2014), indicating very low toxicity.
Determination of PNEC aquatic	Experimental results are available for three trophic levels. Acute LC50 values are available for fish, invertebrates, and algae. On the basis that the data consists of short term results from three trophic levels, an assessment factor of 1000 has been applied to the lowest reported effect concentration of 310 mg/L for invertebrates. The PNEC aquatic is 0.3 mg/L.
Current Regulatory Controls	
Australian Hazard Classification	No data available.
Australian Occupational Exposure Standards	No data available.

International Occupational Exposure Standards	No data available.
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	No data available.
PBT Assessment	
P/vP Criteria fulfilled?	Not applicable (inorganic chemical, ionic species ubiquitous in environment)
B/vB criteria fulfilled?	Not applicable. Bioaccumulation is not applicable to these inorganic ions.
T criteria fulfilled?	Not applicable. Expected to have low toxicity to aquatic organisms.
Overall conclusion	Not PBT
Revised	October 2019

References

1. National Industrial Chemicals Notification and Assessment Scheme (NICNAS). IMAP, Human Health Tier 1 Assessment. Retrieved 2019: https://www.nicnas.gov.au
2. Department of the Environment and Energy 2017, National assessment of chemicals associated with coal seam gas extraction in Australia, prepared by the National Industrial Chemicals Notification and Assessment Scheme
3. ECHA REACH, Calcium carbonate, Retrieved 2019: https://echa.europa.eu/

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Toxicity Summary - Cellulose, carboxymethyl ether, sodium salt

Chemical and Physical Properties[1,2]	
CAS number	9004-32-4
Molecular formula	No data available.
Molecular weight	No data available.
Solubility in water	No data available.
Melting point	No data available.
Boiling point	No data available.
Vapour pressure	No data available.
Henrys law constant	No data available.
Explosive potential	No data available.
Flammability potential	No data available.
Colour/Form	White odourless hygroscopic granules or powder.
Overview	Sodium carboxycellulose is the sodium salt of carboxymethylcellulose. Carboxymethyl cellulose is a cellulose derivative with carboxymethyl groups (-CH2COOH) bound to some of the hydroxyl groups of the glucopyranose monomers that make up the cellulose backbone. Sodium carboxycellulase is a listed as GRAS (Generally Regarded as Safe) by the U.S. Food and Drug Administration (FDA GRAS database). It is an approved food additive in the EU (EC, 1995) and may be added to all foodstuffs following quantum satis principle, except in products for the dietary management of metabolic disorders, where the limit of use is 10 g/L or kg (EC, 1999). Sodium carboxycellulase is also listed as an Inert Ingredient Eligible for US Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) 25(b) pesticide products and US EPA List 4A. The Joint FAO/WHO Expert Committee on Food Additives has determined an Acceptable Daily Intake (ADI) for sodium carboxymethyl cellulose of “Not Specified” (no upper limit) (JECFA, 1989). A Tier 1 Human Health Assessment for this chemical has been conducted by NICNAS which concluded that it was low concern to human health.
Environmental Fate[1]	
Soil/Water/Air	Carboxymethyl cellulose (DS 0.7) showed 25% biodegradation after 28 days in a OECD 301A test. Thus, sodium carboxymethyl cellulose is not readily biodegradable. Other studies have also shown partial degradation of carboxymethyl cellulose in ready and inherent biodegradability tests.
Human Health Toxicity Summary	
Chronic Repeated Dose Toxicity	No data available.
Carcinogenicity	No data available.
Mutagenicity/ Genotoxicity	No data available.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	No data available.

Acute Toxicity	No data available.
Irritation	No data available.
Sensitisation	No data available.
Health Effects Summary	No data available.
Key Study/Critical Effect for Screening Criteria	No data are available for determining the critical effect and the LOAEL/NOAEL for an oral reference dose.
Ecological Toxicity [1]	
Aquatic Toxicity	Carboxymethyl cellulose has been tested in several acute aquatic toxicity tests. The 96-hour LC50 for Brachydanio rerio is >2,500 mg/L; the 48-hour LC50 for Daphnia magna is >5,000 mg/L; and the 96-hour EC50 for Selenastrum capricornutum is 500 mg/L.
Determination of PNEC aquatic	PNECaquatic: Experimental results are available for three trophic levels. Acute E(L)C50 values are available for fish (>2,500 mg/L), Daphnia (>5,000 mg/L), and algae (>500 mg/L). On the basis that the data consists of short-term results from three trophic levels, an assessment factor of 1,000 has been applied to the lowest reported effect concentration of 500 mg/L for algae. The PNECaquatic is 0.5 mg/L.
Current Regulatory Controls[4]	
Australian Hazard Classification	No data available.
Australian Occupational Exposure Standards	No data available.
International Occupational Exposure Standards	No data available.
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	No data available.
PBT Assessment	
P/vP Criteria fulfilled?	Sodium carboxymethyl cellulose is a water-soluble semisynthetic polymer and is not readily biodegradable. Thus, it meets the screening criteria for persistence.
B/vB criteria fulfilled?	Sodium carboxymethyl cellulose is a water-soluble semisynthetic polymer and is expected to have a molecular weight of >1,000 which limits its bioavailability to aquatic organisms. Thus, it is not expected to bioaccumulate.
T criteria fulfilled?	The acute EC(L)50 of sodium carboxymethylcellulose is >0.1 mg/L in fish, invertebrates and algae. Thus, it does not meet the screening criteria for toxicity.
Overall conclusion	Not PBT
Revised	April 2019

References

1. Van Ginkel, C.G., and Gayton, S. (1996). The biodegradability and nontoxicity of carboxymethyl cellulose (DS 0.7) and intermediates. Environ. Toxicol. Chem. 15: 270-274
2. National Industrial Chemicals Notification and Assessment Scheme (NICNAS). IMAP, Human Health Tier 1 Assessment. Retrieved 2019: https://www.nicnas.gov.au
3. EC (1995). European Parliament and Council Directive No 95/2/EC of 20 February 1995 on food additives other than colours and sweeteners, OJ L 61, 18.3.1995, p. 1-63.

4. EC (1999). Food additives permitted in dietary foods for infants and young children for special medical purposes as defined in Directive 1999/21/EC (Commission Directive 1999/21/EC of 25 March 1999 on dietary foods for special medical purposes, (OJ L 91, 7.4.1999, p. 29).
5. FDA GRAS Database: http://www.fda.gov/Food/IngredientsPackagingLabeling/GRAS/SCOGS/ucm260737.htm
6. JECFA (1989). http://apps.who.int/ipsc/database/evaluations/chemical.aspx?chemID=3773

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Toxicity Summary - Ethanol, 2,2'-oxybis-, reaction products with ammonia, morpholine derivatives residues

Chemical and Physical Properties[1]	
CAS number	68909-77-3
Molecular formula	C36H78N6O14
Molecular weight	UVCB
Solubility in water	100 g/L at 20 °C
Melting point	-20 °C at 101.3 kPa
Boiling point	223 °C at 101.3 kPa
Vapour pressure	0.55 - 20 Pa at 20 - 25 °C
Henrys law constant	No data available
Explosive potential	Non-explosive (100%)
Flammability potential	Not classified (50%), Non-flammable (50%)
Colour/Form	Liquid
Overview	The residuum from the reaction of diethylene glycol and ammonia. It consists predominantly of morpholine-based derivatives such as [(aminoethoxy)ethyl]morpholine, [(hydroxyethoxy)ethyl]morpholine, 3-morpholinone, and 4,4'-(oxydi-2,1-ethanediyl)bis[morpholine].
Environmental Fate[1]	
Soil/Water/Air	The substance is hydrolytically stable at pH 4, 7 and 9 at 25°C. Adsorption to solid soil phase is not to be expected. Based on the assessment of the components, it can be concluded that the mixture will not evaporate into the atmosphere. The substance is not readily biodegradable. Based on the low log Kow, the substance will have a low potential for bioaccumulation. Over time, the mixture will preferentially distribute into the compartment water.
Human Health Toxicity Summary[1]	
Chronic Repeated Dose Toxicity	No adverse effects were observed in male and female rats in a 28 days and a 90 days repeated dose toxicity test conducted according to OECD 407 and OECD 408 respectively (Calvert Laboratories, Inc., 2011 and Envigo Research Limited, 2018) in which animals were exposed orally (gavage) to 0, 100, 500 or 1000 mg/kg bw/d (28 days study) and to 0, 10, 100 or 1000 mg/kg bw/d (90 days study). In both studies, an NOAEL of 1000 mg/kg bw was determined.
Carcinogenicity	No data available.
Mutagenicity/ Genotoxicity	In an in vivo micronucleus test on mouse bone marrow erythrocytes (BioReliance, 2010), performed according to OECD guideline 474, the animals were exposed orally (via gavage) with 500, 1000, 2000 mg/kg. This did not induce a statistically positive increase in micronuclei in the hemopoietic cells of the mouse bone marrow at the time intervals evaluated under the experimental condition of this assay. No toxicity was observed. Vehicle and positive controls were valid.

Reproductive Toxicity / Developmental Toxicity/Teratogenicity	A Reproductive / Development Toxicity Screening Testing in Rats was performed according to OECD guideline 421 (Calvert Laboratories, Inc., 2011, Klimisch 1). In this GLP-compliant study, male and female Sprague-Dawley rats (10 animals/sex/dose) were exposed to 1000 mg/kg bw/day. Control animals received concurrent vehicle (water). The rats were exposed on a daily basis, starting two weeks prior to cohabitation until the day before the scheduled euthanasia (minimum of 4 weeks) for males and starting for a minimum of 15 days prior to cohabitation, during cohabitation and from presumed gestation days 0 through day 19 of gestation for females. One female animal was found dead on lactation day 2. All other females survived until scheduled sacrifice. No treatment-related effects were observed in clinical signs, mortality, body weight (gain), food consumption, gross pathology, organ weights or histopathology in the parental animals. There was no treatment-related effect on reproductive performance or in reproductive parameters like for instance number of gravid animals, corpora lutea per dam, total implantations, litter viability or foetal sex ratios. The incidence of neonates born alive/found dead, stillborn or missing between lactation days 0 -4 was comparable among study groups. No treatment-related malformations were observed for neonates. The body weight of neonates was statistically significantly increased with an unknown biological significance for this finding. A NOAEL of 1000 mg/kg bw/day was established.
Acute Toxicity	The oral LD50 in male and female Sprague-Dawley rats was determined to be 5000 mg/kg bw in a reliable, key study conducted similarly to OECD guideline 420 (Calvert Laboratories, Inc., 2010). Calvert Laboratories Inc (2010) determined acute dermal toxicity in 10 male / female rats following a GLP-compliant study performed equivalent to OECD guideline 402 (key study, Klimisch 1). Only one dose was tested (2000 mg/kg bw). No mortality was observed. Shortly after exposure, local erythema and oedema effects were observed in both males and females. The effects seemed to be reversible in males and 1 female. In the 4 other females, necrosis and slouching appeared.
Irritation	The skin irritation potential of the test substance is investigated in a key, reliable study performed according to OECD guideline 404 (Allen, 1994; Klimisch 2) in 3 rabbits. Semi-occlusive patches were removed from shaved test sites after exposure periods of 3 min, 1h, and 4h to 0.5mL of the test substance. The Draize scoring system was used to evaluate the results. No erythema/eschar formation and no oedema formation is observed after 3 min and 1 hour exposure. After 4 hours of exposure, very slight erythema in all 3 animals and very slight oedema in 2 animals was observed, but this was fully reversible within 24 - 48 hrs. Calvert Laboratories, Inc. (2010) investigated the eye irritation potential of the test substance in a key, reliable study performed according to EU method B.5 (Klimisch 1) in 3 rabbits. The treated eyes (with 0.1mL test substance) will remain unrinsed for at least 24 hours after instillation. The 24-, 48- and 72-hours scores will be added separately for each animal and each total divided by 3 to yield the individual mean scores for each animal. Based on the data and according to the criterial of the CLP regulation, the test substance is classified as irritant to the eyes (category 2).
Sensitisation	Based on a guinea pig maximization study, performed according to the OECD guideline 406 (Allen, 1996; Klimisch 2), the test substance is considered not sensitising to the skin.
Health Effects Summary	This chemical may cause skin and eye irritation.
Key Study/Critical Effect for Screening Criteria	The critical lowest No Observed Adverse Effect (NOAEL) level for the purposes of risk assessment is 1000 mg/kg bw/day from the 90 day repeated oral toxicity study.
Ecological Toxicity [1]	

Aquatic Toxicity	In a static test following the procedures of the German national standard DIN 38412 using Leuciscus idus as test species a LC50 (96 h) of 681.2 mg/L (nominal) was determined [BASF AG, 1988; Study No. 10F0118/885140]. In conclusion, the substance is with high probability not acutely harmful to fish. The EC50 of the test item on daphnids was found to be greater than 122 mg/L (measured value) in a GLP guideline study according to OECD 202 [BASF SE, 2010; Study No. 50E0396/09E012]. Therefore, the test substance is with high probability acutely not harmful to aquatic invertebrates. A study was performed to assess the effect of the test item on the growth of the green alga Pseudokirchneriella subcapitata. The method followed that described in the OECD Guidelines for Testing of Chemicals (2006) No 201, "Freshwater Alga and Cyanobacteria, Growth Inhibition Test" referenced as Method C.3 of Commission Regulation (EC) No 440/2008. The effect of the test item on the growth of Pseudokirchneriella subcapitata has been investigated over a 72-Hour period. the ErC50(72h) of the test item is 45 mg/L for Pseudokirchneriella subcapitata. The toxicity to microorganisms was determined in a GLP short-term respiration test according to OECD guideline 209 using activated sludge from a municipal sewage treatment plant. After 180 minutes no inhibition effect on the respiration rate at the highest test concentration (1000 mg/L) was observed [BASF 2010; Study No. 08G0396/09G004]. Therefore, it can be concluded that inhibition of the degradation activity of activated sludge is not anticipated when introduced in appropriately low concentrations.
Determination of PNEC aquatic	The available short-term aquatic tests covering the three trophic levels (fish, daphnids, algae) showed the lowest L(E)C50 to be 45 mg/L in algae. An assessment factor of 1000 was used for a resulting PNEC for of 0.045 mg/L.
Current Regulatory Controls[4]	
Australian Hazard Classification	No data available.
Australian Occupational Exposure Standards	No data available.
International Occupational Exposure Standards	No data available.
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	No data available.
PBT Assessment[1]	
P/vP Criteria fulfilled?	Not readily biodegradable. Thus, it is expected to meet the screening criteria for persistence.
B/vB criteria fulfilled?	As the Log Pow is 0.565 at 20 °C (Log Pow < 4.5), it is not expected to be bioaccumulative.
T criteria fulfilled?	The acute aquatic toxicity of this chemical is >0.1 mg/L. Thus, it is not expected to meet the screening criteria for toxicity
Overall conclusion	Not PBT
Revised	March 2019

References

1. ECHA REACH, Ethanol, 2,2'-oxybis-, reaction products with ammonia, morpholine derivs. residues, Retrieved 2019: https://echa.europa.eu/

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Toxicity Summary - Glyoxal (Ethanedial)

Chemical and Physical Properties[1,2,3]	
CAS number	107-22-2
Molecular formula	C2H2O2
Molecular weight	58.04
Solubility in water	600 g/L at 25 °C
Melting point	15 °C
Boiling point	50.4 °C
Vapour pressure	29.33 kPa at 20 °C
Henrys law constant	No data available.
Explosive potential	Non explosive
Flammability potential	Not classified
Colour/Form	Light yellow liquid with a mild odour at ambient temperatures; yellow crystals at 15 °C.
Overview	Glyoxal is generally available as an aqueous solution, typically containing 30-50% glyoxal in which hydrated oligomers are present. This chemical is used as a chemical intermediate in the production of pharmaceuticals and dyestuffs, as a cross-linking agent in the production of polymers, as a biocide, and as a disinfecting agent. Due to microbial activity as well as non-enzymatic autoxidation of oil or browning reactions of saccharides, glyoxal is frequently detected in fermented food and beverages. It is found in beer, wine and tea.
Environmental Fate[1]	
Soil/Water/Air	Glyoxal's production and use as a crosslinking agent in permanent-press fabrics, textiles, organic synthesis, glues, and biocides may result in its release to the environment through various waste streams. Glyoxal is also released to the environment from the combustion of wood, automobile exhaust, and the atmospheric degradation of aromatic and olefinic hydrocarbons. It may also be produced as a disinfection byproduct during the treatment of drinking water. Glyoxal is also endogenously produced by a variety of enzyme-independent pathways. If released to air, an extrapolated vapor pressure of 255 mm Hg at 25 deg C indicates glyoxal will exist solely in the vapor-phase. Vapor-phase glyoxal is degraded in the atmosphere by reaction with photochemically-produced hydroxyl radicals; the half-life for this reaction in air is estimated to be 34 hours. Glyoxal also undergoes direct photolysis, with an estimated atmospheric lifetime of 5 hours. If released to soil, glyoxal is expected to have very high mobility based upon an estimated Koc of 1. Volatilization from moist soil surfaces is not expected to be an important fate process based upon a Henry's Law constant of 3.33X10-9 atm-cu m/mole. The potential for volatilization of glyoxal from dry soil surfaces may exist based upon the extrapolated vapor pressure of this compound. Screening studies using sewage seed have indicated that glyoxal is readily biodegradable. If released into water, glyoxal is not expected to adsorb to suspended solids and sediment based upon the estimated Koc. Volatilization from water surfaces is not expected to be an important fate process based upon this compound's Henry's Law constant. Photolysis in sunlit surface waters is expected to be an important fate process because glyoxal absorbs light greater than 290 nm and undergoes direct photolysis in the atmosphere. Glyoxal is not expected to undergo hydrolysis in the environment due to the lack of hydrolyzable functional groups. An estimated BCF of 3 suggests the potential for bioconcentration in aquatic organisms is low.

Human Health Toxicity Summary [1]	
Chronic Repeated Dose Toxicity	From an oral 28 day repeat dose toxicity test conducted in accordance with OECD TG 407 a NOAEL was established at 40 mg/kg bw/day (active substance), based on dose-related changes in body weight gain at higher doses. A single inhalation toxicity study in rats revealed no systemic toxicity even at the highest dose of 0.4 mg/m^3.
Carcinogenicity	Results from several carcinogenicity studies, tumour initiation/promotion studies and in vitro cell transformation assays show that ethanedial is not carcinogenic.
Mutagenicity/ Genotoxicity	Ethanedial was shown to be mutagenic in both bacterial and mammalian cells in vitro. Unscheduled DNA synthesis was reported in one study in mice in vivo, but only within the pyloric sphincter and liver and not in more remote organs.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	Available data on ethanedial and an analogue of ethanedial present in aqueous solutions suggest no effects on fertility or developmental toxicity in the absence of material toxicity.
Acute Toxicity	Ethanedial is moderately toxic via the oral and inhalation routes. In a guideline study in rats, an oral LD50 for a 40% ethanedial aqueous solution was reported at 3300 mg/kg bw. This corresponds to 1320 mg/kg bw/day for the active ingredient. An LC50 for inhalation toxicity was established at 2.44 g/L (active ingredient). Ethanedial is therefore considered to be of low dermal toxicity.
Irritation	Animal studies indicate that ethanedial is a skin and eye irritant
Sensitisation	Based on both animal and human studies, ethanedial is also considered a skin sensitiser.
Health Effects Summary	Ethanedial is moderately toxic via the oral and inhalation routes. In a guideline study in rats, an acute oral median lethal dose (LD50) for a 40% ethanedial aqueous solution was reported at 3 300 mg/kg bw. This corresponds to 1 320 mg/kg bw day for the active ingredient. A median lethal concentration (LC50) for inhalation toxicity was established at 2.44 g/L (active ingredient). Ethanedial is of low dermal toxicity. Animal studies indicate that ethanedial is a skin and eye irritant. From both animal and human studies, ethanedial is also a skin sensitiser.
Key Study/Critical Effect for Screening Criteria	A single repeat dose inhalation toxicity study in rats revealed no systemic toxicity even at the highest dose of 10 mg/m^3. From an oral 28-day repeat dose toxicity test conducted in accordance with OECD TG 407, a No-Observed-Adverse-Effect Level (NOAEL) was established at 40 mg/kg bw/day (active substance), based on dose related changes in body weight gain at higher doses. An adjustment factor of three is applied for inadequate duration of this study, as the no-effect dose was derived from a 28 day study. Consequently, for the purposes of quantifying the health risk of the chemical, an adjusted NOAEL of 13.3 mg/kg bw/day is used in this risk assessment.
Ecological Toxicity [1,2,3]	
Aquatic Toxicity	215 mg/L 96 h-LC50 fish. The result of the key study on freshwater invertebrates (BASF, 1988) indicates no acute toxicity of glyoxal (40% in aqueous solution) to Daphnia magna. The EC50 value is above 100 mg/L even when it is considered that no analytical monitoring was performed since glyoxal was shown to be stable at least for this 48-h period. In a GLP guideline study following OECD 210, the chronic treatment of early-life-stages of fish with the test item (Glyoxal 40%) under flow-through conditions resulted in no substance-related effects. Referring to the nominal concentrations of the active substance glyoxal, the NOEC was 119 mg a.i./L (BASF, 2009).
Determination of PNEC aquatic	An assessment factor of 100 has been applied to the reported LC50 of 215 mg/L for fish. The PNECaquatic is 2.15 mg/L.

Current Regulatory Controls[4]	
Australian Hazard Classification	Ethanedial is classified as hazardous for human health in the Hazardous Substances Information System (HSIS) with the following risk phrases (Safe Work Australia 2013): • Muta. Cat. 3 (Mutagenic Substances, Category 3) • R68 (Possible risk of irreversible effects) • Xn; R20 (Harmful by inhalation) • Xi; R36/38 (Irritating to eyes and skin) • R43 (May cause sensitisation by skin contact)
Australian Occupational Exposure Standards	No specific exposure standards were available.
International Occupational Exposure Standards	The following exposure standards are identified (Galleria Chemica 2013). Time Weighted Average (TWA): • 0.1 mg/m³ [Belgium, Columbia, Canada (Alberta, British Columbia, Saskatchewan), • Italy, Nicaragua, Portugal, Spain, United States of America] • 0.5 mg/m³ (0.2 ppm) [Denmark]. • Short Term Exposure Limit (STEL): • 0.3 mg/m³ [Canada (Saskatchewan)].
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No aesthetic or health-related guidance values were identified for this chemical in the Australian Drinking Water Guidelines (National Health and Medical Research Council (NHMRC) 2011).
Aquatic Toxicity Guidelines	No data available.
PBT Assessment[1,2]	
P/vP Criteria fulfilled?	Expected to be readily biodegradable and as such not persistent in the environment.
B/vB criteria fulfilled?	As the Log Pow is 0.85 (Log Pow < 4.5), it is not expected to be bioaccumulative.
T criteria fulfilled?	The acute aquatic toxicity of this chemical is >0.01 mg/L. Thus, it is not expected to meet the screening criteria for toxicity.
Overall conclusion	Not PBT
Revised	April 2019

References

1. Department of the Environment and Energy 2017 , National assessment of chemicals associated with coal seam gas extraction in Australia, prepared by the National Industrial Chemicals Notification and Assessment Scheme
2. ECHA REACH, Glyoxal, Retrieved 2019: https://echa.europa.eu/
3. HSDB (n.d.). Hazardous Substances Data Bank. Retrieved 2019, from Toxnet, Toxicology Data Network, National Library of Medicine: http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB

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Toxicity Summary - Guanidine, hydrochloride (1:1)

Chemical and Physical Properties[2]	
CAS number	50-01-1
Molecular formula	CH5N3.ClH
Molecular weight	95.53 g/mol
Solubility in water	2,150 g/L at 20 °C
Melting point	188 °C
Boiling point	No data available.
Vapour pressure	For the pure solid guanidinium chloride the vapour pressure is expected to be much lower than 0.000005 Pa.
Henrys law constant	No data available.
Explosive potential	No data available.
Flammability potential	No data available.
Colour/Form	Solid, powder, odourless
Overview	This substance is used in the following products: laboratory chemicals, extraction agents and pharmaceuticals. This substance has an industrial use resulting in manufacture of another substance (use of intermediates).
Environmental Fate[2]	
Soil/Water/Air	The guanidine ion is expected to have such a long hydrolysis half-life at environmentally relevant pH that the measurement is not feasable. Due to the low vapour pressure the substance under investigation will not be present in the gas phase in the atmosphere in appreciable amounts and therefore the elimination path photodegradation in air will be only of minor importance. Guanidine chloride is inherently biodegradable. Guanidine chloride is highly water soluble. For the inorganic solid a negligible vapour pressure is expected. According to the measured log Kow < -1.7, a low potential for adsorption is expected (non-ionic adsorption).
Human Health Toxicity Summary[2]	
Chronic Repeated Dose Toxicity	A No Observed Adverse Effect Level (NOAEL) of 100 mg/kg body weight/day for repeated dose toxicity was established from an oral sub chronic toxicity study on Wistar rats according to OECD guideline 408 with Guanidine hydrochloride.
Carcinogenicity	No data available.
Mutagenicity/ Genotoxicity	There is no evidence for genotoxic properties from gene mutation assays in bacteria and mammalian cells, as well as chromosome aberration in mammalian cells.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	A NOAEL of 350 mg/kg body weight/day for developmental toxicity was established from a developmental toxicity study according to OECD guideline 414 with Guanidine hydrochloride.
Acute Toxicity	Acute toxicity data on Guanidine hydrochloride are available for the oral, inhalation and dermal route. The data available from three studies for the oral route all indicate LD50 values for Guanidine hydrochloride in the range between 773.6 and 1120 mg/kg bw. The LC50 from an inhalation study for female rats is 3.181 mg/L air (LC50 for male rats = 7.655 mg/L air). The dermal LD50 is > 2000 mg/kg bw.
Irritation	Based on the available data Guanidine hydrochloride is irritating to the skin and irritating to the eye.

Sensitisation	Not sensitising
Health Effects Summary	After oral exposure signs of systemic toxicity including death were observed in acute toxicity studies, thus absorption of guanidine hydrochloride has occurred. As a consequence, it is likely that the substance will also be absorbed if inhaled. This assumption is supported by data from an acute inhalation toxicity study, were systemic effects and death were observed. The substance is irritating to the skin and eye. The substance is not skin sensitising and there is no evidence of genotoxic toxicity.
Key Study/Critical Effect for Screening Criteria	NOAEL (rat) of 100 mg/kg bw/day from sub-chronic oral toxicity study.
Ecological Toxicity[2]	
Aquatic Toxicity	Short-term toxicity to aquatic organisms: Fish: LC50 (96 h) = 690 mg/L a.i. for Pimephales promelas (test with read-across substance Guanidine nitrate). Invertebrates: EC50 (48h) = 70.2 mg/L for Daphnia magna (test with read-across substance Guanidine nitrate, similar to OECD 202). Algae and cyanobacteria: ErC50 (72 h) = 33.5 mg/L for Pseudokirchneriella subcapitata (test with read-across substance Guanidine nitrate Long-term toxicity to aquatic organisms: Fish: NOEC = 181 mg/L for Fathead minnow (test with read-across substance Guanidine nitrate, similar to OECD 210). Invertebrates: NOEC = 2.9 mg/L for Daphnia magna (test with read-across substance Guanidine nitrate, similar to OECD 211).
Determination of PNEC aquatic	PNEC not calculated. Acute and chronic results for species for all three tropic levels are above 1 mg/L.
Current Regulatory Controls	
Australian Hazard Classification	No data available.
Australian Occupational Exposure Standards	No data available.
International Occupational Exposure Standards	No data available.
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	No data available.
PBT Assessment	
P/vP Criteria fulfilled?	No. Guanidine chloride is inherently biodegradable.
B/vB criteria fulfilled?	No. Log Kow is -1.7 @ 20 °C and BCF is 3.2 L/kg ww
T criteria fulfilled?	No. Acute and chronic toxicity data >1 mg/L for all three tropic levels.
Overall conclusion	Not PBT
Revised	October 2019

References

1. ECHA REACH, Guanidinium chloride, Retrieved 2019: https://echa.europa.eu/

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Toxicity Summary - Kaolin

Chemical and Physical Properties[1,2,4,5]	
CAS number	1332-58-7
Molecular formula	H2Al2Si2O8 H2O
Molecular weight	258 (approx)
Solubility in water	Insoluble
Melting point	No data available.
Boiling point	No data available.
Vapour pressure	No data available.
Henrys law constant	No data available.
Explosive potential	No data available.
Flammability potential	Not combustible
Colour/Form	White, greyish-white, or slightly coloured
Overview	Kaolin is a mixture of different minerals. Its main component is kaolinite and it frequently contains quartz, mica, feldspar, illite and montmorlilonite. Kaolinite composition is tiny sheets of triclinic crystals with pseudohexagonal morphology. It is formed by rock weathering. Kaolin is used in paper production, in paints, rubber, plastic, ceramic, chemical, pharmaceutical and cosmetic industries. It has a high fusion point and is the most refractory of all clays. Kaolin is listed in FIFRA 25(b) and US EPA List 4A. It is also listed as GRAS (Generally Regarded as Safe) by the U.S. Food and Drug Administration (FDA GRAS database). A Tier 1 Human Health Assessment for this chemical has been conducted by NICNAS which concluded that it was low concern to human health.
Environmental Fate[4]	
Soil/Water/Air	Kaolin is a natural component of the soil and occurs widely in ambient air. It has a density of 2.1–2.6 g/cm^3. The cation exchange capacity of kaolinite is considerably less than that of montmorillonite, in the order of 2–10 meq/100 g, depending on the particle size, but the rate of the exchange reaction is rapid, almost instantaneous (Grim, 1968). Kaolinite adsorbs small molecular substances such as lecithin, quinoline, paraquat, and diquat, but also proteins, polyacrylonitrile, bacteria, and viruses (McLaren et al., 1958; Mortensen, 1961; Weber et al., 1965; Steel & Anderson, 1972; Wallace et al., 1975; Adamis & Timár, 1980; Schiffenbauer & Stotzky, 1982; Lipson & Stotzky, 1983). The adsorbed material can be easily removed from the particles because adsorption is limited to the surface of the particles (planes, edges), unlike the case with montmorillonite, where the adsorbed molecules are also bound between the layers (Weber et al., 1965). Upon heating, kaolinite starts to lose water at approximately 400 °C, and the dehydration approaches completeness at approximately 525 °C (Grim, 1968). The dehydration depends on the particle size and crystallinity.
Human Health Toxicity Summary [1,4]	
Chronic Repeated Dose Toxicity	Long-term exposure to kaolin may lead to a relatively benign pneumoconiosis, known as kaolinosis. Deterioration of lung function has been observed only in cases with prominent radiological alterations. Based on data from China clay workers in the United Kingdom, it can be very roughly estimated that kaolin is at least an order of magnitude less potent than quartz.
Carcinogenicity	A4; Not classifiable as a human carcinogen

Mutagenicity/ Genotoxicity	Recently, manufactured nano/microparticles such as fullerenes (C60), carbon black (CB) and ceramic fiber are being widely used because of their desirable properties in industrial, medical and cosmetic fields. However, there are few data on these particles in mammalian mutagenesis and carcinogenesis. To examine genotoxic effects by C60, CB and kaolin, an in vitro micronuclei (MN) test was conducted with human lung cancer cell line, A549 cells. In addition, DNA damage and mutations were analyzed by in vivo assay systems using male C57BL/6J or gpt delta transgenic mice which were intratracheally instilled with single or multiple doses of 0.2 mg per animal of particles. In in vitro genotoxic analysis, increased MN frequencies were observed in A549 cells treated with C60, CB and kaolin in a dose-dependent manner. These three nano/microparticles also induced DNA damage in the lungs of C57BL/6J mice measured by comet assay. Moreover, single or multiple instillations of C60 and kaolin, increased either or both of gpt and Spi- mutant frequencies in the lungs of gpt delta transgenic mice. Mutation spectra analysis showed transversions were predominant, and more than 60% of the base substitutions occurred at G:C base pairs in the gpt genes. The G:C to C:G transversion was commonly increased by these particle instillations. Manufactured nano/microparticles, CB, C60 and kaolin, were shown to be genotoxic in in vitro and in vivo assay systems.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	No data available.
Acute Toxicity	Occupationally inhaled kaolin produced chronic pulmonary fibrosis. In an acute oral study in which 120 rats were fed doses of Kaolin ranging from 100 to 210 g/kg. Fourteen rats were controls. Kaolin was inert and nonstatic except for the danger of bowel obstruction resulting in perforation. The clinical signs were listlessness, anorexia, oliguria, hypothermia, and dyspnea. These were a pathological reaction from over distension of the alimentary canal by an inert solid. The number of fatalities and the incidence and advance of bowel obstruction along the small intestine were dose related. The dose that killed 50% of the rats by bowel obstruction was 149 g/kg.
Irritation	Causes moderate eye irritation. May cause irritation of the respiratory system
Sensitisation	No data available.
Health Effects Summary	Kaolin is toxic to a variety of mammalian cells in vitro, and it produces transient inflammation in the lungs of experimental animals after intratracheal instillation.
Key Study/Critical Effect for Screening Criteria	No data available.

Ecological Toxicity [4]	
Aquatic Toxicity	The 24- and 48-h LC50 values for kaolinite toxicity to the water flea (Daphnia pulex) were >1.1 g/litre (Lee, 1976). Georgia kaolin caused <10% mortality of sea urchin (Strongylocentrosus purpuratus), Japanese clam (Tapes japonica), hermit crab (Pagurus hirsutiusculus), isopod (Sphaeroma pentodon), mud snail (Nassarius obsoletus), blue mussel (Mytilus edulis), and tunicates (Molgula manhattensis and Styela montereyensis) within 5–12 days. The 200-h LC10 values for coast mussel (Mytilus californianus), black-spotted bay shrimp (Crangon nigromaculata), migrant prawn (Palaemon macrodactylus), dungeness crab (Cancer magister), and the polychaete Neanthes succinea were 26, 16, 24, 10, and 9 g/litre, respectively. The 100-h LC10 values for the tunicate Ascidia ceratodes, amphipod Anisogammarus confervicolus, and shiner perch (Cymatogaster aggregata) were 7, 38, and 1 g/litre, respectively (McFarland & Peddicord, 1980). No effect on the hatching success or egg development rate of four marine fish species — red seabream (Pagrus major), black porgy (Acanthopagrus schlegeli), striped knifefish (Oplegnathus fasciatus), and threeline grunt (Parapristipoma trilineatum) — was observed at kaolinite concentrations up to 10 g/litre for 24 h. Larvae were more sensitive to kaolinite: the 12-h LC50 values were 170 and 710 mg/litre for P. trilineatum and O. fasciatus, respectively; mortality was also observed for P. major at concentrations of 1000 mg/litre and above (Isono et al., 1998).
Determination of PNEC aquatic	Kaolin has low toxicity to aquatic species, a large number of which have been tested. As such, $PNEC_{aquatic}$ has not been determined.
Current Regulatory Controls[2,3]	
Australian Hazard Classification	No hazard classification according to GHS criteria
Australian Occupational Exposure Standards	TWA: 10 mg/m^3
International Occupational Exposure Standards	TLV: (respirable fraction): 2 mg/m^3, as TWA
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	No data available.
PBT Assessment	
P/vP Criteria fulfilled?	Not applicable (inorganic salt, ionic species ubiquitous in environment)
B/vB criteria fulfilled?	Not applicable. Bioaccumulation is not applicable to these inorganic ions.
T criteria fulfilled?	Not applicable. Acute toxicity data >1 mg/L in water flea, thus Kaolin does not meet the screening criteria for toxicity.
Overall conclusion	Not PBT
Revised	April 2019

References

1. HSDB (n.d.). Hazardous Substances Data Bank. Retrieved 2019, from Toxnet, Toxicology Data Network, National Library of Medicine: http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB
2. IPCS Kaolin, Retrieved 2019: http://www.inchem.org
3. Safe Work Australia, Hazardous Substances System, Retrieved 2019: http://hcis.safeworkaustralia.gov.au/

4. IPCS INCHEM; Environmental Health Criteria (EHC) Monographs. Bentonite, kaolin, and selected clay minerals (EHC 231). Available from, as of June 25, 2007: http://www.inchem.org/pages/ehc.html
5. National Industrial Chemicals Notification and Assessment Scheme (NICNAS). IMAP, Human Health Tier 1 Assessment. Retrieved 2019: https://www.nicnas.gov.au

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Toxicity Summary - Potassium Hydroxide

Chemical and Physical Properties[1,2,3]	
CAS number	1310-58-3
Molecular formula	KOH
Molecular weight	56.11
Solubility in water	1100 g/l at 25°C
Melting point	406°C
Boiling point	1327°C
Vapour pressure	1.3 hPa at 719°C
Henrys law constant	No data available.
Explosive potential	The solution in water is a strong base. It reacts violently with acid and is corrosive to metals such as aluminium, tin, lead and zinc. This produces a combustible / explosive gas. Reacts with ammonium salts. This produces ammonia. This generates fire hazard. Contact with moisture and water may generate heat.
Flammability potential	Not combustible. Contact with moisture or water may generate sufficient heat to ignite combustible materials.
Colour/Form	White or slightly yellow odourless lumps, rods, pellets.
Overview	Potassium hydroxide is a strong alkaline substance that dissociates completely in water to K+ and OH- ions. KOH is commercialised as a solid or as solutions with varying concentrations. It has many industrial uses; less than 2% is for wide dispersive use. It is used in paint and varnish removers, drain cleaners, degreasing agents and dairy pipeline cleaners.
Environmental Fate[4]	
Soil/Water/Air	The high water solubility and low vapour pressure indicate that KOH will be found predominantly in the aquatic environment. KOH is present in the environment as potassium and hydroxyl ions, which implies that it will not adsorb on particulate matter or surfaces and will not accumulate in living tissues.
Human Health Toxicity Summary[1,3,4]	
Chronic Repeated Dose Toxicity	No studies were identified regarding the repeated dose toxicity of KOH in animals
Carcinogenicity	No data available.
Mutagenicity/ Genotoxicity	There is no evidence for a mutagenic activity. K+ and OH- are not expected to be systemically available in the body over the normal limits, under non-irritating conditions. A genotoxic effect is also not very likely because both the K+ and OH- ions are naturally present in the human body.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	Studies to the reproduction of KOH are not available. Based on the results of corresponding potassium salts like KCl and K2CO3, effects in non-irritating doses/concentrations to reproduction or development are not expected for KOH. The calculated NOAEL for the potassium ion is approximately 164 mg/kg bw.

Acute Toxicity	Potassium hydroxide has moderate acute toxicity based on results from three animal studies in rats following oral exposure. The median lethal dose (LD50) in rats is reported as 273–1230 mg/kg bw. The concentrations used in these tests were not reported. Observed sub-lethal effects included hyperexcitability, followed by apathy and weakness. Haemorrhaging of the stomach and intestine, and adhesions of abdominal organs (stomach, pancreas, spleen, liver and small intestine) were seen following administration of both lethal and sub-lethal doses (OECD, 2002). In contrast, the LD50 value in rats of potassium chloride, 3000 mg/kg bw, is much higher than that of potassium hydroxide, indicating low toxicity of the potassium ion (OECD, 2002).
Irritation	Solid KOH is corrosive. Depending on the concentration, solutions of KOH are non-irritating, irritating or corrosive and they cause direct local effects on the skin, eyes and gastrointestinal tract. Systemic effects are not to be expected. Solutions with concentrations higher than 2% are corrosive, while concentrations of about 0.5 to about 2.0 % are irritating.
Sensitisation	Based on the reported negative results in a guinea pig study and human experience, potassium hydroxide is not considered to be a skin sensitiser (OECD, 2002). Potassium hydroxide has been used extensively for many decades by industry and by consumers. However, skin sensitisation has never been described as secondary to skin irritation or burns. As discussed previously, both the potassium and the hydroxide constituents are ions that are naturally present in the body. For this reason, it is very unlikely that skin sensitisation would result from exposure to the chemical (OECD, 2002)
Health Effects Summary	Potassium hydroxide is corrosive to the skin, eyes, and gastrointestinal and respiratory tracts. Based on human data, concentrations of 0.5–2.0 % are irritating to the skin, while a concentration greater than 2.0 % is corrosive (OECD, 2002). The constituent ions of potassium hydroxide are naturally present in the body. Chronic systemic health effects such as repeated dose toxicity (apart from alkalosis), carcinogenicity and reproductive toxicity are not expected following exposures at non-irritating concentrations. There are limited available data on systemic health effects of potassium hydroxide in vivo (REACH). The very limited data on potassium chloride (OECD, 2002) concludes that there is no evidence of systemic toxicity of the endogenous potassium ion. In addition, similar results were reported for sodium hydroxide (NICNAS). Potassium salts are generally considered by NICNAS to be of low concern to human health (NICNAS, 2012).
Key Study/Critical Effect for Screening Criteria	No oral TRV apply. Acute toxicity only (irritant and corrosive). Systemic effects are not to be expected. The Australian drinking water guideline value for pH may apply to potassium hydroxide.
Ecological Toxicity [4]	
Aquatic Toxicity	The hazard of KOH for the environment is caused by the hydroxyl ion (pH effect). For this reason the effect of KOH on the organisms depends on the buffer capacity of the aquatic or terrestrial ecosystem. Also the variation in acute toxicity for aquatic organisms can be explained for a significant extent by the variation in buffer capacity of the test medium. The LC50 value of acute fish toxicity was in the order of 80 mg/l. It was 880 mg/l for KCl and ranged between 125-189 mg/l for NaOH. The LC50 values of acute invertebrate toxicity for KCl was 660 mg/l (Daphnia magna) and 630 mg/l (Ceriodaphnia dubia), and for NaOH 40 mg/l (Ceriodaphnia dubia). The EC50 algae value (Nitscheria linearis) was 1337 mg/l for KCl.
Determination of PNEC aquatic	It is not considered useful to calculate a PNEC for potassium hydroxide because factors such as the buffer capacity, the natural pH, and the fluctuation of the pH are very specific for a certain ecosystem. Based on the information above, a PNECaquatic was not derived for potassium hydroxide.
Current Regulatory Controls[1]	

Australian Hazard Classification	The chemical is classified as hazardous, with the following risk phrases for human health in the Hazardous Substances Information System (HSIS) (Safe Work Australia): Xn; R22 (acute toxicity) C; R35 (corrosivity)
Australian Occupational Exposure Standards	TWA: 2 mg/m^3 (peak limitation), Safe Work Australia
International Occupational Exposure Standards	The following exposure standards are identified (Galleria Chemica): An exposure limit of 0.5–2 mg/m^3 time weigh ted average (TWA) in different countries such as Bulgaria, Chile, Denmark, Poland and Sweden and 1–2 mg/m^3 short-term exposure limit (STEL) in countries such as the United Kingdom, Spain, South Africa and Poland.
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	No data available.
PBT Assessment	
P/vP Criteria fulfilled?	Not applicable (ionic species ubiquitous in environment)
B/vB criteria fulfilled?	Not applicable (ionic species ubiquitous in environment)
T criteria fulfilled?	No chronic toxicity data exist on potassium hydroxide; however, the acute EC(L)50s for KCl are >0.1 mg/L in fish, invertebrates and algae. Thus, potassium hydroxide does not meet the screening criteria for toxicity.
Overall conclusion	Not PBT
Revised	April 2019

References

1. National Industrial Chemicals Notification and Assessment Scheme (NICNAS). IMAP, Human Health Tier II Assessment for Potassium hydroxide: Retrieved 2019: https://www.nicnas.gov.au
2. HSDB (n.d.). Hazardous Substances Data Bank. Retrieved 2015, from Toxnet, Toxicology Data Network, National Library of Medicine: http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB
3. IPCS Potassium Hydroxide, Retrieved 2015: http://www.inchem.org
4. OECD (2008). Screening Information Dataset (SIDS) Initial Assessment Report for Potassium Hydroxide (CAS No. 1310-58-3)
5. Safe Work Australia Workplace Exposure Standards for Airborne Contaminants, 2013.
6. ECHA REACH, Potassium Hydroxide, Retrieved 2015: http://echa.europa.eu

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Toxicity Summary - Smectite

Chemical and Physical Properties[1,2,3]	
CAS number	12199-37-0
Molecular formula	No data available.
Molecular weight	No data available.
Solubility in water	No data available.
Melting point	No data available.
Boiling point	No data available.
Vapour pressure	No data available.
Henrys law constant	No data available.
Explosive potential	No data available.
Flammability potential	No data available.
Colour/Form	Off-white to tan fine flakes or powder
Overview	Smectites commonly result from the weathering of basic rocks. Smectite formation is favoured by level to gently sloping terranes that are poorly drained, mildly alkaline (such as in marine environments), and have the high Si and Mg potentials (Borchardt, 1977). Other factors that favour the formation of smectites include the availability of Ca and the paucity of K (Deer and others, 1975). Poor drainage is necessary because otherwise water can leach away ions (e.g. Mg) freed in the alteration reactions. Smetites are used in the industry as fillers, carriers, absorbents and a component in drilling fluids (Grim, 1962). A Tier 1 Human Health Assessment for this chemical has been conducted by NICNAS which concluded that it was low concern to human health.
Environmental Fate[4*]	
Soil/Water/Air	Limited data is available for smectite, read across data has been obtained from bentonite. Bentonite is a rock formed of highly colloidal and plastic clays composed mainly of montmorillonite, a clay mineral of the smectite group, and is produced by in situ devitrification of volcanic ash. Bentonite's production and use in domestic products, cat litter, construction materials, ceramics, pharmaceuticals, beer and wine production and cosmetics may result in its release to the environment through various waste streams. Its use in drilling muds, in agricultural practice as a carrier and an animal feed binder will result in its direct release to the environment. Bentonite is a colloidal native hydrated aluminum silicate (clay) found in midwest of USA and in Canada. Occupational exposure to bentonite may occur through inhalation of dust and dermal contact with this compound at workplaces where bentonite is produced or used. Use data indicate that the general population may be exposed to bentonite via ingestion of and dermal contact with consumer products containing bentonite.
Human Health Toxicity Summary[4*]	
Chronic Repeated Dose Toxicity	Mice maintained on diets containing bentonite displayed slightly reduced growth rates. Mice treated with higher doses showed minimal growth and fatty livers and fibrosis of the liver and benign hepatomas. Bentonite increased the susceptibility of mice to pulmonary infection.
Carcinogenicity	No adequate studies are available on the carcinogenicity of bentonite.

Mutagenicity/ Genotoxicity	The genotoxic potential of bentonite particles (diameter < 10 um) with an a-quartz content of up to 6% and different chemical modifications (alkaline, acidic, organic) was investigated. Human lung fibroblasts (IMR90) were incubated for 36 hr, 48 hr, or 72 hr with bentonite particles in concentrations ranging from 1 to 15 ug/sq cm. Genotoxicity was assessed using the micronucleus (MN) assay and kinetochore analysis. The generation of reactive oxygen species (ROS) caused by bentonite particles via Fenton-like mechanisms was measured acellularly using electron spin resonance (ESR) technique and intracellularly by applying an iron chelator. The results show that bentonite-induced genotoxic effects in human lung fibroblasts are weak. The formation of micronuclei was only slightly increased after exposure of IMR90 cells to an acidic sample of bentonite dust with a quartz content of 4-5% for 36 hr (15 ug/sq cm), 48 hr (5 ug/sq cm), and 72 hr (1 ug/sq cm), to an alkaline sample with a quartz content of 5% for 48 hr and 72 hr (15 ug/sq cm), and to an acidic bentonite sample with 1% quartz for 72 hr (1 ug/sq cm). Native (untreated) and organic activated bentonite particles did not show genotoxic effects in most of the experiments. Also, bentonite particles with a quartz content < 1% were negative in the micronucleus assay. Generation of ROS measured by ESR was dependent on the content of transition metals in the sample but not on the quartz content or the chemical modification. Reduction of MN after addition of the iron chelator 2,2'-dipyridyl showed that ROS formation also occurs intracellularly. It was concluded that the genotoxic potential of bentonite particles is generally low but can be altered by the content of quartz and available transition metals.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	Limited studies did not demonstrate developmental toxicity in rats after oral exposure to bentonite.
Acute Toxicity	Single intratracheal injection into rodents of bentonite and montmorillonite with low quartz content caused dose and particle side dependent effects, as well as transient local inflammation, which included oedema and increased lung weight. Single intratracheal exposures of rats to bentonite caused storage foci in the lungs. After intratracheal exposure of rats to this material with high quartz content, fibrosis is noted.
Irritation	The powder may contain large amounts of free silica which can produce pneumoconiosis with chronic inhalation.
Sensitisation	No data available.
Health Effects Summary	The substance can be absorbed into the body by inhalation. The substance is mildly irritating to the eyes and skin. The substance may have effects on the lungs. This may result in fibrosis.
Key Study/Critical Effect for Screening Criteria	No study available.
Ecological Toxicity [4*]	
Aquatic Toxicity	The 96-h LC50 for rainbow trout (Oncorhynchus mykiss) of Wyoming bentonite, used as a viscosifier in drilling fluids, was 19 g/litre (Sprague & Logan, 1979).
Determination of PNEC aquatic	PNEC has not been calculated.
Current Regulatory Controls	
Australian Hazard Classification	No data available.
Australian Occupational Exposure Standards	No data available.
International Occupational Exposure Standards	No data available.
Australian Food Standards	No data available.

Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	No data available.
PBT Assessment[4]	
P/vP Criteria fulfilled?	No data available for Smectite. Information on bentonite reported that Biodegradation of bentonite appears to be minimal.
B/vB criteria fulfilled?	No, bioaccumulation appear minimal for montmorillonite compounds
T criteria fulfilled?	No, read across data from bentonite reported 96h LC50 for fish was > 1 mg/L. Thus, it is not expected to meet the toxicity criteria.
Overall conclusion	Not PBT
Revised	April 2019

* No data available for Smectite. Toxicity data for Bentonite is presented as a surrogate.

References

1. National Industrial Chemicals Notification and Assessment Scheme (NICNAS). IMAP, Human Health Tier 1 Assessment. Retrieved 2019: https://www.nicnas.gov.au
2. HSDB Hazardous Substances Data Bank. U.S. National Library of Medicine, Retrieved 2019: http://toxnet.nlm.nih.gov/
3. USGS Coastal and Marine Geology Program, Smectite Group. Retrieved 2019: https://pubs.usgs.gov/of/2001/of01-041/htmldocs/clays/smc.htm
4. IPCS Bentonite, Kaolin and Selected Clay Minerals, Retrieved 2015: http://www.inchem.org

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Toxicity Summary - Sodium bicarbonate

Chemical and Physical Properties [1,2,4,5,6]	
CAS number	144-55-8
Molecular formula	NaHCO3
Molecular weight	84.01
Solubility in water	96 g/L (at 20 °C)
Melting point	Decomposes when heated over 50 °C
Boiling point	Decomposes
Vapour pressure	Negligible, ionizable inorganic compound
Henrys law constant	No data available
Explosive potential	No data available
Flammability potential	No data available
Colour/Form	white, odourless, crystalline powder
Overview	Sodium bicarbonate is classified by the U.S. Food and Drug Administration (FDA) as a 'Generally Recognised as Safe' (GRAS) ingredient in food with no other limitation than current good manufacturing practice (FDA, 1978; FDA, 1983). In the EU it is approved as a food additive (EU, 2000) and a feed ingredient (EU, 1998).In Australia it is recognised by Food Standards Australia New Zealand (FSANZ) as a food additive. Sodium bicarbonate is used as animal feed additive, human food additive and it is used in pharmaceuticals. It is also used for the production of other chemicals and used in cosmetics and detergents and other household cleaning products. A Tier 1 Human Health Assessment for this chemical has been conducted by NICNAS which concluded that it was low concern to human health.
Environmental Fate[3]	
Soil/Water/Air	The high water solubility and low vapour pressure indicate that sodium bicarbonate will be found predominantly in the aquatic environment. Sodium bicarbonate is present in the environment as sodium and bicarbonate ions, which implies that it will not adsorb on particulate matter or surfaces and will not accumulate in living tissues.
Human Health Toxicity Summary [2,3]	
Chronic Repeated Dose Toxicity	There are no directly relevant studies on repeated dose exposure, however, knowledge of prior use and available literature does not indicate any adverse effects of long-term use of exposure via any route. In humans there is a long history of sodium bicarbonate used as an antacid in doses up to 4 g without adverse effects of long-term use, although it is recommended not to use high doses of pure sodium bicarbonate instead of antacids. In addition, sodium bicarbonate is an important extracellular buffer in vertebrates and is therefore readily regulated in the body.
Carcinogenicity	As with other sodium salts, high doses of sodium bicarbonate promote carcinoma formation in rat urinary bladder after pre-exposure to initiator or BBN. However, when rats were only exposed to sodium bicarbonate no carcinogenic effect on the urinary bladder was found. Based on the available information there are no indications that sodium bicarbonate has carcinogenic effects.
Mutagenicity/ Genotoxicity	*In vitro* bacterial and mammalian cell tests showed no evidence of genotoxic activity.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	Sodium bicarbonate did not induce developmental effects when administered orally at the following doses: 580 mg/kg bw (mice), 340 mg/kg bw (rats) and 330 mg/kg bw (rabbits). Furthermore the substance will usually not reach the foetus when the exposure to sodium bicarbonate is sufficiently low, as it does not become systemically available.

Acute Toxicity	Acute oral ingestion by the patients may result in a ruptured stomach due to excessive gas development. Acute or chronic excessive oral ingestion may cause metabolic alkalosis, cyanosis and hypernatraemia. These conditions are usually reversible, and will not cause adverse effects.
Irritation	Sodium bicarbonate is a minimal or mild ocular and skin irritant
Sensitisation	No data available
Health Effects Summary	This chemical has been identified by NICNAS to be of low concern to human health.
Key Study/Critical Effect for Screening Criteria	The Australian drinking water screening value for sodium (180 ppm, aethestic) and pH may apply to sodium bicarbonate.
Ecological Toxicity [3]	
Aquatic Toxicity	In a 96-hr acute flow-through test with rainbow trout (Oncorhynchus mykiss) a NOEC of 2,300 mg/l and a LC50 of 7,700 mg/l were determined. The test was conducted under GLP conditions and according to FIFRA Guideline Reference number 72-1. In a 96-hr acute flow-through test with bluegill sunfish (Lepomis macrochirus) a NOEC of 5,200 mg/l and a LC50 of 7,100 mg/l were determined. The test was conducted under GLP conditions and according to FIFRA Guideline Reference number 72-1. In a 48-hr acute flow-through test with Daphnia magna a NOEC of 3,100 mg/l and a LC50 of 4,100 mg/l were determine. The test was conducted under GLP conditions and according to FIFRA Guideline Reference number 72-2. A (chronic) reproduction test with Daphnia magna was carried out. Test solutions were prepared to contain the appropriate concentrations of salts to yield a total hardness of170 mg/l $CaCO_3$. At the tested concentration $NaHCO_3$ of 576 mg/l the survival was 100% and the cumulative number of offspring per female did not significantly differ from the control. This demonstrates that the 21-day Daphnia magna NOEC is higher than 576 mg/l. Standard toxicity tests with algae or aquatic plants have not been found, but test medium for acute algae tests contain 50 mg/l sodium bicarbonate. Glass slides were exposed to a portion of a small stream with an addition of sodium bicarbonate to a concentration of 45 mg/l for a period of 63 days. An increasing algal standing crop compared to the controls was found. Except for a small increase of Cyanophycea species, no shift in species was determined.
Determination of PNEC aquatic	It is not considered useful to calculate a PNEC for sodium bicarbonate because factors such as the buffer capacity, the natural pH, and the fluctuation of the pH are very specific for a certain ecosystem. Based on the information above, a PNECaquatic was not derived for sodium bicarbonate.
Current Regulatory Controls[4]	
Australian Hazard Classification	No data available
Australian Occupational Exposure Standards	No data available
International Occupational Exposure Standards	No data available
Australian Food Standards	No data available
Australian Drinking Water Guidelines	No data available
Aquatic Toxicity Guidelines	No data available
PBT Assessment	
P/vP Criteria fulfilled?	Sodium bicarbonate is an inorganic salt that is present in the environment as sodium and bicarbonate ions. Biodegradation is not applicable to these inorganic ions. Thus, the persistent criterion is not considered applicable to this inorganic salt.
B/vB criteria fulfilled?	Sodium and bicarbonate ions are essential to all living organisms and its

	extracellular concentrations are actively regulated. Thus, sodium bicarbonate is not expected to bioaccumulate.
T criteria fulfilled?	The 21 d chronic NOEC is 576 mg/L for Daphnia. Thus, sodium bicarbonate does not meet the screening criteria for toxicity.
Overall conclusion	Not PBT
Revised	March 2019

References

1. HSDB (n.d.). *Hazardous Substances Data Bank*. Retrieved 2015, from Toxnet, Toxicology Data Network, National Library of Medicine: http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB
2. IPCS Sodium Bicarbonate, Retrieved 2015: http://www.inchem.org
3. OECD (2008). Screening Information Dataset (SIDS) Initial Assessment Report for Sodium Bicarbonate (CAS No. 144-55-8).
4. FSANZ 2014, Food Standards Australia New Zealand Food Additives – Alphabetical list.
5. National Industrial Chemicals Notification and Assessment Scheme (NICNAS). IMAP, Human Health Tier 1 Assessment. Retrieved 2019: https://www.nicnas.gov.au
6. Department of the Environment and Energy 2017 , National assessment of chemicals associated with coal seam gas extraction in Australia, prepared by the National Industrial Chemicals Notification and Assessment Scheme

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Toxicity Summary - Sodium carbonate

Chemical and Physical Properties[1,2,3,4,6]	
CAS number	497-19-8
Molecular formula	Na_2CO_3
Molecular weight	105.99 g/mol
Solubility in water	215 g/l at 20 °C
Melting point	851 °C
Boiling point	Decomposition
Vapour pressure	No data found
Henrys law constant	No data found
Explosive potential	It reacts violently with acids and reacts with magnesium, phosphorous pentoxide causing explosion hazard
Flammability potential	Reacts with fluorine causing fire hazard
Colour/Form	White powder
Overview	Sodium carbonate has been reviewed in the OECD-SIDS program (OECD, 2002a,b).Sodium carbonate is a strong alkaline compound with a pH of 11.6 for a 0.1M aqueous solution. The pKa of carbonate (CO3 2-) is 10.33, which means that at a pH of 10.33 both carbonate and bicarbonate are present in equal amounts. In water, sodium carbonate dissociates into sodium ion (Na+) and carbonate (CO3 2-). The carbonate ions will react with water, resulting in the formation of bicarbonate and hydroxide, until equilibrium is established. Sodium carbonate is used in many countries (e.g. U.S. and EU) as a food additive. It is regarded as a 'Generally Recognised as Safe' (GRAS) substance in food with no limitation other than current good manufacturing practice. Sodium carbon is extensively used across a range of industries and processes such as in the manufacturing of sodium salts, glass, soap/detergents and aluminium
Environmental Fate[1,2,3,4]	
Soil/Water/Air	The high water solubility and low vapor pressure indicate that sodium carbonate will be found predominantly in the aquatic environment. In water, sodium carbonate dissociates into sodium (Na+) and carbonate (CO3 2-) and both ions will not adsorb on particulate matter or surfaces and will not accumulate in living tissues.
Human Health Toxicity Summary[1]	
Chronic Repeated Dose Toxicity	No chronic oral and dermal data are available. Due to the biological importance of the products formed by the stomach acid (biocarbonate and carbon dioxide), systemic toxicity is not expected. In rats, histopathological changes of the respiratory tract and the lungs were seen following repeated inhalation exposure to sodium carbonate (70 mg/m^3 aqueous sodium cabonate at pH 11.6 for 3.5 months) and potassium carbonate (0.4 mg/L potassium carbonate at pH 9.9 for 21days). These effects were considered local responses to the high alkalinity of this group of chemicals (OECD, 2002; REACHa; REACHb).
Carcinogenicity	No data are available. Based on the available data from carcinogenicity studies with related substances (sodium bicarbonate and potassium bicarbonate), the chemicals in this group are not considered carcinogenic (OECD, 2002; REACHa; REACHb). Carbonate ions are neutralised under physiological conditions to form bicarbonate ions and/or carbon dioxide, which are major products of all human metabolic activities; therefore, systemic toxicity is not expected.

Mutagenicity/ Genotoxicity	Based on the available data, this chemical is not considered to be genotoxic (OECD, 2002; REACHa; REACHb). Carbonate ions are neutralised under physiological conditions to form bicarbonate ions and/or carbon dioxide, which are major products of all human metabolic activities; therefore, systemic toxicity is not expected.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	Based on the limited information available, this chemical does not show specific reproductive or developmental toxicity (OECD, 2002; REACHa; REACHb). Carbonate ions are neutralised under physiological conditions to form bicarbonate ions and/or carbon dioxide, which are major products of all human metabolic activities; therefore, systemic toxicity is not expected.
Acute Toxicity	In animal tests, this chemical was of low acute toxicity following oral exposure. The median lethal dose (LD50) was >2000 mg/kg bw in rats (OECD, 2002; REACHa; REACHb).The majority of the animals that died following acute oral exposure to sodium carbonate at concentrations up to 2600 mg/kg/bw showed oral or nasal discharge, lesions in the liver, mottled lungs, mottled or pale kidneys and a red or partly gas-filled gastro-intestinal tract. In animal tests, this chemical was of low acute toxicity following dermal exposure. The median lethal dose (LD50) was >2000 mg/kg bw in rats (OECD, 2002; REACHa; REACHb). No systemic effects were observed following dermal exposure to sodium carbonate. Local severe skin irritation (severe erythema and oedema) was seen at the application site (OECD, 2002; REACHa; REACHb). In animal tests, this chemical was of low acute toxicity following inhalation exposure. The median lethal dose (LC50) was >2000 mg/m^3 in rats (OECD, 2002; REACH, a & b). Signs of respiratory impairment including dyspnoea, wheezing, excessive salivation and a distended abdomen were observed immediately after inhalation exposure to sodium carbonate of up to 2300 mg/m^3. Excessive salivation, repeated swallowing and a lack of appetite were observed 2–5 hours after exposure. Animals that died had lesions in the anterior trachea, posterior pharynx and larynx, along with an accumulation of mucus, vesiculation and mucosal oedema (REACHa).
Irritation	Sodium carbonate is classified as hazardous with the risk phrase 'Irritating to eyes' (Xi; R36) in HSIS (Safe Work Australia). However, in several eye irritation studies in rabbits, sodium carbonate was found to be severely irritating to the eyes, with effects including conjunctivitis, marked corneal opacity and iritis, which persisted for seven days (REACHa; REACHb). The available data support an amendment to the current HSIS eye irritation classification for sodium carbonate.
Sensitisation	Based on the limited data available, sodium carbonate is not considered to be skin sensitisers (OECD, 2002; REACHa; REACHb). No structural flags for sensitisation are present.
Health Effects Summary	The critical health effects for risk characterisation include serious eye damage and respiratory irritation because of the high basicity of the chemicals in this group. Skin irritation and corrosion of eyes and mucous membranes are also of concern where long-term exposure to the solid or concentrated solutions may occur. These effects are particularly relevant to domestic use of the chemicals. Sodium carbonate was not genotoxic or carcinogenic. Reproductive toxicity studies are not available; however, no effects on reproductive organs were noted when rats were exposed to sodium carbonate aerosol for over three months. Developmental studies with rats did not show any toxicity.
Key Study/Critical Effect for Screening Criteria	A No Observed Adverse Effect Level (NOAEL) was not available. Based on the absence of adverse effects observed in a repeat dose inhalation toxicity study, for the purposes of quantifying potential health risk, the highest dose tested in the inhalation exposure study in rats of 70 mg/m^3 (equivalent to 9.67 mg/kg bw/day) is used in the human health risk assessment.
Ecological Toxicity [1,2,3,4]	
Aquatic Toxicity	The acute 96-hour LC50 to three sizes of Bluegill sunfish (*Lepomis macrochirus*) exposed to sodium carbonate is 300 mg/L for all sizes. The acute 96-hour LC50 to mosquitofish (*Gambusia affinis*) is 740 mg/L. The acute 48-hour EC50 value to the invertebrate *Ceriodaphnia* cf. *dubia* is from 200 to 227 mg/L.

Determination of PNEC aquatic	PNECaquatic: Experimental results are available for two trophic levels. Acute E(L)C50 values are available for fish (300 mg/L) and *Ceriodaphnia* (200 mg/L). On the basis that the data consists of short-term results from two trophic levels, an assessment factor of 1,000 has been applied to the lowest reported effect concentration of 200 mg/L for Daphnia. The PNECaquatic is 0.2 mg/L.
Current Regulatory Controls[1]	
Australian Hazard Classification	Sodium carbonate is classified as hazardous, with the following risk phrases for human health in the Hazardous Substances Information System (HSIS) (Safe Work Australia): 'Xi; R36 (Irritating to eyes)'.
Australian Occupational Exposure Standards	Sodium carbonate has an exposure standard of 7.5 mg/m^3 (5 ppm) time weighted average (TWA) and 15 mg/m^3 (10 ppm) short-term exposure limit (STEL) (Safework Australia).
International Occupational Exposure Standards	Occupational exposure standard limits for sodium and potassium carbonate recommended by other countries are provided below (Galleria Chemica, 2013): US Dept of Energy (DOE) Temporary Emergency Exposure Limits (TEELs): Sodium carbonate: TEEL-0 = 10 mg/m^3 , TEEL-1 = 30 mg/m^3 , TEEL-2 = 50 mg/m^3, TEEL-3 = 500 mg/m^3 No other country has an occupational exposure limit specifically for sodium and potassium carbonate, although many countries have assigned a generic TWA exposure limits of 10 mg/m^3 (inhalable dust), and 3 mg/m^3 (respirable dust) for particles not otherwise classified (PNOC).
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	No data available.
PBT Assessment[4,6]	
P/vP Criteria fulfilled?	Not applicable, inorganic substance, ubiquitous in environment.
B/vB criteria fulfilled?	Not applicable. Bioaccumulation is not applicable to these inorganic ions.
T criteria fulfilled?	No chronic toxicity data exist; however, the acute EC(L)50s are >0.1 mg/L. Thus, does not meet the screening criteria for toxicity
Overall conclusion	Not PBT
Revised	March 2019

References

1. National Industrial Chemicals Notification and Assessment Scheme (NICNAS). IMAP, Human Health Tier II Assessment for Alkaline Salts-Carbonates: Retrieved 2019: https://www.nicnas.gov.au
2. HSDB Hazardous Substances Data Bank. U.S. National Library of Medicine, < http://toxnet.nlm.nih.gov/>,
3. OECD (2011) SIDS Initial Assessment Report for SIAM 15 (OECD SIDS). *Sodium carbonate: CAS Nº:497-19-8*. United Nations Environment Programme (UNEP) Publications. From http://www.chem.unep.ch/irptc/sids/OECDSIDS/Naco.pdf,
4. ICPS (2004). *Sodium carbonate (anhydrous): Summary*. October 2004. International Programme on Chemical Safety and the Commission of the European Communities (IPCS and CEC). From http://www.inchem.org/documents/icsc/icsc/eics1135.htm
5. Department of the Environment and Energy 2017 , National assessment of chemicals associated with coal seam gas extraction in Australia, prepared by the National Industrial Chemicals Notification and Assessment Scheme
6. ECHA REACH, Sodium carbonate, Retrieved 2019: https://echa.europa.eu/

AECOM Imagine it. Delivered.

Toxicity Summary - PERFORMATROL®

Chemical and Physical Properties[1,2]	
CAS number	Not provided
Molecular formula	No data available.
Molecular weight	No data available.
Solubility in water	Water soluble
Melting point	No data available.
Boiling point	No data available.
Vapour pressure	No data available.
Henrys law constant	No data available.
Explosive potential	No data available.
Flammability potential	No data available.
Colour/Form	Clear, colourless, odourless, viscous liquid
Overview	PERFORMATROL® shale stabilizer is a low weight polymer that stabilizes reactive clays and shale by inhibiting the uptake of water and thereby mitigating their swelling or dispersion tendencies. PERMORMATROL shale stabilizer can also flocculate any dispersed clays or colloidal particles and aid their removal by solids control equipment. PERFOMATROL shale stabilizer is effective in freshwater or monovalent brines, is shear thinning, provides lubricity, has a low environmental toxicity, is highly biodegradable and is non-hazardous to rig personnel. PERFORMATROL shale stabilizer is stable to 250°F (121°C) but may achieve higher temperature stability with the use of oxygen scavengers.
Environmental Fate	
Soil/Water/Air	No data available.
Human Health Toxicity Summary[1,2]	
Chronic Repeated Dose Toxicity	No data available to indicate product or components present at greater than 0.1% are chronic health hazards.
Carcinogenicity	No data available.
Mutagenicity/ Genotoxicity	No data available.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	No data available.
Acute Toxicity	No data available.
Irritation	Non-irritating to rabbit's eye.
Sensitisation	No data available.
Health Effects Summary	No data available.
Key Study/Critical Effect for Screening Criteria	No data available.

Ecological Toxicity	
Aquatic Toxicity	The polymers are expected to be a low concern for toxicity to aquatic organisms. Due to their poor solubility and high molecular weights, they are not expected to be bioavailable.
Determination of PNEC aquatic	No PNEC values were calculated.
Current Regulatory Controls	
Australian Hazard Classification	No data available.
Australian Occupational Exposure Standards	No data available.
International Occupational Exposure Standards	No data available.
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	No data available.
PBT Assessment	
P/vP Criteria fulfilled?	No. Expected to be highly biodegradable.
B/vB criteria fulfilled?	Polymers are expected to have very high molecular weights and poor water solubility. They are not expected to be bioavailable, hence the polymers do not meet the criteria for bioaccumulation.
T criteria fulfilled?	There are no aquatic toxicity studies on this polymer. Polymers are expected to have low aquatic toxicity because of their very high molecular weights and poor water solubility. As such, the polymers do not meet the criteria for toxicity.
Overall conclusion	Not PBT
Revised	February 2020

References

1. PERFORMATROL®, Product Data Sheet, Haliburton, Dated: 8/31/2010
2. PERFORMATROL®, Safety Data Sheet, Haliburton, Revision date: 30 September 2015, Revision number: 24

Toxicity Summary - Hexadec-1-ene

Chemical and Physical Properties[1,2,3]	
CAS number	629-73-2
Molecular formula	C16H32
Molecular weight	224.42
Solubility in water	0.00144 at 25°C
Melting point	4.1
Boiling point	284.9 at 1013 hPa
Vapour pressure	0.00352 hPa at 25°C
Henrys law constant	0.541 – 16.9 atm-m^3/mole
Explosive potential	No data available
Flammability potential	No data available
Colour/Form	Hexadec-1-ene are liquids at room temperature.
Overview	Hexadec-1-ene also known as 1-hexadecene are mono-olefins. It is an alkene in the C6-C18 range. These products are produced commercially in closed systems and are used primarily as intermediates in the production of other chemicals. No non-intermediate applications have been identified. Any occupational exposures that do occur are most likely by the inhalation and dermal routes.
Environmental Fate[1]	
Soil/Water/Air	Members of this category do not contain any hydrolysable functional groups, so will not undergo hydrolysis. Category members with carbon numbers from C6 to C24 have been shown to be readily biodegradable in biodegradation screening tests. The estimated half-life of 1-hexene in air is 10.2 hours. The soil adsorption coefficients (Koc) range from 149 for C6 to 230,800 for C18, indicating increasing partitioning to soil/sediment with increasing carbon number. It is expected that C16-C18 olefins would partition primarily to soil. Volatilization from water is predicted to occur rapidly (hours to days).
Human Health Toxicity Summary[1,2,3]	
Chronic Repeated Dose Toxicity	Repeated-dose studies, using the inhalation (C6 alpha), dermal (C12-C16), or oral (C6 alpha and internal linear/branched; C8 and C14 alpha; and C16, C18 and C20-C24 internal linear/branched) routes of exposure, have shown comparable levels of low toxicity in rats. In females, alterations in body and organ weights, changes in certain clinical chemistry/hematology values, and liver effects were noted (NOELs of ≥ 100 mg/kg oral or ≥ 3.44 mg/L (1000 ppm) inhalation). In males, alterations in organ weights, changes in certain clinical chemistry/hematology values, liver effects, and male rat-specific kidney damage that is likely associated with the alpha 2- globulin protein were noted (LOELs ≥ 100 mg/kg oral only). The male rat kidney damage was seen in oral studies with C6, C8 and C14 linear alpha olefins and C6 internal branched olefins, but was not seen in studies with C16/C18 or C20 - C24 internal linear/branched olefins. The noted liver effects were seen in oral studies with C14 alpha olefins (minimal-to-mild hepatocyte cytoplasmic vacuolation with increased liver weight in males and females) and with C20-C24 internal olefins (minimal centrilobular hepatocyte hypertrophy with increased liver weight in females only). No effects were present in the study with C20-C24 internal olefins following a 4-week recovery period, indicating reversibility of the observed effects. These liver effects seen only with the larger molecules may be indirect effects of an intensified liver burden, rather than a direct toxic effect of the olefin. Based on evidence from neurotoxicity screens included in repeated dose studies with C6 and C14 alpha olefins and with C6, C16/C18 and C20-C24 internal linear/branched olefins, the category members are not neurotoxic.

Carcinogenicity	No carcinogenicity tests have been conducted on C6 – C18 alpha or internal olefins; however, there are no structural alerts indicating a potential for carcinogenicity in humans.
Mutagenicity/ Genotoxicity	Based on the weight of evidence from studies with alpha and internal olefins, category members are not genotoxic.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	Based on evidence from reproductive/developmental toxicity screens in rats with C6 and C14 alpha olefins and C6 and C18 linear/branched internal olefins, along with the findings of no biologically significant effects on male or female reproductive organs in repeated dose toxicity studies, the category members are not expected to cause reproductive or developmental toxicity.
Acute Toxicity	Olefins (alkenes) ranging in carbon number from C6 to C24, alpha (linear) and internal (linear and branched) demonstrate low acute toxicity by the oral, inhalation and dermal routes of exposure: Rat oral LD50 >5 g/kg; rat 4-hr inhalation LC50 range = 110 mg/L (32,000 ppm) to 6.4 mg/L (693 ppm) for C6 to C16; and rat/rabbit dermal LD50 > highest doses tested (1.43 - 10 g/kg).
Irritation	These materials are not eye irritants. Prolonged exposure of the skin for many hours may cause skin irritation.
Sensitisation	These materials are not skin sensitizers.
Health Effects Summary	Olefins (alkenes) ranging in carbon number from C6 to C24, alpha (linear) and internal (linear and branched) demonstrate low acute and chronic toxicity by the oral, inhalation and dermal routes of exposure.
Key Study/Critical Effect for Screening Criteria	The repeated dose toxicity in rats was considered the most sensitive endpoint with a NOEL of 100 mg/kg.
Ecological Toxicity [1,2,3]	
Aquatic Toxicity	Short term toxicity 96-hr LC50 > solubility Actual concentration negligible. Fish 96-hr LL0 = 1000 mg/L (nominal) Long term toxicity: NOEC (21 days) 19.4 µg/L (invertebrates)
Determination of PNEC aquatic	An assessment factor of 1000 is applied to the lowest NOEC of 19.4 µg/L (invertebrates). A PNECaqua of 0.0019 µg/L was derived.
Current Regulatory Controls[4]	
Australian Hazard Classification	No data available.
Australian Occupational Exposure Standards	No data available.
International Occupational Exposure Standards	No data available.
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	No data available.
PBT Assessment[1,2]	
P/vP Criteria fulfilled?	No. Readily biodegradable. The C6-C18 olefins have been shown to degrade to an extent of approximately 8 to 81% in standard 28-day biodegradation tests.
B/vB criteria fulfilled?	No. Based on calculated bioconcentration factors, hexadec-1-ene are not expected to bioaccumulate (BCF = 71).

T criteria fulfilled?	No. Chronic toxicity data >0.01 mg/L in fish, thus the substance does not meet the screening criteria for toxicity.
Overall conclusion	Not PBT
Revised	December 2021

References

1. ECHA REACH, Hexadec-1-ene, Retrieved 2021: https://echa.europa.eu/
2. OECD (2005) SIDS Initial Assessment Profile on Higher Olefins
3. NCBI, 2021. National Center for Biotechnology Information. Available at: https://pubchem.ncbi.nlm.nih.gov/. Retrieved December 2021.
4. ANZG, 2018. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia. Available at www.waterquality.gov.au/anz-guidelines.
5. NHMRC, 2018. Australian Drinking Water Guidelines 6, 2011, Version 3.5 Updated August 2018. National Water Quality Management.
6. HCIS, Hazardous Chemical Information System, Safe Work Australia, Retrieved December 2021: http://hcis.safeworkaustralia.gov.au/HazardousChemical.
7. ILO, International Labour Organisation, International Chemical Safety Cards (ICSCs), Retrieved December 2021: http://www.ilo.org/dyn/icsc/showcard.listcards3?p_lang=en.

Toxicity Summary - Lead

Chemical and Physical Properties[1,2,3,4]	
CAS number	7439-92-1
Molecular formula	Pb
Molecular weight	207.2
Solubility in water	Insoluble
Melting point	326 °C at 101.3 kPa
Boiling point	600 °C at 101.3 kPa
Vapour pressure	0
Henrys law constant	No data available
Explosive potential	No data available
Flammability potential	No data available
Colour/Form	Blueish-white metal with bright lustre, very soft, highly malleable
Overview	Lead is a naturally occurring element found in the Earth's crust at an average concentration of approximately 15 to 20 mg/kg. Lead is used principally in the production of batteries, metal alloys, X-ray shielding materials, ammunition, chemical resistant linings and pigments. It has also been used historically as an additive in petrol and also in many paints. Lead is a poor conductor of electricity and is very resistant to corrosion. Lead is rarely found in its metallic form in nature and commonly occurs as a mineral with sulphur or oxygen.
Environmental Fate[1]	
Soil/Water/Air	The atmosphere is the main environmental transport media for lead that is deposited onto surface water and soils. Upon release to the atmosphere, lead particles are dispersed and ultimately removed from the atmosphere by wet or dry deposition. Lead deposition is typically greatest closer to lead emission sources. An important factor in determining the atmospheric transport of lead is particle size distribution. Large particles settle out of the atmosphere more rapidly and are deposited relatively close to emission sources and smaller particles may be transported much farther distances. After deposition, particles may be resuspended and redeposited. The cycling of lead in aquatic environments is governed by chemical, biological, and mechanical processes. The exchange between sediment and surface water will be affected by pH, ionic strength, formation of organic complexes with Pb ions, and oxidation-reduction potential of the environment.
Human Health Toxicity Summary[4]	
Chronic Repeated Dose Toxicity	Oral: A lowest observed adverse effect level (LOAEL) of 200 ppm (corresponding to PbB levels of 40–60 mg/dL) was derived for lead acetate from a repeated dose toxicity study in Sprague Dawley (SD) rats following the guidelines set out in a US EPA chronic feeding study. Lead acetate was administered in drinking water (which was freely accessible [ad libitum]) to male rats (18 animals/dose group) at 0, 200, 500 or 1000 ppm per day for four, eight or 12 weeks. Decreased body weight and increased kidney weight as a percentage of body weight were reported at all dose ranges at four weeks of exposure. Dermal: In a report available on repeated dose toxicity during dermal exposure, rats were exposed to lead acetate, lead oleate, lead arsenate or tetraethyl lead for 24 hours. The test groups had lead compounds applied either directly to the skin or to skin that had been mechanically injured. Dermal absorption of lead was shown to occur in both test groups. However, comparatively greater absorption of lead was reported in the groups where the skin had been mechanically injured.

	Inhalation: Aerosolised lead nitrate was administered to mice (Swiss Webster) by inhalation at 2.5 mg/m³ per day for 14 or 28 days. It was determined, considering the total retention of the inhaled lead, that each mouse received a dose of 80 µg/day of lead. A statistically significant reduction in the relative size of the spleen and thymus in both test groups was reported when compared with the control group. Increased lung weight was noted in both test groups and an increase in lead concentration was reported in the liver, lung and kidney; although the 28-day group was noted to show a greater concentration than the 14-day group. There were no apparent differences in body weight and food consumption noted for either test group.
Carcinogenicity	A review conducted by the International Agency for Research on Cancer (IARC), indicated that there was sufficient evidence in experimental animals and limited evidence in humans for the carcinogenicity of inorganic lead compounds. The review resulted in the classification of inorganic lead compounds as probably carcinogenic to humans (Group 2A).
Mutagenicity/ Genotoxicity	Lead compounds are considered genotoxic to mammalian cells.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	In a reproductive and developmental toxicity screening test in SD rats, lead acetate was administered in drinking water to nine females at 0.6 % weight per volume (w/v) (equivalent to 502 mg/kg bw/day) on gestation days 5–21. A stillbirth rate of 19 % was recorded in the test group compared with a 2 % rate noted in the control group. The dams and offspring in the test group had PbB levels >200 µg/dL. In a subsequent reproductive and developmental toxicity screening test in SD rats, lead acetate was administered in drinking water to 10 females at 0.05 % w/v, eight females at 0.15 % w/v and nine females at 0.45% w/v, on gestation days 5–21. Stillbirth rates of 3(±3), 10(±6) and 28(±8) % were recorded for increasing dose groups respectively compared with a 4(±3) % rate noted in the control group. At birth, the male pups had PbB levels of 40(±1), 83(±8) and 120(±120) µg/dL for increasing dose groups respectively, while the female pups had PbB levels of 42(±7), 67(±16) and 197(±82) µg/dL. A developmental LOAEL of 0.05 % (equivalent to 42 mg/kg bw/day) was reported for this study. Recent studies have investigated the effect of lead exposure in occupational groups and in general populations living near industrial plants. Although the evidence reported is predominantly qualitative and dose-effect relationships have largely not been established, it has been suggested that moderately high PbB levels in humans could result in spontaneous abortion, pre-term delivery, alterations in sperm and decreased male fertility. Data pertaining to low level exposure to lead contributing to developmental toxicity in infants and young children were recently reviewed. Consensus exists between the reports, which suggest that PbB levels in humans >10 µg/dL can affect paediatric intellectual development. In addition, data regarding the effects on children of higher levels of lead exposure were reviewed. Although neurobehavioral deficits were reported in children with PbB levels <10 µg/dL, there is uncertainty regarding the reported effects of estimates. Even so, the US Centres for Disease Control and Prevention (CDC) has a reference level of 5 µg/dL, for which any levels above it is recommended that public health action be initiated.
Acute Toxicity	Lead oxides are generally demonstrated to be of low acute toxicity in animal tests following oral exposure. The rate oral medial lethal doses (LD50s) for lead oxides are generally reported to be > 2000 mg/kg bw for male and female rats. No clinical signs were reported. Several lead compounds, including lead oxides, were reported to exhibit low acute toxicity in animal tests. Dermal median lethal dose (LD50) values in rats are reported to be >2000 mg/kg bw. The rat median lethal concentrations (LC50s) for lead oxide (PbO) is reported to be > 5.05 mg/L for male and female rats. No abnormal signs were observed. Lead metal is expected to have lower bioavailability.
Irritation	Lead compounds are not considered to irritate the skin, eyes or cause serious eye damage.
Sensitisation	Non-sensitisers

Health Effects Summary	The critical health effects for risk characterisation include systemic long-term effects (reproductive and developmental toxicity, carcinogenicity and mutagenicity). The chemical may also cause harmful effects following repeated exposure and harmful systemic effects following a single exposure.
Key Study/Critical Effect for Screening Criteria	The lowest blood lead levels studied were ≤5 µg/dL which has been associated with serious adverse effects.
Ecological Toxicity[1,5]	
Aquatic Toxicity	Short-term toxicity data: LC50 (96 h) 40.8 µg/L (Fish) LC50 (48 h) 26 µg/L (Invertebrates) EC50 (72 h) 20.5 µg/L (algae) Long-term toxicity data: NOEC (53 days) 13.3 µg/L (Fish) NOEC (42 days) 5.9 µg/L (Invertebrates) EC10 (72 h) 6.1 µg/L (algae)
Determination of PNEC aquatic	The PNEC freshwater is 2.4 µg Pb/L.
Current Regulatory Controls[4,5,6,7,8,9]	
Australian Hazard Classification	Lead metal (CAS No. 7439-92-1 as lead, inorganic dusts & fumes (as Pb)) is listed in the Hazardous Substances Information System (HSIS), but no classification is specified. For classification purposes, the chemical is considered to be covered by the generic 'lead and lead compounds' classification as hazardous with the following risk phrases for human health in HSIS: Xn; R20/R22 (Harmful by inhalation and if swallowed) Xn; R33 (Danger of cumulative effects) Repr. Cat. 1; R61 (Reproductive toxicity—may cause harm to the unborn child) Repr. Cat. 3; R62 (Reproductive toxicity—possible risk of impaired fertility)
Australian Occupational Exposure Standards	Time weighted average (TWA): 0.15 mg/m^3 for lead compounds (as lead). Short-term exposure limits (STEL): No specific exposure standards are available
International Occupational Exposure Standards	For lead compounds in general, the following exposure limits were identified: TWA = 0.05 mg/m^3 [Bulgaria, Canada, China, Italy, Malaysia, USA] TWA = 0.10 mg/m^3 [Austria, New Zealand, Republic of South Africa, Sweden] TWA = 0.15 mg/m^3 [Argentina, Egypt, EU (Directive 98/24/EC), Malta, Singapore] TWA = 0.20 mg/m^3 [Thailand] STEL: 0.10 mg/m^3 [Austria] STEL: 0.15 mg/m^3 [Canada] STEL: 0.45 mg/m^3 [Argentina, Egypt]
Australian Food Standards	The tolerable limit for lead is 25 µg/kg bw/week.
Australian Drinking Water Guidelines	Based on health considerations, the concentration of lead in drinking water should not exceed 0.01 mg/L.
Aquatic Toxicity Guidelines	A high reliability freshwater trigger value for lead of 3.4 µg/L was calculated using the statistical distribution method at 95% protection. A marine high reliability trigger value for lead of 4.4 µg/L was calculated using the statistical distribution method with 95% protection.
PBT Assessment[1]	
P/vP Criteria fulfilled?	Not applicable (lead as a metal do not degrade and traditional persistence measures used for organic substances do not equally apply to metals).
B/vB criteria fulfilled?	Not applicable. Due to their natural occurrence, biota will naturally accumulate metals at least to some degree without deleterious effect and non-essential metals such as lead are homeostatically regulated to some extent.
T criteria fulfilled?	Yes. Lead fulfils the toxicity criteria based on the most sensitive NOEC, HC5-50 and PNEC values, which are below 10µg/L.

Overall conclusion	It is not currently possible to categorise the environmental hazards of metals and other inorganic chemicals according to standard persistence, bioaccumulation and toxicity (PBT) hazard criteria. These criteria were developed for organic chemicals and do not take into account the unique properties of inorganic substances and their behaviour in the environment.
Revised	December 2021

References

1. ECHA REACH, Lead, Retrieved 2021: https://echa.europa.eu/
2. USEPA, 2021. Regional Risk Levels. November 2021. https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables. Retrieved December 2021.
3. ATSDR, 2020. Toxicological Profile for Lead. Agency for Toxic Substances and Disease Registry. August 2020.
4. National Industrial Chemicals Notification and Assessment Scheme (NICNAS). IMAP, Human Health Tier II Assessment for Lead: Retrieved 2021: https://www.industrialchemicals.gov.au/.
5. ANZG, 2018. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia. Available at www.waterquality.gov.au/anz-guidelines.
6. Food Standards Australia New Zealand (FSANZ) 20th Australian Total Diet Survey. Retrieved 2021: https://www.foodstandards.gov.au/publications/pages/20thaustraliantotaldietsurveyjanuary2003/20thaustraliantotaldietsurveyfullreport/partb20thatds/partbmetals.aspx.
7. NHMRC, 2018. Australian Drinking Water Guidelines 6, 2011, Version 3.7 Updated January 2022. National Water Quality Management.
8. HCIS, Hazardous Chemical Information System, Safe Work Australia, Retrieved December 2021: http://hcis.safeworkaustralia.gov.au/HazardousChemical.
9. ILO, International Labour Organisation, International Chemical Safety Cards (ICSCs), Retrieved December 2021: http://www.ilo.org/dyn/icsc/showcard.listcards3?p_lang=en.

Toxicity Summary - Phosphorodithioic acid, mixed O,O-bis(isobutyl and pentyl) esters, zinc salts

Chemical and Physical Properties[1,2,3]	
CAS number	68457-79-4
Molecular formula	C16H36O4P2S4Zn
Molecular weight	548.1
Solubility in water	1.658 g/L at 22°C and pH 5
Melting point	-21°C
Boiling point	Decomposes before boiling
Vapour pressure	0.003 - 0.107 Pa at 25 - 70°C
Henrys law constant	No data available
Explosive potential	No data available
Flammability potential	No data available
Colour/Form	Viscous, amber-coloured liquid capable of producing an odour characteristic of sulphur-containing compounds
Overview	The uses and applications for this substance include: Antioxidant; lubricating oil additive for corrosion and wear resistance; accelerator for rubber. A Tier 1 Human Health Assessment for this chemical has been conducted by NICNAS which concluded that it was low concern to human health.
Environmental Fate[1]	
Soil/Water/Air	The test substance is hydrolytically stable at pH 4, 7 and 9 as defined by the OECD 111 criterion of a < 10% change in the concentration of the parent compound. The substance has a low octanol water partition coefficient. It is not readily biodegradable under test conditions. Based on the weight of evidence from read across to structurally similar ZDDP substances with BCF data in fish (from Japanese MITI data, US EPA database, CAESAR database), measured Log Kow data, and QSAR predictions, this substance is expected to have low bioaccumulation potential.
Human Health Toxicity Summary[1,2,3]	
Chronic Repeated Dose Toxicity	The oral repeat dose toxicity was evaluated with rats at doses as high as 160 mg/kg/day for up to 52 consecutive days in accordance with OECD 422. Substance-related toxicity was limited to moribundity, adverse clinical signs, and epithelial hyperplasia, hyperkeratosis, and inflammation of the stomach. The NOAEL for systemic toxicity was 160 mg/kg/day. The NOEL for portal of entry irritation and related secondary effects parental toxicity was 40 mg/kg/day.
Carcinogenicity	Not expected to be carcinogenic.
Mutagenicity/ Genotoxicity	No non-threshold mode of action is associated with this substance, in particular, the test substance has no genotoxic potential. The weight of evidence suggests that the test substance is not expected to present a significant risk for mutagenicity or carcinogenicity in humans,
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	The reproductive toxicity of this substance was evaluated with rats at doses as high as 160 mg/kg/day for up to 52 consecutive days in accordance with OECD 422. The NOAEL and NOEL for reproductive fertility and neonatal toxicity was determined to be 160 mg/kg/day.
Acute Toxicity	This substance does not show any evidence of toxicity via the oral route of exposure in animals when tested in accordance with OECD Guideline 401. The rat oral LD50 is 3,600 mg/kg in male rats. Sublethal effects of lethargy, diarrhea, piloerection, chromodacryorrhea, chromorhinorrhea and ptosis were observed. Necropsy observations included lung and gastrointestinal abnormalities, but no

	specific organ toxicity is significant; all animals showed expected bodyweight gain during the course of study. This substance does not show adverse toxicity effects via the dermal route of exposure in animals when tested in accordance with OECD Guideline 402. The rat dermal LD50 is greater than 20,000 mg/kg in rabbits. No mortality occurred. Toxic signs observed included lethargy, diarrhea, ataxia, ptosis, alopecia, emaciation, and yellow nasal discharge. No specific organ toxicity is evident.
Irritation	The substance is a skin and eye irritant.
Sensitisation	Not a skin sensitizer.
Health Effects Summary	The substance causes skin and eye irritation. Poses no unreasonable risk to human health based on Tier I assessment under the NICNAS IMAP assessment framework.
Key Study/Critical Effect for Screening Criteria	The oral repeated dose toxicity in rats was considered the most sensitive endpoint with a NOEL of 160 mg/kg bw/day.
Ecological Toxicity [1,2,3]	
Aquatic Toxicity	Short term toxicity: LC50 (4 days): 46 mg/L (fish) LL50 (4 days): 4.5 mg/L (fish) EL50 (48 h): 23 mg/L (invertebrates) EL50 (72 h): 21 mg/L (algae) Long term toxicity: NOEC (21 days): 0.4 mg/L (invertebrates)
Determination of PNEC aquatic	Data from short-term tests with three trophic levels and one long-term test on invertebrates are available. An assessment factor of 100 is applied to the lowest NOEC of 0.4 mg/L (invertebrates). A PNECaqua of 0.004 mg/L was derived.
Current Regulatory Controls[4,5,6]	
Australian Hazard Classification	No data available.
Australian Occupational Exposure Standards	No data available.
International Occupational Exposure Standards	No data available.
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	No data available.
PBT Assessment[1]	
P/vP Criteria fulfilled?	Yes. Not readily biodegradable.
B/vB criteria fulfilled?	No. Based on the measured log Kow value of less than 3, this substance is not bioaccumulative.
T criteria fulfilled?	Not applicable. Chronic toxicity data >1 mg/L in invertebrates, thus sodium hydroxide does not meet the screening criteria for toxicity.
Overall conclusion	Not PBT
Revised	December 2021

References

1. ECHA REACH, Phosphorodithioic acid, mixed O,O-bis(iso-Bu and pentyl) esters, zinc salts, Retrieved 2021: https://echa.europa.eu/
2. National Industrial Chemicals Notification and Assessment Scheme (NICNAS). IMAP, Human Health Tier 1 Assessment. Retrieved 2021: https://www.industrialchemicals.gov.au/.
3. NCBI, 2021. National Center for Biotechnology Information. Available at: https://pubchem.ncbi.nlm.nih.gov/. Retrieved December 2021
4. HCIS, Hazardous Chemical Information System, Safe Work Australia, Retrieved December 2021: http://hcis.safeworkaustralia.gov.au/HazardousChemical.
5. ILO, International Labour Organisation, International Chemical Safety Cards (ICSCs), Retrieved December 2021: http://www.ilo.org/dyn/icsc/showcard.listcards3?p_lang=en.
6. NHMRC, 2018. Australian Drinking Water Guidelines 6, 2011, Version 3.5 Updated August 2018. National Water Quality Management.

Toxicity Summary - Sulphur dioxide

Chemical and Physical Properties[1,2,3]	
CAS number	7446-09-5
Molecular formula	SO_2
Molecular weight	64.064
Solubility in water	114 g/L at 20 °C
Melting point	-75.5 - -74.5 °C
Boiling point	-10.05 - -10 °C at 101.3 - 101.325 kPa
Vapour pressure	327.1 kPa at 20 °C
Henrys law constant	No data available
Explosive potential	No data available
Flammability potential	No data available
Colour/Form	Colourless gas with a characteristic, irritating, pungent odour
Overview	Sulphur dioxide is a colourless gas with a pungent odour. It is a liquid when under pressure. Sulphur dioxide dissolves in water very easily. It cannot catch fire. Sulphur dioxide in the air results primarily from activities associated with the burning of fossil fuels (coal, oil) such as at power plants or from copper smelting. In nature, sulphur dioxide can be released to the air, for example, from volcanic eruptions.
Environmental Fate[1,3]	
Soil/Water/Air	Once released into the environment, sulphur dioxide moves to the air. In the air, sulphur dioxide can be converted to sulfuric acid, sulphur trioxide, and sulphates. Sulphur dioxide dissolves in water. Once dissolved in water, sulphur dioxide can form sulphurous acid. Soil can absorb sulphur dioxide, with uptake being dependent on the pH and moisture content of the soil.
Human Health Toxicity Summary [1,2,3,4]	
Chronic Repeated Dose Toxicity	Based on the available data, repeated inhalation exposure to sulphur dioxide is associated with local effects. The airway response to the chemical indicates a defence mechanism to local irritation, such as mild to moderate pathological changes in tracheal and lung tissues, that may lead to persistent defects with prolonged exposure. In a non-guideline study, three groups of male Sprague-Dawley (SD) rats (70/group) were treated with 0, 10, or 30 ppm (0, 28.2, or 84.6 mg/m^3) sulphur dioxide for 21 weeks (six hours/day, five days/week) by whole body exposure. Mild to moderate pathological changes in tracheal and lung tissues were detected at the 10 and 30 ppm groups, with no significant recovery detected in the respiratory tract during the four-week post-exposure period. In another non-guideline study, male SD rats were exposed to 1 ppm (2.8 mg/m^3) sulphur dioxide for either four or eight months (five hours/day, five days/week) by whole body exposure. Temporary bronchiolar epithelial hyperplasia was observed at four months only. Respiratory function was impaired at four months (not examined at eight months). No other details of the study were provided. No adverse systemic effects were reported in multiple non-guideline chronic or subchronic studies in dogs, rats, guinea pigs and cynomolgous monkeys treated daily for various durations and a range of concentrations of the chemical.
Carcinogenicity	Based on the available data, the chemical is not considered to be carcinogenic. In a non-guideline study, male SD rats were exposed to 10 or 30 ppm (28.2 or 84.6 mg/m^3) sulphur dioxide for 21 weeks (six hours/day, five days/week) and followed for up to two years. The rats exposed to the chemical had normal survival and showed increases in tumour occurrence over their lifetimes. Lack of carcinogenic potential was supported by another nonguideline study, where no increases in lung tumours were seen in rats (sex and strain not specified) exposed chronically to 10

	ppm sulphur dioxide for 534 days (five hours/day, five days/week) and observed for further 260 days. In a non-guideline study, male and female mice (strain not specified) treated with daily short-term exposures (five minutes/day, five days/week) to a high concentration of 500 ppm (1410 mg/m^3) sulphur dioxide over their lifetime (300 days or more) had increased incidence and larger primary lung tumours at an earlier age when compared to untreated controls.
Mutagenicity/ Genotoxicity	Based on the available data, the chemical is potentially mutagenic.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	Based on the available data, the chemical is not considered to be a reproductive toxicant. Some evidence exists for the chemical to potentially cause developmental toxicity.
Acute Toxicity	In a non-guideline study, male CD-1 rats (8/dose) were exposed to sulphur dioxide gas concentrations of 224, 593, 965, 1168, or 1319 ppm (632, 1670, 2720, 3295, or 3720 mg/m^3) for four hours and observed for 14 days following exposure. The median lethal concentration (LC50) was between 965–1168 ppm/4 hours. No deaths occurred at the 593 ppm concentration, while the 1319 ppm concentration was lethal to 100% of rats. Clinical signs included respiratory difficulties followed by exhaustion and death. In another non-guideline study, male Syrian hamsters were exposed to sulphur dioxide gas at concentrations of 40, 200, or 400 ppm (113, 564, or 1130 mg/m^3) for 4–6 hours. All hamsters died due to development of respiratory distress following exposure to 400 ppm of the chemical. No deaths occurred at 40 and 200 ppm. Ciliary loss in the trachea was observed at 40 and 200 ppm. The calculated LC50 values of sulphur dioxide for male Swiss mice were 9,600 ppm (27,080 mg/m^3)/ 5 min, 4,800 ppm (13,540 mg/m^3)/ 10-min, 3,800 ppm (10,720 mg/m^3)/ 15-min, and 3,400 ppm (9,590 mg/m^3)/ 30-min. Clinical signs and cause of deaths were not reported.
Irritation	Sulphurous acid, which is formed when sulphur dioxide comes in contact with moist surfaces, is the primary cause of irritation and corrosivity of the chemical
Sensitisation	Available data suggest potential respiratory sensitisation potential for the chemical. In a non-guideline study, male Dunkin-Hartley or female Dunkin-Hartley Pirbright-White guinea pigs were exposed to 0.1–16 ppm (0.28–45.1 mg/m^3) sulphur dioxide for five to eight hours a day for five consecutive days, and additionally exposed to ovalbumin aerosol on days 3, 4 and 5 for 45 minutes/day, followed by provocation on day 13 by 1 % ovalbumin aerosol. Exposure to the chemical at the low concentration of 0.1 ppm significantly enhanced the development of ovalbumin-induced asthmatic reactions (increases in airway resistance and infiltration of inflammatory cells and epithelial damage in bronchial and lung tissue) in guinea pigs. Exposure to sulphur dioxide alone had no effect. In another non-guideline study, male Hartley guinea pigs (12/group) were exposed to sulphur dioxide. The initial phase consisted of intraperitoneal (i.p.) injection of 10 mg Candida albicans in physiological saline vehicle. Two weeks later, the guinea pigs were exposed to 5 ppm of the chemical 30 times (four hours/day, five days/week). Two weeks after exposure to the chemical, the animals were exposed to C. albicans for 30 minutes. Exposure of guinea pigs to the chemical increased sensitivity to C. albicans and resulted in significantly increased numbers of animals with prolonged expiration and/or inspiration and in a decrease of respiratory rate and even mortality in 25% of sulphur dioxide exposed animals.
Health Effects Summary	The critical health effects for risk characterisation include local effects (corrosive effects on the eyes, skin and respiratory tract).
Key Study/Critical Effect for Screening Criteria	An minimal risk level (MRL) of 0.01 ppm has been derived for acute-duration exposure (14 days or less) to sulphur dioxide. This MRL is derived from the study by Sheppard et al. (1981) in which exercising mild asthmatics were exposed to ≥0.1 ppm sulphur dioxide for 10 minutes. The two most sensitive subjects developed slight bronchoconstriction after inhaling 0.1 ppm sulphur dioxide (ATSDR).
Ecological Toxicity [1,2,3]	
Aquatic Toxicity	Sulphur dioxide, however, is a gaseous substance and does not remain present in the aquatic environment under this form: Sulphur dioxide will react with water (or water vapour) to form sulphurous acid. Consequently, an E(L)C50, EC10 or NOEC

	expressed as mg SO2/L cannot be determined (i.e., no acute or chronic reference values can be generated). Secondly, as SO2 is not present in the aquatic compartment for a relevant time period, this substance will not cross biological membranes, or will not interact with it in another way.
Determination of PNEC aquatic	Not determined
Current Regulatory Controls[1,5]	
Australian Hazard Classification	The chemical is classified as hazardous, with the following risk phrases for human health in the Hazardous Substances Information System (HSIS) (Safe Work Australia): Acute toxicity – category 3 Skin corrosion – category 1B Gases under pressure
Australian Occupational Exposure Standards	The following exposure standards are identified (Galleria Chemica): Time-weighted average (TWA) of 5.2 mg/m^3 (2 ppm) Short-term exposure limits (STEL) 13 mg/m^3 (5ppm)
International Occupational Exposure Standards	The following exposure standards are identified (Galleria Chemica): An exposure limit (occupational exposure limit (OEL) or TWA) of 1 – 5.3 mg/m^3 and STEL of 5-13 mg/m^3 in most countries. The STEL established by American Conference of Governmental Industrial Hygienists (ACGIH) is 0.25 ppm (0.7 mg/m^3). The chemical is included in US NIOSH Substances Immediately Dangerous to Life or Health (IDLH) List at a level of 100 ppm (282 mg/m^3). US Department of Energy (DOE) has Temporary Emergency Exposure Limits (TEELs) for Protective Action Criteria (PAC): PAC-1 at 0.2, PAC-2 at 0.75 and PAC-3 at 30 ppm (84.6 mg/m^3).
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	No data available.
PBT Assessment	
P/vP Criteria fulfilled?	Not applicable (inorganic substance, ionic species ubiquitous in environment)
B/vB criteria fulfilled?	Not applicable. Bioaccumulation is not applicable to this inorganic substance.
T criteria fulfilled?	Not applicable.
Overall conclusion	It is not currently possible to categorise the environmental hazards of inorganic chemicals according to standard persistence, bioaccumulation and toxicity (PBT) hazard criteria. These criteria were developed for organic chemicals and do not take into account the unique properties of inorganic substances and their behaviour in the environment.
Revised	December 2021

References

1. ECHA REACH, Sulfur dioxide, Retrieved 2021: https://echa.europa.eu/
2. National Industrial Chemicals Notification and Assessment Scheme (NICNAS). IMAP, Sulfur dioxide: Human health tier II assessment: Retrieved 2021: https://www.industrialchemicals.gov.au/.
3. ATSDR, 1998. Toxicological Profile for Sulfur Dioxide. Agency for Toxic Substances and Disease Registry. December 1998.
4. Sheppard D, Saisho A, Nadel JA, et al. 198 1. Exercise increases sulfur dioxide-induced bronchoconstriction in asthmatic subjects. Am Rev Respir Dis 123:486-491.
5. HCIS, Hazardous Chemical Information System, Safe Work Australia, Retrieved December 2021: http://hcis.safeworkaustralia.gov.au/HazardousChemical.

Toxicity Summary - 1,3,5-Triazine-1,3,5(2H,4H,6H)-triethanol

Chemical and Physical Properties[1,2,3]	
CAS number	4719-04-4
Molecular formula	C9H21N3O3
Molecular weight	219.28
Solubility in water	Miscible at 20°C and at pH 5, 7, and 9
Melting point	-79 °C
Boiling point	110.1°C at 101.325 kPa
Vapour pressure	0 Pa at 25 °C
Henrys law constant	0 Pa m^3/mol at 25 °C
Explosive potential	Non-explosive
Flammability potential	Not classified
Colour/Form	Viscous yellow liquid
Overview	The substance in is generally used as a biocide to control bacterial growth.
Environmental Fate[1]	
Soil/Water/Air	After evaporation or exposure to the air, the substance will be rapidly degraded by photochemical processes. Based upon a calculated log Koc adsorption to soil phase is not expected. From the water surface the substance will not evaporate into the atmosphere. The substance will preferentially distribute into the compartment water.
Human Health Toxicity Summary [1,2,3]	
Chronic Repeated Dose Toxicity	In a subchronic oral toxicity study in Wistar rats with administration of the test substance in drinking water for 3 months, the NOAEL was determined to be 64 mg/kg/day based on reduced water consumption at this dose level but without any corroborating changes in-life or pathologically (BASF SE, 2002). In a repeated dose oral toxicity 90-day study conducted according to the OECD TG 442, the chemical was administered to Wistar CrlGlxBrlHan rats (10/sex/dose) at dietary concentrations of 200 ppm (14 mg/kg bw/day in males; 21 mg/kg bw/day in females), 1000 ppm (64 mg/kg bw/day in males; 91 mg/kg bw/day in females), and 5000 ppm (285 mg/kg bw/day in males; 339 mg/kg bw/day in females). The animals were observed for signs of toxicity or mortality up to twice a day for 3 months. At the end of the study, neither mortality nor clinical symptoms of toxicity were observed, and the appearance and behaviour of the animals showed no treatment related changes. Repeat dose exposure to the chemical via dermal route is not considered to be hazardous. In a subchronic dermal toxicity 90-day study, male and female Charles River rats (10 animals per sex per dose) were treated with the chemical under semi-occlusive conditions for 6 hours/day, 5 days/week for 90 days. Doses were 0, 5, 50 or 250 mg/kg bw/day. The application site was not washed between doses. No mortality occurred during the test. There were no treatment related clinical signs. Yellow staining at the site of application in the 50 and 250 mg/kg bw/day groups was seen. In a repeated dose inhalation toxicity study (OECD Guideline 412) Wistar rats (10 animals per sex per dose) were exposed (nose only) to the aerosol chemical at 3, 10, 30 and 100 mg/m^3. The highest concentration was decreased to 50 mg/m^3 after the first exposure day for females and the second exposure day for males due to clinical signs indicative of a severe irritant response. The animals were exposed for 6 hrs/day for 5 consecutive days per week for 4 weeks. The target concentrations were maintained throughout the exposure period. Severe clinical signs of toxicity (gasping, intermittent respiration, respiration sound, red encrusted nose, hypothermia, poor general state and yellow discoloured fur), significantly reduced body weight change in males and premature death of 5 of the 10 males were observed in the highest dose group (initially 100 mg/m^3, then lowered to 50 mg/m^3). In the 30 mg/m^3 and 10 mg/m^3 groups, intermittent respiration, rales, red

	encrusted nose, squamous metaplasia occurred in all treated groups. The presence of erosion/ulceration of the larynx, squamous metaplasia of the nasal cavity, squamous metaplasia of the carina epithelium, necrosis of the u-shaped cartilage of the larynx, epithelial hyperplasia of the larynx and degeneration of the bronchial epithelium for both sexes were noted. In the lowest dose group (3 mg/m^3): multifocal squamous metaplasia of the larynx in all animals; necrosis of the u-shaped cartilage of the larynx in 1/10 males; degeneration of the bronchial epithelium in 3/10 males and 7/10 females and squamous metaplasia of the carina epithelium in 4/10 males and 3/10 females were noted). In conclusion, exposure of male and female Wistar rats to the aerosol of the chemical caused concentration-related local irritation of the respiratory tract. Systemic toxicity was not observed in clinical chemistry, haematology or in histological examinations up to 30 mg/m^3. The reduced body weight gain and premature death were considered to be associated with the severe local irritation. Based on histopathology findings in larynx, trachea and lung, a no observed adverse effect concentration (NOAEC) could not be established for the local irritation effect under the current study conditions. For systemic effects the NOAEC is 30 mg/m^3.
Carcinogenicity	Carcinogenicity studies for the chemical are not available. In a poorly documented dermal study with only limited number of animals (NMRI mice), limited scope of parameters examined and with short study duration, the chemical did not result in any carcinogenic effects. Many methodological details of the study are lacking. The test substance was applied to a shaved area of the upper part of the back. Applications, 0.15%, 1.5 % and 15% of the chemical (purity not specified) were made three times a week, over 31 consecutive weeks. All mice survived to the end of the study. Slight dysplasia was reported in two high-dose animals. Hyperplasia occurred in one mid-dose and seven high-dose mice. Three of the high-dose animals had degenerative changes (amyloid deposition) in the kidney, but not the spleen or liver. The test substance did not induce papillomas. No information is provided on clinical observations in the treated animals.
Mutagenicity/ Genotoxicity	Genotoxicity potential of the chemical was tested in several in vitro and in vivo genotoxicity tests. Based on the weight of evidence from the available data, the chemical is not considered to be genotoxic.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	Studies for reproductive toxicity are not available. In a prenatal developmental toxicity study in rats, artificially inseminated female Sprague-Dawley rats (24/group) were administered the aqueous chemical (78.5% 1,3,5-tris(2-hydroxyethyl)hexahydro-1,3,5-triazine) by gavage at doses of 0, 250, 500, and 750 mg/kg/day in deionised water on gestation days 6 through 15. All animals survived the duration of the study. High dose females exhibited post-dosing salivation. Rales, laboured breathing, wheezing, and tachypnea were observed occasionally in the mid and high dose groups toward the end of the dosing period. No other clinical signs were reported. Maternal body weight gain and food consumption were significantly lower in the high dose females during the dosing period than the controls. Stomach lesions characterised by ulceration and/or scarring of the mucosa were observed in 14 of 20 high dose females. No gross abnormalities were reported in the other dosage groups. No differences were seen between the control and treated dams with respect to pregnancy rates, number of corpora lutea, implantation sites, number of live foetuses, or early and late resorptions. There were no abortions and no premature deliveries. At these doses, developmental toxicity as measured by foetal pup weight, external, or visceral, abnormalities was not seen. There were increased incidences of vestigial 14th ribs and retarded ossification of the vertebral thoracic centra which appeared to be dose-related. The effects were not statistically significant, and the incidence of these abnormalities is highly variable in rats, they are not considered treatment related. The maternal no observed adverse effect level (NOAEL) is 500 mg/kg bw/day, based on decreased body weight gain, ulcerations and/or scarring of the stomach mucosa at the higher dose. The NOAEL for developmental toxicity is 750 mg/kg bw/day.
Acute Toxicity	In the only available oral acute toxicity study (OECD Guideline 401) groups of 10 fasted Wistar rats (5 per sex) were given a single oral dose of the test substance at dose levels of 500, 1000 or 2000 mg/kg bw. Four males and all females in the 2000 mg/kg bw dose group and two males and four females in the 1000 mg/kg bw

	dose group died within two days after administration. Necroscopy findings of the animals that died included agonal congestion, erythema, erosion in the glandular stomach and discolouration of the mucosa of the forestomach and the glandular stomach. Observed sub-lethal effects included general depressed activity, staggering, paresis and diarrhoea. The median lethal dose (LD50) was calculated as 763 mg/kg bw in rats. The chemical has low acute toxicity based on results from an animal test following dermal exposure. The LD50 in rats in this study was >4000 mg/kg bw. The chemical has high acute toxicity following inhalation exposure based on results from animal tests. The median lethal concentration (LC50) in rats is 0.371 mg/L.
Irritation	The chemical did not cause irritation to the skin in rabbits exposed dermally to 0.5 mL of the unchanged substance for four hours via a test patch moistened with the substance. Slight irritation was observed in rabbits administered 0.1 mL of the chemical in the conjunctival sac of the right eye but was reversible within 8 days. No eye lesions remained in any of the test animals at the end of the three-week observation period
Sensitisation	The substance was considered to be a skin sensitiser in studies with guinea pigs. Case studies on humans have indicated that the chemical is a skin sensitising agent.
Health Effects Summary	The critical health effects for risk characterisation include acute toxicity effects from oral and inhalation exposure and skin sensitisation.
Key Study/Critical Effect for Screening Criteria	The subchronic oral repeated dose toxicity in rats was considered the most sensitive endpoint with a NOAEL of 64 mg/kg bw/day.
Ecological Toxicity[1]	
Aquatic Toxicity	Fish: LC50 (4 days) 16.07 - 240.04 mg/L LC100 (4 days) 58.9 mg/L Invertebrates: EC50 (48 h) 11.9 mg/L LC50 (48 h) 60.67 mg/L EC100 (48 h) 17.5 mg/L Algae: EC50 for freshwater algae: 6.6 mg/L EC50 for marine water algae: 21 mg/L EC10 or NOEC for freshwater algae: 3.4 mg/L EC10 or NOEC for marine water algae: 10 mg/L
Determination of PNEC aquatic	Data from short-term tests with three trophic levels are available. An assessment factor of 1000 is applied to the lowest EC50 of 6.6 mg/L (algae). A PNECaqua of 7 µg/L was derived.
Current Regulatory Controls[2,4,5,6]	
Australian Hazard Classification	The chemical is classified as hazardous, with the following risk phrases for human health in the Hazardous Substances Information System (HCIS): Skin sensitisation – category 1 Specific target organ toxicity (repeated exposure) – category 1 Acute toxicity (inhalation) - category 3 Acute toxicity (ingestion) - category 4
Australian Occupational Exposure Standards	No data available.
International Occupational Exposure Standards	The following exposure standards are identified (Galleria Chemica). US DOE Temporary Emergency Exposure Limits (TEELs) TEEL 1: 2.3 mg/m^3; TEEL 2: 25 mg/m^3 and TEEL 3: 150 mg/m^3.

Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	No data available.
PBT Assessment[1]	
P/vP Criteria fulfilled?	No. Expected to be readily biodegradable.
B/vB criteria fulfilled?	No. Based on Log Kow = -2.3 - -1.3 at 24 °C and pH 5 – 9 (Log Kow < 4.2)
T criteria fulfilled?	No. Acute toxicity data >1 mg/L in fish, invertebrates and algae, thus the substance does not meet the screening criteria for toxicity.
Overall conclusion	Not PBT
Revised	December 2021

References

1. ECHA REACH, 2,2',2''-(hexahydro-1,3,5-triazine-1,3,5-triyl)triethanol, Retrieved 2021: https://echa.europa.eu/
2. National Industrial Chemicals Notification and Assessment Scheme (NICNAS). IMAP, 1,3,5-Triazine-1,3,5(2H,4H,6H)-triethanol: Human health tier II assessment: Retrieved 2021: https://www.industrialchemicals.gov.au/.
3. NCBI, 2021. National Center for Biotechnology Information. Available at: https://pubchem.ncbi.nlm.nih.gov/. Retrieved December 2021
4. HCIS, Hazardous Chemical Information System, Safe Work Australia, Retrieved December 2021: http://hcis.safeworkaustralia.gov.au/HazardousChemical.
5. ILO, International Labour Organisation, International Chemical Safety Cards (ICSCs), Retrieved December 2021: http://www.ilo.org/dyn/icsc/showcard.listcards3?p_lang=en.
6. NHMRC, 2018. Australian Drinking Water Guidelines 6, 2011, Version 3.5 Updated August 2018. National Water Quality Management.

Toxicity Summary - Zinc

Chemical and Physical Properties[1,2,3,4]	
CAS number	7440-66-6
Molecular formula	Zn
Molecular weight	65.38
Solubility in water	Insoluble
Melting point	409°C
Boiling point	No data
Vapour pressure	1 at 487°C
Henrys law constant	Not applicable
Explosive potential	No data
Flammability potential	Not flammable
Colour/Form	Bluish-white, shiny metal
Overview	Zinc is a naturally occurring element found in the earth's surface rocks. Because of its reactivity, zinc metal is not found as the free element in nature. Powdered zinc is explosive and may burst into flames if stored in damp places. Zinc is found in the air, soil, and water and is present in all foods. Metallic zinc is used in industry to coat steel and iron as well as other metals to prevent rust and corrosion. Metallic zinc is also mixed with other metals to form alloys such as brass and bronze. Metallic zinc is also used to make dry cell batteries. A Tier 1 Human Health Assessment for this chemical has been conducted by NICNAS which concluded that it was low concern to human health.
Environmental Fate[3]	
Soil/Water/Air	Zinc partitions to the air, water, and soil. Zinc occurs in the environment mainly in the +2 oxidation state (ATSDR, 2005). Adsorption is the dominant fate of zinc, resulting in enrichment of zinc in suspended and bed sediments. Zinc can occur in both suspended and dissolved forms in surface water. In the aquatic environment, zinc partitions to sediments or suspended solids in surface waters through sorption onto hydrous iron and manganese oxides, clay minerals, and organic material. The transport of zinc in the aquatic environment is controlled by anion species. In natural waters, complexing agents, such as humic acid, can bind zinc. The stability of zinc complexes depends on the pH of the water and the nature of the complex. Zinc sorbs strongly onto soil particulates. The mobility of zinc in soil depends on the solubility of the speciated forms of the element and on soil properties such as cation exchange capacity, pH, redox potential, and chemical species present in soil.
Human Health Toxicity Summary [1,2,3]	
Chronic Repeated Dose Toxicity	Following longer-term exposure to lower doses (~0.5–2 mg zinc/kg/day) of zinc compounds, the observed symptoms generally result from a decreased absorption of copper from the diet, leading to early symptoms of copper deficiency. The most noticeable manifestation of the decreased copper levels is anaemia, manifesting as decreased erythrocyte number or decreased hematocrit. High-dose zinc administration has also resulted in reductions in leukocyte number and function. Some studies have also found decreases in high-density lipoprotein (HDL) levels in humans exposed to increased levels of zinc; however, not all studies have confirmed this observation. Long-term consumption of excess zinc may also result in decreased iron stores, although the mechanism behind this effect is not presently clear.
Carcinogenicity	Available studies of zinc-induced carcinogenic effects in humans and animals following both oral or inhalation exposure have not adequately demonstrated an increase in cancer incidence following long term exposure to zinc compounds.

Mutagenicity/ Genotoxicity	Genotoxicity studies conducted in a variety of test systems have failed to provide evidence for mutagenicity of zinc. However, there are indications of weak clastogenic effects following zinc exposure.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	Available studies have not presented evidence of reproductive or developmental effects in humans or animals following inhalation of zinc compounds. Effects on reproductive or developmental end points have been noted in oral-exposure animal studies, but generally only at very high doses (>200 mg/kg/day).
Acute Toxicity	The effects of inhalation exposure to zinc and zinc compounds vary somewhat with the chemical form of the zinc compound, but the majority of the effects seen will occur within the respiratory tract. Following inhalation of zinc oxide, and to a lesser extent zinc metal and many other zinc compounds, the most commonly reported effect is the development of “metal fume fever” which is characterized by chest pain, cough, dyspnoea, reduced lung volumes, nausea, chills, malaise, and leucocytosis. Symptoms generally appear a few hours after exposure and are reversible 1–4 days following cessation of exposure.
Irritation	Not irritating.
Sensitisation	Not sensitising.
Health Effects Summary	Poses no unreasonable risk to human health based on Tier I assessment under the NICNAS IMAP assessment framework.
Key Study/Critical Effect for Screening Criteria	The chronic reference dose (RfD) was based on the average LOAEL of 0.91 mg/kg/day for blood effects observed in four principal studies on male and female adults.
Ecological Toxicity[1,5]	
Aquatic Toxicity	Fish: 24 µg/L (Oncorhynchus tshawytscha; from LC50) to 1316 µg/L (Ptylocheilus oregonensis; from LC50). Amphibians: Ambystoma opacum, 180 µg/L (from LOEC). Crustaceans: 5.5 µg/L (C. dubia; from LC50) to 25.3 µg/L (C. dubia). Molluscs: 54 µg/L (Dreissena polymorpha) to 11,200 µg/L (Velesunio ambigua), a NOEC of 487 µg/L was measured for Physa gyrina. Annelid: one species, Limnodrilus hoffmeisteri, 560 µg/L (from LC50).
Determination of PNEC aquatic	The PNECaquatic (freshwater) is determined to be 20.6 µg/L.
Current Regulatory Controls[5,6,7,8]	
Australian Hazard Classification	H260 (In contact with water releases flammable gases which may ignite spontaneously) H250 (Catches fire spontaneously if exposed to air) H410 (Very toxic to aquatic life with long-lasting effects)
Australian Occupational Exposure Standards	No data available.
International Occupational Exposure Standards	An exposure limit for zinc and its inorganic compounds (inhalable fraction) (TWA) of 2 mg/m^3 and (respirable fraction) (TWA) of 0.1 mg/m^3 in Germany.
Australian Food Standards	Tolerable limit = 45 mg/person/day
Australian Drinking Water Guidelines	Based on aesthetic considerations (taste), the concentration of zinc in drinking water should be less than 3 mg/L. No health-based guideline value is proposed for zinc.
Aquatic Toxicity Guidelines	A freshwater and marine high reliability trigger value of 8 µg/L was calculated for zinc.
PBT Assessment	
P/vP Criteria fulfilled?	Not applicable (zinc is an essential element and is ubiquitous in environment).

B/vB criteria fulfilled?	No. As an essential element, zinc is commonly regulated by the organism and do not bioaccumulate or biomagnify.
T criteria fulfilled?	Not applicable. Zinc is an essential nutrient for all living organisms.
Overall conclusion	It is not currently possible to categorise the environmental hazards of metals and other inorganic chemicals according to standard persistence, bioaccumulation and toxicity (PBT) hazard criteria. These criteria were developed for organic chemicals and do not take into account the unique properties of inorganic substances and their behaviour in the environment.
Revised	December 2021

References

1. ECHA REACH, Zinc, Retrieved 2021: https://echa.europa.eu/
2. USEPA, 2021. Regional Risk Levels. November 2021. https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables. Retrieved December 2021.
3. ATSDR, 2005. Toxicological Profile for Zinc. Agency for Toxic Substances and Disease Registry. August 2005.
4. National Industrial Chemicals Notification and Assessment Scheme (NICNAS). IMAP, Human Health Tier 1 Assessment. Retrieved 2019: https://www.industrialchemicals.gov.au/.
5. ANZG, 2018. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia. Available at www.waterquality.gov.au/anz-guidelines.
6. NHMRC, 2018. Australian Drinking Water Guidelines 6, 2011, Version 3.5 Updated August 2018. National Water Quality Management.
7. HCIS, Hazardous Chemical Information System, Safe Work Australia, Retrieved December 2021: http://hcis.safeworkaustralia.gov.au/HazardousChemical.
8. ILO, International Labour Organisation, International Chemical Safety Cards (ICSCs), Retrieved December 2021: http://www.ilo.org/dyn/icsc/showcard.listcards3?p_lang=en.
9. Food Standards Australia New Zealand (FSANZ) 19th ATDS Supplementary Information – Part 1. Retrieved 2021: https://www.foodstandards.gov.au/publications/documents/tables%201-8.pdf.

Toxicity Summary - Distillates (Fischer-Tropsch), C8-26-branched and linear

Chemical and Physical Properties[1,2]	
CAS number	848301-67-7
Molecular formula	Unknown or variable composition, complex reaction products or biological materials (UVCB)
Molecular weight	UVCB
Solubility in water	1 mg/L at 20°C and pH 5.1 - 5.3
Melting point	-20°C
Boiling point	218 - 357 °C at 101.1 kPa
Vapour pressure	0.54 Pa at 25°C
Henrys law constant	No data available
Explosive potential	No data available
Flammability potential	No data available
Colour/Form	Colourless, liquid, mild-paraffinic odour
Overview	Gas-to-liquid (GTL) products are synthetic hydrocarbons produced from natural gas using a Fischer–Tropsch process. This process yields a synthetic crude oil that consists of saturated hydrocarbons, primarily linear alkanes, with increasing amounts of branched (methyl-groups) alkanes as the chains get longer. In addition, small amounts of cycloalkanes (branched cyclopentanes and cyclohexanes) may be formed as the polymerisation reaction prolongs. This synthetic crude can subsequently be refined to a range of products very similar to petroleum refining. However, in contrast to their petroleum-derived analogues, GTL products are essentially free of unsaturated or aromatic constituents and also no sulphur-, oxygen-, or nitrogen-containing constituents are present.
Environmental Fate[1]	
Soil/Water/Air	The substance is expected to be readily biodegradable. It has a Log Koc of > 5.63 and is expected to be immobile in soils. If released into water, the substance is expected to adsorb to suspended solids and sediment based upon the Log Koc.
Human Health Toxicity Summary [1,2]	
Chronic Repeated Dose Toxicity	NOAEL (rat, oral): 200 mg/kg bw/day
Carcinogenicity	No data available.
Mutagenicity/ Genotoxicity	The substance was found to be non-mutagenic.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	No data available.
Acute Toxicity	The acute oral median lethal dose (LD50) of the test material in the female Sprague-Dawley CD strain rat was estimated to be greater than 5000 mg/kg bodyweight.
Irritation	Not irritating based on read across data.
Sensitisation	Not sensitising based on read across data.
Health Effects Summary	The critical health effect for risk characterisation is chronic repeated dose toxicity from oral exposure.
Key Study/Critical Effect for Screening Criteria	The repeated dose toxicity in rats via oral exposure was considered the most sensitive endpoint with a NOAEL of 200 mg/kg bw/day.

Ecological Toxicity [1,8]	
Aquatic Toxicity	Short-term toxicity: NOEC (48 h): 1000 mg/L (fish) LC50 (7 day): >100000 mg/L (fish) EL50 (72 h): >1000 mg/L (invertebrates) EL50 (48 h): 1000 mg/L (crustaceans) EL50 (72 h): 1000 mg/L (algae) Long-term toxicity: NOEL (33 day): >100 mg/L (fish) NOEL (21 day): <100 mg/L (invertebrates)
Determination of PNEC aquatic	Based on the lowest chronic endpoint for aquatic toxicity (100 mg/L), an assessment factor of 100 has been applied, resulting in a PNECaquatic of 1 mg/L.
Current Regulatory Controls[2,3,4,5,6]	
Australian Hazard Classification	No data available.
Australian Occupational Exposure Standards	No data available.
International Occupational Exposure Standards	No data available.
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	Oils and greases (including petrochemicals) for freshwater production: <300[3] µg/L (ANZECC, 2000)
PBT Assessment[1]	
P/vP Criteria fulfilled?	No. Readily biodegradable.
B/vB criteria fulfilled?	No. Based on log BCF of 3.17 or BCF of 1479.
T criteria fulfilled?	No. Acute toxicity data >1 mg/L in fish and invertebrates, thus the substance does not meet the screening criteria for toxicity.
Overall conclusion	Not PBT
Revised	February 2022

References

1. ECHA REACH, Distillates (Fischer-Tropsch), C8-26-branched and linear, Retrieved 2021: https://echa.europa.eu/
2. Peter J. Boogaard, Juan-Carlos Carrillo, Linda G. Roberts & Graham F. Whale (2017) Toxicological and ecotoxicological properties of gas-to-liquid (GTL) products. 1. Mammalian toxicology, Critical Reviews in Toxicology, 47:2, 121-144, DOI: 10.1080/10408444.2016.1214676.
3. ANZECC (2000) Australian and New Zealand Guidelines for Fresh and Marine Water Quality for protection for aquatic ecosystems.
4. Food Standards Australia New Zealand (FSANZ) 20th Australian Total Diet Survey. Retrieved 2021: https://www.foodstandards.gov.au/publications/pages/20thaustraliantotaldietsurveyjanuary2003/20thaustraliantotaldietsurveyfullreport/partb20thatds/partbmetals.aspx.
5. NHMRC, 2018. Australian Drinking Water Guidelines 6, 2011, Version 3.5 Updated August 2018. National Water Quality Management.
6. HCIS, Hazardous Chemical Information System, Safe Work Australia, Retrieved December 2021: http://hcis.safeworkaustralia.gov.au/HazardousChemical.

7. ILO, International Labour Organisation, International Chemical Safety Cards (ICSCs), Retrieved December 2021: http://www.ilo.org/dyn/icsc/showcard.listcards3?p_lang=en.
8. Shell GTL Saraline 185V Synthetic Base Fluid for High Performance Drilling. Retrieved 2022: https://www.shell.com/business-customers/chemicals/our-products/shell-gtl-drilling-fluids/_jcr_content/par/textimage_1477979319.stream/1580450325747/4322827486b4e1ef86e8858f64ce9b8100f1c2da/saraline-brochure.pdf.

Toxicity Summary - Fatty acids, tall-oil, reaction products with polyethylenepolyamines

Chemical and Physical Properties[1]	
CAS number	68910-93-0
Molecular formula	Unknown or variable composition, complex reaction products or biological materials (UVCB)
Molecular weight	UVCB
Solubility in water	No data available.
Melting point	-85 °C at 101.3 kPa
Boiling point	No data available.
Vapour pressure	No data available.
Henrys law constant	No data available.
Explosive potential	Non-explosive (100%)
Flammability potential	Not classified
Colour/Form	Liquid
Overview	This substance is used by consumers, in articles, by professional workers (widespread uses), in formulation or re-packing, at industrial sites and in manufacturing.
Environmental Fate[1]	
Soil/Water/Air	One study investigating the adsorption/desorption behaviour of Fatty acids, tall-oil, ethoxylated (CAS 61791-00-2) is available. The study was performed according to GLP and OECD guideline 121 (BASF 2017). 6 different peaks were observed with log Koc values ranging from < 1.8 to > 5.63. The two main components (> 85%) show log Koc values > 4. Thus, adsorption of Fatty acids, tall-oil, ethoxylated to solid soil is expected. The test with the source substance was conducted according to OECD Guideline 301B, under GLP conditions (BASF 2005). Domestic, non-adapted activated sludge was exposed to the test substance for 28 days at 22°C, and biodegradation was measured by CO2 consumption. After 28 days, the test substance reached a biodegradation of 90 - 100 %. Based on the results for the read-across substance, Fatty acids, tall oil, ethoxylated (EO > 1 < 2.5) (CAS 61791-00-2) is considered to be readily biodegradable. The test substance consists of components with log Kow values in the range of 5 to > 10 (KOWWIN v1.68) indicating a potential for bioaccumulation. But due to rapid environmental biodegradation, metabolisation via enzymatic hydrolysis (monoesters and diesters) as well as sterical hindrance of crossing biological mebranes (high molecular weight of diesters) a relevant uptake and bioaccumulation in aquatic organisms is not expected. This is supported by low BCF values of < 100 L/kg ww (BCFBAF v3.01, Arnot-Gobas, including biotransformation, upper trophic) calculated for different components of the UVCB (mono- and diester EO1 to EO5). Thus, taking all information into account, the test substance is not considered to be bioaccumulative.
Human Health Toxicity Summary [1]	
Chronic Repeated Dose Toxicity	Under the conditions of this Combined Repeated Dose Toxicity Study with the Reproduction/Developmental Toxicity Screening Test, the oral administration by gavage of test substance to Wistar rats revealed no adverse signs of toxicity in male and female animals at a dose level of 1000 mg/kg bw/d. Thus, the no observed adverse effect level (NOAEL) for general systemic toxicity was 1000 mg/kg bw/d for male and female Wistar rats.
Carcinogenicity	No data available.

Mutagenicity/ Genotoxicity	The test substance is not mutagenic in bacteria, as determined in an OECD 471 study. The test substance is not chromosome damaging, as determined in an OECD 487 study. The test substance is not mutagenic in mammalian cells, as determined in an OECD 476 study.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	Under the conditions of this Combined Repeated Dose Toxicity Study with the Reproduction/Developmental Toxicity Screening Test, the oral administration by gavage of the test substance to Wistar rats revealed no adverse signs of toxicity in male and female animals at a dose level of 1000 mg/kg bw/d. Thus, the no observed adverse effect level (NOAEL) for general systemic toxicity was 1000 mg/kg bw/d for male and female Wistar rats. The NOAEL for reproductive performance and fertility was set to 1000 mg/kg bw/d for male and female Wistar rats.
Acute Toxicity	In an acute oral toxicity study performed similar to OECD guideline 401 (BASF 1971), three groups of rats consisting of 10 animals/sex/dose were treated by single gavage application with an aqueous solution of the test substance (10000, 8000, 6400 mg/kg bw). The animals were observed for mortality and for clinical symptoms of toxicity over a period of 7 days. At the end of the observation period, the surviving animals were sacrificed for the purpose of necropsy. No mortality occurred at the tested concentrations. At all doses mastication, irregular breathing, redness of the eyes and closed eyes were seen immediately after dosing. The next morning mastication and irregular breathing was observed. On the following days, no clinical sings were observed. Pathological examination revealed hydrometra in 3 animals exposed to 10000 mg/kg bw, 2 animals exposed to 8000 mg/kg bw, and 3 animals exposed to 6400 mg/kg bw. Based on the results obtained under the test conditions of this study, the acute oral LD50 was determined to be > 10000 mg/kg bw. To evaluate the potential acute inhalation toxicity of the test substance an Inhalation Risk Test conducted according to a BASF internal testing method (BASF 1971). The test demonstrates the toxicity of an atmosphere saturated with vapours of the volatile components of a test substance at the temperature chosen for vapour generation (20 °C). Rats were exposed sequentially to the vapours, generated by bubbling 200 l/h air through a substance column of about 5 cm above a fritted glass disc in a glass cylinder. The animals were exposed for 8 hour. The exposure concentration was estimated to be 0.28 mg/L based on evaporated substance. In addition to mortality, clinical signs were recorded and necropsy on surviving animals performed. No mortality occurred and no clinical sign were noted during exposure and observation period. In one animal exposed for 8 hours hydrometra was observed after necropsy. Since no mortality occurred at the concentrations tested an LC50 estimation cannot be made. In another Inhalation Risk Test of similar design, Rats (12 animals) were exposed sequentially to the vapours, generated by bubbling 200 l/h air through a substance column of about 5 cm above a fritted glass disc in a glass cylinder. This time vapours were generated at 20 °C as well as 50 °C. The exposure concentrations were 0.04 mg/L and 0.34 mg/L. Rats were exposed for 8 hour. As in the previous study, no mortality occurred after exposure up to 8 hours. Clinical sings observed in the animals exposed to the vapour generated at 20°C included mild escape attempts when exposure began and at the end of the exposure period slight eye irritation was observed. The next day, the animals were without symptoms. In the animals exposed to the vapour generated at 50 °C escape attempts were noted in the first 60 minutes of exposure. Exposure to the saturated atmosphere caused slight eye irritation. At the end of the exposure period, all clinical signs were resolved. Since no mortality occurred at the concentrations tested an LC50 estimation cannot be made. Based on the inhalation studies, no conclusion on LC50 can be drawn, because the tested concentrations are too low in relation to the classification criteria.
Irritation	The test substance was not irritant or corrosive to the skin in a GLP-compliant OECD 431 and 439 study. The test substance was not irritant to the eyes in a GLP-compliant OECD 492 study.

	Based on the available information, classification for skin and eye irritation is not warranted, in accordance with EU Classification, Labelling and Packaging of Substances and Mixtures (CLP) Regulation No. (EC) 1272/2008.
Sensitisation	The test substance did not show an indication of skin sensitising potential in an OECD 429 (LLNA) study. However, an earlier Buehler test (OECD 406) did indicate skin sensitising potential of the substance.
Health Effects Summary	Possible sensitiser.
Key Study/Critical Effect for Screening Criteria	The NOAEL for general systemic toxicity of 1000 mg/kg bw/d was selected as the key study.
Ecological Toxicity [1]	
Aquatic Toxicity	Short-term toxicity tests with the target substance for all trophic levels (fish, daphnia, algae) are available. The test substance did not indicate to be harmful to freshwater fish (96h-LL50 > 100 mg/L), but showed to be toxic to aquatic invertebrates (48h-EL50 = 12.41 mg/L) and harmful to algae (72h-EL50 = 39.7 mg/L). Hence, aquatic invertebrates were most susceptible to the test substance and this effect value was used for the PNEC derivation. Long-term toxicity data with the source substance are only available for algae. The algal test revealed the substance to be of low toxicity to algae (72h-EL10 = 7.08 mg/L). In addition, data are available for toxicity to microorganisms. A test on respiration inhibition with activated sludge resulted in an 3h-EC10 of > 10000 mg/L indicating that detrimental effects in STPs are not to be expected.
Determination of PNEC aquatic	A PNECaqua = 0.012 mg/L can be calculated based on the lowest acute toxicity value (EL50 = 12.41 mg/L) for aquatic invertebrates (Daphnia) with the assessment factor of 1000.
Current Regulatory Controls	
Australian Hazard Classification	No data available.
Australian Occupational Exposure Standards	No data available.
International Occupational Exposure Standards	No data available.
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	No data available.
PBT Assessment[1]	
P/vP Criteria fulfilled?	No. Based on the results from the read-across substance, Fatty acids, tall oil, ethoxylated (EO > 1 < 2.5) (CAS 61791-00-2) is considered to be readily biodegradable.
B/vB criteria fulfilled?	No. The test substance consists of components with log Kow values of > 10 (KOWWIN v1.68) indicating a potential for bioaccumulation. But due to rapid environmental biodegradation, metabolisation via enzymatic hydrolysis (monoesters and diesters) as well as sterical hindrance of crossing biological membranes (high molecular weight of diesters) a relevant uptake and bioaccumulation in aquatic organisms is not expected. This is supported by low BCF values of < 100 L/kg ww (BCFBAF v3.01, Arnot-Gobas, including biotransformation, upper trophic) calculated for different components of the UVCB (mono- and diester EO1 to EO5). Thus, taking all information into account, the test substance is not considered to be B or vB.
T criteria fulfilled?	No. Available short-term and long-term toxicity tests with aquatic organisms resulted in effect values > 1 mg/L. Thus, this substance does not meet the screening criteria for toxicity.

Overall conclusion	Not PBT
Revised	January 2022

References

1. ECHA REACH, Fatty acids, tall-oil, ethoxylated, Retrieved 2019: https://echa.europa.eu/

Toxicity Summary - Mineral Oil

Chemical and Physical Properties[1,2,3]	
CAS number	8042-47-5
Molecular formula	UVCB
Molecular weight	UVCB
Solubility in water	Insoluble
Melting point	-60 - 0 °C at 101.3 - 101.325 kPa
Boiling point	218 - 800 °C at 101.3 kPa
Vapour pressure	10 Pa at 20 °C
Henrys law constant	No data available
Explosive potential	Non-explosive
Flammability potential	Non-flammable
Colour/Form	Liquid, odourless
Overview	A highly refined petroleum mineral oil consisting of a complex combination of hydrocarbons obtained from the intensive treatment of a petroleum fraction with sulphuric acid and oleum, or by hydrogenation, or by a combination of hydrogenation and acid treatment. Additional washing and treating steps may be included in the processing operation. It consists of saturated hydrocarbons having carbon numbers predominantly in the range of C15 through C50. A Tier 1 Human Health Assessment for this chemical has been conducted by NICNAS which concluded that it was low concern to human health.
Environmental Fate[3]	
Soil/Water/Air	The environmental fate assessment of these chemicals indicates they have low to very low vapor pressures, very low solubility in water, high octanol-water partition coefficients, and high sorption to organic matter. Thus, these chemicals will exhibit very poor migration, due to their high sorption and low solubility in water, as well as low potential for volatility. Fugacity modelling suggests they would remain partitioned to the terrestrial phase, remaining sorbed to soil or the foliar surfaces to which they are applied.
Human Health Toxicity Summary [2,3]	
Chronic Repeated Dose Toxicity	The effects of long-term exposure include possible dermatitis with repeated or prolonged contact with skin
Carcinogenicity	Evidence of carcinogenicity is inadequate in humans and inadequate or limited in experimental animals.
Mutagenicity/ Genotoxicity	The mutagenicity of various test materials were all characterized as being non-mutagenic, in general, but with problems due to the presence of suspended oil droplets, due to the poor water solubility of the test materials.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	It was concluded from dermal dosing studies, that mineral oil had no effects (on mortality, clinical signs of toxicity, body weight, food consumption, absolute organ weights, microscopic changes in reproductive organs of parental animals, number of corpora lutea, implantation sites, live pups per litter, no gross anomalies, and body weights of pups or weight gains of pups). In a 4-week inhalation study, there were no treatment related effects on sperm morphology. In a one-generation reproduction study, both males and females were dosed by gavage, and there were no adverse effects (no clinical findings, growth weights and food consumption was normal, no effects on fertility and mating indices in either males or females, and at necropsy, organ weights and histopathology were considered normal by the study authors). Two other studies were reported with white mineral oil, both via single daily gavage doses. In one study, both sexes were dosed, and some effects were observed, which the study authors concluded were within the “spectrum of malformations [which] occurs spontaneously in Sprague-Dawley rat.” In the

	companion study in which only pregnant females were dosed, foetal effects were noted, but "the study authors considered these malformations to be minor and within the normal ranges for the strain of rat" (SpragueDawley). In general, these studies were performed at very high dosages, from about 900 mg/kg-bw/day (1 mL/kg-bw/day) to about 4500 mg/kg-bw/day (5 mL/kg-bw/day).
Acute Toxicity	A short-term exposure duration dermal NOAEL of 2000 mg/kg/day was observed in a 28-day repeat-dose study, in which no adverse effects were observed at the highest test concentration (2000 mg/kg/day). A short-term exposure duration inhalation LOAEL of 146.64 mg/kg/day was observed in a 28-day inhalation study. Adverse effects were reported at the lowest exposure dosage, 0.5 mg/L, based on the following observations: (1) multiple lung effects, (2) increased white blood cell counts in males, (3) increased absolute liver weight, (4) accessory spleens and/or abnormally coloured spleens, and (5) additional microscopic findings. An intermediate-term exposure duration inhalation NOAEL of 26.1 mg/kg/day was observed in a 90-day inhalation study, in which effects were observed at 0.9 mg/L, but there were no adverse effects observed at 0.1 mg/L
Irritation	Slight eye irritation in rats and rabbits.
Sensitisation	Not a dermal sensitizer.
Health Effects Summary	Poses no unreasonable risk to human health based on Tier I assessment under the NICNAS IMAP assessment framework.
Key Study/Critical Effect for Screening Criteria	The intermediate-term inhalation NOAEL of 26.1 mg/kg/day, derived from a 90-day inhalation study, based on effects observed at 0.9 mg/L, with no adverse effects observed at 0.1 mg/L was considered the most sensitive endpoint.
Ecological Toxicity [1]	
Aquatic Toxicity	Rainbow trout 96 hr LL50 (48 h) 100 mg/L
Determination of PNEC aquatic	This substance has a low acute toxicity concern to aquatic organisms and thus required no further assessment.
Current Regulatory Controls[4]	
Australian Hazard Classification	No data available.
Australian Occupational Exposure Standards	No data available.
International Occupational Exposure Standards	MAK: (respirable fraction): 5 mg/m^3; peak limitation category: II(4); pregnancy risk group: C
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	No data available.
PBT Assessment [1]	
P/vP Criteria fulfilled?	No. Not readily biodegradable based on read across study.
B/vB criteria fulfilled?	Not applicable. This substance is a UVCB.
T criteria fulfilled?	No. The acute LL50 value in fish is >1 mg/L. Thus, it does not meet the criteria for toxicity.
Overall conclusion	Not PBT
Revised	February 2022

References

1. ECHA REACH, White mineral oil (petroleum), Retrieved 2022: https://echa.europa.eu/.
2. National Industrial Chemicals Notification and Assessment Scheme (NICNAS). IMAP, Human Health Tier 1 Assessment. Retrieved 2022: https://www.industrialchemicals.gov.au/
3. USEPA 2007. Revised Reregistration Eligibility Decision for Aliphatic Solvents, 29 November 2007. US Environmental Protection Agency Office of Pesticide Programs.
4. HCIS, Hazardous Chemical Information System, Safe Work Australia, Retrieved February 2022: http://hcis.safeworkaustralia.gov.au/HazardousChemical.
5. ILO, International Labour Organisation, International Chemical Safety Cards (ICSCs), Retrieved February 2022: http://www.ilo.org/dyn/icsc/showcard.listcards3?p_lang=en.

Toxicity Summary - Partially hydrolysed polyacrylamide

Chemical and Physical Properties[1,2,3,4]	
CAS number	9003-05-8
Molecular formula	(C3H5NO)x
Molecular weight	1,000,000 to > 50,000,000 g/mol for polyacrylamide copolymers used as flocculants
Solubility in water	Water soluble
Melting point	No data available.
Boiling point	No data available.
Vapour pressure	No data available.
Henrys law constant	No data available.
Explosive potential	No data available.
Flammability potential	No data available.
Colour/Form	No data available.
Overview	Polyacrylamide polymers can exist in cationic, anionic or non-ionic forms, depending on their ionic charge. The non-ionic form of polyacrylamide is generated from the basic polymerisation of acrylamide. Anionic polyacrylamide polymer can then be formed from the hydrolysis of the acrylamide homopolymer either simultaneously during the polymerisation process or as a subsequent step. Anionic polyacrylamide polymer can also be formed from the copolymerisation of acrylamide and acrylic acid. A Tier 1 Human Health and Environmental Assessment for this chemical has been conducted by NICNAS which concluded that it was low concern to human health and the environment and thus required no further assessment.
Environmental Fate [3]	
Soil/Water/Air	No studies on the environmental fate of anionic polyacrylamide are available. As a high-molecular weight, water-soluble polymer, it is not expected to biodegrade or bioaccumulate. The environmental fate of anionic polyacrylamide will be determined primarily by adsorption. The polyanions in this group are expected to partition onto natural colloids in surface waters and in soil and are not expected to undergo long-range transport in the environment.
Human Health Toxicity Summary [1,2,4]	
Chronic Repeated Dose Toxicity	No data available.
Carcinogenicity	No data available.
Mutagenicity/ Genotoxicity	No data available.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	No data available.
Acute Toxicity	Mouse LD50 (oral): 12950 mg/kg Rabbit LD50 (oral): 11250 mg/kg Rat LD50 (oral): >1000 mg/kg
Irritation	No data available.
Sensitisation	No data available.
Health Effects Summary	Poses no unreasonable risk to human health based on Tier I assessment under the NICNAS IMAP assessment framework.

Key Study/Critical Effect for Screening Criteria	The oral acute toxicity in rats was considered the most sensitive endpoint with a LD50 of 1000 mg/kg.
Ecological Toxicity [3]	
Aquatic Toxicity	Fathead minnow LC50: 810 mg/L Rainbow trout LC50: > 100 mg/L Bluegill sunfish LC50: >300 mg/L Daphnia magna LC50: 470 mg/L
Determination of PNEC aquatic	Anionic polyacrylamide has a low acute toxicity concern to aquatic organisms and thus required no further assessment.
Current Regulatory Controls	
Australian Hazard Classification	No data available.
Australian Occupational Exposure Standards	No data available.
International Occupational Exposure Standards	No data available.
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	No data available.
PBT Assessment [3]	
P/vP Criteria fulfilled?	Yes. Anionic polyacrylamide is a large molecular weight, water-soluble polymer. It is not expected to be readily biodegradable; thus, it meets the screening criteria for persistence.
B/vB criteria fulfilled?	No. Pharmacokinetic studies showed that anionic polyacrylamide was not bioavailable to rats when ingested; this is most likely due to its large size (high molecular weight) and presumed resistance to break down in the gastrointestinal tract. Anionic polyacrylamide is thus not expected to be bioavailable to aquatic or terrestrial organisms. It is not expected to meet the criteria for bioaccumulation.
T criteria fulfilled?	No. The acute LC50 values in fish and invertebrates are >1 mg/L. Thus, it does not meet the criteria for toxicity.
Overall conclusion	Not PBT
Revised	February 2022

References

1. Department of the Environment and Energy 2017, National assessment of chemicals associated with coal seam gas extraction in Australia, prepared by the National Industrial Chemicals Notification and Assessment Scheme
2. National Industrial Chemicals Notification and Assessment Scheme (NICNAS). IMAP, Human Health Tier 1 Assessment. Retrieved 2022: https://www.industrialchemicals.gov.au/.
3. EHS Support, Anionic Polyacrylamide. Available at: https://www.santos.com/wp-content/uploads/2021/04/Anionic-Polyacrylamide-March-2021.pdf. Retrieved February 2022.
4. ChemIDplus, Polyacrylamide, Retrieved February 2022: https://chem.nlm.nih.gov/chemidplus/rn/9003-05-8.
5. HCIS, Hazardous Chemical Information System, Safe Work Australia, Retrieved February 2022: http://hcis.safeworkaustralia.gov.au/HazardousChemical.
6. ILO, International Labour Organisation, International Chemical Safety Cards (ICSCs), Retrieved February 2022: http://www.ilo.org/dyn/icsc/showcard.listcards3?p_lang=en.

Toxicity Summary - Phosphoric ester of ethoxylated fatty alcohol

Chemical and Physical Properties[1]	
CAS number	68585-36-4
Molecular formula	Unknown or variable composition, complex reaction products or biological materials (UVCB)
Molecular weight	UVCB
Solubility in water	No data available.
Melting point	-85 °C at 101.3 kPa
Boiling point	No data available.
Vapour pressure	No data available.
Henrys law constant	No data available.
Explosive potential	Non-explosive (100%)
Flammability potential	Not classified
Colour/Form	Liquid
Overview	This substance is used by consumers, in articles, by professional workers (widespread uses), in formulation or re-packing, at industrial sites and in manufacturing.
Environmental Fate[1]	
Soil/Water/Air	One study investigating the adsorption/desorption behaviour of Fatty acids, tall-oil, ethoxylated (CAS 61791-00-2) is available. The study was performed according to GLP and OECD guideline 121 (BASF 2017). 6 different peaks were observed with log Koc values ranging from < 1.8 to > 5.63. The two main components (> 85%) show log Koc values > 4. Thus, adsorption of Fatty acids, tall-oil, ethoxylated to solid soil is expected. The test with the source substance was conducted according to OECD Guideline 301B, under GLP conditions (BASF 2005). Domestic, non-adapted activated sludge was exposed to the test substance for 28 days at 22°C, and biodegradation was measured by CO2 consumption. After 28 days, the test substance reached a biodegradation of 90 - 100 %. Based on the results for the read-across substance, Fatty acids, tall oil, ethoxylated (EO > 1 < 2.5) (CAS 61791-00-2) is considered to be readily biodegradable. The test substance consists of components with log Kow values in the range of 5 to > 10 (KOWWIN v1.68) indicating a potential for bioaccumulation. But due to rapid environmental biodegradation, metabolisation via enzymatic hydrolysis (monoesters and diesters) as well as sterical hindrance of crossing biological mebranes (high molecular weight of diesters) a relevant uptake and bioaccumulation in aquatic organisms is not expected. This is supported by low BCF values of < 100 L/kg ww (BCFBAF v3.01, Arnot-Gobas, including biotransformation, upper trophic) calculated for different components of the UVCB (mono- and diester EO1 to EO5). Thus, taking all information into account, the test substance is not considered to be bioaccumulative.
Human Health Toxicity Summary [1]	
Chronic Repeated Dose Toxicity	Under the conditions of this Combined Repeated Dose Toxicity Study with the Reproduction/Developmental Toxicity Screening Test, the oral administration by gavage of test substance to Wistar rats revealed no adverse signs of toxicity in male and female animals at a dose level of 1000 mg/kg bw/d. Thus, the no observed adverse effect level (NOAEL) for general systemic toxicity was 1000 mg/kg bw/d for male and female Wistar rats.
Carcinogenicity	No data available.

Mutagenicity/ Genotoxicity	The test substance is not mutagenic in bacteria, as determined in an OECD 471 study. The test substance is not chromosome damaging, as determined in an OECD 487 study. The test substance is not mutagenic in mammalian cells, as determined in an OECD 476 study.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	Under the conditions of this Combined Repeated Dose Toxicity Study with the Reproduction/Developmental Toxicity Screening Test, the oral administration by gavage of the test substance to Wistar rats revealed no adverse signs of toxicity in male and female animals at a dose level of 1000 mg/kg bw/d. Thus, the no observed adverse effect level (NOAEL) for general systemic toxicity was 1000 mg/kg bw/d for male and female Wistar rats. The NOAEL for reproductive performance and fertility was set to 1000 mg/kg bw/d for male and female Wistar rats.
Acute Toxicity	In an acute oral toxicity study performed similar to OECD guideline 401 (BASF 1971), three groups of rats consisting of 10 animals/sex/dose were treated by single gavage application with an aqueous solution of the test substance (10000, 8000, 6400 mg/kg bw). The animals were observed for mortality and for clinical symptoms of toxicity over a period of 7 days. At the end of the observation period, the surviving animals were sacrificed for the purpose of necropsy. No mortality occurred at the tested concentrations. At all doses mastication, irregular breathing, redness of the eyes and closed eyes were seen immediately after dosing. The next morning mastication and irregular breathing was observed. On the following days, no clinical sings were observed. Pathological examination revealed hydrometra in 3 animals exposed to 10000 mg/kg bw, 2 animals exposed to 8000 mg/kg bw, and 3 animals exposed to 6400 mg/kg bw. Based on the results obtained under the test conditions of this study, the acute oral LD50 was determined to be > 10000 mg/kg bw. To evaluate the potential acute inhalation toxicity of the test substance an Inhalation Risk Test conducted according to a BASF internal testing method (BASF 1971). The test demonstrates the toxicity of an atmosphere saturated with vapours of the volatile components of a test substance at the temperature chosen for vapour generation (20 °C). Rats were exposed sequentially to the vapours, generated by bubbling 200 l/h air through a substance column of about 5 cm above a fritted glass disc in a glass cylinder. The animals were exposed for 8 hour. The exposure concentration was estimated to be 0.28 mg/L based on evaporated substance. In addition to mortality, clinical signs were recorded and necropsy on surviving animals performed. No mortality occurred and no clinical sign were noted during exposure and observation period. In one animal exposed for 8 hours hydrometra was observed after necropsy. Since no mortality occurred at the concentrations tested an LC50 estimation cannot be made. In another Inhalation Risk Test of similar design, Rats (12 animals) were exposed sequentially to the vapours, generated by bubbling 200 l/h air through a substance column of about 5 cm above a fritted glass disc in a glass cylinder. This time vapours were generated at 20 °C as well as 50 °C. The exposure concentrations were 0.04 mg/L and 0.34 mg/L. Rats were exposed for 8 hour. As in the previous study, no mortality occurred after exposure up to 8 hours. Clinical sings observed in the animals exposed to the vapour generated at 20°C included mild escape attempts when exposure began and at the end of the exposure period slight eye irritation was observed. The next day, the animals were without symptoms. In the animals exposed to the vapour generated at 50 °C escape attempts were noted in the first 60 minutes of exposure. Exposure to the saturated atmosphere caused slight eye irritation. At the end of the exposure period, all clinical signs were resolved. Since no mortality occurred at the concentrations tested an LC50 estimation cannot be made. Based on the inhalation studies, no conclusion on LC50 can be drawn, because the tested concentrations are too low in relation to the classification criteria.
Irritation	The test substance was not irritant or corrosive to the skin in a GLP-compliant OECD 431 and 439 study. The test substance was not irritant to the eyes in a GLP-compliant OECD 492 study.

	Based on the available information, classification for skin and eye irritation is not warranted, in accordance with EU Classification, Labelling and Packaging of Substances and Mixtures (CLP) Regulation No. (EC) 1272/2008.
Sensitisation	The test substance did not show an indication of skin sensitising potential in an OECD 429 (LLNA) study. However, an earlier Buehler test (OECD 406) did indicate skin sensitising potential of the substance.
Health Effects Summary	Possible sensitiser.
Key Study/Critical Effect for Screening Criteria	The NOAEL for general systemic toxicity of 1000 mg/kg bw/d was selected as the key study.
Ecological Toxicity [1]	
Aquatic Toxicity	Short-term toxicity tests with the target substance for all trophic levels (fish, daphnia, algae) are available. The test substance did not indicate to be harmful to freshwater fish (96h-LL50 > 100 mg/L), but showed to be toxic to aquatic invertebrates (48h-EL50 = 12.41 mg/L) and harmful to algae (72h-EL50 = 39.7 mg/L). Hence, aquatic invertebrates were most susceptible to the test substance and this effect value was used for the PNEC derivation. Long-term toxicity data with the source substance are only available for algae. The algal test revealed the substance to be of low toxicity to algae (72h-EL10 = 7.08 mg/L). In addition, data are available for toxicity to microorganisms. A test on respiration inhibition with activated sludge resulted in an 3h-EC10 of > 10000 mg/L indicating that detrimental effects in STPs are not to be expected.
Determination of PNEC aquatic	A PNECaqua = 0.012 mg/L can be calculated based on the lowest acute toxicity value (EL50 = 12.41 mg/L) for aquatic invertebrates (Daphnia) with the assessment factor of 1000.
Current Regulatory Controls	
Australian Hazard Classification	No data available.
Australian Occupational Exposure Standards	No data available.
International Occupational Exposure Standards	No data available.
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	No data available.
PBT Assessment[1]	
P/vP Criteria fulfilled?	No. Based on the results from the read-across substance, Fatty acids, tall oil, ethoxylated (EO > 1 < 2.5) (CAS 61791-00-2) is considered to be readily biodegradable.
B/vB criteria fulfilled?	No. The test substance consists of components with log Kow values of > 10 (KOWWIN v1.68) indicating a potential for bioaccumulation. But due to rapid environmental biodegradation, metabolisation via enzymatic hydrolysis (monoesters and diesters) as well as sterical hindrance of crossing biological membranes (high molecular weight of diesters) a relevant uptake and bioaccumulation in aquatic organisms is not expected. This is supported by low BCF values of < 100 L/kg ww (BCFBAF v3.01, Arnot-Gobas, including biotransformation, upper trophic) calculated for different components of the UVCB (mono- and diester EO1 to EO5). Thus, taking all information into account, the test substance is not considered to be B or vB.
T criteria fulfilled?	No. Available short-term and long-term toxicity tests with aquatic organisms resulted in effect values > 1 mg/L. Thus, this substance does not meet the screening criteria for toxicity.

Overall conclusion	Not PBT
Revised	January 2022

References

1. ECHA REACH, Fatty acids, tall-oil, ethoxylated, Retrieved 2019: https://echa.europa.eu/

Toxicity Summary - Polyanionic cellulose, low viscosity

Chemical and Physical Properties[1,2,3,4]	
CAS number	9004-32-4
Molecular formula	C8H15NaO8
Molecular weight	262.19
Solubility in water	The sodium salt disperses and its solubility in water depends upon the degree of substitution.
Melting point	300°C
Boiling point	No data available.
Vapour pressure	No data available.
Henrys law constant	No data available.
Explosive potential	No data available.
Flammability potential	No data available.
Colour/Form	White or slightly yellowish, almost odourless and tasteless hydroscopic powder, consisting of very fine particles, fine granules or fine fibres.
Overview	Sodium carboxymethyl cellulose (CMC) is used in drilling muds, detergents, resin emulsion paints, adhesives, printing inks, and textile sizes. It is also used as a protective colloid, a stabilizer for foods, and a pharmaceutical additive. A Tier 1 Human Health and Environmental Assessment for this chemical has been conducted by NICNAS which concluded that it was low concern to human health and the environment and thus required no further assessment.
Environmental Fate [4]	
Soil/Water/Air	Sodium carboxymethylcellulose is biodegradable, but is not considered to be readily biodegradable. It is not expected to bioaccumulate. All of the polymers in this group are expected to be water soluble. If discharged into natural waters, sodium carboxymethylcellulose is expected to be present as a polyanion as a result of the ionisation of the carboxymethyl substituents. Comparatively complex partitioning behaviour in aquatic systems may occur based on the well-established interactions between colloids and carboxymethylcellulose, which is a key part of the function of this polymer in laundry detergents. No experimental partition coefficient data are available for sodium carboxymethylcellulose. Based on its high water solubility, the substance is likely to be mobile in the environment.
Human Health Toxicity Summary [1,2,3]	
Chronic Repeated Dose Toxicity	Ten rats received 300 to 500 mg of CMC daily for two months without any adverse effect. Another group of 10 rats received a diet containing 20% of CMC for 63 days. Slight growth retardation and a laxative effect were observed. Organ weights and both gross and microscopic pathological examination revealed no abnormalities. Oral rat TDLo: 227 g/kg/13W (continuous)
Carcinogenicity	Carboxymethyl cellulose sodium salt is a “suspected carcinogen”.
Mutagenicity/ Genotoxicity	Carboxymethylcellulose has been used often as the vehicle control in a number of genotoxicity studies as the control agent or vehicle and as such would not be expected to show activity in these types of studies.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	In several studies, carboxymethylcellulose and its sodium salt have been used as the vehicle in developmental, embryotoxic and teratogenic studies on rats, mice or rabbits and as such would not be expected to have any adverse effect.
Acute Toxicity	Rats, guinea pigs and rabbits showed no symptoms after administration by stomach tube of 3000 mg/kg in three divided doses. Rat LD50 (oral): 270000 mg/kg/bw Guinea pig LD50 (oral): 160000 mg/kg/bw

	A 4-hr inhalation LC50 value of 5.8 g/m^3 has been reported for the sodium salt in rats.
Irritation	No data available.
Sensitisation	Suspected skin sensitiser
Health Effects Summary	Poses no unreasonable risk to human health based on Tier I assessment under the NICNAS IMAP assessment framework.
Key Study/Critical Effect for Screening Criteria	The oral rat chronic toxicity TDLo: 227 g/kg/13W (continuous) was considered the most sensitive endpoint.
Ecological Toxicity [4]	
Aquatic Toxicity	Brachydanio rerio 96-hour LC50 >2,500 mg/L Daphnia magna 48-hour EC50 >5,000 mg/L Daphnia magna 48-hour EC50 87.26 mg/L Selenastrum capricornutum 96-hour EC50 500 mg/L
Determination of PNEC aquatic	This compound has a low acute toxicity concern to aquatic organisms and thus required no further assessment.
Current Regulatory Controls [5,6]	
Australian Hazard Classification	No data available.
Australian Occupational Exposure Standards	No data available.
International Occupational Exposure Standards	No data available.
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	No data available.
PBT Assessment [4]	
P/vP Criteria fulfilled?	No. Sodium carboxymethylcellulose is a water-soluble semisynthetic polymer that is not readily biodegradable. Therefore, it meets the screening criteria for persistence.
B/vB criteria fulfilled?	No. Not expected to bioaccumulate.
T criteria fulfilled?	No. The acute EC50 of sodium carboxymethylcellulose is >1 mg/L in fish, invertebrates and algae. Therefore, it does not meet the screening criteria for toxicity.
Overall conclusion	Not PBT
Revised	February 2022

References

1. National Industrial Chemicals Notification and Assessment Scheme (NICNAS). IMAP, Human Health Tier 1 Assessment. Retrieved 2022: https://www.industrialchemicals.gov.au/.
2. NCBI, 2022. National Center for Biotechnology Information. Available at: https://pubchem.ncbi.nlm.nih.gov/. Retrieved February 2022.
3. Toxicological profile for sodium carboxy methyl cellulose, Retrieved February 2022: https://tobacco-information.hpa.gov.tw/common/Download.ashx?t=CLI8001&f=54368658_336/54368658_336_A0191.pdf
4. EHS Support, Sodium Carboxymethylcellulose. Available at: https://www.santos.com/wp-content/uploads/2021/04/Sodium-Carboxymethylcellulose-March-2021.pdf. Retrieved February 2022.

5. HCIS, Hazardous Chemical Information System, Safe Work Australia, Retrieved February 2022: http://hcis.safeworkaustralia.gov.au/HazardousChemical.
6. ILO, International Labour Organisation, International Chemical Safety Cards (ICSCs), Retrieved February 2022: http://www.ilo.org/dyn/icsc/showcard.listcards3?p_lang=en.

Toxicity Summary - Disodium, Trisodium, Tetrasodium EDTA

Chemical and Physical Properties [1,2,3]	
CAS number	139-33-3 – Disodium EDTA 150-38-9 – Trisodium EDTA 64-02-8 – Tetrasodium EDTA
Molecular formula	Na2EDTA – Disodium EDTA NA3EDTA – Trisodium EDTA NA4EDTA – Tetrasodium EDTA
Molecular weight	336.21 g/mol - Disodium EDTA 380.17 g/mol – Tetrasodium EDTA
Solubility in water	$1.0X10^{+6}$ mg/L (miscible) at 25 ^{o}C - Disodium EDTA
Melting point	242 ^{o}C - Disodium EDTA >300 ^{o}C – Tetrasodium EDTA
Boiling point	252 ^{o}C (decomposes) - Disodium EDTA
Vapour pressure	Negligible
Henrys law constant	Negligible
Explosive potential	No data found
Flammability potential	No data found
Colour/Form	Solid granular materials
Overview	Disodium, trisodium and tetrasodium EDTA are members of the Amino Carboxylic Acid-Based Chelants Category. EDTA is a metal-complexing agent and may act to mobilise some heavy metals in the environment. EDTA is used widely in industry and agriculture. It is used in laundry detergents, water softening, electroplating, textile and paper production, as a food additive, and in cosmetics. Most of these uses will result in the release of EDTA to the aquatic environment. It is also used as a drug in chelation therapy, particularly in cases involving lead poisoning. EDTA is poorly absorbed in the gut and does not form any significant metabolites. It does not accumulate in the body. Long-term feeding studies with rats and dogs reported no interference to mineral metabolism. Results from other studies have been affected by the formation of zinc complexes in the gastrointestinal tract,which prevents the zinc from being absorbed. As metal-organic salts, or inner salts, all category members decompose before melting upon sufficient heating (generally at temperatures > 200 °C). Therefore true melting points are not applicable. Chelants that are metal salts do not exist as discrete neutral molecules, and therefore cannot volatilize, exert appreciable vapour pressure, or boil. Therefore, vapour pressure and boiling point data are not applicable for such chelants and are not determined. Henry's law constants are also expected to be negligible. Chelants that exist as neutral molecules (not metal salts) can exert vapour pressure, but in this case the vapour pressure is exceedingly low. All category members are highly soluble to miscible in water (generally > 10,000 mg/L) and insoluble in organic solvents, therefore also possessing negative partition coefficients (log Kows). The ability of chelants to remove and add ions to solution is the mechanism whereby these chemicals produce toxicity. Environmental fate and ecological and mammalian toxicity profiles are consistent within the category. A Tier 1 Human Health Assessment for these chemicals has been conducted by NICNAS which concluded that these chemicals were identified as low concern to human health.

Environmental Fate [1,2,3]	
Soil/Water/Air	EDTAs have demonstrated high stability to hydrolysis, and most are commercially available primarily or solely in aqueous solution. EDTAs emitted to waterways will remain dissolved in this environmental compartment. If emitted to soil or sediment, they will exhibit high water solubility and soil mobility. This behaviour is based on the presence of multiple carboxylate anion groups in the molecular structure, and is supported by the demonstrated high water solubility and negligible vapor pressure of EDTAs. Results of recent studies indicate that EDTA, calcium EDTA and Na2EDTA can biodegrade under certain conditions.
Human Health Toxicity Summary [1,2,3]	
Chronic Repeated Dose Toxicity	In a 13-week repeated-dose toxicity study, rats (both sexes) fed Na2EDTA (0, 1, 5, 10%) showed mortality at the highest dose. In addition, there was decreased food consumption (emaciation at 10%) and diarrhea at doses of 5% (approximately 4206 mg/kg bw/day) and above. The NOAEL was 1% (approximately 692 mg/kg bw/day). Range finding studies with higher dose levels revealed diarrhea, emaciation, loss of body weight and sometimes parakeratosis in esophagus and forestomach as well as decreased hemoglobin and hematocrit levels. In a 2- year bioassay in rats and mice (both sexes) with Na3EDTA (0, 3750 or 7500 ppm) a NOAEL of 7500 ppm (approximately 500 mg/kg bw/day in rats and 938 mg/kg bw/day in mice; highest dose tested) was determined.
Carcinogenicity	An oral two-year study with Na3EDTA trihydrate in mice and rats indicated no evidence of carcinogenicity. The amino carboxylic acid-based chelants category members are not expected to be carcinogens.
Mutagenicity/ Genotoxicity	Available data indicate disodium and trisodium EDTA do not induce gene mutations or chromosomal aberrations in vitro or in vivo.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	Chronic studies with Na3EDTA that included histological examination of gonadal tissues for evidence of adverse effects also showed no adverse effects on reproductive organs. The weight of evidence from a two-generation reproductive toxicity study in rats shows that dietary ingestion of 1% Na2EDTA (approx. 920 mg/kg bw/day) had no effect on reproduction; however, no litters were produced at 5% (approx. 4600 mg/kg bw/day); the NOAEL for reproductive toxicity was 920 mg/kg bw/day. Developmental toxicity data are available for EDTA, CaNa2EDTA, Na2EDTA, Na3EDTA, and Na5DTPA. Data from multigenerational and prenatal developmental toxicity studies suggest that developmental effects are observed in the presence of maternal toxicity and are related to plasma zinc concentrations. Studies on developmental toxicity showed a specific fetotoxic and teratogenic potential of EDTA, Na2EDTA and CaNa2EDTA; a LOAEL of 1000 mg/kg bw/day was determined. Increased proportions/litter and significantly lower fetal body weights are indicative for an impaired fetal development. The pattern of malformations comprised cleft palate, severe brain deformities, eye defects, micro- or agnathia, syndactyly, clubbed legs and tail anomalies. These effects were exhibited in studies using maternally toxic dose levels. The mechanism resulting in developmental effects is found to occur via zinc depletion resulting in zinc deficit. These effects are independent of whether the acid or sodium or calcium salts are applied.
Acute Toxicity	Limited acute inhalation toxicity data with atmospheres enriched in the dusts of certain of the chelants were generally without effect in rats. However, inhalation of respirable dust aerosols of Na2EDTA in male rats exposed to 30, 300 or 1103 mg/m^3 6 hours/day for up to 5 days produced adverse effects at all concentration levels. Mortality was observed at 1103 mg/m^3 following a single 6-h exposure. These effects were fully reversed in surviving animals after a 14-day recovery. Acute dermal toxicity studies in rats, oral LD50 values for Na2EDTA, Na3EDTA were > 2000 mg/kg bw
Irritation	The aminocarboxylic acid-based chelants are not irritating to moderately irritating to the skin, and slightly to moderately irritating to the eyes in rabbits. The irritancy potential is related to the pH of the individual salt. Thus, more acidic members of the category such as disodium EDTA have inherently greater irritancy potential.

Sensitisation	The aminocarboxylic acid-based chelants are not skin sensitisers based on studies in mice and guinea pigs.
Health Effects Summary	These chemicals have been identified by NICNAS to be of low concern to human health.
Key Study/Critical Effect for Screening Criteria	The Australian Drinking Water Guideline (0.25 mg/L, health) may be used. for EDTA
Ecological Toxicity [1,2,3]	
Aquatic Toxicity	According to the results from different ecotoxicological studies, EDTA mainly influences the pathway of metal ions. For EDTA long-term studies with fish, daphnids and algae are available. The following results were found: *Danio rerio*: 35 d-NOEC > 26.8 mg/L (CaNa2EDTA); *Daphnia magna*: 21d-NOEC = 22 mg/L; *Scenedesmus subspicatus*: 72h-EC10 = > 100 mg/L. For Na2EDTA, *Daphnia magna*: 21d-NOEC = 25 mg/L.
Determination of PNEC aquatic	The effects assessment of EDTA is based on long-term tests, which are available for fish,daphnids and algae. The most sensitive endpoint could be found for *Daphnia magna* with a NOEC of 22 mg/l H4EDTA. An assessment factor of 10 has been used leading to a PNECaqua of 2.2 mg/l.
Current Regulatory Controls [4]	
Australian Hazard Classification	No data available
Australian Occupational Exposure Standards	No data available
International Occupational Exposure Standards	No data available
Australian Food Standards	No data available
Australian Drinking Water Guidelines	The Australian Drinking Water Guideline for EDTA is 0.25 mg/L.
Aquatic Toxicity Guidelines	No data available
PBT Assessment [1,2,3]	
P/vP Criteria fulfilled?	EDTAs are not readily biodegradable and as such are persistent in the environment.
B/vB criteria fulfilled?	EDTAs have a low potential for bioaccumulation.
T criteria fulfilled?	The acute aquatic toxicity of EDTAs are > 0.01 mg/L. Hence the substances do not fulfill the screening criteria for toxic (T)
Overall conclusion	Not a PBT substance (based on screening data).
Revised	December 2018

References

1. European Commission Joint Research Centre 2004, European Union Risk Assessment Report, Tetrasodium Ethylenediaminetetracetate (Na4EDTA), CAS no. 64-02-8.
2. HSDB (n.d.). *Hazardous Substances Data Bank*. Retrieved 2017, from Toxnet, Toxicology Data Network, National Library of Medicine: http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB
3. OECD (2012) SIDS Initial Assessment Profile for Amino Carboxylic Acid-Based Chelants Category
4. National Health and Medical Research Council, Natural Resources Management Ministerial Council, national Water Quality Management Strategy, Australian Drinking Water Guidelines 6, 2011, Version 3.3 Updated November 2016.
5. National Industrial Chemicals Notification and Assessment Scheme (NICNAS). IMAP, Human Health Tier 1 Assessment. Retrieved 2018: https://www.nicnas.gov.au

Toxicity Summary - Talc

Chemical and Physical Properties [1,4]	
CAS number	14807-96-6
Molecular formula	H2-O3-Si 3/4Mg or Mg3Si4O10(OH)2
Molecular weight	78.10 (estimate)
Solubility in water	Insoluble in water, cold acids or in alkalis
pH	9.0 to 9.5
Melting point	800-900°C (disintegration; WHO 2005)
Boiling point	549.7°C (estimate)
Vapour pressure	NA
Henrys law constant	NA
Explosive potential	NA
Flammability potential	Not flammable
Colour/Form	white to gray-white, fine crystalline powder.
Overview	Talc finely powdered hydrous magnesium silicate mineral sometimes found in association with asbestos. After being mined, it is processed to remove impurities and powdered. Talc is a useful commercial product due to its fragrance retention, luster, purity, softness, and whiteness as well as its chemical inertness and oil and grease adsorption. Talc is a mineral composed of hydrated magnesium silicate. Talc refers to both mineral talc and industrial mineral products that are marketed under the name talc and contain proportions of mineral talc that range from about 35% to almost 100%. Industrial talc generally refers to products that contain abundant minerals other than talc; cosmetic talc now normally contains >98% talc but the content may have been lower in the past. Pharmaceutical talc contains >99% talc. Talcum powder is cosmetic-grade talc. This chemical has been identified by NICNAS to be of low concern to human health based on an initial screening approach and thus required no further assessment. Further assessment of the environmental risks from the use of this chemical is also not required.
Environmental Fate [2,3]	
Soil/Water/Air	As a mineral, talc does not biodegrade

Human Health Toxicity Summary [1,2]	
Chronic Repeated Dose Toxicity **Carcinogenicity**	Talc-based body powder, when used perineally, is classified by IARC as group 2B as possibly carcinogenic to humans. However, talc for general use not containing asbestos or asbestiform fibres is classified as group 3 as not classifiable to its carcinogenicity to humans. Talc containing asbestiform fibres is classified by IARC as group 1 for carcinogenic to humans. Talc alone failed to induce respiratory tumors, granulomas or mesothelial proliferation in a hamster study but produced tumours of the larynx, trachea and lungs when tested in association with benzo(a)pyrene. In a rat study of aerosol talc there was some evidence of carcinogenic activity of talc in male F344/N rats and clear evidence of carcinogenic activity in female F344/N rats. No evidence of carcinogenicity was evident in intraperitoneal or inhalation studies in hamsters. Male and female Wistar rats were given in their diet 0 or 50 mg/kg of commercial talc [characteristics unspecified] for the life of the animals (average survival was 702 and 649 days, respectively). There was no significant difference in the talc-fed animals compared with control animals (Gibel *et al.*, 1976). In humans and experimental animals, the effects of talc are dependent on the route of exposure, and the dose and properties of the talc. Talc pneumoconiosis was somewhat more prevalent and severe among miners exposed to talc containing asbestiform minerals and/or asbestos than among those exposed to talc without such contaminants. However, the role of quartz and asbestos in the observed pneumoconiosis could not be ruled out. Among drug users, intravenous injection of talc present as a filler in the drugs resulted in microembolization in a variety of organs and alterations in pulmonary function. In animal studies, talc has been shown to cause granulomas and mild inflammation when inhaled. Observations of the effects that occurred in the lungs of rats exposed by inhalation to talc suggested that the operative mechanisms may be similar to those identified for carbon black, and talc is known to cause the release of cytokines, chemokines and growth factors from pleural mesothelial cells. IARC: There is *inadequate evidence* in humans for the carcinogenicity of inhaled talc not containing asbestos or asbestiform fibres. There is *limited evidence* in experimental animals for the carcinogenicity of talc not containing asbestos or asbestiform fibres. Inhaled talc not containing asbestos or asbestiform fibres is *not classifiable as to its carcinogenicity (Group 3)*.
Mutagenicity/ Genotoxicity	Talc was not mutagenic in host-mediated assays in mice. It did not produce chromosomal aberrations or dominant lethal mutations in rats. The IARC (1987) review of talc included unpublished results from a 1974 study conducted by Litton Bionetics that showed no mutagenic activity for talc *in vitro* or *in vivo.* Talc did not induce mutations in *Salmonella typhimurium* strains TA1530 or HisG46, or in the yeast, *Saccharomyces cerevisiae.* No chromosomal aberrations were observed in human fibroblasts treated with talc *in vitro. In vivo* tests conducted in rats gave negative results for induction of chromosomal aberrations in bone marrow cells and dominant lethal mutations in germinal cells
Reproductive Toxicity **Developmental Toxicity/Teratogenicity**	No teratological effects were observed in hamsters, rats, mice, or rabbits after oral administration of 900-1600 mg/kg. No teratologic effects were observed in hamsters, rats, mice, or rabbits after oral administration of talc. The doses used were 1,600 mg/kg for rats and mice on days *6* through 15 of gestation; 1,200 mg/kg for hamsters on day 6 through 10 of gestation; and 900 mg/kg for rabbits on days 6 through 18 of gestation
Acute Toxicity	Acute inhalation exposure to talc causes symptoms such as cough, dyspnea, sneezing, vomiting, and cyanosis. Other inhalation exposure symptoms include diffuse pleural thickening and fibrous adhesions of pleural surfaces. Respiratory distress syndrome has been reported in children after massive accidental inhalation of talcum powder. Animal (rat, dog, rabbit) studies showed internal accumulation of talc after short- and long-term inhalation exposure as well as numerous lung afflictions such as fibrosis and inflammation.
Irritation	In monkey eyes, talc in the anterior chamber has induced persistent glaucoma. Talc can induce severe granulomatous reactions when introduced into wounds. It has induced granulomas in and about the human eye when as a dusting powder for surgeons' gloves.

Sensitisation	Talc particles are smaller than 1 um and these particles are respirable and produce an intense inflammatory response characterized by cough, rhinitis, dyspnea, and vomiting.
Health Effects Summary	This chemical has been identified by NICNAS to be of low concern to human health, and it is listed by the US Food and Drug Administration (FDA) as a Generally Recognised as Safe (GRAS) substance.
Key Study/Critical Effect for Screening Criteria	There are no adequate studies for which to derive am oral reference dose. Talc is poorly absorbed from the gastrointestinal tract, if at all, and the limited data available by the oral route indicate that talc is essentially non-toxic by the oral route of exposure
Ecological Toxicity [2,3,4]	
Aquatic Toxicity	No data were found. Talc is expected to have low toxicity to the environmental based on its ubiquity in the environment, its low bioavailability, and its widespread use in consumer products (Zazenski et al. 1995).
Determination of PNEC aquatic	PNEC values for talc cannot be calculated.
Current Regulatory Controls	
Australian Hazard Classification	No data available
Australian Occupational Exposure Standards	TWA: 2.5 mg/m^3
International Occupational Exposure Standards	NIOSH: TWA 2 mg/m^3
Australian Food Standards	No data available
Australian Drinking Water Guidelines	No data available
Aquatic Toxicity Guidelines	No data available
PBT Assessment [4]	
P/vP Criteria fulfilled?	Talc does not biodegrade in the environment. It is a naturally-occurring mineral and is persistent in the environment. However, for the purposes of this PBT assessment, it does not meet the criteria for persistence.
B/vB criteria fulfilled?	Talc is not expected to be bioavailable to aquatic organisms; thus, it is does not meet the criteria for bioaccumulation
T criteria fulfilled?	Talc is not expected to be bioavailable to aquatic organisms; thus, it is does not meet the criteria for toxicity.
Overall conclusion	It is not currently possible to categorise the environmental hazards of metals and other inorganic chemicals according to standard persistence, bioaccumulation and toxicity (PBT) hazard criteria. These criteria were developed for organic chemicals and do not take into account the unique properties of inorganic substances and their behaviour in the environment (UNECE 2007; US EPA 2007).
Revised	April 2018

References

1. HSDB (n.d.). *Hazardous Substances Data Bank*. Retrieved 2015, from Toxnet, Toxicology Data Network, National Library of Medicine: http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB

2. IARC (2010) Carbon Black, Titanium Oxide and Talc. Volume 93. International Agency for Research on Cancer Monographs on the Evaluation of Carcinogenic Risks to Humans. Available at http://monographs.iarc.fr/ENG/Monographs/vol93/mono93.pdf.

3. Pfizer (2006) Material Safety Data Sheet for Gemfibrozil Tablets, 90mg. Available at http://www.pfizer.com/files/products/material_safety_data/CI-719.pdf.

4. Department of the Environment and Energy 2017 , National assessment of chemicals associated with coal seam gas extraction in Australia, prepared by the National Industrial Chemicals Notification and Assessment Scheme

Toxicity Summary - Amides, tall-oil fatty, N,N-bis(hydroxyethyl)

Chemical and Physical Properties [1,2]	
CAS number	68155-20-4
Molecular formula	UVCB
Molecular weight	370 (typical C18 monounsaturated)
Solubility in water	Dispersible
Melting point	<25 °C (liquid)
Boiling point	>300 °C (estimated)
Vapour pressure	$<1.0\times10^{-10}$ (estimated)
Henrys law constant	$<1.0\times10^{-10}$ (estimated)
Explosive potential	No data available.
Flammability potential	No data available.
Colour/Form	Liquid
Overview	Non-confidential information in the IUR indicated that the industrial processing and uses of the chemical include other basic organic chemical manufacturing as surface active agents and intermediates; pesticide and other agricultural chemical manufacturing as surface active agents; soap and cleaning compound manufacturing as surface active agents; support activities for mining as surface active agents; and petrochemical manufacturing as surface active agents. Non-confidential commercial and consumer uses of this chemical include lubricants, greases and fuel additives.
Environmental Fate [1,2]	
Soil/Water/Air	The members of the fatty nitrogen derived amides category are long-chain alkyl substituted amides used in commercial product mixtures. The category consists of three subcategories: Subcategory I, fatty acid amides; Subcategory II, fatty alkanolamides; and Subcategory III, fatty acid reaction products with amines. The components of Subcategory I are solids possessing low vapor pressure and low water solubility. The substances in Subcategory II contain solids and liquids with negligible to low vapor pressure and tend to be dispersible in water. The substances in Subcategory III also contain solids and liquids possessing negligible to low vapor pressure that tend to be dispersible in water. The fatty acid amides (Subcategory I) and the fatty acid reaction products with amines (Subcategory III) are expected to possess low mobility in soil. The fatty alkanolamides (Subcategory II) are expected to possess moderate to high mobility in soil. Volatilization is low to moderate for the fatty acid amides and low for the fatty alkanolamides and the fatty acid reaction products with amines. The rate of hydrolysis is considered negligible for all category members. The rate of atmospheric photooxidation is considered moderate to rapid for members of each subcategory; however, this is not expected to be an important environmental fate process since these substances are not expected to exist in the vapor phase in the atmosphere. The overall weight of evidence suggests that the members of the fatty nitrogen derived amides category should possess low persistence (P1) and low bioaccumulation potential (B1) with the exception of two members of subcategory III. Fatty acids, tall-oil, reaction products with tetraethylenepentamine and fatty acids, tall-oil, reaction products with polyethylenepolyamines are expected to possess low persistence (P1), but moderate bioaccumulation potential (B2). As there is limited toxicological data on amides, tall oils fatty, N,N-bis(hydroxyethyl), read across information has been obtained from oleamide DEA (CAS No. 93-83-4) because amides, tall oils fatty, N,N-bis(hydroxyethyl) is

	predominantly diethanolamides of unsaturated C18 fatty acids similar to the composition of oleamide DEA.
Human Health Toxicity Summary [1,2, 3,4]	
Chronic Repeated Dose Toxicity	Based on read-across from CAS 93-83-4, an oral sub-acute repeated dose toxicity study reported NOAEL = 750 mg/kg/day. Groups of 10 male and 10 female Wistar rats were orally gavaged with the substance diluted in olive oil, 5 d/week for 28 d at doses of 0, 70, 250, 750 (Days 1-14) and 1500 (Days 15-28) mg/kg bw/d. Clinical signs, bodyweight, haematology, clinical chemistry, urinalysis, gross and microscopic pathology were recorded. Additional groups of 5 male and 5 female rats were kept for a 4 month recovery period. No treatment-related adverse effects were observed at any of the doses. Changes in the forestomach at some doses including controls were attributed to the use of olive oil and found to be reversible after end of exposure. Under the study conditions, the 28 d NOAEL to rats was considered to be >750 mg/kg bw/day (Potokar, 1983).
Carcinogenicity	Not regarded as carcinogenic.
Mutagenicity/ Genotoxicity	Based on read-across from CAS 93-83-4, the test substance was negative in short-term in vitro and in vivo genotoxicity tests.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	Based on read-across from CAS 68603-42-9, the results from a developmental toxicity study showed that repeated oral administration of COMPERLAN KD to pregnant rats on day 6 through 15 of gestation, caused no symptoms of cumulative toxicity up to a dose level of 1000 mg/kg/day. With the exception of salivation and propulsion of the head during the dose administration, there were no treatment-related effects. Also, COMPERLAN KD does not reveal any embryotoxic or teratogenic potential at dose levels up to 1000 mg/kg/day (author of the report).
Acute Toxicity	Acute oral and dermal toxicities of CAS 68140-00-1 in rat and rabbit, respectively, are low. Further, CAS 93-83-4 is not considered acutely toxic via oral route of exposure with a LD50 of 10,000 mg/kg in rats. Based on read-across from CAS 68140-00-1, an oral acute toxicity test on rats reported LD50 > 5 g/kg. All animals survived the 8-day observation period and no adverse effects were observed. With respect to the determined LD50 value, it is assumed that the LD50 value for female rats also exceeds the limit dose of > 2000 mg/kg body weight. In a dermal acute toxicity test on rabbits, LD50 > 2 g/kg was reported. All animals survived. All animals appeared normal through day 14. Two females that had abraded skin lost weight (0.01 and 0.25 kg) over the 14-day post-exposure period. All remaining rabbits gained weight through day 14. Swiss-Webster mice (4 males/dose) were administered “Alkanolamide #1”, identified in the robust summary as CASRN 68144-20-4, via whole body exposure for 3 hours. Doses were 86- 219 mg/m3 (0.086 – 0.219 mg/L). Animals were observed for several days. No mortality was observed. LC50 > 0.219 mg/L
Irritation	CAS 93-83-4 is considered irritating to skin and eyes.
Sensitisation	The test substance did not cause sensitisation on laboratory animals.
Health Effects Summary	Acute oral and dermal toxicities of CAS 93-83-4 are low. It is considered a skin and eye irritant but does not cause skin sensitisation. It is considered not toxic via repeated oral doses and not genotoxic or carcinogenic. It has no reported adverse reproductive or developmental effects.
Key Study/Critical Effect for Screening Criteria	The oral repeated dose toxicity in rats was considered the most sensitive endpoint with a NOAEL of 750 mg/kg bw/day.
Ecological Toxicity [1, 3]	
Aquatic Toxicity	Based on read-across for CAS No: 68603-42-9 Daphnia: EC50 (24-hour): 3.3 mg active matter/l Daphnia: 48-hour LC50 = 2.15 and 2.64 mg/l Based on read-across for CAS No: 112-84-5 The experiment measured the survival and reproduction of Daphnia magna over a 21-day exposure to the test and control substances. Daphnids were cultured in

	the laboratory using Elendt M7 medium and a daily feeding regiment of green algal cells (Chlorella vulgaris). Four experimental groups: control (Elendt M7 medium), solvent control (0.1 ml methanol/l), 33 µg/l, and 100 µg/l (nominal concentrations) were used in a static-renewal exposure system. All test solutions were prepared with Elendt M7 medium. Replicate test vessels consisted of 4 oz glass bottles containing 100 ml of test solution. There were 10 replicates per experimental group. On the day of test initiation, neonate daphnids were removed from cultures and placed in a crystallizing dish containing Elendt M7 medium. One daphnid was placed in each replicate test vessel, and each vessel was randomly placed in the testing area. Light intensity was not measured, but ambient laboratory lighting was provided with a photoperiod of 16 hours light/8 hours dark. Each day, test solutions were renewed, and the daphnids were fed 1.7 x 10(5) cells/ml of Chlorella vulgaris. Adult survival and reproduction was assessed each day and neonates were removed daily. The pH, dissolved oxygen (DO) and total hardness (as mg/l CaCO(3)) were measured on test days 0, 1, every Tuesday and Friday and on day 21. Means and ranges for temperature, water pH, DO and total hardness were 19.7 °C (14.5 - 25.0 °C), 7.6 (7.2 - 8.1), 8.2 mg/l (4.5 - 9.3 mg/l) and 245 mg/l (234 - 256 mg/l) as CaCO(3), respectively. Concentrations of the test substance in exposure solutions were measured on test days 0, 1, 5, 9, 12, 16 and 19 in both the old and the new solutions. Effect concentrations were based on mean measured concentrations. 21 d NOEC = 0.08 mg/L
Determination of PNEC aquatic	Applying an assessment factor of 1000 to the NOEC (0.08 mg/l) gives a PNEC of 0.08 µg/l.
Current Regulatory Controls	
Australian Hazard Classification	No data available.
Australian Occupational Exposure Standards	No data available.
International Occupational Exposure Standards	No data available.
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	No data available.
PBT Assessment	
P/vP Criteria fulfilled?	No. Expected to be readily biodegradable based on similar substances.
B/vB criteria fulfilled?	No. Based on BAF = 108 and log Kow of 3 (estimated)
T criteria fulfilled?	No. Acute toxicity data was >1 mg/L.
Overall conclusion	Not PBT
Revised	January 2019

References

1. OECD, Amides, tall-oil fatty, N,N-bis(hydroxyethyl), Retrieved 2019: http://www.echemportal.org
2. USEPA Hazard Characterization Document, Fatty Nitrogen Derived (FND) Amides Category, September 2010
3. Halliburton Safety data sheet Date / Revised: 31.08.2018 Version: 3 Product: DCA-32014
4. ECHA REACH, Amides, C18-unsatd., N,N-bis(hydroxyethyl), Retrieved 2022: https://echa.europa.eu/

Toxicity Summary - Ethanol, 2,2'-oxybis-, reaction products with ammonia, morpholine derivatives residues

Chemical and Physical Properties[1]	
CAS number	68909-77-3
Molecular formula	C36H78N6O14
Molecular weight	UVCB
Solubility in water	100 g/L at 20 °C
Melting point	-20 °C at 101.3 kPa
Boiling point	223 °C at 101.3 kPa
Vapour pressure	0.55 - 20 Pa at 20 - 25 °C
Henrys law constant	No data available
Explosive potential	Non-explosive (100%)
Flammability potential	Not classified (50%), Non-flammable (50%)
Colour/Form	Liquid
Overview	The residuum from the reaction of diethylene glycol and ammonia. It consists predominantly of morpholine-based derivatives such as [(aminoethoxy)ethyl]morpholine, [(hydroxyethoxy)ethyl]morpholine, 3-morpholinone, and 4,4'-(oxydi-2,1-ethanediyl)bis[morpholine].
Environmental Fate[1]	
Soil/Water/Air	The substance is hydrolytically stable at pH 4, 7 and 9 at 25°C. Adsorption to solid soil phase is not to be expected. Based on the assessment of the components, it can be concluded that the mixture will not evaporate into the atmosphere. The substance is not readily biodegradable. Based on the low log Kow, the substance will have a low potential for bioaccumulation. Over time, the mixture will preferentially distribute into the compartment water.
Human Health Toxicity Summary[1]	
Chronic Repeated Dose Toxicity	No adverse effects were observed in male and female rats in a 28 days and a 90 days repeated dose toxicity test conducted according to OECD 407 and OECD 408 respectively (Calvert Laboratories, Inc., 2011 and Envigo Research Limited, 2018) in which animals were exposed orally (gavage) to 0, 100, 500 or 1000 mg/kg bw/d (28 days study) and to 0, 10, 100 or 1000 mg/kg bw/d (90 days study). In both studies, an NOAEL of 1000 mg/kg bw was determined.
Carcinogenicity	No data available.
Mutagenicity/ Genotoxicity	In an in vivo micronucleus test on mouse bone marrow erythrocytes (BioReliance, 2010), performed according to OECD guideline 474, the animals were exposed orally (via gavage) with 500, 1000, 2000 mg/kg. This did not induce a statistically positive increase in micronuclei in the hemopoietic cells of the mouse bone marrow at the time intervals evaluated under the experimental condition of this assay. No toxicity was observed. Vehicle and positive controls were valid.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	A Reproductive / Development Toxicity Screening Testing in Rats was performed according to OECD guideline 421 (Calvert Laboratories, Inc., 2011, Klimisch 1). In this GLP-compliant study, male and female Sprague-Dawley rats (10 animals/sex/dose) were exposed to 1000 mg/kg bw/day. Control animals received concurrent vehicle (water). The rats were exposed on a daily basis, starting two weeks prior to cohabitation until the day before the scheduled euthanasia (minimum of 4 weeks) for males and starting for a minimum of 15 days prior to cohabitation, during cohabitation and from presumed gestation days 0 through day 19 of gestation for females. One female animal was found dead on lactation day 2. All other females survived until scheduled sacrifice. No treatment-related effects were observed in clinical signs, mortality, body weight (gain), food consumption, gross pathology, organ weights or histopathology in the parental

	animals. There was no treatment-related effect on reproductive performance or in reproductive parameters like for instance number of gravid animals, corpora lutea per dam, total implantations, litter viability or foetal sex ratios. The incidence of neonates born alive/found dead, stillborn or missing between lactation days 0 -4 was comparable among study groups. No treatment-related malformations were observed for neonates. The body weight of neonates was statistically significantly increased with an unknown biological significance for this finding. A NOAEL of 1000 mg/kg bw/day was established.
Acute Toxicity	The oral LD50 in male and female Sprague-Dawley rats was determined to be 5000 mg/kg bw in a reliable, key study conducted similarly to OECD guideline 420 (Calvert Laboratories, Inc., 2010). Calvert Laboratories Inc (2010) determined acute dermal toxicity in 10 male / female rats following a GLP-compliant study performed equivalent to OECD guideline 402 (key study, Klimisch 1). Only one dose was tested (2000 mg/kg bw). No mortality was observed. Shortly after exposure, local erythema and oedema effects were observed in both males and females. The effects seemed to be reversible in males and 1 female. In the 4 other females, necrosis and slouching appeared.
Irritation	The skin irritation potential of the test substance is investigated in a key, reliable study performed according to OECD guideline 404 (Allen, 1994; Klimisch 2) in 3 rabbits. Semi-occlusive patches were removed from shaved test sites after exposure periods of 3 min, 1h, and 4h to 0.5mL of the test substance. The Draize scoring system was used to evaluate the results. No erythema/eschar formation and no oedema formation is observed after 3 min and 1 hour exposure. After 4 hours of exposure, very slight erythema in all 3 animals and very slight oedema in 2 animals was observed, but this was fully reversible within 24 - 48 hrs. Calvert Laboratories, Inc. (2010) investigated the eye irritation potential of the test substance in a key, reliable study performed according to EU method B.5 (Klimisch 1) in 3 rabbits. The treated eyes (with 0.1mL test substance) will remain unrinsed for at least 24 hours after instillation. The 24-, 48- and 72-hours scores will be added separately for each animal and each total divided by 3 to yield the individual mean scores for each animal. Based on the data and according to the criterial of the CLP regulation, the test substance is classified as irritant to the eyes (category 2).
Sensitisation	Based on a guinea pig maximization study, performed according to the OECD guideline 406 (Allen, 1996; Klimisch 2), the test substance is considered not sensitising to the skin.
Health Effects Summary	This chemical may cause skin and eye irritation.
Key Study/Critical Effect for Screening Criteria	The critical lowest No Observed Adverse Effect (NOAEL) level for the purposes of risk assessment is 1000 mg/kg bw/day from the 90 day repeated oral toxicity study.
Ecological Toxicity [1]	
Aquatic Toxicity	In a static test following the procedures of the German national standard DIN 38412 using Leuciscus idus as test species a LC50 (96 h) of 681.2 mg/L (nominal) was determined [BASF AG, 1988; Study No. 10F0118/885140]. In conclusion, the substance is with high probability not acutely harmful to fish. The EC50 of the test item on daphnids was found to be greater than 122 mg/L (measured value) in a GLP guideline study according to OECD 202 [BASF SE, 2010; Study No. 50E0396/09E012]. Therefore, the test substance is with high probability acutely not harmful to aquatic invertebrates. A study was performed to assess the effect of the test item on the growth of the green alga Pseudokirchneriella subcapitata. The method followed that described in the OECD Guidelines for Testing of Chemicals (2006) No 201, "Freshwater Alga and Cyanobacteria, Growth Inhibition Test" referenced as Method C.3 of Commission Regulation (EC) No 440/2008. The effect of the test item on the growth of Pseudokirchneriella subcapitata has been investigated over a 72-Hour

	period. the ErC50(72h) of the test item is 45 mg/L for Pseudokirchneriella subcapitata. The toxicity to microorganisms was determined in a GLP short-term respiration test according to OECD guideline 209 using activated sludge from a municipal sewage treatment plant. After 180 minutes no inhibition effect on the respiration rate at the highest test concentration (1000 mg/L) was observed [BASF 2010; Study No. 08G0396/09G004]. Therefore, it can be concluded that inhibition of the degradation activity of activated sludge is not anticipated when introduced in appropriately low concentrations.
Determination of PNEC aquatic	The available short-term aquatic tests covering the three trophic levels (fish, daphnids, algae) showed the lowest L(E)C50 to be 45 mg/L in algae. An assessment factor of 1000 was used for a resulting PNEC for of 0.045 mg/L.
Current Regulatory Controls[4]	
Australian Hazard Classification	No data available.
Australian Occupational Exposure Standards	No data available.
International Occupational Exposure Standards	No data available.
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	No data available.
PBT Assessment[1]	
P/vP Criteria fulfilled?	Not readily biodegradable. Thus, it is expected to meet the screening criteria for persistence.
B/vB criteria fulfilled?	As the Log Pow is 0.565 at 20 °C (Log Pow < 4.5), it is not expected to be bioaccumulative.
T criteria fulfilled?	The acute aquatic toxicity of this chemical is >0.1 mg/L. Thus, it is not expected to meet the screening criteria for toxicity
Overall conclusion	Not PBT
Revised	March 2019

References

1. ECHA REACH, Ethanol, 2,2'-oxybis-, reaction products with ammonia, morpholine derivs. residues, Retrieved 2019: https://echa.europa.eu/

Toxicity Summary - (2-Methoxymethylethoxy)propanol

Chemical and Physical Properties[1,2,3]	
CAS number	34590-94-8
Molecular formula	C7H16O3
Molecular weight	148.20
Solubility in water	1 g/L at 25 °C and pH 7
Melting point	-83 °C at 101.325 kPa
Boiling point	190 °C at 101.325 kPa
Vapour pressure	37.1 Pa at 20 °C
Henrys law constant	No data available
Explosive potential	Non-explosive
Flammability potential	Non-flammable
Colour/Form	Colourless organic liquid with a mild odour
Overview	(2-Methoxymethylethoxy) propanol is used as hydraulic fluid and as a high boiling solvent. A Tier 1 Human Health and Environmental Assessment for this chemical has been conducted by NICNAS which concluded that it was low concern to human health and the environment.
Environmental Fate[1]	
Soil/Water/Air	The substance has a low Kow and a high water solubility, therefore has a low potential for adsorption to soil or sediments, and a low potential for bioaccumulation in biota. If released to air, The substance will rapidly react in the atmosphere with hydroxyl radicals. If released directly to water, the substance will remain in the water compartment and ultimately biodegrade, as the substance meets the criteria for “ready biodegradation reaching the 10 day window
Human Health Toxicity Summary [1,2,3]	
Chronic Repeated Dose Toxicity	The 28-day oral gavage study in rats is of high quality and considered to be reliable without restrictions. The only effects observed during this study were salivation and increased liver weights at the highest dose level. The liver weight increase observed at the highest dose level was only slight and no histopathologic changes, except for hypertrophy, accompanied this effect. There were no changes in clinical chemistry (ALP, ASP) indicating a liver damage. The same effect was observed with other structurally related molecules, e.g. propylene glycol methyl ether has been shown to cause liver weight increases via a phenobarbital-like enzyme induction mode of action and it is highly likely that dipropylene glycol methyl ether liver weight increases occur via the same mode of action. As this is an adaptive effect typical for many glycol ethers, it is not considered as adverse. Based on the results of this study a no observed adverse effect level (NOAEL) of 1000 mg/kg bw/day and a no observed effect level (NOEL) of 200 mg/kg/day can be established in rats under the conditions of this study. The two studies via the dermal route are both reliable with restrictions as they were not conducted under GLP, but are equivalent to OECD guidelines. No adverse effects were observed up to 1000 mg/kg bw/day in a 28 -day study in rats. In a 90-day study in rabbits dipropylene glycol methyl ether produced some narcosis at 10 ml/kg bw/day and 5 ml/kg bw/day. No narcosis was observed at lower dose levels (1.0 and 3.0 ml/kg bw/day). Mortality was high at the 10.0 ml/kg dose level, some mortality was observed at 5.0 ml/kg bw/day and no mortality was observed at the 1.0 and 3.0 ml/kg bw/day dose levels. No haematological changes occurred at any dosage level. No significant organ weight changes occurred at any dosage level. Observations for gross pathology revealed only gastric distension and occasional gastric irritation in those animals dying at the 10 ml/kg dosage level. Histopathological analysis done on the liver, lung, spleen, adrenal, heart, testes and stomach of those animals receiving the 5.0 and 10.0 ml/kg bw/day dose levels

	revealed no changes. The kidneys of those animals on the 10.0 ml/kg bw/day level showed some granular and some hydropic changes, at the 5.0 ml/kg same kidney abnormalities were observed but they were of no greater intensity than those observed in some of the controls. The effect of severe (repeated and prolonged) exposure to the skin was slight, being similar to that caused by distilled water under similar conditions. Based on the results of this study a NOAEL of 3.0 ml/kg bw/day (2850 mg/kg/day) was established for dermal exposure to dipropylene glycol methyl ether. No significant adverse effects were observed in rats, rabbits, guinea pigs and monkeys after repeated inhalation exposure to dipropylene glycol methyl ether at any of the test concentrations. The 90 -day inhalation studies in rats and rabbits were selected as key studies as these studies are reliable without restrictions. The highest concentration tested in these studies were 200 ppm which was identified as the NOAEC. Based on the molecular weight of 148, this converts to 1232 mg/m^3 at 20 deg Celcius and 1 atm.
Carcinogenicity	No specific studies for the substance are available. Two inhalation studies with propylene glycol methyl ether in rats and mice are available for read-across to dipropylene glycol methyl ether. Both studies are reliable without restrictions as they were conducted under GLP and according to OECD guideline 453. No carcinogenic effect as evidenced by any increase in tumour incidence occurred from exposure to propylene glycol methyl ether
Mutagenicity/ Genotoxicity	The substance was not mutagenic in bacteria (Salmonella typhimuriumTA 1535, TA 1537, TA 1538, TA 98, and TA 100) and in yeast, and no cytogenetic effect were observed in mammalian cells. The data available indicates that the substance is not genotoxic.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	No treatment related adverse effects - no maternal toxicity, no embryo-/fetotoxicity and no teratogenicity - were observed in rats or rabbits at the highest attainable concentration of dipropylene glycol methyl ether. The studies in both species are of good quality and reliable without restrictions. The no observed adverse effect level for dipropylene glycol methyl ether is 300 ppm in both species.
Acute Toxicity	Oral - All acute toxicity studies via the oral route reported LD50 values greater than 5000 mg/kg for dipropylene glycol methyl ether. The key study identified for acute oral toxicity is the BASF (1979) study in rats with a reported LD50 of greater than 5000 mg/kg body weight. Inhalation - Via the inhalation route no mortality was observed at the highest attainable concentration (i.e. LC0 values > ca. 552.6 ppm, 3404.47 mg/m^3) in three independent studies. The key study identified is the BASF (1979) study in rats with a LC0 greater than 275 ppm (duration 7 hours) which would be equivalent to approximately 1.69422 mg/L (based on conversion equation at 20 degree celsius and 1 atmosphere). Using Haber's law for converting this 7-hour exposure to a 4 -hour exposure, the equivalent LC0 value is greater than 2.04 mg/L or 2040 mg/m^3. Dermal - For the dermal route, two studies reported no mortality up to the highest dose tested (20 ml/kg bw) in rats and rabbits. One study in rabbits reported a dermal LD50 of 10 ml/kg bw (9510 mg/kg bw). The lowest LD50 will be taken into account for the risk assessment. The other study reported LD50 greater than 19020 mg/kg body weight in rats.
Irritation	Several non-GLP studies in rabbits equivalent or similar to OECD guidelines 404 and 405 are available for the substance. These studies are supported by a human volunteer study for eye irritation and a 90-day dermal study in rabbits. No irritation was observed in rabbits and humans
Sensitisation	No sensitization reaction was observed with the substance in the study with human volunteers.
Health Effects Summary	Poses no unreasonable risk to human health based on Tier I assessment under the NICNAS IMAP assessment framework.
Key Study/Critical Effect for Screening Criteria	The oral repeated dose toxicity in rats was considered the most sensitive endpoint with a NOAEL of 1000 mg/kg bw/day.
Ecological Toxicity[1,2,3]	
Aquatic Toxicity	Acute toxicity studies have been conducted in fish, daphnia and algae. In summary, for the aquatic compartment dipropylene glycol methyl ether shows

	EC50s/LC50s that exceed 1000 mg/l in daphnia (48 hr), fish (96 hr) and algae (7 days). The NOEC for reproduction of Daphnia magna corresponds to the highest concentration tested of 0.5 mg/L in the long-term test, which was set very low considering the low acute toxicity of the substance on Daphnia magna. The low chronic toxicity is highlighted in a freshwater algae test with a NOEC at 1000 mg/L. An activated sludge respiration inhibition test showed an EC50 of 4168 mg/L for micro-organisms.
Determination of PNEC aquatic	Data from short-term tests with three trophic levels and one long-term test on invertebrates are available. An assessment factor of 100 is applied to the lowest NOEC of 0.5 mg/L (daphnia). A PNECaqua of 0.005 mg/L was derived.
Current Regulatory Controls[4,5,6]	
Australian Hazard Classification	No data available.
Australian Occupational Exposure Standards	A TWA of 50 ppm (308 mg/m^3) is recommended to protect for eye, nose and throat irritation in exposed workers
International Occupational Exposure Standards	TLV: 100 ppm as TWA; 150 ppm as STEL; (skin). MAK: 310 mg/m^3, 50 ppm; peak limitation category: I(1); pregnancy risk group: D. EU-OEL: 308 mg/m^3, 50 ppm as TWA; (skin)
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	No data available.
PBT Assessment	
P/vP Criteria fulfilled?	No. Expected to be readily biodegradable.
B/vB criteria fulfilled?	No. Based on the Log Kow of 0.004 at 25 °C (Log Kow < 4.2).
T criteria fulfilled?	No. Chronic toxicity data >0.01 mg/L in invertebrates, thus the substance does not meet the screening criteria for toxicity.
Overall conclusion	Not PBT
Revised	December 2021

References

1. ECHA REACH, 2,2',2''-(hexahydro-1,3,5-triazine-1,3,5-triyl)triethanol, Retrieved 2021: https://echa.europa.eu/
2. National Industrial Chemicals Notification and Assessment Scheme (NICNAS). IMAP, Human Health Tier 1 Assessment. Retrieved 2019: https://www.industrialchemicals.gov.au/.
3. NCBI, 2021. National Center for Biotechnology Information. Available at: https://pubchem.ncbi.nlm.nih.gov/. Retrieved December 2021
4. HCIS, Hazardous Chemical Information System, Safe Work Australia, Retrieved December 2021: http://hcis.safeworkaustralia.gov.au/HazardousChemical.
5. ILO, International Labour Organisation, International Chemical Safety Cards (ICSCs), Retrieved December 2021: http://www.ilo.org/dyn/icsc/showcard.listcards3?p_lang=en.
6. NHMRC, 2018. Australian Drinking Water Guidelines 6, 2011, Version 3.5 Updated August 2018. National Water Quality Management.

Toxicity Summary - 1-Tetradecene

Chemical and Physical Properties[1,2]	
CAS number	1120-36-1
Molecular formula	C14H28
Molecular weight	196.37
Solubility in water	4.0 x 10^{-4} mg/L at 25°C (estimated)
Melting point	-12°C
Boiling point	233.0 °C
Vapour pressure	1.5 x 10^{-2} mm Hg at 25°C
Henrys law constant	8.48 atm-cu m/mole at 25°C (estimated)
Explosive potential	No data available.
Flammability potential	Non-flammable
Colour/Form	Watery liquid; colourless; mild pleasant odour.
Overview	1-Tetradecene is an anthropogenic compound which is used as a specialty solvent. It may be released to the environment as a fugitive emission during its production and use, and as a result of the burning of plastics.
Environmental Fate[1,2]	
Soil/Water/Air	If released to soil, 1-tetradecene will be essentially immobile. It may rapidly volatilize from moist soil to the atmosphere although its expected strong adsorption to soil may attenuate the rate of this process. 1-Tetradecene will not volatilize from dry soil to the atmosphere. Pure culture studies indicate that 1-tetradecene has the potential to biodegrade in soil and water under aerobic conditions. If released to water, 1-tetradecene will bioconcentrate in fish and aquatic organisms and strongly adsorb to sediment and suspended organic matter. It may rapidly volatilize from water to the atmosphere. The estimated half-life for volatilization from a model river is 4.1 hrs. Its expected strong adsorption to sediment and suspended organic matter may attenuate the rate of this process. The estimated half-life for volatilization from a model pond, which takes into account adsorptive processes, is 7.3 months. If released to the atmosphere, 1-tetradecene may undergo removal by gas-phase reaction with atmospheric oxidants. Estimated half-lives for the reaction with photochemically produced hydroxyl radicals and ozone are 9.3 hrs and 23 hrs.
Human Health Toxicity Summary[1,2]	
Chronic Repeated Dose Toxicity	Guideline repeat dose toxicity studies in rats have been conducted for fourteen members of the higher olefin category, covering C6 to C20-24. The majority of these investigations (27 studies) have used oral (gavage) exposure, with three sub-acute (28-day), nine screening (OECD 421/422), and seven sub-chronic (90-day) studies available for this route. Two sub-acute dermal, two sub-acute inhalation and one sub-chronic inhalation tests, are also available; eight short-term repeat dose range-finding studies are also available. For the oral studies, systemic toxicity findings were typically limited to body weight, liver changes, and effects on clinical chemistry parameters as well as organ weights. Some of the effects observed were adaptive rather than adverse. While most of the studies revealed no systemic toxicity at doses up to 1000 mg/kg bw/day, a conservative NOAEL for this category was determined to be 100 mg/kg bw/day, based on minor effects observed with some category members. The inhalation toxicity NOAEC was determined to be 3,000 ppm (10,326 mg/m^3).
Carcinogenicity	No data available.
Mutagenicity/ Genotoxicity	There was no evidence of mutagenicity or genotoxicity in any of the studies.

Reproductive Toxicity / Developmental Toxicity/Teratogenicity	The weight of evidence from oral reproductive and developmental toxicity studies, accompanied with data from oral and inhalation sub-chronic toxicity studies in rats indicate that category members have little or no potential to be considered reproductive/developmental toxicants.
Acute Toxicity	Not acutely hazardous after ingestion, inhalation or skin contact, based on read across animal test data. The acute oral LD50 for hex-1-ene (Neodene 6) alpha olefin in male and female rats was reported as >5600 mg/kg. To assess acute oral toxicity of alkenes, C20-24, groups of 5 fasted female Sprague-Dawley CD strain rats were given a single oral dose (2000 mg/kg bw) of ENORDET O241 and observed for 14 days (Sanders, 2008). There were no treatment related clinical signs, necropsy findings or changes in body weight. The oral LD50 was determined to be greater than 2000 mg/kg in this single sex study.
Irritation	Not irritating to skin and eyes.
Sensitisation	There was no evidence of dermal sensitization in any of the studies.
Health Effects Summary	The substance is expected to have low acute toxicity and is not an irritant.
Key Study/Critical Effect for Screening Criteria	A conservative NOAEL for this category was determined to be 100 mg/kg bw/day, based on minor effects observed with some category members.
Ecological Toxicity[1,2]	
Aquatic Toxicity	Short term toxicity: LC50 (4 days): 3.4 µg/L (fish) EC50 (48 h): 2.8 µg/L (invertebrates) EC50 (4 days): 4.5 µg/L (algae) Long term toxicity: NOEC (21 days): 19.4 µg/L (invertebrates)
Determination of PNEC aquatic	Based on the lowest chronic endpoint for aquatic toxicity (19.4 µg/L), an assessment factor of 100 has been applied, resulting in a PNECaquatic of 0.194 µg/L.
Current Regulatory Controls[3,4,5]	
Australian Hazard Classification	No data available.
Australian Occupational Exposure Standards	No data available.
International Occupational Exposure Standards	No data available.
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	No data available.
PBT Assessment[1,4]	
P/vP Criteria fulfilled?	No. Expected to be readily biodegradable.
B/vB criteria fulfilled?	Yes. Bioaccumulation of this substance may occur in aquatic organisms based on the estimated Log Kow of 7.3 (Log Kow > 4.2)
T criteria fulfilled?	No. Chronic toxicity data >0.01 mg/L in invertebrates, thus the substance does not meet the screening criteria for toxicity.

Overall conclusion	Not PBT
Revised	December 2021

References

1. ECHA REACH, Tetradec-1-ene, Retrieved 2021: https://echa.europa.eu/
2. NCBI, 2021. National Center for Biotechnology Information. Available at: https://pubchem.ncbi.nlm.nih.gov/. Retrieved December 2021
3. HCIS, Hazardous Chemical Information System, Safe Work Australia, Retrieved December 2021: http://hcis.safeworkaustralia.gov.au/HazardousChemical.
4. ILO, International Labour Organisation, International Chemical Safety Cards (ICSCs), Retrieved December 2021: http://www.ilo.org/dyn/icsc/showcard.listcards3?p_lang=en.
5. NHMRC, 2018. Australian Drinking Water Guidelines 6, 2011, Version 3.5 Updated August 2018. National Water Quality Management.

Toxicity Summary - Aluminium

Chemical and Physical Properties[1,2,3,4,5]	
CAS number	7429-90-5
Molecular formula	Al
Molecular weight	26.982
Solubility in water	Insoluble
Melting point	660.32°C
Boiling point	2,327°C
Vapour pressure	0
Henrys law constant	No data available
Explosive potential	No data
Flammability potential	Finely divided aluminium dust is easily ignited
Colour/Form	Silver white, malleable, ductile metal, cubic crystal, odourless
Overview	Aluminium is the most abundant metal in the earth's crust and it is widely distributed. Aluminium is a very reactive element and is never found as the free metal in nature. It is found combined with other elements, most commonly with oxygen, silicon, and fluorine. These chemical compounds are commonly found in soil, minerals (e.g., sapphires, rubies, turquoise), rocks (especially igneous rocks), and clays. Aluminium as the metal is obtained from aluminium-containing minerals, primarily bauxite. A Tier 1 Human Health and Environmental Assessment for this chemical has been conducted by NICNAS which concluded that it was low concern to human health and the environment.
Environmental Fate[1]	
Soil/Water/Air	Aluminium is the most abundant metal in the earth's crust, but is never found in its elemental state in nature. In compounds, aluminium occurs in its only oxidation state (+3). The transport and partitioning of aluminium in the environment is determined by its chemical properties, as well as the characteristics of the environmental matrix that affect its solubility. At a pH >5.5, naturally occurring aluminium compounds exist predominantly in an undissolved form such as gibbsite, Al(OH)3, or as aluminosilicates except in the presence of high amounts of dissolved organic material or fulvic acid, which binds with aluminium and can cause increased dissolved aluminium concentrations in streams and lakes. As an element, aluminium cannot be degraded in the environment, but may undergo various precipitation or ligand exchange reactions. The solubility of aluminium in the environment will depend on the ligands present and the pH.
Human Health Toxicity Summary [1,2,3,4,5]	
Chronic Repeated Dose Toxicity	Aluminium has been implicated in causing neurological and hematopoietic effects in individuals with impaired renal function. Respiratory and neurological effects have been observed in workers exposed to finely ground aluminium and aluminium welding fumes. Impaired lung function has been observed in workers employed in various aluminium industries including potrooms, foundry, and welders. Other studies have provided some suggestive evidence that aluminium exposure can result in occupational asthma or pulmonary fibrosis. A common limitation of most of these occupational exposure studies is co-exposure to other compounds, such as silica, which can also damage the respiratory tract. Subtle neurological effects have been observed in workers exposed to aluminium dust in the form of McIntyre powder, aluminium dust and fumes in potrooms, and aluminium fumes during welding. Studies examining the systemic toxicity of aluminum following chronic oral exposure have identified two potential targets of toxicity: the nervous system and the hematopoietic system.

Carcinogenicity	The current weight of evidence does not support an association between inhalation exposure to aluminium metal/aluminium oxide and cancers in the respiratory organs. The weight of evidence also does not support a systemic carcinogenic effect from exposure to aluminium metal and aluminium oxide.
Mutagenicity/ Genotoxicity	Several in vitro studies have found significant increases in the occurrence of micronuclei formation and chromosome aberrations in human lymphocytes; no human in vivo studies were identified. One study examined the in vivo genotoxicity of aluminium and found clastogenic changes in mice receiving an intraperitoneal injection of aluminium chloride. In vitro studies in mammalian and bacterial systems have not found mutagenic alterations.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	No studies were located regarding reproductive effects of various forms of aluminium following inhalation, oral, or dermal exposure in humans. No histological alterations were observed in the reproductive tissues of rats or guinea pigs exposed to airborne aluminium chlorhydrate. A number of oral-exposure studies examining reproductive end points in several animal species were identified. In general, the results of these studies suggest that aluminium is not associated with alterations in fertility, mating success, or number of implantations, implantation losses, or litter size.
Acute Toxicity	Aluminium metal (dust/powder) is not to be classified for acute oral, inhalation and dermal toxicity. Oral LD50 (rat) > 2000 mg/kg bw Inhalation LC50 (rat) > 888 mg/m^3 Inhalation NOAEC (rat) = 10 mg/m^3
Irritation	Not irritating to eye and skin.
Sensitisation	Not sensitising
Health Effects Summary	Poses no unreasonable risk to human health based on Tier I assessment under the NICNAS IMAP assessment framework.
Key Study/Critical Effect for Screening Criteria	The toxicological effects of Al in rodents suggests that neurotoxicological and developmental (including neurodevelopmental) endpoints are among the most sensitive indicators of Al toxicity. The LOAEL of 100 mg Al/kg-day for minimal neurotoxicity in the offspring of mice is selected as the basis for the chronic reference dose (RfD). Application of an uncertainty factor (UF) of 100 (3 for use of a minimal LOAEL, 10 for interspecies extrapolation and 3 for intra-human variability where the critical effects have been observed in a sensitive sub-group) results in a provisional RfD of 1 mg Al/kg-day.
Ecological Toxicity[6]	
Aquatic Toxicity	8-day LC50 0.17 mg/L (fish) 8-day LC50 of 2.28 mg/L (amphibian)
Determination of PNEC aquatic	PNEC freshwater: 74.9 µg/L
Current Regulatory Controls[6,7,8,9]	
Australian Hazard Classification	Aluminium powder (pyrophoric): H261 (In contact with water releases flammable gas) H250 (Catches fire spontaneously if exposed to air) Aluminium powder (stabilised): H261 (In contact with water releases flammable gas) H228 (Flammable solid)
Australian Occupational Exposure Standards	Time Weighted Average (TWA): Aluminium (metal dust) = 10 mg/m^3 Aluminium (welding fumes) (as Al) = 5 mg/m^3 Aluminium, alkyls (NOC) (as Al) = 2 mg/m^3 Aluminium, pyro powders (as Al) = 5 mg/m^3 Aluminium, soluble salts (as Al) = 2 mg/m^3

International Occupational Exposure Standards	TLV: 1 mg/m^3, as TWA; A4 (not classifiable as a human carcinogen). MAK: (inhalable fraction): 4 mg/m3; (respirable fraction): 1.5 mg/m3; pregnancy risk group: D
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	A freshwater moderate reliability trigger value of 55 µg/L was derived for aluminium at pH >6.5 using the statistical distribution method (Burr distribution as modified by CSIRO, ANZECC & ARMCANZ 2000 Section 8.3.3.3) with 95% protection and an ACR of 8.2. A freshwater low reliability trigger value of 0.8 µg/L was derived for aluminium at pH <6.5 using an assessment factor (AF) of 20 (essential element) on the low pH trout LC50 figure. The low reliability figures should only be used as indicative interim working levels. There were limited marine data and procedures for calculating an Environmental Concern Level (ECL) (ANZECC & ARMCANZ 2000 Section 8.3.4.5) were used to calculate a low reliability marine trigger value of 0.5 µg/L derived for aluminium using an AF of 200. This figure should only be used as an indicative interim working level but could be revisited as more data become available. The factor of 200 was used because the ECL factor of 1000 was considered excessive for such a commonly found element.
PBT Assessment[1]	
P/vP Criteria fulfilled?	Not applicable (aluminium as a metal do not degrade and traditional persistence measures used for organic substances do not equally apply to metals).
B/vB criteria fulfilled?	Not applicable. Bioaccumulation is not applicable to inorganic compounds; aluminium ions are ubiquitous and are present in most water, soil and sediment.
T criteria fulfilled?	No. LC50 >0.1 mg/L in fish (The lowest measured chronic figure was an 8-day LC50 of 0.17 mg/L for fish).
Overall conclusion	It is not currently possible to categorise the environmental hazards of metals and other inorganic chemicals according to standard persistence, bioaccumulation and toxicity (PBT) hazard criteria. These criteria were developed for organic chemicals and do not take into account the unique properties of inorganic substances and their behaviour in the environment.
Revised	December 2021

References

1. ECHA REACH, Aluminium, Retrieved 2021: https://echa.europa.eu/
2. USEPA, 2021. Regional Risk Levels. November 2021. https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables. Retrieved December 2021.
3. National Industrial Chemicals Notification and Assessment Scheme (NICNAS). IMAP, Human Health Tier 1 Assessment. Retrieved 2019: https://www.industrialchemicals.gov.au/.
4. ATSDR, 2008. Toxicological Profile for Aluminium. Agency for Toxic Substances and Disease Registry. September 2008.
5. USEPA, 2006. Provisional Peer-Reviewed Toxicity Values for Aluminium. U.S. Environmental Protection Agency, Washington, DC, EPA/690/R-06/001F.
6. ANZG, 2018. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia. Available at www.waterquality.gov.au/anz-guidelines.
7. NHMRC, 2018. Australian Drinking Water Guidelines 6, 2011, Version 3.5 Updated August 2018. National Water Quality Management.
8. HCIS, Hazardous Chemical Information System, Safe Work Australia, Retrieved December 2021: http://hcis.safeworkaustralia.gov.au/HazardousChemical.
9. ILO, International Labour Organisation, International Chemical Safety Cards (ICSCs), Retrieved December 2021: http://www.ilo.org/dyn/icsc/showcard.listcards3?p_lang=en.

Toxicity Summary - Ammonium hydrogensulfite

Chemical and Physical Properties[1,2,3]	
CAS number	10192-30-0
Molecular formula	H3N.H2O3S
Molecular weight	99.11
Solubility in water	718 - 6 200 g/L at 0 - 60 °C
Melting point	No data available
Boiling point	No data available
Vapour pressure	No data available
Henrys law constant	No data available
Explosive potential	No data available
Flammability potential	No data available
Colour/Form	Colourless to yellow crystals
Overview	Ammonium hydrogensulfite are soluble in water. It is non-combustible. It is corrosive to aluminium. It is a strong irritant to skin and mucous membranes. It is toxic by skin absorption.
Environmental Fate[1]	
Soil/Water/Air	The substance has a very low vapour pressure, and also does not sublime. Therefore, the substance will not be present as a gas and no radical reactions can be expected. According to its chemical properties, hydrolysis is not expected/probable. Photodegradation in water is not relevant because it dissociates rapidly into ions and decomposes in water, and it not susceptible to visible light. The substance is an inorganic compound which does not undergo biodegradation. The substance readiliy dissociates in aqueous solution, as with soil moisture. Bioaccumulation is not to be expected. a low log Kow underlines this statement. Due to the ionic salt-character and other physico-chemical properties (negligible vapour pressure, very high water solubility and decomposition in water), the Henry constant is near to zero. Because of its ionic nature, ammonium hydrogensulfite as well as its dissociation products are not volatile from aqueous solutions. Relevant adsorption onto soils, sediments or suspended matter is not expected.
Human Health Toxicity Summary[1,2,3]	
Chronic Repeated Dose Toxicity	Male and female rats received 0, 0.125, 0.25, 0.5, 1.0 or 2.0% $Na_2S_2O_5$ in a thiamine-containing diet (50 ppm) for 104 weeks. Based on the occurrence of occult blood in faeces and changes in gastric morphology at dose levels of 0.5% or more, the NOAEL for local chronic toxicity in this study is represented by the dose of 0.25% metabisulfite (or 0.215% accounting for the loss of metabisulfite). The corrected dose level corresponded to a dose of 108 mg/kg bw/d $Na_2S_2O_5$ or an equivalent dose of 113 mg/kg bw/day ammonium hydrogensulfite. Because there was no evidence of systemic toxicity following chronic treatment, the NOAEL for systemic effects can be expected above the highest dose of 2% sodium metabisulfite corresponding to 955 mg/kg bw/d of $Na_2S_2O_5$ or 996 mg/kg bw/d ammonium hydrogensulfite.
Carcinogenicity	Not considered to be carcinogenic.
Mutagenicity/ Genotoxicity	Not considered to be genotoxic
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	Not considered to cause reproductive or developmental toxicity

Acute Toxicity	Based on the described read-across methodology information from sodium sulfite (CAS 7757-83-7), sodium metabisulfite (CAS 7681 -57 -4) and potassium metabisulfite (CAS 16731 -55 -8) were used to determine acute toxicity values (oral, dermal and inhalatiion) for ammonium hydrogensulfite. In total, four reliable animal studies on acute oral exposure for sulfite substances are available, conducted equivalent or similar to OECD guideline 401. One study (Grundler, 1981) indicates a LD50 value of >2610 mg/kg/bw (male and female rats) for the test item sodium sulfite (CAS 7757 -83 -7). One study performed with potassium metabisulfite (CAS 16731 -55 -8) as test item indicated a LD50 >2000 mg/kg/bw (no clinical symptoms were observed in the concentration rang 200 - 2000 mg/kg bw). Two animal study reports on acute oral exposure to sodium metabisulfite (CAS 7681 -57 -4) are available (Hofmann & Jung, 1987 and Zeller&Hofmann, 1974), conducted according to or equivalent/similar to OECD guideline 401. The study of Hofmann & Jung indicated a LD50 >1540 mg/kg/bw. whereas the study performed by Zeller & Hofmann indicated a LD50 value of >3200 mg/kg bw. One study on acute dermal toxicity, performed according to OECD 402 for the test item sodium sulfite (CAS 7757 -83 -7) is available. LD50 value was determined to be greater than 2000 mg/kg/bw (limit test).No systemic clinical observations were observed during clinical examination. No local effects were observed. One study equivalent or similar to OECD 403 for sodium sulfite (CAS 7757 -83 -7) has been performed which indicated a LC50 >5.5 mg/l (limit test). During exposure nothing abnormal was detected. After exposure: substance-contaminated heads, and unstable, staggering gait. After one day nothing abnormal was detected.
Irritation	Not irritating
Sensitisation	Not likely to be skin sensitisers
Health Effects Summary	The main critical effects to human health are severe eye irritation and acute oral toxicity. This chemical will liberate toxic gas when in contact with acid and therefore may cause effects in individuals with a high acid content in the stomach.
Key Study/Critical Effect for Screening Criteria	The chronic repeated dose study in rats with a NOAEL of 113 mg/kg bw/day ammonium hydrogensulfite was used in the risk assessment.
Ecological Toxicity[1]	
Aquatic Toxicity	Algae NOEC/EC10 = 28 mg SO_3^{2-}/L Invertebrates NOEC/EC10 = ≥8.41 mg SO_3^{2-}/L Fish NOEC/EC10 = 50 mg SO_3^{2-}/L
Determination of PNEC aquatic	The lowest value for chronic toxicity was the NOEC for invertebrates of 8.41 mg SO_3^{2-}/L. Applying the AF of 10 results in a PNECaquatic of 0.84 mg SO_3^{2-}/L. Translating this value to H3N.H2O3S gives a PNECaquatic of 1.04 mg test substance/L.
Current Regulatory Controls[2,4,5,6,7]	
Australian Hazard Classification	Acute toxicity – category 4 Eye damage – category 1
Australian Occupational Exposure Standards	No data available.
International Occupational Exposure Standards	The following exposure standards are identified for sulfites: An exposure limit (OEL, TWA, STEL, PEL or STV) of 5 – 10 mg/m^3 in different countries such as USA, United Kingdom, Canada, Ireland, Spain, Norway and Switzerland.
Australian Food Standards	The ADI value of 0-0.7 mg/kg bw/day for sulphites was used by FSANZ for the dietary risk assessment.
Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	Inorganic substance comprising ions of low ecotoxicological concern. This chemical is not expected to pose an unreasonable risk to the environment provided

	that ANZECC water quality guidelines for physical and chemical stressors are not exceeded.
PBT Assessment[1]	
P/vP Criteria fulfilled?	Not applicable (inorganic substance, ionic species ubiquitous in environment)
B/vB criteria fulfilled?	Not applicable. Bioaccumulation is not applicable to these inorganic substances.
T criteria fulfilled?	No. Inorganic substance comprising ions of low ecotoxicological concern.
Overall conclusion	It is not currently possible to categorise the environmental hazards of inorganic chemicals according to standard persistence, bioaccumulation and toxicity (PBT) hazard criteria. These criteria were developed for organic chemicals and do not take into account the unique properties of inorganic substances and their behaviour in the environment.
Revised	December 2021

References

1. ECHA REACH, Ammonium hydrogensulfite, Retrieved 2021: https://echa.europa.eu/
2. National Industrial Chemicals Notification and Assessment Scheme (NICNAS). IMAP, Sulfites: Human health tier II assessment: Retrieved 2021: https://www.industrialchemicals.gov.au/.
3. NCBI, 2021. National Center for Biotechnology Information. Available at: https://pubchem.ncbi.nlm.nih.gov/. Retrieved December 2021
4. HCIS, Hazardous Chemical Information System, Safe Work Australia, Retrieved December 2021: http://hcis.safeworkaustralia.gov.au/HazardousChemical.
5. ILO, International Labour Organisation, International Chemical Safety Cards (ICSCs), Retrieved December 2021: http://www.ilo.org/dyn/icsc/showcard.listcards3?p_lang=en.
6. Food Standards Australia New Zealand (FSANZ). Retrieved December 2021: https://www.foodstandards.gov.au/consumer/additives/sulphite/Pages/default.aspx
7. NHMRC, 2018. Australian Drinking Water Guidelines 6, 2011, Version 3.5 Updated August 2018. National Water Quality Management.

Toxicity Summary - Barite

Chemical and Physical Properties[1,2,3]	
CAS number	13462-86-7
Molecular formula	Ba(SO4)
Molecular weight	233.39
Solubility in water	3.1 mg/L at 20°C
Melting point	1580°C
Boiling point	1600°C at 760 mm Hg (Decomposes)
Vapour pressure	No data available
Henrys law constant	No data available
Explosive potential	No data available
Flammability potential	No data available
Colour/Form	Odourless white powder
Overview	Barium sulphate is an inorganic compound. It is partially soluble in water, dissociating into barium and sulphate ions; both are ubiquitous in the environment. The ions will not adsorb on particulate matter or surfaces and will not accumulate in living tissues A Tier 1 Human Health Assessment for this chemical has been conducted by NICNAS which concluded that it was low concern to human health.
Environmental Fate[1]	
Soil/Water/Air	The dissolution of barium substances in the environment and corresponding dissolved Ba levels are controlled by the solubility of barite (BaSO4) and witherite (BaCO3), two naturally occurring barium minerals and the concentration of dissolved Ba cations in freshwater is rather low. However, in the dissolved state, the divalent barium cation, is the predominant form in soil, sediments and water. The solubility of barium compounds increases as solution pH decreases. Barium in soils is not expected to be very mobile because of the formation of water-insoluble salts (sulphate and carbonate) and its inability to form soluble complexes with humic and fulvic materials. Transport, fate, and toxicity of barium in the environment are largely controlled by the solubility of barium minerals. The barium cation is the moiety of toxicological concern, and thus the hazard assessment is based on Ba2+.
Human Health Toxicity Summary [1,2,3]	
Chronic Repeated Dose Toxicity	The NOAEL for barium toxicity in this study is based on depressed body weight gains, elevated phosphorus levels, neurobehavioral effects and chemically related lesions in the kidney and lymphoid tissue at the highest dose level of 4000 pm. Individual effects observed at 2000 ppm barium chloride in drinking water (corresponding to the final barium dose of 61.1 and 80.9 mg Ba/kg bw/day to male and female rats respectively) were regarded as not treatment-related, and this dose level therefore represents the NOAEL. No systemic toxicity was shown to result from long term inhalation exposure in humans to high concentrations of barium sulphate. Particle overload is observed for insoluble particles such as barium sulphate, whereby the rat is the most sensitive species studied, and species-specific differences are demonstrated in various mechanistic animal studies. It has been demonstrated with reasonable certainty that lung overload conditions are not relevant for human health.
Carcinogenicity	There was no evidence of carcinogenic activity (showing no chemical related increase of malignant or benign neoplasms) of barium chloride in both sexes of rats and mice that received 500, 1250, and 2500 ppm. Thus, the concentration of 2500 ppm represents a NOAEL (corresponding to barium doses of 60 and 75 mg/kg bw/d to male and female rats, respectively, and 160 and 200 mg/kg bw/d to male and female mice, respectively).

Mutagenicity/ Genotoxicity	Not likely to be mutagenic or genotoxic.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	Only a screening test is available. However, based on this study there are no indications of a substantial impairment of fertility in rats up to the highest dose tested. Thus, the NOAEL was 4000 ppm (to average doses of 201.5 and 179.5 mg Ba/kg bw/d to male and and female rats, respectively). NOAELs on developmental toxicity for rats of 4000 ppm were derived. However, this NOAEL is of limited value to evaluate the potential for barium to induce developmental effects because there was no exposure of the females during gestation.
Acute Toxicity	The toxicity of barium sulphate and barium chloride is based on the Ba2+cation and therefore on the solubility of the test substance. Barium chloride is well water soluble (ca. 375 g/L) at pH ca. 6.5 (pH of artificial sweat solution), whereas barium sulphate is low soluble (3.1 mg/L at pH 9). Due to the fact that Barium chloride seems to be no toxic via the dermal route it can be concluded that barium sulphate will result in a dermal LD50 of >>2000 mg/kg bw and should therefore not classified as acute toxic to the dermal route.
Irritation	Not irritating to skin or eyes.
Sensitisation	Barium sulphate is expected to be not sensitizing to skin.
Health Effects Summary	Poses no unreasonable risk to human health based on Tier I assessment under the NICNAS IMAP assessment framework.
Key Study/Critical Effect for Screening Criteria	The repeated dose toxicity via oral application was considered the key study. Rats were dosed at 61.1 and 80.9 mg Ba2+ /kg bw/day to male and female rats via feed for 90 days. The values refer to 104 and 138 mg/kg bw/day. The NOAEL for barium toxicity in this study is based on depressed body weight gains, elevated phosphorus levels, neurobehavioral effects and chemically related lesions in the kidney and lymphoid tissue at the highest dose level. Individual effects observed were regarded as non-treatment related.
Ecological Toxicity[1]	
Aquatic Toxicity	Short-term toxicity EC/LC50 values of barium sulphate available for 3 trophic levels: 96 hrs LC50: >3.5 mg/L (Fish) 48 hrs LC50: 14.5 mg/L (Invertebrates) 72 hrs EC50: 1.15 mg/L (Algae) Long-term toxicity data are available for three trophic levels: 33 days NOEC: 1.26 mg/L (Fish) 21 days NOEC: 2.9 mg/L (Invertebrates) 72 hrs NOEC: 1.15 mg/L (Algae)
Determination of PNEC aquatic	Data from short and long-term tests with three trophic levels are available. An assessment factor of 10 is applied to the lowest EC50 of 1.15 mg/L (algae). A PNECaqua of 115 µg/L was derived.
Current Regulatory Controls[5,6,7,8]	
Australian Hazard Classification	No data available.
Australian Occupational Exposure Standards	No data available.
International Occupational Exposure Standards	No data available.
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	No data available.

PBT Assessment[1]	
P/vP Criteria fulfilled?	Not applicable (inorganic salt, ionic species ubiquitous in environment)
B/vB criteria fulfilled?	Not applicable. Bioaccumulation is not applicable to these inorganic ions; barium and sulphate ions are ubiquitous and are present in most water, soil and sediment.
T criteria fulfilled?	Not applicable. Chronic toxicity data >1 mg/L, thus barium sulphate does not meet the screening criteria for toxicity.
Overall conclusion	Not PBT
Revised	December 2021

References

1. ECHA REACH, Barite sulfate, Retrieved 2021: https://echa.europa.eu/
2. National Industrial Chemicals Notification and Assessment Scheme (NICNAS). IMAP, Human Health Tier 1 Assessment. Retrieved 2019: https://www.industrialchemicals.gov.au/.
3. NCBI, 2021. National Center for Biotechnology Information. Available at: https://pubchem.ncbi.nlm.nih.gov/. Retrieved December 2021.
4. EHS Support, Barium Sulfate. Available at: https://www.santos.com/wp-content/uploads/2021/04/Barium-sulfate-March-2021.pdf. Retrieved December 2021.
5. ANZG, 2018. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia. Available at www.waterquality.gov.au/anz-guidelines.
6. NHMRC, 2018. Australian Drinking Water Guidelines 6, 2011, Version 3.5 Updated August 2018. National Water Quality Management.
7. HCIS, Hazardous Chemical Information System, Safe Work Australia, Retrieved December 2021: http://hcis.safeworkaustralia.gov.au/HazardousChemical.
8. ILO, International Labour Organisation, International Chemical Safety Cards (ICSCs), Retrieved December 2021: http://www.ilo.org/dyn/icsc/showcard.listcards3?p_lang=en.

Toxicity Summary - Barium Sulphate

Chemical and Physical Properties[1,2,3]	
CAS number	13462-86-7, 7727-43-7
Molecular formula	Ba(SO4)
Molecular weight	233.39
Solubility in water	3.1 mg/L at 20°C
Melting point	1580°C
Boiling point	1600°C at 760 mm Hg (Decomposes)
Vapour pressure	No data available
Henrys law constant	No data available
Explosive potential	No data available
Flammability potential	No data available
Colour/Form	Odourless white powder
Overview	Barium sulphate is an inorganic compound. It is partially soluble in water, dissociating into barium and sulphate ions; both are ubiquitous in the environment. The ions will not adsorb on particulate matter or surfaces and will not accumulate in living tissues A Tier 1 Human Health Assessment for this chemical has been conducted by NICNAS which concluded that it was low concern to human health.
Environmental Fate[1]	
Soil/Water/Air	The dissolution of barium substances in the environment and corresponding dissolved Ba levels are controlled by the solubility of barite (BaSO4) and witherite (BaCO3), two naturally occurring barium minerals and the concentration of dissolved Ba cations in freshwater is rather low. However, in the dissolved state, the divalent barium cation, is the predominant form in soil, sediments and water. The solubility of barium compounds increases as solution pH decreases. Barium in soils is not expected to be very mobile because of the formation of water-insoluble salts (sulphate and carbonate) and its inability to form soluble complexes with humic and fulvic materials. Transport, fate, and toxicity of barium in the environment are largely controlled by the solubility of barium minerals. The barium cation is the moiety of toxicological concern, and thus the hazard assessment is based on Ba2+.
Human Health Toxicity Summary [1,2,3]	
Chronic Repeated Dose Toxicity	The NOAEL for barium toxicity in this study is based on depressed body weight gains, elevated phosphorus levels, neurobehavioral effects and chemically related lesions in the kidney and lymphoid tissue at the highest dose level of 4000 pm. Individual effects observed at 2000 ppm barium chloride in drinking water (corresponding to the final barium dose of 61.1 and 80.9 mg Ba/kg bw/day to male and female rats respectively) were regarded as not treatment-related, and this dose level therefore represents the NOAEL. No systemic toxicity was shown to result from long term inhalation exposure in humans to high concentrations of barium sulphate. Particle overload is observed for insoluble particles such as barium sulphate, whereby the rat is the most sensitive species studied, and species-specific differences are demonstrated in various mechanistic animal studies. It has been demonstrated with reasonable certainty that lung overload conditions are not relevant for human health.
Carcinogenicity	There was no evidence of carcinogenic activity (showing no chemical related increase of malignant or benign neoplasms) of barium chloride in both sexes of rats and mice that received 500, 1250, and 2500 ppm. Thus, the concentration of 2500 ppm represents a NOAEL (corresponding to barium doses of 60 and 75 mg/kg bw/d to male and female rats, respectively, and 160 and 200 mg/kg bw/d to male and female mice, respectively).

Mutagenicity/ Genotoxicity	Not likely to be mutagenic or genotoxic.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	Only a screening test is available. However, based on this study there are no indications of a substantial impairment of fertility in rats up to the highest dose tested. Thus, the NOAEL was 4000 ppm (to average doses of 201.5 and 179.5 mg Ba/kg bw/d to male and and female rats, respectively). NOAELs on developmental toxicity for rats of 4000 ppm were derived. However, this NOAEL is of limited value to evaluate the potential for barium to induce developmental effects because there was no exposure of the females during gestation.
Acute Toxicity	The toxicity of barium sulphate and barium chloride is based on the Ba2+cation and therefore on the solubility of the test substance. Barium chloride is well water soluble (ca. 375 g/L) at pH ca. 6.5 (pH of artificial sweat solution), whereas barium sulphate is low soluble (3.1 mg/L at pH 9). Due to the fact that Barium chloride seems to be no toxic via the dermal route it can be concluded that barium sulphate will result in a dermal LD50 of >>2000 mg/kg bw and should therefore not classified as acute toxic to the dermal route.
Irritation	Not irritating to skin or eyes.
Sensitisation	Barium sulphate is expected to be not sensitizing to skin.
Health Effects Summary	Poses no unreasonable risk to human health based on Tier I assessment under the NICNAS IMAP assessment framework.
Key Study/Critical Effect for Screening Criteria	The repeated dose toxicity via oral application was considered the key study. Rats were dosed at 61.1 and 80.9 mg Ba2+ /kg bw/day to male and female rats via feed for 90 days. The values refer to 104 and 138 mg/kg bw/day. The NOAEL for barium toxicity in this study is based on depressed body weight gains, elevated phosphorus levels, neurobehavioral effects and chemically related lesions in the kidney and lymphoid tissue at the highest dose level. Individual effects observed were regarded as non-treatment related.
Ecological Toxicity[1]	
Aquatic Toxicity	Short-term toxicity EC/LC50 values of barium sulphate available for 3 trophic levels: 96 hrs LC50: >3.5 mg/L (Fish) 48 hrs LC50: 14.5 mg/L (Invertebrates) 72 hrs EC50: 1.15 mg/L (Algae) Long-term toxicity data are available for three trophic levels: 33 days NOEC: 1.26 mg/L (Fish) 21 days NOEC: 2.9 mg/L (Invertebrates) 72 hrs NOEC: 1.15 mg/L (Algae)
Determination of PNEC aquatic	Data from short and long-term tests with three trophic levels are available. An assessment factor of 10 is applied to the lowest EC50 of 1.15 mg/L (algae). A PNECaqua of 115 µg/L was derived.
Current Regulatory Controls[5,6,7,8]	
Australian Hazard Classification	No data available.
Australian Occupational Exposure Standards	No data available.
International Occupational Exposure Standards	No data available.
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	No data available.

PBT Assessment[1]	
P/vP Criteria fulfilled?	Not applicable (inorganic salt, ionic species ubiquitous in environment)
B/vB criteria fulfilled?	Not applicable. Bioaccumulation is not applicable to these inorganic ions; barium and sulphate ions are ubiquitous and are present in most water, soil and sediment.
T criteria fulfilled?	Not applicable. Chronic toxicity data >1 mg/L, thus barium sulphate does not meet the screening criteria for toxicity.
Overall conclusion	Not PBT
Revised	December 2021

References

1. ECHA REACH, Barite sulfate, Retrieved 2021: https://echa.europa.eu/
2. National Industrial Chemicals Notification and Assessment Scheme (NICNAS). IMAP, Human Health Tier 1 Assessment. Retrieved 2019: https://www.industrialchemicals.gov.au/.
3. NCBI, 2021. National Center for Biotechnology Information. Available at: https://pubchem.ncbi.nlm.nih.gov/. Retrieved December 2021.
4. EHS Support, Barium Sulfate. Available at: https://www.santos.com/wp-content/uploads/2021/04/Barium-sulfate-March-2021.pdf. Retrieved December 2021.
5. ANZG, 2018. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia. Available at www.waterquality.gov.au/anz-guidelines.
6. NHMRC, 2018. Australian Drinking Water Guidelines 6, 2011, Version 3.5 Updated August 2018. National Water Quality Management.
7. HCIS, Hazardous Chemical Information System, Safe Work Australia, Retrieved December 2021: http://hcis.safeworkaustralia.gov.au/HazardousChemical.
8. ILO, International Labour Organisation, International Chemical Safety Cards (ICSCs), Retrieved December 2021: http://www.ilo.org/dyn/icsc/showcard.listcards3?p_lang=en.

Toxicity Summary - Bitumen

Chemical and Physical Properties[1,2]	
CAS number	8052-42-4
Molecular formula	Unknown or variable composition, complex reaction products or biological materials (UVCB)
Molecular weight	UVCB
Solubility in water	No data available
Melting point	30 - 128°C at 101.3 - 101.325 kPa
Boiling point	320 - 500°C at 101.325 kPa
Vapour pressure	1 hPa @ 20 °C
Henrys law constant	No data available
Explosive potential	No data available
Flammability potential	No data available
Colour/Form	Black or dark brown solid or semi-solid at 20°C and 101.3 kPa
Overview	A very complex combination of high molecular weight organic compounds containing a relatively high proportion of hydrocarbons having carbon numbers predominantly greater than C25 with high carbon-to-hydrogen ratios. It also contains small amounts of various metals such as nickel, iron, or vanadium. It is obtained as the non-volatile residue from distillation of crude oil or by separation as the raffinate from a residual oil in a deasphalting or decarbonization process. Bitumen is also commonly known as asphalt.
Environmental Fate[1]	
Soil/Water/Air	Hydrocarbons are degraded (under aerobic conditions) via mono-oxygenases or di-oxygenases and are subsequently carboxylated and ultimately hydroxylated. In further assessing the type of metabolites formed, it has been demonstrated that for all the major classes of hydrocarbons, the major metabolites are in most cases less toxic, and always less bioaccumulative than the parent molecule.
Human Health Toxicity Summary[1,2]	
Chronic Repeated Dose Toxicity	Based on the data available, the chemicals in this group are not considered to cause serious damage to health from repeated dermal exposure. In a GLP-compliant study conducted similarly to OECD TG 410, residues, petroleum, vacuum (CAS No. 64741-56-6) was administered at dosages of 200, 1000, or 2000 mg/kg bw three times a week for four weeks. Clinical observations included slight oedema, flaking skin, wheezing and decreased food-intake (qualitative observation), resulting in reduced body weight gain in all dose groups when compared to controls. There were statistically significant reduced body weight gains in males in the high-dose group. There were no significant changes in clinical chemistry, haematology parameters or reproductive organs reported. A no observed adverse effect level (NOAEL) for local effects of 200 mg/kg bw/day was reported based on dermal irritation. A NOAEL for systemic effects of 1000 mg/kg bw/day was reported based on decreased body weight (which was considered to be secondary to the reduced food intake). Based on the data available, the chemicals in this group are not considered to cause serious damage to health from repeated inhalation exposure. The fume condensate from oxidized asphalt (CAS No. 64742-93-4) was tested in rats in a combined repeated dose and reproductive and developmental screening test conducted in accordance with OECD TG 474. Wistar rats were exposed (nose only) to concentrations of approximately 30, 100 or 300 mg/m^3 for 28 days. A no observed adverse effect concentration (NOAEC) was established as 100 mg/m^3 based on slight histopathological changes observed in the lungs observed at the highest dose.

	Asphalt fume condensate collected over a paving asphalt tank was tested in a repeated dose inhalation study conducted in accordance with OECD TG 413. Wistar rats were exposed (nose-only) to concentrations of approximately 5, 28 or 149 mg/m^3 for 90 days. The NOAEC was established as 28 mg/m^3 based on reduced body weights and histopathological changes in the nasal and paranasal cavities observed at the highest dose.
Carcinogenicity	Based on the available data, the chemicals in this group as whole materials are not considered carcinogenic, although dilution in organic solvents may produce some carcinogenic effects following prolonged dermal exposure. Exposure to asphalt emissions during certain occupations has been linked to increased risks of carcinogenicity.
Mutagenicity/ Genotoxicity	Based on the weight of evidence, the chemicals in this group (as whole materials) are not considered to be mutagenic. Asphalt fume condensates are mutagenic, with the level of mutagenic activity related to the temperature at which they are generated and levels of PACs.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	There are no reproductive or developmental toxicity studies available on asphalt or asphalt fumes. Based on the limited data available, and the low concentration of PACs generated in asphalt fumes, a classification for reproductive or developmental effects is not warranted. In a GLP-compliant two-generation reproduction toxicity study conducted in accordance with OECD TG 416, rats were exposed (oral gavage) to the analogue chemical, distillates (Fischer-Tropsch), heavy, C18-50- branched, cyclic and linear (CAS No. 848301-69-9) at dosages of 0, 50, 250 or 1000 mg/kg bw/day. The analogue chemical is mainly comprised of saturated oil components, which may be found in asphalts. There were histopathological lesions in the lungs (chronic interstitial/alveolar inflammation) of the F0- and F1-generations. There were corresponding macroscopic findings and/or increased lung weights, and effects in the kidneys (renal tubular hyaline droplets likely associated with alpha-2µ-globulin) of the F1 males only. The study authors stated that the lung lesions were most likely secondary to aspiration of the chemical and, therefore, not relevant for human risk assessment. The renal effects are specific to male rats. These are induced by hydrocarbons and have no relevance for humans. An equivocal, non-adverse slight decrease in F2 pup brain weights was reported. A NOAEL of 1000 mg/kg bw/day was determined for reproductive and systemic toxicity, based on no adverse effects on the male and female reproductive systems, non-reproductive tissues, and other parameters (such as body weight, feed consumption, and clinical observations).
Acute Toxicity	Oral: Based on the data available, the chemicals in this group have low acute toxicity based on results from animal tests following oral exposure to residues, petroleum, vacuum (CAS No. 64741-56-6). The median lethal dose (LD50) in rats is >5000 mg/kg bw. Observed sub-lethal effects included hypoactivity and diarrhoea. Dermal: Based on the data available, the chemicals in this group have low acute toxicity based on results from animal tests following dermal exposure to residues, petroleum, vacuum (CAS No. 64741-56-6). The LD50 value in rats is >2000 mg/kg bw. Inhalation: Based on the data available, the chemicals in this group have low acute toxicity following inhalation exposure. No mortality or significant signs of toxicity were noted in rats exposed to fumes generated from condensates collected from the headspace of a bitumen storage unit. Mean exposures were estimated to be 182 mg/m^3 for four hours. No mortality or toxic effects have been reported in several other studies in which rats were repeatedly exposed up to 300 mg/m^3.
Irritation	Based on the available data, the chemicals in this group may slightly irritate skin in animal studies, particularly following repeated exposure. Based on the available data, the chemicals in this group may be, at most, slightly irritating to the eye in animal studies.

	Exposure to asphalt vapours was reported to cause only minor, transient conjunctivitis in the eyes of rabbits.
Sensitisation	The negative results observed for residues, petroleum, vacuum (CAS No. 64741-56-6), in several skin sensitisation animal studies conducted in accordance with OECD TG 406 (Buehler test), support a conclusion that the chemicals in this group are not skin sensitisers.
Health Effects Summary	The critical health effects for risk characterisation relate to the use of the chemicals at elevated temperatures. Fumes from asphalts have been associated with carcinogenicity and mutagenicity in humans and animals. There is considered to be an increased risk for fumes containing higher levels of PACs. The levels of PACs are affected by the temperature of fume generation. Exposure to asphalt fumes could also cause irritant effects (skin, eye, nasal and throat) and respiratory effects. Severe burns to the skin have been reported in workers from hot asphalt (usually used at temperatures from 150 to 190°C).
Key Study/Critical Effect for Screening Criteria	The repeated dose toxicity in rats via dermal application was considered the most sensitive endpoint with a NOAEL of 200 mg/kg bw/day.
Ecological Toxicity[1]	
Aquatic Toxicity	Short term toxicity: LL50 (4 days): 1 g/L (fish) LL50 (48 h): 1 g/L (invertebrates) EL50 (72 h): 1 g/L (algae) Long term toxicity: LL50 (28 days): 1 g/L (fish)
Determination of PNEC aquatic	Based on the lowest endpoint for aquatic toxicity (1 g/L), an assessment factor of 100 has been applied, resulting in a PNECaquatic of 0.01 g/L.
Current Regulatory Controls[2,3,4]	
Australian Hazard Classification	No data available.
Australian Occupational Exposure Standards	Asphalt as bitumen fumes, has an occupational exposure limit (OEL) of 5 mg/m^3 time weighted average (TWA).
International Occupational Exposure Standards	The following exposure standards are identified (Galleria Chemica) for asphalt: An OEL of 0.5–10 mg/m^3 TWA and 1.5–10 mg/m^3 short-term exposure limit (STEL) in different countries such as Canada, Chile, China, Germany, Indonesia, Ireland, Malaysia, Mexico, Norway, Singapore, South Africa, Spain, Switzerland, United Kingdom, and USA. The American Conference of Governmental Industrial Hygienists (ACGIH) recommends a threshold limited value (TLV) of 0.5 mg/m^3 (TWA) as benzene-soluble (or equivalent method) inhalable aerosol. 'This value is intended to minimize the potential for mucous membrane and ocular irritation'.
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	No data available.
PBT Assessment[1]	
P/vP Criteria fulfilled?	No. Based on QSAR modelling, the substance is expected to be readily biodegradable.
B/vB criteria fulfilled?	Not applicable (substance is a UVCB). Calculated BCF for constituents of this substance range between 0.4 and 13300 L/kg.
T criteria fulfilled?	No. Chronic toxicity data >1 g/L in invertebrates, thus the substance does not meet the screening criteria for toxicity.

Overall conclusion	Not PBT. These chemicals are a UVCB. They do not contain PBT constituents included in the Substances of Very High Concern (SVHC) candidate list at concentrations above 0.1%.
Revised	December 2021

References

1. ECHA REACH, Asphalt, Retrieved 2021: https://echa.europa.eu/
2. National Industrial Chemicals Notification and Assessment Scheme (NICNAS). IMAP, Asphalt: Human health tier II assessment: Retrieved 2021: https://www.industrialchemicals.gov.au/.
3. NHMRC, 2018. Australian Drinking Water Guidelines 6, 2011, Version 3.5 Updated August 2018. National Water Quality Management.
4. HCIS, Hazardous Chemical Information System, Safe Work Australia, Retrieved December 2021: http://hcis.safeworkaustralia.gov.au/HazardousChemical.

Toxicity Summary - Calcium oxide

Chemical and Physical Properties[1,2,3,4]	
CAS number	1305-78-8
Molecular formula	CaO
Molecular weight	56.08
Solubility in water	1.19 g/L at 20 °C
Melting point	2572°C
Boiling point	2850°C
Vapour pressure	Negligible at 25 °C
Henrys law constant	No data available
Explosive potential	Non-explosive
Flammability potential	Non-flammable
Colour/Form	Greyish yellow, odourless, hygroscopic solid
Overview	Calcium oxide (CaO), is an inorganic compound commonly known as quicklime or burnt lime, is a widely used chemical compound. The chemical is used as a component of a hydraulic fracturing fluid formulation for coal seam gas extraction. A Tier 1 Human Health and Environmental Assessment for this chemical has been conducted by NICNAS which concluded that it was low concern to human health and the environment.
Environmental Fate[5]	
Soil/Water/Air	Calcium oxide reacts immediately upon exposure to water, forming calcium hydroxide, which itself reacts with carbon dioxide to form calcium carbonate. The final reaction products of both limestone and calcium oxide in the environment are therefore essentially the same, although calcium oxide typically has lower concentrations of magnesium and other inorganic chemicals than limestone and produces a higher initial concentration of hydroxide ions. Calcium and carbonate ions occur naturally in all environmental compartments and are important nutrients for various organisms. Calcium is mobile in soil and, if released to the environment, should be expected to experience significant partitioning to the water compartment. However, calcium ions may also form insoluble precipitates with anions present in the environment, such as carbonate ions, and settle out of the aqueous phase.
Human Health Toxicity Summary[2]	
Chronic Repeated Dose Toxicity	Several repeat dose studies using analogues of calcium oxide (calcium hydroxide, calcium carbonate, calcium gluconate) investigating the effect of calcium ions on various metabolic functions in experimental animals are available in the literature. However, all these studies were considered inappropriate for derivation of a No Observed Adverse Effect Level (NOAEL) by the study authors, as they did not follow any international guidelines (ECHA REACH).
Carcinogenicity	No data available. Using a read across study, calcium oxide is considered not likely to be carcinogenic.
Mutagenicity/ Genotoxicity	Calcium oxide is not mutagenic.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	In two developmental toxicity studies conducted according to methods equivalent or similar to the OECD TG 414 (Prenatal Developmental Toxicity Study), calcium oxide was administered by gavage to pregnant female Wistar rats up to 680 mg/kg bw/day and CD-1 mice up to 440 mg/kg bw/day during gestation days 6 to 15 (10 consecutive doses). There were no clear discernible effects on implantation, maternal survival or foetal survival in any species at any of the doses. The number of abnormalities seen in either soft or skeletal tissues of the test groups did not

	differ significantly from those occurring spontaneously in the controls. No NOAEL could be established for maternal toxicity or foetal developmental effects. Based on the available data, calcium oxide is not considered to be a developmental toxicant.
Acute Toxicity	A study on acute oral toxicity of calcium oxide in female rats was conducted by a scientifically accepted method. Different doses of calcium oxide suspended in polyethylene glycol (0.2 g/mL) were administered to rats by gavage. No deaths were observed at 2000 mg/kg bw, indicating that the oral median lethal dose (LD50) for rats is >2000 mg/kg bw. No adverse effects were observed following treatment. No macroscopic findings were observed at necropsy. Calcium oxide has low oral acute toxicity with an oral LD50 of >2000 mg/kg bw. Acute dermal toxicity studies with calcium oxide are not available. An acute dermal toxicity study was conducted in rabbits using moistened calcium hydroxide (Ca(OH)2). As calcium oxide (CaO) is converted to Ca(OH)2 in the presence of moisture, the test results for Ca(OH)2 are also applicable for CaO. No animal deaths were observed at 2500 mg/kg bw Ca(OH)2, indicating that the dermal LD50 for male/female rabbits is >2500 mg/kg bw. No adverse effects were observed following the treatment. Based on the results with Ca(OH)2, calcium oxide is considered to have low acute dermal toxicity.
Irritation	Results from two skin irritation studies with calcium hydroxide (hydrated calcium oxide) indicated that calcium hydroxide causes skin irritation. The US Occupational Health Guideline for calcium oxide states 'calcium oxide causes irritation of the eyes, nose, throat and skin. Severe burns may result from contact with this chemical'. Calcium oxide is also considered to be a severe eye irritant.
Sensitisation	No data available.
Health Effects Summary	Poses no unreasonable risk to human health based on Tier I assessment under the NICNAS IMAP assessment framework.
Key Study/Critical Effect for Screening Criteria	Calcium oxide has low acute oral and dermal toxicity, is a skin and respiratory irritant and a severe eye irritant. Calcium oxide is not genotoxic or carcinogenic and does not have any developmental effects in animals. Given the constituent ions of calcium oxide which are subject to tight homeostatic control in the body, repeated exposure to calcium oxide is regarded to have no significant systemic effects. In an epidemiological study, no significant adverse effects were observed in lime-kiln workers exposed to 1.2 mg/m^3 lime dust. This atmospheric concentration was taken as an overall NOAEC for calcium oxide. This NOAEC will be carried forward for human health risk assessment. The critical health effects of calcium oxide are skin and respiratory irritation and severe eye irritation.
Ecological Toxicity [2,5]	
Aquatic Toxicity	Oncorhynchus mykiss 96-hour LC50: 50.6 mg/L Daphnia magna 48-hour EC50: 49.1 mg/L Pseudokirchneriella subcapitata 72 hour EC10: 79.22 mg/L A 42-day Oncorhynchus mykiss test showed that enhanced Ca2+ diets (60 mg Ca2+) had no effects on survival. Mean fish weights remained constant across all treatments. A 14-day Crangon septemspinosa test showed an EC10 of 32 mg/L.
Determination of PNEC aquatic	A Tier 1 assessment of the environmental risks from the use of substances in the Limestone and its derivatives group is not required.
Current Regulatory Controls[2]	
Australian Hazard Classification	Calcium oxide is listed as hazardous in the Hazardous Substances Information System (HSIS). No risk phrases have been assigned to this chemical.
Australian Occupational Exposure Standards	The chemical has an exposure standard of 2 mg/m^3, Time Weighted Average (TWA)

International Occupational Exposure Standards	The following exposure standards are identified in Galleria Chemica (2013): Occupational Exposure limit (TWA) of 2 mg/m^3 [Canada, Denmark, Korea, UK, US (NIOSH)] Permissible Exposure Limits (PEL) of 5 mg/m^3 [US (OSHA 1978)].
Australian Food Standards	Calcium oxide is allotted the following International Numbering System of food additives number: INS 529 (Food Standards Australia New Zealand 2013).
Australian Drinking Water Guidelines	Calcium oxide is used in water treatment to correct pH and adjust alkalinity, for coagulation optimisation, corrosion control and water softening. Typical calcium oxide concentrations used in drinking water treatment depend on the quality of the water to be treated and the purpose of treatment (e.g. water softening, pH adjustment or alkalinity increase) and can vary from 5 to 500 mg/L.
Aquatic Toxicity Guidelines	No data available.
PBT Assessment	
P/vP Criteria fulfilled?	Not applicable (inorganic salt, ionic species ubiquitous in environment).
B/vB criteria fulfilled?	Not applicable. Bioaccumulation is not applicable to these inorganic ions; sodium and hydroxide ions are ubiquitous and are present in most water, soil and sediment.
T criteria fulfilled?	No. Chronic and acute toxicity data >1 mg/L, calcium oxide does not meet the screening criteria for toxicity.
Overall conclusion	It is not currently possible to categorise the environmental hazards of metals and other inorganic chemicals according to standard persistence, bioaccumulation and toxicity (PBT) hazard criteria. These criteria were developed for organic chemicals and do not take into account the unique properties of inorganic substances and their behaviour in the environment.
Revised	December 2021

References

1. ECHA REACH, Calcium oxide, Retrieved 2021: https://echa.europa.eu/
2. Department of the Environment and Energy 2017, National assessment of chemicals associated with coal seam gas extraction in Australia, prepared by the National Industrial Chemicals Notification and Assessment Scheme
3. National Industrial Chemicals Notification and Assessment Scheme (NICNAS). IMAP, Human Health Tier 1 Assessment. Retrieved 2021: https://www.industrialchemicals.gov.au/.
4. NCBI, 2021. National Center for Biotechnology Information. Available at: https://pubchem.ncbi.nlm.nih.gov/. Retrieved December 2021.
5. EHS Support, Calcium oxide, calcium hydroxide. Available at: https://www.santos.com/wp-content/uploads/2021/05/Calcium-oxide-and-calcium-hydroxide-March-2021.pdf. Retrieved December 2021.
6. HCIS, Hazardous Chemical Information System, Safe Work Australia, Retrieved December 2021: http://hcis.safeworkaustralia.gov.au/HazardousChemical.
7. ILO, International Labour Organisation, International Chemical Safety Cards (ICSCs), Retrieved December 2021: http://www.ilo.org/dyn/icsc/showcard.listcards3?p_lang=en.

Toxicity Summary - Copper (II) oxide

Chemical and Physical Properties[1,2,3,4]	
CAS number	1317-38-0
Molecular formula	CuO
Molecular weight	79.55
Solubility in water	Insoluble
Melting point	1,326 °C
Boiling point	No data available.
Vapour pressure	No data available.
Henrys law constant	No data available.
Explosive potential	No data available.
Flammability potential	No data available.
Colour/Form	Black to brownish-black amorphous or crystalline powder or granules
Overview	CuO is an inorganic compound. It is a product of copper mining and is used for the production of other copper-containing products. A Tier 1 Human Health Assessment for this chemical has been conducted by NICNAS which concluded that it was low concern to human health.
Environmental Fate[1]	
Soil/Water/Air	Among the copper species released/transformed, Cu (II) is thus the most environmental relevant species. It is further recognised that Cu (II) ions - commonly named free cupric ions- are the most active copper species and that total Cu or Cu(II) concentrations are usually not directly related to ecological effects since exposure of biota may be limited by processes that render Cu unavailable for uptake. Assessing the species of Cu (II) therefore has ecotoxicological relevance. After being released into the environment, the Cu(II) ions typically bind to inorganic and organic ligands contained within water, soil, and sediments. In water Cu(II) binds to dissolved organic matter (e. g. humic or fulvic acids). The Cu(II) ion forms stable complexes with -NH2, -SH, and, to a lesser extent, -OH groups in these organic acids. Cu(II) will also bind with varying affinities to inorganic and organic components in sediments and soils. For example, Cu(II) binds strongly to hydrous manganese and iron oxides in clay and to humic acids, but much less strongly to aluminosilicates in sand. In all environmental compartments (water, sediment, soil), the binding affinities of Cu(II) with inorganic and organic matter is dependent on pH, the oxidation-reduction potential in the local environment, and the presence of competing metal ions and inorganic anions.
Human Health Toxicity Summary [1,2,3]	
Chronic Repeated Dose Toxicity	The chronic toxicity of CuO is based on studies on copper sulphate. The pivotal repeat dose study was a 90-day study by the oral route with copper sulphate pentahydrate. In rats and mice, ingestion of copper sulphate pentahydrate produced forestomach lesions that could be due to the irritant effects of the compound. The no-observed-adverse-effect level (NOAEL) for this effect was 16.7 mg Cu/kg bw/day in rats and 97 and 126 mg Cu/kg bw/day in male and female mice respectively. In rats, inflammation of the liver was observed. The NOAEL for liver and kidney damage were 16.7 mg Cu/kg bw/day in rats.
Carcinogenicity	The carcinogenicity of copper has not been adequately studied. An increase in cancer risk has been found among copper smelters; however, the increased risk has been attributed to concomitant exposure to arsenic. Increased lung and stomach cancer risks have also been found in copper miners. However, a high occurrence of smoking and exposure to radioactivity, silica, iron, and arsenic obscure the association of copper exposure with carcinogenesis. Animal studies have not found increased cancer risks in orally exposed rats or mice.

Mutagenicity/ Genotoxicity	The available genotoxicity studies support the indication that copper compounds have no carcinogenic potential. The studies include Ames assays in Salmonella typhimurium on copper II sulphate pentahydrate; a micronucleus study on copper II sulphate pentahydrate and an unscheduled DNA synthesis ex vivo study in rat liver on copper II sulphate. The Ames tests indicated that copper sulphate had no mutagenic activity. No evidence of an increase in the incidence of micronuclei was detected in the mouse micronucleus study when mice were orally administered two doses of 447 mg/kg copper sulphate, 24 h apart. There was also no evidence of unscheduled DNA synthesis in the rat liver. These studies are consistent and show a lack of in vitro mutagenic activity or in vivo clastogenic potential associated with soluble copper compounds. The results of these studies do not highlight a concern regarding the genotoxic potential of copper compounds.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	The two-generation study in the rat indicate that that under the conditions of this study, the NOAEL for reproductive toxicity was 1500 ppm, the highest concentration tested. The NOAEL for P1 and F1 rats and F1 and F2 offspring during lactation was 1000 ppm, based on reduced spleen weight in P1 adult females, and F1 and F2 male and female weanlings at 1500 ppm however the transient reduced spleen weights are not considered a reproductive endpoint as it did not affect growth or fertility.
Acute Toxicity	In a study to assess the acute oral toxicity of copper oxide following a single oral administration by gavage, there were no mortalities or signs of systemic toxicity among any of the animals treated with copper oxide at the test concentration of 2000 mg/kg bw. An LD50 of >2500 mg/kg bw can be estimated using the flow chart in annex 2d of OECD Guidelines for the Testing of Chemicals No. 423 “Acute Oral Toxicity – Acute Toxic Class Method. The acute median lethal dose (LD50) of copper oxide in the Sprague-Dawley CD (Crl: CD (SD) IGS BR) strain of rats study to assess the acute dermal toxicity of copper oxide was found to be >2000 mg/kg bw.
Irritation	Not irritating to the skin and eyes.
Sensitisation	Not sensitising.
Health Effects Summary	Poses no unreasonable risk to human health based on Tier I assessment under the NICNAS IMAP assessment framework.
Key Study/Critical Effect for Screening Criteria	The NOAEL of 16.7 mg Cu/kg bw/day for liver and kidney damage in rats is used in the risk characterisation.
Ecological Toxicity [1,3]	
Aquatic Toxicity	Based on copper ecotoxicity data: Fish: 2.6 µg/L (Ptylocheilus oregonensis, from 7-day LC50) 131 µg/L (Pimephales promelas, 7-day LC50) Crustaceans: 1.7 µg/L (D. pulex and G. pulex, NOEC, reproduction & mortality) 12.1 µg/L (Hyalella azteca, from 10 to 14-day LC50). Insects: 2.2 µg/L (Tanytarsus dissimilis, from 10-day LC50) 11 µg/L (Chironomus tentans, 10 to 20-day LC50). Molluscs: 1.64 µg/L (Flumicola virens, from 14-day LC50) 56.2 (Corbicula manilensis, from 7 to 42-day LC50).
Determination of PNEC aquatic	The PNECaquatic for freshwater is determined to be 7.8 µg/L based on the conclusion that the copper concentrations in food items and daily dietary copper dose in fish are unlikely to cause negative effects at this threshold.
Current Regulatory Controls[4]	
Australian Hazard Classification	H410 (Very toxic to aquatic life with long-lasting effects)

Australian Occupational Exposure Standards	No data availanle
International Occupational Exposure Standards	TWA = 1 mg/m^3 (dust & mists) TWA = 0.2 mg/m^3 (fume)
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	Based on health considerations, the concentration of copper in drinking water should not exceed 2 mg/L. Based on aesthetic considerations, the concentration of copper in drinking water should not exceed 1 mg/L.
Aquatic Toxicity Guidelines	A freshwater high reliability trigger value for copper of 1.4 µg/L was derived using the statistical distribution method with 95% protection. A marine high reliability trigger value for copper of 1.3 µg/L was derived using the statistical distribution method with 95% protection.
PBT Assessment	
P/vP Criteria fulfilled?	Not applicable (ionic species ubiquitous in environment).
B/vB criteria fulfilled?	Not applicable. Bioaccumulation is not applicable to these inorganic ions; copper ions are ubiquitous and are present in most water, soil and sediment.
T criteria fulfilled?	Not applicable. Copper is an essential nutrient for all living organisms.
Overall conclusion	It is not currently possible to categorise the environmental hazards of metals and other inorganic chemicals according to standard persistence, bioaccumulation and toxicity (PBT) hazard criteria. These criteria were developed for organic chemicals and do not take into account the unique properties of inorganic substances and their behaviour in the environment.
Revised	December 2021

References

1. ECHA REACH, Copper (II) oxide, Retrieved 2021: https://echa.europa.eu/
2. NCBI, 2021. National Center for Biotechnology Information. Available at: https://pubchem.ncbi.nlm.nih.gov/. Retrieved December 2021.
3. ANZG, 2018. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia. Available at www.waterquality.gov.au/anz-guidelines.
4. National Industrial Chemicals Notification and Assessment Scheme (NICNAS). IMAP, Human Health Tier 1 Assessment. Retrieved 2019: https://www.industrialchemicals.gov.au/.
5. NHMRC, 2018. Australian Drinking Water Guidelines 6, 2011, Version 3.5 Updated August 2018. National Water Quality Management.
6. HCIS, Hazardous Chemical Information System, Safe Work Australia, Retrieved December 2021: http://hcis.safeworkaustralia.gov.au/HazardousChemical.
7. ILO, International Labour Organisation, International Chemical Safety Cards (ICSCs), Retrieved December 2021: http://www.ilo.org/dyn/icsc/showcard.listcards3?p_lang=en.

Toxicity Summary - Copper

Chemical and Physical Properties[1,2,3,4]	
CAS number	7440-50-8
Molecular formula	Cu
Molecular weight	63.546
Solubility in water	Insoluble
Melting point	1,057 – 1,059 °C
Boiling point	No data
Vapour pressure	1 (1,628 °C)
Henrys law constant	No data
Explosive potential	No data
Flammability potential	No data
Colour/Form	Reddish, solid
Overview	Copper is a reddish metal that occurs naturally in rock, soil, water, sediment, and at low levels in air. Copper's unique chemical and physical properties include high thermal conductivity, high electrical conductivity, malleability, low corrosion, alloying ability, and pleasing appearance. Properties of metallic copper such as electrical conductivity and fabricability vary markedly with purity. A Tier 1 Human Health Assessment for this chemical has been conducted by NICNAS which concluded that it was low concern to human health.
Environmental Fate[3]	
Soil/Water/Air	Copper is released to the atmosphere in the form of particulate matter or adsorbed to particulate matter. Atmospheric copper is removed by gravitational settling, dry deposition, and wet deposition (rain and snow). Much of the copper discharged into waterways is in particulate matter and settles out. In the water column and in sediments, copper adsorbs to organic matter, hydrous iron and manganese oxides, and clay. Copper binds primarily to organic matter in estuarine sediment unless the sediment is low in organic matter content. Most copper deposited on soil from the atmosphere, agricultural use, and solid waste and sludge disposal will be adsorbed with greater concentrations of copper measured in the upper 5 – 10 centimetres of soil in comparison to lower soil depths, except in sandy soils where the lability of bound copper is greater. Copper's movement in soil is determined by a host of physical and chemical interactions of copper with the soil components. In general, copper will adsorb to organic matter, carbonate minerals, clay minerals, or hydrous iron and manganese oxides. Sandy soils with low pH have the greatest potential for leaching. Copper binds strongly to soils with high organic content.
Human Health Toxicity Summary[3,4]	
Chronic Repeated Dose Toxicity	Liver damage (necrosis, fibrosis, abnormal biomarkers of liver damage) have been reported in individuals ingesting lethal doses of copper sulphate. There is some evidence from animal studies to suggest that exposure to airborne copper or high levels of copper in drinking water can damage the immune system. Impaired cell-mediated and humoral-mediated immune function have been observed in mice. Studies in rats, mice, and mink suggest that exposure to high levels of copper in the diet can result in decreased embryo and foetal growth.
Carcinogenicity	The carcinogenicity of copper has not been adequately studied. An increase in cancer risk has been found among copper smelters; however, the increased risk has been attributed to concomitant exposure to arsenic. Increased lung and

	stomach cancer risks have also been found in copper miners. However, a high occurrence of smoking and exposure to radioactivity, silica, iron, and arsenic obscure the association of copper exposure with carcinogenesis. Animal studies have not found increased cancer risks in orally exposed rats or mice. The IARC has classified the pesticide, copper 8-hydroxyquinoline, in Group 3, unclassifiable as to carcinogenicity in humans and EPA has classified copper in Group D, not classifiable as to human carcinogenicity.
Mutagenicity/ Genotoxicity	No data on the genotoxicity of copper in humans were located. The available genotoxicity data suggest that copper is a clastogenic agent. Several studies have also shown that exposure to copper can result in DNA damage.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	No studies were located regarding developmental effects in humans and animals following inhalation exposure to copper.
Acute Toxicity	One of the most commonly reported adverse health effect of copper is gastrointestinal distress. Nausea, vomiting, and/or abdominal pain have been reported, usually occurring shortly after drinking a copper sulphate solution, beverages that were stored in a copper or untinned brass container, or first draw water (water that sat in the pipe overnight).
Irritation	Copper is a respiratory tract irritant and causes coughing, sneezing, runny nose, pulmonary fibrosis, and increased vascularity of the nasal mucosa.
Sensitisation	Not sensitising.
Health Effects Summary	Poses no unreasonable risk to human health based on Tier I assessment under the NICNAS IMAP assessment framework.
Key Study/Critical Effect for Screening Criteria	The chronic oral reference dose (RfD) of 4 x 10^{-2} mg/kg/day is based drinking water standard of 1.3 mg/L, assuming a water consumption rate of 2 L/day and a body weight of 70 kg.
Ecological Toxicity[1,5]	
Aquatic Toxicity	Based on copper ecotoxicity data: Fish: 2.6 µg/L (Ptylocheilus oregonensis, from 7-day LC50) 131 µg/L (Pimephales promelas, 7-day LC50) Crustaceans: 1.7 µg/L (D. pulex and G. pulex, NOEC, reproduction & mortality) 12.1 µg/L (Hyalella azteca, from 10 to 14-day LC50). Insects: 2.2 µg/L (Tanytarsus dissimilis, from 10-day LC50) 11 µg/L (Chironomus tentans, 10 to 20-day LC50). Molluscs: 1.64 µg/L (Flumicola virens, from 14-day LC50) 56.2 (Corbicula manilensis, from 7 to 42-day LC50).
Determination of PNEC aquatic	The PNECaquatic for freshwater is determined to be 7.8 µg/L based on the conclusion that the copper concentrations in food items and daily dietary copper dose in fish are unlikely to cause negative effects at this threshold.
Current Regulatory Controls[5,6,7,8,9]	
Australian Hazard Classification	No data available.
Australian Occupational Exposure Standards	TWA = 1 mg/m^3 (dust & mists) TWA = 0.2 mg/m^3 (fume)
International Occupational Exposure Standards	TWA = 1 mg/m^3 (dust & mists) TWA = 0.2 mg/m^3 (fume)

Australian Food Standards	Tolerable limit = 0.2 mg/kg bw/day
Australian Drinking Water Guidelines	Based on health considerations, the concentration of copper in drinking water should not exceed 2 mg/L. Based on aesthetic considerations, the concentration of copper in drinking water should not exceed 1 mg/L.
Aquatic Toxicity Guidelines	A freshwater high reliability trigger value for copper of 1.4 µg/L was derived using the statistical distribution method with 95% protection. A marine high reliability trigger value for copper of 1.3 µg/L was derived using the statistical distribution method with 95% protection.
PBT Assessment	
P/vP Criteria fulfilled?	Not applicable (copper is an essential element and is ubiquitous in environment).
B/vB criteria fulfilled?	No. As an essential element, copper is commonly regulated by the organism and do not bioaccumulate or biomagnify.
T criteria fulfilled?	Not applicable. Copper is an essential nutrient for all living organisms.
Overall conclusion	It is not currently possible to categorise the environmental hazards of metals and other inorganic chemicals according to standard persistence, bioaccumulation and toxicity (PBT) hazard criteria. These criteria were developed for organic chemicals and do not take into account the unique properties of inorganic substances and their behaviour in the environment.
Revised	December 2021

References

1. ECHA REACH, Copper, Retrieved 2021: https://echa.europa.eu/
2. USEPA, 2021. Regional Risk Levels. November 2021. https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables. Retrieved December 2021.
3. ATSDR, 2004. Toxicological Profile for Copper. Agency for Toxic Substances and Disease Registry. September 2004.
4. National Industrial Chemicals Notification and Assessment Scheme (NICNAS). IMAP, Human Health Tier 1 Assessment. Retrieved 2019: https://www.industrialchemicals.gov.au/.
5. ANZG, 2018. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia. Available at www.waterquality.gov.au/anz-guidelines.
6. NHMRC, 2018. Australian Drinking Water Guidelines 6, 2011, Version 3.5 Updated August 2018. National Water Quality Management.
7. HCIS, Hazardous Chemical Information System, Safe Work Australia, Retrieved December 2021: http://hcis.safeworkaustralia.gov.au/HazardousChemical.
8. ILO, International Labour Organisation, International Chemical Safety Cards (ICSCs), Retrieved December 2021: http://www.ilo.org/dyn/icsc/showcard.listcards3?p_lang=en.
9. Food Standards Australia New Zealand (FSANZ) 20th Australian Total Diet Survey. Retrieved 2021: https://www.foodstandards.gov.au/publications/pages/20thaustraliantotaldietsurveyjanuary2003/20thaustraliantotaldietsurveyfullreport/partb20thatds/partbmetals.aspx.

Toxicity Summary - Distillates (petroleum), hydrotreated light naphthenic

Chemical and Physical Properties[1,2]	
CAS number	64742-53-6
Molecular formula	Unknown or variable composition, complex reaction products or biological materials (UVCB)
Molecular weight	UVCB
Solubility in water	No data available
Melting point	0°C at 101.325 kPa
Boiling point	207 - 750°C at 101.325 kPa
Vapour pressure	10 Pa at 20 °C
Henrys law constant	No data available
Explosive potential	No data available
Flammability potential	Non-flammable
Colour/Form	Liquid, petroleum product
Overview	These chemicals are refined distillate base oils derived from crude oil. It undergoes a series of extractive or transforming processes that improve the base stocks' performance characteristics and remove or reduce undesirable components such as polyaromatic compounds (PACs). The chemicals are complex mixtures of straight and branched-chain paraffinic, naphthenic and aromatic hydrocarbons having carbon numbers in the C15–C50 range. The chemical composition of these chemicals depends on both the original crude oil and on the refining process. The toxicity profile of these chemicals is dictated by the levels of PACs. Mineral oils containing <3 % w/w dimethylsulfoxide (DMSO) extractables (as measured by the IP346 assay) are considered highly or severely refined. Only white oils are considered highly refined by definition.
Environmental Fate[1]	
Soil/Water/Air	Hydrocarbons are degraded (under aerobic conditions) via mono-oxygenases or di-oxygenases and are subsequently carboxylated and ultimately hydroxylated. In further assessing the type of metabolites formed, it has been demonstrated that for all the major classes of hydrocarbons, the major metabolites are in most cases less toxic, and always less bioaccumulative than the parent molecule.
Human Health Toxicity Summary[1,2,3]	
Chronic Repeated Dose Toxicity	In separate 4-week single-dose studies, New Zealand White rabbits were dermally exposed to 1000 mg/kg bw/day of the chemicals identified by CAS Nos. 64741-88-4, 64742-56-9 and 64742-65-0. There were no significant signs of systemic toxicity. Signs of irritation were observed both macroscopically (erythema and oedema) and microscopically (inflammation, hyperplasia and hyperkeratosis). In a 13-week study, Sprague Dawley (SD) rats were dermally exposed to 800 or 2000 mg/kg bw/day, for five days a week. The no observed adverse effect level (NOAEL) for systemic effects was reported as 800 mg/kg bw/day based on increased liver weights and histopathological changes observed in high-dose females. Signs of irritation were observed at both dose levels, both macroscopically (erythema and oedema) and microscopically (inflammation, hyperplasia and hyperkeratosis). As application sites were not covered, exposure may have been less than intended. Increased liver weights were also observed in a 3-week dermal study with CAS No. 64742-70-7. In this study, SD rats were dermally exposed to 1720 mg/kg bw/day (five days/week). Effects were observed in both males and females. As application sites were not covered, exposure may have been less than intended.

Carcinogenicity	These chemicals are classified as hazardous, Category 2 carcinogens with the risk phrase 'May cause cancer'. Skin tumours have been observed in mice following exposure to several unrefined or mildly refined base oils. In a dermal carcinogenicity study in mice, the chemical with CAS No. 64742-53-6 increased the incidence of skin tumours. Petroleum substances containing <3 % w/w DMSO extractables (as measured by the IP346 assay), or which are negative in the modified Ames test (mutagenicity index <1) are not carcinogenic to skin.
Mutagenicity/ Genotoxicity	The genetic toxicity of the chemicals is expected to be related to the level of refinement and associated removal of PACs. The results for the chemical CAS No. 64742-53-6 were positive in an in vitro mouse lymphoma mutation assay but the results for CAS No. 64742-52-5 were negative in a similar study.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	No data are available for the chemicals. Certain petroleum streams have been shown to be developmentally toxic from dermal exposure. Effects include increased incidence of resorptions and decrease in foetal body weight. The developmental toxicity of the chemicals is expected to be correlated with the level of refinement of the chemicals.
Acute Toxicity	These chemicals are considered to be of low acute toxicity following oral and dermal exposure. The chemical identified by CAS Nos. 64742-53-6, has a reported median lethal dose (LD50) in rabbits of greater than 2000 mg/kg bw. Signs of skin irritation (slight to severe for erythema and oedema and desquamation) were observed in some studies. Based on data available, the chemicals in this group are expected to have low to moderate toxicity following inhalation exposure. Based on the reported median lethal concentration (LC50) value (2.18 mg/L/4-h) for an insufficiently refined oil, classification is considered appropriate for the chemicals in this group. However, this classification need not apply for highly or severely refined oils, containing <3 % w/w DMSO extractables (as measured by the IP346 assay). In an acute inhalation toxicity study, rats were exposed to an aerosol of the chemical identified by CAS No. 64742-53-6 at concentrations of 1, 1.5, 2.5, 3.5 and 5 mg/L for four hours. All the animals in the two high dose groups, and three males and three females in the 2.5 mg/L dose group died. The LC50 was 2.18 mg/L/4-h. Observed sublethal effects included decreased activity, rapid breathing and congestion, and inflammation of the lungs. The test chemical was reported to have a DMSO extractable content of >3 % as measured by the IP346 assay. Two further acute inhalation studies were available for the chemical identified by CAS No. 64742-53-6. In a single dose study in rats, 80 % mortality was observed at 5.7 mg/L/4-h. The DMSO extractable content was not reported. In another rat study, the LC50 was reported to be 10.5 mg/L/4-h for males and 9.5 mg/L/4-h for females. The cause of death appeared to be associated with lung congestion and/or oedema. The test chemical was reported to be highly or severely refined oils containing <3 % w/w DMSO extractables. Acute inhalation data were available for several highly or severely refined oils containing <3 % w/w DMSO extractables. In general, no mortalities were observed.
Irritation	Animal skin irritation data were available for several highly or severely refined oils containing <3 % w/w DMSO extractables. In general, slight skin irritation effects were considered to be not sufficient for classification. These minimally irritant effects are consistent with irritant responses observed in humans. Very slight irritant effects were observed in four separate repeated insult patch tests in human volunteers with highly or severely refined oils, containing <3 % w/w DMSO extractables. CAS No. 64742-53-6 produced erythema and oedema (mean scores greater than two over 72 hours for both endpoints) following application to intact rabbit skin. Effects were fully reversible within 14 days. The test chemical was reported to have a DMSO extractable content (as measured by the IP346 assay) of >3 %. CAS No. 64742-53-6 also reported to be a slight eye irritant in animal studies. Based on the data available, the chemicals are considered to be, at most, slightly irritating to eyes.
Sensitisation	The limited data available do not indicate a potential for skin sensitisation. CAS No. 64742-53-6 was negative in Buehler-type studies in guinea pigs.

Health Effects Summary	The critical health effects for the chemicals in this group are dependent upon the level of refinement. The critical health effects for less refined base oils (DMSO extractable content > 3 % in the IP346 assay) include carcinogenicity and developmental toxicity, acute effects (acute toxicity by the inhalation route of exposure) and local effects (skin irritation). Exposure to mists may also cause respiratory symptoms such as cough and phlegm.
Key Study/Critical Effect for Screening Criteria	The repeated dose toxicity via dermal application was considered the most sensitive endpoint with the NOAEL for systemic effects reported at 800 mg/kg bw/day.
Ecological Toxicity[1]	
Aquatic Toxicity	Short-term toxicity to fish: In a key static 96-hour short-term fathead minnow (Pimephales promelas) limit test (OECD 203; KS=1), 10 animals/loading were exposed to the WAF of Basestock Solvent Neutral 600 (MRD-94 -981) at a nominal concentration of 100 mg/L. The LL50 was > 100 mg/L and the NOEL was ≥100 mg/L. Long-term toxicity to fish: For other lubricant base oils, read across has been applied for the long-term toxicity in fish endpoint, using the results of long-term toxicity testing on invertebrates (Daphnia magna). Toxic effects of hydrocarbons are primarily caused by narcosis and occur in a narrow range of molar concentrations across aquatic taxa; hence, read across between species is justified. Results of computer modelling to estimate aquatic chronic toxicity of other lubricant base oils in a 28-day freshwater fish study show no chronic toxicity to freshwater fish at or below its maximum attainable water solubility. This supports the applied interspecies read across. Short-term toxicity to aquatic invertebrates: In a key static 48-hour short-term Daphnia magna toxicity test (OECD 202; KS = 2), 10 animals/loading were exposed to the WAF of an other lubricant base oil, MVI(N) 40 base oil (CAS # 64742-53-6 or 64741-97-5), at nominal concentrations of 0, 10, 100, 1000, and 10,000 mg/L. The EL50 was >10,000 mg/L based on mobility and the NOEL was ≥ 1000 mg/L. Long-term toxicity to aquatic invertebrates: In a key semi-static 21-day long-term Daphnia magna toxicity test (OECD 211; KS = 2), 10 animals/loading were exposed to the WAF of other lubricant base oil LVIN 38 (CAS #64742-53-6) at nominal concentrations of 1, 10, 100 and 1000 mg/L. The NOEL was 10 mg/L based on reproduction. The loss of all daphnids in the 100 mg/L WAF was attributed to a non-treatment related effect, the cause of which was unknown. Further testing would be required to clarify the consequences of exposure to a 100 mg/L WAF of the base oil. Toxicity to aquatic algae: In a key static 72-hour algal (Pseudokirchneriella subcapitata) limit test (OECD 201; KS = 2), the freshwater alga was exposed to the WAF of another lubricant base oil (N100DW; CAS # 72623-87-1), at a nominal concentration of 100 mg/L. The NOEL was ≥ 100 mg/L based upon average specific growth rate and cell yield. Toxicity to microorganisms: In a key static 4-day Photobacterium phosphoreum luminescence inhibition study (KS=2) using other lubricant base oils as control substances, no significant luminescence inhibition was observed for Spindle oil (BP 320-400 ºC) and Neutral oil Ro NIII (BP 400-450 ºC), as well as for the n-paraffin dodecane. The actual NOEL for Spindle oil was > 1.93 mg/L and the actual NOEL for Neutral oil Ro NIII was > 2.17 mg/L.
Determination of PNEC aquatic	Based on the lowest chronic endpoint for Daphnia (10 mg/L), an assessment factor of 100 has been applied, resulting in a PNECaquatic of 0.1 mg/L.
Current Regulatory Controls[2,3,4,5,6]	
Australian Hazard Classification	Acute toxicity – category 4 Carcinogenicity – category 1B

	Skin irritation – category 2 Reproductive toxicity – category 2
Australian Occupational Exposure Standards	No specific exposure standards are available for specific chemicals. The exposure standard for oil mist, refined mineral is 5 mg/m^3 time weighted average (TWA). The applicability of this exposure standard for the chemicals will depend on the level of refinement.
International Occupational Exposure Standards	A number of countries have exposure standards for oil mist mineral including an exposure limit of 0.2–5 mg/m^3 (TWA) in different countries such as the United Arab Emirates, Japan, Austria, United States of America (USA) and Canada; and a short-term exposure limit (STEL) of 3–10 mg/m^3 in countries such as Sweden, Egypt, the USA, Canada, Singapore and Poland. The American Conference of Governmental Industrial Hygienists (ACGIH) recommends a threshold limit value (TLV) of 5 mg/m^3 (TWA) for pure, highly and severely refined mineral oils. The ACGIH does not recommend application of this TLV to poorly- and mildly-refined mineral oils. No TLV is assigned based on insufficient data, although an A2 suspected human carcinogen classification is assigned.
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	Oils and greases (including petrochemicals) for freshwater production: <300^3 µg/L (ANZECC, 2000)
PBT Assessment[1]	
P/vP Criteria fulfilled?	Yes. In a supporting biodegradability study, Solvent Neutral 600 Base Oil (MRD-94 -981), was determined to be inherently biodegradable but not readily biodegradable with a mean degradation of 31.13% by day 28. In an additional supporting biodegradability study, an other lubricant base oil (GOHC 1468) was determined not to be readily biodegradable when it attained 2 to 4 % degradation within 28 days.
B/vB criteria fulfilled?	Calculated BCF for constituents of this substance range between 0.4 and 71100 L/kg.
T criteria fulfilled?	No. Chronic and acute toxicity data >1 mg/L, these chemicals do not meet the screening criteria for toxicity.
Overall conclusion	Not PBT. These chemicals are a UVCB. They do not contain PBT constituents included in the Substances of Very High Concern (SVHC) candidate list at concentrations above 0.1%.
Revised	December 2021

References

1. ECHA REACH, Distillates (petroleum), hydrotreated heavy naphthenic, Retrieved 2021: https://echa.europa.eu/
2. National Industrial Chemicals Notification and Assessment Scheme (NICNAS). IMAP, Selected refined base oils: Human health tier II assessment: Retrieved 2021: https://www.industrialchemicals.gov.au/.
3. ANZECC (2000) Australian and New Zealand Guidelines for Fresh and Marine Water Quality for protection for aquatic ecosystems.
4. Food Standards Australia New Zealand (FSANZ) 20th Australian Total Diet Survey. Retrieved 2021: https://www.foodstandards.gov.au/publications/pages/20thaustraliantotaldietsurveyjanuary2003/20thaustraliantotaldietsurveyfullreport/partb20thatds/partbmetals.aspx.
5. NHMRC, 2018. Australian Drinking Water Guidelines 6, 2011, Version 3.5 Updated August 2018. National Water Quality Management.
6. HCIS, Hazardous Chemical Information System, Safe Work Australia, Retrieved December 2021: http://hcis.safeworkaustralia.gov.au/HazardousChemical.

Toxicity Summary - Distillates (petroleum), straight-run middle

Chemical and Physical Properties[1,2]	
CAS number	64741-44-2
Molecular formula	Unknown or variable composition, complex reaction products or biological materials (UVCB)
Molecular weight	UVCB
Solubility in water	No data available
Melting point	-21 - 6°C at 101.325 kPa
Boiling point	150 - 399°C at 101.3 kPa
Vapour pressure	4 hPa at 40°C
Henrys law constant	No data available
Explosive potential	Non-explosive
Flammability potential	Non-flammable
Colour/Form	Liquid, petroleum product
Overview	Whilst other compositional characteristics could influence toxicity, the toxicity profile of this chemical is expected to be dictated by the levels of polycyclic aromatic compounds (PACs), particularly those composed of 3, 4, 5, 6 and/or 7 fused aromatic rings. Due to the hydrotreating process, the chemicals in this group are expected to contain low levels of these PACs.
Environmental Fate[1]	
Soil/Water/Air	Hydrocarbons are degraded (under aerobic conditions) via mono-oxygenases or di-oxygenases and are subsequently carboxylated and ultimately hydroxylated. In further assessing the type of metabolites formed, it has been demonstrated that for all the major classes of hydrocarbons, the major metabolites are in most cases less toxic, and always less bioaccumulative than the parent molecule.
Human Health Toxicity Summary[1,2]	
Chronic Repeated Dose Toxicity	A key 'read across' 90-day dermal study in rats was identified in which vacuum tower overheads was applied to the shaved skin of rats, 5 days a weeks for 90-days. The NOAEL was 30 mg/kg/day, based on findings in liver, thymus and blood. A 28 day repeated dose toxicity studies in rabbits was identified for dermal exposure, plus a supporting 28 day dermal study in rats. There was one key read-across 90-day repeated dose toxicity study (OECD 413) for inhalation. For the read-across 90-day inhalation study, a NOAEC of 0.88 mg/L for local effects on the lung (increased relative wet weight in the absence of histopathological change) was established in rats expose to aerosol. A NOAEC of greater than or equal to 1.71 mg/L is established for systemic effects, based on no significant findings at this level. For the 28-day dermal study, a LOAEL of 200 mg/kg/day was established based on local irritation. No NOEL was determined for local irritation. The NOAEL for systemic effects in rabbits following repeated dermal exposure was greater than or equal to 2000 mg/kg/day.
Carcinogenicity	Distillates (petroleum), straight-run middle has been reported to produce squamous cell carcinomas and fibrosarcomas (20–25 % incidence) in long-term dermal carcinogenicity studies in mice when applied undiluted. However, data from other straight run gas oils that have been applied in diluted form indicate that the tumorigenic activity of straight-run middle distillates, with low levels of PACs, is likely to be a consequence of a non-genotoxic process associated with frequent cell damage and repair. In these studies, when the irritant effects were reduced, there were no significant increases in tumours relative to controls.

Mutagenicity/ Genotoxicity	In the key in vitro modified bacteria Ames study (similar to OECD 471), there was no evidence of mutagenic activity. This result was supported by other studies with straight run gas oils and related materials, the majority of which were negative. A key in vivo chromosome aberration assay (OECD 475) was identified, in which straight run middle distillate was not found to be mutagenic in male rat bone marrow cells. An additional chromosome aberration assay also showed negative results for mutagenicity (OECD 475).
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	Based on the expected negligible amounts of PACs with 3–7 rings, the chemicals are not expected to show specific reproductive or developmental toxicity.
Acute Toxicity	The substance is considered to have low acute toxicity following oral and dermal exposure and moderate acute toxicity following inhalation exposure. The reported median lethal dose (LD50) for oral exposure in rats for distillates (petroleum), straight-run middle is >5000 mg/kg bw. Reported signs of toxicity included hypoactivity, diarrhoea and hair loss. In general, gas oils produced from secondary processing are considered to have low acute toxicity following oral exposure. The reported LD50 for dermal exposure in rats for distillates (petroleum), straight-run middle is >2000 mg/kg bw. Whilst no systemic effects were reported slight to moderate dermal irritation was observed. In an acute inhalation study conducted similarly to the Organisation for Economic Co-operation and Development Test Guideline (OECD TG) 403 with distillates (petroleum), straight-run middle, the median lethal concentration (LC50) was determined to be 1.78 mg/L. Reported signs of toxicity included reduced body weight gain, gross necropsy findings and acute histopathological changes in the lung.
Irritation	In general, gas oils are considered to be slightly to moderately irritating to the skin. In a skin irritation study in New Zealand White rabbits, distillates (petroleum), straight-run middle was applied to intact and abraded clipped skin on the back and flank of six rabbits, under occlusion for 24 hours. For intact skin, the mean erythema and oedema scores were 1.80 and 1.58, respectively. Effects were reversible within 14 days. Given that the chemical was tested under occlusive patch conditions and for longer periods of time than specified in the OECD TG 404 conditions, irritant responses might be more pronounced than would be expected in a standard study. Distillates (petroleum), straight-run middle were reported to be non-irritating to the eyes (unrinsed and rinsed) when tested equivalently or similarly to OECD TG 405. The mean conjunctival, iridial and corneal scores at 24-, 48- and 72-hours post-exposure were 0.
Sensitisation	Gas oils produced by secondary processing and distillates (petroleum), straight-run middle were not skin sensitisers in the guinea pig Buehler test.
Health Effects Summary	The critical health effect for risk characterisation is acute toxicity from inhalation exposure. The chemicals also have the potential to cause chemical pneumonitis if aspirated. Due to the hydrotreating process, the chemicals in this group are expected to contain low levels of PACs composed of 3–7 fused aromatic rings and, as such, are not considered to be genotoxic carcinogens. The chemicals are considered unlikely to cause skin tumours in the absence of prolonged skin irritation.
Key Study/Critical Effect for Screening Criteria	The 90-day repeated dose toxicity in rats via dermal application was considered the most sensitive endpoint with a NOAEL of 30 mg/kg bw/day.
Ecological Toxicity[1]	
Aquatic Toxicity	The 96h LL50 for freshwater fish is 21 mg/L. The estimated freshwater fish NOEL (No Observed Effect Level) value is 0.068 mg/L based on mortality. The 48 h EL50 for Daphnia was 68 mg/L. The estimated freshwater invertebrate NOEL (No Observed Effect Level) value is 0.167 mg/L based on immobility and numbers of live young produced per adult by Day 21.

	The 72 h ErL50 for algae was 22 mg/L.
Determination of PNEC aquatic	Based on the lowest endpoint for aquatic toxicity (0.167 mg/L), an assessment factor of 100 has been applied, resulting in a PNECaquatic of 0.001 mg/L.
Current Regulatory Controls[4,5]	
Australian Hazard Classification	No data available.
Australian Occupational Exposure Standards	No data available.
International Occupational Exposure Standards	No data available.
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	Oils and greases (including petrochemicals) for freshwater production: <300[3] µg/L (ANZECC, 2000)
PBT Assessment[1]	
P/vP Criteria fulfilled?	No. Degradation was achieved at varying levels in the available tests. Two tests indicate that the substance is readily biodegradable (ignoring the 10-day window). As the 10-day window is not relevant to UVCB substances, therefore the substance is considered readily biodegradable
B/vB criteria fulfilled?	Gas oils components have log Kow values in the range 3.9 to greater than 6.
T criteria fulfilled?	No. Aquatic toxicity data >1 mg/L, thus the substance does not meet the screening criteria for toxicity.
Overall conclusion	Not PBT. These chemicals are a UVCB. They do not contain PBT constituents included in the Substances of Very High Concern (SVHC) candidate list at concentrations above 0.1%.
Revised	December 2021

References

1. ECHA REACH, Distillates (petroleum), straight-run middle, Retrieved 2021: https://echa.europa.eu/
2. National Industrial Chemicals Notification and Assessment Scheme (NICNAS). IMAP, Hydrocracked gas oils: Human health tier II assessment: Retrieved 2021: https://www.industrialchemicals.gov.au/.
3. ANZECC (2000) Australian and New Zealand Guidelines for Fresh and Marine Water Quality for protection for aquatic ecosystems.
4. NHMRC, 2018. Australian Drinking Water Guidelines 6, 2011, Version 3.5 Updated August 2018. National Water Quality Management.
5. HCIS, Hazardous Chemical Information System, Safe Work Australia, Retrieved December 2021: http://hcis.safeworkaustralia.gov.au/HazardousChemical.

Toxicity Summary - Distillates, petroleum, hydrotreated heavy naphthenic

Chemical and Physical Properties[1,2]	
CAS number	64742-52-5
Molecular formula	Unknown or variable composition, complex reaction products or biological materials (UVCB)
Molecular weight	UVCB
Solubility in water	No data available
Melting point	0°C at 101.325 kPa
Boiling point	207 - 750°C at 101.325 kPa
Vapour pressure	10 Pa at 20 °C
Henrys law constant	No data available
Explosive potential	No data available
Flammability potential	Non-flammable
Colour/Form	Liquid, petroleum product
Overview	These chemicals are refined distillate base oils derived from crude oil. It undergoes a series of extractive or transforming processes that improve the base stocks' performance characteristics and remove or reduce undesirable components such as polyaromatic compounds (PACs). The chemicals are complex mixtures of straight and branched-chain paraffinic, naphthenic and aromatic hydrocarbons having carbon numbers in the C15–C50 range. The chemical composition of these chemicals depends on both the original crude oil and on the refining process. The toxicity profile of these chemicals is dictated by the levels of PACs. Mineral oils containing <3 % w/w dimethylsulfoxide (DMSO) extractables (as measured by the IP346 assay) are considered highly or severely refined. Only white oils are considered highly refined by definition.
Environmental Fate[1]	
Soil/Water/Air	Hydrocarbons are degraded (under aerobic conditions) via mono-oxygenases or di-oxygenases and are subsequently carboxylated and ultimately hydroxylated. In further assessing the type of metabolites formed, it has been demonstrated that for all the major classes of hydrocarbons, the major metabolites are in most cases less toxic, and always less bioaccumulative than the parent molecule.
Human Health Toxicity Summary[1,2,3]	
Chronic Repeated Dose Toxicity	In separate 4-week single-dose studies, New Zealand White rabbits were dermally exposed to 1000 mg/kg bw/day of the chemicals identified by CAS Nos. 64741-88-4, 64742-56-9 and 64742-65-0. There were no significant signs of systemic toxicity. Signs of irritation were observed both macroscopically (erythema and oedema) and microscopically (inflammation, hyperplasia and hyperkeratosis). In a 13-week study, Sprague Dawley (SD) rats were dermally exposed to 800 or 2000 mg/kg bw/day, for five days a week. The no observed adverse effect level (NOAEL) for systemic effects was reported as 800 mg/kg bw/day based on increased liver weights and histopathological changes observed in high-dose females. Signs of irritation were observed at both dose levels, both macroscopically (erythema and oedema) and microscopically (inflammation, hyperplasia and hyperkeratosis). As application sites were not covered, exposure may have been less than intended. Increased liver weights were also observed in a 3-week dermal study with CAS No. 64742-70-7. In this study, SD rats were dermally exposed to 1720 mg/kg bw/day (five days/week). Effects were observed in both males and females. As application sites were not covered, exposure may have been less than intended.

Carcinogenicity	These chemicals are classified as hazardous, Category 2 carcinogens with the risk phrase 'May cause cancer'. Skin tumours have been observed in mice following exposure to several unrefined or mildly refined base oils. In a dermal carcinogenicity study in mice, the chemical with CAS No. 64742-53-6 increased the incidence of skin tumours. Petroleum substances containing <3 % w/w DMSO extractables (as measured by the IP346 assay), or which are negative in the modified Ames test (mutagenicity index <1) are not carcinogenic to skin.
Mutagenicity/ Genotoxicity	The genetic toxicity of the chemicals is expected to be related to the level of refinement and associated removal of PACs. The results for the chemical CAS No. 64742-53-6 were positive in an in vitro mouse lymphoma mutation assay but the results for CAS No. 64742-52-5 were negative in a similar study.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	No data are available for the chemicals. Certain petroleum streams have been shown to be developmentally toxic from dermal exposure. Effects include increased incidence of resorptions and decrease in foetal body weight. The developmental toxicity of the chemicals is expected to be correlated with the level of refinement of the chemicals.
Acute Toxicity	These chemicals are considered to be of low acute toxicity following oral and dermal exposure. The chemical identified by CAS Nos. 64742-53-6, has a reported median lethal dose (LD50) in rabbits of greater than 2000 mg/kg bw. Signs of skin irritation (slight to severe for erythema and oedema and desquamation) were observed in some studies. Based on data available, the chemicals in this group are expected to have low to moderate toxicity following inhalation exposure. Based on the reported median lethal concentration (LC50) value (2.18 mg/L/4-h) for an insufficiently refined oil, classification is considered appropriate for the chemicals in this group. However, this classification need not apply for highly or severely refined oils, containing <3 % w/w DMSO extractables (as measured by the IP346 assay). In an acute inhalation toxicity study, rats were exposed to an aerosol of the chemical identified by CAS No. 64742-53-6 at concentrations of 1, 1.5, 2.5, 3.5 and 5 mg/L for four hours. All the animals in the two high dose groups, and three males and three females in the 2.5 mg/L dose group died. The LC50 was 2.18 mg/L/4-h. Observed sublethal effects included decreased activity, rapid breathing and congestion, and inflammation of the lungs. The test chemical was reported to have a DMSO extractable content of >3 % as measured by the IP346 assay. Two further acute inhalation studies were available for the chemical identified by CAS No. 64742-53-6. In a single dose study in rats, 80 % mortality was observed at 5.7 mg/L/4-h. The DMSO extractable content was not reported. In another rat study, the LC50 was reported to be 10.5 mg/L/4-h for males and 9.5 mg/L/4-h for females. The cause of death appeared to be associated with lung congestion and/or oedema. The test chemical was reported to be highly or severely refined oils containing <3 % w/w DMSO extractables. Acute inhalation data were available for several highly or severely refined oils containing <3 % w/w DMSO extractables. In general, no mortalities were observed.
Irritation	Animal skin irritation data were available for several highly or severely refined oils containing <3 % w/w DMSO extractables. In general, slight skin irritation effects were considered to be not sufficient for classification. These minimally irritant effects are consistent with irritant responses observed in humans. Very slight irritant effects were observed in four separate repeated insult patch tests in human volunteers with highly or severely refined oils, containing <3 % w/w DMSO extractables. CAS No. 64742-53-6 produced erythema and oedema (mean scores greater than two over 72 hours for both endpoints) following application to intact rabbit skin. Effects were fully reversible within 14 days. The test chemical was reported to have a DMSO extractable content (as measured by the IP346 assay) of >3 %. CAS No. 64742-53-6 also reported to be a slight eye irritant in animal studies. Based on the data available, the chemicals are considered to be, at most, slightly irritating to eyes.
Sensitisation	The limited data available do not indicate a potential for skin sensitisation. CAS No. 64742-53-6 was negative in Buehler-type studies in guinea pigs.

Health Effects Summary	The critical health effects for the chemicals in this group are dependent upon the level of refinement. The critical health effects for less refined base oils (DMSO extractable content > 3 % in the IP346 assay) include carcinogenicity and developmental toxicity, acute effects (acute toxicity by the inhalation route of exposure) and local effects (skin irritation). Exposure to mists may also cause respiratory symptoms such as cough and phlegm.
Key Study/Critical Effect for Screening Criteria	The repeated dose toxicity via dermal application was considered the most sensitive endpoint with the NOAEL for systemic effects reported at 800 mg/kg bw/day.
Ecological Toxicity[1]	
Aquatic Toxicity	Short-term toxicity to fish: In a key static 96-hour short-term fathead minnow (Pimephales promelas) limit test (OECD 203; KS=1), 10 animals/loading were exposed to the WAF of Basestock Solvent Neutral 600 (MRD-94 -981) at a nominal concentration of 100 mg/L. The LL50 was > 100 mg/L and the NOEL was ≥100 mg/L. Long-term toxicity to fish: For other lubricant base oils, read across has been applied for the long-term toxicity in fish endpoint, using the results of long-term toxicity testing on invertebrates (Daphnia magna). Toxic effects of hydrocarbons are primarily caused by narcosis and occur in a narrow range of molar concentrations across aquatic taxa; hence, read across between species is justified. Results of computer modelling to estimate aquatic chronic toxicity of other lubricant base oils in a 28-day freshwater fish study show no chronic toxicity to freshwater fish at or below its maximum attainable water solubility. This supports the applied interspecies read across. Short-term toxicity to aquatic invertebrates: In a key static 48-hour short-term Daphnia magna toxicity test (OECD 202; KS = 2), 10 animals/loading were exposed to the WAF of an other lubricant base oil, MVI(N) 40 base oil (CAS # 64742-53-6 or 64741-97-5), at nominal concentrations of 0, 10, 100, 1000, and 10,000 mg/L. The EL50 was >10,000 mg/L based on mobility and the NOEL was ≥ 1000 mg/L. Long-term toxicity to aquatic invertebrates: In a key semi-static 21-day long-term Daphnia magna toxicity test (OECD 211; KS = 2), 10 animals/loading were exposed to the WAF of other lubricant base oil LVIN 38 (CAS #64742-53-6) at nominal concentrations of 1, 10, 100 and 1000 mg/L. The NOEL was 10 mg/L based on reproduction. The loss of all daphnids in the 100 mg/L WAF was attributed to a non-treatment related effect, the cause of which was unknown. Further testing would be required to clarify the consequences of exposure to a 100 mg/L WAF of the base oil. Toxicity to aquatic algae: In a key static 72-hour algal (Pseudokirchneriella subcapitata) limit test (OECD 201; KS = 2), the freshwater alga was exposed to the WAF of another lubricant base oil (N100DW; CAS # 72623-87-1), at a nominal concentration of 100 mg/L. The NOEL was ≥ 100 mg/L based upon average specific growth rate and cell yield. Toxicity to microorganisms: In a key static 4-day Photobacterium phosphoreum luminescence inhibition study (KS=2) using other lubricant base oils as control substances, no significant luminescence inhibition was observed for Spindle oil (BP 320-400 ºC) and Neutral oil Ro NIII (BP 400-450 ºC), as well as for the n-paraffin dodecane. The actual NOEL for Spindle oil was > 1.93 mg/L and the actual NOEL for Neutral oil Ro NIII was > 2.17 mg/L.
Determination of PNEC aquatic	Based on the lowest chronic endpoint for Daphnia (10 mg/L), an assessment factor of 100 has been applied, resulting in a PNECaquatic of 0.1 mg/L.
Current Regulatory Controls[2,3,4,5,6]	
Australian Hazard Classification	Acute toxicity – category 4 Carcinogenicity – category 1B

	Skin irritation – category 2 Reproductive toxicity – category 2
Australian Occupational Exposure Standards	No specific exposure standards are available for specific chemicals. The exposure standard for oil mist, refined mineral is 5 mg/m^3 time weighted average (TWA). The applicability of this exposure standard for the chemicals will depend on the level of refinement.
International Occupational Exposure Standards	A number of countries have exposure standards for oil mist mineral including an exposure limit of 0.2–5 mg/m^3 (TWA) in different countries such as the United Arab Emirates, Japan, Austria, United States of America (USA) and Canada; and a short-term exposure limit (STEL) of 3–10 mg/m^3 in countries such as Sweden, Egypt, the USA, Canada, Singapore and Poland. The American Conference of Governmental Industrial Hygienists (ACGIH) recommends a threshold limit value (TLV) of 5 mg/m^3 (TWA) for pure, highly and severely refined mineral oils. The ACGIH does not recommend application of this TLV to poorly- and mildly-refined mineral oils. No TLV is assigned based on insufficient data, although an A2 suspected human carcinogen classification is assigned.
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	Oils and greases (including petrochemicals) for freshwater production: <300^3 µg/L (ANZECC, 2000)
PBT Assessment[1]	
P/vP Criteria fulfilled?	Yes. In a supporting biodegradability study, Solvent Neutral 600 Base Oil (MRD-94 -981), was determined to be inherently biodegradable but not readily biodegradable with a mean degradation of 31.13% by day 28. In an additional supporting biodegradability study, an other lubricant base oil (GOHC 1468) was determined not to be readily biodegradable when it attained 2 to 4 % degradation within 28 days.
B/vB criteria fulfilled?	Calculated BCF for constituents of this substance range between 0.4 and 71100 L/kg.
T criteria fulfilled?	No. Chronic and acute toxicity data >1 mg/L, these chemicals do not meet the screening criteria for toxicity.
Overall conclusion	Not PBT. These chemicals are a UVCB. They do not contain PBT constituents included in the Substances of Very High Concern (SVHC) candidate list at concentrations above 0.1%.
Revised	December 2021

References

1. ECHA REACH, Distillates (petroleum), hydrotreated heavy naphthenic, Retrieved 2021: https://echa.europa.eu/
2. National Industrial Chemicals Notification and Assessment Scheme (NICNAS). IMAP, Selected refined base oils: Human health tier II assessment: Retrieved 2021: https://www.industrialchemicals.gov.au/.
3. ANZECC (2000) Australian and New Zealand Guidelines for Fresh and Marine Water Quality for protection for aquatic ecosystems.
4. Food Standards Australia New Zealand (FSANZ) 20th Australian Total Diet Survey. Retrieved 2021: https://www.foodstandards.gov.au/publications/pages/20thaustraliantotaldietsurveyjanuary2003/20thaustraliantotaldietsurveyfullreport/partb20thatds/partbmetals.aspx.
5. NHMRC, 2018. Australian Drinking Water Guidelines 6, 2011, Version 3.5 Updated August 2018. National Water Quality Management.
6. HCIS, Hazardous Chemical Information System, Safe Work Australia, Retrieved December 2021: http://hcis.safeworkaustralia.gov.au/HazardousChemical.

Toxicity Summary - Fatty acids, tall-oil, reaction products with diethylenetriamine, maleic anhydride, tetraethylenepentamine and triethylenetetramine

Chemical and Physical Properties[1,2]	
CAS number	68990-47-6
Molecular formula	Unknown or variable composition, complex reaction products or biological materials (UVCB)
Molecular weight	UVCB
Solubility in water	2.17 mg/L
Melting point	No data available
Boiling point	No data available
Vapour pressure	No data available
Henrys law constant	No data available
Explosive potential	Non-explosive
Flammability potential	No data available
Colour/Form	Solid with a dark colour at room temperature
Overview	This substance is used by consumers, in articles, by professional workers (widespread uses), in formulation or re-packing, at industrial sites and in manufacturing.
Environmental Fate[1]	
Soil/Water/Air	The substance is not expected to be readily biodegradable. On the basis of the very low water solubility and its chemical nature, the substance is expected to have a high ability to absorb to soil. Due to its complex composition, methods for the experimental measurement of octanol -water partition coefficient (Kow) of Fatty acids, tall-oil, reaction products with diethylenetriamine, maleic anhydride, tetraethylenepentamine and triethylenetetramine are technically not applicable. On the basis of the high solubility in octanol (> 30 mg/L) compared to the solubility in water (2.17 ppm), and the chemical nature, Kow value for the substance is expected to be high. Estimated Log Kow value for the smallest molecule arising from the chemical synthesis is 11.
Human Health Toxicity Summary [1,2,3]	
Chronic Repeated Dose Toxicity	Test item-related histopathological changes were restricted to the lung. Multifocal subacute bronchopneumonia, characterized by peribronchial foci of prominent fibrosis, with re-epithelialization, infiltration with mononuclear cells, histiocytes and occasional multinucleated cells, was observed in a small proportion of treated males and females of all dose groups, without dose relationship. In addition, a mild amount of intrahistiocytic black material was seen in the lung of each one male treated at 300 or 1000 mg/kg/day. As a conclusion, based on the pathological evaluation, a No-Observed-Effect-Level (NOEL) could not be determined in this study.
Carcinogenicity	No data available.
Mutagenicity/ Genotoxicity	The test item Fatty acids, tall-oil, reaction products with diethylenetriamine, maleic anhydride, tetraethylenepentamine and triethylenetetramine is considered to be non-clastogenic.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	Based on the data generated from this combined repeated dose toxicity and reproduction/ developmental toxicity screening test with Fatty acids, tall-oil, reaction products with diethylenetriamine, maleic anhydride, tetraethylenepentamine and triethylenetetramine, no effects were reported on reproductive/ developmental toxicity parameters measured in this study. There

	were also no effects reported on general toxicity parameters except for the reported macroscopic/microscopic lung changes. Due to the lack of clear dose-response relationship (solely restricted to histopathological lung changes) observed in this study, the suitable NOAEL (No observed adverse effect level) general toxicity could not be determined. However, for reproductive/ developmental toxicity, the NOAEL could be set at 1000 mg/kg bw.
Acute Toxicity	The test substance was assessed for its acute oral toxicity potential when administered to albino rats. The acute oral LD50, as indicated by the data, is greater than 2020 mg/kg in males and females.
Irritation	Not irritating to skin and eye.
Sensitisation	Fatty acids, tall-oil, reaction products with diethylenetriamine, maleic anhydride, tetraethylenepentamine and triethylenetetramine caused reactions identified as sensitisation at the tested concentration.
Health Effects Summary	The substance is expected to have low acute toxicity and is not an irritant. The substance may cause skin sensitisation.
Key Study/Critical Effect for Screening Criteria	The reproductive/ developmental toxicity in rats was considered the most sensitive endpoint with a NOAEL of 1000 mg/kg bw/day.
Ecological Toxicity[1,2,3]	
Aquatic Toxicity	Short term toxicity: LC50 (4 days): 100 mg/L (fish) NOEC (4 days): 100 mg/L (fish) LOEC (4 days): 100 mg/L (fish) IC50 (48 h): 100 mg/L (invertebrates) NOEC (48 h): 100 mg/L (invertebrates) LOEC (48 h): 100 mg/L (invertebrates) EC50 (72 h): 100 mg/L (algae)
Determination of PNEC aquatic	Data from short-term tests with three trophic levels are available. An assessment factor of 1000 is applied to the lowest NOEC of 100 mg/L. A PNECaqua of 0.1 mg/L was derived.
Current Regulatory Controls[4]	
Australian Hazard Classification	No data available.
Australian Occupational Exposure Standards	No data available.
International Occupational Exposure Standards	No data available.
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	No data available.
PBT Assessment[1]	
P/vP Criteria fulfilled?	Yes. Not inherently biodegradable.
B/vB criteria fulfilled?	Yes. Bioaccumulation of this substance may occur in aquatic organisms based on the estimated Log Kow of 11 (Log Kow > 4.2).
T criteria fulfilled?	No. Acute toxicity data >1 mg/L in fish, invertebrates and algae, thus the substance does not meet the screening criteria for toxicity.
Overall conclusion	Not PBT

Revised	December 2021

References

1. ECHA REACH, Fatty acids, tall-oil, reaction products with diethylenetriamine, maleic anhydride, tetraethylenepentamine and triethylenetetramine, Retrieved 2021: https://echa.europa.eu/.
2. NHMRC, 2018. Australian Drinking Water Guidelines 6, 2011, Version 3.5 Updated August 2018. National Water Quality Management.
3. HCIS, Hazardous Chemical Information System, Safe Work Australia, Retrieved December 2021: http://hcis.safeworkaustralia.gov.au/HazardousChemical.
4. ILO, International Labour Organisation, International Chemical Safety Cards (ICSCs), Retrieved December 2021: http://www.ilo.org/dyn/icsc/showcard.listcards3?p_lang=en.

Toxicity Summary - Graphite

Chemical and Physical Properties[1,2]	
CAS number	7782-42-5
Molecular formula	C
Molecular weight	12.011
Solubility in water	Insoluble
Melting point	600°C at 101.3 kPa
Boiling point	No data available
Vapour pressure	No data available
Henrys law constant	No data available
Explosive potential	No data available
Flammability potential	No data available
Colour/Form	Odourless black solid powder
Overview	Graphite is a naturally-occurring form of crystalline carbon. It is a native element mineral found in metamorphic and igneous rocks. It is extremely soft, cleaves with very light pressure, and has a very low specific gravity. In contrast, it is extremely resistant to heat and nearly inert in contact with almost any other material. A Tier 1 Human Health and Environmental Assessment for this chemical has been conducted by NICNAS which concluded that it was low concern to human health and the environment.
Environmental Fate[1,2]	
Soil/Water/Air	Graphite is a crystal modification of the chemical element carbon, an inorganic substance with negligible water solubility. Therefore, neither hydrolysis, biodegradation, nor adsorption is of relevance for the fate of the molecule. Transport and distribution is of no relevance by the negligible solubility of the substance and as element "C" in its overall availability in different organic and inorganic forms in the environment.
Human Health Toxicity Summary[1,7]	
Chronic Repeated Dose Toxicity	Oral: - One study according to OECD 422 (subacute) was conducted - Concentrations tested were up to the limit dose specified in OECD 422 = 1000 mg/kg bw/day (nominal) - No effects due to Graphite exposure were found, neither on systemic toxicity nor on reproductive/developmental toxicity Inhalation: - Two studies according to OECD 412 (subacute) were conducted - Synthetic Graphite (SG; w/o Quartz) and Expanded Graphite (EG; with Quartz) were compared separately - Testing of SG resulted in a NOAEL of 12 mg/m^3, whereas testing of EG resulted in a NOAEL of 8 mg/m^3 - Both qualities showed effects that were to be expected for a poorly soluble dust with low toxicity, with partly recovery after 28 days - Exposure was generally well tolerated - Despite the respiratory system no other organs were affected at all - No sign of systemic toxicity was observed
Carcinogenicity	No data available.
Mutagenicity/ Genotoxicity	No evidence for any genotoxic potential of Graphite.

Reproductive Toxicity / Developmental Toxicity/Teratogenicity	OECD 422 (combined repeated dose toxicity study with the reproductive/developmental toxicity screening test) - Oral administration via food (incl. analytical verification) - Graphite was tested up to the limit dose given in OECD 422 (nominal 1000 mg/kg bw/day) - Result: No signs of systemic toxicity were observed, no signs of any effects on development, reproduction, or fertility - NOAEL based on nominal food intake = 1000 mg/kg bw/day
Acute Toxicity	Oral (OECD 423, conducted as limit test): - None of the animals showed any clinical signs of reaction to the treatment. - LD50 > 2000 mg/kg bw Inhalation (OECD 403, conducted as limit test): - Upon cessation of exposure via inhalation none of the rats exposed to Graphite showed any signs of toxicity. - Only usual signs of discomfort after exposure to particles were observed. Grooming activity started immediately after the end of exposure. - LC50 > 2000 mg/m^3
Irritation	Not irritating to skin and eyes.
Sensitisation	Not sensitising
Health Effects Summary	A harmful concentration of airborne particles can be reached quickly when dispersed, especially if powdered. Repeated or prolonged inhalation of dusts may cause effects on the lungs. This may result in graphite pneumoconiosis. Poses no unreasonable risk to human health based on Tier I assessment under the NICNAS IMAP assessment framework.
Key Study/Critical Effect for Screening Criteria	Nominal doses up to 1000 mg/kg bw/day were well tolerated and did not show any sign for systemic toxicity. Since the study was conducted as a combined repeated dose toxicity study with the reproductive/developmental toxicity screening test, several NOAELs were obtained, all representing the nominal dose of 1000 mg/kg bw/day. However, the actual substance intake varied from about 813 mg/kg bw/day up to 1159 mg/kg bw/day. The derived no effect levels were calculated using the NOAEL of 813 mg/kg bw/day.
Ecological Toxicity[1]	
Aquatic Toxicity	The short-term fish toxicity was determined to be > 100 mg/L for the LC50 and > 100 mg/L for the NOEC. The short-term toxicity for aquatic invertebrates (daphnids) was determined to be > 100 mg/L for the EC50 and > 100 mg/L for the NOEC. Based in the result obtained by a valid GLP-OECD 201 study in algae with graphite as test item, no toxic effects were found up to the highest tested concentration of 100 mg/L.
Determination of PNEC aquatic	A Tier 1 assessment of the environmental risks of graphite is not required.
Current Regulatory Controls[4,5,6,7]	
Australian Hazard Classification	No data available.
Australian Occupational Exposure Standards	Time Weighted Average (TWA): 3 mg/m^3
International Occupational Exposure Standards	Threshold limit value, TLV: (respirable fraction): 2 mg/m^3, as TWA. Maximum workplace concentration, MAK: (inhalable fraction): 4 mg/m^3. MAK: (respirable fraction): 0.3 mg/m^3; peak limitation category: II(8); pregnancy risk group: C; carcinogen category: 4
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No data available.

Aquatic Toxicity Guidelines	No data available.
PBT Assessment[1]	
P/vP Criteria fulfilled?	Not applicable (inorganic mineral, ionic species ubiquitous in environment)
B/vB criteria fulfilled?	Not applicable. Bioaccumulation is not applicable to these inorganic, insoluble minerals.
T criteria fulfilled?	No. Acute data >1 mg/L. Thus, it is not expected to meet the screening criteria for toxicity.
Overall conclusion	Not PBT
Revised	December 2021

References

1. ECHA REACH, Graphite, Retrieved 2021: https://echa.europa.eu/
2. EHS Support, Graphite. Available at: https://www.santos.com/wp-content/uploads/2021/04/Graphite-March-2021.pdf. Retrieved December 2021.
3. National Industrial Chemicals Notification and Assessment Scheme (NICNAS). IMAP, Human Health Tier 1 Assessment. Retrieved 2021: https://www.industrialchemicals.gov.au/.
4. ANZG, 2018. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia. Available at www.waterquality.gov.au/anz-guidelines.
5. NHMRC, 2018. Australian Drinking Water Guidelines 6, 2011, Version 3.5 Updated August 2018. National Water Quality Management.
6. HCIS, Hazardous Chemical Information System, Safe Work Australia, Retrieved December 2021: http://hcis.safeworkaustralia.gov.au/HazardousChemical.
7. ILO, International Labour Organisation, International Chemical Safety Cards (ICSCs), Retrieved December 2021: http://www.ilo.org/dyn/icsc/showcard.listcards3?p_lang=en.

Toxicity Summary - Disodium pyrophosphate

Chemical and Physical Properties[1,2,3]	
CAS number	[redacted]
Molecular formula	Na2H2P2O7
Molecular weight	221.94
Solubility in water	170 g/L at 20 °C and pH 3.8 - 3.9
Melting point	449.85 °C
Boiling point	No data available.
Vapour pressure	0 Pa at 20 °C
Henrys law constant	No data available.
Explosive potential	Non-explosive
Flammability potential	Non-flammable
Colour/Form	White crystalline powder
Overview	A Tier 1 Human Health and Environmental Assessment for this chemical has been conducted by NICNAS which concluded that it was low concern to human health and the environment and thus required no further assessment.
Environmental Fate [4]	
Soil/Water/Air	Disodium pyrophosphate is an inorganic solid and therefore can be considered to be non volatile. No experimental data on bioaccumulation exist. However due to the hydrophilic nature of the substance, bioaccumulation is not expected as accumulation in fats is not possible. The substance when dissolved in water (and so animal tissues/fluids) will effectively separate into/become simply the two ions "phosphate" and "sodium" which are natural ionic components of blood, cell fluids, etc and therefore no further testing is considered to be necessary.
Human Health Toxicity Summary [1,2,3]	
Chronic Repeated Dose Toxicity	One key study is available on an analogous substance for the sub-chronic toxicity endpoint. On the basis of this study the NOAEL was determined to be 500 mg/kg bw/day.
Carcinogenicity	No data available.
Mutagenicity/ Genotoxicity	None of the studies suggest the substance is mutagenic.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	No data available.
Acute Toxicity	Acute oral toxicity: The oral LD50 value is derived using a weight of evidence approach. Taking into account the five studies available on disodium dihydrogenpyrophosphate and the available studies on tetrapotassium pyrophosphate and tetrasodium pyrophosphate which are considered to be of similar systemic toxicity, the weight of evidence indicates that the oral LD50 is greater than the classification limit of 2000 mg/kg bw/day. Acute inhalation toxicity: One key study is available to assess the acute inhalation toxicity of disodium dihydrogenpyrophosphate. Disodium dihydrogenpyrophosphate is considered to exhibit a low potential toxicity via the inhalation route and is not expected to be of significant concern. The acute inhalation median concentration (LC50) of disodium dihydrogenpyrophosphate in male and female rats was estimated to be > 0.58 mg/L (the maximum attainable concentration). Acute dermal toxicity: One key study is available to assess the acute dermal toxicity of disodium dihydrogenpyrophosphate. The key study (Bradshaw, 2010) has been conducted according to a current guideline (OECD Method 402) and

	according to the principles of GLP. The acute dermal median lethal dose (LD50) of the test material in the Wistar strain rat was found to be > 2000 mg/kg bodyweight.
Irritation	Disodium pyrophosphate was determined to be a mild irritant to rabbit skin with a primary dermal irritation score of 2.58, mostly the reactions were noted in abraded skin. The test material produced a maximum group mean score of 39.0 and was classified as a moderate irritant (Class 5 on a 1 to 8 scale) to the rabbit eye.
Sensitisation	Disodium pyrophosphate is a non-sensitiser under the conditions of the study.
Health Effects Summary	Disodium pyrophosphate has low acute oral and dermal toxicity and moderate acute toxicity by the inhalation route. The substance is a skin and eye irritant.
Key Study/Critical Effect for Screening Criteria	The NOAEL from the sub-chronic toxicity study of 500 mg/kg bw/day is used for risk characterisation.
Ecological Toxicity [4]	
Aquatic Toxicity	96h LC50 (fish): > 100 mg/l 48h EC50 (invertebrates): 100 mg/L 72h EC50 (algae): 100 mg/L
Determination of PNEC aquatic	Data from short-term tests with three trophic levels are available. An assessment factor of 100 is applied to the lowest EC50 100 mg/L (fish, invertebrates, algae). A PNECaqua of 1 mg/L was derived.
Current Regulatory Controls [4,5,6,7]	
Australian Hazard Classification	No data available.
Australian Occupational Exposure Standards	No data available.
International Occupational Exposure Standards	No data available.
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	No data available.
PBT Assessment [4]	
P/vP Criteria fulfilled?	No. The substance is an inorganic compound and is not subject to biodegradation.
B/vB criteria fulfilled?	No. Not expected to bioaccumulate.
T criteria fulfilled?	No. Inorganic substance comprising ions of low ecotoxicological concern. This chemical is not expected to pose an unreasonable risk to the environment provided that ANZECC water quality guidelines for physical and chemical stressors are not exceeded.
Overall conclusion	Not PBT
Revised	June 2022

References

1. ECHA REACH, Disodium dihydrogenpyrophosphate, Retrieved 2022: https://echa.europa.eu/
2. National Industrial Chemicals Notification and Assessment Scheme (NICNAS). IMAP, Human Health Tier 1 Assessment. Retrieved 2022: https://www.industrialchemicals.gov.au/.

3. NCBI, 2022. National Center for Biotechnology Information. Available at: https://pubchem.ncbi.nlm.nih.gov/. Retrieved February 2022.
4. HCIS, Hazardous Chemical Information System, Safe Work Australia, Retrieved February 2022: http://hcis.safeworkaustralia.gov.au/HazardousChemical.
5. ILO, International Labour Organisation, International Chemical Safety Cards (ICSCs), Retrieved February 2022: http://www.ilo.org/dyn/icsc/showcard.listcards3?p_lang=en.
6. ANZG, 2018. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia. Available at www.waterquality.gov.au/anz-guidelines.
7. NHMRC, 2018. Australian Drinking Water Guidelines 6, 2011, Version 3.5 Updated August 2018. National Water Quality Management.

Toxicity Summary - Ethanamine, N-ethyl-N-hydroxy-

Chemical and Physical Properties[1,2]	
CAS number	[redacted]
Molecular formula	C4H11NO
Molecular weight	89.14
Solubility in water	8.9 x 10^4 mg/L at 25 °C (estimated)
Melting point	10.0 °C
Boiling point	133.0 °C
Vapour pressure	3.36 mm Hg at 25 °C
Henrys law constant	5.9 x 10^{-8} atm-cu m/mol at 25 °C (estimated)
Explosive potential	No data available.
Flammability potential	No data available.
Colour/Form	Liquid
Overview	Diethylhydroxylamine's is used as photographic developer, antioxidant, corrosion inhibitor and as a short stopping agent in synthetic rubber production.
Environmental Fate [2]	
Soil/Water/Air	If released to air, an extrapolated vapor pressure of 3.36 mm Hg at 25 °C, indicates that diethylhydroxylamine is expected to exist solely in the vapour phase in the ambient atmosphere. Vapour-phase diethylhydroxylamine is degraded in the atmosphere by reaction with photochemically-produced hydroxyl radicals; the half-life for this reaction in air is estimated to be 4 hours. Diethylhydroxylamine does not contain chromophores that absorb at wavelengths >290 nm and therefore is not expected to undergo direct photolysis by sunlight. If released to soil, diethylhydroxylamine is expected to have high mobility based upon an estimated Koc of 74. The estimated pKa of diethylhydroxylamine is 5.7, indicating it will partially exist in the protonated form in moist soils. The mobility of diethylhydroxylamine may be overestimated since cations generally adsorb more strongly to soils containing organic carbon and clay than neutral species. Volatilization from moist soil surfaces is not expected to be an important fate process based upon an estimated Henry's Law constant of 5.9 x 10^{-8} atm cu m/mol atm-cu m/mole for the free base, and the fact that cations do not volatilize. The potential for volatilization of diethylhydroxylamine from dry soil surfaces may exist based upon the extrapolated vapor pressure. Diethylhydroxylamine was biodegraded between 1-9% in the Japanese MITI test, suggesting it may be slow to biodegrade in the environment. If released to water, diethylhydroxylamine (free base) is not expected to adsorb to suspended solids and sediment based upon the estimated Koc; however, the protonated form (conjugate acid) may be more likely to adsorb to sediment. Volatilization from water surfaces is not expected to be an important environmental fate process based on the Henry's Law constant for the neutral species and the fact that cations do not volatilize. Hydrolysis is not expected to be an important environmental fate process since this compound lacks functional groups that hydrolyze under environmental conditions. An estimated BCF value of 3, suggests the potential for bioconcentration in aquatic organisms is low.
Human Health Toxicity Summary [1,2]	
Chronic Repeated Dose Toxicity	1 -Diethylhydroxylamine toxicity was evaluated in a 28-day study in rats performed according to the OECD TG # 412 (Naas, 1996a). The test article was administered via nose-only inhalation to three groups, each comprised of 15 male and 15 female Crl: CDBR rats, for a period of six hours per day, five days per week, for four consecutive weeks (minimum of 20 total exposures). The targeted exposure concentrations were 15, 150 and 1500 ppm. The test atmosphere concentrations were monitored by infrared absorbance and were found to be 15, 150 and 1500

	ppm (54.6, 546.0 and 5481.8 mg/m3). A concurrent control group of identical design received only filtered air, on a comparable regimen. The animals were observed for clinical signs and effects on body weight, food consumption and clinical pathology parameters. Data from detailed physical examinations, including Functional Observational Battery data (handling and open field observations), were recorded during the pre-test period and during weeks 0 through 5. After completion of exposure, 5 rats/sex/group entered an approximate two-week (non exposure) recovery period, after which they were euthanized; necropsies were performed, and selected organs were weighed. The remaining rats in each group were euthanized immediately following the exposure period and necropsied as described above. A microscopic examination was conducted on selected tissues from all groups. In the control, 15, 150 and 1500 ppm groups, 2, 1, 2 and 2 animals, respectively, were found dead during the study. These deaths were noted while the animals were in the exposure tube either prior to exposure, during exposure or at the time of unloading from the exposure tubes. The deaths did not occur in an exposure-related manner and were not related to exposure to the test article. All other animals survived to the scheduled necropsies. The predominant treatment-related clinical signs were dried yellow dorsal posterior and urogenital matting, lack of grooming, eye closure and hypoactivity in males and females in the 1500 ppm group, and ataxia, paleness in colour, walking on tiptoes and hunched posture in the females in this group. The findings of ataxia, paleness in colour, walking on tiptoes, hunched posture, eye closure and hypoactivity were transient in that they occurred only at the post-exposure observation and not prior to exposure or during the Functional Observational Battery. During the recovery period, no significant findings were noted at any exposure level. The only potential test article-related finding noted during the Functional Observational Battery evaluations (handling and open field observations) was an increase in slightly soiled or very soiled fur in the 1500 ppm group males and females during weeks 0 to 2. During the recovery period, no test article-related findings were noted during the Functional Observational Battery evaluations. Reductions in mean body weight gain were noted in males and females in the 1500 ppm group during week 0-1 and in males in this group throughout the remainder of the exposure period. Food consumption was reduced in the 1500 ppm group males and females during week 0-1. During the recovery period, body weights and food consumption in these animals were similar to the control group values. At the week 4 evaluation, the segmented neutrophil count was increased in the 1500 ppm group mates and females, and the lymphocyte count was reduced in the females in this group. Alkaline phosphatase and phosphorous values were increased in the 1500 ppm group males and females at the week 4 evaluation. At the week 4 evaluation, albumin levels were decreased in the 1500 ppm group (both sexes) and the 150 ppm group (females only), and globulin was increased in the 1500 ppm females. These changes corresponded with decreased A/G ratios in the 1500 ppm group (both sexes) and the 150 ppm group females. A slight but statistically significant increase in alanine aminotransferase in the 1500 ppm group females (week 4) may also have been treatment-related. Bile acids were increased in the mates in the 1500 ppm group at the week 4 evaluation. At the week 6 evaluation, the values for all of these parameters were similar to the control group values. (Although bile acids appeared elevated at the week 6 evaluation for 1500 ppm mates, this was due to a low control value and unrelated to the test article.) Other hematology and serum chemistry values and urinalysis parameters were unaffected by exposure to the test article at any exposure level. No test article-related internal findings were noted at the necropsies of animals that died during the study or at the scheduled necropsies. At the week 4 necropsy, thymus gland weights (relative and absolute) were reduced in males and females in the 1500 ppm group. Mean liver weights (absolute and relative) were increased in the 1500 ppm group females at the week 4 necropsy. Organ weights were comparable to the control group values at the week 6 (recovery) necropsy. test article-related microscopic observations were noted. At the week 4 necropsy, reversible test article-related microscopic changes consisting primarily of non suppurative mucosal inflammation, but also including squamous hyperplasia and necrosis in a limited number of animals, were noted in the nasal passages of male and female rats in the 150 and 1500 ppm groups; these effects were considered to be local, not systemic. At the recovery necropsy, only one rat of each sex in the 1500 ppm group had minimal non suppurative mucosal inflammation in the nasal cavity. Medullary plasmacytosis was noted at an increased incidence in the iliac and popliteal lymph nodes in males in the 1500 ppm group. At the recovery necropsy, no exposure-related microscopic effects were noted in males or females at any dose level. In conclusion, toxicity was exhibited in the 1500 ppm group by clinical signs, inhibition of body weight gain

	and food consumption, changes in white blood cell differential counts, various serum chemistry changes, reduced thymus gland weights-and increased liver weights. Medullary plasmacytosis was noted in the iliac and popliteal lymph nodes in males in the 1500 ppm group. Systemic effects in the 150 ppm group were limited to slight decreases in albumin and A/G ratio (females only). Based on data collected following a two-week non exposure (recovery) period, all of these effects were considered to be reversible. Microscopic changes were noted in the nasal passages of male and female rats in the 150 and 1500 ppm groups; these effects were considered to be due to local irritation, not systemic toxicity, and reversible. The hematological, serum chemistry and organ weight (thymus and liver) effects in the 1500 ppm group indicate that the liver and thymus were the target organs, however, no test article related histomorphological changes were seen in these tissues. Based on these results, exposure levels of 150 ppm (546.0 mg/m^3) and 15 ppm (54.6 mg/m^3) were considered to be the NOAEC (no observed adverse effect concentration) and NOEC (no observed effect concentration), respectively, for systemic toxicity and the exposure level of 15 ppm (54.6 mg/m^3) was considered to be the NOEC for nasal irritation.
Carcinogenicity	No data available.
Mutagenicity/ Genotoxicity	In an in vitro genotoxicity assays, diethylhydroxylamine appeared to be clastogenic.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	The developmental toxicity of diethylhydroxylamine was evaluated in rats according to OECD Guideline 414. Diethylhydroxylamine was administered by oral gavage on gestation days 6 to 15. Maternal toxicity included decreased body weight and food consumption at 393 and 568 mg/kg/day. No evidence of developmental toxicity was observed at any dose level. No teratogenic effects were detected in mice exposed to 8.9 ppm on days 6-17 of gestation. While negative, this study is compromised by technical and protocol deficiencies.
Acute Toxicity	Oral route In a pre-guideline study, groups of 5 WBS/W rats were administered dose levels of 1400, 2000, 2800, 4000 mg/kg bw of diethylhydroxylamine (undiluted) by stomach tube (Latven, 1977a). The animals were then observed for 7 days following exposure. At 4000 mg/kg, 5/5 rats died, at 2800 mg/kg bw 4/5 rats died, at 2000 mg/kg bw, 2/5 rats died and at 1400 mg/kg bw none died. Clinical observations revealed muscular incoordination and general depression. Autopsy findings were negative. The LD50 was 2190 mg/kg bw. In a pre-guideline study, groups of 2, 5 or 10 male OF1 mice were administered dose levels of 875, 1000, 1300, 1800, 2400, 3200, 4300, 8750 mg/kg bw of diethylhydroxylamine by stomach tube (Latven, 1957). The animals were then observed for 7 days following exposure. No mortality was observed at 875, 1000 and 1300 mg/kg bw, at 1800 mg/kg, 2/10 mice died, at 2400 mg/kg bw 7/10 mice died, at 3200 mg/kg bw, 10/10 mice died and at 4300 and 8750 mg/kg bw 2/2 mice died. Clinical observations revealed decrease motor activity, ataxia, complete inactivity, muscular hypotonicity, loss of righting reflex, muscular spasms, mild clonic convulsions, respiratory depression, cyanosis and death. The LD50 was 2150 mg/kg bw. Inhalation route In an acute inhalation toxicity study performed according to the US EPA guideline (Terrill, 1986), series of groups consisting of five male and five female Sprague-Dawley derived rats was exposed to diethylhydroxylamine vapor for four hours mean analytical levels in the range of 1410 to 4720 parts per million (ppm). At 1410 and 2650 ppm, no rat died, 3240 and 3560 ppm, 1/5 male and 5/5 female rats died, and at 4720 ppm, all rats died. The mortality results indicated the test material was more lethal to female rats than to male rats. Signs attributable to treatment included death, increased incidences of secretory responses, respiratory distress, general signs of poor condition, corneal opacity and loss of body weight. Overall, the time-to-onset and time-to-recovery of these signs were related to exposure concentration. The lungs of numerous animals, both treated and control,

	were discoloured primarily scattered red-grey foci were observed in the animals which were killed at the end of the study, whereas in the animals which died, the lungs were bright to dark red. The toxicologic significance of these findings, if any, cannot be determined on the basis of a gross examination only. The LC50 was determined 4400 ppm for the males, 2620 ppm for the females and 3140 ppm for both sexes combined. Dermal route In a pre-guideline study, groups of 4 albino rabbits were treated dermally under a pre-fitted occluding sleeve with 707, 1000, 1414 and 2000 mg/kg body weight of diethylhydroxylamine (Latven, 1980a). The occluding sleeve was removed 24 hours following exposure and the animals were observed for 7 days. No rabbit died at 707 mg/kg/bw, at 1000 mg/kg bw, 1/4 rabbit died, at 1414 mg/kg bw, 2/4 rabbits died and at 2000 mg/kg bw, all rabbits died. The clinical signs observed were hypersensitivity, mydriasis, and incoordination prior to toxic incapacitation. The acute dermal LD50was 1300 mg/kg bw. In two other pre-guideline studies (Latven, 1977 and 1979), groups of three albino rabbits were treated dermally with a single dose of 2000 mg/kg (2.24 ml/kg) diethylhydroxylamine and three additional rabbits were treated with a single dose of 200 mg/kg (2.0 ml/kg of a 10% W/V aqueous dilution). Individual doses were applied to the fur-clipped skin of the trunk under a pre-fitted impervious sleeve on each of the animals. After a skin-contact period of 24 hours, the sleeves were removed and in one study (Latven, 1979) the treated sites were gently cleansed with a 2% solution of acetic acid. Surviving animals were then observed for seven days. All animals died at 2000 mg/kg bw and none at 200 mg/kg bw.
Irritation	Diethylhydroxylamine is slightly irritating to rabbit skin and eyes and irritating to the respiratory tract. In an in vitro genotoxicity assays, diethylhydroxylamine appeared to be clastogenic.
Sensitisation	Not a skin sensitizer.
Health Effects Summary	Diethylhydroxylamine has moderate chronic toxicity, is a potential skin and eye irritant, and is not a skin sensitiser.
Key Study/Critical Effect for Screening Criteria	The NOEC of 15 ppm (54.6 mg/m^3) for nasal irritation was considered to be key study for risk characterisation.
Ecological Toxicity [1]	
Aquatic Toxicity	96 hr LC50 (fish): 134 mg/L 48 hr EC50 (invertebrates): 8.2 mg/L 72 hr EC50 (algae): 101 mg/L 28 days NOEC (microorganisms): 100 mg/L
Determination of PNEC aquatic	Data from short-term tests with three trophic levels are available. An assessment factor of 100 is applied to the lowest 48 hr EC50 of 8.2 mg/L (invertebrates). A PNECaqua of 82 µg/L was derived.
Current Regulatory Controls [5,6]	
Australian Hazard Classification	No data available.
Australian Occupational Exposure Standards	No data available.
International Occupational Exposure Standards	No data available.
Australian Food Standards	No data available.

Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	No data available.
PBT Assessment [4]	
P/vP Criteria fulfilled?	Yes. The substance is not readily biodegradable. Therefore, it meets the screening criteria for persistence.
B/vB criteria fulfilled?	No. As the log Pow = -0.17 (Log Pow < 4.5), it is not expected to be bioaccumulative.
T criteria fulfilled?	No. The acute EC50 of the substance is >1 mg/L in fish, invertebrates and algae. Therefore, it does not meet the screening criteria for toxicity.
Overall conclusion	Not PBT
Revised	June 2022

References

1. ECHA REACH, N,N-diethylhydroxylamine, Retrieved 2022: https://echa.europa.eu/
2. NCBI, 2022. National Center for Biotechnology Information. Available at: https://pubchem.ncbi.nlm.nih.gov/. Retrieved February 2022.
3. HCIS, Hazardous Chemical Information System, Safe Work Australia, Retrieved February 2022: http://hcis.safeworkaustralia.gov.au/HazardousChemical.
4. ILO, International Labour Organisation, International Chemical Safety Cards (ICSCs), Retrieved February 2022: http://www.ilo.org/dyn/icsc/showcard.listcards3?p_lang=en.
5. ANZG, 2018. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia. Available at www.waterquality.gov.au/anz-guidelines.
6. NHMRC, 2018. Australian Drinking Water Guidelines 6, 2011, Version 3.5 Updated August 2018. National Water Quality Management.

Toxicity Summary - Ethanolamine

Chemical and Physical Properties[1,2]	
CAS number	[redacted]
Molecular formula	C_2H_7NO
Molecular weight	61.08
Solubility in water	Miscible in water at 25 °C
Melting point	10.3 °C
Boiling point	170.8 °C
Vapour pressure	0.05 kPa at 20 °C
Henrys law constant	0 Pa m^3/mol at 25 °C
Explosive potential	Non-explosive
Flammability potential	Non-flammable
Colour/Form	Colourless viscous liquid (or solid below 10oC), with unpleasant, fishy, ammoniacal smell.
Overview	A Tier 1 Environmental Assessment for this chemical has been conducted by NICNAS which concluded that it was low concern to the environment.
Environmental Fate [1]	
Soil/Water/Air	According to structural properties, hydrolysis of ethanolamine is not expected. In addition, the substance is readily biodegradable. Adsorption of the substance to the solid soil phase is not expected under environmentally relevant conditions. From the water surface the substance will not evaporate into the atmosphere under environmentally relevant conditions. Over time, the uncharged substance will preferentially distribute into the compartment water (99.9%). At environmentally conditions the substance will be ionized (pKa = 9.25 at 25 °C, experimental data); therefore, the distribution into the compartment water seems to be appropriate.
Human Health Toxicity Summary [1,2,3]	
Chronic Repeated Dose Toxicity	In a 90-day sub-chronic oral study, rats were fed 320, 640 or 1280 mg/kg/day ethanolamine mixed in food. No effects were observed in rats at 320 mg/kg bw/day ethanolamine. At 640 mg/kg/day, liver and kidney weights were altered and at the highest dose of 1280 mg/kg/day, death occurred. No further details of the study were available. The results indicated an oral NOAEL (No Observed Adverse Effect Level) of 320 mg/kg/day. In a reproductive/development toxicity study, pregnant rats were administered 0, 40, 120 and 450 mg/kg bw/day ethanolamine by gavage. Evidence of maternal toxicity such as reduced food consumption, lower mean body weights and impaired body weight gain were reported at 450 mg/kg/day. These observed effects were not sufficient to establish a NOAEL in this study.
Carcinogenicity	No data on the carcinogenicity of ethanolamine are available.
Mutagenicity/ Genotoxicity	Ethanolamine lacked mutagenic potential in the Ames bacterial mutagenicity test when tested in the presence or absence of a metabolic activation system with a variety of Salmonella typhimurium tester strains, namely TA 1535, TA 1537, TA 1538, TA 98, and TA 100. The highest ineffective dose tested in any Salmonella typhimurium strain was 10 000 mg/plate. Ethanolamine also failed to cause mutations in a test organism sensitive to oxidative-type mutagens (Escherichia coli). Assays of the potential of ethanolamine to damage DNA in Bacillus subtilis and to cause chromosomal damage in yeast cells (Saccharomyces cerevisiae gene conversion assay) were negative. Ethanolamine did not induce chromosome damage in rat liver epithelial-type cells or transformation of Chinese hamster cells. It did not induce a mutagenic response

	in the mouse lymphoma forward mutation assay in the absence or presence of metabolic activation. In the only in vivo chromosomal aberration study, the Mammalian Erythrocyte Micronucleus Test, in which mice were fed 375, 750 and 1500 mg/kg ethanolamine dissolved in water, there were no biologically relevant, significant differences in the frequency of erythrocytes containing micronuclei between the solvent control and the three dose groups. The study concluded that, under the experimental conditions chosen, ethanolamine has no chromosome-damaging (clastogenic) effect, nor does it lead to any impairment of chromosome distribution in the course of mitosis. Based on the observations, it is concluded that ethanolamine is not genotoxic.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	The study shows that ethanolamine may affect fertility in rats at very high concentrations (1000 mg bw/day), at which maternal toxicity is also observed. Based on the study observations, ethanolamine is not considered a developmental toxin in rats.
Acute Toxicity	In a study conducted according to the Organisation for Economic Cooperation and Development (OECD) Test Guidelines (TG), Sprague-Dawley rats (five rats per sex) were administered 254, 509, 1018, 2036 and 4072 mg/kg bw/day ethanolamine by gavage, and the animals observed for 14 days. Animals with high doses (2036 and 4072 mg/kg bw) displayed sluggishness and piloerection. All deaths occurred relatively rapidly after dosing (within two days), except for one male rat that died after 12 days following a dose of 509 mg/kg bw. Rats receiving ethanolamine at the maximum dosage died after three hours. The median lethal dose (LD50) values and the estimated LD50 slopes were calculated by the moving average method. An oral LD50 of 1089 mg/kg bw was established in this study. The study shows that ethanolamine has moderate toxicity by the oral route in rats. In the only reported dermal toxicity study, ethanolamine at 1.0, 2.0, or 4.0 mL/kg (1010, 2020 or 4040 mg/kg bw) was applied to the clipped, intact skin of New Zealand White rabbits (five per sex). Gauze was wrapped around the trunk over the sample for the 24 hour exposure period. Observations for toxicity and skin reactions were made at one hour, seven days, and 14 days after the contact period. At death or termination, each animal was subjected to a gross pathologic evaluation. Erythema, oedema, necrosis and ecchymosis were common findings in all dose groups. Nearly all animals in the highest dose group died within 1 to 2 days. The calculated LD50 values for males and females were 2504 mg/kg and 2881 mg/kg, respectively. The study shows that ethanolamine has low acute toxicity by the dermal route in rabbits. In three separate studies that were reliable (with restrictions), rats were exposed to saturated vapour of ethanolamine generated by bubbling 200 l/hour air at 20°C through a column of test material (5 cm) above a fritted glass disc in a glass cylinder. Animals were exposed for eight hours and observed for seven days. No deaths occurred in any of the studies. Based on the atmospheric concentration of ethanolamine (1.3 mg/L air) derived from its theoretical saturated vapour concentrations at room temperature, the median lethal concentration (LC50) for ethanolamine was estimated as >1.3 mg/L. In a sub-acute inhalation study, rats were exposed to 10, 50 or 150 mg/m^3 ethanolamine aerosol, 6 hrs/day, 5 days/wk for 28 days. The aerosol was generated with compressed air mixed with conditioned dilution air into the inhalation system using a two-component atomiser. The control group was exposed to conditioned air only. No deaths were recorded throughout the study. No treatment-related changes in food intake, body weight or adverse changes in haematology or clinical chemistry parameters were observed. There were no gross lesions in treated male or female animals. At 50 and 150 mg/m^3 all the animals developed submucosal inflammation at the base of the epiglottis, characterised by infiltrates of granulocytes and lymphoid cells. In addition, a focal squamous cell metaplasia was observed in some animals at 50 mg/m3 and in all animals of the 150 mg/m^3 group. Some animals in the 150 mg/m^3 group also showed focal epithelial necrosis at the base of the epiglottis. A minimal focal epithelial hyperplasia also occurred in the 150 mg/m^3 group of rats. Histopathological changes such as

	squamous metaplasia in the trachea and mucous cell hyperplasia in the lungs were also noted at 150 mg/m^3. All the findings were considered treatment-related. A NOAEL of 10 mg/m^3 was established for local effects based on the concentration-related lesions in larynx, trachea and lung observed in rats. No adverse systemic effects were reported. A NOAEL for systemic effects could not be established in this study. Repeated inhalation exposure of dogs, guinea pigs and rats to 66 to 102 ppm (160 to 255 mg/m^3) ethanolamine for 24 to 90 days induced behavioural effects and degenerative changes in different organs, especially cloudy swelling in the liver and in the tubular epithelium of the kidneys. The animals also displayed pronounced clinical signs of skin and respiratory irritation, which progressed with time to hair loss, severe skin lesions, moist rales and fever in dogs and breathing difficulties in rats and guinea pigs. There was a decrease in the albumin-globulin ratio and a decrease in haemoglobin and haematocrit values in dogs exposed to 102 ppm ethanolamine. A NOAEL could not be established in this study as the effects were seen at all doses tested. Repeated inhalation of low doses of 30 mg/m^3 ethanolamine for 90 days caused behavioural effects in dogs, such as progressive stages of excitation followed by depression. Rats exposed to 5 ppm (13 mg/m^3) ethanolamine also exhibited skin irritation and lethargy after 2 to 3 weeks exposure. The EU Scientific Expert Group on Occupational Exposure Limits for Ethanolamine considered this LOAEL (5 ppm or 13 mg/m^3) as the best available basis for proposing occupational exposure limits. Based on the observations in the above studies, a NOAEL of 10 mg/m^3 was established for local effects being just below the LOAEL derived by the EU Scientific Expert group. A NOAEL for systemic effects due to repeated inhalation of ethanolamine could not be established in any of the available studies.
Irritation	Based on the available studies, ethanolamine is considered to be corrosive to animal skin and to the rabbit eye. Based on the effects of ethanolamine on the skin and eyes of animals, the chemical is expected to be a respiratory irritant.
Sensitisation	The sensitisation effect of ethanolamine was tested in guinea pigs using the guinea pig maximisation test (GPMT). Groups of 15 animals were induced with 0.6% (intradermal) and 10.3% (epicutaneous) ethanolamine and then challenged after three weeks with 0.41, 2.05 and 4.1% ethanolamine. Prior to the topical induction, the animals were pretreated with 10% sodium dodecyl sulphate. The challenge reactions were read blindly 48 and 72 hours after application of the patches (Finn chambers). Control groups of 12 animals were given the same treatment (Freund's Complete Adjuvant, vehicle, occlusion, etc.). After the challenge with 4.1%, 2.05% and 0.41% ethanolamine, 3/15, 2/15 and 3/15 of the animals, respectively, reacted positively after 72 hours. Two out of 15 animals showed a reaction to the vehicle. The study concluded that ethanolamine is not a skin sensitiser.
Health Effects Summary	Ethanolamine has moderate acute oral and inhalational toxicity and low acute toxicity by the dermal route. The oral and dermal LD50 values in rats are 1089 mg/kg bw and 2504 mg/kg bw, respectively and the inhalation LC50 is >1.3 mg/L. Ethanolamine is corrosive to the skin and eyes. Information on respiratory irritation activity is not available, however based on a repeated dose inhalation study, signs of irritation were reported in the trachea and lungs indicating that it is respiratory irritant. Ethanolamine is not considered to be a skin sensitiser. The most appropriate NOAEL for human health risk assessment purposes is 320 mg/kg bw/day, determined in an oral repeat dose study in rats based on increase in liver and kidney weights. Repeat dose dermal studies for ethanolamine are not available. Ethanolamine is not genotoxic or a carcinogen based on available data. Effects on fertility were observed at a high dose of 1000 mg/kg bw/day at which dose maternal toxicity was also observed. No developmental toxicity effects were noted in rats. Skin and eye irritation is the critical effect for human health risk assessment. Ethanolamine is also harmful by oral and inhalation routes.

Key Study/Critical Effect for Screening Criteria	The NOAEL from the 90-day study, 320 mg/kg bw/day, will be used for human risk assessment.
Ecological Toxicity [1]	
Aquatic Toxicity	Acute toxicity: 96 h LC50 (fish): 105 mg/L 48 h EC50 (invertebrates): 27.04 mg/L 72 h ErC50 (algae): 2.8 mg/L Chronic toxicity: 41 d NOEC (fish): 1.24 mg/L 21 d NOEC (invertebrates): 0.85 mg/L 72 h ErC10 (algae): 0.7 mg/L
Determination of PNEC aquatic	Data from short and long-term tests with three trophic levels are available. An assessment factor of 10 is applied to the lowest 21-day NOEC of 0.85 mg/L (invertebrates). A PNECaqua of 85 µg/L was derived.
Current Regulatory Controls [2,3,4,5]	
Australian Hazard Classification	Ethanolamine is classified as hazardous for human health in the Hazardous Substances Information System (HSIS) with the following risk phrases (Safe Work Australia 2013): • C, R34 (Corrosive; causes burns) • Xn, R20/21/22 (Harmful by inhalation, in contact with skin and if swallowed). Mixtures containing ethanolamine are classified as hazardous with the following risk phrases based on the concentration (conc) of the chemicals in the mixtures. The risk phrases are: • Conc ≥25%: C; R34; R20/21/22 (Corrosive, causes burns, harmful by inhalation, in • contact with skin and if swallowed) • 10% ≤Conc <25%: C; R34 (Corrosive, causes burns) • 5% ≤Conc <10%: Xi; R36/37/38 (Harmful, irritating to eyes, respiratory system and • skin).
Australian Occupational Exposure Standards	The occupational exposure standards for ethanolamine are (Safework Australia 2013): • Time Weighted Average (TWA): 7.5 mg/m^3 (5 ppm) • Short-Term Exposure Limit (STEL): 15 mg/m^3 (10 ppm).
International Occupational Exposure Standards	Occupational exposure limits for ethanolamine identified internationally are provided below (Galleria Chemica 2013). TWA: • 7.5 mg/m^3 (5 ppm) [Canada, Colombia, Japan] • 2.5 mg/m^3 (2 ppm) [Bulgaria, UK] • 8 mg/m^3 [US] STEL: • 15 mg/m^3 (10 ppm) [Canada, Colombia, Japan, US] • 7.5 mg/m^3 (5 ppm) [Bulgaria, UK].
Australian Food Standards	No Australian food standards have been identified.
Australian Drinking Water Guidelines	No aesthetic or health-related guidance values were identified for this chemical in the Australian Drinking Water Guidelines (National Health and Medical Research Council (NHMRC) 2011).
Aquatic Toxicity Guidelines	No data available.
PBT Assessment [1]	
P/vP Criteria fulfilled?	No. The substance is readily biodegradable.
B/vB criteria fulfilled?	No. As the Log Pow is -1.31 at 25 °C (Log Pow < 4.5), it is not expected to be bioaccumulative.

T criteria fulfilled?	No. Chronic toxicity data >0.01 mg/L and substance is readily biodegradable, ethanolamine does not meet the screening criteria for toxicity.
Overall conclusion	Not PBT
Revised	June 2022

References

1. ECHA REACH, 2-aminoethanol, Retrieved 2022: https://echa.europa.eu/
2. Department of the Environment and Energy 2017, National assessment of chemicals associated with coal seam gas extraction in Australia, prepared by the National Industrial Chemicals Notification and Assessment Scheme
3. National Industrial Chemicals Notification and Assessment Scheme (NICNAS). IMAP, Ethanol, 2-amino-: Human health tier II assessment. Retrieved 2022: https://www.industrialchemicals.gov.au/.
4. HCIS, Hazardous Chemical Information System, Safe Work Australia, Retrieved February 2022: http://hcis.safeworkaustralia.gov.au/HazardousChemical.
5. ILO, International Labour Organisation, International Chemical Safety Cards (ICSCs), Retrieved February 2022: http://www.ilo.org/dyn/icsc/showcard.listcards3?p_lang=en.

Toxicity Summary - Fatty acids, tall-oil

Chemical and Physical Properties[1,2]	
CAS number	[redacted]
Molecular formula	Variable
Molecular weight	Variable
Solubility in water	0.0126 g/L at 20°C
Melting point	No data available
Boiling point	No data available
Vapour pressure	No data available
Henrys law constant	No data available
Explosive potential	No data available
Flammability potential	No data available
Colour/Form	
Overview	A Tier 1 Human Health and Environmental Assessment for this chemical has been conducted by NICNAS which concluded that it was low concern to human health and the environment and thus required no further assessment.
Environmental Fate [4]	
Soil/Water/Air	Fatty acids, tall oil is readily biodegradable. It is insoluble and will likely strongly adsorb to soil or sediment. Substances in this category have a low potential for bioaccumulation.
Human Health Toxicity Summary	
Chronic Repeated Dose Toxicity	No data available.
Carcinogenicity	No data available.
Mutagenicity/ Genotoxicity	No data available.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	No data available.
Acute Toxicity	No data available.
Irritation	No data available.
Sensitisation	No data available.
Health Effects Summary	Poses no unreasonable risk to human health based on Tier I assessment under the NICNAS IMAP assessment framework.
Key Study/Critical Effect for Screening Criteria	No data available.
Ecological Toxicity [1,2]	
Aquatic Toxicity	Pimephales promelas: 96-hour LL50 >1,000 (WAF) NOEC 1,000 (WAF) Daphnia magna: 48-hour EL50 >1,000 (WAF) NOEL 1,000 (WAF)

	Selenastrum capricornutum: 72-hour EL50 854.90 (WAF) NOEL 500 (WAF)
Determination of PNEC aquatic	Not determined. Fatty acids, tall oil is of low acute toxicity concern to aquatic organisms. Poses no unreasonable risk to the environment based on Tier I assessment under the NICNAS IMAP assessment framework.
Current Regulatory Controls [5,6]	
Australian Hazard Classification	No data available.
Australian Occupational Exposure Standards	No data available.
International Occupational Exposure Standards	No data available.
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	No data available.
PBT Assessment [4]	
P/vP Criteria fulfilled?	No. Fatty acid tall oil is readily biodegradable.
B/vB criteria fulfilled?	No. No experimental data are available for fatty acids, tall oil. Using the bioconcentration factor/bioaccumulation factor (BCFBAF) model in EPISuite™ (USEPA, 2017), the estimated BCF for oleic and linoleic acid, the two major fatty acids, is 56.23 L/kg based on a regression-based estimate. Based on this BCF value, this substance has a low potential for bioaccumulation.
T criteria fulfilled?	No. For fatty acids, tall oil, the NOEC from an algal study and the acute EC50 values in fish, invertebrates and algae are greater than the water solubility of fatty acids, tall oil. Thus, it does not meet the screening criteria for toxicity.
Overall conclusion	Not PBT
Revised	June 2022

References

1. National Industrial Chemicals Notification and Assessment Scheme (NICNAS). IMAP, Human Health Tier 1 Assessment. Retrieved 2022: https://www.industrialchemicals.gov.au/.
2. EHS Support, Mixture of Dimer/Trimer Fatty Acids of Indefinite Composition Derived from Tall Oil (Fatty Acids, Tall Oil. Available at: https://www.santos.com/wp-content/uploads/2021/04/Tall-oil-fatty-acids-March-2021.pdf. Retrieved February 2022.
3. HCIS, Hazardous Chemical Information System, Safe Work Australia, Retrieved February 2022: http://hcis.safeworkaustralia.gov.au/HazardousChemical.
4. ILO, International Labour Organisation, International Chemical Safety Cards (ICSCs), Retrieved February 2022: http://www.ilo.org/dyn/icsc/showcard.listcards3?p_lang=en.
5. ANZG, 2018. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia. Available at www.waterquality.gov.au/anz-guidelines.
6. NHMRC, 2018. Australian Drinking Water Guidelines 6, 2011, Version 3.5 Updated August 2018. National Water Quality Management.

Toxicity Summary - Hexanedinitrile, hydrogenated, high boiling fraction

Chemical and Physical Properties[1,2,3]	
CAS number	[redacted]
Molecular formula	$C_6H_8N_2$
Molecular weight	108.14 g/mol
Solubility in water	80 g/L at 20°C
Melting point	-5 °C to 6°C
Boiling point	305.3°C at 99.5 kPa
Vapour pressure	0.091 Pa at 25°C
Henrys law constant	1.21 x 10^{-9} atm-cu m/mole
Explosive potential	Non-explosive
Flammability potential	No information available
Colour/Form	Slightly brown liquid
Overview	Adiponitrile appears as a colourless to light yellow liquid which is fairly soluble and is less dense than water. Contact may irritate skin, eyes and mucous membranes. May be toxic by ingestion, inhalation and skin absorption.
Environmental Fate [3]	
Soil/Water/Air	Hexanedinitrile is expected to readily degrade. It is not expected to bioaccumulate, and it has a low potential to adsorb to soil. Hexanedinitrile is highly soluble in water. Volatilisation from water surfaces or moist soil surfaces is not expected to be an important fate process based upon this compound's estimated Henry's Law constant. It is also not expected to volatilise from dry soil surfaces based upon its vapour pressure
Human Health Toxicity Summary [1,2,3]	
Chronic Repeated Dose Toxicity	Inhalation subchronic NOAEC (rat): 30.6 mg/m³ air
Carcinogenicity	No data available.
Mutagenicity/ Genotoxicity	Hexanedinitrile did not exhibit mutagenic or clastogenic effects in either in vivo or in vitro tests systems.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	Treatment with adiponitrile did not produce a teratogenic response when administered orally to pregnant Charles River COBS CD rats at a dosage level of 80 mg/kg/day or less.
Acute Toxicity	Oral LD50 for rats is 215 mg/kg Inhalation LC50 for rats of 2.18 mg/L
Irritation	For Skin: The compound was classed as non-irritating when applied to the intact skin of male and female rabbits. No erythema or oedema developed when the compound was applied undiluted for twenty-four hours. For eye: The substance is classified as a slight eye irritant based on Draize test results.
Sensitisation	Not sensitising
Health Effects Summary	Moderately toxic based on acute toxicity.
Key Study/Critical Effect for Screening Criteria	Key study: Inhalation LC50 for rats of 2.18 mg/L

Ecological Toxicity [4]	
Aquatic Toxicity	96 hr LC50 (fish): 670 mg/L 48 hr EC50 (invertebrates): 1189 mg/L 72 hr EC50/NOEC (algae): >97.4 mg/L
Determination of PNEC aquatic	Data from short-term tests with three trophic levels are available. An assessment factor of 100 is applied to the lowest 72h EC50 of 97.4 mg/L (algae). A PNECaqua of 974 µg/L was derived.
Current Regulatory Controls [4,5,6,7]	
Australian Hazard Classification	No data available.
Australian Occupational Exposure Standards	No data available.
International Occupational Exposure Standards	TLV: 2 ppm as TWA; (skin)
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	No data available.
PBT Assessment [3]	
P/vP Criteria fulfilled?	No. The weight of evidence suggests that the substance in readily degradable.
B/vB criteria fulfilled?	No. The substance is not expected to bioaccumulate to a substantial degree based on the low log Kow of -0.32 and predicted low log BCF of 0.5.
T criteria fulfilled?	No. The acute toxicity of hexanedinitrile is >1 mg/L in fish, invertebrates and algae. Therefore, it does not meet the screening criteria for toxicity.
Overall conclusion	Not PBT
Revised	June 2022

References

1. ECHA REACH, Adiponitrile, Retrieved 2022: https://echa.europa.eu/
2. NCBI, 2022. National Center for Biotechnology Information. Available at: https://pubchem.ncbi.nlm.nih.gov/. Retrieved February 2022.
3. EHS Support, Hexanedinitrile. Available at: https://www.santos.com/wp-content/uploads/2021/04/Hexanedinitrile-March-2021.pdf. Retrieved February 2022.
4. HCIS, Hazardous Chemical Information System, Safe Work Australia, Retrieved February 2022: http://hcis.safeworkaustralia.gov.au/HazardousChemical.
5. ILO, International Labour Organisation, International Chemical Safety Cards (ICSCs), Retrieved February 2022: http://www.ilo.org/dyn/icsc/showcard.listcards3?p_lang=en.
6. ANZG, 2018. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia. Available at www.waterquality.gov.au/anz-guidelines.
7. NHMRC, 2018. Australian Drinking Water Guidelines 6, 2011, Version 3.5 Updated August 2018. National Water Quality Management.

Toxicity Summary - Magnesium oxide

Chemical and Physical Properties[1,2,3]	
CAS number	[redacted]
Molecular formula	MgO
Molecular weight	40.305
Solubility in water	Solubility in water: poor
Melting point	2,825 °C
Boiling point	3,600 °C
Vapour pressure	0 mmHg (approximate)
Henrys law constant	No data available.
Explosive potential	No data available.
Flammability potential	No data available.
Colour/Form	White odourless powder
Overview	An inorganic compound that occurs in nature as the mineral periclase. In aqueous media combines quickly with water to form magnesium hydroxide. It is used as an antacid and mild laxative and has many nonmedicinal uses. When fine particles of magnesium oxide are dispersed in air, whether directly or when generated by the burning or cutting of magnesium metal, the resulting magnesium oxide fume is an inhalation hazard. A Tier 1 Human Health and Environmental Assessment for this chemical has been conducted by NICNAS which concluded that it was low concern to human health and the environment and thus required no further assessment.
Environmental Fate [3]	
Soil/Water/Air	Magnesium oxide occurs in nature as the mineral periclase. Magnesium oxide is an inorganic substance that is not subject to biodegradation, is not expected to bioaccumulate, and has a low potential to adsorb to soil. As an inorganic substance, magnesium oxide is expected to disassociate in the environment to its respective cation and anion as limited by its aqueous solubility and pH. In soil, as well as in sediment-water systems, magnesium oxide will react and release magnesium ions and hydroxyl ions. Therefore, relevant information on adsorption/desorption of magnesium oxide can be broadened to data on adsorption/desorption of magnesium. The behaviour of hydroxyl ions depends on the pH buffer capacity of the tested medium. The pH buffer capacity is controlled by a whole range of processes (mineral dissolution/precipitation, protonation/deprotonation of pH dependent charge sites, reaction with CO2, biological processes, etc.) and as such, partition coefficients are not relevant for the fate and behaviour of OH- in soils or sediment.
Human Health Toxicity Summary [1,2,3]	
Chronic Repeated Dose Toxicity	No data available.
Carcinogenicity	Not classifiable as a human carcinogen.
Mutagenicity/ Genotoxicity	No data available.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	No data available.
Acute Toxicity	Lowest published toxic concentration: 400 mg/m^3 (inhalation/human)

Irritation	Causes skin and eye irritation. May cause respiratory irritation.
Sensitisation	May cause an allergic skin reaction.
Health Effects Summary	Magnesium oxide can cause irritation of the eyes and nose when inhaled. Chemical identified as low concern to human health by application of expert validated rules under the NICNAS targeted tier I approach.
Key Study/Critical Effect for Screening Criteria	Lowest published toxic concentration: 400 mg/m^3 (inhalation/human)
Ecological Toxicity [1,3]	
Aquatic Toxicity	No studies were available on magnesium oxide. Magnesium oxide is an inorganic substance with low toxicity and/or low bioavailability. Low concern to the environment. The following presents the results of acute aquatic toxicity studies on the hydrated magnesium hydroxide. 96-hour LC50: 306.79 mg/L (Fish) 96-hour EC50: 170.6 mg/L (Invertebrates) 72-hour EC50: >100 mg/L (Algae)
Determination of PNEC aquatic	Data from short-term tests with three trophic levels are available. An assessment factor of 100 is applied to the lowest 72h EC50 of 100 mg/L (algae). A PNECaqua of 1 mg/L was derived.
Current Regulatory Controls [4,5,6,7]	
Australian Hazard Classification	No data available.
Australian Occupational Exposure Standards	TWA: 10 mg/m^3 (fumes)
International Occupational Exposure Standards	TLV: (inhalable fraction): 10 mg/m^3, as TWA; A4 (not classifiable as a human carcinogen). MAK: (inhalable fraction): 4 mg/m^3; pregnancy risk group: C. MAK: (respirable fraction): 0.3 mg/m^3; peak limitation category: II(8); pregnancy risk group: C
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	No data available.
PBT Assessment [3]	
P/vP Criteria fulfilled?	No. The substance is an inorganic compound and is not subject to biodegradation.
B/vB criteria fulfilled?	No. There are no bioaccumulation studies on magnesium oxide. Magnesium is an essential element in biological systems
T criteria fulfilled?	No. Low toxicity.
Overall conclusion	Not PBT
Revised	June 2022

References

1. National Industrial Chemicals Notification and Assessment Scheme (NICNAS). IMAP, Human Health Tier 1 Assessment. Retrieved 2022: https://www.industrialchemicals.gov.au/.
2. NCBI, 2022. National Center for Biotechnology Information. Available at: https://pubchem.ncbi.nlm.nih.gov/. Retrieved February 2022.

3. EHS Support, Magnesium Oxide. Available at: https://www.santos.com/wp-content/uploads/2021/04/Magnesium-Oxide-March-2021.pdf. Retrieved June 2022.
4. HCIS, Hazardous Chemical Information System, Safe Work Australia, Retrieved February 2022: http://hcis.safeworkaustralia.gov.au/HazardousChemical.
5. ILO, International Labour Organisation, International Chemical Safety Cards (ICSCs), Retrieved February 2022: http://www.ilo.org/dyn/icsc/showcard.listcards3?p_lang=en.
6. ANZG, 2018. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia. Available at www.waterquality.gov.au/anz-guidelines.
7. NHMRC, 2018. Australian Drinking Water Guidelines 6, 2011, Version 3.5 Updated August 2018. National Water Quality Management.

Toxicity Summary - Methyl alpha-D-glucopyranoside

Chemical and Physical Properties[1,2]	
CAS number	[redacted]
Molecular formula	$C_7H_{14}O_6$
Molecular weight	194.18
Solubility in water	1 080 g/L at 20 °C
Melting point	68 °C at 10.13 hPa
Boiling point	200 °C at 26.57 Pa
Vapour pressure	0 Pa at 25 °C
Henrys law constant	No data available
Explosive potential	Non-explosive
Flammability potential	Not classified
Colour/Form	Solid white crystals
Overview	Methyl alpha-D-glucopyranoside is an alpha-D-glucopyranoside having a methyl substituent at the anomeric position. It is an alpha-D-glucoside and a methyl D-glucoside. Methyl alpha-D-glucopyranoside is a natural product found in Pseudoceratina purpurea, Forsythia viridissima, and Quassia amara.
Environmental Fate [1,2]	
Soil/Water/Air	The substance is readily biodegradable. Adsorption in the environment is not expected.
Human Health Toxicity Summary [1]	
Chronic Repeated Dose Toxicity	Sub-acute (42 d study) combined 28 -day repeated dose toxicity study with reproduction/developmental toxicity screening test according to OECD guideline 422, GLP, RL1, NOAEL > 1000 mg/kg bw/day, read-across. Short-term repeated dose (28 d study) according to OECD guideline 422, GLP, RL2, dose selection for OECD guideline study 422: 50, 150 and 1000 mg/kg bw/day, read-across.
Carcinogenicity	No data available.
Mutagenicity/ Genotoxicity	Not mutagenic
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	Reproduction/developmental screening study according to OECD 422, GLP, RL1, administered doses: 50, 150 and 1000 mg/kg bw/d; NOAEL >= 1000 mg/kg bw/d, read across from Isostearic acid, esters with methyl- α-D-glucose
Acute Toxicity	Acute oral toxicity study, LD50 > 2000 mg/kg bw for Isostearic acid, esters with methyl α-D-glucoside in 1% aq. carboxymethyl cellulose, read-across
Irritation	Not irritating to skin or eyes.
Sensitisation	Not sensitising
Health Effects Summary	Low acute and chronic toxicity, not mutagenic, not irritating/sensitising
Key Study/Critical Effect for Screening Criteria	Sub-acute (42 d study) combined 28 -day repeated dose toxicity was considered the key study. The NOAEL was > 1000 mg/kg bw/day.
Ecological Toxicity [1]	
Aquatic Toxicity	LC50 (96 hr) for fish: 1 770 g/L LOEC (48 h) for invertebrates: 100 mg/L LOEC (72 h) for algae: 125.3 mg/L

Determination of PNEC aquatic	Data from short-term tests with three trophic levels are available. An assessment factor of 100 is applied to the lowest 48h LOEC of 100 mg/L (algae). A PNECaqua of 1 mg/L was derived.
Current Regulatory Controls [3,4,5,6]	
Australian Hazard Classification	No data available.
Australian Occupational Exposure Standards	No data available.
International Occupational Exposure Standards	No data available.
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	No data available.
PBT Assessment [1]	
P/vP Criteria fulfilled?	No. The substance has been found to be readily biodegradable.
B/vB criteria fulfilled?	No. As the Log Pow is -2.5 - -2.19 at 25 °C (Log Pow < 4.5), it is not expected to be bioaccumulative.
T criteria fulfilled?	No. The acute toxicity of this substance is >1 mg/L in fish, invertebrates and algae. Therefore, it does not meet the screening criteria for toxicity.
Overall conclusion	Not PBT
Revised	June 2022

References

1. ECHA REACH, Methyl α-D-glucoside, Retrieved 2022: https://echa.europa.eu/
2. NCBI, 2022. National Center for Biotechnology Information. Available at: https://pubchem.ncbi.nlm.nih.gov/. Retrieved June 2022.
3. HCIS, Hazardous Chemical Information System, Safe Work Australia, Retrieved February 2022: http://hcis.safeworkaustralia.gov.au/HazardousChemical.
4. ILO, International Labour Organisation, International Chemical Safety Cards (ICSCs), Retrieved February 2022: http://www.ilo.org/dyn/icsc/showcard.listcards3?p_lang=en.
5. ANZG, 2018. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia. Available at www.waterquality.gov.au/anz-guidelines.
6. NHMRC, 2018. Australian Drinking Water Guidelines 6, 2011, Version 3.5 Updated August 2018. National Water Quality Management.

Toxicity Summary - Octan-2-ol

Chemical and Physical Properties[1,2]	
CAS number	[redacted]
Molecular formula	C8H18O
Molecular weight	130.23
Solubility in water	986 mg/L @ 20 °C and pH 7.1 - 7.5
Melting point	-38.6 to -27.45 °C @ 101.325 kPa
Boiling point	178.5 - 181.87 °C @ 101.325 kPa
Vapour pressure	64.7 Pa @ 25 °C
Henrys law constant	No data available
Explosive potential	No data available
Flammability potential	No data available
Colour/Form	The substance is clear, colourless liquid.
Overview	2-Octanol is a natural product found in Curcuma aromatica, Curcuma wenyujin, and other organisms. Octan-2-ol is an octanol carrying the hydroxy group at position 2. It has a role as a volatile oil component and a plant metabolite. It is an octanol and a secondary alcohol.
Environmental Fate [2]	
Soil/Water/Air	2-Octanol's production and use as a solvent, in manufacture of plasticizers, wetting and foam control agents, hydraulic oils, petroleum additives, perfume intermediates and in masking of industrial odours may result in its release to the environment through various waste streams. 2-Octanol has been identified as a volatile component from a diverse array of plants. If released to air, a vapor pressure of 0.242 mm Hg at 25 °C indicates 2-octanol will exist solely as a vapor in the atmosphere. Vapor-phase 2-octanol will be degraded in the atmosphere by reaction with photochemically-produced hydroxyl radicals; the half-life for this reaction in air is estimated to be 32 hours. 2-Octanol does not contain chromophores that absorb at wavelengths >290 nm and, therefore, is not expected to be susceptible to direct photolysis by sunlight. If released to soil, 2-octanol is expected to have very high mobility based upon an estimated Koc of 32. Volatilization from moist soil surfaces is expected based upon a Henry's Law constant of 3.23X10-5 atm-cu m/mole. 2-Octanol is not expected to volatilize from dry soil surfaces based upon its vapor pressure. Utilizing the Japanese MITI test, 76% of the theoretical BOD was reached in 2 weeks indicating that biodegradation is an important environmental fate process in soil and water. If released into water, 2-octanol is not expected to adsorb to suspended solids and sediment based upon the estimated Koc. Volatilization from water surfaces is expected based upon this compound's Henry's Law constant. Estimated volatilization half-lives for a model river and model lake are 34 hours and 14 days, respectively. An estimated BCF of 38 suggests the potential for bioconcentration in aquatic organisms is moderate. Hydrolysis is not expected to be an important environmental fate process since this compound lacks functional groups that hydrolyze under environmental conditions (pH 5 to 9). Occupational exposure to 2-octanol may occur through inhalation and dermal contact with this compound at workplaces where 2-octanol is produced or used. Monitoring data indicate that the general population may be exposed to 2-octanol via inhalation of ambient air, ingestion of food and beverages, and dermal contact with consumer products containing 2-octanol.
Human Health Toxicity Summary [1,2]	
Chronic Repeated Dose Toxicity	The test item, was administered daily by oral gavage to male and female Sprague-Dawley rats, for 2 weeks before mating, during mating, and until sacrifice for males, or through gestation and until Day 14 p.p. for females, at dose-levels of 100, 300 and 1000 mg/kg/day. Based on the results, the NOAEL (No Observed

	Adverse Effect Level) was considered to be 300 mg/kg/day for systemic toxicity due to clinical signs observed at the high dose-level and 100 mg/kg/day for local toxicity due to microscopic findings noted in the forestomach of animals of the mid- and high-dose groups.
Carcinogenicity	No data available.
Mutagenicity/ Genotoxicity	The available data from three in vitro assays (reverse gene mutation assay in bacteria, in vitro micronucleus test and mammalian cell gene mutation assay) show that the substance does not have a genotoxic potential.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	The test item, was administered daily by oral gavage to male and female Sprague-Dawley rats, for 2 weeks before mating, during mating, and until sacrifice for males, or through gestation and until Day 14 p.p. for females, at dose-levels of 100, 300 and 1000 mg/kg/day. Based on the results, the NOAEL was considered 300 mg/kg/day for systemic toxicity due to clinical signs observed at the high dose-level and 100 mg/kg/day for local toxicity due to microscopic findings noted in the forestomach of animals of the mid- and high-dose groups. The NOAEL for reproductive toxicity of females was 300 mg/kg/day due to the effects on oestrous cycle noted in the high dose females. The NOAEL for reproductive toxicity of males was 1000 mg/kg/day. The NOAEL for pups development was 100 mg/kg/day considering the observed pup loss and reduced litter/pup weights noted in mid- and high dose levels.
Acute Toxicity	One acute study by oral route is available for octan-2-ol with an LD50 > 2000 mg/kg. No mortality was observed indicating that acute toxicity is of low concern. No acute studies are available by dermal route or inhalation.
Irritation	Non-irritating to skin. The substance is considered to have the potential to cause severe ocular irritancy in vivo based on the results of a rabbit enucleated eye test.
Sensitisation	Octan-2-ol was tested in a Local Lymph Node Assay (OECD 429) and showed no sensitizing potential.
Health Effects Summary	Octan-2-ol has low acute oral toxicity, is not a skin irritant, is a potential eye irritant, and is not a skin sensitiser. The NOAEL for reproductive toxicity of males was 1000 mg/kg/day. The NOAEL for pups development was 100 mg/kg/day considering the observed pup loss and reduced litter/pup weights noted in mid- and high dose levels.
Key Study/Critical Effect for Screening Criteria	The developmental toxicity via oral application to pups was considered the key study. The NOAEL for pups development was 100 mg/kg/day.
Ecological Toxicity [1]	
Aquatic Toxicity	96h-LC50 for fish = 18.57 mg/L 48h-EC50 for invertebrates = 30 mg/L 72h-ErC50 for algae = 48 mg/L 72h-NOErC for algae = 8.7 mg/L
Determination of PNEC aquatic	Data from short-term tests with three trophic levels are available. An assessment factor of 100 is applied to the lowest 72h-NOErC of 8.7 mg/L (algae). A PNECaqua of 87 µg/L was derived.
Current Regulatory Controls [3,4,5,6]	
Australian Hazard Classification	No data available.
Australian Occupational Exposure Standards	No data available.
International Occupational Exposure Standards	No data available.
Australian Food Standards	No data available.

Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	No data available.
PBT Assessment [1,2]	
P/vP Criteria fulfilled?	No. The substance has been found to be readily biodegradable.
B/vB criteria fulfilled?	No. As the Log Pow is 2.86 @ 22 °C and pH 7 (Log Pow < 4.5), it is not expected to be bioaccumulative.
T criteria fulfilled?	No. The acute EC50 of sodium carboxymethylcellulose is >1 mg/L in fish, invertebrates and algae. Therefore, it does not meet the screening criteria for toxicity.
Overall conclusion	Not PBT
Revised	June 2022

References

1. ECHA REACH, Octan-2-ol, Retrieved 2022: https://echa.europa.eu/
2. NCBI, 2022. National Center for Biotechnology Information. Available at: https://pubchem.ncbi.nlm.nih.gov/. Retrieved June 2022.
3. HCIS, Hazardous Chemical Information System, Safe Work Australia, Retrieved February 2022: http://hcis.safeworkaustralia.gov.au/HazardousChemical.
4. ILO, International Labour Organisation, International Chemical Safety Cards (ICSCs), Retrieved February 2022: http://www.ilo.org/dyn/icsc/showcard.listcards3?p_lang=en.
5. ANZG, 2018. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia. Available at www.waterquality.gov.au/anz-guidelines.
6. NHMRC, 2018. Australian Drinking Water Guidelines 6, 2011, Version 3.5 Updated August 2018. National Water Quality Management.

Toxicity Summary - Oxirane, 2-methyl-, polymer with oxirane, di-(9Z)-9-octadecenoate

Chemical and Physical Properties[1,2]	
CAS number	[redacted]
Molecular formula	C41H78O6
Molecular weight	667.1
Solubility in water	No data available
Melting point	No data available
Boiling point	No data available
Vapour pressure	No data available
Henrys law constant	No data available
Explosive potential	No data available
Flammability potential	No data available
Colour/Form	No data available
Overview	NICNAS concluded that this substance is a low concern polymer for the environment.
Environmental Fate [4]	
Soil/Water/Air	No data available
Human Health Toxicity Summary	
Chronic Repeated Dose Toxicity	No data available
Carcinogenicity	No data available
Mutagenicity/ Genotoxicity	No data available
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	No data available
Acute Toxicity	No data available
Irritation	No data available
Sensitisation	No data available
Health Effects Summary	No data available
Key Study/Critical Effect for Screening Criteria	No data available
Ecological Toxicity [1]	
Aquatic Toxicity	Polymer of low concern to the environment.
Determination of PNEC aquatic	Not determined
Current Regulatory Controls [3,4,5,6]	
Australian Hazard Classification	No data available.
Australian Occupational Exposure Standards	No data available.

International Occupational Exposure Standards	No data available.
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	No data available.
PBT Assessment [1]	
P/vP Criteria fulfilled?	No data available.
B/vB criteria fulfilled?	No data available.
T criteria fulfilled?	No. Polymer of low concern to the environment.
Overall conclusion	Not PBT
Revised	June 2022

References

1. National Industrial Chemicals Notification and Assessment Scheme (NICNAS). IMAP, Human Health Tier 1 Assessment. Retrieved 2022: https://www.industrialchemicals.gov.au/.
2. NCBI, 2022. National Center for Biotechnology Information. Available at: https://pubchem.ncbi.nlm.nih.gov/. Retrieved February 2022.
3. HCIS, Hazardous Chemical Information System, Safe Work Australia, Retrieved February 2022: http://hcis.safeworkaustralia.gov.au/HazardousChemical.
4. ILO, International Labour Organisation, International Chemical Safety Cards (ICSCs), Retrieved February 2022: http://www.ilo.org/dyn/icsc/showcard.listcards3?p_lang=en.
5. ANZG, 2018. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia. Available at www.waterquality.gov.au/anz-guidelines.
6. NHMRC, 2018. Australian Drinking Water Guidelines 6, 2011, Version 3.5 Updated August 2018. National Water Quality Management.

Toxicity Summary - Poly(oxy-1,2-ethanediyl), .alpha.-octyl-.omega.-hydroxy-

Chemical and Physical Properties[1,2,3,4]	
CAS number	[redacted]
Molecular formula	(C2H4O)nC8H18O
Molecular weight	174.3
Solubility in water	1.85 g/L @ 20 °C and pH 3.6 - 3.7
Melting point	-20 °C at 101.3 kPa
Boiling point	204 °C at 102 kPa
Vapour pressure	7.72 Pa at 25 °C
Henrys law constant	No data available
Explosive potential	No data available
Flammability potential	No data available
Colour/Form	Clear colourless liquid
Overview	Alcohol ethoxylates (AEs) are not expected to be systemically toxic, although some short chain ethylene glycol ethers, e.g. methyl and ethyl homologues are of concern for a range of adverse health effects. They include skin and eye irritation, liver and kidney damage, bone marrow and central nervous system (CNS) depression, testicular atrophy, developmental toxicity, and immunotoxicity. For higher propyl and butyl homologues, the toxicity involves haemolysis (anaemia) with secondary effects relating to haemosiderin accumulation in the spleen, liver and kidney, and compensatory haematopoiesis in the bone marrow. Systemic toxicity was shown to decrease with increasing alkyl chain lengths and/or alkoxylation degrees.
Environmental Fate [4]	
Soil/Water/Air	The substance is readily biodegradable and is expected to be immobile in soil with a calculated Koc of 383.
Human Health Toxicity Summary [1,2,3]	
Chronic Repeated Dose Toxicity	Based on the available data, the chemicals in this group are not expected to cause serious damage to health from repeated oral exposure. No correlation with ethoxylation or alkyl chain length of the AEs was noted for repeated dose oral toxicity. Based on the available data, the chemicals in this group are not expected to cause serious damage to health (apart from local effects) from repeated dermal exposure. No correlation with ethoxylation or alkyl chain length of the AEs was found for repeated dose dermal toxicity.
Carcinogenicity	Based on the available data, chemicals in this group are not considered carcinogenic.
Mutagenicity/ Genotoxicity	Based on the data available, the chemicals in this group are not considered mutagenic or genotoxic.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	Based on the data available, the chemicals of this group are not considered to cause reproductive or developmental toxicity. The oral NOAELs were determined at 250 mg/kg bw/day for reproductive toxicity, and >50 mg/kg bw/day for maternal and developmental toxicity.
Acute Toxicity	Based on the available animal data and international reviews, the AEs in this group are expected to have low to moderate acute oral toxicity. The toxicity appears to correlate with the degree of ethoxylation (highest for EO5–EO14) and is unlikely to be greatly affected by the alkyl chain length

	The oral median lethal dose (LD50) values in rats ranged from 600 mg/kg bw ($C_{15–16}EO_{10}$, $C_{14–15}EO_{11}$) to 10000 mg/kg bw ($C_xEO_{1–3}$, $C_xEO_{>15}$). Based on the available data, the AEs in this group are expected to have low acute dermal toxicity. No structural relationship was evident between the AEs and acute dermal toxicity. Based on the available data, the AEs in this group are expected to have low acute inhalation toxicity.
Irritation	Not considered skin sensitisers.
Sensitisation	The data generated was not be sufficient to conclude on the absence of skin sensitisation potential of chemicals
Health Effects Summary	The critical human health effects of the AEs for risk characterisation are acute oral toxicity and skin and eye irritation. The irritant effects are similar to those caused by other surfactants. The severity of irritation appears to increase directly with the chemical concentration. Skin irritation, but not eye irritation, generally decreases with an increasing degrees of ethoxylation.
Key Study/Critical Effect for Screening Criteria	The lowest oral median lethal dose (LD50) values in rats of 600 mg/kg bw is chosen for risk characterisation.
Ecological Toxicity [1]	
Aquatic Toxicity	48h EC50 Invertebrates: 40 mg/L 72h EC50 Algae: 14 mg/L
Determination of PNEC aquatic	Data from short-term tests with two trophic levels are available. An assessment factor of 1000 is applied to the lowest 72h EC50 of 14 mg/L (algae). A PNECaqua of 14 µg/L was derived.
Current Regulatory Controls [5,6,7,8]	
Australian Hazard Classification	Acute toxicity (ingestion) - category 4 Eye damage – category 1 Skin irritation – category 2
Australian Occupational Exposure Standards	No data available.
International Occupational Exposure Standards	No data available.
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	No data available.
PBT Assessment [1]	
P/vP Criteria fulfilled?	No. The substance has been found to be readily biodegradable.
B/vB criteria fulfilled?	No. As the Log Pow is 1.98 - 2.81 (Log Pow < 4.5), it is not expected to be bioaccumulative.
T criteria fulfilled?	No. The acute EC50 of sodium carboxymethylcellulose is >1 mg/L in invertebrates and algae. Therefore, it does not meet the screening criteria for toxicity.
Overall conclusion	Not PBT
Revised	June 2022

References

1. ECHA REACH, Octan-1-ol, ethoxylated, Retrieved 2022: https://echa.europa.eu/

2. National Industrial Chemicals Notification and Assessment Scheme (NICNAS). IMAP Ethoxylates of aliphatic alcohols (>C6): Human health tier II assessment. Retrieved 2022: https://www.industrialchemicals.gov.au/.
3. NCBI, 2022. National Center for Biotechnology Information. Available at: https://pubchem.ncbi.nlm.nih.gov/. Retrieved February 2022.
4. CompTox Chemicals Dashboard. Retrieved 2022: https://comptox.epa.gov/dashboard/chemical/env-fate-transport/DTXSID4075328
5. HCIS, Hazardous Chemical Information System, Safe Work Australia, Retrieved February 2022: http://hcis.safeworkaustralia.gov.au/HazardousChemical.
6. ILO, International Labour Organisation, International Chemical Safety Cards (ICSCs), Retrieved February 2022: http://www.ilo.org/dyn/icsc/showcard.listcards3?p_lang=en.
7. ANZG, 2018. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia. Available at www.waterquality.gov.au/anz-guidelines.
8. NHMRC, 2018. Australian Drinking Water Guidelines 6, 2011, Version 3.5 Updated August 2018. National Water Quality Management.

Toxicity Summary - Poly(oxy-1,2-ethanediyl),alpha-hydro-omega-hydroxy-,mono(2-(4,5-ihydro-2-nortall-oil alkyl-1H-imidazol-1-yl)ethyl) ethers

Chemical and Physical Properties[1]	
CAS number	[redacted]
Molecular formula	Not available
Molecular weight	< 1,000 g/mol
Solubility in water	1,000 g/L
Melting point	24 to 29 °C
Boiling point	> 150 °C at 101.3 kPa
Vapour pressure	≤ 0.537 kPa at 25 °C
Henrys law constant	Not available
Explosive potential	Non-explosive
Flammability potential	Not determined
Colour/Form	Dark brown liquid
Overview	The polymer (at < 10% concentration) functions as a surfactant and will be used as a corrosion inhibitor for drilling completion workovers and for water-based mud drilling processes in the oil and gas industry. The product containing the polymer is used exclusively in off-shore oil and gas wells operations.
Environmental Fate [1]	
Soil/Water/Air	The polymer is not readily biodegradable in seawater (35.1% in 28 days). The polymer is not expected to bioaccumulate in biota based on its high water solubility and surfactant properties. Most of the polymer may remain inside the well holes for one month to two years where it is expected to degrade eventually to form water and oxides of carbon and nitrogen. Based on its high water solubility, the polymer is expected to dissolve in seawater and be dispersed by tidal and ocean currents following mixing of completion fluids with seawater around the discharge point. The polymer is expected to remain dissolved in seawater until it is degraded by biotic/abiotic processes to form water, oxides of carbon and nitrogen.
Human Health Toxicity Summary [1]	
Chronic Repeated Dose Toxicity	No data available.
Carcinogenicity	No data available.
Mutagenicity/ Genotoxicity	No data available.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	No data available.
Acute Toxicity	No data available.
Irritation	May cause eye and skin irritation.
Sensitisation	No data available.
Health Effects Summary	Based on the relatively low molecular weight (Mn < 1,000 g/mol), high water solubility (1,000 g/L) and surface-active properties of the polymer, absorption across the skin or biological membranes may occur. The acute and repeated dose toxicity of the polymer is unknown. The polymer may cause eye and skin irritation.

Key Study/Critical Effect for Screening Criteria	No data available.
Ecological Toxicity [1]	
Aquatic Toxicity	Fish (Cyprinodon variegatus) 96 h LC50 > 0.53 mg/L Invertebrate (Acartia tonsa) 48 h LC50 = 3.81 mg/L Invertebrate (Corophium volutator) 10 d LC50 ≥ 13,471 mg/L Algal Toxicity (Skeletonema costatum) 72 h ErC50 = 0.53 mg/L
Determination of PNEC aquatic	The predicted no-effect concentration (PNEC) for marine species has been calculated by using the endpoint of the most sensitive species, namely algae, 72 hours ErC50 = 0.53 mg/L. The PNEC is conservatively predicted based on the acute result from algae and a safety factor of 100. A safety factor of 100 was used since acute endpoints for three trophic levels are available. A PNEC of 5.3 µg/L was calculated.
Current Regulatory Controls [2,3,4,5]	
Australian Hazard Classification	No data available.
Australian Occupational Exposure Standards	No data available.
International Occupational Exposure Standards	No data available.
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	No data available.
PBT Assessment [1]	
P/vP Criteria fulfilled?	Yes. The polymer is not readily biodegradable.
B/vB criteria fulfilled?	No. The polymer is not expected to bioaccumulate in biota based on its high water solubility and surfactant properties.
T criteria fulfilled?	Yes. The acute EC50 for the polymer is <1 mg/L in fish algae. Therefore, it meets the screening criteria for toxicity.
Overall conclusion	Not PBT
Revised	June 2022

References

1. National Industrial Chemicals Notification and Assessment Scheme (NICNAS). Public Report Poly(oxy-1,2-ethanediyl), α-hydro-ω-hydroxy-, mono[2-(4,5-dihydro-2-nortall-oil alkyl1H-imidazol-1-yl)ethyl] ethers. File No: LTD/2040, June 2018. Retrieved 2022: https://www.industrialchemicals.gov.au/sites/default/files/LTD2040%20Public%20Report%20PDF.pdf
2. HCIS, Hazardous Chemical Information System, Safe Work Australia, Retrieved February 2022: http://hcis.safeworkaustralia.gov.au/HazardousChemical.
3. ILO, International Labour Organisation, International Chemical Safety Cards (ICSCs), Retrieved February 2022: http://www.ilo.org/dyn/icsc/showcard.listcards3?p_lang=en.
4. ANZG, 2018. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia. Available at www.waterquality.gov.au/anz-guidelines.
5. NHMRC, 2018. Australian Drinking Water Guidelines 6, 2011, Version 3.5 Updated August 2018. National Water Quality Management.

Toxicity Summary - Polyanionic cellulose, low viscosity

Chemical and Physical Properties[1,2,3,4]	
CAS number	[redacted]
Molecular formula	C8H15NaO8
Molecular weight	262.19
Solubility in water	The sodium salt disperses and its solubility in water depends upon the degree of substitution.
Melting point	300°C
Boiling point	No data available.
Vapour pressure	No data available.
Henrys law constant	No data available.
Explosive potential	No data available.
Flammability potential	No data available.
Colour/Form	White or slightly yellowish, almost odourless and tasteless hydroscopic powder, consisting of very fine particles, fine granules or fine fibres.
Overview	Sodium carboxymethyl cellulose (CMC) is used in drilling muds, detergents, resin emulsion paints, adhesives, printing inks, and textile sizes. It is also used as a protective colloid, a stabilizer for foods, and a pharmaceutical additive. A Tier 1 Human Health and Environmental Assessment for this chemical has been conducted by NICNAS which concluded that it was low concern to human health and the environment and thus required no further assessment.
Environmental Fate [4]	
Soil/Water/Air	Sodium carboxymethylcellulose is biodegradable, but is not considered to be readily biodegradable. It is not expected to bioaccumulate. All of the polymers in this group are expected to be water soluble. If discharged into natural waters, sodium carboxymethylcellulose is expected to be present as a polyanion as a result of the ionisation of the carboxymethyl substituents. Comparatively complex partitioning behaviour in aquatic systems may occur based on the well-established interactions between colloids and carboxymethylcellulose, which is a key part of the function of this polymer in laundry detergents. No experimental partition coefficient data are available for sodium carboxymethylcellulose. Based on its high water solubility, the substance is likely to be mobile in the environment.
Human Health Toxicity Summary [1,2,3]	
Chronic Repeated Dose Toxicity	Ten rats received 300 to 500 mg of CMC daily for two months without any adverse effect. Another group of 10 rats received a diet containing 20% of CMC for 63 days. Slight growth retardation and a laxative effect were observed. Organ weights and both gross and microscopic pathological examination revealed no abnormalities. Oral rat TDLo: 227 g/kg/13W (continuous)
Carcinogenicity	Carboxymethyl cellulose sodium salt is a “suspected carcinogen”.
Mutagenicity/ Genotoxicity	Carboxymethylcellulose has been used often as the vehicle control in a number of genotoxicity studies as the control agent or vehicle and as such would not be expected to show activity in these types of studies.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	In several studies, carboxymethylcellulose and its sodium salt have been used as the vehicle in developmental, embryotoxic and teratogenic studies on rats, mice or rabbits and as such would not be expected to have any adverse effect.
Acute Toxicity	Rats, guinea pigs and rabbits showed no symptoms after administration by stomach tube of 3000 mg/kg in three divided doses. Rat LD50 (oral): 270000 mg/kg/bw Guinea pig LD50 (oral): 160000 mg/kg/bw

	A 4-hr inhalation LC50 value of 5.8 g/m^3 has been reported for the sodium salt in rats.
Irritation	No data available.
Sensitisation	Suspected skin sensitiser
Health Effects Summary	Poses no unreasonable risk to human health based on Tier I assessment under the NICNAS IMAP assessment framework.
Key Study/Critical Effect for Screening Criteria	The oral rat chronic toxicity TDLo: 227 g/kg/13W (continuous) was considered the most sensitive endpoint.
Ecological Toxicity [4]	
Aquatic Toxicity	Brachydanio rerio 96-hour LC50 >2,500 mg/L Daphnia magna 48-hour EC50 >5,000 mg/L Daphnia magna 48-hour EC50 87.26 mg/L Selenastrum capricornutum 96-hour EC50 500 mg/L
Determination of PNEC aquatic	This compound has a low acute toxicity concern to aquatic organisms and thus required no further assessment.
Current Regulatory Controls [5,6]	
Australian Hazard Classification	No data available.
Australian Occupational Exposure Standards	No data available.
International Occupational Exposure Standards	No data available.
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	No data available.
PBT Assessment [4]	
P/vP Criteria fulfilled?	Yes. Sodium carboxymethylcellulose is a water-soluble semisynthetic polymer that is not readily biodegradable. Therefore, it meets the screening criteria for persistence.
B/vB criteria fulfilled?	No. Not expected to bioaccumulate.
T criteria fulfilled?	No. The acute EC50 of sodium carboxymethylcellulose is >1 mg/L in fish, invertebrates and algae. Therefore, it does not meet the screening criteria for toxicity.
Overall conclusion	Not PBT
Revised	February 2022

References

1. National Industrial Chemicals Notification and Assessment Scheme (NICNAS). IMAP, Human Health Tier 1 Assessment. Retrieved 2022: https://www.industrialchemicals.gov.au/.
2. NCBI, 2022. National Center for Biotechnology Information. Available at: https://pubchem.ncbi.nlm.nih.gov/. Retrieved February 2022.
3. Toxicological profile for sodium carboxy methyl cellulose, Retrieved February 2022: https://tobacco-information.hpa.gov.tw/common/Download.ashx?t=CLI8001&f=54368658_336/54368658_336_A0191.pdf
4. EHS Support, Sodium Carboxymethylcellulose. Available at: https://www.santos.com/wp-content/uploads/2021/04/Sodium-Carboxymethylcellulose-March-2021.pdf. Retrieved February 2022.

5. HCIS, Hazardous Chemical Information System, Safe Work Australia, Retrieved February 2022: http://hcis.safeworkaustralia.gov.au/HazardousChemical.
6. ILO, International Labour Organisation, International Chemical Safety Cards (ICSCs), Retrieved February 2022: http://www.ilo.org/dyn/icsc/showcard.listcards3?p_lang=en.

Toxicity Summary - Sodium sulphite

Chemical and Physical Properties[1,2,3]	
CAS number	[redacted]
Molecular formula	Na_2SO_3
Molecular weight	126.043 g/mol
Solubility in water	125.4 g/L at 0 °C 283 g/L at 80 °C
Melting point	Decomposes at 150 °C
Boiling point	No data available
Vapour pressure	No data available
Henrys law constant	No data available
Explosive potential	No data available
Flammability potential	No data available
Colour/Form	White, hexagonal crystalline or powder
Overview	Sulphites in aqueous solutions involve complex equilibria among the different species of sulphur oxidation state IV. The composition of their mixture in solutions depends on the pH and temperature. Sulphites occur naturally in some foods and beverages as a result of fermentation (e.g. in beer and wine). A small percentage of the population (up to 1 %) is sensitive to sulphites, as sulphur dioxide may be generated from sulphites in the stomach at low pH (Simon, 1986). The sensitivity to sulphur dioxide can cause a wide range of reactions in humans ranging from mild to severe dermatological, pulmonary, gastrointestinal, or cardiovascular symptoms. A Tier 1 Environmental Assessment for this chemical has been conducted by NICNAS which concluded that it was low concern to the environment.
Environmental Fate [1]	
Soil/Water/Air	The substance has a very low vapour pressure, and also does not sublime. Therefore, the substance will not be present as a gas and no radical reactions can be expected. According to its chemical properties, hydrolysis is not expected/probable. Photodegradation in water is not relevant because it dissociates rapidly into ions and decomposes in water, and it not susceptible to visible light. The substance is an inorganic compound which does not undergo biodegradation. The substance readily dissociates in aqueous solution, as with soil moisture. Bioaccumulation is not to be expected. Due to the ionic salt-character and other physico-chemical properties (negligible vapour pressure, very high water solubility and decomposition in water), the Henry constant is near to zero. Because of its ionic nature, sodium sulphite as well as its dissociation products are not volatile from aqueous solutions. Relevant adsorption onto soils, sediments or suspended matter is not expected.
Human Health Toxicity Summary [1,2,3]	
Chronic Repeated Dose Toxicity	Wistar rats were administered anhydrous sodium sulphite daily for three months at dietary doses of 0, 620, 1670, or 3230 mg/kg bw/day for males, and 0, 650, 1190, or 3070 mg/kg bw/day for females. At the top dose in males, effects were 9.8% decrease in bodyweight gain, increased relative testis and brain weights, and increased blood urea nitrogen. No treatment-related effects were reported in the females. The NOAEL is 1670 mg/kg bw/day based on systemic effects at the LOAEL of 3230 mg/kg bw/day.

	In a study specifically examining lung response parameters, male Sprague-Dawley rats were exposed to 0, 0.1, 1, 5, or 15 mg/m^3 dry sodium sulphite particles in filtered air for 23.5 hours/day for three consecutive days. The MMAD of the aerosol particles was 0.83 to 1.15 µm. At 15 mg/m^3, effects reported were increased glycoprotein secretion and tracheal epithelium irritation. At concentrations of 1 mg/m3 and higher, a dose-dependent increase of wet to dry weight ratio of lungs, indicative of mild pulmonary oedema, was observed. The No Observed Adverse Effect Concentration (NOAEC) is 0.1 mg/m^3 based on lung responses at the Lowest Observed Adverse Effect Concentration (LOAEC) of 1 mg/m^3. Beagle dogs were exposed to 1 mg/m3 sodium metabisulfite aerosols for 290 days. The dose equivalent in terms of the S(IV) particles was 0.3 mg/m3 (CIR 2003). The MMAD of the aerosol particles was 0.63 µm. Severe epithelial changes were observed with hyperplastic foci in the respiratory region of the nasal cavity. An increase in the non-ciliated cell numbers in the membranous portion of the trachea of the animals was also observed. No other effects were reported.
Carcinogenicity	No data were available for sodium sulphite. The International Agency for Research on Cancer (IARC) reported that sulphites, bisulphites, and metabisulfites are not classifiable as to their carcinogenicity to humans (IARC 1997).
Mutagenicity/ Genotoxicity	Sodium sulphite is not considered to be genotoxic based on the available data.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	Increased relative testes weights of Wistar rats was reported at 3230 mg/kg bw/day. No histopathological changes were observed in the testes. There was no indication of male fertility impairment. Sodium sulphite is not considered to be toxic to fertility. Pregnant Wistar rats were fed diets containing 0, 0.32, 0.63, 1.25, 2.5, or 5% sodium sulphite heptahydrate on gestational days 8 to 20. The doses were equivalent to 0, 150, 300, 550, 1050, or 1650 mg/kg bw/day sodium sulphite. Dams showed decreased food consumption and bodyweight gain at 1650 mg/kg bw/day. Foetal bodyweight was reduced at all doses except the female offspring of the 1050 mg/kg bw/day group. There were no significant increases in malformations, skeletal variations, or delayed ossification. The NOAEL for maternal toxicity is 1050 mg/kg bw/day. A NOAEL for developmental toxicity could not be established in this study. Sodium sulphite is not considered to be a developmental toxicant.
Acute Toxicity	Sodium sulphite has an oral LD50 >2000 mg/kg bw in rats (3560 mg/kg bw for females and 3930 mg/kg bw for males). However, the mouse or rabbit oral LD50 is <2000 mg/kg bw (820 mg/kg bw for the mouse and 600–700 mg/kg bw for rabbits). The studies show that sodium sulphite has low acute oral toxicity in rats and moderate acute oral toxicity in mice and rabbits.
Irritation	In a study conducted in accordance with OECD Technical Guideline (TG) 404, semi-occlusive application of 500 mg sodium sulphite to clipped intact skin of male New Zealand White rabbits produced no signs of irritation. Thirty-eight per cent sodium sulphite solution, applied by semi-occlusive patches to the shaved skin of male New Zealand albino rabbits, was not irritating based on the conditions of the test conducted in accordance with OECD TG 404. The chemical is not a skin irritant in rabbits. Three eye irritation tests, all conducted in accordance with OECD TG 405, were available. There were no signs of irritation after a 24-hour instillation of 100 mg of the chemical (concentration not specified) into the eyes of male New Zealand rabbits. A 38% sodium sulphite and sodium bisulphite solution was instilled into the conjunctival sac of New Zealand White rabbits. No effects were seen on the cornea and iris. Slight erythema and oedema were observed at the 24 hour observation period only and was considered reversible. In another study, a 38% solution of sodium sulphite (without crystal water) and sodium bisulphite was instilled in the eyes of male Vienna White rabbits. Slight, at observation day 8, to severe, at observation day 15, changes in the cornea and iris were reported. Slight to moderate conjunctival effects, such as erythema and

	oedema, were also reported up to the end of the observation periods. Based on the persistency of effects, the chemicals were considered severe eye irritants. The chemical is a severe eye irritant in rabbits. There were no effects on respiratory rates in mice treated sodium sulphite aerosol for 10 minutes at concentrations up to 1603 mg/m^3 or 1834 mg/m^3. In guinea pigs exposed to the aerosolised chemical for one hour, bronchoconstriction was observed at concentrations of 0.204 mg/m^3 and higher. Respiratory tract irritation was observed in guinea pigs at ≥0.204 mg/m^3 while no respiratory effects were seen in mice at concentrations up to 1834 mg/m^3.
Sensitisation	Sulphites (including sulphite, bisulphite and metabisulfite), which are used widely in cosmetic products, are rarely contact allergens and were not found to be potent primary sensitisers. The chemical is not a skin sensitiser.
Health Effects Summary	Sodium sulphite has low acute oral toxicity in rats, is not a skin irritant, is a severe eye irritant, and is not a skin sensitiser. The critical health effect of the chemical is severe eye irritation. Irritation of the human stomach from sodium sulphite ingestion is possible from the liberation of SO_2 in highly acidic environments. A NOAEL of 1670 mg/kg bw/day was established from repeated exposures to the chemical, with systemic effects reported at the LOAEL of 3230 mg/kg bw/day. The chemical is neither genotoxic, carcinogenic, nor a reproductive toxicant.
Key Study/Critical Effect for Screening Criteria	The most appropriate NOAEL for risk assessment, determined from the developmental toxicity study, is 1050 mg/kg bw/day based on maternal systemic toxicity at the LOAEL of 1650 mg/kg bw/day.
Ecological Toxicity [1]	
Aquatic Toxicity	Acute toxicity: 96h LC50 Fish: 149.6 mg/L 48h EC50 Invertebrate: 74.9 mg/L 72h EC50 Algae: 36.8 mg/L Chronic toxicity: NOEC Algae: 28 mg/L NOEC Invertebrates: ≥8.41 mg/L NOEC Fish: 50 mg/L
Determination of PNEC aquatic	Data from short and long-term tests with three trophic levels are available. An assessment factor of 10 is applied to the lowest NOEC of 8.41 mg/L (algae). A PNECaqua of 841 µg/L was derived.
Current Regulatory Controls [2,3]	
Australian Hazard Classification	The chemical is not listed in the Hazardous Substances Information System (HSIS) (Safe Work Australia 2013).
Australian Occupational Exposure Standards	No specific exposure standards were available.
International Occupational Exposure Standards	The following exposure standards are identified for chemicals in this group (Galleria Chemica): An exposure limit (OEL, TWA, STEL, PEL or STV) of 5–10 mg/m^3 in different countries such as USA, United Kingdom, Canada, Ireland, Spain, Norway and Switzerland.
Australian Food Standards	The chemical is listed in Standard 1.3.3 of the Australia New Zealand Food Standards Code as permitted processing aid in packaged water and water used as an ingredient in other foods under conditions of Good Manufacturing Practice (GMP), and as a dough conditioner at a maximum permitted level of 60 mg/kg (Food Standards Australia New Zealand 2013).
Australian Drinking Water Guidelines	No aesthetic or health-related guidance values were identified for this chemical in the Australian Drinking Water Guidelines (National Health and Medical Research Council (NHMRC) 2011).

Aquatic Toxicity Guidelines	Inorganic substance comprising ions of low ecotoxicological concern. This chemical is not expected to pose an unreasonable risk to the environment provided that ANZECC water quality guidelines for physical and chemical stressors are not exceeded.
PBT Assessment [1,3]	
P/vP Criteria fulfilled?	No. The substance is an inorganic compound and is not subject to biodegradation.
B/vB criteria fulfilled?	No. As the Log Pow is -4 (Log Pow < 4.5), it is not expected to be bioaccumulative.
T criteria fulfilled?	No. Chronic and acute toxicity data >1 mg/L, sodium sulphite does not meet the screening criteria for toxicity.
Overall conclusion	Not PBT
Revised	June 2022

References

1. ECHA REACH, Sodium sulphite, Retrieved 2022: https://echa.europa.eu/
2. Department of the Environment and Energy 2017, National assessment of chemicals associated with coal seam gas extraction in Australia, prepared by the National Industrial Chemicals Notification and Assessment Scheme
3. National Industrial Chemicals Notification and Assessment Scheme (NICNAS). IMAP, Sulfites: Human health tier II assessment. Retrieved 2022: https://www.industrialchemicals.gov.au/.

Toxicity Summary - Starch, carboxymethyl ether, sodium salt

Chemical and Physical Properties[1,2,4,6]	
CAS number	[redacted]
Molecular formula	(C6H10O5)n
Molecular weight	UVCB
Solubility in water	In cold water, starch absorbs water reversibly and swells slightly. In hot water, irreversible swelling occurs, producing gelatisation.
Melting point	No data available.
Boiling point	No data available.
Vapour pressure	No data available.
Henrys law constant	No data available.
Explosive potential	Combustible
Flammability potential	No data available.
Colour/Form	White powder, tasteless and has no smell
Overview	Starch is a high –polymeric carbohydrate material primarily composed of amylopectin and amylose. It is usually derived from cereal grains such as corn, wheat and sorghum and from roots and tubers such as potatoes and tapioca. It includes starch which has been pregelatinized by heating in the presence of water. This chemical has been identified by NICNAS to be of low concern to human health and thus required no further assessment.
Environmental Fate[7]	
Soil/Water/Air	Based on information from NICNAS (2006): In a ready biodegradation test, the notified polymer (Potato Starch Modified) showed an 86.87% degradation during a Modified Sturm Test (OECD Test Guideline 301B) indicating that it was readily biodegradable. The test was verified using a sodium benzoate standard which showed 93.77% degradation at the end of the study. In addition a toxicity control consisting of a mixture of the test substance and sodium benzoate showed 83.49% degradation at the end of the study period, indicating that the test material did not inhibit the microbial activity. The notified polymer does potentially contain cationic and anionic functional groups, however based on the typical dissociation constants for the functionalities and their ratio within the polymer it is expected to have a net anionic charge throughout most of the environmental pH range, becoming slightly cationic only at the low end of the range. In landfill and the sewer, the notified chemical is expected to be relatively readily degraded by biotic and abiotic pathways to ultimately yield water and oxides of carbon and nitrogen and salts of chlorine and sodium. Any incineration of the notified polymer would result in its destruction and the formation of carbon dioxide and water and ash containing salts of chlorine and sodium. The notified polymer has a high molecular weight not expected to bioaccumulate.
Human Health Toxicity Summary[2,3]	
Chronic Repeated Dose Toxicity	A long-term study was carried out on the effects of inoculating 1.5 g of starch powder into the peritoneal cavity of rats. After an initial considerable inflammatory reaction, the intense vascular reaction subsided, leaving firm adhesions that were still present in animals sacrificed at 18 months (Ell90). Feeding of unmodified cornstarch and potato starch to groups of rats at dietary levels up to 30% (equivalent to 27.4-33.6 g/kg bw/d) in a 2-year test and 10% (food intake not indicated) in a 3-generation test did not result in distinct toxicologically

	significant effects (Gro74). Rats fed a cooked diet containing 62% unmodified maize starch (equivalent to 51.1 g/kg bw/d*) for 2 years also did not show significant toxicological effects, including reproductive effects over 3 generations (Tru79). Slight growth retardation was seen in rats exposed for 4 weeks to raw potato starch at a dietary level of 40% (equivalent to 46.0-52.8 g/kg bw/d) (Fer73).
Carcinogenicity	Not classifiable as a human carcinogen (A4)
Mutagenicity/ Genotoxicity	There were no indications for significant toxicity, carcinogenicity or reproduction toxicity of starch in rats fed 27.4-52.8 g/kg bw/day.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	There were no indications for significant toxicity, carcinogenicity or reproduction toxicity of starch in rats fed 27.4-52.8 g/kg bw/day.
Acute Toxicity	Toxicity of starch given orally to albino rats were studied. Experiments were performed upon CBL albino rats weighing 140 ± 15 (mean ± S.D.). Starch was given daily for 14 consecutive days in total daily oral doses of 36, 72, 120 and 168 g/kg and in animals which did not succumb to gastric rupture in doses gradually increasing to 204, 240 and 288 g/kg. Gastric rupture appeared in 50 – 75% of rats given starch in amounts of 168 g/kg and over. Of the survivors of gastric rupture, 5% died of pneumonia and 20% from bowel obstruction during the 14 days of starch administration. Doses of one tenth body weight and above produced some inhibition of growth, doses of one fifth body weight and above increased the susceptibility to pneumonia and bowel obstruction owing to the inability of the animal to evacuate the starch calculi. It was noted that doses of this order could not readily be taken by humans and smaller doses had insignificant toxicity. Acute respiratory effects after exposure to dust from the refining process of potato starch have been described (personal sampling: 3.9-56.0 mg/m^3, total dust). The responsible agent could not be identified although the authors suspected endotoxin to be the causative agent (Hol94). Millers and bakers occupationally exposed to grain and flour dusts (personal sampling: 1.1-14.3 mg/m^3, total dust) showed significantly higher incidences of coughing and chronic bronchitis compared to a non-exposed reference group (Mas95, Mas96). A dose-response relationship was observed between dust exposure levels and chronic respiratory symptoms (Mas95). Although flour is a complex product that is mainly made up of starch (70%) and gluten (12%), it may also contain mite dust and endotoxins. The causative role of starch in the observed respiratory symptoms is therefore not clear. The intraperitoneal LD50 of starch in mice is 6600 mg/kg (ACG99).
Irritation	Skin contact with a total dose of 300 µg of starch, intermittently applied over a 3-day period, resulted in a mild erythema and slight oedema of the skin in humans (ACG99).
Sensitisation	No data available.
Health Effects Summary	This chemical has been identified by NICNAS to be of low concern to human health.
Key Study/Critical Effect for Screening Criteria	The intraperitoneal LD50 of starch in mice is 6600 mg/kg (ACG99).
Ecological Toxicity[7]	
Aquatic Toxicity	Based on QSAR modelling: Crassostrea virginica 96 h = 1000 mg/L Orthopristis chrysoptera 96 h = 5000 mg/L Bairdiella chrysoura 96 h = 5000 mg/L
Determination of PNEC aquatic	Based on the lack of ecotoxicity data, PNECaquatic was not determined.
Current Regulatory Controls[2,4]	
Australian Hazard Classification	No data available.

Australian Occupational Exposure Standards	TWA = 10 mg/m^3
International Occupational Exposure Standards	TLV: 10 mg/m^3, as TWA The current administrative occupational exposure limit (MAC) for starch in the Netherlands is 10 mg/m^3, 8-hour TWA, equal to the occupational exposure limit for nuisance dust.
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	No data available.
PBT Assessment	
P/vP Criteria fulfilled?	No. This substance is expected to be readily biodegradable.
B/vB criteria fulfilled?	No. This substance is not expected to be bioaccumulative.
T criteria fulfilled?	Based on QSAR modelling, this substance is not expected to meet the toxicity criteria.
Overall conclusion	Not PBT
Revised	June 2022

References

1. ECHA REACH, Starch, Retrieved 2019: https://echa.europa.eu/
2. IPCS Starch, Retrieved 2019: http://www.inchem.org
3. Boyd, E. M., & Liu, S. J. (1968). Toxicity of starch administered by mouth. Canadian Medical Association journal, 98(10), 492–499.
4. Health Council of the Netherlands: Committee on Updating of Occupational Exposure Limits. Starch; Health-based Reassessment of Administrative Occupational Exposure Limits. The Hague: Health Council of the Netherlands, 2002; 2000/15OSH/038.
5. Safe Work Australia, Hazardous Substances System, Starch, Retrieved 2019: http://hcis.safeworkaustralia.gov.au/
6. National Industrial Chemicals Notification and Assessment Scheme (NICNAS). IMAP, Human Health Tier 1 Assessment. Retrieved 2019: https://www.nicnas.gov.au
7. Daugherty,F.M.J Sewage Ind. Wastes 23(10):1282-1286. Effects of Some Chemicals Used in Oil Well Drilling on Marine Animals
8. NICNAS (2006) Potato Starch Modified, Full Public Report, File No PLC/639

Toxicity Summary - Calcium chloride

Chemical and Physical Properties [1,4]	
CAS number	[redacted]
Molecular formula	$CaCl_2$
Molecular weight	110.98
Solubility in water	81.3 g/100 g water at 25 ^oC
Melting point	775 ^oC
Boiling point	1935 ^oC
Vapour pressure	No data found
Henrys law constant	No data found
Explosive potential	No data found
Flammability potential	No data found
Colour/Form	Odourless white powder
Overview	Calcium chloride is easily dissociated into calcium and chloride ions in water. Both ions are essential elements in animals and humans. Calcium is essential for the formation of skeletal structure, neural transmission, muscle contraction, coagulation of the blood, and a range of other physiological functions. Chloride is required for regulating intracellular osmotic pressure and buffering.
Environmental Fate [2,3]	
Soil/Water/Air	Calcium chloride is soluble in water and its vapour pressure is negligible. When released into the environment calcium chloride is distributed into the water in the form of calcium and chloride ions. Calcium chloride is not expected to be absorbed in soil due to its dissociation properties and high water solubility. The chloride ion is mobile in soil and eventually drains into surface water because it is readily dissolved in water. Calcium chloride is not expected to undergo photolysis or biodegradation. Considering its dissociation properties, calcium chloride is not expected to accumulate in living organisms.
Human Health Toxicity Summary [4]	
Chronic Repeated Dose Toxicity	No reliable repeated dose oral studies are available. In one study, which was not conducted according to OECD guidelines, 40-day-old rats were fed 20 mg/g of anhydrous calcium chloride for 12 months (Pamukcu, Yalciner & Bryan, 1977). No differences in mortality, weight gain, or daily food consumption were observed between the test and the control groups. No neoplastic lesions were observed in the gastrointestinal tract, urinary tract, liver, heart, brain or spleen of the animals. Based on food consumption, the daily intake of calcium chloride was estimated to be 440 mg. Considering that 1 mg/g in the diet is equivalent to 100 and 50 mg/kg bw/day for young and old rats, respectively, the dose used in this study corresponded to 1000 to 2000 mg/kg bw/day.
Carcinogenicity	No data available.
Mutagenicity/ Genotoxicity	In an in vitro study, conducted according to OECD guidelines, doses of calcium chloride up to 5 mg/plate were examined in a Salmonella typhimurium mutation test using strains TA92, TA94, TA98, TA100, TA1535 and TA1537 with metabolic activation (Ishidate et al., 1984). In another reverse mutation test, doses up to 10 mg/plate were examined using S. typhimurium strains TA97 and TA102 with or without metabolic activation (Fujita & Sasaki, 1987). No significant increases in mutation frequencies were observed in either study. In two additional bacterial genotoxicity studies, which were not conducted according to OECD test guidelines, no DNA damage was reported at calcium chloride concentrations of up to 0.5 molar (Kanematsu et al., 1980; Olivier & Marzin, 1987). An in vitro chromosome aberration test comparable to OECD test guidelines, using Chinese hamster lung cells (CHL), has also been reported. Cells were exposed to

	calcium chloride at doses up to 4 mg/mL for 48 hours without metabolic activation. No significant increases in polyploid formation or structural chromosome aberration were observed (Ishidate et al., 1984).
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	No data are available on the effects of calcium chloride on fertility. In a series of developmental toxicity studies conducted comparably to OECD TG 414, the effects of calcium chloride on embryo-lethality and teratogenicity were studied in mice, rats and rabbits at different dose levels. The maximum doses of calcium chloride were 189, 176, and 169 mg/kg bw/day in mice, rats and rabbits, respectively. Calcium chloride had no discernible effect on implantation or on maternal or foetal survival. There were no differences in numbers of abnormalities in soft or skeletal tissues between test and control animals. The studies concluded that calcium chloride up to 189 mg/kg bw/day in the mouse, 176 mg/kg bw/day in the rat and 169 mg/kg bw/day in the rabbit had no developmentally toxic effects (Food and Drug Research Laboratories, 1974).
Acute Toxicity	Calcium chloride has low acute toxicity following oral exposure in animal tests. Acute oral toxicity of calcium chloride has been tested in several mice, rat and rabbit studies. The oral lethal median doses (LD50s) values range from 2120–3798 (male) and 2361–4179 (female) mg/kg bw in rats to 2045 (male) and 1940 (female) mg/kg bw in mice (Akatsuka, 1997). Calcium chloride has low acute toxicity from dermal exposure. An acute dermal toxicity study was conducted in rabbits by a scientifically accepted method (Carreon et al., 1981). No adverse effects were observed and no deaths occurred up to 5000 mg/kg bw, the highest applied dose. No significant change was found either at gross necropsy examination or at the site of application except for some skin lesions (see Skin irritation). The dermal LD50 from this study was >5000 mg/kg bw. Reliable studies on acute inhalation toxicity of calcium chloride are not available. In one study, rats were exposed to 40 and 160 mg/m^3 anhydrous calcium chloride (CAS No. [redacted]) for four hours. Signs of irritation of the trachea were observed in the animals. No deaths were reported (Sukhanov et al., 1990). However, the reliability of this study is questioned due to insufficient information on the form of calcium chloride and methodology used.
Irritation	No data are available. However, signs of irritation of the trachea were observed in animals in an acute inhalation study (Sukhanov et al., 1990), indicating that calcium chloride is likely to be a respiratory irritant. In studies conducted according to OECD test guidelines, no or only slight skin irritation were observed in rabbits from four-hour exposures to anhydrous calcium chloride (CAS No. [redacted]), calcium chloride dihydrate (CAS No. [redacted]), and/or calcium chloride hexahydrate (CAS [redacted] (Koopman and Pot, 1986b-e). Rabbits exposed for 24 hours to anhydrous calcium chloride and solid or 38 % calcium chloride dihydrate solution had slight to moderate irritation on intact skin and more severe irritation on abraded skin (Norris, 1971a, b; Carreon, Yano & New, 1981). Anhydrous calcium chloride was a severe irritant to rabbit eyes. The cornea and conjunctivae were moderately to severely irritated from one hour until 14 days after treatment, and were still moderately irritated 21 days after treatment. Hydrated forms of calcium chloride were less irritating to the eyes. With the dihydrate form, the cornea and conjunctivae were moderately irritated from one hour to 72 hours post application, and in one rabbit for up to 14 days. The hexahydrate caused slight to moderate irritation of the cornea and conjuntivae, which persisted for up to 48 hours, and in one rabbit, for up to 14 days. The 33 % and 38 % solutions of calcium chloride were slight to moderate eye irritants causing diffuse corneal opacity and slight to moderate conjunctival redness. Slight to moderate chemosis was also observed in some, but not all, rabbits (Norris, 1971a, b; Koopman & Pot, 1986f-i).

Sensitisation	No data available
Health Effects Summary	The critical health effects for risk characterisation are local effects (severe eye irritation). Observations in humans suggest that calcium chloride may be a slight respiratory irritant.
Key Study/Critical Effect for Screening Criteria	The drinking water guidelines for chloride and hardness (as calcium carbonate) may apply to calcium chloride.
Ecological Toxicity [2,3]	
Aquatic Toxicity	Several studies on acute toxicity to fish have been reported. The lowest 96-hr LC50 value was 4,630 mg/L in fathead minnow (Pimephales promelas). No chronic toxicity studies on fish conducted under standard guidelines have been reported. There are seven acute toxicity data available for Daphnia. Two of these studies were conducted according to international or national guidelines, giving the 48-hr EC50 of 2,400 mg/L for Daphnia magna and the 48-hr LC50 of 1,830 mg/L for Ceriodaphnia sp. The lowest 48-hr EC50 was 1,062 mg/L for Daphnia magna. The chronic effect of 21-day exposure on reproduction of Daphnia magna has been investigated as a long-term study. The concentration required for 16% and 50% inhibition of reproduction (EC16 and EC50) were 320 and 610 mg/L, respectively. The NOEC = EC16/2 = 320/2 = 160 mg/L. There is one study with fresh water algae, Selenastrum capricornutum, which was conducted according to OECD TG 201. The 72-hr EC50 and EC20 obtained on the basis of growth rate from the study were >4,000 and 2,700 mg/L, respectively. The 72-hr EC50 and EC20 obtained on the basis of biomass from the study were 2,900 and 1,000 mg/L, respectively. The NOECs are calculated as EC20/2, which corresponds to 1,350 and 500 mg/L for growth rate and biomass, respectively.
Determination of PNEC aquatic	Experimental results are available for three trophic levels. Acute E(L)C50 values are available for fish (4,630 mg/L), Daphnia (1,062 mg/L), and algae (2,900 mg/L). Results from a chronic Daphnia study (NOEC = 160 mg/L) and algae study (NOECs = 1,350 and 500 mg/L for growth rate and biomass, respectively) are also available. On the basis that the data consists of short-term results from three trophic levels and chronic studies on Daphnia and algae, an assessment factor of 50 has been applied to the lowest reported NOEC of 160 mg/L for Daphnia.
Current Regulatory Controls [4]	
Australian Hazard Classification	No data available
Australian Occupational Exposure Standards	No data available
International Occupational Exposure Standards	The following exposure standards are identified (Galleria Chemica): • an occupational exposure limit (OEL) of 5 mg/m^3 for calcium chloride (CAS [redacted] in Canada; and • an OEL of 2 mg/m^3 for calcium chloride (CAS No. [redacted]) in Latvia.
Australian Food Standards	No data available
Australian Drinking Water Guidelines	No data available
Aquatic Toxicity Guidelines	No data available
PBT Assessment	
P/vP Criteria fulfilled?	Not applicable (inorganic salt, ionic species ubiquitous in environment)
B/vB criteria fulfilled?	Not applicable (inorganic salt, ionic species ubiquitous in environment)
T criteria fulfilled?	No chronic toxicity data exist on calcium chloride; however, the acute EC(L)50s are >0.1 mg/L in fish, invertebrates and algae. Thus, calcium chloride does not meet the screening criteria for toxicity.
Overall conclusion	Not PBT

References

1. HSDB (n.d.). *Hazardous Substances Data Bank*. Retrieved 2015, from Toxnet, Toxicology Data Network, National Library of Medicine: http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB
2. IUCLID (2002) IUCLID Data Set for Calcium chloride (CASRN 10043-52-4), UNEP Publications.
3. OECD-SIDS (2002) Screening Information Dataset (SIDS) Initial Assessment Report for Calcium chloride (CASRN 10043-52-4), UNEP Publications.
4. National Industrial Chemicals Notification and Assessment Scheme (NICNAS), IMAP Single Assessment Report, Calcium chloride (CaCl2): Human health tier II assessment, Retrieved 2018: https://www.nicnas.gov.au/

Toxicity Summary - 1-Dodecene, dimer

Chemical and Physical Properties[1,2]	
CAS number	[redacted]
Molecular formula	(C12H24)2
Molecular weight	UVCB
Solubility in water	100 - 400 µg/L at 19.5 - 24 °C and pH 6.4 - 7
Melting point	-73 - -20.15 °C at 101.3 - 101.325 kPa
Boiling point	144.85 - 596 °C at 101.3 - 103 kPa
Vapour pressure	0 - 258 205.43 Pa at 20 - 400 °C
Henrys law constant	No data available
Explosive potential	No data available
Flammability potential	No data available
Colour/Form	Clear liquid
Overview	Dodecene, dimer is a petroleum product.
Environmental Fate [1]	
Soil/Water/Air	Members of this category do not contain any hydrolysable functional groups, so will not undergo hydrolysis. Data for various category members indicate that they cannot be considered to be readily biodegradable. Members of this category are expected to adsorb strongly to soil and sediment.
Human Health Toxicity Summary [1]	
Chronic Repeated Dose Toxicity	Three read-across 28-day oral exposure studies (OECD 407) and three 90-day oral exposure studies (OECD 408/OECD 415) were identified either within category or from a structural analogue. There were no key dermal or inhalation repeated dose studies identified. Overall, the 28-day exposure studies found no toxicity when the respective poly alpha olefins were administered orally. Results were as follows. • The NOAEL is 6245 mg/kg/day in male rats and 6771 mg/kg/day in female rats for the 28-day oral repeated dose study from 1-decene, homopolymer, hydrogenated. • The NOAEL is 1000 mg/kg/day in male and female rats for the 28-day oral repeated dose study from 1-dodecene dimer with 1-decene, hydrogenated. • The NOAEL is 1000 mg/kg/day in male and female rats for the 28-day oral repeated dose study from Alkane 4. For the 90-day oral exposure studies, results were as follows. • The NOAEL is 4145.4 mg/kg bw in male rats and 4619.9 mg/kg bw in female rats for the 90-day exposure study from 1-decene, homopolymer, hydrogenated. • The NOAEL is 1000 mg/kg bw in male and female rats for the 91-day exposure study from 1-decene, homopolymer, hydrogenated. • The NOAEL is 1000 mg/kg bw in male and female rats for the 90-day one-generation reproduction study with subchronic toxicity from Alkane 4.
Carcinogenicity	No data available
Mutagenicity/ Genotoxicity	All read-across in vitro genetic toxicity studies (i. e., gene mutation studies in bacteria; cytogenicity studies in mammalian cells; and gene mutation studies in mammalian cells) from substances within category or from structural analogues showed negative results.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	Two read-across studies were identified for poly alpha olefins and its structural analogues: a 91-day study which assessed the systemic toxicological effects of treatment with 1-decene, homopolymer, hydrogenated (Ethylflo 166) on rats previously treated in utero with the same chemical and a 90-day study with Alkane 4 which assessed fertility and developmental effects in a one-generation study

	(OECD 415). Neither study showed any treatment-related effects on fertility or reproductive endpoints in rats. Both studies reported a NOAEL of 1000 mg/kg bw.
Acute Toxicity	The oral LD50 was > 5000 mg/kg bw in male and female rats for dec-1-ene, dimers, hydrogenated. The dermal LD50 was > 3000 mg/kg/bw in male and female rabbits for dec-1-ene, dimers, hydrogenated.
Irritation	Not irritating
Sensitisation	Not sensitising
Health Effects Summary	Expected to have low acute and chronic toxicity based on read across data.
Key Study/Critical Effect for Screening Criteria	The 28-day oral repeated dose study from 1-dodecene dimer with 1-decene, hydrogenated with a NOAEL of 1000 mg/kg/day in male and female rats is selected as the key study.
Ecological Toxicity [1]	
Aquatic Toxicity	LL50 (96 hrs) for fish: 1 g/L EL50 (48 h) for invertebrates: 1 g/L EL50 (48 h) for algae: 1 g/L 21 day NOELR for invertebrates: 125 mg/L WAF.
Determination of PNEC aquatic	Data from short-term tests with three trophic levels and one long-tern test are available. An assessment factor of 10 is applied to 21 day NOELR for invertebrates: 125 mg/L WAF. A PNECaqua of 12.5 mg/L was derived.
Current Regulatory Controls [3,4,5,6]	
Australian Hazard Classification	No data available.
Australian Occupational Exposure Standards	No data available.
International Occupational Exposure Standards	No data available.
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	No data available.
PBT Assessment [1]	
P/vP Criteria fulfilled?	Yes. Not considered readily biodegradable.
B/vB criteria fulfilled?	No. Members of this category are not expected to be bioaccumulative.
T criteria fulfilled?	No. The acute and chronic toxicity of this substance is >1 mg/L in fish, invertebrates and algae. Therefore, it does not meet the screening criteria for toxicity.
Overall conclusion	Not PBT
Revised	June 2022

References

1. ECHA REACH, 1-Dodecene, dimers, Retrieved 2022: https://echa.europa.eu/
2. NCBI, 2022. National Center for Biotechnology Information. Available at: https://pubchem.ncbi.nlm.nih.gov/. Retrieved June 2022.
3. HCIS, Hazardous Chemical Information System, Safe Work Australia, Retrieved February 2022: http://hcis.safeworkaustralia.gov.au/HazardousChemical.

4. ILO, International Labour Organisation, International Chemical Safety Cards (ICSCs), Retrieved February 2022: http://www.ilo.org/dyn/icsc/showcard.listcards3?p_lang=en.
5. ANZG, 2018. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia. Available at www.waterquality.gov.au/anz-guidelines.
6. NHMRC, 2018. Australian Drinking Water Guidelines 6, 2011, Version 3.5 Updated August 2018. National Water Quality Management.

Toxicity Summary - Acetic acid

Chemical and Physical Properties[1,6]	
CAS number	[redacted]
Molecular formula	$C_2H_4O_2$
Product name	Acetic Acid 60%
Molecular weight	60 g/mol
Solubility in water	1000 g/L at 25°C
pH	1.38
Melting point	16.6 °C
Boiling point	117.9 °C
Vapour pressure	1.5 kPa at 20°C
Henrys law constant	0.0101 Pa m^3/mol
Explosive potential	Above 39°C explosive vapour mixtures may be formed. Risk of fire and explosion on contact with strong oxidants.
Flammability potential	Flammable. Flashpoint = 39°C
Colour/Form	Clear colourless liquid with a pungent vinegar smell
Overview	Acetic acid is naturally occurring as the acid in apple cider vinegar and other fruit derived products. Acetic acid is recognised by Food Standards Australia New Zealand (FSANZ) and the US Food and Drug Administration (FDA) as safe as a food additives (e.g. flavouring agent, preservative).
Environmental Fate[1]	
Soil/Water/Air	When released into the environment, acetic acid is not expected to adsorb onto suspended solids or sediments. Acetic acid dissociates in aqueous media to H+ and the acetate anion ($CH_3CO_2^-$). The compound is expected to be present in the dissociated form, where volatilisation is not an important process. Based on the range of expected Koc values, acetic acide is expected to have a very high to moderate mobility in soil. In air acetic acid will exist soley in the vapour phase where it is degraded with photochemically produced hydroxyl radicals with a half-life for this reaction in air of approximately 22 days. Acetic acid is readily biodegradable, and biodegrades rapidly under aerobic and anaerobic conditions. Based on an estimated bioconcentration factor of 3.2, the potential for bioaccumulation is low.

Human Health Toxicity Summary [1,2,5,6]	
Chronic Repeated Dose Toxicity	In a six-month repeat dose oral toxicity study (Lamb and Evard 1919), pigs were initially fed acetic acid at 155 mg/kg bw/day with the dose was raised every 10 to 30 days until a final dose of 380 to 450 mg/kg bw/day was reached after 60 days. There was no mortality and no effects on body weight or acid-base balance noted in this study (REACH 2013). A NOAEL was not established in this study. Repeated intra-gastric administration of the chemical at 3% concentration in animals (unspecified) for six months resulted in chronic inflammation of the oesophageal mucosa (HSDB 2013). Similarly, intra-gastric administration to rats of 3 mL of a 10% solution for 90 days produced a drop in haemoglobin concentration and erythrocyte count (HSDB 2013). In another similar study, pigs were fed daily diets containing the chemical at 0, 240, 720, 960 and 1200 mg/kg bw/day for successive 30-day periods for a total of 150 days (HSDB 2013).There were no significant differences in growth rate, weight gain, early morning urinary ammonia and terminal blood pH between controls and test groups. A NOEL or NOAEL was not indicated by the authors. Based on the available information and taking a conservative approach, the NOAEL in the study is considered to be 1200 mg/kg bw/day, the highest tested dose with no adverse effects. This NOAEL will be used for human health risk assessment. In the only available dermal repeat dose toxicity study (Slaga et al. 1975), acetic acid was applied dermally to mice at doses of 1 to 40 mg/animal, one to three times/week for 32 weeks. Single dermal applications of acetic acid at doses of up to 40 mg/animal did not induce mortality. However, more than one application per week of 10 mg acetic acid or more caused excessive mortality. 33% of mice died when 10 mg acetic acid/animal was applied dermally three times/week and approximately 50% of mice died when 20 mg was applied twice a week. No biochemical or histopathological effects were reported. A LOAEL of 10 mg/animal was suggested by the authors, however it was expressed in terms of ‘mg/animal’ rather than ‘mg/kg bw/day’ and it therefore cannot be adopted. Dermal NOAEL or LOAEL for acetic acid are not available. Repeated oral, inhalation and dermal exposure of humans to pure acetic acid has been reported to have effects on the gastrointestinal tract and to cause digestive disorders including heartburn and constipation, chronic inflammation of the respiratory tract, pharyngitis, catarrhal bronchitis, darkening of skin, skin dermatitis and erosion of the exposed front teeth enamel. In addition, skin on the palms of hands can become dry, cracked and hyperkeratotic. These observed effects were not associated with any systemic findings, suggesting the effects observed could be due to its corrosive action (EC 2012; HSDB 2013).

Carcinogenicity	In a carcinogenicity study (Slaga et al. 1975), acetic acid was tested as the promoter for tumour development in mice. Acetic acid was applied dermally to mice initiated with a carcinogenic agent, dimethylbenz(a)anthracene (DMBA) at doses of 1 to 40 mg/animal, one to three times/week for 32 weeks. Control animals received acetic acid dermally once per week. No further details were provided about the exposure duration. Single dermal application of acetic acid at doses of up to 40 mg/animal did not induce mortality. However, more than one application per week of 10 to 40 mg acetic acid caused excessive mortality. Thirty three per cent of mice died when 10 mg acetic acid/animal was applied dermally three times/week and approximately 50% of mice died when 20 mg was applied twice a week. No biochemical or histopathological effects were reported. Acetic acid did not produce any carcinogenic effects in mice (REACH 2013). In another study, oral administration of the chemical as a 3% solution in rats, three times/week for eight months did not induce tumours in the oesophagus and fore-stomach, although epithelial hyperplasia was observed. When dosed in combination with the known carcinogen, N-nitrososarcosine ethyl ester (positive control), there was an increase in oesophageal/stomach tumour formation (REACH 2013). Based on the limited available data, acetic acid is not likely to be a carcinogen.
Mutagenicity/ Genotoxicity	Acetic acid was not mutagenic in bacterial reverse mutation assays using Salmonella typhimurium strains TA100, TA1535, TA97 and TA98 with and without metabolic activation (Ishidate et al. 1984). Acetic acid was negative in the chromosome aberration assay using Chinese hamster lung fibroblasts at concentrations of up to 1 mg/mL with or without metabolic activation. In one study using Chinese hamster ovary Kl cells, acetic acid induced chromosomal aberrations at the initial pH of 6.0 or below (about 10 to 14 mM of acid) both with and without S9 mix (REACH 2013). However, when the culture medium was neutralised to pH 7.2 with sodium hydroxide, no clastogenic activity was observed. Moreover, pH lower than 6.0 (pH 5.7 or below) were also found to be cytotoxic. Chromosomal aberrations induced at these high concentrations were therefore considered to be artefacts due to acidification of the culture medium. Acetic acid was concluded not to be clastogenic when tested in cultured Chinese hamster K1 cells (REACH 2013; HSDB 2013). It was concluded that acetic acid is not mutagenic.
Reproductive Toxicity	No data available
Developmental Toxicity/Teratogenicity	In two developmental toxicity studies conducted according to the EU Method B.31 (prenatal developmental toxicity study), acetic acid was administered by gavage to pregnant female Wistar rats and CD-1 mice at 16, 74.3, 345, and 1600 mg/kg bw/day during gestation days 6 to 15 (10 consecutive doses) (REACH 2013). In a similar study, the chemical was administered by gavage to female Dutch rabbits at 16, 74.3, 345, and 1600 mg/kg bw/day during gestation days 6 to 18 (13 consecutive doses) (REACH 2013). There were no clearly discernible effects on implantation, maternal survival or foetal survival in any species at any of the doses. The number of abnormalities seen in either soft or skeletal tissues of the test groups did not differ significantly from those occurring spontaneously in the controls. No NOAEL could be established for maternal toxicity or foetal developmental effects. Based on the available data, the chemical does not show developmental toxicity.

Acute Toxicity	Acetic acid was of low acute toxicity in animal tests following oral exposure. The median lethal dose (LD50) observed in two rat studies is greater than 2000 mg/kg bw (REACH2013). In one study, groups of unfasted rats were fed 2239, 2512, 2859, 3100, 3500, 4000, 4467 mg/kg bw sodium acetate and observed for six days (REACH 2013). The acute oral median lethal dose (LD50) of the sodium salt of acetic acid was found to be 3310 mg/kg bw for rats. Acetic acid was of moderate acute toxicity in rabbits following dermal exposure. The LD50 in rabbits was 1060 mg/kg bw (HSDB 2013). Details regarding the concentration of the administered test substance were not provided. The moderate acute dermal toxicity is believed to be due to its local corrosive effects rather than any systemic toxicity. Acetic acid was of low acute toxicity in animal tests following inhalation exposure. In an acute inhalation study, mice were exposed to various concentrations of acetic acid (experimental details and concentration range not provided) (HSDB 2013). Clinical signs of respiratory irritation were evident at concentrations of 2.46 mg/L and higher. Animals exposed to concentrations higher than 11.07 mg/L died within 27 hours of exposure. Surviving mice recovered quickly and showed no abnormalities three days after exposure. The median lethal concentration (LC50) was determined by the Weil's method and was estimated to be 13.8 mg/L in the mouse. Severe health effects have been reported in humans following accidental exposure to acetic acid by different routes, mainly due to the local corrosive effects of the chemical leading to systemic effects (HSDB 2013).
Irritation	Pure acetic acid is corrosive to skin. In animal studies, severe skin burns were reported in guinea pigs following application to intact or abraded skin of patches of 80% solution of the chemical, moderate to severe burns at 50 to 80% solution, mild injury at 50% solution, and no effect at 10% solution (HSDB 2013). In a study with rabbits, the chemical was considered to be slightly irritating at concentrations of 3.3% and 10% (REACH 2013). In another study with rabbits, a concentration of 2.5% of the chemical was not irritating while concentrations of 10 to 25% caused moderate to severe erythema, slight to severe oedema, skin lesions over the application site and eschar formation (REACH 2013). A 10% solution was therefore considered a skin irritant. As part of a study to select the optimum testing conditions for predicting hazard to the human eye, 3%and 10% aqueous acetic acid were tested in rabbit eyes (REACH 2013). Materials were applied directly to the central corneal surface. Irritation was followed for up to 21 days and scored according to the Draize scale. The 3% acetic acid gave moderate irritation and 10% acetic acid was severely irritating or corrosive. In other studies, instillation of 0.5 mL of a 1% acetic acid solution in the eyes of rabbits caused a severe burn (Smyth et al. 1951). Solutions of 5% induced injury in eyes of rabbits which healed by 14 days, while a 10% solution resulted in severe permanent damage (Henschler 1973). Based on the results of the studies pure acetic acid is considered to be corrosive to eyes. In an acute inhalation study in mice, clinical signs of respiratory irritation were evident at concentrations of 2.46 mg/L and higher (see Section A28.5.2.3). Acetic acid vapours were reported to cause damage to nose, throat and lungs in humans (SCOEL 2012). Acetic acid is considered to be a respiratory tract irritant. Chemical burns and eye and nasal irritation have been reported in humans following exposure

Sensitisation	No experimental data were available, however the US National Institute of Occupational Safety and Health (NIOSH) Pocket Guide to Chemical Hazards mentions skin sensitisation as one of the symptoms of acetic acid exposure (NIOSH 2010). A 1994 report (Kivity et al. 1994) describes a late asthmatic response to inhaled glacial acetic acid by an asthma patient. Based on reports of patients with bronchial asthma reacting to acetic acid challenge, it is believed that acetic acid may cause allergic reactions in humans (HSDB 2013). Some researchers consider acetic acid capable of causing a syndrome known as 'reactive airways dysfunction', which resembles bronchial asthma. Symptoms include dyspnoea, wheezing, and cough.
Health Effects Summary	Acetic acid has low acute oral and inhalation toxicity but moderate dermal toxicity. LD50 for oral, dermal and inhalation routes were >3100 mg/kg bw, 1060 mg/kg bw and 13.8 mg/L, respectively in laboratory animals. It is corrosive to skin, eyes and respiratory tract. Acetic acid has low repeat dose toxicity by oral and dermal routes. Information on toxicity by the inhalation route is not available. It is not genotoxic or carcinogenic and does not have any developmental effects in animals. Information on effects on fertility is not available. The critical health effect of acetic acid for risk characterisation is its corrosivity.
Key Study/Critical Effect for Screening Criteria	A NOEL or NOAEL was not established in any of the repeat dose studies. Based on the available information and taking a conservative approach, the highest tested dose with no adverse effects in the repeat dose oral study (1200 mg/kg bw/day) was taken as the NOAEL for human health risk assessment.
Ecological Toxicity [2]	
Aquatic Toxicity	Acute endpoints: Fish = 75 mg/L (measured), Daphnia EC50 = 32 mg/L (Dept. Env. (2013a) in LMC, 2012 Chronic endpoints: Daphnia = 150 mg/L (measured)
Determination of PNEC aquatic	PNECaquatic: On the basis of the chronic results for Daphnia, an assessment factor of 10 has been applied to the lowest reported effect concentration of 150 mg/L. The PNECaquatic is determined to be 15 mg/L.
Current Regulatory Controls	
Australian Hazard Classification	Acetic acid is classified as hazardous, with the following risk phrase for human health in the Hazardous Substances Information System (HSIS) (Safe Work Australia 2013): C; R35 (Corrosive, causes severe burns). Mixtures containing the chemical are classified as hazardous with the following risk phrases based on the concentration (Conc) of the chemical in the mixtures: Conc >=90%: C; R35 (Corrosive, causes severe burns) ≥25% Conc <90%: C; R34 (Corrosive, causes burns) ≥10% Conc <25%: Xi; R36/38 (Irritant, Irritating to eyes and skin).
Australian Occupational Exposure Standards	The chemical has an exposure standard of 25 mg/m³ (10 ppm) Time Weighted Average (TWA) and 37 mg/m³ (15 ppm) Short-Term Exposure Limit (STEL) (Safe Work Australia 2013).
International Occupational Exposure Standards	The following exposure standards are identified in Galleria Chemica (2013). Occupational Exposure limit (TWA): 10 to 25 mg/m^3 [China, Canada, Denmark, Germany, Ireland, South Africa, Spain, Sweden, Switzerland, and the US]. An exposure limit (STEL): 15 to 50 mg/m^3 [China, Canada, France, Ireland, Singapore, South Africa, Spain, Sweden, Switzerland, and the US].
Australian Food Standards	Acetic acid is allotted the following International Numbering System of food additives number: INS 260 (Food Standards Australia New Zealand 2013).

Australian Drinking Water Guidelines	No data found
Aquatic Toxicity Guidelines	No data found
PBT Assessment	
P/vP Criteria fulfilled?	No. The acetate ion of acetic acid is readily biodegradable and thus it does not meet the screening criteria for persistence.
B/vB criteria fulfilled?	The log Kow for acetic acid is reported to be -0.136. Acetate is also found in the body and is metabolized as part of the body's biochemical pathways. Thus, acetic acid (specifically, the acetate ion) does not meet the screening criteria for bioaccumulation.
T criteria fulfilled?	No. The NOECs from the chronic aquatic toxicity data on acetic acid are >1 mg/L, hence does not meet the screening criteria for toxicity.
Overall conclusion	Not PBT

References

1. National Industrial Chemicals Notification and Assessment Scheme (NICNAS). IMAP, Human Health Tier II Assessment for Acetic acid, Retrieved 2019: https://www.nicnas.gov.au
2. HSDB (n.d.). *Hazardous Substances Data Bank*. Retrieved 2015, from Toxnet, Toxicology Data Network, National Library of Medicine: http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB
3. ECHA REACH, Acetic Acid, Retrieved 2015: http://apps.echa.europa.eu
4. JECFA http://apps.who.int/ipsc/database/evaluations/chemical.aspx?chemID=4785
5. U.S. EPA HPVIS database, http://www.epa.gov/chemrtk/hpvis/index.html
6. OECD, Acetic Acid, Retrieved 2015: http://www.echemportal.org
7. IPCS Acetic Acid, Retrieved 2015: http://www.inchem.org

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Toxicity Summary - Citric acid

Chemical and Physical Properties[2,3,5]	
CAS number	[redacted]
Molecular formula	C6-H8-O7
Product name	--
Molecular weight	192.124
Solubility in water	1000000 mg/L
pH	2 to 2.2
Melting point	Decomposition > 175 C
Boiling point	152 to159 C
Vapour pressure	White powder or granules
Henrys law constant	1.7 $x10^{-8}$ mm Hg at 25 deg C
Explosive potential	4.39 x 10^{-09} $Pa.m^3/mol$
Flammability potential	Dust explosion possible if powder or granular form, mixed with air
Colour/Form	Melts and decomposes in fire, a non-hazardous reaction.
Overview	Citric acid is a water soluble organic solid. It is a natural substance that appears as an intermediate in the basic physiological citric acid or Krebs cycle in every eukaryote cell. Citric acid has been produced for many years in high volumes. It has wide dispersive use, being added to processed food and beverages, used in pharmaceutical preparations and in household cleaners as well as in special technical applications. Citric acid is recognised by Food Standards Australia New Zealand (FSANZ) and the WHO JECFA as safe as a multipurpose food additive. No upper limit of concentrations has been established in food products. This chemical has been identified by NICNAS to be of low concern to human health based on an initial screening approach and thus required no further assessment.
Environmental Fate[2,5]	
Soil/Water/Air	Citric acid is highly mobile in the environment and is extremely soluble in water. The pKa of citric acid is 2.79, indicating that this compound will exist almost entirely in the anion form in the environment. The compound does not sorb to soil or particles in the water column and is readily and rapidly degraded in surface waters and in soil. (OECD, hsdb)

Human Health Toxicity Summary [1,2,4,5]	
Chronic Repeated Dose Toxicity	A 2-year chronic oral study in rats being given 5% or 3% citric acid in feed (approx. 2 resp. 1.2 g/kg/d) found slightly decreased growth in the higher dosage group but no tissue abnormalities in the major organs. From the lower dosage a NOAEL of 1200 mg/kg/d results. Similarly, NOAELs of 1500 mg/kg/d (rabbit) and of 1400 mg/kg/d (dog) have been determined. In general, citric acid is a strong chelating agent, the dietary uptake of which may interfere with biological availability, absorption and excretion of metals. Further, loss of superficial enamel and erosion of teeth as well as local irritation result from frequent ingestion of citric acid in beverages including natural fruit juices; citric acid fumes were reported to apparently affect the teeth of exposed workers. The average daily intake of citric acid from natural sources in the diet and food additives was estimated at about 40 mg/kg for women, 130 mg/kg for infants and 400 mg/kg for individuals on slimming diets; maximum daily intake is reported to reach levels of 500 mg/kg. No formal ADI (acceptable daily intake) level has been specified for citric acid and its common salts by the Joint FAO/WHO Expert Committee on Food Additives nor by the EC Scientific Committee for Food.
Carcinogenicity	Citric acid has not been classified by the IARC.
Mutagenicity/ Genotoxicity	In several in vitro and in vivo tests citric acid was not mutagenic. The substance was not mutagenic either in bacterial tests with Salmonella typhimurium (Ames test, 2 studies) and Escherichia coli, with and without metabolic activation.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	In a two-generation 90 days study with male and female rats fed 1.2 % citric acid no adverse effect on reproductive parameters nor any teratogenicity of dietary citric acid was seen. There were no indications of teratogenic or other adverse effects in three shorter term reproductive studies in rats with dietary dosage of either 5% citric acid (approx. 2.5 g/kg/d) previous, during and after mating (NOEL = 2500 mg/kg/d), or 295 mg/kg/d (route unspecified) during days 6–15 of pregnancy
Acute Toxicity	Citric acid has a low acute toxicity by oral application in both rat (LD50 = 3,000–12,000 mg/kg, 3 different values) and mouse (LD50 = 5,400 mg/kg). General effects comprised physiological disturbances (acidosis and calcium deficiency), while “high” doses caused nervous system effects as well as severe damage to the stomach mucosa.
Irritation	Local effects of citric acid to the skin (rabbit) are reported as slightly irritating in two studies and as not irritating in a third study using a 30% aqueous solution. In an acute eye irritation/corrosion test in rabbits according to OECD 405 citric acid was highly irritating.
Sensitisation	The sensitising potential is low.
Key Study/Critical Effect for Screening Criteria	A 2-year chronic oral study in rats being given 5% or 3% citric acid in feed resulted in a NOAEL of 1200 mg/kg/d. Uncertainty factors: 10 (interspecies variability) and 10 (intraspecies variability). Drinking water guideline = 4.7 ppm
Ecological Toxicity [1,5]	
Aquatic Toxicity	The 96-hour LC50 values for citric acid to fish are from 440 to 1,516 mg/L. The acute toxicity 24 hour EC50 value for invertebrates is 85 mg/L. The 7 day toxic limit concentration (TLC) values for algae range from 300 to 640 mg/L. In an 8 day freshwater static test for the algae Scenedesmus quadricauda, the NOEC is 425 mg/L. In freshwater, citric acid appears to be of low toxicity to aquatic acute test standard organisms, fish, daphnia and algae, with consistent LC50/EC50 values of several hundred milligrams per litre.

Determination of PNEC aquatic	$PNEC_{aquatic}$: Experimental results are available for three trophic levels. Acute $E(L)C_{50}$ values are available for fish (440 mg/L), Daphnia (85 mg/L). A TLC value of 300 mg/L was obtained for algae from which no dependable EC50 can be derived. Even though a NOEC was obtained from the algae study, there were no chronic studies conducted on fish or Daphnia. On the basis that the data consists of short-term results from three trophic levels, an assessment factor of 1,000 has been applied to the lowest reported effect concentration of 85 mg/L for Daphnia Magna. The $PNEC_{aquatic}$ was calculated to be 0.085 mg/L.
Current Regulatory Controls	
Australian Hazard Classification	
Australian Occupational Exposure Standards	
International Occupational Exposure Standards	
Australian Food Standards	
Australian Drinking Water Guidelines	No data found
Aquatic Toxicity Guidelines	No data found
Australian Hazard Classification	
PBT Assessment[1]	
P/vP Criteria fulfilled?	Citric acid is expected to be readily biodegradable and does not persist in the environment
B/vB criteria fulfilled?	Based on the low Log Kow and widespread natural occurrence, citric acid is not expected to have potential for bioaccumulation.
T criteria fulfilled?	Long term data not available (acute data >0.1 mg/L); potentially not toxic.
Overall conclusion	Not a PBT substance (based on screening data).

References

1. ECHA REACH, Citric Acid, Retrieved 2015: http://apps.echa.europa.eu
2. HSDB (n.d.). *Hazardous Substances Data Bank*. Retrieved 2015, from Toxnet, Toxicology Data Network, National Library of Medicine: http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB
3. IPCS Citric Acid, Retrieved 2015: http://www.inchem.org
4. JECFA http://apps.who.int/ipsc/database/evaluations/chemical.aspx?chemID=4785
5. OECD, Citric Acid, Retrieved 2015: http://www.echemportal.org

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Toxicity Summary - Crystalline silica-cristobalite, crystalline silica-quartz, tridymite

Chemical and Physical Properties[1,3]	
CAS number	Crystalline Silica (Cristobalite) : [redacted] Crystalline Silica (Quartz): [redacted] Diatomacous Earth (Calcined silica): [redacted] Tridymite: [redacted]
Molecular formula	Crystalline Silica (Cristobalite): SiO_2 Crystalline Silica (Quartz): SiO_2 Diatomacous Earth (Calcined silica): SiO_2
Molecular weight	60.09 g/mol
Solubility in water	Insoluble/negligible
pH	-
Melting point	1713◦C (Cristobalite) 1610◦C (Quartz)
Boiling point	2230 ◦C
Vapour pressure	NA
Henrys law constant	NA
Explosive potential	Not explosive
Flammability potential	Not flammable
Colour/Form	Transparent crystals
Overview	Silica is an off-white granule that occurs naturally in various crystalline and amorphous or other non-crystalline forms. Crystalline silica is characterized by silicon dioxide (SiO2) molecules oriented in fixed, periodic patterns to form stable crystals. The primary crystalline form of silica is quartz. Other crystalline forms of silica include cristobalite, tripoli and tridymite. Particle size is a key determinate of silica toxicity, since toxicity is restricted to particles that are small enough to be deposited into the target regions of the respiratory tract. Uncalcined diatomaceous earth typically contains around 1%crystalline silica. When diatomaceous earth is subjected to pressure or is processed ("calcined") at temperatures above 1000°C some of the amorphous silica is converted to crystalline silica in the form of cristobalite. Calcined diatomaceous earth can contain anywhere from 1% to 75% cristobalite.
Environmental Fate [1,2]	
Soil/Water/Air	Crystalline Silica consists of diatomaceous earth, a naturally occurring material. Its primary component, silica, is found in common materials like quartz, sand and agate. The materials are ubiquitous and unlikely to react chemically with any other substance in the environment.

Human Health Toxicity Summary [1,2,3]	
Chronic Repeated Dose Toxicity	A number of animal studies have found that cristobalite is more toxic to the lung than quartz, and more tumorigenic (e.g., King et al. 1953; Wagner et al. 1980). However, several other authors concluded that this is not the case (Bolsaitis and Wallace 1996; Guthrie and Heaney 1995). OSHA (2013) has examined evidence on the comparative toxicity of the silica polymorphs (quartz, cristobalite, and tridymite) and found no difference in toxicity effects between cristobalite and quartz. Furthermore, no difference in toxicity between cristobalite and quartz has been observed in epidemiologic studies (NIOSH 2002). There is no information on the repeat dose oral, inhalation or dermal effect of calcined silica. However, since calcined diatomaceous earth contains varying amounts of crystalline silica in the form of cristobalite, and may also contain small amounts of quartz and tridymite, it is expected that any long-term health hazards associated with diatomaceous earth would mainly be due to the effects of crystalline silica. In humans, the most prevalent effect identified from long term exposure in occupational settings is silicosis, a diffused nodular pulmonary fibrosis (US EPA 1996).
Carcinogenicity	IARC (2012) concluded that there is sufficient evidence in humans for the carcinogenicity of inhaled crystalline silica in the form of quartz or cristobalite from occupational sources. There is sufficient evidence in experimental animals for the carcinogenicity of quartz and cristobalite. The IARC has also concluded that inhaled crystalline silica in the form of cristobalite or quartz from occupational sources is carcinogenic to humans (Group 1) (IARC 2012).
Mutagenicity/ Genotoxicity	Conflicting results have been reported in genotoxicity studies with crystalline quartz or cristobalite, and a direct genotoxic effect for crystalline silica has not been confirmed or ruled out. Studies on genotoxicity of calcined diatomaceous silica are not available.
Reproductive Toxicity Developmental Toxicity/Teratogenicity	No data available.
Acute Toxicity	No data available.
Irritation	No data available. Most acute toxicity studies for quartz or cristobalite were conducted using intratracheal instillation. Single intratracheal instillation of quartz caused inflammatory effects and formation of discrete silicotic nodules in rats, mice and hamsters (IARC 2012; WHO 2000). Other effects like oxidative stress, cellular proliferation and increases in water, protein, and phospholipid content of rat lungs, apoptosis (programmed cell death) and lung cancer were also noted. In general, exposure to high concentrations of dust may cause coughing and mild, temporary irritation (CCOHS 2001).
Sensitisation	No data available. However, based on the structure and physico-chemical properties, the three forms of crystalline silica or the calcined diatomaceous silica are not expected to cause skin sensitisation.
Health Effects Summary	The substances are not skin or eye irritants but acute inhalation of dust may cause discomfort and stress as well as signs of local irritation to nasal, bronchiolar and ocular mucous membranes. Based on the evaluation of the epidemiological data it is concluded that inhalation exposure to crystalline silica results in lung cancer. This conclusion is also supported by animal studies in which inhalation and intratracheal exposure to crystalline silica resulted in lung tumours. The most common types of lung tumour observed in rats were lung adenocarcinomas.
Key Study/Critical Effect for Screening Criteria	Not applicable.

Ecological Toxicity [1,2,3]	
Aquatic Toxicity	Aquatic toxicity studies performed at saturation concentrations of synthetic amorphous silica showed no acute toxicity to fish, Daphnia, or algae, though some physical effects were observed with loading rates of greater than or equal to 10 g/L (OECD 2004). Any harmful effects to aquatic ecosystems are therefore not ecotoxicological in nature. No chronic toxicity data were identified.
Determination of PNEC aquatic	Not applicable.
Current Regulatory Controls [3]	
Australian Hazard Classification	Quartz and cristobalite are listed in the Hazardous Substances Information System (HSIS) (Safe Work Australia 2014a) as hazardous substances. Calcined silica is not listed in the HSIS.
Australian Occupational Exposure Standards	Time Weighted Average (TWA) occupational exposure standard of 0.1 mg/m³ for quartz and cristobalite are recommended in Australia (Safework Australia 2013). A Short-Term Exposure Limit (STEL) is not recommended for any of the compounds.
International Occupational Exposure Standards	TWA for quartz, cristobalite: Canada: 0.025 mg/m³ France: 0.05 mg/m³ Japan: 0.03 mg/m³ Sweden: 0.05 mg/m³ US (ACGIH): 0.025 mg/m³ US (NIOSH): 0.05 mg/m³ US (OSHA): 0.1 mg/m³ US: 0.3, 0.9, 1.5, 500 mg/m³ Temporary Emergency Exposure Limits (TEEL) (Diatomaceous silica, calcined)
Australian Food Standards	No data found.
Australian Drinking Water Guidelines	The Australian Drinking Water Guidelines state: 'To minimise an undesirable scale build up on surfaces, silica (SiO¬2) within drinking water should not exceed 80 mg/L' (National Health and Medical Research Council (NHMRC) 2001).
Aquatic Toxicity Guidelines	No data found.
PBT Assessment [3]	
P/vP Criteria fulfilled?	No. Not applicable, inorganic substance, ubiquitous in environment.
B/vB criteria fulfilled?	No. Not applicable, inorganic substance, ubiquitous in environment.
T criteria fulfilled?	No. Long term data not available (acute data >0.1 mg/L).
Overall conclusion	It is not currently possible to categorise the environmental hazards of metals and other inorganic chemicals according to standard persistence, bioaccumulation and toxicity (PBT) hazard criteria. These criteria were developed for organic chemicals and do not take into account the unique properties of inorganic substances and their behaviour in the environment (UNECE 2007; US EPA 2007). Further assessment of the environmental risks from the use of this chemical is not required as identified by DoEE
Revised	April 2018

References

1. HSDB. Hazardous Substances Data Bank. Retrieved 2015, from Toxnet, Toxicology Data Network, National Library of Medicine: http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB
2. OECD-SIDS Initial Targeted Assessment Profile on Quartz and Cristobalite, SIAM 32, 19-21 April 2011.
3. Department of the Environment and Energy 2017 , National assessment of chemicals associated with coal seam gas extraction in Australia, prepared by the National Industrial Chemicals Notification and Assessment Scheme

Toxicity Summary - 2,2`,2"- Nitrilotriethanol

Chemical and Physical Properties [1,2, 3,6]	
CAS number	[redacted]
Molecular formula	C6H15NO3
Molecular weight	149.19 g/mol
Solubility in water	Miscible with water.
pH	10.5
Melting point	17-21.6 °C
Boiling point	153 °C at 0.1007 kPa 192.87 °C at 0.7996 kPa 236.69 °C at 5.01 kPa 320 °C at 101 kPa
Vapour pressure	3.59×10^{-6} mm Hg at 25 °C
Henrys law constant	7.05×10^{-13} atm-cu m/mole at 25 °C
Explosive potential	No data found.
Flammability potential	Combustible, when exposed to heat or flame. Gives off irritating or toxic fumes (or gases) in a fire.
Colour/Form	Pale yellow to colourless viscous liquid with a slight ammonia odour.
Overview	Triethanolamine is a member of the ethanolamines family that combines the properties of amines and alcohols. Triethanolamine is typically supplied as a pale colourless to yellow liquid with an ammonia-like odor. Triethanolamine is primarily used in detergents, personal-care products, and textile finishing. Triethanolamine may also be used as in other applications including adhesives, agricultural products, concrete additives, gas treating processes, rubber, surfactants, photographic chemicals, and urethane foams. Contact with triethanolamine may cause slight to severe eye irritation. Brief contact is essentially nonirritating to the skin, but repeated exposure may cause irritation and burns. Skin contact may cause an allergic skin reaction. At room temperature, exposure to vapour is minimal due to low volatility; single exposure is not likely to be hazardous. This product has very low toxicity if swallowed. Harmful effects are not anticipated from swallowing small amounts, but swallowing larger amounts may cause injury. This product has been toxic to the fetus in laboratory animals at doses toxic to the mother. Findings from a study by the National Toxicology Program suggest an increased incidence of liver tumors in mice, but their relevant to humans is not clear. Triethanolamine is water soluable and biodegradable according to the OECD 301A test for biodegradation. It is not expected to bioaccumulate or persist in the environment. Triethanolimine is practically non-toxic to aquatic organisms on an acute basis. However large releases may increase the pH of aquatic systems to levels that may be toxic to aquatic organisms.

Environmental Fate [1,3,4,6]	
Soil/Water/Air	If released to soil, triethanolamine is expected to have very high mobility based upon an estimated Koc of 7. However, the pKa of triethanolamine is 7.8, indicating that this compound will primarily exist in cation form; and cations generally adsorb to organic carbon and clay more strongly than their neutral counterparts. Volatilization from moist soil surfaces is not expected to be an important fate process based upon an estimated Henry's Law constant of 7.1X10-13 atm-cu m/mole. If released into water, triethanolamine is not expected to adsorb to suspended solids and sediment based upon the estimated Koc. Triethanolamine biodegraded in a biochemical oxygen demand (BOD) test at an initial concn 50 ppm. After 10 days, the ThOD (theoretical oxygen demand) was 70% using acclimated water as seed and sewage as inoculum. Volatilization from water surfaces is not expected to be an important fate process based upon this compound's estimated Henry's Law constant. An estimated BCF of 3 suggests the potential for bioconcentration in aquatic organisms is low. Hydrolysis is not expected to be an important environmental fate process since this compound lacks functional groups that hydrolyze under environmental conditions

Human Health Toxicity Summary [1,2,3,4,5,6]	
Chronic Repeated Dose Toxicity	Fischer 344 rats and B6C3F1 mice were administered 0, 500, 1000, 2000, 4000 or 8000 mg/100 mL triethanolamine in drinking water (NTP 1990). Water consumption was reduced at the top two doses. No other details were provided. In a 91-day study conducted in accordance with OECD TG 408, Cox CD rats were administered 88.5% triethanolamine in the diet at doses of 0, 250, 500 or 1000 mg/kg bw/day (REACH 2013). There were no significant dose-dependent changes in bodyweight, organ weight, histopathology, pathology and haematology. No Lowest Observed Adverse Effect Level (LOAEL) or No Observed Adverse Effect Level (NOAEL) can be established for this study. In a 90-day study, rats (strain not specified) were administered doses of 5 to 2610 mg/kg bw/day triethanolamine in the diet (Smyth et al. 1951). The study reported microscopic lesions and mortality at doses of 730 mg/kg bw/day and above. The authors indicated the NOAEL as 80 mg/kg bw/day. No other details were provided. In 60- and 120-day studies in rats (strain not specified) given 200 to 1800 mg/kg bw/day triethanolamine, effects observed included liver changes at all treatment doses after 60 and 120 days administration, kidney changes at 400 mg/kg bw/day after 60 and 120 days administration, and kidney damage at >800 mg/kg bw/day after 60 and 120 days administration (Kindsvatter 1940). The specific changes in the liver and kidney were not described. No other details were provided. The LOAEL for this study was 200 mg/kg bw/day. Repeated dermal dose toxicity with triethanolamine application was consistently associated with inflammation at the treatment site. Systemic effects included changes in bodyweight and organ to bodyweight ratios. The critical study for determining the effects of repeated dermal exposures to the chemical is the 90-day study cited in REACH (2013) conducted similarly to OECD TG 411. The NOAELs for this study are 125 mg/kg bw/day for males and 250 mg/kg bw/day for females. In an inhalation study, Fischer 344 rats were exposed to 0, 125, 250, 500, 1000 or 2000 mg/m3 triethanolamine for 16 days (NTP 1985b). The effects observed included decreased bodyweight at 2000 mg/m3 for both sexes, increased liver weight in males at 2000 mg/m3, increased kidney weight in males at concentrations ≥500 mg/m3, and increased kidney weight in females at concentrations ≥250 mg/m3. Minimal to slight acute inflammation of the larynx was reportedbut the doses for which this effect was seen were not specified. The LOAECs are 500 mg/m3 in males and 250 mg/m3 in females. The NOAECs are 250 and 125 mg/m3 in males and females, respectively. Wistar rats were exposed through the head and nose to 0, 0.02, 0.1 or 0.5 mg/L aerosolised triethanolamine in a 28-day study conducted in accordance with OECD TG 412 (Gamer et al., 2008). There were no treatment-related effects seen on bodyweight, haematology, clinical chemistry and neurobehavioural parameters. Local effects, such as minimal to moderate focal inflammation in the submucosa of the larynx region, were reported at all treatment concentrations. The LOAEC and NOAEC for systemic effects cannot be established. The LOAEC for local effects is 0.02 mg/L. B6C3F1 mice exposed to 0, 125, 250, 500, 1000 or 2000 mg/m3 triethanolamine for 14 days showed minimal acute inflammation of the laryngeal submucosa (NTP 1985a). The doses for which this effect was seen were not specified.
Carcinogenicity	The International Agency for Research on Cancer (IARC) has classified the chemical as 'not classifiable as to its carcinogenicity to humans' (Group 3), based on inadequate evidence for carcinogenicity in humans and experimental animals (IARC, 2000). There was no evidence of carcinogenicity by oral (up to 1000 mg/kg/day for 104 weeks, and up to 3334 mg/kg/day for 82 weeks amongst rats and mice respectively) or dermal routes (dose unknown) in studies of 14-18 months duration using rats and mice. No inhalation data were available.

Mutagenicity/ Genotoxicity	Triethanolamine was not genotoxic in a number of in vitro studies (bacterial reverse mutation, mammalian cell cytogenetics, and unscheduled DNA synthesis). On the basis of the negative results observed in a range of in vitro studies, in vivo genotoxicity is not anticipated.
Reproductive Toxicity Developmental Toxicity/Teratogenicity	Triethanolamine is not considered to be toxic to fertility and not considered to be a developmental toxicant. There were no effects observed in the reproductive organs of the animals treated with the chemical from repeated oral, dermal and inhalation toxicity studies. In a reproduction/developmental toxicity screening test conducted in accordance with OECD TG 421, Wistar rats were administered 0, 100, 300 or 1000 mg/kg bw/day triethanolamine by gavage (REACH 2013). The animals were treated during pre-mating (two weeks for both sexes), mating (maximum of two weeks for both sexes), post-mating (one week in males), and the entire gestation period and four days of lactation in females. There were no parental systemic effects reported in all of the treated animals. Most of the animals treated at the top dose showed transient salivation, which could be attributed to the unpalatability of the chemical or local irritation of the upper digestive tract. There were no effects on fertility observed in any of the treated animals. The parental LOAEL and NOAEL for local effects are 1000 and 300 mg/kg bw/day, respectively. The developmental LOAEL and NOAEL are 1000 and 300 mg/kg bw/day, respectively. The LOAEL and NOAEL for fertility cannot be established. A dye formulation containing 0.15, 1.5 or 2% triethanolamine was applied to the shaved skin of CD-1 rats (Burnett et al. 1976). The application occurred seven times during the gestation period. There were no systemic or local effects observed. No developmental effects were reported.
Acute Toxicity	The chemical was of low acute toxicity in animal tests following oral exposure. The median lethal dose (LD50) in experimental rats studies ranged from is 4190–11300 mg/kg bw triethanolamine. Two studies in mice (strain not specified), two studies in rabbits (strain not specified), and three studies in guinea pigs (strain not specified) reported acute oral LD50s of 5400 to 7800, 2200 to 5200, and 2200 to 8000 mg/kg bw, respectively.Observed sub-lethal effects included agitation, elevated respiration and reduced grooming (NIWL, 2003; CIR, 2011). The chemical was of low acute toxicity in animal tests following dermal exposure. The median lethal dose (LD50) in rabbits is greater than 2000 mg/kg bw. Observed sublethal effects included mild erythema 24 hours after exposure, resolving after 6 –10 days (REACH; CIR, 2011). Due to the low vapour pressure of the chemical, the highest attainable vapour concentration is 1.8 mg/m^3. In a study conducted in rats (strain not specified) exposed to the chemical (1.8 mg/m^3), no deaths were reported. One out of 12 rats exposed showed signs of chronic bronchitis (REACH).

Irritation	Based on the available data, the chemical is considered a respiratory and eye irritant. In two studies conducted similarly to OECD TG 405 the average Draize scores for corneal opacity, redness of the conjunctivae and chemosis were 1, 2 and 1.75 respectively (REACH). In one study, the corneal opacity in one animal had not fully resolved by day eight of the observation period. However, based on the results seen in the other animals, it is expected that the corneal opacity would fully resolve had the observation period continued for 21 days. The chemical was not irritating to skin in studies that were performed in accordance with OECD Test Guideline (TG) 404 (REACH). In one study, three Vienna White Rabbits were dermally exposed to the chemical (85 % concentration of triethanolamine and 15 % diethanolamine) through a occlusive patch for four hours. Neither oedema nor erythema was observed throughout the observation period (REACH). In animal studies with repeated exposures, the chemical was applied to rabbit ears over 10 open applications, with 10 unoccluded applications to abdominal intact skin, or with three semi-occluded 24-hour applications to abraded skin. These exposures resulted in slight to moderate irritation (CIR, 2013). In a two-year repeated dose dermal study, the chemical caused lesions consisting of acanthosis (thickened skin), ulceration and chronic active inflammation at the application site. In the repeated dose inhalation studies, minimal to slight acute inflammation of the larynx was observed in rats and mice (NTP 1985a, 1985b). In a more recent 28-day inhalation study, minimal to moderate focal inflammation in the submucosa of the larynx was observed in rats (Gamer et al. 2008).
Sensitisation	Triethanolamine is not a skin sensitizer in animals. The negative results observed for the chemical in several guinea pig maximisation tests and one local lymph node assay support a conclusion that the chemical is not a skin sensitiser (REACH; CIR, 2013).
Health Effects Summary	Triethanolamine has low acute oral and dermal toxicity but may cause eye and respiratory irritation. Triethanolamine was non-irritating to the skin in rabbit studies, whilst studies in humans indicate that the chemical can cause skin irritation. The chemical is not a skin sensitiser. The chemical is neither genotoxic, carcinogenic nor a reproductive toxicant.
Key Study/Critical Effect for Screening Criteria	The most appropriate NOAELs for risk assessment, determined from the 90-day repeat dermal dose toxicity study cited in REACH (2013) are 125 (males) and 250 (females) mg/kg bw/day based on systemic effects. Uncertainty factors: 10 (interspecies variability); 10 (intraspecies variability); 10 (subchronic to chronic) Oral RfD = 125/1000 = 0.125 mg/kg/day Drinking water guideline value = 0.49 ppm

Ecological Toxicity [1,3, 4,6]	
Aquatic Toxicity	Triethanolamine is of low acute toxicity to fish and aquatic invertebrates. The most sensitive fish species tested was the fathead minnow Pimephales promelas for which a 96h-LC50 of 11,800 mg/l was determined. Triethanolamine was slightly more toxic to Daphnia, which had a 24h-EC50 of 1,390 mg/l. In a 21 day reproduction test with Daphnia magna, a NOEC of 16 mg/l and an EC50 of 2,038 mg/l were determined in a semi-static test (concentrations measured twice during the test). Triethanolamine appears to be more toxic to algal species. Toxicity tests have been carried out at both constant pH and allowing the pH to increase with increasing triethanolamine concentration. In two cases triethanolamine appears to be more toxic when the test is carried out allowing the pH to increase. In one case, using the green algae Scenedesmus quadricauda, the 7-8 day toxicity threshold (defined as the concentration which just caused an effect of cell multiplication of around 3% compared with controls - can be considered as a NOEC) for triethanolamine was found to be much lower at constant pH (toxicity threshold = 1.8 mg/l) than when the pH was allowed to vary (toxicity threshold = 715 mg/l). The EC50 was reported as 910 mg/l for Scenedesmus subspicatus (algae) for 96 hour exposure under test conditions where the test media was neutralised.
Determination of PNEC aquatic	PNECaquatic: On the basis that the data consists of short-term and long-term results from three trophic levels, an assessment factor of 10 has been applied to the lowest reported NOEC of1.8 mg/L for Scenedesmus quadricauda mg/L for invertebrates. The PNECaquatic is 0.18 mg/L.
Current Regulatory Controls[2]	
Australian Hazard Classification	Triethanolamine is listed on the Hazardous Substances Information System (HSIS) (Safe Work Australia 2013) with a recommended Exposure Standard.
Australian Occupational Exposure Standards	Time Weighted Average (TWA) of 5 mg/m^3 (Safe Work Australia 2013).
International Occupational Exposure Standards	TWA: 5 mg/m^3 [Belgium, Finland, Iceland, New Zealand, Peru] 0.5 mg/m^3 [Denmark].
Australian Food Standards	Triethanolamine is listed as a permitted processing aid in bleaching agents, washing and peeling agents, water used as an ingredient in other foods, and miscellaneous functions under the conditions of Good Manufacturing Practice (GMP) (Food Standards Australia New Zealand 2013).
Australian Drinking Water Guidelines	No data found
Aquatic Toxicity Guidelines	No data found
PBT Assessment [1,3,4,6]	
P/vP Criteria fulfilled?	There are conflicting findings from standard ready biodegradability tests regarding the rate of biodegradation of triethanolamine. Some studies indicate relative rapid biodegradation, whereas some closed bottle studies indicate slow biodegradation under the test conditions (OECD 1995). However, the chemical is inherently biodegradable. The results of a test using OECD test guideline 302B showed that 89% of the chemical is degraded after 14 days (OECD 1995). Thus, Triethanolamine is categorised as Persistent.
B/vB criteria fulfilled?	Based on the measured log Kow of -1.0 and a measured BCF of <3.9 L/kg in fish, triethanolamine has low bioaccummulation potential and is considered not bioaccumulative.
T criteria fulfilled?	The acute aquatic toxicity of triethanolamine is > 0.01 mg/L. Hence the substance does not fulfill the screening criteria for toxic (T)
Overall conclusion	Not a PBT substance (based on screening data). Further assessment of the environmental risks from the use of this chemical is not required as identified by DoEE.

Ecological Toxicity [1,3, 4,6]	
Aquatic Toxicity	Triethanolamine is of low acute toxicity to fish and aquatic invertebrates. The most sensitive fish species tested was the fathead minnow Pimephales promelas for which a 96h-LC50 of 11,800 mg/l was determined. Triethanolamine was slightly more toxic to Daphnia, which had a 24h-EC50 of 1,390 mg/l. In a 21 day reproduction test with Daphnia magna, a NOEC of 16 mg/l and an EC50 of 2,038 mg/l were determined in a semi-static test (concentrations measured twice during the test). Triethanolamine appears to be more toxic to algal species. Toxicity tests have been carried out at both constant pH and allowing the pH to increase with increasing triethanolamine concentration. In two cases triethanolamine appears to be more toxic when the test is carried out allowing the pH to increase. In one case, using the green algae Scenedesmus quadricauda, the 7-8 day toxicity threshold (defined as the concentration which just caused an effect of cell multiplication of around 3% compared with controls - can be considered as a NOEC) for triethanolamine was found to be much lower at constant pH (toxicity threshold = 1.8 mg/l) than when the pH was allowed to vary (toxicity threshold = 715 mg/l). The EC50 was reported as 910 mg/l for Scenedesmus subspicatus (algae) for 96 hour exposure under test conditions where the test media was neutralised.
Determination of PNEC aquatic	PNECaquatic: On the basis that the data consists of short-term and long-term results from three trophic levels, an assessment factor of 10 has been applied to the lowest reported NOEC of1.8 mg/L for Scenedesmus quadricauda mg/L for invertebrates. The PNECaquatic is 0.18 mg/L.
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Australian Hazard Classification	Triethanolamine is listed on the Hazardous Substances Information System (HSIS) (Safe Work Australia 2013) with a recommended Exposure Standard.
Australian Occupational Exposure Standards	Time Weighted Average (TWA) of 5 mg/m^3 (Safe Work Australia 2013).
International Occupational Exposure Standards	TWA: 5 mg/m^3 [Belgium, Finland, Iceland, New Zealand, Peru] 0.5 mg/m^3 [Denmark].
Australian Food Standards	Triethanolamine is listed as a permitted processing aid in bleaching agents, washing and peeling agents, water used as an ingredient in other foods, and miscellaneous functions under the conditions of Good Manufacturing Practice (GMP) (Food Standards Australia New Zealand 2013).
Australian Drinking Water Guidelines	No data found
Aquatic Toxicity Guidelines	No data found
PBT Assessment [1,3,4,6]	
Revised	April 2018

References

1. HSDB (n.d.). *Hazardous Substances Data Bank*. Retrieved 2016, from Toxnet, Toxicology Data Network, National Library of Medicine: http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB
2. National Industrial Chemicals Notification and Assessment Scheme (NICNAS), 2014. Inventory Multi-Tiered Assessment and Prioitisation (IMAP), Human Health Tier II Assessment for Ethanol, 2,2',2''- nitrilotris-, CAS Number [redacted]
3. OECD (1995) SIDS Initial Assessment Report for Triethanolamine, CAS Number [redacted]
4. DOW Product Safety Assessment Triethanolamine, 2014
5. International Agency for Research on Cancer (IARC) – Summaries & Evaluations, Triethanolamine, 2000

6. Department of the Environment and Energy 2017 , National assessment of chemicals associated with coal seam gas extraction in Australia, prepared by the National Industrial Chemicals Notification and Assessment Scheme

Toxicity Summary - Non Crystalline Silica

Chemical and Physical Properties [1]	
CAS number	[redacted]
Molecular formula	SiO_2
Molecular weight	60.1 g/mol
Solubility in water	Insoluble
Melting point	1710 °C
Boiling point	2230 °C
Vapour pressure	NA
Henrys law constant	NA
Explosive potential	NA
Flammability potential	NA
Colour/Form	Amorphous powder
Overview	Non crystalline silica (silica gel/amorphous silica) is silicon dioxide, an inorganic compound which is ubiquitous in the environment. Amorphous silica is incorporated in a variety of food products as anti-caking agent and as an excipient in pharmaceuticals.
Environmental Fate [2,3]	
Soil/Water/Air	Silicon oxides are the most abundant compounds in the earth's crust mass. Synthetic amorphous silica and silicates are released into the environment are expected to be distributed mainly into soils and sediments, weakly into water and probably not at all in the air due to their physico-chemical properties, particularly low water solubility and very low vapour pressure. Synthetic amorphous silica and silicates released into the environment are expected to combine indistinguishably with the soil or sediment due to their similarity with inorganic soil/sediment matter and will be subjected to natural processes under environmental conditions (cation exchange, dissolution, sedimentation). Biodegradation is not applicable to these inorganic substances. The bioavailable form of synthetic amorphous silica and silicates is the dissolved form which exists exclusively as monosilicic [Si(OH)4] acid under environmental pH. In analogy to the general chemical reaction of weak acids and salts of weak acids with water, the water-soluble fraction of silica acts as a weak acid and, therefore, will tend to lower the pH value, while that of a silicate acts as a base tending to bind protons and, thus, raise the pH value by forming hydroxyl ions. But pH shifts which are measurable at high loadings under laboratory conditions are not expected to occur from the anthropogenic deposition in the aquatic environment of synthetic amorphous silicas due to low aquatic releases and sufficient natural buffer capacities. Finally, these materials are supposed to combine indistinguishably with the soil layer or sediment due to their chemical similarity with inorganic soil matter. Dissolved silica can be actively assimilated by some marine and terrestrial organisms as normal natural processes mainly related to structural function.
Human Health Toxicity Summary [4]	
Chronic Repeated Dose Toxicity	Inhalation: Based on the available data in animals and humans, the chemicals are considered to have repeated dose inhalation toxicity, warranting hazard classification. The reported lowest observed adverse effect concentration

	(LOAEC) for adverse pulmonary effects in various rat and mice studies ranged between 1–5 mg/m^3 (US EPA, 1996). Non-neoplastic adverse effects specific to the lungs of rodents included granulomatous lesions in the walls of the large bronchi, pulmonary fibrosis, hyperplasia of the alveolar compartment and increases in lung collagen content. Dermal (in humans): Long-term (3–34 years) occupational dermal exposure to silica dusts are reported to be associated with connective tissue diseases with a potential to produce progressive systemic scleroderma. While there is debate about a true cause and effect relationship, there is evidence to show a link between scleroderma and lung silicosis in occupational settings (Thomas et al., 2000). Inhalation (in humans): In humans, inhaled particles of crystalline silica can be transported to other parts of the body through the lymphatic system (US EPA, 1996; Thomas et al., 2000). Two forms of silicosis—accelerated (develops 5–10 years after initial exposure) and chronic (develops 10 years after initial exposure)—have been reported after repeated occupational exposure to crystalline silica dust, mainly that from quartz (US EPA, 1996; WHO, 2000). In a study of 67 gold mine workers in Canada, there was a significant linear relationship between lung quartz concentration and the severity of silicosis. While there were other particles detected in the lung tissue, quartz was the only significant indicator of silicosis severity (WHO, 2000).
Carcinogenicity	The International Agency for Research on Cancer (IARC) has classified the chemical as 'Carcinogenic to humans' (Group 1), based on sufficient evidence for carcinogenicity in humans and experimental animals.
Mutagenicity/ Genotoxicity	In vitro studies with chemicals in this group gave both positive and negative results. The majority of positive genotoxicity assay results can be explained by the generation of reactive oxygen species (OECD, 2011) resulting in DNA damage. Since DNA damage is secondary to crystalline silica-induced oxidative damage, a direct genotoxic effect is not expected. Based on this information, it is not expected that chemicals in this group directly induce heritable mutations in human germ cells. Therefore, the available data do not warrant hazard classification.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	An early limited one-generation study on rats gave no evidence of adverse effects on reproduction performance at 500 mg/kg/day, the highest dose tested (NOAEL). But the reliability is poor due to the small group size of animals. SAS was examined for embryotoxic and developmental effects during the gestation phase in various animals' species, rat, mouse, rabbit and hamster, at oral doses up to 1,600 mg/kg/day. There were no significant signs of maternal or embryotoxic/developmental toxic effects in any species tested. The number of abnormalities seen in either soft or skeletal tissues of the test groups did not differ from the frequencies occurring spontaneously in the control animals.
Acute Toxicity	No guideline studies have been conducted to assess the acute inhalation exposure to crystalline silica. Studies conducted using a single intratracheal instillation of crystalline silica in rodents have shown significant lung pathology such as the formation of silicotic nodules and lung fibrosis (WHO, 2000). However, these studies are not directly relevant for human exposure. A single intratracheal instillation of quartz (50 mg, particle size <5 mm in diameter) in male rats (strain unspecified) resulted in a three-fold increase in water, protein and phospholipid content in lungs within 28 days of administration (WHO, 2000). In another study, 12 mg of quartz (particle size <5 mm in diameter) was administered to male and female rats (strain unspecified) using a single intratracheal instillation. Discrete silicotic granulomas in the lungs of both sexes were observed 21–30 days after instillation (WHO, 2000).
Irritation	Synthetic amorphous silicas are not irritating to the skin of rabbits exposed to 0.19 g (one case) or 0.5 g of dry or moistened test item under occlusive conditions for 4 or 24 hours. All products tested as a powder (0.1 g) have shown no or only

	weak and transient irritating effects on the conjunctivae of the eyes of rabbits with the iris and cornea not affected at all.
Sensitisation	No experimental data are available on the synthetic amorphous silicas. Medical surveillance records on workers gave no evidence of skin sensitization over decades of practical experience.
Health Effects Summary	The critical health effects for risk characterisation include local long-term effects (carcinogenicity) and harmful effects following repeated exposure through inhalation (silicosis). According to NICNAS, A Tier III assessment might be necessary to provide further information whether the current exposure controls are appropriate to offer adequate protection to workers. All other risks are considered to have been sufficiently assessed at the Tier II level, subject to implementing any risk management recommendations, and provided that all requirements are met under workplace health and safety and poisons legislation as adopted by the relevant state or territory.
Key Study/Critical Effect for Screening Criteria	The lowest NOAEL from the two-year dietary study was 2,500 mg/kg/day for rats. Uncertainty factors: 10 (interspecies variability); 10 (intraspecies variability)
Ecological Toxicity [2,3]	
Aquatic Toxicity	Studies on fish, Daphnia and algae using excess loadings of SAS or NAS showed no acute toxicity, although physical effects on Daphnia were observed in tests using unfiltered test medium. Test results, based on loading rates, are as follows: 96hr-LL0 *(Brachydanio rerio)* is 10,000 mg/L for SAS and NAS; 24hr-EL50 *(Daphnia magna)* >10,000 mg/L for SAS; 72hr-NOEL *(Scenedesmus subspicatus)* is 10,000 mg/L for NAS. There are no chronic aquatic toxicity data, but due to the known inherent physico-chemical properties, absence of acute toxic effects as well as the ubiquitous presence of silica/silicates in the environment, there is no evidence of harmful long-term effects arising from exposure to synthetic amorphous silica/silicates.
Determination of PNEC aquatic	Not applicable
Current Regulatory Controls [4,5]	
Australian Hazard Classification	Not specifically listed on the HSIS (Safe Work Australia)
Australian Occupational Exposure Standards	Silica (CAS No. [redacted]) is listed as 'Fumed silica (respirable dust)' with an exposure standard of 2 mg/m3 TWA – although the CAS No. used for this entry is the same as the crystalline form, it refers to the amorphous form of the chemical.
International Occupational Exposure Standards	No data available
Australian Food Standards	Silica is regarded as GRAS (generally recognised as safe) for food use (FDA, 2013)
Australian Drinking Water Guidelines	To minimise an undesirable scale build up on surfaces, silica (SiO2) within drinking waters should not exceed 80 mg/L.
Aquatic Toxicity Guidelines	No data available
PBT Assessment	
P/vP Criteria fulfilled?	No. Not applicable, inorganic substance, ubiquitous in environment.
B/vB criteria fulfilled?	No. Not applicable, inorganic substance, ubiquitous in environment.
T criteria fulfilled?	No. Chronic toxicity data not available. Acute data >0.1 mg/L in fish, invertebrates and algae, hence does not meet the screening criteria for toxicity.
Overall conclusion	Not PBT

Revised	December 2018

References

1. HSDB. Hazardous Substances Data Bank. Retrieved 2015, from Toxnet, Toxicology Data Network, National Library of Medicine: http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB
2. IUCLID (2004) IUCLID Data Set for Synthetic Amorphous Silica and Silicates: Silicon Dioxide (CAS No. [redacted]; Silicic Acid, Aluminum Sodium Salt (CAS No. [redacted]); Silicic Acid, Calcium Salt (CAS No. [redacted]), UNEP Publications.
3. OECD-SIDS (2004) Screening Information Dataset (SIDS) Initial Assessment Report for Synthetic Amorphous Silica and Silicates: Silicon Dioxide (CAS No. [redacted]; Silicic Acid, Aluminum Sodium Salt (CAS No. [redacted]); Silicic Acid, Calcium Salt (CAS No. [redacted]), UNEP Publications.
4. National Industrial Chemicals Notification and Assessment Scheme (NICNAS). Crystalline silica: Human health tier II assessment, Retrieved 2018: https://www.nicnas.gov.au
5. NHMRC, 2011. Australian Drinking Water Guidelines 6. Volume 1. National Water Quality Management Strategy. National Health and Medical Research Council.

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Toxicity Summary - Sodium chloride

Chemical and Physical Properties [1,4]	
CAS number	[redacted]
Molecular formula	NaCl
Molecular weight	58.44 g/mol
Solubility in water	3.57 x 10 5 g/m3 at 25oC
pH	In aqueous solution is neutral
Melting point	1 mm Hg at 865oC
Boiling point	1670 ^{o}C
Vapour pressure	No data found
Henrys law constant	No data found
Explosive potential	Not explosive
Flammability potential	Not flammable
Colour/Form	light brown liquid or colourless crystals
Overview	Sodium, together with potassium is an essential mineral for the regulation of body fluid balance. Sodium is the most abundant cation in the extracellular fluid and sodium salts account for more than 90% of the osmotically active solute in the plasma and interstitial fluid. Consequently, sodium load is the major determinant of extracellular volume. Chloride is also important in maintaining the fluid balance and is an essential component of the gastric and intestinal secretions Sodium chloride occurs naturally as rock salt which comprises 95% to 99% NaCl. It is also widely used in food products. The NHMRC has established dietary guidelines for the intake of sodium per day (adults should consume less than 2300 mg sodium per day). This chemical has been identified by NICNAS to be of low concern to human health based on an initial screening approach and thus required no further assessment.
Environmental Fate [2,3]	
Soil/Water/Air	Due to its high solubility, sodium chloride is highly mobile in the environment. Once dissociated, chloride ions will migrate readily, however sodium ions will sorb to clay-rich materials limiting mobility. If released into the environment, sodium chloride is not likely to sorb to solid particles in the water column, is readily dissociated to form chloride and sodium ions, is not bioaccumulative in aquatic species or the food chain.

Human Health Toxicity Summary [2,3]	
Chronic Repeated Dose Toxicity	High sodium chloride intakes increase calcium excretion and may increase the risk of kidney stone formation. There is evidence for a causal relationship between the consumption of sodium (mainly from common salt) and both blood pressure and the age-related rise in blood pressure. Data suggest that30% of a normotensive population may be salt sensitive. Sodium chloride has been demonstrated to be a gastric tumour promoter in experimental animals and high sodium chloride intakes have been associated with incidence of stomach cancer in human populations with traditional diets of highly concentrated, salted foods.
Carcinogenicity	Not listed with IARC.
Mutagenicity/ Genotoxicity	No data available.
Reproductive Toxicity Developmental Toxicity/Teratogenicity	No data available.
Acute Toxicity	No data available.
Irritation	Although rare, acute toxicity may be caused by ingestion of 500 – 1000 mg sodium chloride/kg body weight. Symptoms include vomiting, ulceration of the gastrointestinal tract, muscle weakness and renal damage, leading to dehydration, metabolic acidosis and severe peripheral and central neural effects.
Sensitisation	No data available.
Health Effects Summary	Sodium is an essential mineral for the regulation of body fluid balance. This chemical has been identified by NICNAS to be of low concern to human health.
Key Study/Critical Effect for Screening Criteria	The Australian drinking water guideline value for sodium and chloride may apply.
Ecological Toxicity [2,3,4]	
Aquatic Toxicity	A large number of studies are available in relation to the aquatic toxicity of sodium chloride with the USEPA ECOTOX database identifying 1712 records. The evaluation of ecological effects of sodium chloride has been evaluated in detail for the assessment of the use of rock salt in the US on roadways during the winter months. The following has been summarised from the US review: The presence of sodium chloride may result in the increased mobilisation of other contaminants (metals, nutrients etc) and a shift in the acid buffering capacity may compromise aquatic ecosystems. Most sensitive species are birds where a safe concentration of 1000 mg/L sodium chloride can be established. Salt tolerance of aquatic species varies significantly with EC50 concentrations ranging from 400 to 30000 mg/L. The measured acute endpoint for Fish was reported at 1290 mg/L. The measured NOEC for Daphnia is 314 mg/L.
Determination of PNEC aquatic	PNECaquatic: On the basis of the chronic results for Daphnia, an assessment factor of 100 has been applied to the lowest reported effect concentration of 314 mg/L. The PNECaquatic is determined to be 3.14 mg/L.
Current Regulatory Controls	
Australian Hazard Classification	No data available
Australian Occupational Exposure Standards	No data available
International Occupational Exposure Standards	No data available
Australian Food Standards	No data available

Australian Drinking Water Guidelines	No data available
Aquatic Toxicity Guidelines	No data available
PBT Assessment [4]	
P/vP Criteria fulfilled?	Sodium chloride is an organic salt that dissociates completely to sodium and chloride ions in aqueous solutions. Biodegradation is not applicable to these inorganic ions; both sodium and chloride ions are also ubiquitous and are present in most water, soil and sediment. The persistent criteria is not considered applicable to this inorganic salt.
B/vB criteria fulfilled?	Sodium and chloride ions are essential to all living organisms and their intracellular and extracellular concentrations are actively regulated. Thus, sodium chloride is not expected to bioaccumulate.
T criteria fulfilled?	The measured chronic toxicity data for sodium chloride was 314 mg/L for Daphnia Thus, sodium chloride does not meet the screening criteria for toxicity.
Overall conclusion	Not PBT
Revised	April 2018

References

1. HSDB (n.d.). *Hazardous Substances Data Bank*. Retrieved 2015, from Toxnet, Toxicology Data Network, National Library of Medicine: http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB
2. UK 2003. Expert Group on Vitamins and Minerals, Risk Assessment - Sodium Chloride
3. US, 2007. Hazard Identification for Human and Ecological Effects of Sodium Chloride Rock Salt. Prepared by the New Hampshire Department of Environmental Services
4. Department of the Environment and Energy 2017 , National assessment of chemicals associated with coal seam gas extraction in Australia, prepared by the National Industrial Chemicals Notification and Assessment Scheme

Toxicity Summary - Sodium hydroxide

Chemical and Physical Properties	
CAS number	[redacted]
Molecular formula	Na-O-H
Product name	40 g/mol
Molecular weight	1.11E+06 mg/L at 20C
Solubility in water	13
Melting point	318 °C
Boiling point	1388 °C
Vapour pressure	Negligible at 25 deg C
Henrys law constant	No data found.
Explosive potential	No
Flammability potential	No
Colour/Form	Anhydrous (pure) NaOH is a solid – *refer melting point above*. However it is a hygoscopic, ionic solid, and will absorb water from air and is highly soluble
Incompatibility	Avoid contact of solid NaOH with water due to strong exothermic reaction, leather, wood, acids, organic halogen compounds or organic nitro compounds. Carbon monoxide gas can form upon contact with reducing sugars, food and beverage products in enclosed spaces. NAoH is neither explosive, flammable, nor oxidising.
Overview	Vegetable oil refining, regenerating iron exchange resins, organic fusions, peeling of fruits and vegetables in the food industry, etching and electroplating.
Environmental Fate[1]	
Soil/Water/Air	Sodium hydroxide is highly soluble, not volatile and unlikely to materially adsorb to soil and is therefore predominately found in the aquatic environment if released to the environment. NaOH will readily dissociate to be present in the environment as sodium and hydroxyl ions, both being ubiquitous in the environment. NaOH is a strong alkali, so it's dissolution in water may locally raise the pH of the affected environment. The dissolution reaction is also strongly exothermic.

Human Health Toxicity Summary [1,2,,3]	
Chronic Repeated Dose Toxicity	No animal data are available on repeated dose toxicity studies by oral or dermal routes for sodium hydroxide. In a repeat dose inhalation study, twenty seven white rats died within a month, mostly from bronchopneumonia, after being exposed twice weekly to an aerosol of unknown airborne concentration of sodium hydroxide, generated from an aqueous 40% sodium hydroxide solution (NIOSH 1975). When exposed to an aerosol generated from a 20% sodium hydroxide solution, the bronchi were dilated, the epithelial cover was thin and frequently desquamated, and the septa were dilated and cracked. A light round cell infiltration of the sub-mucus membrane tissue was also observed. Few changes occurred in a group of rats exposed to aerosols from 10% sodium hydroxide, but rats exposed to an aerosol of 5% sodium hydroxide had dilation of the bronchi and a slight degeneration of the mucus membrane and thickened strata of lymphadenoid tissue surrounding the bronchi. A NOAEL could not be established in this study. Workers exposed to 0.24 to 1.86 mg/m^3 sodium hydroxide for 2 to 15 minutes reported throat irritation and watery eyes (NIOSH 1975). Based on the observations of the irritant effects on workers exposed to 1 to 40 mg/m^3 sodium hydroxide, it was concluded that 2 mg/m^3 represented a concentration that is 'noticeably but not extensively irritant' (NIOSH 1975). Obstructive airway disease has been reported following chronic occupational exposure to sodium hydroxide mist (IPCS 1996). The patient developed cough, dyspnoea and tachypnoea after a 20-year exposure to sodium hydroxide.
Carcinogenicity	IARC Category 3 - not classifiable as to human carcinogenicity
Mutagenicity/ Genotoxicity	In vitro and vivo genetic toxicity testing reported no evidence of mutagenic activity.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	No valid studies were identified regarding reproduction toxicity after oral, dermal or inhalation exposure to NaOH. Sodium hydroxide is not expected to be systemically available to the body under normal handling and use conditions.
Acute Toxicity	Exposure to the solid or concentrated liquid can cause severe burns to the eyes, skin and gastrointestinal tract which may cause death. An oral LD50 of a 1-10% solution of NaOH in rabbits was 325 mg/kg bw (as 100% NaOH). An oral LD50 of 140 to 340 mg/kg in rats has also been reported (National Research Council 2011), however details of the study are not available. In an acute dermal study, mice were treated dermally with 50% sodium hydroxide, and the treated area was irrigated with water at various intervals (OECD 2002). The mortality of mice was 20, 40, 80 and 71% when they were irrigated at 30 minutes, one hour, two hours or not at all after the application. All animals developed rapidly progressive burns. No mortality or burns were observed when the treated area was irrigated immediately after the application. A 5% aqueous solution of sodium hydroxide produced severe necrosis when applied to the skin of rabbits for four hours (Clayton and Clayton 1993). A dermal LD50 of 1350 mg/kg has been reported in rabbits (National Research Council 2011), however details of the study are not available. Caustic dusts are irritating to the upper respiratory system. Prolonged exposure to high concentrations may cause discomfort and ulceration of nasal passages. Cases of fatality due to ingestion of liquid sodium hydroxide have been reported in humans.
Irritation	Sodium hydroxide is a corrosive irritant to skin, eyes and mucous membranes. A NaOH solution of 8% can be considered corrosive based on animal data. Human data indicate that concentrations of 0.5 to 4% were irritating.
Sensitisation	Sodium hydroxide has no skin sensitisation potential.

Health Effects Summary	An oral LD50 of 325 mg/kg in rats and a dermal LD50 of 1350 mg/kg in rabbits were reported for sodium hydroxide. Lethality has been reported in animals at oral doses of 240 mg/kg bw. Inhalational LC50 is not available. Sodium hydroxide is corrosive to skin, eyes and gastrointestinal and respiratory tracts. Based on human data, concentrations of 0.5 to 4.0% are irritating to the skin, while a concentration of 8.0% is corrosive. Sodium hydroxide is not a skin sensitiser. No animal data were available on repeated dose toxicity by oral or dermal routes for sodium hydroxide. In the single reported repeat dose inhalation study, a NOAEL could not be established. Both in vitro and in vivo genetic toxicity tests indicated no evidence of a mutagenic activity. Information is not available on reproductive and developmental toxicity and carcinogenicity of sodium hydroxide. Due to dissociation into ions which are subject to homeostatic controls in the human body, systemic effects from repeated exposures to sodium hydroxide are not expected. The critical health effect of sodium hydroxide is its corrosive effect.
Key Study/Critical Effect for Screening Criteria	No oral TRV apply. Acute toxicity only (irritant and corrosive), not systemically available in body. The Australian drinking water guideline value for pH may apply to sodium hydroxide.
Ecological Toxicity [1,2,3]	
Aquatic Toxicity	Measured acute endpoints were available for fish (196 mg/L). Measured chronic endpoint were available for Daphnia (240 mg/L)
Determination of PNEC aquatic	An assessment factor of 10 has been applied to the lowest reported NOEC of 240 mg/L for Daphnia. The PNECaquatic is 24 mg/L.
Current Regulatory Controls[4]	
Australian Hazard Classification	C: R35 (Corrosive, causes severe burns)
Australian Occupational Exposure Standards	Sodium hydroxide has an exposure standard of 2 mg/m³, Time Weighted Average (Safe Work Australia 2013).
International Occupational Exposure Standards	Occupational Exposure Limit (OEL) or limit values in working environment of 2 mg/m³ [Argentina, Belgium, Bulgaria, Canada, China, India, Japan and the US (NIOSH 1975)]. Occupational exposure standard: 2 mg/m³ [Korea] Occupational exposure limit values: 0.5 mg/m³ [Latvia] Short Term Exposure Limit (STEL): 2 mg/m³ [UK] US Department of Energy Temporary Emergency Exposure Limits (TEELs) = 0.5 mg/m³ (TEEL-0 and TEEL-1), 5 mg/m³ (TEEL-2) and 50 mg/m³ (TEEL-3).
Australian Food Standards	Processing aids - Generally permitted - permitted for use as acidity regulator (FSANZ 2013). Sodium hydroxide is allotted an International Numbering System (INS) of food additives number: INS 524 (Food Standards Australia New Zealand 2013).
Australian Drinking Water Guidelines	No data found. However, since sodium hydroxide readily dissociates in water into sodium and hydroxyl ions, the Australian Drinking Water Guidelines for sodium state that, based on aesthetic considerations (taste), the concentration of sodium in drinking water should not exceed 180 mg/L (National Health and Medical Research Council (NHMRC) 2011). No health-based guideline value is proposed for sodium.
Aquatic Toxicity Guidelines	No data found.
Occupational Exposure Limits	Peak limitation – 2 mg/m³
PBT Assessment	
P/vP Criteria fulfilled?	Not applicable (inorganic salt, ionic species ubiquitous in environment)

B/vB criteria fulfilled?	Not applicable. Bioaccumulation is not applicable to these inorganic ions; sodium and hydroxide ions are ubiquitous and are present in most water, soil and sediment.
T criteria fulfilled?	Not applicable. Chronic toxicity data >1 mg/L in invertebrates, thus sodium hydroxide does not meet the screening criteria for toxicity.
Overall conclusion	Not PBT

References

1. OECD SIDS Sodium Hydroxide, UNEP Publications, March 2002
2. HSDB (n.d.). *Hazardous Substances Data Bank*. Retrieved March 2015, from Toxnet, Toxicology Data Network, National Library of Medicine: http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB
3. European Commission (EC) Joint Research Centre (JRC) Institute for Health and Consumer Protection - European Chemical Substances Information System (ESIS), Sodium Hydroxide, Summary Risk Assessment Report, 2008
4. Safe Work Australia, Hazardous Substances System, sodium hydroxide

Toxicity Summary - Sodium sulphate

Chemical and Physical Properties[1,3,4,5]	
CAS number	[redacted]
Molecular formula	Na2SO4
Product name	142.04 g/mol
Molecular weight	161 g/l at 20 °C
Solubility in water	No data found.
Melting point	884 °C
Boiling point	Decomposition occurs above 884°C.
Vapour pressure	Solid
Henrys law constant	Expected to be extremely low
Explosive potential	No data found.
Flammability potential	No data found.
Colour/Form	Not combustible. Gives off irritating or toxic fumes/gases in a fire.
Overview	Sodium sulfate is widely distributed in nature; it occurs as mineral salts (e.g. thenardite, mirabilite), it is present in almost all fresh and salt waters and sulfate as such is normally present in almost all natural foodstuffs. Both sodium and sulfate ions are among the most common ions found in all living organisms. In mammals, sulfate is an normal metabolite of sulfur-containing amino-acids, it is normally incorporated in a variety of body compounds and it plays an important role in detoxification/ excretion processes due to sulfoconjugation Sodium sulfate has been produced for many years in high volumes for use in detergents, glass and paper manufacture and a variety of smaller industrial uses National Industrial Chemicals Notification and Assessment Scheme (NICNAS) has performed an IMAP environment Tier 1 summary which concluded that sodium sulphate is an inorganic substance comprising ions of low ecotoxicological concern. This chemical is not expected to pose an unreasonable risk to the environment provided that ANZECC water quality guidelines for physical and chemical stressors are not exceeded.
Environmental Fate[1,4,5]	
Soil/Water/Air	Sodium sulphate is a solid inorganic salt well soluble in water. In water solutions it is fully dissociated to sodium and sulfate ions. In anaerobic environments sulfate is biologically reduced to (hydrogen) sulphide by sulfate reducing bacteria, or incorporated into living organisms as source of sulphur, and thereby included in the sulphur cycle. The BCF of sodium sulfate is very low (0.5) and therefore bioconcentration is not expected. Sodium and sulfate ions are essential to all living organisms and their intracellular and extracellular concentrations are actively regulated. However some plants (e.g. corn and *Kochia Scoparia*), are capable of accumulating sulfate to concentrations that are potentially toxic to ruminants.
Human Health Toxicity Summary [1,2,4,5]	
Chronic Repeated Dose Toxicity	Valid oral repeated dose toxicity studies with 21, 28 and 35 day studies in hens and pigs are available. Toxicity was confined to changes in bodyweight, water and feed intake and diarrhoea. These changes occurred only at very high doses of sodium sulfate. In ruminants, high concentrations of sulfate in food may result in the formation of toxic amounts of sulfites by bacterial reduction the rumen, leading to poly-encephalomalacia. The available data do not allow the derivation of a NOAEL. Based on available consumer data, a daily dose of around 25 mg/kg/day is well tolerated by humans

Carcinogenicity	There is no valid oral carcinogenicity study. Limited data from experimental studies support the notion that a substance that is abundantly present in and essential to the body is unlikely to be carcinogenic.
Mutagenicity/ Genotoxicity	Sodium sulfate has been shown to be without effect in the Ames test using various strains of *S. typhimurium* (TA1535, TA1537, TA100, TA98) both with and without S9 activation in a GLP standardised test Based on the natural intra- and extracellular occurrence of the substance it can be concluded that sodium sulfate is highly unlikely to be mutagenic
Reproductive Toxicity	Limited data of poor validity did not provide an indication of toxicity to reproduction.
Developmental Toxicity/Teratogenicity	No data were found.
Acute Toxicity	The acute toxicity (LD50) of sodium sulfate has not been reliably established but is probably far in excess of 5000 mg/kg. In an inhalation study with an aerosol, no adverse effects were found at 10 mg/m3. Also human data indicate a very low acute toxicity of sodium sulfate. Human clinical experience indicates that very high oral doses of sodium sulfate, 300 mg/kg bw up to 20 grams for an adult, are well tolerated, except from (intentionally) causing severe diarrhoea. WHO/FAO did not set an ADI for sodium sulfate. There is no data on acute dermal toxicity, but this is probably of no concern because of total ionisation in solution.
Irritation	Sodium sulfate is not irritating to the skin and slightly irritating to the eyes. Respiratory irritation has never been reported.
Sensitisation	Sodium sulphate is not a skin or respiratory sensitiser
Key Study/Critical Effect for Screening Criteria	The Australian Drinking Water Guidelines for sodium and sulphate may apply to sodium sulphate.
Ecological Toxicity [3,4,5]	
Aquatic Toxicity	Algae were shown to be the most sensitive to sodium sulfate; EC50 120h = 1,900 mg/l. For invertebrates *(Daphnia magna)* the EC50 48h = 4,580 mg/l and fish appeared to be the least sensitive with a LC50 96h = 7,960 mg/l for *Pimephales promelas*. No data were found for long term toxicity. The acute studies all show a toxicity of sodium sulfate higher than 100 mg/l, no bioaccumulation is expected
Determination of PNEC aquatic	An assessment factor of 1000 has been applied to the lowest reported effect concentration of 1900 mg/L for Daphnia. The PNEC aquatic is 1.9 mg/L.
Current Regulatory Controls	
Australian Hazard Classification	The chemical is not listed in the Hazardous Substance Information System (HSIS) (Safe Work Australia 2013).
Australian Occupational Exposure Standards	No data found
International Occupational Exposure Standards	No data found
Australian Food Standards	No data found
Australian Drinking Water Guidelines	The Australian Drinking Water Guideline for sulphate is 250 mg/L (aesthetic) and sodium is 180 mg/L (aesthetic).
Aquatic Toxicity Guidelines	No data found
PBT Assessment	
P/vP Criteria fulfilled?	Sodium sulphate is an inorganic salt that dissociates completely to sodium and sulphate ions in aqueous solutions. The persistent criterion is not considered applicable to this inorganic salt.

B/vB criteria fulfilled?	The BCF of sodium sulfate is very low (0.5) and therefore bioconcentration is not expected.
T criteria fulfilled?	The acute aquatic toxicity of sodium sulfate is > 0.01 mg/L. Hence the substance does not fulfill the screening criteria for toxic (T)
Overall conclusion	Not a PBT substance (based on screening data).

References

1. HSDB (n.d.). *Hazardous Substances Data Bank*. Retrieved 2017, from Toxnet, Toxicology Data Network, National Library of Medicine: http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB
2. National Health and Medical Research Council, Natural Resources Management Ministerial Council, national Water Quality Management Strategy, Australian Drinking Water Guidelines 6, 2011, Version 3.3 Updated November 2016.
3. National Industrial Chemicals Notification and Assessment Scheme (NICNAS), IMAP Environment Tier I Summary all tranches, 2016.
4. OECD (2005a) Screening Information Dataset (SIDS) Initial Assessment Report for Sodium Sulfate, CAS Number [redacted], UNEP Publications
5. OECD (2005b) SIDS Initial Assessment Profile for Sodium Sulfate, CAS Number[redacted], UNEP Publications

Toxicity Summary - Calcium Carbonate (Limestone)

Chemical and Physical Properties[1,2]	
CAS number	[redacted]
Molecular formula	Not applicable
Molecular weight	Not applicable
Solubility in water	No data available
Melting point	Approximately 900°C (Oates 1998).
Boiling point	No data available
Vapour pressure	No data available
Henrys law constant	No data available
Explosive potential	No data available
Flammability potential	No data available
Colour/Form	Solid
Overview	Limestone is the name given to a type of rock mostly composed of calcium carbonate. It also contains minor impurities of iron, magnesium, quartz, clay, pyrite, phosphate, and organic matter (Pohl 2011). It is used widely in agriculture to increase calcium concentrations and the pH of soils (Upjohn et al. 2005). Limestone is used industrially on a very large scale as an ingredient in concrete production and in metallurgy (Oates 1998; Pohl 2011). In the Australian coal seam gas industry, it is used as a bridging agent in drilling fluid formulations. A Tier 1 Human Health Assessment for these chemicals has been conducted by NICNAS which concluded that these chemicals were identified as low concern to human health by application of expert validated rules.
Environmental Fate[2]	
Soil/Water/Air	Limestone dissolves slowly in water, releasing calcium and carbonate ions as well as other trace elements, such as iron and magnesium (Deer et al. 1992; Clair and Hindar 2005; Pohl 2011). These trace elements are naturally ubiquitous in the environment and are subject to natural biogeochemical processes. Calcium oxide reacts immediately upon exposure to water, forming calcium hydroxide, which itself reacts with carbon dioxide to form calcium carbonate. The final reaction products of both limestone and calcium oxide in the environment are therefore essentially the same, although calcium oxide typically has lower concentrations of magnesium and other inorganic chemicals than limestone and produces a higher initial concentration of hydroxide ions (Upjohn et al. 2005). Calcium and carbonate ions occur naturally in all environmental compartments, and are important nutrients for various organisms. Calcium is mobile in soil (ANZECC and ARMCANZ 2000) and, if released to the environment, should be expected to experience significant partitioning to the water compartment. However, calcium ions may also form insoluble precipitates with anions present in the environment, such as carbonate ions, and settle out of the aqueous phase. Carbonate is an important component of the global carbon cycle (Wetzel 2001).
Human Health Toxicity Summary[3]	
Chronic Repeated Dose Toxicity	No systemic toxicological findings could be detected in rats after repeated administration of uncoated nano calcium carbonate by the oral route for a period of 90 days. The results of this study are read across to bulk calcium carbonate. Several potential adverse effects have been reported following calcium supplementation e.g. effects on kidney function, milk-alkali syndrome, kidney stones and interactions with minerals. However, these effects are more prevalent in those people suffering from renal insufficiency and following the ingestion of high doses of calcium. No systemic toxicity was observed in a 90-day inhalation study where rats were exposed to uncoated calcium carbonate at a maximum concentration of 0.399 mg/L, stated as the NOEC. The local effects observed at this level were limited to

	increased lung weights accompanied by increases in BAL-derived inflammation and cytotoxicity biomarkers, which were reversible in males but were not fully reversible in females within a 4-week recovery period. Hence the NOAEC for local effects was established as 0.212 mg/L and the LOAEC at 0.399 mg/L. The results of this study are read across to bulk calcium carbonate.
Carcinogenicity	Uncoated nano calcium carbonate is not expected to pose a risk of carcinogenicity.
Mutagenicity/ Genotoxicity	Uncoated nano calcium carbonate was negative in the following assays: In vitro gene mutation study in bacteria (OECD TG 471) using Salmonella typhimurium strains TA 98, TA 100, TA 1535 and TA 1537 and Escherichia coli WP2 uvrA with and without metabolic activation (S9). In vitro chromosome aberration study in mammalian cells (OECD TG 473) using human lymphocytes in the presence and absence of metabolic activation. In vitro gene mutation study in mammalian cells (OECD TG 476) using mouse lymphoma L5178Y cells in the presence and absence of metabolic activation. The results of these studies are read across to bulk calcium carbonate.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	Under the conditions of the OECD TG 422 study, uncoated nano calcium carbonate administered to male and female rats up to a dose level of 1000 mg/kg bw/day for a period of up to 48 days is not toxic to reproduction and has no effect on fertility or development. No treatment-related effects were observed for reproduction; hence, a NOEL for reproductive toxicity was considered to be 1000 mg/kg bw/day. The results of this study are read across to bulk calcium carbonate. The prenatal developmental toxicity study also demonstrated that calcium carbonate was neither foetotoxic nor teratogenic at the concentrations used. Since no adverse effects were noted at the highest dose level tested (1.25% Ca in diet), the NOAEL for teratogenic and maternal toxic effects in rats is in excess of 1.25% Ca, equivalent to approximately 1963 - 2188 mg/kg bw/day of calcium carbonate.
Acute Toxicity	Bulk calcium carbonate is not considered to be acutely harmful by the oral, dermal or inhalation routes.
Irritation	Bulk calcium carbonate is not considered to be irritating to the skin or eyes.
Sensitisation	Based on the results of an OECD TG 429 study performed using nano calcium carbonate and read across to bulk calcium carbonate, where the Stimulation Index was < 3, bulk calcium carbonate is considered to be a non-sensitiser
Health Effects Summary	This chemical has been identified by NICNAS to be of low concern to human health.
Key Study/Critical Effect for Screening Criteria	In the repeated dose toxicity study, NOAEC for local effects was established as 0.212 mg/L and the LOAEC at 0.399 mg/L.
Ecological Toxicity[2]	
Aquatic Toxicity	Calcium carbonate has low toxicity to aquatic and terrestrial organisms. Ecotoxicological endpoint values for aquatic organisms generally greatly exceed 100 mg/L (LMC 2014), indicating very low toxicity.
Determination of PNEC aquatic	Experimental results are available for three trophic levels. Acute LC50 values are available for fish, invertebrates, and algae. On the basis that the data consists of short term results from three trophic levels, an assessment factor of 1000 has been applied to the lowest reported effect concentration of 310 mg/L for invertebrates. The PNEC aquatic is 0.3 mg/L.
Current Regulatory Controls	
Australian Hazard Classification	No data available.
Australian Occupational Exposure Standards	No data available.
International Occupational Exposure Standards	No data available.
Australian Food Standards	No data available.

Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	No data available.
PBT Assessment	
P/vP Criteria fulfilled?	Not applicable (inorganic chemical, ionic species ubiquitous in environment)
B/vB criteria fulfilled?	Not applicable. Bioaccumulation is not applicable to these inorganic ions.
T criteria fulfilled?	Not applicable. Expected to have low toxicity to aquatic organisms.
Overall conclusion	Not PBT
Revised	October 2019

References

1. National Industrial Chemicals Notification and Assessment Scheme (NICNAS). IMAP, Human Health Tier 1 Assessment. Retrieved 2019: https://www.nicnas.gov.au
2. Department of the Environment and Energy 2017, National assessment of chemicals associated with coal seam gas extraction in Australia, prepared by the National Industrial Chemicals Notification and Assessment Scheme
3. ECHA REACH, Calcium carbonate, Retrieved 2019: https://echa.europa.eu/

Toxicity Summary - Diethanolamine

Chemical and Physical Properties [1,2,4]	
CAS number	[redacted]
Molecular formula	C4H11NO2
Molecular weight	105.14
Solubility in water	1,000 g/L @ 20 °C
Melting point	27 °C at 101.3 kPa
Boiling point	269.9 °C at 101.325 kPa
Vapour pressure	0.0028 hPa (25 °C)
Henrys law constant	3.97 x 10-6 Pa*m^3/mol
Explosive potential	Non explosive
Flammability potential	Non flammable
Colour/Form	Colourless crystals or a white syrupy liquid with a mild ammonical odour.
Overview	2,2'-Iminodiethanol (diethanolamine, DEA) belongs to the ethanolamines group that includes monoethanolamine (MEA), diethanolamine (DEA) and triethanolamine (TEA). Large-scale production of DEA is carried out by the reaction of ethylene oxide and excess ammonia, followed by fractionation of the three ethanolamines (mono-, di- and triethanolamine). Ethanolamines are used widely as intermediates in the production of anionic and non-ionic surfactants, which have become commercially important as detergents, textile and leather chemicals, and emulsifiers. Their uses range from drilling and cutting oils to medicinal soaps and high-quality toiletries. DEA is an important additive of corrosion inhibitors, particularly in coolants for automobile engines. DEA is also employed as an additive in lubricants and in cement/concrete production. Large amounts of DEA are used as such in closed systems for absorptive gas purification to remove weakly acidic components. In the production of detergents, cleaners, fabric softeners and metalworking fluids DEA is used for acid neutralization and to prevent soil deposition. DEA is also used as an intermediate in the production of morpholine, photographic chemicals and polyurethanes. In addition, DEA is used as a building block for agrochemicals.
Environmental Fate[4]	
Soil/Water/Air	The colourless solid DEA is completely miscible with water at ambient temperature and has a negligible vapour pressure of 0.0028 hPa (25 °C). The measured log KOW of -2.18 (25 °C) and the calculated BCF of 3.16 indicate a low potential for bioaccumulation. The Henry's law constant of 3.97 x 10-6 Pa*m^3/mol (uncharged) is considered as an indication for low volatility. The calculated Koc of uncharged DEA is 1 (corrected log Koc = 0). Thus, the potential for adsorption to soil, sediment, and suspended solid may be low. However, binding of the substance to the matrix of soils (and sediments) with high capacities for cation exchange (e.g. clay) cannot be excluded for the charged molecule. The measured pKa value of 8.92 (23 °C) indicates that at environmentally relevant conditions of pH 6 – 8, the molecule will predominantly occur in the charged (cationic) form. At pH values > 9, DEA will predominantly be present as the uncharged species. According to Mackay Level I modelling, uncharged DEA will distribute almost completely into water (99.99 %). DEA is readily biodegradable according to OECD criteria. Potential for anaerobic degradation of DEA was also observed. In the atmosphere, it will be photodegraded by reactions with OH radicals (calculated half-life of the uncharged molecule for a 12-hour day and 1.5E06 OH/cm^3: 2.4 hours = 0.1 day; for a 24-h day and 0.5E06 OH/cm^3: 4.2 hours = 0.2 days). At environmental pH conditions hydrolysis is not expected to be a relevant degradation process due to the absence of hydrolysable groups
Human Health Toxicity Summary [1,2]	

Chronic Repeated Dose Toxicity	In a 90 day oral gavage study conducted similarly to OECD TG 408 in F344 rats, lowest observed adverse effect levels (LOAEL) of 320 and 160 ppm (equivalent to 25 and 14 mg/kg bw/day, respectively) was reported in male and female rats, respectively. These were the lowest doses tested. Mortality was observed in males (2/10 animals) at the highest dose (5000 ppm) before the completion of the study (REACH; OECD, 2008). Signs of toxicity were observed across all dose groups (160 - 2500 ppm), and included tremors, extreme weight loss, abnormal posture and a dose dependent increase in microcytic anaemia. Dose related (≥ 320 ppm in males and ≥ 160 ppm in females) changes in kidney weights were associated with an increase in nephropathy and renal cell necrosis. Dose related (≥ 320 ppm in males and ≥ 630 ppm in females) increase in liver weight was associated with a moderate increase in serum bile acid concentration (REACH; OECD, 2008). Based on treatment-related effects reported with a LOAEL of 32 and 80 mg/kg bw/day in rat and mouse studies, respectively, the chemical is considered to cause serious damage to health from repeated oral exposure. In a 90 day dermal application study conducted similarly to OECD TG 411 in F344 rats, a LOAEL of 32 mg/kg bw/day was reported in male and female rats. Mortality occurred in one male and two female rats administered the highest dose of 500 mg/kg bw/day (REACH; OECD, 2008). Ulceration, inflammation, hyperkeratosis, and acanthosis occurred at all administered doses (32 - 500 mg/kg bw/day). Other signs of toxicity included reductions in body weight gain, anaemia, renal function changes and liver weight increases. Demyelination in the brain, nephropathy and renal tubular necrosis were also observed (REACH; OECD, 2008). In a similar study conducted similarly to OECD TG 411 in B6C3F1 mice, a LOAEL of 80 mg/kg bw/day was reported in male and female mice. Effects on the skin were noted at all doses (80 - 1250 mg/kg bw/day) and consisted of acanthosis at the lower doses and a dose-dependent increase in ulcerations, inflammation and hyperkeratosis at higher dose levels (630 and 1250 mg/kg bw/day in males and females, respectively) (REACH; OECD, 2008). Further signs of toxicity included dose dependent increases in liver and kidney weights. The increase in liver weight was associated with hepatocellular changes consisting of enlarged hepatocytes and, at the higher dose levels, the presence of multinucleated, giant hepatocytes. Liver damage (hepatocellular necrosis) was observed in male mice only (REACH; OECD, 2008). Based on the available data no adverse systemic toxicity was evident. Local effects were observed at a lowest observed adverse effect concentration (LOAEC) of 0.15 mg/L in one study. The available data do not warrant a hazard classification for repeated dose inhalation toxicity. However, a classification for respiratory irritation is warranted. In a 90 day inhalation study conducted according to OECD TG 413 in Wistar rats, a LOAEC of 0.15 mg/L was reported in male and female rats. Local inflammation (focal squamous metaplasia and hyperplasia) was evident in the larynx (0.15 mg/L) and trachea (0.4 mg/L) in a concentration dependent manner (REACH, SIDS, 2008). Marginal increases in liver weight and serum alkaline phosphatase levels occurred at the mid - high doses (0.15 and 0.4 mg/L, respectively), although, no histopathological changes were noted. In females, erosions of the glandular stomach occurred in a dose dependent manner (0.15 mg/L and 0.4 mg/L) (REACH; OECD, 2008). A further study conducted according to OECD TG 413 in male and female Wistar rats using lower doses (0.0015, 0.003 or 0.008 mg/L) showed similar local irritation effects (focal squamous metaplasia) after 90 days of exposure. After 90 days of exposure to the chemical, a group of 10 animals were given three months of recovery. At the end of the recovery period, no treatment related systemic effects were observed, indicating reversibility in the laryngeal epithelium up to the highest dose administered (0.008 mg/L) (REACH, OECD, 2008).
Carcinogenicity	Limited data are available on the carcinogenicity of DEA. A two-year carcinogenicity study was conducted by the United States National Toxicology

	Program (NTP, 1999). Based on the pattern of occupational and consumer exposure, dermal administration was considered the most appropriate route for the carcinogenicity study in rats and mice. Groups of 50 male F344/N rats were administered dermal doses of 0, 16, 32, or 64 mg/kg bw DEA in ethanol solutions, 5 days per week for 103 weeks. Female rats were administered 0, 8, 16, or 32 mg/kg bw, and male and female B6C3F1 mice were administered 0, 40, 80, or 160 mg/kg bw DEA dermally, 5 days per week for 103 weeks. Mean body weights of treated rats were generally lower than those of the control rats. The only clinical finding attributed to DEA administration was irritation of the skin at the site of application. This effect was dose-related. Exudate, consisting of focal accumulations of serum and cellular debris on the epidermal surface, occurred at significantly increased incidences in 64 mg/kg bw males and in all dosed female groups. In rats, the main histopathological effects were noted in kidneys of female rats with nephropathy, renal tubular epithelial cell necrosis and/or mineralisation, which increased in incidence and/or severity in a dose-dependent manner. The incidence of nephropathy in dosed female groups was significantly greater than that in the vehicle controls; but no such effects were seen in male rats. There was no neoplastic response in the skin or any organ associated with DEA exposure during the two-year study. The incidence of basophilic foci was significantly decreased in all dosed groups of males and females. The incidence of fibroadenoma in mammary glands in female rats occurred with a negative trend, being lower in all dosed groups compared to the historical control range. In mice, mean body weights of treated groups were depressed, more so in female mice than in male mice. The liver was clearly the most affected organ, and female mice were more sensitive than males. Exposure to diethanolamine for two years produced a marked neoplastic response in the liver characterised by significant increases in the incidences and multiplicity of hepatocellular adenomas (males: 31/50, 42/50, 49/50, 45/50 and females: 32/50, 50/50, 48/50, 48/50) and hepatocellular carcinoma (males: 12/50, 17/50, 33/50, 34/50 and females: 5/50, 19/50, 38/50, 42/50) at 0, 40, 80 and 160 mg/kg bw/day, respectively. The microscopic appearance of these liver neoplasms was typical of those usually observed spontaneously in B6C3F1 mice. There was a morphologic continuum from adenoma to carcinoma, with less differentiation and typical trabecular formations in the carcinomas. Increased mortality was noted in female mice and this, along with reduced body weights, was considered to be a consequence of the presence of liver neoplasms. The incidence of hepatoblastomas, uncommon phenotypic variants of hepatocellular carcinoma, was significantly increased in male mice, but not in females. In addition, the incidence of syncytial alteration, a non-neoplastic lesion characterised by the presence of hepatocytes containing multiple (three or more) nuclei, was increased in all groups of dosed mice; this lesion was not present in the controls. Centrilobular cytoplasmic alteration was increased in treated males but was not present in females. There were no neoplasms of the skin in mice. Effects in the kidneys included increased organ weights and increased incidence of tubular epithelial cell necrosis. The incidences of renal tubule adenoma and renal tubule adenoma or carcinoma (combined) occurred with a positive trend in male mice, but renal tubule carcinoma did not follow the same pattern. Detailed evaluation of the renal neoplasms indicated a treatment- and dose-related increase in the incidences of renal tubule adenoma (1/50, 4/50, 6/50 and 6/50) and adenoma or carcinoma (combined) (3/50, 5/50, 6/50 and 8/50 at 0, 40, 80 and 160 mg/kg, respectively). Diethanolamine is eliminated in urine as the parent compound. The data on the mode of action are insufficient to conclude that diethanolamine-induced tumours in mice are relevant for humans and, therefore, based on the available information, diethanolamine is not classified for carcinogenicity.
Mutagenicity/ Genotoxicity	The chemical tested negative in several in vitro (Ames test with and without metabolic activation, reverse mutation assay, cytogenic assay and the mouse lymphoma assay) and in vivo (micronucleus assay and the alkaline elution assay) tests for gene mutation and clastogenicity (NICNAS; OECD, 2008).

Reproductive Toxicity / Developmental Toxicity/Teratogenicity	No reproductive toxicity studies are available for diethanolamine. Repeated dose studies were conducted in F344/N rats and B6C3F1 mice of both sexes for 13 weeks (10/sex/species/dose) to characterise the effects of oral and dermal exposure (NTP, 1992). No reproductive toxicity in male or female rats was reported following dermal administration of the chemical for 13 weeks. There were no morphological effects on male or female reproductive organs or in sperm parameters (NTP, 1992). It is likely that testicular degeneration in a 90-day drinking water study is a direct toxic effect of diethanolamine. However, no effect on the reproductive organs of the female rats was noted. The NOAEL for reproductive effects in males is 630 ppm (48 mg/kg bw/day). In an inhalation study, conducted according to OECD TG 413, male and female Wistar rats were exposed to the chemical via inhalation (0.015, 0.15 or 0.4 mg/L), five times a week for 90 days. Reproductive effects in males were reported at the highest concentration (0.4 mg/L) and these included testicular atrophy and slight atrophy of the prostate. No changes were observed in female rats (OECD, 2008). The effects of diethanolamine on the male reproductive system are indicative of a potential to impair reproductive capability. However, more detailed reproductive toxicity studies are needed to confirm the potential effects on fertility observed in male rats. The current information is insufficient to classify diethanolamine for reproductive toxicity. Developmental effects were tested following exposure of dams to diethanolamine by oral, dermal and inhalation routes. In almost all the rodent studies, developmental effects were seen only at higher doses, at which maternal effects were also noted. In a dermal study in rabbits, the overall incidence of malformation was similar to the incidence seen in control animals. The current data therefore do not allow for a clear delineation of reproductive and developmental toxicity of diethanolamine in experimental animals. Classification of diethanolamine for reproductive and developmental toxicity is, therefore, not recommended at this stage.
Acute Toxicity	The reported oral median lethal dose (LD50) values in rats ranged from 780 - 3540 mg/kg bw (OECD, 2008). In one study male Sprague Dawley (SD) rats administered a single oral dose of aqueous DEA (100 – 6400 mg/kg bw) resulting in 90 % mortality at the highest dose. Doses greater than 100 mg/kg bw resulted in an increase in liver weight. An increase in the relative kidney weight was observed at doses greater than 1600 mg/kg bw. Clinical chemistry changes were reported for the liver at doses greater than 200 mg/kg bw and for the kidney at greater than 400 mg/kg bw (OECD, 2008). The chemical was of low acute toxicity in animal tests following dermal exposure. The median lethal dose (LD50) in rabbits is greater than 12000 mg/kg bw (IUCLID, 2000). The chemical was of low acute toxicity in animal tests following inhalation exposure. The median lethal concentration (LC50) in rats is 6.4 mg/L. The available data do not warrant hazard classification. Acute inhalation exposure to the chemical for 1.5 – 4 hours at concentrations between 30 – 1476 ppm (0.13 - 6.4 mg/L) caused mortality in 5/8 rats after 105 minutes of exposure to 6.4 mg/L. Exposure to 3.35 mg/L (768 ppm) for up to 4 hours resulted in no mortality. It was reported that the exposure was to vapours or aerosols (most likely at the higher concentration). Observed sub-lethal effects included lethargy, increased breathing, increased blood pressure, congestion in the lung and discolouration in the kidney and thymus (REACH; OECD 2008).
Irritation	The chemical on unabraded rabbit skin produced skin irritation after 1 - 15 minutes and marked irritation after 20 hours. Over 72 hours, erythema increased and oedema decreased (REACH). After 20 hours of exposure the mean Draize

	scores for erythema and oedema formation were 2 and 1.33, respectively. While the Draize scores for erythema and oedema returned to normal after 8 days, severe desquamation of the skin persisted. The chemical is also reported to cause ulceration, inflammation and hyperkeratosis following repeated exposure. In an eye irritation study in Vienna White rabbits, 0.05 mL of the chemical was instilled into the rabbit's eyes and observed for eight days. The chemical caused signs of severe irritation consisting of superficial corrosion, corneal opacity, conjunctival bleeding, conjunctivitis and oedema (OECD, 2008; REACH). Extensive corrosion was evident at the end of the observation period. In a further study, 0.1 g of the chemical was applied into the conjunctival sac of New Zealand White rabbits. This resulted in strong irritation of the cornea, iris and conjunctiva, which did not completely resolve over seven days of observation (OECD, 2008).
Sensitisation	The chemical was not found to induce dermal sensitisation in the Guinea pig maximization test conducted according to OECD Test Guideline (TG) 406 (OECD, 2008).
Health Effects Summary	The critical health effects for risk characterisation include systemic acute effects (acute toxicity by the oral route of exposure) and local effects (skin, eye and respiratory irritation). The chemical may also cause harmful effects following repeated exposure through oral and dermal routes.
Key Study/Critical Effect for Screening Criteria	The lowest observed adverse effect levels (LOAEL) of 320 and 160 ppm (equivalent to 25 and 14 mg/kg bw/day, respectively) were reported in male and female rats, respectively, based on kidney and liver weights in the drinking water study (US NTP, 1992). In mice, the LOAEL was 630 ppm (104 mg/kg bw/day for males and 142 mg/kg bw/day for females) based on liver weight changes. It is reported that the fatal oral dose of the chemical is 20g in humans (HSDB).
Ecological Toxicity [3,4]	
Aquatic Toxicity	The lowest reliable acute toxicity values for aquatic species were as follows: Pimephales promelas (fish) 96-h LC50 = 1370 mg/l (nominal) Daphnia magna (invertebrates) 48-h EC50 = 55 mg/l (nominal) Pseudokirchneriella subcapitata 96-h ErC50 = 2.2 mg/l (nominal) Pseudomonas sp. (microorganisms) 16-h TTC = 16 mg/l (nominal) In a chronic toxicity test on reproduction of the water flea Daphnia magna, the NOEC (21 days) was 0.78 mg/l (nominal, based on analytical verification).
Determination of PNEC aquatic	Using an uncertainty factor of 50 on the lowest NOEC to Daphnia a PNEC (Predicted No Effect Concentration) of 0.02 mg/L is calculated, for aquatic organisms.
Current Regulatory Controls [1]	
Australian Hazard Classification	The chemical is classified as hazardous, with the following risk phrases for human health in the Hazardous Substances Information System (HSIS) (Safe Work Australia): Xn; R22 (Acute toxicity) Xi; R38/41 (Irritation) Xn; R48/22 (Repeated dose toxicity)
Australian Occupational Exposure Standards	The chemical has an exposure standard of 13 mg/m^3 (3 ppm) time weighted average (TWA).
International Occupational Exposure Standards	The following exposure standards are identified (Galleria Chemica): An exposure limit (TWA) of 2 - 15 mg/m^3 (0.46 – 3 ppm) in different countries such as USA (Alaska, Hawaii), Canada (Yukon), Norway and Switzerland.
Australian Food Standards	No data available.

Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	No data available.
PBT Assessment [4]	
P/vP Criteria fulfilled?	No. DEA is readily biodegradable according to OECD criteria.
B/vB criteria fulfilled?	No. Based on a measured log Kow of -2.18 and a calculated BCF of 3.16, this chemical does not meet the screening criteria for bioaccumulation.
T criteria fulfilled?	No. The chronic aquatic toxicity of the chemical is > 0.01 mg/L. Hence the substance does not fulfil the screening criteria for toxicity.
Overall conclusion	Not PBT
Revised	January 2019

References

1. National Industrial Chemicals Notification and Assessment Scheme (NICNAS). Human Health Tier II Assessment for Ethanol, 2,2'-iminobis-, Retrieved 2019: https://www.nicnas.gov.au
2. National Industrial Chemicals Notification and Assessment Scheme (NICNAS). Human Health Tier III Assessment for Ethanol, 2,2'-iminobis-, Retrieved 2019: https://www.nicnas.gov.au
3. ECHA REACH, 2,2'-iminodiethanol, Retrieved 2019: https://echa.europa.eu/
4. OECD (2002) SIDS Initial Assessment Profile for 2,2'-iminodiethanol (diethanolamine, DEA)

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Toxicity Summary - Distillates, Hydrotreated Light

Chemical and Physical Properties [1,2,3,4]	
CAS number	[redacted]
Molecular formula	C48H94
Molecular weight	Not applicable - unknown or variable composition, complex reaction products or biological materials (UVCB)
Solubility in water	0.009 to 6.45 mg/L (at 25°C)
Melting point	-49 °C
Boiling point	146 to 299 °C
Vapour pressure	1 to 3.7 kPa at 37.8 °C
Henrys law constant	No data found.
Explosive potential	Above 66°C explosive vapour/air mixtures may be formed
Flammability potential	Combustible
Colour/Form	Liquid at room temperature
Overview	Distillates, hydrotreated light (also called deodorised kerosene) is a petroleum substance. The C_9-C_{14} Aliphatic [< 2% Aromatic] Hydrocarbon Solvents Category is comprised of complex aliphatic hydrocarbon solvents that contain >98% aliphatic constituents with carbon numbers in the range of C9-C14 and less than 2% aromatic constituents. The chemical is used as a component of a drilling fluid formulation for coal seam gas extraction.
Environmental Fate[1]	
Soil/Water/Air	Members of the C_9-C_{14} Aliphatic [≤2% aromatics] Hydrocarbon Solvents Category have the potential to volatilize from surface waters, based on Henry's Law constants (HLC) representing volatility for category members that range from 4.76×10^4 to 1.67×10^6 Pa-m^3/mole (at 25°C). In the air, category members have the potential to rapidly degrade through indirect photolytic processes mediated primarily by hydroxyl radicals (•OH) with calculated degradation half-lives ranging from 0.42 to 1.10 days or 10.8 to 26.4 hours based on a 12-hr day and an •OH concentration of 1.5×10^6 •OH/cm^3. These chemicals are unlikely to degrade by hydrolysis as they lack a functional group that is hydrolytically reactive.

Human Health Toxicity Summary [1,2,3]	
Chronic Repeated Dose Toxicity	In a 90-day study conducted in accordance with OECD TG 408, Sprague-Dawley rats were administered deodorized kerosene by gavage at doses of 0, 100, 500 or 1000 mg/kg bw/day (REACH 2013). Microscopic changes, such as incidence of a2µ-globulin, were seen in male kidneys. These effects are not considered relevant to humans. No other treatment-related effects were observed. No Lowest Observed Adverse Effect Level (LOAEL) or No Observed Adverse Effect Level (NOAEL) could be established in this study. Repeated dermal exposures to members of the kerosene/jet fuel category showed minimal systemic effects (API 2010). Animal data on repeat dermal toxicity of kerosene (petroleum) are summarised from REACH (2013) and presented in Table A29.2. The LOAELs and NOAELs are indicated for each study. Prolonged skin exposure to kerosene (petroleum) in rats and rabbits were consistently associated with local irritation. In rabbits only, systemic effects included changes in bodyweight and organ weights. It is expected that deodorized kerosene would have similar effects in the animals. In a 13-week study, rats (strain not specified) were exposed to deodorized kerosene vapour at concentrations of 0, 0.02, 0.048 or 0.10 mg/L for six hours/day, five days/week. No treatment-related effects were reported (REACH 2013).
Carcinogenicity	A study for deodorized kerosene is available in the REACH Dossier (REACH 2013) but was not reported in enough detail to be able to determine the carcinogenicity of the substance. In a study conducted similarly to OECD TG 451, B6C3F1 mice were applied 0, 250 or 500 mg/kg bw/day kerosene (petroleum) in the interscapular region (type of wrapping not specified) for 103 weeks (REACH 2013). At the end of the study, less than 10% decrease in bodyweight gain was observed at the top dose in both sexes. Mortality in females was significantly higher at the two doses compared to controls. Increased incidence and severity of chronic dermatitis was seen in all treatment groups. At the top dose, increased incidence of the following non-neoplastic lesions was reported: amyloid in the liver, kidney, adrenal cortex (males only), spleen; granulocytic hyperplasia in the bone marrow; and hyperplasia of the axillary lymph nodes (females only). The only indication of neoplastic lesions was an increased incidence of malignant lymphomas observed in treated female animals but the values were within the range of historical controls. Under the conditions of the test, kerosene (petroleum) was not carcinogenic. The LOAEL for systemic effects is 250 mg/kg bw/day. The International Agency for Research on Cancer (IARC) concluded that there is inadequate evidence for the carcinogenicity of kerosene (petroleum) in experimental animals and humans, placing the chemical in Group 3 (Not classifiable as to its carcinogenicity to humans) (IARC 1989). Deodorized kerosene is not carcinogenic, based on reading across the information available for kerosene (petroleum).
Mutagenicity/ Genotoxicity	In vitro tests reported deodorized kerosene as negative both with and without metabolic activation in Ames tests conducted in accordance with OECD TG 471 (REACH 2013; OECD 2011) and in chromosomal aberration tests conducted in accordance with OECD TG 473 (OECD 2011, 2012). In an in vivo study, deodorized kerosene was negative in a dominant lethal assay, conducted in accordance with OECD TG 478, in male Swiss mice and Long Evans rats administered 10% deodorized kerosene intraperitoneally (REACH 2013). These studies demonstrate that deodorized kerosene is not genotoxic.

Reproductive Toxicity / Developmental Toxicity/Teratogenicity	C9-C14 aliphatic (≤2% aromatic) hydrocarbon solvents and C14-C20 aliphatic (≤2% aromatic) hydrocarbon solvents are not toxic to fertility (OECD 2011, 2012). Members of the kerosene/jet fuel category are not toxic to fertility (API 2010). Sprague-Dawley rats were administered undiluted kerosene (petroleum) by gavage at doses of 0, 750, 1500 or 3000 mg/kg bw/day in males treated for 70-90 days and 0, 325, 750 or 1500 mg/kg bw/day in females treated for 21 weeks. At 750 and 1500 mg/kg bw/day, increased absolute liver weight was observed in females but with no corresponding changes in clinical chemistry or histopathology. In females only, other effects included perianal dermatitis at 1500 mg/kg bw/day and stomach hyperplasia at 750 and 1500 mg/kg bw/day. These parameters were not measured in males. In males, the study indicated dose dependent decrease in male bodyweight that was linked to nephropathy specific to male rats. Data for this effect were not provided in the study description. There were no treatment related effects on fertility in both sexes (REACH 2013). The NOAEL for systemic effects in females only was 325 mg/kg bw/day. No NOAEL can be established for fertility effects. C9-C14 aliphatic (≤2% aromatic) hydrocarbon solvents and C14-C20 aliphatic (≤2% aromatic) hydrocarbon solvents are not developmental toxicants (OECD 2011, 2012). Members of the kerosene/jet fuel category are not developmental toxicants (API 2010). In a study conducted in accordance with OECD TG 414, Sprague-Dawley rats were administered kerosene (petroleum) by gavage on gestation days (GD) 6 to 15 at doses of 0, 500, 1000, 1500 or 2000 mg/kg bw/day (REACH 2013). Bodyweight gain was decreased at 1500 and 2000 mg/kg bw/day. Foetal weight was decreased at 1500 and 2000 mg/kg bw/day which may be attributed to decreased maternal bodyweight gain. No malformations were reported. The maternal NOAEL is 1000 mg/kg bw/day. In another study, Sprague-Dawley rats were exposed (whole body) to kerosene (petroleum) in air at concentrations of 0, 106 or 364 ppm on GD 6-15. There were no treatment-related effects observed in the dams and offspring (REACH 2013). Deodorized kerosene is not considered a developmental toxicant, based on reading across data available for kerosene (petroleum).
Acute Toxicity	The chemicals have low acute toxicity based on results from animal tests following oral exposure. The median lethal dose (LD50) in rats is >2000 mg/kg bw (OECD, 2011; US EPA, 2011; OECD, 2012a; OECD, 2012b; OECD, 2012c). The chemicals have low acute toxicity based on results from animal tests following dermal exposure. The LD50 in rats and rabbits is >2000 mg/kg bw (OECD, 2011; US EPA, 2011; OECD, 2012a; OECD, 2012b; OECD, 2012c). The chemicals have low acute toxicity based on results from animal tests following inhalation exposure.
Irritation	Semi-occlusive applications of commercial grade deodorized kerosene produced slight irritation in New Zealand White and SPF rabbits in dermal irritation studies conducted in accordance with OECD TG 404. The studies reported the range of erythema and oedema scores to be 0.3-0.9 and 0.2-1.0, respectively, based on Draize scoring at 24, 48 and 72 hours. Deodorized kerosene is slightly irritating to rabbit skin. Several studies conducted similarly to OECD TG 405 showed minimal effects to the eye with the reported range of conjunctival redness score to be 0-0.2 from instillation of undiluted deodorized kerosene in the eyes of New Zealand White and SPF rabbits (OECD 2011). Deodorized kerosene is slightly irritating to rabbit eye.
Sensitisation	The C9-C14 aliphatic (≤2% aromatics) Category members do not cause skin sensitization.

Health Effects Summary	Deodorised kerosene is an aspiration hazard since it has low viscosity and is composed of aliphatic and aromatic hydrocarbons up to 10%. Deodorised kerosene has low acute oral, dermal and inhalation toxicity, and is slightly irritating to the skin and eyes. The substance is not a skin sensitiser, based on reading across data available for kerosene (petroleum). No treatment-related effects were reported in repeated oral and inhalation exposures to deodorised kerosene. Prolonged dermal exposure to kerosene (petroleum) reported local irritation in rats and rabbits, and changes in bodyweight and organ weights in rabbits. It is expected that these effects would be similar for deodorised kerosene. Based on the absence of adverse effects observed in repeat dose toxicity studies, for the purposes of quantifying the health risk to the general worker and public, the highest dose tested in the study conducted in rats (1 000 mg/kg bw/day) is used in this risk assessment. The substance is not genotoxic. It is neither a carcinogen nor a reproductive toxicant, based on reading across data available for kerosene (petroleum).
Key Study/Critical Effect for Screening Criteria	The most appropriate No-Observed-Adverse-Effect Level (NOAEL) for risk assessment is 1 000 mg/kg bw/day based on maternal toxicity (decreased bodyweight gain) at the Lowest- Observed-Adverse-Effect Level (LOAEL) of 1 500 mg/kg bw/day from a developmental toxicity study on kerosene (petroleum).
Ecological Toxicity [2]	
Aquatic Toxicity	Lowest acute endpoint for Daphnia = 0.018 mg/L (modelled)
Determination of PNEC aquatic	Based on the lowest acute endpoint for Daphnia (0.018 mg/L), an assessment factor of 100 has been applied, resulting in a PNECaquatic of 1.80E-04 mg/L.
Current Regulatory Controls [2]	
Australian Hazard Classification	All of the chemicals are classified as hazardous, with the following risk phrase for human health in the Hazardous Substances Information System (HSIS) (Safe Work Australia): Xn; R65 (acute toxicity) Mixtures containing the substance are classified as hazardous with the following risk phrase based on the concentration (Conc) of the substance in the mixtures: Conc ≥10%: Xn; R65 (May cause lung damage if swallowed)
Australian Occupational Exposure Standards	No specific exposure standards are available.
International Occupational Exposure Standards	No specific exposure standards are available for this chemical.
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	Oils and greases (including petrochemicals) for freshwater production: <300[6] µg/L (ANZECC 2000)
PBT Assessment	
P/vP Criteria fulfilled?	No. This chemical is expected to be biodegradable. The ready biodegradability of SHELLSOL NF a solvent naphtha (petroleum), heavy aromatics (consists predominantly of C9 aromatics 25%m/m; C10 aromatics 65%, and indanes 10%) was studied in mineral nutrient medium inoculated with activated sludge (mixed liquor suspended solids 100-101 mg/L, pH 6.9) and incubated for 28 days at 20°C. SHELLSOL NF is readily biodegrade after 28 days but not within the 10 day window.
B/vB criteria fulfilled?	Category members have a potential to bioaccumulate, based on calculated log BCF values for constituents that range from 2.78 to 4.06, and calculated BCF values of 598 to 11,430 L/kg wet-weight, based on the Arnot and Gobas model, that take into account biotransformation of the chemicals in fish tissue. This chemical also has a log Kow of 6.025.

T criteria fulfilled?	Yes. The lowest acute endpoint is <1 mg/L.
Overall conclusion	Not PBT
Revised	January 2019

Human Health Risk Assessment

Occupational Exposure

Table 2 presents the calculated internal doses for adult workers associated with drilling chemical exposure/hydraulic fracturing chemical exposure.

Table 2 Calculated Internal Doses for Adult Workers

Occupational Activity	E_{derm} (mg/kg bw/day)	E_{inh} (mg/kg bw/day)	E_{total} (mg/kg bw/day)
Transport and storage	Negligible*	Negligible*	Negligible*
Mixing/blending drilling of hydraulic fracturing chemicals	0.06	0.750	**0.810**
Injection of drilling chemicals	Negligible*	Negligible*	Negligible*
Cleaning and maintenance (hydraulic fracturing)	0.012	0.150	**0.162**
Combined exposure Mixing/blending and cleaning and maintenance			**0.972**
Transport and storage of drilling muds	Negligible*	Negligible*	Negligible*

Ederm - Internal dose from dermal exposure; Einh – Internal dose from inhalation exposure; Etotal – Total internal dose from all routes.

* In the absence of accidents/incidents, repeated occupational exposures during transport and storage, or during injection of mixed/blended chemicals, are negligible. Similarly, repeated occupational exposures to the chemical via the transport and storage of drilling muds are negligible (NICNAS 2017).

Human Health Risk Characterisation

Uncertainty Factors

Using the Margin of Exposure (MOE) approach, conservative default uncertainty factors for intra- and inter-species variability are assumed to be 10 each. A MOE of less than 100 is considered a concern (NICNAS 2017).

Acute Health Risks

Acute exposure to the chemical is unlikely to result in adverse health effects. In addition, given the low concentration in the drilling fluids, exposure to the chemical via these fluids is of low concern for workers.

Chronic long-term health risks

The critical (most sensitive) adverse health effect is maternal toxicity (decreased bodyweight gain). The NOAEL established for this effect is 1000 mg/kg bw/day from a reproductive toxicity study. There are no adverse effects observed from repeated exposures to the chemical at any dose tested, up to 1000 mg/kg bw/day. This highest no-effect dose is applicable for a general worker. Margins of Exposure (MOE) for adverse health effects from repeated occupational exposures are calculated by comparing the NOAEL with exposures estimated for different occupational activities and combined activities. **Table 3** presents Margin of Exposure calculated for Adult Workers associated with drilling

chemical exposure/hydraulic fracturing chemical exposure. Risk characterisation calculations are presented in **Attachment A**.

Table3 Margins of exposure calculated for adult workers

Adult worker exposure scenario	E_{total} (mg/kg bw/day)	NOAEL (mg/kg bw/day)	Critical effect	MOE (NOAEL / E_{total})	Chemical is of concern? (MOE < 100)
Occupational Activity					
Mixing/blending drilling of hydraulic fracturing chemicals	0.810	1000	Maternal toxicity in rats	1235	No
Cleaning and maintenance (hydraulic fracturing)	0.162			6173	
Combined exposure Mixing/blending and cleaning and maintenance	0.972			1029	

Based on uncertainty factors derived for this risk characterisation, the MOEs indicate that the chemical is of low concern for workers from repeated exposures during certain operations.

References

1. OECD (2012) SIDS Initial Assessment Profile on C_9-C_{14} Aliphatic [≤2% aromatic] Hydrocarbon Solvents Category. Available at: http://webnet.oecd.org/HPV/UI/SIDS_Details.aspx?id=476560b6-e2b7-4466-9c52-0b278c8b71a7
2. National Industrial Chemicals Notification and Assessment Scheme (NICNAS, 2017). National assessment of chemicals associated with coal seam gas extraction in Australia. Human health hazards of chemicals associated with coal seam gas extraction in Australia.
3. National Industrial Chemicals Notification and Assessment Scheme (NICNAS). IMAP, Human Health Tier II Assessment for Kerosene, Retrieved 2019: https://www.nicnas.gov.au
4. ECHA REACH, Distillates (petroleum), hydrotreated light, Retrieved 2017: https://echa.europa.eu/information-on-chemicals/registered-substances
5. ICSC Distillates (petroleum), hydrotreated light, Retrieved 2017: http://www.inchem.org
6. ANZECC (2000) Australian and New Zealand Guidelines for Fresh and Marine Water Quality for protection for aquatic ecosystems

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Toxicity Summary - Ethanol, 2,2'-oxybis-, reaction products with ammonia, morpholine derivatives residues

Chemical and Physical Properties[1]	
CAS number	[redacted]
Molecular formula	C36H78N6O14
Molecular weight	UVCB
Solubility in water	100 g/L at 20 °C
Melting point	-20 °C at 101.3 kPa
Boiling point	223 °C at 101.3 kPa
Vapour pressure	0.55 - 20 Pa at 20 - 25 °C
Henrys law constant	No data available
Explosive potential	Non-explosive (100%)
Flammability potential	Not classified (50%), Non-flammable (50%)
Colour/Form	Liquid
Overview	The residuum from the reaction of diethylene glycol and ammonia. It consists predominantly of morpholine-based derivatives such as [(aminoethoxy)ethyl]morpholine, [(hydroxyethoxy)ethyl]morpholine, 3-morpholinone, and 4,4'-(oxydi-2,1-ethanediyl)bis[morpholine].
Environmental Fate[1]	
Soil/Water/Air	The substance is hydrolytically stable at pH 4, 7 and 9 at 25°C. Adsorption to solid soil phase is not to be expected. Based on the assessment of the components, it can be concluded that the mixture will not evaporate into the atmosphere. The substance is not readily biodegradable. Based on the low log Kow, the substance will have a low potential for bioaccumulation. Over time, the mixture will preferentially distribute into the compartment water.
Human Health Toxicity Summary[1]	
Chronic Repeated Dose Toxicity	No adverse effects were observed in male and female rats in a 28 days and a 90 days repeated dose toxicity test conducted according to OECD 407 and OECD 408 respectively (Calvert Laboratories, Inc., 2011 and Envigo Research Limited, 2018) in which animals were exposed orally (gavage) to 0, 100, 500 or 1000 mg/kg bw/d (28 days study) and to 0, 10, 100 or 1000 mg/kg bw/d (90 days study). In both studies, an NOAEL of 1000 mg/kg bw was determined.
Carcinogenicity	No data available.
Mutagenicity/ Genotoxicity	In an in vivo micronucleus test on mouse bone marrow erythrocytes (BioReliance, 2010), performed according to OECD guideline 474, the animals were exposed orally (via gavage) with 500, 1000, 2000 mg/kg. This did not induce a statistically positive increase in micronuclei in the hemopoietic cells of the mouse bone marrow at the time intervals evaluated under the experimental condition of this assay. No toxicity was observed. Vehicle and positive controls were valid.

Reproductive Toxicity / Developmental Toxicity/Teratogenicity	A Reproductive / Development Toxicity Screening Testing in Rats was performed according to OECD guideline 421 (Calvert Laboratories, Inc., 2011, Klimisch 1). In this GLP-compliant study, male and female Sprague-Dawley rats (10 animals/sex/dose) were exposed to 1000 mg/kg bw/day. Control animals received concurrent vehicle (water). The rats were exposed on a daily basis, starting two weeks prior to cohabitation until the day before the scheduled euthanasia (minimum of 4 weeks) for males and starting for a minimum of 15 days prior to cohabitation, during cohabitation and from presumed gestation days 0 through day 19 of gestation for females. One female animal was found dead on lactation day 2. All other females survived until scheduled sacrifice. No treatment-related effects were observed in clinical signs, mortality, body weight (gain), food consumption, gross pathology, organ weights or histopathology in the parental animals. There was no treatment-related effect on reproductive performance or in reproductive parameters like for instance number of gravid animals, corpora lutea per dam, total implantations, litter viability or foetal sex ratios. The incidence of neonates born alive/found dead, stillborn or missing between lactation days 0 -4 was comparable among study groups. No treatment-related malformations were observed for neonates. The body weight of neonates was statistically significantly increased with an unknown biological significance for this finding. A NOAEL of 1000 mg/kg bw/day was established.
Acute Toxicity	The oral LD50 in male and female Sprague-Dawley rats was determined to be 5000 mg/kg bw in a reliable, key study conducted similarly to OECD guideline 420 (Calvert Laboratories, Inc., 2010). Calvert Laboratories Inc (2010) determined acute dermal toxicity in 10 male / female rats following a GLP-compliant study performed equivalent to OECD guideline 402 (key study, Klimisch 1). Only one dose was tested (2000 mg/kg bw). No mortality was observed. Shortly after exposure, local erythema and oedema effects were observed in both males and females. The effects seemed to be reversible in males and 1 female. In the 4 other females, necrosis and slouching appeared.
Irritation	The skin irritation potential of the test substance is investigated in a key, reliable study performed according to OECD guideline 404 (Allen, 1994; Klimisch 2) in 3 rabbits. Semi-occlusive patches were removed from shaved test sites after exposure periods of 3 min, 1h, and 4h to 0.5mL of the test substance. The Draize scoring system was used to evaluate the results. No erythema/eschar formation and no oedema formation is observed after 3 min and 1 hour exposure. After 4 hours of exposure, very slight erythema in all 3 animals and very slight oedema in 2 animals was observed, but this was fully reversible within 24 - 48 hrs. Calvert Laboratories, Inc. (2010) investigated the eye irritation potential of the test substance in a key, reliable study performed according to EU method B.5 (Klimisch 1) in 3 rabbits. The treated eyes (with 0.1mL test substance) will remain unrinsed for at least 24 hours after instillation. The 24-, 48- and 72-hours scores will be added separately for each animal and each total divided by 3 to yield the individual mean scores for each animal. Based on the data and according to the criterial of the CLP regulation, the test substance is classified as irritant to the eyes (category 2).
Sensitisation	Based on a guinea pig maximization study, performed according to the OECD guideline 406 (Allen, 1996; Klimisch 2), the test substance is considered not sensitising to the skin.
Health Effects Summary	This chemical may cause skin and eye irritation.
Key Study/Critical Effect for Screening Criteria	The critical lowest No Observed Adverse Effect (NOAEL) level for the purposes of risk assessment is 1000 mg/kg bw/day from the 90 day repeated oral toxicity study.
Ecological Toxicity [1]	

Aquatic Toxicity	In a static test following the procedures of the German national standard DIN 38412 using Leuciscus idus as test species a LC50 (96 h) of 681.2 mg/L (nominal) was determined [BASF AG, 1988; Study No. 10F0118/885140]. In conclusion, the substance is with high probability not acutely harmful to fish. The EC50 of the test item on daphnids was found to be greater than 122 mg/L (measured value) in a GLP guideline study according to OECD 202 [BASF SE, 2010; Study No. 50E0396/09E012]. Therefore, the test substance is with high probability acutely not harmful to aquatic invertebrates. A study was performed to assess the effect of the test item on the growth of the green alga Pseudokirchneriella subcapitata. The method followed that described in the OECD Guidelines for Testing of Chemicals (2006) No 201, "Freshwater Alga and Cyanobacteria, Growth Inhibition Test" referenced as Method C.3 of Commission Regulation (EC) No 440/2008. The effect of the test item on the growth of Pseudokirchneriella subcapitata has been investigated over a 72-Hour period. the ErC50(72h) of the test item is 45 mg/L for Pseudokirchneriella subcapitata. The toxicity to microorganisms was determined in a GLP short-term respiration test according to OECD guideline 209 using activated sludge from a municipal sewage treatment plant. After 180 minutes no inhibition effect on the respiration rate at the highest test concentration (1000 mg/L) was observed [BASF 2010; Study No. 08G0396/09G004]. Therefore, it can be concluded that inhibition of the degradation activity of activated sludge is not anticipated when introduced in appropriately low concentrations.
Determination of PNEC aquatic	The available short-term aquatic tests covering the three trophic levels (fish, daphnids, algae) showed the lowest L(E)C50 to be 45 mg/L in algae. An assessment factor of 1000 was used for a resulting PNEC for of 0.045 mg/L.
Current Regulatory Controls[4]	
Australian Hazard Classification	No data available.
Australian Occupational Exposure Standards	No data available.
International Occupational Exposure Standards	No data available.
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	No data available.
PBT Assessment[1]	
P/vP Criteria fulfilled?	Not readily biodegradable. Thus, it is expected to meet the screening criteria for persistence.
B/vB criteria fulfilled?	As the Log Pow is 0.565 at 20 °C (Log Pow < 4.5), it is not expected to be bioaccumulative.
T criteria fulfilled?	The acute aquatic toxicity of this chemical is >0.1 mg/L. Thus, it is not expected to meet the screening criteria for toxicity
Overall conclusion	Not PBT
Revised	March 2019

References

1. ECHA REACH, Ethanol, 2,2'-oxybis-, reaction products with ammonia, morpholine derivs. residues, Retrieved 2019: https://echa.europa.eu/

Toxicity Summary - Glutaraldehyde

Chemical and Physical Properties [1,2,3]	
CAS number	[redacted]
Molecular formula	C5H8O2
Molecular weight	100.11
Solubility in water	Soluble in all proportions in water and ethanol; soluble in benzene and ether.
Melting point	-14°C
Boiling point	188°C
Vapour pressure	2.03 x 10^{-3} kPa at 25 °C (50% solution)
Henrys law constant	0.011 Pa m^3/mol @ 25 °C
Explosive potential	Non explosive
Flammability potential	Non flammable
Colour/Form	Colourless oily liquid. In the vapour state, glutaraldehyde has a pungent odour, with an odour threshold of 0.04 ppm.
Overview	Glutaraldehyde is manufactured in Germany by BASF and in the USA by Union Carbide Corporation. It is usually sold commercially as a 45% or 50% aqueous solution. Glutaraldehyde has a wide variety of uses throughout the world with its use spread over a number of different industries. It is used primarily as a biocide but it also has wide use as a fixative, and some use as a therapeutic agent. The principal health effects of glutaraldehyde are irritation of the skin, eye and respiratory tract, skin sensitisation and occupational asthma. Exposure data indicated that, in some situations, particularly the health care industry (disinfection), x-ray film processing and the animal health industry (spray use), health concerns may arise where available control measures such as ventilation have not been implemented to minimise exposure. Due to low and intermittent exposure, the public health risk from the industrial use of glutaraldehyde is minimal. For the use of glutaraldehyde in cosmetics, a safety margin of >400 for extensive use indicated low concern.
Environmental Fate[1]	
Soil/Water/Air	Glutaraldehyde is a hydrophilic substance that will be mainly associated with the aquatic compartment, with minor amounts partitioning to the atmosphere, following release to the environment. Hydrolysis is slow, but glutaraldehyde, like other aldehydes, undergoes aerial oxidation in solution. It biodegrades rapidly in aerobic and anaerobic aquatic environments at subcidal concentrations (below 10 mg/L) and will not bioaccumulate. Tropospheric degradation is also rapid.
Human Health Toxicity Summary [1,2,3]	

Chronic Repeated Dose Toxicity	A two-year chronic study was conducted in male and female Fischer 344 rats (NICNAS 1994). Groups of 100 male and 100 female rats were administered 0, 50, 250, or 1000 ppm w/v glutaraldehyde in drinking water (4, 17 and 64 mg/kg bw/day for the males and 6, 25 and 86 mg/kg/day for the females). The mortality rate over the treatment period was 25 to 30% for males and 19 to 23% for females with no dose-related increase. The major cause of death in all rats (control and dose groups) was large granular cell lymphatic leukaemia (LGLL). Small dose-related decreases in absolute body weight and body weight gain occurred at 250 and 1000 ppm in males and at 1000 ppm in females. Dose-related decrease in urine volumes and associated increase in osmolality were observed in higher dose animals. At necropsy at 52, 78 and 104 weeks, the only statistically significant changes in organ weights were for the kidney. Relative kidney weights were increased for males and females at 52 and 78 weeks. A significant dose-related increase in kidney weight relative to final body weight occurred for males and females in the 250 and 1000 ppm groups, including an increase in absolute kidney weight for the female rats. Changes in final body weights and the weights of other organs were minor and / or sporadic and were unlikely to be related to glutaraldehyde exposure. The total leucocyte count was significantly increased at week 104 in males at 250 and 1000 ppm, and in females at 250 ppm only. The variation in counts was large, possibly due to the large monocyte count at 250 and 1000 ppm. Changes in clinical chemistry parameters included decreases in the activities of some enzymes at 250 and 1000 ppm and occasional decreases in total protein, globulin and phosphorous; these were probably due to reduced food consumption and body weight. Gross pathology showed evidence of gastric inflammation, particularly in rats sacrificed at the end of the study, with irritation observed as ulceration, a multifocal colour change and thickening of the mucosa (dose groups not specified). Histologic examination of the tissues revealed squamous epithelial hyperplasia and keratinised cysts and oedema. Based on the observations, a NOAEL of 4 mg/kg bw/day for males and 6 mg/kg bw/day for females was established in this study. For the purpose of human health risk assessment, the lowest NOAEL (4 mg/kg bw/day) established in the two-year chronic study in rats will be used.
Carcinogenicity	In a two-year chronic/carcinogenicity study by Van Miller et al. (2002), groups of 100 male and 100 female Fischer 344 rats were treated with 0, 50, 250, or 1000 ppm w/v glutaraldehyde in drinking water. The mean glutaraldehyde consumption for each of the three groups was 4, 17 and 64 mg/kg bw/day for the males and 6, 25 and 86 mg/kg bw/day for the females. The mortality rate during the study period was 25 to 30% for males and 19 to 23% for females and was not dose-related. Gross pathology showed evidence of gastric inflammation. The main finding of the study was an increased incidence of large granular lymphocytic leukaemia (LGLL) in the spleen and liver of male and female rats in all groups, including the control group. Treated females showed a significantly increased incidence of LGLL and analysis for dose-response trend for the severity of LLGL revealed an increased severity in females at the higher dosages (53% in spleen and 54% in liver versus respectively 20% and 23% in untreated females) while no such observation were made for the males. No other significant oncogenic effects were observed during the study. Occurrence of LGLL was seen in all groups including controls; the incidence of LGLL in the 1000 ppm group was high compared to controls but no clear dose-response relationship was evident, and LGLL mainly affected treated females whereas the incidence in treated males was within the control range (REACH 2013). Historical control data for untreated Fischer 344 rats in NTP studies also indicates that the ranges for this tumour are 10 to 72% in males and 6 to 31% in females (REACH 2013). The control data in the Van Miller et al. study fitted in with the historical control data reported from NTP studies. The variability in control data for LGLL and the wide variation reported in the literature makes a definitive conclusion difficult. Base on this study, glutaraldehyde was considered not to be carcinogenic.
Mutagenicity/ Genotoxicity	Glutaraldehyde has been extensively tested for genetic activity in vitro and in vivo, however there is disagreement in the literature regarding glutaraldehyde's genetic activity (Zeiger et al. 2005). While all in vivo genotoxicity tests with glutaraldehyde

	gave negative results, mixed results were reported for in vitro mutagenicity tests. Early in vitro tests were negative (Watts 1984), but some recent bacterial assays and tests in mammalian cells indicated that glutaraldehyde could be mutagenic in vitro. A series of reverse mutation assays was carried out with various Salmonella typhimurium strains, with and without metabolic activation (REACH 2013). All assays with TA 100, 1535, 1537 and 98 were negative. Some assays with TA 102 and 104 gave positive results. Tests with Escherichia coli also yielded both positive as well as negative results. Glutaraldehyde induced sister chromatid exchanges in CHO cells with and without S9 metabolic activation in one laboratory, but was negative without S9 and only weakly positive with S9 in the second laboratory (NICNAS 1994). The difference in the results was attributed to slight differences between the data evaluation systems used in the two laboratories. Glutaraldehyde was not mutagenic in any of the in vivo assays such as peripheral blood micronucleus test, rat bone marrow chromosomal aberration assay and the Drosophila melanogaster sex-linked recessive lethal test (NICNAS 1994; REACH 2013). Chromosome aberrations in bone marrow cells were reported in only one out of eight studies using rats and mice, micronuclei were not induced in bone marrow cells of mice, and dominant lethal mutations were not induced in mice. Glutaraldehyde did not induce cell transformation in Syrian hamster embryo cells in vitro (Zeiger et al. 2005). In vivo, inhalation of glutaraldehyde induced cell proliferation in nasal tissue in rats and mice, but did not induce DNA damage at these sites. Based on these observations, it is concluded that glutaraldehyde is not a genotoxin.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	Studies on the incidence of miscarriage in pregnant women have shown no difference between those exposed to glutaraldehyde and those not exposed to the chemical. Studies in female rats and mice have resulted in embryotoxicity/foetotoxicity for glutaraldehyde, but only at doses which are maternally toxic. A number of studies have found no evidence of teratogenicity.
Acute Toxicity	Several acute oral toxicity studies with glutaraldehyde have been reported in rats and other species. In one reliable study, administration of 0.2, 0.3, 0.5, 1.0, 1.7 mL/kg bw glutaraldehyde (corresponding to 226, 339, 565, 1130 and 1921 mg/kg bw, respectively) to male/female Wistar rats by gavage gave a median lethal dose (LD50) of 226 mg/kg bw (REACH 2013). Necropsy of animals that died during the observation period revealed congestion of the lungs and the abdominal viscera. In another study in Sprague-Dawley rats, the oral LD50 was 316 mg/kg bw for males and 285 mg/kg bw for females, when 10 mL of 2.15, 3.16, 4.64, 14.7% glutaraldehyde (corresponding to 215, 316, 464 and 1470 mg/kg bw) was administered by oral gavage (REACH 2013). In a separate study using different strengths of glutaraldehyde, Ballantyne (1986) showed that the oral LD50 for glutaraldehyde in rats varied with the concentration of the glutaraldehyde used. By using different concentrations of glutaraldehyde solutions (1% to 50%) and varying the administration volume to maintain a constant dose, oral LD50 in the range 66 to 733 mg/kg bw were obtained. These studies indicate that glutaraldehyde has high acute oral toxicity. Of the 18 acute dermal toxicity studies reported in REACH (2013) dossiers, results from 14 studies indicated LD50 higher than 2000 mg/kg bw. In four other studies, LD50 ranged between 250 and 1432 mg/kg bw. These studies however did not follow international guidelines and have low reliability. Based on these studies, glutaraldehyde is considered to have low acute dermal toxicity. In a well-defined study, 10 male and 10 female Sprague-Dawley rats per dose group were exposed to glutaraldehyde as liquid aerosol at 0.22, 0.31 and 0.63 mg/L for 4 hours (REACH 2013). Exposure was followed by an observation period of 14 days. During the exposure period slight nasal discharge, snout wiping, flank respiration and irregular to intermittent respiration were reported in rats. During the post-exposure period, bloody nasal discharge, red crusts surrounding the nose, whooping or gasping respiration with rasping sounds and a tremulous gait were observed. These symptoms disappeared in the surviving animals within 5 to 9 days post-exposure. Mortalities were noted in all treated groups. The determination of the LC50 values was based on the Probit Analysis. An LC50 of 0.48 mg/L was calculated for both male and female rats. In another acute inhalation study conducted in a similar manner to the above study, Sprague-Dawley rats, 10 rats per sex per dose group, were exposed to 0.1,

	0.18, 0.28, 0.39 and 0.44 mg/L glutaraldehyde as liquid aerosol for 4 hours (REACH 2013). During and after exposure, mortality and clinical signs of toxicity were recorded at regular time intervals. The LC50 in this study was established as 0.28 mg/L for females and 0.39 mg/L for males. Based on the above studies, glutaraldehyde is considered to have high acute inhalation toxicity.
Irritation	Glutaraldehyde is corrosive to the skin and eyes of rabbits at high concentrations, with signs of skin irritation evident at 2%, and eye irritation at 0.2%. Exposure to glutaraldehyde vapours in acute inhalational studies resulted in nasal irritation and respiratory difficulties. Joint irritation was seen in rabbits after intra-articular administration.
Sensitisation	The skin sensitisation effect of glutaraldehyde was demonstrated in tests with guinea pigs.
Health Effects Summary	Glutaraldehyde has high acute oral and inhalation toxicity and low to moderate acute dermal toxicity. Based on human and animal data, it is corrosive, the vapours are irritating to the respiratory tract, and it has skin and respiratory sensitisation potential. Glutaraldehyde has high repeat dose oral and inhalation toxicity, with an oral No-Observed-Adverse-Effect Level (NOAEL) of 4 mg/kg bw/day based on changes in liver and kidney weights and clinical chemistry parameters. Glutaraldehyde is not genotoxic or carcinogenic. It did not have any adverse effects on the reproductive system of adult rats or on the development of foetuses. The critical adverse health effects of glutaraldehyde are corrosivity, skin and respiratory tract sensitisation and acute and repeat dose oral and inhalation toxicity.
Key Study/Critical Effect for Screening Criteria	From the hazard characterisation, the critical (most sensitive) adverse health effects for repeated exposures to the chemical are changes in clinical chemistry parameters and relative organ (liver and kidney) weights. Glutaraldehyde has high repeat dose oral toxicity with an oral NOAEL of 4 mg/kg bw/day. This NOAEL is used in this human health risk assessment.
Ecological Toxicity [1,2,3,4]	
Aquatic Toxicity	96 h acute Bluegill sunfish LC50 = 11.2 mg/L 48 h acute Oyster larvae LC550 = 2.1 mg/L 96 h acute Green crabs LC50 = 465 mg/L 96 h acute Grass shrimp LC50 = 41 mg/L 48 acute Daphnia magna LC50 = 0.35 mg/L 48 acute Daphnia magna LC50 = 16.3 mg/L 21 d reproduction Daphnia magna LOEC = 4.3 mg/L, NOEC = 2.1 mg/L 96 h algal growth inhibition Selenastrum capricornutum ILm = 3.9 mg/L (median inhibitory limit) 96 h algal growth inhibition Scenedesmus subspicatus EC50 = 1.0 mg/L Bacterial inhibition Sewage microbes IC50 = 25-34 mg/L In summary, the test results indicate that glutaraldehyde is slightly to moderately toxic to aquatic fauna and moderately to highly toxic to algae. In some instances, glutaraldehyde appeared to be rapidly lost from test waters in the laboratory. Such behaviour in aquatic toxicity tests generally means that their results will underestimate the inherent toxicity of a substance. However, the toxicity that will prevail under environmental conditions is likely to be lower than that recorded in the laboratory in view of the rapid degradation that would be expected to occur in natural surface waters.
Determination of PNEC aquatic	As a wide selection of species is available, applying a safety factor of 10 to the NOEC (2.1 mg/L) derived from Daphnia seems most appropriate, giving a PNEC of 2100/10 = 0.21 mg/L.
Current Regulatory Controls [1,2,4]	
Australian Hazard Classification	Glutaraldehyde is classified as hazardous in the Hazardous Substances Information System (HSIS) with the following risk phrase (Safe Work Australia 2013):

	· T (Toxic); R23/25 (Toxic by inhalation and if swallowed) · C (Corrosive ; R34 (causes burns) · R42/43 (May cause sensitisation by inhalation and skin contact). Mixtures containing the chemical are classified as hazardous with the following risk phrases based on the concentration (Conc) of the chemical in the mixtures. The risk phrases for this chemical are: · Conc ≥50%: T; R23/25; R34; R42/43 (Toxic; toxic by inhalation and if swallowed; causes burns; may cause sensitisation by inhalation and skin contact) · ≥25% Conc <50%: T; R23; R22; R34; R42/43 (Toxic; toxic by inhalation, harmful if swallowed, causes burns; may cause sensitisation by inhalation and skin contact) · ≥10% Conc <25%: C; R20/22; R34; 42/43 (Corrosive; harmful by inhalation and if swallowed; causes burns; may cause sensitisation by inhalation and skin contact) · ≥2% Conc <10%: Xn; R20/22; R37/38; R41; R42/43 (Harmful; harmful by inhalation and if swallowed; irritating to respiratory system and skin; risk of serious eye damage; may cause sensitisation by inhalation and skin contact) · ≥1% Conc <2%: Xn; R36/37/38 R42/43 (Harmful; Irritating to eyes, respiratory system and skin; may cause sensitisation by inhalation and skin contact) · ≥0.5% Conc <1%: Xi; R36/37/38; R43 (Irritating; irritating to eyes, respiratory system and skin; may cause sensitisation by skin contact)
Australian Occupational Exposure Standards	The chemical has an exposure standard of 0.41 mg/m³, 0.1 ppm; Time Weighted Average (TWA).
International Occupational Exposure Standards	The following exposure standards are identified in Galleria Chemica (2013): · Occupational Exposure limit (TWA) of 0.2 mg/m3 [Canada, China, Denmark, Japan, Korea, UK] · 0.4 mg/m3 TWA [Sweden] · 0.8 mg/m3 TWA [US (NIOSH), Greece]
Australian Food Standards	No Australian food standards relating to the chemical have been identified (Food Standards Australia New Zealand 2013).
Australian Drinking Water Guidelines	No aesthetic or health-related guidance values were identified for this chemical in the Australian Drinking Water Guidelines. (National Health and Medical Research Council (NHMRC) 2011).
Aquatic Toxicity Guidelines	No data available.
PBT Assessment	
P/vP Criteria fulfilled?	No. Readily biodegradable and as such not persistent in the environment.
B/vB criteria fulfilled?	No. As the Log Pow is -0.01 (Log Pow < 4.5), it is not expected to be bioaccumulative.
T criteria fulfilled?	No. Chronic toxicity data >1 mg/L in invertebrates, thus glutaraldehyde does not meet the screening criteria for toxicity.
Overall conclusion	Not PBT
Revised	January 2019

References

1. NICNAS (1994) Priority Existing Chemical 3, Glutaraldehyde: Retrieved 2019: https://www.nicnas.gov.au
2. National Industrial Chemicals Notification and Assessment Scheme (NICNAS, 2017). National assessment of chemicals associated with coal seam gas extraction in Australia. Human health hazards of chemicals associated with coal seam gas extraction in Australia.
3. OECD (1995) SIDS Initial Assessment Profile on Glutaraldehyde
4. ECHA REACH, Glutaral, Retrieved 2019: https://echa.europa.eu/
5. Hazardous Chemical Information System (HCIS), Safe Work Australia. Retrieved 2019: http://hcis.safeworkaustralia.gov.au/

6. National Occupational Health and Safety Commission, Approved Criteria for Classifying Hazardous Substances [NOHSC:0006(1993)], AGPS, Canberra, 1993.

Toxicity Summary - Methanol

Chemical and Physical Properties[1,3,4]	
CAS number	[redacted]
Molecular formula	CH4O
Molecular weight	32.04
Solubility in water	1,000 g/L at 20 °C
Melting point	-98 °C
Boiling point	65 °C
Vapour pressure	16.927 kPa at 25 °C
Henrys law constant	0.461 Pa m^3/mol
Explosive potential	Vapour/air mixtures are explosive
Flammability potential	Highly flammable
Colour/Form	Clear colourless liquid
Overview	Methanol occurs naturally in humans, animals and plants. The general population is exposed to methanol mainly through consumption of food and beverages and through use of consumer products such as paints, sealers and adhesives that contain methanol as a solvent.
Environmental Fate [1,3]	
Soil/Water/Air	Air is the main target compartment, based on a fugacity model calculation (Mackay Level III) with about 73 % of environmental methanol distributing to air and 16 % to water. Methanol is degraded in the atmosphere by photochemical, hydroxyl-radical dependent reactions. The estimated elimination half-life is calculated to be about 17-18 days with a rate constant of 0.93 x 10-2 cm3/molecule-sec. Methanol is completely miscible in water and has a low octanol/water partition coefficient. These properties are indicative of high mobility in soil.
Human Health Toxicity Summary [1,2,3]	
Chronic Repeated Dose Toxicity	Considering the no observed adverse effect level (NOAEL) available from a 90-day rat study (500 mg/kg bw/day), the chemical is not considered to cause serious damage to health by repeated oral exposure. In a 20-day inhalation study in monkeys, 3.9 mg/L (3000 mL/m3) was identified as the LOAEL (continuous exposure) where neurotoxic lesions appeared to progress in monkeys (according to NEDO 1987). This exposure concentration correlated with methanol blood levels 80 mg/L and formate levels 30 mg/L. There was no evidence of adverse effects in rats exposed to methanol up to 6.6 mg/L, six hours/day for 28 days, except local nasal irritation and increased relative spleen weights, which were observed only at the middle dose and not considered treatment-related (Andrews et al. 1987). A NOAEL could not be established in this study. In the chronic exposure studies in rats and mice, slight treatment-related decreases in body and organ weights were reported at the highest dose. These are however not considered as 'adverse' effects. In monkeys, slight degeneration of the inside nucleus of the thalamus was observed at 0.13 and 1.3 mg/L after seven months or more (NEDO 1987). One monkey at 0.13 mg/L and two at 1.3 mg/L showed slight but clear changes in peroneal nerves indicating damage to peripheral nerves. Some signs of fibrosis at 1.3 mg/L, which were considered borderline. There were mild but significant effects on heart and kidney at 0.13 and 1.3 mg/L. Histologically, a significant increase of Sudan positive granules was noted in the 1.3 mg group without pathological manifestations (e.g. fibrosis). Although the authors considered the lowest dose (0.013 mg/L) as the LOAEL, it was observed that effects at this dose were very mild and reversible and therefore not

	considered to be adverse effects. Based on these observations, a NOAEL of 0.013 mg/L was established in this study.
Carcinogenicity	The chemical is not likely to be a carcinogen. In a chronic inhalation study, Fisher rats and B6C3F1 mice were exposed to 0.013, 0.13, and 1.3 mg/L methanol for 24 and 18 months, respectively (NEDO 1987). No differences in survival were noted in the treatment groups compared with the control group. There was no evidence of an increase in liver tumours in rats or in the spontaneous liver tumour rate in mice. In the rats, some tumours such as papillary lung adenomas (males only), adrenal phaeochromocytomas (females only) and metastatic (transition) tumours appeared at a somewhat higher incidence in high-dose group rats after week 79 and 104 without clear dose-response relationship. However these tumour incidences were not statistically significantly different from those in the control group. In the mice, there were no appreciable differences from the control in either numbers of animals with tumours or in degree of malignancy observed. Proliferative effects on the astroglia cells were observed in monkeys continuously exposed to 0.013, 0.13 and 1.3 mg/L methanol by the inhalation route (NEDO 1987). These effects however were of a transient nature and disappeared after a six-month recovery period. There were no signs of histological degeneration.
Mutagenicity/ Genotoxicity	Methanol has been examined in numerous in vitro and in vivo test systems, including bacterial, mammalian and fungal test systems. Most in vitro studies did not demonstrate mutagenic activity. A small number of studies gave ambiguous results. All other studies produced negative results consistently. The majority of in vivo assays were negative for mutagenicity and clastogenicity (OECD 2004). Methanol was therefore concluded to be not mutagenic.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	No impairment of fertility or reproductive performance was reported in male and female rats exposed to the chemical, except at very high doses. Male mice had morphological anomalies in spermatozoa after repeated oral dosing at 1000 mg/kg bw/day (blood level > 500 to 1000 mg/L in mice) (OECD 2004). Rodent studies indicate that methanol has developmental toxicity effects. The rodent data on developmental toxicity are relevant for humans despite the known differences in methanol metabolism between the two species. However, rodents are considered adequate models for humans only at levels where formate does not accumulate (NTP 2003). Blood methanol levels associated with serious developmental effects in rodents were in the range associated with formate accumulation (1000 to 2000 mg methanol per litre of blood), which is likely to result in metabolic acidosis, and visual and clinical effects in humans (NTP 2003; OECD 2004). The limited data available in humans do not show an association between reproductive and developmental toxicity and methanol (NTP 2003). Following a review of the developmental toxicity studies, the NTP concluded that there is evidence to suggest that females with low folate levels may be more susceptible to the adverse developmental effects of methanol, but more information was necessary to clarify this issue (NTP 2003). Based on the data available, the chemical is not considered to have reproductive or developmental toxicity in humans.
Acute Toxicity	In rats, mice, rabbits and dogs, the LD50 values after single oral administration range from about 5600 to 14 400 mg/kg bw (EHC 1997). Adverse effects noted in these animals were ataxia, narcosis and coma after high methanol doses. The animals did not exhibit acidosis and ophthalmologic changes typically seen in humans at high lethal and sub-lethal doses In rhesus monkeys, no deaths were reported at doses of 1000 to 2000 mg/kg bw, while animals receiving 3000 to 8000 mg/kg bw died within two days (OECD 2004). Treated animals showed acidosis, and some exhibited semi-coma and ophthalmologic changes. Human data, however, indicate acute oral toxicity at comparatively lower doses of 300 to 1000 mg/kg bw (EHC 1997). The reported median lethal doses (LD50) for experimental animals are 7300 mg/kg bw (mouse), 5628 mg/kg bw (rat), 14 200 mg/kg bw (rabbit) and 7000 mg/kg bw (monkey). The lowest lethal dose (LDLo) for humans ranges from 143 to 428 mg/kg bw (ChemIDplus 2012). There are limited available dermal toxicity studies in animals. In one dermal exposure study all the rats survived after application of 35 000 mg/kg bw methanol to the skin under occlusive conditions, while deaths were reported at 45 000 mg/kg bw (Eulner and Gedicke 1955). In rabbits, a dermal LD50 of 17 000 mg/kg bw was reported although no details of the study were provided (Carnegie-

	Mellon 1981). Limited data in monkeys indicate that the chemical is toxic via the dermal route (McCord 1931). Humans have been found to be more susceptible to methanol as compared to monkeys. Therefore, acute dermal toxicity with methanol is expected in humans (OECD 2004). The lowest reported dermal LD50 is 17 000 mg/kg bw, which was recorded in rabbits. Median lethal concentrations (LC50) of 87.5 and 128.2 mg/L were reported in rats following six and four hour inhalation exposures to methanol, respectively (BASF 1980a, 1980b). Clinical signs of toxicity were secretions from eyes and nose, laboured breathing, staggering, apathy and narcosis. A similar LC50 value (79 mg/L) was reported for mice following 2.25 hours exposure (Von Burg 1994). In cats, LC50 values after six-hour exposures ranged from 26 to 48 mg/L. A shorter duration of 4.5 hours led to an LC50 of 85.4 mg/L (Von Burg 1994). Studies in Rhesus monkeys indicated lethal concentrations (percent mortality not reported) at 13 mg/L after 18 hour exposure and 52 mg/L after one to four hour exposure (OECD 2004).
Irritation	The chemical is not a skin irritant. The chemical is a slight eye irritant in rabbits. High concentration of methanol vapours may cause irritation of the respiratory tract. In a short-term exposure study (details not available), exposure of rats to an atmosphere saturated with methanol vapours produced severe irritation of mucous membranes and milky corneal opacity (BASF 1975). All animals died after eight hours (BASF 1975).
Sensitisation	The chemical is not a skin sensitiser.
Health Effects Summary	Methanol has low acute oral, dermal and inhalation toxicity in experimental animals but moderate to high acute oral and dermal toxicity in humans. A Lowest Lethal Dose (LDLo) of 143 - 428 mg/kg bw (humans) has been reported. It is not a skin or eye irritant but is expected to be a moderate respiratory irritant, based on its effect on the mucous membrane in rats exposed to methanol vapours and on the effects observed in repeat dose inhalation studies. Tests with guinea pigs indicated that methanol is not a skin sensitiser. The critical effects to human health are acute toxicity from inhalation, skin contact and swallowing, and possible irreversible effects from acute oral exposure. No deaths were reported in Rhesus monkeys dosed at 2 000 mg/kg bw, but treated animals showed acidosis, and some exhibited semi-coma and ophthalmic changes. Human data, however, indicate acute oral toxicity and ophthalmic changes at comparatively lower doses of 300 - 1 000 mg/kg bw. Information on repeated dose toxicity by the dermal route is not available. Methanol was not genotoxic or carcinogenic. Reproductive and developmental toxicity studies did not show any significant effects of relevance to humans.
Key Study/Critical Effect for Screening Criteria	A No-Observed-Adverse-Effect-Concentration (NOAEC) of 0.013 mg/L (13 mg/m3) is used for this risk assessment. This NOAEC is derived from a chronic inhalation study in monkeys, in which degenerative effects in the brain and slight damage to the optic and peripheral nerves were noted at 0.13 mg/L and above. Changes in peroneal nerves were also noted in higher dosed animals, indicating damage to peripheral nerves. An oral No Observed Adverse Effect Level (NOAEL) of 500 mg/kg bw/day was also established in rats in a 90-day oral study based on increased liver enzymes (enzymes not specified) and decreased absolute brain weights at the highest dose. This value is not used in this risk assessment because acute oral data indicate that humans are more sensitive to methanol toxicity than rodents.
Ecological Toxicity [2,3]	
Aquatic Toxicity	In several 96-hour studies in fish in which methanol concentrations were measured during the tests, LC50s ranged from 15,400 to 29,400 mg/L. In the chronic toxicity study to invertebrates, the NOEC was 32,000 mg/L.
Determination of PNEC aquatic	A PNECaqua = 3.20E+03 mg/L can be calculated based on the lowest chronic toxicity value for aquatic invertebrates (Daphnia) with the assessment factor of 10.
Current Regulatory Controls[4]	
Australian Hazard Classification	The chemical is classified as hazardous with the following risk phrases for human health in the Hazardous Substances Information System (HSIS) (Safe Work Australia):

	T; R23/24/25 (acute toxicity) T; R39/23/24/25 (irreversible effects from acute exposure) Mixtures containing the chemical are classified as hazardous based on the concentration (Conc) of the chemical in the mixtures. The risk phrases for this chemical are: Conc ≥20%: T; R23/24/25; (Toxic: Toxic by inhalation, in contact with skin and if swallowed); R39/23/24/25; (Toxic: danger of very serious irreversible effects through inhalation, in contact with skin and if swallowed) 10% ≤Conc <20%: T; R20/21/22; (Toxic: Harmful by inhalation, in contact with skin and if swallowed); R39/23/24/25; (Toxic: danger of very serious irreversible effects through inhalation, in contact with skin and if swallowed) 3% ≤Conc <10%: Xn; R20/21/22; (Harmful: Harmful by inhalation, in contact with skin and if swallowed); R68/20/21/22; (Harmful: possible risk of irreversible effects through inhalation, in contact with skin and if swallowed).
Australian Occupational Exposure Standards	The chemical has an exposure standard of 262 mg/m³ (200 ppm) Time Weighted Average (TWA) and 328 mg/m³ (250 ppm) Short-Term Exposure Limits (STEL) (Safe Work Australia).
International Occupational Exposure Standards	The following were identified (Galleria Chemica): 250-270 mg/m³ (200 ppm) TWA in USA, Canada, Denmark, United Kingdom, Germany, France, Estonia, Greece, Hungary, South Africa, Spain, Singapore, Taiwan, Sweden, Malta, Malaysia, Latvia, Japan, Indonesia, India, Iceland, Egypt, Ireland, Mexico, Philippines and Switzerland; 250-350 mg/m³ (250-328 ppm) STEL in USA, Canada, United Kingdom, Greece, South Africa, Singapore, Sweden, India, Egypt and Mexico; 50 mg/m³ TWA in Bulgaria; 100 mg/m³ TWA and 300 mg/m³ STEL in Poland; 133 mg/m³ TWA in Netherlands; 25 mg/m³ TWA and 50 mg/m³ STEL in China; 1300 mg/m³ (1000 ppm) STEL in France; and 1040 mg/m³ STEL in Hungary and Switzerland.
Australian Food Standards	No Australian food standards were identified (FSANZ 2013)
Australian Drinking Water Guidelines	No aesthetic or health-related guidance values were identified for methanol in the Australian Drinking Water Guidelines (National Health and Medical Research Council (NHMRC) 2011).
Aquatic Toxicity Guidelines	No data available.
PBT Assessment	
P/vP Criteria fulfilled?	No. Methanol is expected to be readily biodegradable.
B/vB criteria fulfilled?	No. The Log Kow for methanol is -0.82 to -0.64. Thus, methanol does not meet the screening criteria for bioaccumulation.
T criteria fulfilled?	No. The EC50s from the acute aquatic toxicity data on methanol are >1 mg/L, hence does not meet the screening criteria for toxicity.
Overall conclusion	Not PBT
Revised	January 2019

References

1. NICNAS (2017) Human Health Tier II Assessment for Methanol
2. National Industrial Chemicals Notification and Assessment Scheme (NICNAS, 2017). National assessment of chemicals associated with coal seam gas extraction in Australia. Human health hazards of chemicals associated with coal seam gas extraction in Australia.
3. OECD (2008) SIDS Initial Assessment Profile on Methanol
4. ECHA REACH, Methanol, Retrieved 2017: https://echa.europa.eu/information-on-chemicals/registered-substances
5. IPCS Acetic Acid, Retrieved 2015: http://www.inchem.org

Toxicity Summary - Polyethylene glycol

Chemical and Physical Properties	
CAS number	[redacted]
Molecular formula	(C2H4O)nH2O
Molecular weight	UVCB
Solubility in water	40 g/L @ 30 °C
Melting point	-10 °C at 101.3 kPa
Boiling point	870 °C at 101.3 kPa
Vapour pressure	0 Pa @ 25 °C
Henrys law constant	No data available
Explosive potential	Non explosive
Flammability potential	Non flammable
Colour/Form	Odourless, viscous transparent organic liquid
Overview	Polyethylene glycols, also known as PEGs, are clear, colourless, thick liquids to waxy solids, depending on the molecular weight. The molecular weight of PEGs ranges from 200 to over 6000. Some may have a faint odour and bitter taste. PEGs mix easily with water. PEGs are important commercial chemicals. They are used to make other chemicals, paper coatings, solvents, plasticizers and used in many household products, cosmetics and pharmaceuticals. One formulation, PEG 3500, is used as a laxative. PEGs are also used as food and animal feed additives.
Environmental Fate[1]	
Soil/Water/Air	Koc value of PEG was estimated as 10 L/kg by means of MCI method. This indicates that PEG will have a negligible tendency of sorption to soil and sediment and therefore have rapid migration potential to groundwater. The estimated half-life of the substance indicates that the substance is rapidly hydrolysable.
Human Health Toxicity Summary [1]	
Chronic Repeated Dose Toxicity	The substance PEG exhibits repeated dose toxicity by oral, dermal and inhalation route. A study was designed to investigate the subacute repeated dose toxicity effects of Polyethylene Glycols (PEG 400) in Wistar rats (male/female) by oral route, in an overall study period of 90 days. Dose group (5 animals per group) was fed a solution ofPEG400 equivalent to 0, 2000, 4000, 8000, 16000 or 24000 mg/kg/day in the diet. The control group received no polyethylene glycol. During the study period, body weight as a ratio to the amount of nutrient consumed, body weight, liver weight, kidney weight, micro pathology of liver and kidneys were examined. No effects upon male and female rats were observed when PEG 400 was present in the diet at a level up to 8000 mg/kg/day (8%concentration) for 90 days study period. But at 16000 mg/kg/day it showed effects on organ weight (liver and kidney heavier than that of control rats); and a decrease in weight gain was observed. Thus, from overall conclusion of the study the NOAEL (no observed adverse effect level) for repeated dose oral toxicity was considered to be 8000 mg/kg/day. And the LOAEL (low observed adverse effect level) for subacute repeated dose toxicity was considered to be 16000 mg/kg/day. Rats were exposed to airborne concentrations of 100 mg/m^3 and 1000 mg/m^3 of PEG-200 for periods up to 13 weeks. Toxicological, physiological, hematological, blood chemical, and pathological effects were evaluated during the course of the exposures. No significant lesions observed in this study occurred exclusively in exposed animals and the severity of lesions which were found was not dose-related. It is our impression that there were no PEG 200 induced lesions in rat tissue at the dosage level and exposure/post exposure periods evaluated in this study. Organ:body weight ratios in rats at all concentrations and for the 6- and 13-week exposure periods and the 30-day post exposure period showed no pattern

	of significance that could be related to PEG 200. The mice organ:body weights for the 6-week·exposure period are unavailable. No pattern of significance could be related to PEG 200 exposure for the 13-week or the 30-day post exposure periods. There were no consistently significant changes in rat blood chemistry at the end of the 6- or 13-week exposures or the 30-day post exposure period. It appears that PEG-200 produced no positive effects in the rodents at the Inn and 1000 mg/m3 PEG 200 concentrations over the 13 weeks of exposure used in this study. Thus it is concluded that the NOAEC value of PEG-200 in rats was observed at dose level of 1000 mg/m^3. The NOAEL value of PEG in rabbit was observed at dose level of 760 mg/kg bw/day. The supporting study indicates the TDLo (TDLo - Lowest published toxic dose) of PEG was observed at a dose concentration of 30 mL/kg (30000 mg/kg) in a 30 days study period where the dosage of PEG was intermittently given to rodent-rabbit by the dermal route(full study is not available). Considering the above results it is concluded that PEG is non-toxic by dermal route.
Carcinogenicity	No data available.
Mutagenicity/ Genotoxicity	PEG was found to be non-genotoxic.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	The one generation reproductive toxicity NOAEL (no observed adverse effect level) of PEG in rat was observed at a dose concentration of 1698.09 mg/kg bw/day. On the basis of this NOAEL value it indicates that PEG does not exhibit toxic effects to rat below the above mention dose.
Acute Toxicity	Acute toxicity of PEG to mouse by the oral route indicates that the substance does not exhibits acute toxicity by the oral route. Similarly the acute values of inhalation also indicate that the substance does not exhibits acute toxicity by the inhalative route. Thus, it can be inferred that the target substance is non-toxic to any of the oral, dermal and inhalation route of exposure.
Irritation	The available studies indicate that the substance PEG is not classified as a skin and eye irritant according to CLP regulation within the dose levels mentioned in the study.
Sensitisation	In the human repeat insult patch test 216 subjects were enrolled and 200 subsequently completed the study. PEG 200 caused some degree of sensitization response in 1 of the 200 subjects. This subject was a 61 year old white woman.
Health Effects Summary	PEG is non acute toxic to oral, dermal and inhalation route, shows no irritation effect to skin and eye, is not genotoxic and is not developmental and reproductive toxic.
Key Study/Critical Effect for Screening Criteria	Oral: In chronic repeated dose toxicity study by polyethylene glycols (PEG) 400 showed no effect upon male and female dogs when present in the diet at a level of 500 mg/kg/day (2% concentration) for one year. Thus NOAELs (no observed adverse effect level) for repeated dose oral toxicity was considered to be 500 mg/kg/day. Inhalation: The NOAEC value of PEG-200 in rats was observed at dose level of 1000 mg/m^3. Dermal: The NOAEL value of PEG in rabbit was observed at dose level of 760 mg/kg bw/day.
Ecological Toxicity [1]	
Aquatic Toxicity	The toxicity values of fish, invertebrates and algae are LC50 = 100 mg/L, LC50 = 1000 mg/L and EC 50 = 15.91 mg/L, respectively.
Determination of PNEC aquatic	Acute LC50 values are reported for fish, aquatic invertebrates, and freshwater algae. Since there is valid acute toxicity data for three trophic levels, an assessment factor of 1000 is used (in accordance with EU guidance). Based on the EC50 for freshwater algae (the most sensitive species in short term tests), the aquatic PNEC is 15.91 µg/L.
Current Regulatory Controls	
Australian Hazard Classification	No data available.

Australian Occupational Exposure Standards	No data available.
International Occupational Exposure Standards	No data available.
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	No data available.
PBT Assessment [1]	
P/vP Criteria fulfilled?	No. PEG is non persistent in nature and so is considered to have rapid biodegradation in the environment.
B/vB criteria fulfilled?	No. The calculated BCF of PEG is 3.2 dimensionless and below the threshold of 2000.
T criteria fulfilled?	No. Acute toxicity data >1 mg/L in fish, invertebrates and algae, thus PEG does not meet the screening criteria for toxicity.
Overall conclusion	Not PBT
Revised	January 2019

References

1. ECHA REACH European Chemicals Agency Database: http://apps.echa.europa.eu

Toxicity Summary - Sodium carbonate

Chemical and Physical Properties[1,2,3,4,6]	
CAS number	[redacted]
Molecular formula	Na_2CO_3
Molecular weight	105.99 g/mol
Solubility in water	215 g/l at 20 °C
Melting point	851 °C
Boiling point	Decomposition
Vapour pressure	No data found
Henrys law constant	No data found
Explosive potential	It reacts violently with acids and reacts with magnesium, phosphorous pentoxide causing explosion hazard
Flammability potential	Reacts with fluorine causing fire hazard
Colour/Form	White powder
Overview	Sodium carbonate has been reviewed in the OECD-SIDS program (OECD, 2002a,b).Sodium carbonate is a strong alkaline compound with a pH of 11.6 for a 0.1M aqueous solution. The pKa of carbonate (CO3 2-) is 10.33, which means that at a pH of 10.33 both carbonate and bicarbonate are present in equal amounts. In water, sodium carbonate dissociates into sodium ion (Na+) and carbonate (CO3 2-). The carbonate ions will react with water, resulting in the formation of bicarbonate and hydroxide, until equilibrium is established. Sodium carbonate is used in many countries (e.g. U.S. and EU) as a food additive. It is regarded as a 'Generally Recognised as Safe' (GRAS) substance in food with no limitation other than current good manufacturing practice. Sodium carbon is extensively used across a range of industries and processes such as in the manufacturing of sodium salts, glass, soap/detergents and aluminium. Inorganic substance comprising ions of low ecotoxicological concern. This chemical is not expected to pose an unreasonable risk to the environment provided that ANZECC water quality guidelines for physical and chemical stressors are not exceeded.
Environmental Fate[1,2,3,4]	
Soil/Water/Air	The high water solubility and low vapor pressure indicate that sodium carbonate will be found predominantly in the aquatic environment. In water, sodium carbonate dissociates into sodium (Na+) and carbonate (CO3 2-) and both ions will not adsorb on particulate matter or surfaces and will not accumulate in living tissues.
Human Health Toxicity Summary[1]	
Chronic Repeated Dose Toxicity	No chronic oral and dermal data are available. Due to the biological importance of the products formed by the stomach acid (biocarbonate and carbon dioxide), systemic toxicity is not expected. In rats, histopathological changes of the respiratory tract and the lungs were seen following repeated inhalation exposure to sodium carbonate (70 mg/m^3 aqueous sodium cabonate at pH 11.6 for 3.5 months) and potassium carbonate (0.4 mg/L potassium carbonate at pH 9.9 for 21days). These effects were considered local responses to the high alkalinity of this group of chemicals (OECD, 2002; REACHa; REACHb).
Carcinogenicity	No data are available. Based on the available data from carcinogenicity studies with related substances (sodium bicarbonate and potassium bicarbonate), the chemicals in this group are not considered carcinogenic (OECD, 2002; REACHa; REACHb). Carbonate ions are neutralised under physiological conditions to form bicarbonate ions and/or carbon dioxide, which are major products of all human metabolic activities; therefore, systemic toxicity is not expected.

Mutagenicity/ Genotoxicity	Based on the available data, this chemical is not considered to be genotoxic (OECD, 2002; REACHa; REACHb). Carbonate ions are neutralised under physiological conditions to form bicarbonate ions and/or carbon dioxide, which are major products of all human metabolic activities; therefore, systemic toxicity is not expected.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	Based on the limited information available, this chemical does not show specific reproductive or developmental toxicity (OECD, 2002; REACHa; REACHb). Carbonate ions are neutralised under physiological conditions to form bicarbonate ions and/or carbon dioxide, which are major products of all human metabolic activities; therefore, systemic toxicity is not expected.
Acute Toxicity	In animal tests, this chemical was of low acute toxicity following oral exposure. The median lethal dose (LD50) was >2000 mg/kg bw in rats (OECD, 2002; REACHa; REACHb).The majority of the animals that died following acute oral exposure to sodium carbonate at concentrations up to 2600 mg/kg/bw showed oral or nasal discharge, lesions in the liver, mottled lungs, mottled or pale kidneys and a red or partly gas-filled gastro-intestinal tract. In animal tests, this chemical was of low acute toxicity following dermal exposure. The median lethal dose (LD50) was >2000 mg/kg bw in rats (OECD, 2002; REACHa; REACHb). No systemic effects were observed following dermal exposure to sodium carbonate. Local severe skin irritation (severe erythema and oedema) was seen at the application site (OECD, 2002; REACHa; REACHb). In animal tests, this chemical was of low acute toxicity following inhalation exposure. The median lethal dose (LC50) was >2000 mg/m^3 in rats (OECD, 2002; REACH, a & b). Signs of respiratory impairment including dyspnoea, wheezing, excessive salivation and a distended abdomen were observed immediately after inhalation exposure to sodium carbonate of up to 2300 mg/m^3. Excessive salivation, repeated swallowing and a lack of appetite were observed 2–5 hours after exposure. Animals that died had lesions in the anterior trachea, posterior pharynx and larynx, along with an accumulation of mucus, vesiculation and mucosal oedema (REACHa).
Irritation	Sodium carbonate is classified as hazardous with the risk phrase 'Irritating to eyes' (Xi; R36) in HSIS (Safe Work Australia). However, in several eye irritation studies in rabbits, sodium carbonate was found to be severely irritating to the eyes, with effects including conjunctivitis, marked corneal opacity and iritis, which persisted for seven days (REACHa; REACHb). The available data support an amendment to the current HSIS eye irritation classification for sodium carbonate.
Sensitisation	Based on the limited data available, sodium carbonate is not considered to be skin sensitisers (OECD, 2002; REACHa; REACHb). No structural flags for sensitisation are present.
Health Effects Summary	The critical health effects for risk characterisation include serious eye damage and respiratory irritation because of the high basicity of the chemicals in this group. Skin irritation and corrosion of eyes and mucous membranes are also of concern where long-term exposure to the solid or concentrated solutions may occur. These effects are particularly relevant to domestic use of the chemicals.
Key Study/Critical Effect for Screening Criteria	The Australian drinking water screening value for sodium (180 ppm, aesthetic) and pH may apply to sodium carbonate.
Ecological Toxicity [1,2,3,4]	
Aquatic Toxicity	The acute 96-hour LC50 to three sizes of Bluegill sunfish (*Lepomis macrochirus*) exposed to sodium carbonate is 300 mg/L for all sizes. The acute 96-hour LC50 to mosquitofish (*Gambusia affinis*) is 740 mg/L. The acute 48-hour EC50 value to the invertebrate *Ceriodaphnia* cf. *dubia* is from 200 to 227 mg/L.
Determination of PNEC aquatic	PNECaquatic: Experimental results are available for two trophic levels. Acute E(L)C50 values are available for fish (300 mg/L) and *Ceriodaphnia* (200 mg/L). On the basis that the data consists of short-term results from two trophic levels, an assessment factor of 1,000 has been applied to the lowest reported effect concentration of 200 mg/L for Daphnia. The PNECaquatic is 0.2 mg/L.

Current Regulatory Controls[1]	
Australian Hazard Classification	Sodium carbonate is classified as hazardous, with the following risk phrases for human health in the Hazardous Substances Information System (HSIS) (Safe Work Australia): 'Xi; R36 (Irritating to eyes)'.
Australian Occupational Exposure Standards	Sodium carbonate has an exposure standard of 7.5 mg/m^3 (5 ppm) time weighted average (TWA) and 15 mg/m^3 (10 ppm) short-term exposure limit (STEL) (Safework Australia).
International Occupational Exposure Standards	Occupational exposure standard limits for sodium and potassium carbonate recommended by other countries are provided below (Galleria Chemica, 2013): US Dept of Energy (DOE) Temporary Emergency Exposure Limits (TEELs): Sodium carbonate: TEEL-0 = 10 mg/m^3 , TEEL-1 = 30 mg/m^3 , TEEL-2 = 50 mg/m^3, TEEL-3 = 500 mg/m^3 No other country has an occupational exposure limit specifically for sodium and potassium carbonate, although many countries have assigned a generic TWA exposure limits of 10 mg/m^3 (inhalable dust), and 3 mg/m^3 (respirable dust) for particles not otherwise classified (PNOC).
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	No data available.
PBT Assessment[4,6]	
P/vP Criteria fulfilled?	Not applicable, inorganic substance, ubiquitous in environment.
B/vB criteria fulfilled?	Not applicable. Bioaccumulation is not applicable to these inorganic ions.
T criteria fulfilled?	No chronic toxicity data exist; however, the acute EC(L)50s are >0.1 mg/L. Thus, does not meet the screening criteria for toxicity
Overall conclusion	Not PBT
Revised	March 2019

References

1. National Industrial Chemicals Notification and Assessment Scheme (NICNAS). IMAP, Human Health Tier II Assessment for Alkaline Salts-Carbonates: Retrieved 2019: https://www.nicnas.gov.au
2. HSDB Hazardous Substances Data Bank. U.S. National Library of Medicine, < http://toxnet.nlm.nih.gov/>,
3. OECD (2011) SIDS Initial Assessment Report for SIAM 15 (OECD SIDS). *Sodium carbonate: CAS Nº:*[redacted]- [redacted] United Nations Environment Programme (UNEP) Publications. From http://www.chem.unep.ch/irptc/sids/OECDSIDS/Naco.pdf,
4. ICPS (2004). *Sodium carbonate (anhydrous): Summary*. October 2004. International Programme on Chemical Safety and the Commission of the European Communities (IPCS and CEC). From http://www.inchem.org/documents/icsc/icsc/eics1135.htm
5. Department of the Environment and Energy 2017, National assessment of chemicals associated with coal seam gas extraction in Australia, prepared by the National Industrial Chemicals Notification and Assessment Scheme
6. ECHA REACH, Sodium carbonate, Retrieved 2019: https://echa.europa.eu/

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Toxicity Summary - Sodium Erythorbate

Chemical and Physical Properties[1,2]	
CAS number	[redacted]
Molecular formula	C6H7NaO6
Molecular weight	199.13
Solubility in water	Soluble; 146 g/L at 20 °C and pH 6
Melting point	160 °C at 101.3 kPa
Boiling point	No data available.
Vapour pressure	No data available.
Henrys law constant	No data available.
Explosive potential	No data available.
Flammability potential	Non-flammable (100%)
Colour/Form	White, free-flowing crystals
Overview	Sodium erythorbate is a synthetic antioxidant used in food and cosmetic formulations. Foliar application of sodium erythorbate sprays and dusts are used to control young tree decline in citrus trees and to reduce ozone damage to Thompson seedless grapes. It is also used in hydraulic fracturing mixtures to prevent precipitation of metal oxides (iron control). This chemical has been identified by NICNAS to be of low concern to human health based on an initial screening approach and thus required no further assessment.
Environmental Fate[1]	
Soil/Water/Air	The chemical is not expected to be readily biodegradable. The chemical achieved 56% degradation in 28 days according to test guidelines OECD 301E. However, the degradation after 28 d was not yet finished as a plateau is not yet visible in the degradation curve; thus, a further degradation of the product seems to be possible.
Human Health Toxicity Summary[1]	
Chronic Repeated Dose Toxicity	Male 6-week-old F344 rats were given doses of 5% Sodium Erythorbate in feed for 168 days. Parameters of urinary excretion were investigated and the urinary bladder epithelium was examined using light and scanning electron microscopy at weeks 8, 16, and 24. The urine of rats fed Sodium Erythorbate had increased pH, elevated content of crystals and sodium, and decreased osmolality; however, no morphological alterations such as hyperplasia were detected in the mucosa. The urine values and urinary bladder mucosa were similar to controls at doses below 5 g/kg/day.

Carcinogenicity	F344/DuCrj rats of both sexes (6-week-old) were given 1.25% or 2.5% Sodium Erythorbate in drinking water for 104 weeks and untreated water for 8 additional weeks. Rats of the control group were given untreated water only. Each group consisted of 52 male and 50 female rats. Cumulative consumption of Sodium Erythorbate by male rats was 217 g/rat (1.25%) and 430 g/rat (2.5%). Consumption by females was 206 g/rat (1.25%) and 583 g/rat (2.5%). Body weight of rats given 2.5% Sodium Erythorbate was reduced by 8.5% for males and 15.5% for females at weeks 88 and 85, respectively, compared to controls. Body weight gain was normal in rats of the low dose group. All male treated and control rats (except two of the high-dose group) had testicular interstitial cell tumours. Various tumours occurred in 80% of control males, 69% of males given the low dose, and 78% of males given the high dose. A 6-18% incidence of leukaemia, pheochromocytoma, mammary fibroadenoma, and mesothelioma was observed. Of the females of the control, 1.25%, and 2.5% dose groups, 94%, 88%, and 78% had tumours, respectively. Twenty to 43% of females (all groups) had leukaemia, mammary fibroadenoma, endometrial stromal polyp and/or pituitary adenoma. Females given 2.5% Sodium Erythorbate had significantly fewer tumours than control females. The pattern of occurrence of the various types of tumours was similar among the groups. Sodium Erythorbate did not enhance the development of rare spontaneous tumours or transform benign tumours (e.g., solid adenoma of the thyroid) to carcinomas. The investigators concluded that Sodium Erythorbate was not carcinogenic in F344 rats.
Mutagenicity/ Genotoxicity	Sodium Erythorbate (99.8% pure; 5.0 mg/plate) was non-mutagenic in S. typhimurium strains TA92, TA94, TA98, TA100, TA1535, and TA1537 with and without S9 activation. Sodium Erythorbate (0.25 mg/mL plate) was also negative in the chromosomal aberration assay using Chinese hamster fibroblasts; Sodium Erythorbate did not induce the formation of polyploid cells after 48 hours, and caused 1 % chromosomal breaks after 24 hours.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	Sodium erythorbate did not cause maternal or fetal toxicity when administered to female rats and mice during gestation by oral intubation at dosages up to 1,030 mg/kg/day. Developmental toxicity did not occur after pregnant rats were given up to 5% sodium erythorbate in feed during a 13-week teratogenesis study. It produced negative results in the Ames test, the host-mediated assay using S. typhimurium, chromosomal aberration tests using Chinese hamster ovary fibroblasts, the dominant lethal test using rats, and the B. subtilis rec assay.
Acute Toxicity	Sodium erythorbate powder was applied to the intact and abraded skin of six rabbits as a single 2 g/kg dose. A substantial amount of residual compound was observed 24 hours after dosing. No erythema, edema, or other signs of dermal irritation were observed at five of six test sites. One rabbit (abraded skin) had slight (1+) erythema at 24 hours that cleared by 48 hours.
Irritation	Sodium erythorbate powder did not cause signs of dermal irritation when applied to the intact and abraded skin of rabbits. Instillation of sodium erythorbate powder to the conjunctival sac of rabbits caused slight and transient reddening of the conjunctiva that cleared within 24 hours.
Sensitisation	In a dermal sensitization study (according to OECD 429) with Sodium erythorbate (5, 10, 25% w/w in propylene glycol), young adult female CBA/Ca (CBA/CaOlaHsd) mice (4/group) were tested using the local lymph node assay (LLNA). In this study, Sodium erythorbate was not considered a potential skin sensitizer.
Health Effects Summary	Sodium erythorbate did not show signs of toxicity, carcinogenicity, mutagenicity, irritation and sensitisation in the studies reported. This chemical has been identified by NICNAS to be of low concern to human health.
Key Study/Critical Effect for Screening Criteria	The Australian drinking water guideline value for sodium may apply.

Ecological Toxicity [1,2]	
Aquatic Toxicity	The acute toxicity of the sodium erythorbate to the freshwater fish rainbow trout (Oncorhynchus myldss) has been investigated and gave a 96-Hour LC50 of greater than 100 mg/L (semi-static). The acute toxicity of sodium erythorbate to Daphnia magna gave an EC50 (48 h) of 84 - 100 mg/L. The effect of the test item on the growth of Pseudokirchneriella subcapitata has been investigated over a 72-Hour period. The EC50 (72 h) was 160 mg/L while the NOEC (72 h) was 20 mg/L.
Determination of PNEC aquatic	A PNECaquatic of 84 µg/L was calculated using the lowest endpoint of EC50 of 84 mg/L for Daphnia magna. An assessment factor of 1000 was used.
Current Regulatory Controls[4]	
Australian Hazard Classification	No data available.
Australian Occupational Exposure Standards	No data available.
International Occupational Exposure Standards	No data available.
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	No data available.
PBT Assessment	
P/vP Criteria fulfilled?	Could potentially be persistent as it is not readily biodegradable.
B/vB criteria fulfilled?	No. The Log Pow is -3.29 (Log Pow < 4.5) which does not meet the screening criteria for bioaccumulation.
T criteria fulfilled?	No. Based on measured acute toxicity endpoints of greater than 1 mg/L Sodium erythorbate does not meet the screening criteria for toxicity.
Overall conclusion	Not PBT
Revised	April 2019

References

1. HSDB (n.d.). *Hazardous Substances Data Bank*. Retrieved 2015, from Toxnet, Toxicology Data Network, National Library of Medicine: http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB
2. ECHA REACH, 2,3-didehydro-3-O-sodio-D-erythro-hexono-1,4-lactone, Retrieved 2019: https://echa.europa.eu/
3. Department of the Environment and Energy 2017 , National assessment of chemicals associated with coal seam gas extraction in Australia, prepared by the National Industrial Chemicals Notification and Assessment Scheme

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Toxicity Summary - Starch

Chemical and Physical Properties[1,2,4,6]	
CAS number	[redacted]
Molecular formula	(C6H10O5)n
Molecular weight	UVCB
Solubility in water	In cold water, starch absorbs water reversibly and swells slightly. In hot water, irreversible swelling occurs, producing gelatisation.
Melting point	No data available.
Boiling point	No data available.
Vapour pressure	No data available.
Henrys law constant	No data available.
Explosive potential	Combustible
Flammability potential	No data available.
Colour/Form	White powder, tasteless and has no smell
Overview	Starch is a high –polymeric carbohydrate material primarily composed of amylopectin and amylose. It is usually derived from cereal grains such as corn, wheat and sorghum and from roots and tubers such as potatoes and tapioca. It includes starch which has been pregelatinized by heating in the presence of water. This chemical has been identified by NICNAS to be of low concern to human health and thus required no further assessment.
Environmental Fate[7]	
Soil/Water/Air	Based on information from NICNAS (2006): In a ready biodegradation test, the notified polymer (Potato Starch Modified) showed an 86.87% degradation during a Modified Sturm Test (OECD Test Guideline 301B) indicating that it was readily biodegradable. The test was verified using a sodium benzoate standard which showed 93.77% degradation at the end of the study. In addition a toxicity control consisting of a mixture of the test substance and sodium benzoate showed 83.49% degradation at the end of the study period, indicating that the test material did not inhibit the microbial activity. The notified polymer does potentially contain cationic and anionic functional groups, however based on the typical dissociation constants for the functionalities and their ratio within the polymer it is expected to have a net anionic charge throughout most of the environmental pH range, becoming slightly cationic only at the low end of the range. In landfill and the sewer, the notified chemical is expected to be relatively readily degraded by biotic and abiotic pathways to ultimately yield water and oxides of carbon and nitrogen and salts of chlorine and sodium. Any incineration of the notified polymer would result in its destruction and the formation of carbon dioxide and water and ash containing salts of chlorine and sodium. The notified polymer has a high molecular weight not expected to bioaccumulate.

Human Health Toxicity Summary[2,3]	
Chronic Repeated Dose Toxicity	A long-term study was carried out on the effects of inoculating 1.5 g of starch powder into the peritoneal cavity of rats. After an initial considerable inflammatory reaction, the intense vascular reaction subsided, leaving firm adhesions that were still present in animals sacrificed at 18 months (Ell90). Feeding of unmodified cornstarch and potato starch to groups of rats at dietary levels up to 30% (equivalent to 27.4-33.6 g/kg bw/d) in a 2-year test and 10% (food intake not indicated) in a 3-generation test did not result in distinct toxicologically significant effects (Gro74). Rats fed a cooked diet containing 62% unmodified maize starch (equivalent to 51.1 g/kg bw/d*) for 2 years also did not show significant toxicological effects, including reproductive effects over 3 generations (Tru79). Slight growth retardation was seen in rats exposed for 4 weeks to raw potato starch at a dietary level of 40% (equivalent to 46.0-52.8 g/kg bw/d) (Fer73).
Carcinogenicity	Not classifiable as a human carcinogen (A4)
Mutagenicity/ Genotoxicity	There were no indications for significant toxicity, carcinogenicity or reproduction toxicity of starch in rats fed 27.4-52.8 g/kg bw/day.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	There were no indications for significant toxicity, carcinogenicity or reproduction toxicity of starch in rats fed 27.4-52.8 g/kg bw/day.
Acute Toxicity	Toxicity of starch given orally to albino rats were studied. Experiments were performed upon CBL albino rats weighing 140 ± 15 (mean ± S.D.). Starch was given daily for 14 consecutive days in total daily oral doses of 36, 72, 120 and 168 g/kg and in animals which did not succumb to gastric rupture in doses gradually increasing to 204, 240 and 288 g/kg. Gastric rupture appeared in 50 – 75% of rats given starch in amounts of 168 g/kg and over. Of the survivors of gastric rupture, 5% died of pneumonia and 20% from bowel obstruction during the 14 days of starch administration. Doses of one tenth body weight and above produced some inhibition of growth, doses of one fifth body weight and above increased the susceptibility to pneumonia and bowel obstruction owing to the inability of the animal to evacuate the starch calculi. It was noted that doses of this order could not readily be taken by humans and smaller doses had insignificant toxicity. Acute respiratory effects after exposure to dust from the refining process of potato starch have been described (personal sampling: 3.9-56.0 mg/m^3, total dust). The responsible agent could not be identified although the authors suspected endotoxin to be the causative agent (Hol94). Millers and bakers occupationally exposed to grain and flour dusts (personal sampling: 1.1-14.3 mg/m^3, total dust) showed significantly higher incidences of coughing and chronic bronchitis compared to a non-exposed reference group (Mas95, Mas96). A dose-response relationship was observed between dust exposure levels and chronic respiratory symptoms (Mas95). Although flour is a complex product that is mainly made up of starch (70%) and gluten (12%), it may also contain mite dust and endotoxins. The causative role of starch in the observed respiratory symptoms is therefore not clear. The intraperitoneal LD50 of starch in mice is 6600 mg/kg (ACG99).
Irritation	Skin contact with a total dose of 300 µg of starch, intermittently applied over a 3-day period, resulted in a mild erythema and slight oedema of the skin in humans (ACG99).
Sensitisation	No data available.
Health Effects Summary	This chemical has been identified by NICNAS to be of low concern to human health.
Key Study/Critical Effect for Screening Criteria	The intraperitoneal LD50 of starch in mice is 6600 mg/kg (ACG99).

Ecological Toxicity[7]	
Aquatic Toxicity	Based on QSAR modelling: Crassostrea virginica 96 h = 1000 mg/L Orthopristis chrysoptera 96 h = 5000 mg/L Bairdiella chrysoura 96 h = 5000 mg/L
Determination of PNEC aquatic	Based on the lack of ecotoxicity data, PNECaquatic was not determined.
Current Regulatory Controls[2,4]	
Australian Hazard Classification	No data available.
Australian Occupational Exposure Standards	TWA = 10 mg/m^3
International Occupational Exposure Standards	TLV: 10 mg/m^3, as TWA The current administrative occupational exposure limit (MAC) for starch in the Netherlands is 10 mg/m^3, 8-hour TWA, equal to the occupational exposure limit for nuisance dust.
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	No data available.
PBT Assessment	
P/vP Criteria fulfilled?	No. This substance is expected to be readily biodegradable.
B/vB criteria fulfilled?	No. This substance is not expected to be bioaccumulative.
T criteria fulfilled?	Based on QSAR modelling, this substance is not expected to meet the toxicity criteria.
Overall conclusion	Not PBT
Revised	April 2019

References

1. ECHA REACH, Starch, Retrieved 2019: https://echa.europa.eu/
2. IPCS Starch, Retrieved 2019: http://www.inchem.org
3. Boyd, E. M., & Liu, S. J. (1968). Toxicity of starch administered by mouth. Canadian Medical Association journal, 98(10), 492–499.
4. Health Council of the Netherlands: Committee on Updating of Occupational Exposure Limits. Starch; Health-based Reassessment of Administrative Occupational Exposure Limits. The Hague: Health Council of the Netherlands, 2002; 2000/15OSH/038.
5. Safe Work Australia, Hazardous Substances System, Starch, Retrieved 2019: http://hcis.safeworkaustralia.gov.au/
6. National Industrial Chemicals Notification and Assessment Scheme (NICNAS). IMAP, Human Health Tier 1 Assessment. Retrieved 2019: https://www.nicnas.gov.au
7. Daugherty,F.M.J Sewage Ind. Wastes 23(10):1282-1286. Effects of Some Chemicals Used in Oil Well Drilling on Marine Animals
8. NICNAS (2006) Potato Starch Modified, Full Public Report, File No PLC/639

Toxicity Summary - Xanthan Gum

Chemical and Physical Properties[1,3]	
CAS number	[redacted]
Molecular formula	Unspecified
Molecular weight	high-molecular weight (of the order of 1000 kDa)
Solubility in water	Water-soluble
Melting point	No data available.
Boiling point	No data available.
Vapour pressure	No data available.
Henrys law constant	No data available.
Explosive potential	No data available.
Flammability potential	No data available.
Colour/Form	No data available.
Overview	Xanthan gum is a high molecular weight anionic polysaccharide secreted by the bacteria *Xanthomonas compestris*. It is used as a stabilizer and thickener for foods, pharmaceuticals, and cosmetics, for rheology control in water-based systems, and in oil and gas drilling. Xanthan gum is used for controlling the viscosity of drilling muds (DoE 2014). This chemical has been identified by NICNAS to be of low concern to human health based on an initial screening approach and thus required no further assessment.
Environmental Fate[1]	
Soil/Water/Air	Xanthan gum is expected to exhibit similar behaviour to that of guar gum because the two compounds are chemically similar. Thus, it is expected to adsorb strongly to soil and sediment and there is limited potential for it to reach surface waters via dissolved runoff and / or to leach into ground water. Volatilisation from soils and water is not considered to be a likely transport process in the environment (US EPA 2005). Xanthan gum is expected to readily undergo microbial biodegradation in the environment (on the bases that it is polysaccharide and expected to be readily biodegradable), and the potential to bioaccumulate in organisms is considered to be low.
Human Health Toxicity Summary[2]	
Chronic Repeated Dose Toxicity	Groups of 30 male and 30 female Charles River CD strain rats were fed diets for 104 weeks supplying O, 0.25, 0.5, or 1.0 g/kg b.w./day xanthan gum. No abnormalities which could be attributed to ingestion of these experimental diets were found with regard to survival, body-weight gain, food consumption, behaviour, or appearance. Ophthalmic and haematologic examination yielded normal results. Analysis of blood for glucose, SGOT, and prothrombin time showed no abnormalities in test groups. Organ weights were within normal limits and no lesions attributable to xanthan gum were found on gross and histopathological examination (Woodard et al., 1973). Xanthan gum was administered in the diet at levels supplying 0, 0.25, 0.37, or 1.0 g/kg b.w./day to groups of 4 male and 4 female beagle dogs for 107 weeks. No effects attributable to administration of the gum were seen in the treated animals with regard to survival, food intake, body-weight gain, electrocardiograms, blood pressure, heart rate, body temperature, or ophthalmic and neurological examinations. Haemoglobin, total and differential white cell counts, coagulation and prothrombin times, thrombocyte counts, serum alkaline phosphatase, blood urea nitrogen, blood glucose, SGOT, and SPGT were the same in control and treated animals. Urine pH, glucose concentrations, and sediment contents were comparable between test and control groups, but there was a dose-related

	increase in urine SG and a more frequent appearance of urinary albumin in dogs consuming 1.0 g/kg b.w./day of gum than in the other groups. Stool consistency was normal at the 0.37 g/kg level, but stools were loose at the top-dose level. The weight of the faeces showed a dose-related increase, as would be expected from feeding a non-absorbed hydrophilic gum at high-dose levels. The increased urinary SG is consistent with physiological adjustment for the extra water excreted in the faeces. Examination of the appearance and weights of organs and histopathological examinations failed to detect any adverse effects of treatment with xanthan gum at any dose level (Woodward et al.,1973).
Carcinogenicity	No data available.
Mutagenicity/ Genotoxicity	No data available.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	A three-generation reproduction study was carried out using groups of 10 male and 20 female rats in the first generation and 20 male and 20 female rats in subsequent generations. Dosage levels of 0, 0.25, and 0.5 g/kg/day were administered in the diet. Criteria evaluated were survival, body weight, general appearance, behaviour, the number of litters produced, number of live births and still births, physical condition of the young, weight at birth and weaning, and survival of the young. Females that had fewer than two litters were examined to determine whether there was foetal resorption. Malformations in offspring were recorded and gross and micropathological examinations were made on the offspring of the second and third generations. No adverse effects attributable to xanthan gum were found in this study (Woodard et al., 1973).
Acute Toxicity	A study was carried out on an unspecified number of rats fed diets containing 7.5 or 10% xanthan gum for 99-110 days. No adverse effects were observed in extensive investigatins on these animals (Booth et al., 1963). In a 91-day feeding study, a reduced rate of weight gain was found in groups of rats receiving 7.5 or 15% xanthan gum in the diet. Diets containing 3 or 6% gum did not reduce weight gain. No significant alterations in haemoglobin, red or white cell counts, or organ weights were observed in these rats. Histological examination of tissues from rats at the 15% level showed no pathological effects. At the highest-dose level the animals produced abnormally large faecal pellets, but diarrhoea did not occur. A paired-feeding test was used to compare the growth of rats ingesting a diet containing 7.5% xanthan gum and comparable rats restricted to the same intake of control diet. No differences in weight gain were found at the end of 18 days, indicating the absence of a growth-inhibiting factor (Booth et al.,1963). Groups of 3 male and 3 female beagle dogs were fed diets supplying 0, 0.25, or 0.5 g/kg b.w./day xanthan gum for 12 weeks. Animals in the high-dose group had softer stools than normal, but no diarrhoea. Growth was slightly retarded in the males and the serum cholesterol level was lowered in both sexes of the high-dose group. No other adverse effects were seen. The no-adverse-effect-level in this test was considered to be 0.25 g/kg b.w./day (USDA, 1964).
Irritation	Daily application of a 1% solution for 15 days to rat skin produced no signs of irritation. Daily application of a 1% solution for five days to rabbit conjunctiva produced no signs of irritation.
Sensitisation	Intradermal challenge tests in guinea-pigs did not produce evidence of sensitization (Hendrickson & Booth, sine data).
Health Effects Summary	A mild skin and eye irritant
Key Study/Critical Effect for Screening Criteria	The Joint FAO/WHO Expert Committee on Food Additives allocated an Acceptable Daily Intake (ADI) of “not specified”.
Ecological Toxicity [1,2,3]	
Aquatic Toxicity	Acute Fish (measured) = 420 mg/L
Determination of PNEC aquatic	Based on acute fish toxicity of 420 mg/L, an assessment factor of 1000 was used for a resulting PNEC of 0.42 mg/L.
Current Regulatory Controls	

Australian Hazard Classification	No data available.
Australian Occupational Exposure Standards	No data available.
International Occupational Exposure Standards	No data available.
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	No data available.
PBT Assessment	
P/vP Criteria fulfilled?	No biodegradation information was found on xanthan gum. However, xantham gum is a naturally occurring polysaccharide which would be expected to readily biodegrade. Thus, it is not expected to meet the screening criteria for persistence
B/vB criteria fulfilled?	Xantham gum is not expected to meet the criteria for bioaccumulation.
T criteria fulfilled?	Not applicable. Acute toxicity data >1 mg/L in fish, thus xanthan gum does not meet the screening criteria for toxicity.
Overall conclusion	Not PBT
Revised	March 2019

References

1. Department of the Environment and Energy 2017, National assessment of chemicals associated with coal seam gas extraction in Australia, prepared by the National Industrial Chemicals Notification and Assessment Scheme
2. IPCS INCHEM, Xanthan Gum, Retrieved 2019: http://www.inchem.org/
3. Food and Agriculture Organization of the United Nations (FAO) 2016, 82nd JECFA - Chemical and Technical Assessment (CTA),XANTHAN GUM

Toxicity Summary - Sodium Glycolate

Chemical and Physical Properties[1,2,3]	
CAS number	[redacted]
Molecular formula	C2H3NaO3
Molecular weight	98.033 g/mol
Solubility in water	1.00E+06 g/mL at 25 C
Melting point	210-218 °C
Boiling point	265.6 °C at 760 mmHg
Vapour pressure	4.58E-10 at 25 deg C
Henrys law constant	No data available
Explosive potential	No data found
Flammability potential	Non flammable
Colour/Form	White powder
Overview	Sodium Glycolate is the salt of glycolic acid and is used in cosmetics and personal care products primarily as an exfoliant or buffering agent Limited information is available for sodium glycolate, as such, this toxicity profile includes data on Glycolic Acid. Glycolic acid is widely used in cosmetic products. Glycolic acid belongs to a group of chemicals commonly known as fruit acids or AHAs (alpha hydroxy acids). The National Industrial Chemical Notification and Assessments Scheme (NICNAS) conducted a preliminary assessment of the use of glycolic acid in cosmetics in April 2000. The assessment concluded there was no significant risk. Glycolic acid is absorbed by ingestion, inhalation and through the skin. In humans, it is mainly excreted unchanged in the urine while smaller amounts are metabolised to glyoxylic and oxalic acids, which are also excreted in the urine. The kinetics and metabolism are qualitatively similar in rats and humans; however, rats metabolise a greater proportion to carbon dioxide and eliminate the chemical faster than humans. In laboratory animals, glycolic acid is harmful by single-dose ingestion or inhalation of high doses. Depending on concentration and pH, it may be corrosive or irritating to the skin, eyes and respiratory system. It is toxic to the kidneys by repeated oral administration. When glycolic acid is given to pregnant rats by mouth on a daily basis, it induces malformations at high, maternally toxic doses. In two studies, there was an 8-9% reduction in foetal body weight and a substantial increase in minor skeletal abnormalities at dose levels associated with mild maternal toxicity. In another study, a marginal increase in foetal abnormalities was seen at a dose associated with marginal maternal toxicity, with no effects on foetal development seen at lower doses. Glycolic acid is not mutagenic. It does not impair fertility or neonatal growth during lactation. There are no animal studies of systemic or developmental toxicity from dermal exposure and no carcinogenicity studies. Glycolic acid is a metabolite of ethylene glycol and is the immediate cause of the metabolic acidosis and kidney failure associated with ethylene glycol poisoning in humans.

Environmental Fate[1]	
Soil/Water/Air	If released to soil, sodium glycolate is expected to have very high mobility based upon an estimated Koc of 0.14. The pKa of sodium glycolate is 3.6, indicating that this compound will exist almost entirely in anion form in the environment and anions generally do not adsorb more strongly to soils containing organic carbon and clay than their neutral counterparts. Volatilization of sodium glycolate from moist soil surfaces is not expected to be an important fate process because the compound exists as an anion and ions do not volatilize. Sodium glycolate is not expected to volatilize from dry soil surfaces based upon its vapor pressure. Utilizing the Japanese MITI test, 86% of the Theoretical BOD was reached in 2 weeks indicating that biodegradation is an important environmental fate process in soil and water. If released into water, sodium glycolate is not expected to adsorb to suspended solids and sediment based upon the estimated Koc. A pKa of 3.6 indicates hydroxycaetic acid will exist almost entirely in the anion form at pH values of 5 to 9 and, therefore, volatilization from water surfaces is not expected to be an important fate process. An estimated BCF of 3 suggests the potential for bioconcentration in aquatic organisms is low. Hydrolysis is not expected to be an important environmental fate process since this compound lacks functional groups that hydrolyze under environmental conditions
Human Health Toxicity Summary [1]	
Chronic Repeated Dose Toxicity	A 3-month oral gavage study was conducted in Sprague-Dawley rats given solutions containing technical grade glycolic acid at doses of 0, 150, 300 or 600 mg/kg/day of glycolic acid (DuPont, 1999a*). The study determined an overall NOAEL equal to 150 mg/kg/day, based on body weight, body weight gain, food consumption and food efficiency in both sexes and on kidney lesions in males.
Carcinogenicity	No carcinogenicity studies were available for assessment and it is not possible to classify glycolic acid for carcinogenic effects. Ethylene glycol did not induce tumours in carcinogenicity studies in rats and mice and is not suspected of having carcinogenic effects in humans (Cavender & Sowinski, 1994).
Mutagenicity/ Genotoxicity	Glycolic acid has been tested in a number of assays for genetic toxicity in accordance with OECD's Test Guidelines and to GLP standards. The tests available for assessment included *in vitro* assays for reverse mutation in bacteria, forward mutation in mouse lymphoma cells and chromosomal aberration in Chinese hamster ovary cells. An *in vivo* somatic cell mutagenicity test (mouse bone marrow micronucleus test) was also available. All tests were negative, except the *in vitro* assay for gene mutation in mouse lymphoma cells which was positive at high concentrations of glycolic acid (2500-5000 mg/L) in the presence of metabolic activation.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	Statistically significant developmental toxicity occurred at doses of 332 mg/kg/day glycolic acid by mouth and 833 mg/kg/day sodium glycolate by subcutaneous injection. These doses are assessed to be high as they correspond to an internal dose that is estimated to be unattainable in humans exposed to glycolic acid by skin contact and/or inhalation in the occupational environment. No impairment of fertility was observed in a well-conducted study involving the oral administration of up to 600 mg/kg/day of glycolic acid to male and female rats for 18-22 weeks.
Acute Toxicity	In animal studies, glycolic acid was found to cause lethality by ingestion, inhalation or injection in all species tested. Deaths occurred up to 12 days following exposure, with kidney lesions being the most common finding at necropsy. In GLP studies in the rat conducted according to OECD's Test Guidelines or similar protocols, the oral LD_{50} was 1357 mg/kg and the

	LC_{50} from nasal inhalation of aerosolised glycolic acid was 2520 mg/m^3 (2.5 mg/L) in male and >3640 mg/m^3 (>3.6 mg/L) in female rats. No dermal toxicity studies were available. In mice and rats, lethal dose levels were consistently lower in males than in females, apparently because the metabolite oxalic acid, which is prone to precipitate as calcium oxalate in the kidney and urinary tract of rodents, is formed at a faster rate in male as compared to female animals. Cases of human intoxication have not been reported. However, there is a considerable body of data on the effects of acute poisoning from ingestion of ethylene glycol, which is of low toxicity in itself, but is slowly metabolised to glycolic acid. The estimated lethal dose of ethylene glycol in humans is approximately 1600 mg/kg, with death occurring from metabolic acidosis, cardiopulmonary collapse and/or renal failure within one to several days of exposure (Cavender & Sowinski, 1994). There is no evidence of non-lethal irreversible effects from single exposures to glycolic acid in animals, or in humans from ethylene glycol poisoning.
Irritation	Glycolic acid irritates the skin and eyes.
Sensitisation	One skin sensitisation study in guinea pigs conducted according to OECD Guideline No. 406 and to GLP standards was negative, as were repeat insult patch tests of numerous cosmetic products covering a wide range of concentrations and pH values in groups comprising 25-198 healthy human subjects per product. When a small number of commercial cosmetic products containing 0.5-6% glycolic at pH 3.6-4.2 were tested by repeat insult patching followed by UV irradiation, no evidence of photosensitising potential was observed. A maximization study using guinea pigs (number of animals not stated) was performed in which induction consisted of intradermal injection of 10% and topical application of 25% Sodium Glycolate; the challenge application was 25% (ESLUR, 1994b). Sodium Glycolate was not a sensitiser. There were no findings indicating that glycolic acid may be a respiratory sensitiser.
Health Effects Summary	The available animal studies indicate that glycolic acid is harmful by single-dose ingestion or inhalation. Depending on concentration and pH, it may be either corrosive or irritating to the skin, eyes and respiratory system.
Key Study/Critical Effect for Screening Criteria	The NOAEL based on a 3-month oral rat toxicity test and on maternal and developmental toxicity in pregnant rats given oral doses of glycolic acid is 150 mg/kg/day.
Ecological Toxicity [4]	
Aquatic Toxicity	Green algae (Pseudokirchnerie lla subcapitata) 72-hr EC50 (growth) = 44.0 mg/L; 72-hr EC50 (biomass) = 21.6 mg/L Fathead minnows (Pimephales promelas) . 96-hr LC50 = 164 mg/L. Water fleas (Daphnia magna) 48-hr EC50 = 141 mg/L
Determination of PNEC aquatic	On the basis that the data consists of short-term results from three trophic levels, an assessment factor of 1,000 has been applied to the lowest reported effect concentration of 21.6 mg/L for green algae. The $PNEC_{aquatic}$ was calculated to be 0.0216 mg/L.
Current Regulatory Controls	
Australian Hazard Classification	No data available.

Australian Occupational Exposure Standards	No data available.
International Occupational Exposure Standards	No data available.
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	No data available.
PBT Assessment[1]	
P/vP Criteria fulfilled?	Glycolic acid is readily biodegradable and as such not persistent in the environment.
B/vB criteria fulfilled?	Based on the measured log Kow of -1.11 and an estimated BCF of 3, Glycolic acid is not bioaccumulative.
T criteria fulfilled?	The acute aquatic toxicity of Glycolic acid is > 0.01 mg/L. Hence the substance does not fulfill the screening criteria for toxic (T)
Overall conclusion	Not a PBT substance (based on screening data).
Revised	September 2020

References

1. HSDB (n.d.). *Hazardous Substances Data Bank*. Retrieved 2017, from Toxnet, Toxicology Data Network, National Library of Medicine: http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB
2. National Industrial Chemicals Notification and Assessment Scheme (NICNAS), 2000. Glycolic Acid, Priority Existing Chemical Assessment Report No. 12
3. OECD Categorisation Results from the Canadian Domestic Substance List, Acetic acid, hydroxyl-, monosodium salt, CAS # [redacted]
4. USEPA; Hazard Characterization Document, Screening level Hazard Characterization for Glycolic Acid (79-14-1). P. 14. Available from as of May 7, 2014: http://www.epa.gov/chemrtk/hpvis/hazchar/79141_Glycolic%20Acid_June%202010.pdf)

Toxicity Summary - Barium Sulphate

Chemical and Physical Properties[1,2,3]	
CAS number	[redacted]
Molecular formula	Ba(SO4)
Molecular weight	233.39
Solubility in water	3.1 mg/L at 20°C
Melting point	1580°C
Boiling point	1600°C at 760 mm Hg (Decomposes)
Vapour pressure	No data available
Henrys law constant	No data available
Explosive potential	No data available
Flammability potential	No data available
Colour/Form	Odourless white powder
Overview	Barium sulphate is an inorganic compound. It is partially soluble in water, dissociating into barium and sulphate ions; both are ubiquitous in the environment. The ions will not adsorb on particulate matter or surfaces and will not accumulate in living tissues A Tier 1 Human Health Assessment for this chemical has been conducted by NICNAS which concluded that it was low concern to human health.
Environmental Fate[1]	
Soil/Water/Air	The dissolution of barium substances in the environment and corresponding dissolved Ba levels are controlled by the solubility of barite (BaSO4) and witherite (BaCO3), two naturally occurring barium minerals and the concentration of dissolved Ba cations in freshwater is rather low. However, in the dissolved state, the divalent barium cation, is the predominant form in soil, sediments and water. The solubility of barium compounds increases as solution pH decreases. Barium in soils is not expected to be very mobile because of the formation of water-insoluble salts (sulphate and carbonate) and its inability to form soluble complexes with humic and fulvic materials. Transport, fate, and toxicity of barium in the environment are largely controlled by the solubility of barium minerals. The barium cation is the moiety of toxicological concern, and thus the hazard assessment is based on Ba2+.
Human Health Toxicity Summary [1,2,3]	
Chronic Repeated Dose Toxicity	The NOAEL for barium toxicity in this study is based on depressed body weight gains, elevated phosphorus levels, neurobehavioral effects and chemically related lesions in the kidney and lymphoid tissue at the highest dose level of 4000 pm. Individual effects observed at 2000 ppm barium chloride in drinking water (corresponding to the final barium dose of 61.1 and 80.9 mg Ba/kg bw/day to male and female rats respectively) were regarded as not treatment-related, and this dose level therefore represents the NOAEL. No systemic toxicity was shown to result from long term inhalation exposure in humans to high concentrations of barium sulphate. Particle overload is observed for insoluble particles such as barium sulphate, whereby the rat is the most sensitive species studied, and species-specific differences are demonstrated in various mechanistic animal studies. It has been demonstrated with reasonable certainty that lung overload conditions are not relevant for human health.
Carcinogenicity	There was no evidence of carcinogenic activity (showing no chemical related increase of malignant or benign neoplasms) of barium chloride in both sexes of rats and mice that received 500, 1250, and 2500 ppm. Thus, the concentration of 2500 ppm represents a NOAEL (corresponding to barium doses of 60 and 75 mg/kg bw/d to male and female rats, respectively, and 160 and 200 mg/kg bw/d to male and female mice, respectively).

Mutagenicity/ Genotoxicity	Not likely to be mutagenic or genotoxic.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	Only a screening test is available. However, based on this study there are no indications of a substantial impairment of fertility in rats up to the highest dose tested. Thus, the NOAEL was 4000 ppm (to average doses of 201.5 and 179.5 mg Ba/kg bw/d to male and and female rats, respectively). NOAELs on developmental toxicity for rats of 4000 ppm were derived. However, this NOAEL is of limited value to evaluate the potential for barium to induce developmental effects because there was no exposure of the females during gestation.
Acute Toxicity	The toxicity of barium sulphate and barium chloride is based on the Ba2+cation and therefore on the solubility of the test substance. Barium chloride is well water soluble (ca. 375 g/L) at pH ca. 6.5 (pH of artificial sweat solution), whereas barium sulphate is low soluble (3.1 mg/L at pH 9). Due to the fact that Barium chloride seems to be no toxic via the dermal route it can be concluded that barium sulphate will result in a dermal LD50 of >>2000 mg/kg bw and should therefore not classified as acute toxic to the dermal route.
Irritation	Not irritating to skin or eyes.
Sensitisation	Barium sulphate is expected to be not sensitizing to skin.
Health Effects Summary	Poses no unreasonable risk to human health based on Tier I assessment under the NICNAS IMAP assessment framework.
Key Study/Critical Effect for Screening Criteria	The repeated dose toxicity via oral application was considered the key study. Rats were dosed at 61.1 and 80.9 mg Ba2+ /kg bw/day to male and female rats via feed for 90 days. The values refer to 104 and 138 mg/kg bw/day. The NOAEL for barium toxicity in this study is based on depressed body weight gains, elevated phosphorus levels, neurobehavioral effects and chemically related lesions in the kidney and lymphoid tissue at the highest dose level. Individual effects observed were regarded as non-treatment related.
Ecological Toxicity[1]	
Aquatic Toxicity	Short-term toxicity EC/LC50 values of barium sulphate available for 3 trophic levels: 96 hrs LC50: >3.5 mg/L (Fish) 48 hrs LC50: 14.5 mg/L (Invertebrates) 72 hrs EC50: 1.15 mg/L (Algae) Long-term toxicity data are available for three trophic levels: 33 days NOEC: 1.26 mg/L (Fish) 21 days NOEC: 2.9 mg/L (Invertebrates) 72 hrs NOEC: 1.15 mg/L (Algae)
Determination of PNEC aquatic	Data from short and long-term tests with three trophic levels are available. An assessment factor of 10 is applied to the lowest EC50 of 1.15 mg/L (algae). A PNECaqua of 115 µg/L was derived.
Current Regulatory Controls[5,6,7,8]	
Australian Hazard Classification	No data available.
Australian Occupational Exposure Standards	No data available.
International Occupational Exposure Standards	No data available.
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	No data available.

PBT Assessment[1]	
P/vP Criteria fulfilled?	Not applicable (inorganic salt, ionic species ubiquitous in environment)
B/vB criteria fulfilled?	Not applicable. Bioaccumulation is not applicable to these inorganic ions; barium and sulphate ions are ubiquitous and are present in most water, soil and sediment.
T criteria fulfilled?	Not applicable. Chronic toxicity data >1 mg/L, thus barium sulphate does not meet the screening criteria for toxicity.
Overall conclusion	Not PBT
Revised	December 2021

References

1. ECHA REACH, Barite sulfate, Retrieved 2021: https://echa.europa.eu/
2. National Industrial Chemicals Notification and Assessment Scheme (NICNAS). IMAP, Human Health Tier 1 Assessment. Retrieved 2019: https://www.industrialchemicals.gov.au/.
3. NCBI, 2021. National Center for Biotechnology Information. Available at: https://pubchem.ncbi.nlm.nih.gov/. Retrieved December 2021.
4. EHS Support, Barium Sulfate. Available at: https://www.santos.com/wp-content/uploads/2021/04/Barium-sulfate-March-2021.pdf. Retrieved December 2021.
5. ANZG, 2018. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia. Available at www.waterquality.gov.au/anz-guidelines.
6. NHMRC, 2018. Australian Drinking Water Guidelines 6, 2011, Version 3.5 Updated August 2018. National Water Quality Management.
7. HCIS, Hazardous Chemical Information System, Safe Work Australia, Retrieved December 2021: http://hcis.safeworkaustralia.gov.au/HazardousChemical.
8. ILO, International Labour Organisation, International Chemical Safety Cards (ICSCs), Retrieved December 2021: http://www.ilo.org/dyn/icsc/showcard.listcards3?p_lang=en.

Toxicity Summary - Calcium oxide

Chemical and Physical Properties[1,2,3,4]	
CAS number	[redacted]
Molecular formula	CaO
Molecular weight	56.08
Solubility in water	1.19 g/L at 20 °C
Melting point	2572°C
Boiling point	2850°C
Vapour pressure	Negligible at 25 °C
Henrys law constant	No data available
Explosive potential	Non-explosive
Flammability potential	Non-flammable
Colour/Form	Greyish yellow, odourless, hygroscopic solid
Overview	Calcium oxide (CaO), is an inorganic compound commonly known as quicklime or burnt lime, is a widely used chemical compound. The chemical is used as a component of a hydraulic fracturing fluid formulation for coal seam gas extraction. A Tier 1 Human Health and Environmental Assessment for this chemical has been conducted by NICNAS which concluded that it was low concern to human health and the environment.
Environmental Fate[5]	
Soil/Water/Air	Calcium oxide reacts immediately upon exposure to water, forming calcium hydroxide, which itself reacts with carbon dioxide to form calcium carbonate. The final reaction products of both limestone and calcium oxide in the environment are therefore essentially the same, although calcium oxide typically has lower concentrations of magnesium and other inorganic chemicals than limestone and produces a higher initial concentration of hydroxide ions. Calcium and carbonate ions occur naturally in all environmental compartments and are important nutrients for various organisms. Calcium is mobile in soil and, if released to the environment, should be expected to experience significant partitioning to the water compartment. However, calcium ions may also form insoluble precipitates with anions present in the environment, such as carbonate ions, and settle out of the aqueous phase.
Human Health Toxicity Summary[2]	
Chronic Repeated Dose Toxicity	Several repeat dose studies using analogues of calcium oxide (calcium hydroxide, calcium carbonate, calcium gluconate) investigating the effect of calcium ions on various metabolic functions in experimental animals are available in the literature. However, all these studies were considered inappropriate for derivation of a No Observed Adverse Effect Level (NOAEL) by the study authors, as they did not follow any international guidelines (ECHA REACH).
Carcinogenicity	No data available. Using a read across study, calcium oxide is considered not likely to be carcinogenic.
Mutagenicity/ Genotoxicity	Calcium oxide is not mutagenic.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	In two developmental toxicity studies conducted according to methods equivalent or similar to the OECD TG 414 (Prenatal Developmental Toxicity Study), calcium oxide was administered by gavage to pregnant female Wistar rats up to 680 mg/kg bw/day and CD-1 mice up to 440 mg/kg bw/day during gestation days 6 to 15 (10 consecutive doses). There were no clear discernible effects on implantation, maternal survival or foetal survival in any species at any of the doses. The number of abnormalities seen in either soft or skeletal tissues of the test groups did not

	differ significantly from those occurring spontaneously in the controls. No NOAEL could be established for maternal toxicity or foetal developmental effects. Based on the available data, calcium oxide is not considered to be a developmental toxicant.
Acute Toxicity	A study on acute oral toxicity of calcium oxide in female rats was conducted by a scientifically accepted method. Different doses of calcium oxide suspended in polyethylene glycol (0.2 g/mL) were administered to rats by gavage. No deaths were observed at 2000 mg/kg bw, indicating that the oral median lethal dose (LD50) for rats is >2000 mg/kg bw. No adverse effects were observed following treatment. No macroscopic findings were observed at necropsy. Calcium oxide has low oral acute toxicity with an oral LD50 of >2000 mg/kg bw. Acute dermal toxicity studies with calcium oxide are not available. An acute dermal toxicity study was conducted in rabbits using moistened calcium hydroxide (Ca(OH)2). As calcium oxide (CaO) is converted to Ca(OH)2 in the presence of moisture, the test results for Ca(OH)2 are also applicable for CaO. No animal deaths were observed at 2500 mg/kg bw Ca(OH)2, indicating that the dermal LD50 for male/female rabbits is >2500 mg/kg bw. No adverse effects were observed following the treatment. Based on the results with Ca(OH)2, calcium oxide is considered to have low acute dermal toxicity.
Irritation	Results from two skin irritation studies with calcium hydroxide (hydrated calcium oxide) indicated that calcium hydroxide causes skin irritation. The US Occupational Health Guideline for calcium oxide states 'calcium oxide causes irritation of the eyes, nose, throat and skin. Severe burns may result from contact with this chemical'. Calcium oxide is also considered to be a severe eye irritant.
Sensitisation	No data available.
Health Effects Summary	Poses no unreasonable risk to human health based on Tier I assessment under the NICNAS IMAP assessment framework.
Key Study/Critical Effect for Screening Criteria	Calcium oxide has low acute oral and dermal toxicity, is a skin and respiratory irritant and a severe eye irritant. Calcium oxide is not genotoxic or carcinogenic and does not have any developmental effects in animals. Given the constituent ions of calcium oxide which are subject to tight homeostatic control in the body, repeated exposure to calcium oxide is regarded to have no significant systemic effects. In an epidemiological study, no significant adverse effects were observed in lime-kiln workers exposed to 1.2 mg/m^3 lime dust. This atmospheric concentration was taken as an overall NOAEC for calcium oxide. This NOAEC will be carried forward for human health risk assessment. The critical health effects of calcium oxide are skin and respiratory irritation and severe eye irritation.
Ecological Toxicity [2,5]	
Aquatic Toxicity	Oncorhynchus mykiss 96-hour LC50: 50.6 mg/L Daphnia magna 48-hour EC50: 49.1 mg/L Pseudokirchneriella subcapitata 72 hour EC10: 79.22 mg/L A 42-day Oncorhynchus mykiss test showed that enhanced Ca2+ diets (60 mg Ca2+) had no effects on survival. Mean fish weights remained constant across all treatments. A 14-day Crangon septemspinosa test showed an EC10 of 32 mg/L.
Determination of PNEC aquatic	A Tier 1 assessment of the environmental risks from the use of substances in the Limestone and its derivatives group is not required.
Current Regulatory Controls[2]	
Australian Hazard Classification	Calcium oxide is listed as hazardous in the Hazardous Substances Information System (HSIS). No risk phrases have been assigned to this chemical.
Australian Occupational Exposure Standards	The chemical has an exposure standard of 2 mg/m^3, Time Weighted Average (TWA)

International Occupational Exposure Standards	The following exposure standards are identified in Galleria Chemica (2013): Occupational Exposure limit (TWA) of 2 mg/m^3 [Canada, Denmark, Korea, UK, US (NIOSH)] Permissible Exposure Limits (PEL) of 5 mg/m^3 [US (OSHA 1978)].
Australian Food Standards	Calcium oxide is allotted the following International Numbering System of food additives number: INS 529 (Food Standards Australia New Zealand 2013).
Australian Drinking Water Guidelines	Calcium oxide is used in water treatment to correct pH and adjust alkalinity, for coagulation optimisation, corrosion control and water softening. Typical calcium oxide concentrations used in drinking water treatment depend on the quality of the water to be treated and the purpose of treatment (e.g. water softening, pH adjustment or alkalinity increase) and can vary from 5 to 500 mg/L.
Aquatic Toxicity Guidelines	No data available.
PBT Assessment	
P/vP Criteria fulfilled?	Not applicable (inorganic salt, ionic species ubiquitous in environment).
B/vB criteria fulfilled?	Not applicable. Bioaccumulation is not applicable to these inorganic ions; sodium and hydroxide ions are ubiquitous and are present in most water, soil and sediment.
T criteria fulfilled?	No. Chronic and acute toxicity data >1 mg/L, calcium oxide does not meet the screening criteria for toxicity.
Overall conclusion	It is not currently possible to categorise the environmental hazards of metals and other inorganic chemicals according to standard persistence, bioaccumulation and toxicity (PBT) hazard criteria. These criteria were developed for organic chemicals and do not take into account the unique properties of inorganic substances and their behaviour in the environment.
Revised	December 2021

References

1. ECHA REACH, Calcium oxide, Retrieved 2021: https://echa.europa.eu/
2. Department of the Environment and Energy 2017, National assessment of chemicals associated with coal seam gas extraction in Australia, prepared by the National Industrial Chemicals Notification and Assessment Scheme
3. National Industrial Chemicals Notification and Assessment Scheme (NICNAS). IMAP, Human Health Tier 1 Assessment. Retrieved 2021: https://www.industrialchemicals.gov.au/.
4. NCBI, 2021. National Center for Biotechnology Information. Available at: https://pubchem.ncbi.nlm.nih.gov/. Retrieved December 2021.
5. EHS Support, Calcium oxide, calcium hydroxide. Available at: https://www.santos.com/wp-content/uploads/2021/05/Calcium-oxide-and-calcium-hydroxide-March-2021.pdf. Retrieved December 2021.
6. HCIS, Hazardous Chemical Information System, Safe Work Australia, Retrieved December 2021: http://hcis.safeworkaustralia.gov.au/HazardousChemical.
7. ILO, International Labour Organisation, International Chemical Safety Cards (ICSCs), Retrieved December 2021: http://www.ilo.org/dyn/icsc/showcard.listcards3?p_lang=en.

Toxicity Summary - 1,2,3-Propanetriol, homopolymer, (Z)-9-octadecenoate

Chemical and Physical Properties[1,2,3]	
CAS number	[redacted]
Molecular formula	(C3H8O3)x
Molecular weight	UVCB
Solubility in water	550 g/L at 20 °C and pH 6.5
Melting point	-90 °C at 101.3 kP
Boiling point	274 °C at 100.8 kPa
Vapour pressure	0.047 Pa at 20 °C
Henrys law constant	No data available
Explosive potential	Non-explosive
Flammability potential	Non-flammable
Colour/Form	Colourless to slightly yellow liquid with characteristic odour
Overview	A Tier 1 Human Health and Environmental Assessment for this chemical has been conducted by NICNAS which concluded that it was low concern to human health and the environment and thus required no further assessment.
Environmental Fate [1]	
Soil/Water/Air	Based on the available data for the substance itself and for read-across substances and main components of the target UVCB substance, 1,2,3-Propanetriol, homopolymer (CAS [redacted]) is readily biodegradable according to OECD criteria. The half-life time of the major constituents in Polyglycerol-3 (diglycerol and triglycerol) at pH values normally found in the environment (pH 4-9) were determined to be > 1 year. Thus, the substance will slowly hydrolyse under environmental conditions. However, due to their ready biodegradability, hydrolysis is not expected to be a relevant degradation pathway for this substance. 1,2,3 -Propanetriol, homopolymer is water soluble (> 550 g/L) and has a low log Kow value (log Kow = -2) assuming a low adsorption potential. Bioaccumulation in aquatic organisms is unlikely since the substance has a low log Kow of -2, which assumes that the substance will not cross biological membranes.
Human Health Toxicity Summary [1,2,3]	
Chronic Repeated Dose Toxicity	Repeated dose toxicity studies with Polyglycerin are not available. The results of experimental studies with the read across substance glycerol are presented below. Repeated oral exposure to glycerol does not induce adverse effects other than local irritation of the gastro-intestinal tract. In a 2 year study, groups of 22 rats (Long-Evans) received 5, 10 and 20% glycerol (natural or synthetic) in their diet (males 2000, 4000 and 8000 mg/kg bw; females 2500, 5000 and 10000 mg/kg bw). No systemic or local effects were observed (NOEL 10,000 mg/kg bw/day).
Carcinogenicity	Based on the read-across substance (Polyglycerol Polyricinoleate PGPR) and supporting information (glycerol), Polyglycerol-3 does not possess any carcinogenic properties.
Mutagenicity/ Genotoxicity	Based on available data with polyglycerin (not containing glycerin), the test substance is not mutagenic or clastogenic.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	Based on the read-across substance (glycerol): No effects on fertility and reproductive performance were observed in a two-generation study with glycerol administered by gavage (NOAEL 2000 mg/kg bw/day). No maternal toxicity or teratogenic effects were seen in the rat, mouse or rabbit at the highest dose levels tested in a guideline comparable teratogenicity study (NOEL 1180 mg/kg bw/day).

Acute Toxicity	The acute oral toxicity of the test item was investigated in 5 female and 5 male rats using purified water as vehicle. The study was performed according to OECD test guideline 401 and followed the principles of GLP. All animals were administered the test compound by single-dose gavage at a dose-level of 2000 mg/kg body weight. The observation period was 14 days. No deaths occurred during the study. Clinical signs of intoxication were also not observed during the course of the study. Body weight development was normal and within the range commonly recorded for this strain and age. At necropsy no macroscopic findings were recorded. Based on the findings of this limit-test the median lethal dosage (LD50) of the test item in male/female rats is greater than 2000 mg/kg body weight. The acute dermal toxicity of glycerin was tested in a method equivalent to the OECD 402 guideline. No adverse effects were observed. The same can be expected for polyglycerin.
Irritation	Not irritating to rabbit eyes or skin.
Sensitisation	Not a skin sensitiser
Health Effects Summary	This chemical has been identified by NICNAS to be of low concern to human health.
Key Study/Critical Effect for Screening Criteria	A 2 year oral toxicity study conducted was conducted in rats with glycerin. No systemic or local effects were observed. The NOAEL for this study is 10,000 mg/kg/day. Uncertainty factors: 10 (interspecies variability); 10 (intraspecies variability). Derived drinking water guideline = 39 ppm
Ecological Toxicity [1]	
Aquatic Toxicity	LC50 (96 hrs) for fish: 500 mg/L EC50 (48 h) for invertebrates: 1 g/L EC50/NOEC (72 h) for algae: 1 g/L
Determination of PNEC aquatic	Data from short-term tests with three trophic levels are available. An assessment factor of 100 is applied to the lowest 72h-NOErC of 500 mg/L (algae). A PNECaqua of 5 mg/L was derived.
Current Regulatory Controls [4,5,6,7]	
Australian Hazard Classification	No data available.
Australian Occupational Exposure Standards	No data available.
International Occupational Exposure Standards	No data available.
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	No data available.
PBT Assessment [1]	
P/vP Criteria fulfilled?	No. The substance has been found to be readily biodegradable.
B/vB criteria fulfilled?	No. As the Log Pow is -2 at 25 °C and pH 6.2 - 6.3 (Log Pow < 4.5), it is not expected to be bioaccumulative.
T criteria fulfilled?	No. The acute EC50 for this substance is >1 mg/L in fish, invertebrates and algae. Therefore, it does not meet the screening criteria for toxicity.
Overall conclusion	Not PBT
Revised	June 2022

References

1. ECHA REACH, 1,2,3-Propanetriol, homopolymer, Retrieved 2022: https://echa.europa.eu/
2. National Industrial Chemicals Notification and Assessment Scheme (NICNAS). IMAP, Human Health Tier 1 Assessment. Retrieved 2022: https://www.industrialchemicals.gov.au/.
3. NCBI, 2022. National Center for Biotechnology Information. Available at: https://pubchem.ncbi.nlm.nih.gov/. Retrieved February 2022.
4. HCIS, Hazardous Chemical Information System, Safe Work Australia, Retrieved February 2022: http://hcis.safeworkaustralia.gov.au/HazardousChemical.
5. ILO, International Labour Organisation, International Chemical Safety Cards (ICSCs), Retrieved February 2022: http://www.ilo.org/dyn/icsc/showcard.listcards3?p_lang=en.
6. ANZG, 2018. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia. Available at www.waterquality.gov.au/anz-guidelines.
7. NHMRC, 2018. Australian Drinking Water Guidelines 6, 2011, Version 3.5 Updated August 2018. National Water Quality Management.

Toxicity Summary - 1,2,3-Propanetriol, homopolymer

Chemical and Physical Properties[1,2,3]	
CAS number	[redacted]
Molecular formula	(C3H8O3)x
Molecular weight	UVCB
Solubility in water	550 g/L at 20 °C and pH 6.5
Melting point	-90 °C at 101.3 kP
Boiling point	274 °C at 100.8 kPa
Vapour pressure	0.047 Pa at 20 °C
Henrys law constant	No data available
Explosive potential	Non-explosive
Flammability potential	Non-flammable
Colour/Form	Colourless to slightly yellow liquid with characteristic odour
Overview	A Tier 1 Human Health and Environmental Assessment for this chemical has been conducted by NICNAS which concluded that it was low concern to human health and the environment and thus required no further assessment.
Environmental Fate [1]	
Soil/Water/Air	Based on the available data for the substance itself and for read-across substances and main components of the target UVCB substance, 1,2,3-Propanetriol, homopolymer (CAS [redacted] is readily biodegradable according to OECD criteria. The half-life time of the major constituents in Polyglycerol-3 (diglycerol and triglycerol) at pH values normally found in the environment (pH 4-9) were determined to be > 1 year. Thus, the substance will slowly hydrolyse under environmental conditions. However, due to their ready biodegradability, hydrolysis is not expected to be a relevant degradation pathway for this substance. 1,2,3 -Propanetriol, homopolymer is water soluble (> 550 g/L) and has a low log Kow value (log Kow = -2) assuming a low adsorption potential. Bioaccumulation in aquatic organisms is unlikely since the substance has a low log Kow of -2, which assumes that the substance will not cross biological membranes.
Human Health Toxicity Summary [1,2,3]	
Chronic Repeated Dose Toxicity	Repeated dose toxicity studies with Polyglycerin are not available. The results of experimental studies with the read across substance glycerol are presented below. Repeated oral exposure to glycerol does not induce adverse effects other than local irritation of the gastro-intestinal tract. In a 2 year study, groups of 22 rats (Long-Evans) received 5, 10 and 20% glycerol (natural or synthetic) in their diet (males 2000, 4000 and 8000 mg/kg bw; females 2500, 5000 and 10000 mg/kg bw). No systemic or local effects were observed (NOEL 10,000 mg/kg bw/day).
Carcinogenicity	Based on the read-across substance (Polyglycerol Polyricinoleate PGPR) and supporting information (glycerol), Polyglycerol-3 does not possess any carcinogenic properties.
Mutagenicity/ Genotoxicity	Based on available data with polyglycerin (not containing glycerin), the test substance is not mutagenic or clastogenic.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	Based on the read-across substance (glycerol): No effects on fertility and reproductive performance were observed in a two-generation study with glycerol administered by gavage (NOAEL 2000 mg/kg bw/day). No maternal toxicity or teratogenic effects were seen in the rat, mouse or rabbit at the highest dose levels tested in a guideline comparable teratogenicity study (NOEL 1180 mg/kg bw/day).

Acute Toxicity	The acute oral toxicity of the test item was investigated in 5 female and 5 male rats using purified water as vehicle. The study was performed according to OECD test guideline 401 and followed the principles of GLP. All animals were administered the test compound by single-dose gavage at a dose-level of 2000 mg/kg body weight. The observation period was 14 days. No deaths occurred during the study. Clinical signs of intoxication were also not observed during the course of the study. Body weight development was normal and within the range commonly recorded for this strain and age. At necropsy no macroscopic findings were recorded. Based on the findings of this limit-test the median lethal dosage (LD50) of the test item in male/female rats is greater than 2000 mg/kg body weight. The acute dermal toxicity of glycerin was tested in a method equivalent to the OECD 402 guideline. No adverse effects were observed. The same can be expected for polyglycerin.
Irritation	Not irritating to rabbit eyes or skin.
Sensitisation	Not a skin sensitiser
Health Effects Summary	This chemical has been identified by NICNAS to be of low concern to human health.
Key Study/Critical Effect for Screening Criteria	A 2 year oral toxicity study conducted was conducted in rats with glycerin. No systemic or local effects were observed. The NOAEL for this study is 10,000 mg/kg/day. Uncertainty factors: 10 (interspecies variability); 10 (intraspecies variability). Derived drinking water guideline = 39 ppm
Ecological Toxicity [1]	
Aquatic Toxicity	LC50 (96 hrs) for fish: 500 mg/L EC50 (48 h) for invertebrates: 1 g/L EC50/NOEC (72 h) for algae: 1 g/L
Determination of PNEC aquatic	Data from short-term tests with three trophic levels are available. An assessment factor of 100 is applied to the lowest 72h-NOErC of 500 mg/L (algae). A PNECaqua of 5 mg/L was derived.
Current Regulatory Controls [4,5,6,7]	
Australian Hazard Classification	No data available.
Australian Occupational Exposure Standards	No data available.
International Occupational Exposure Standards	No data available.
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	No data available.
PBT Assessment [1]	
P/vP Criteria fulfilled?	No. The substance has been found to be readily biodegradable.
B/vB criteria fulfilled?	No. As the Log Pow is -2 at 25 °C and pH 6.2 - 6.3 (Log Pow < 4.5), it is not expected to be bioaccumulative.
T criteria fulfilled?	No. The acute EC50 for this substance is >1 mg/L in fish, invertebrates and algae. Therefore, it does not meet the screening criteria for toxicity.
Overall conclusion	Not PBT
Revised	June 2022

References

1. ECHA REACH, 1,2,3-Propanetriol, homopolymer, Retrieved 2022: https://echa.europa.eu/
2. National Industrial Chemicals Notification and Assessment Scheme (NICNAS). IMAP, Human Health Tier 1 Assessment. Retrieved 2022: https://www.industrialchemicals.gov.au/.
3. NCBI, 2022. National Center for Biotechnology Information. Available at: https://pubchem.ncbi.nlm.nih.gov/. Retrieved February 2022.
4. HCIS, Hazardous Chemical Information System, Safe Work Australia, Retrieved February 2022: http://hcis.safeworkaustralia.gov.au/HazardousChemical.
5. ILO, International Labour Organisation, International Chemical Safety Cards (ICSCs), Retrieved February 2022: http://www.ilo.org/dyn/icsc/showcard.listcards3?p_lang=en.
6. ANZG, 2018. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia. Available at www.waterquality.gov.au/anz-guidelines.
7. NHMRC, 2018. Australian Drinking Water Guidelines 6, 2011, Version 3.5 Updated August 2018. National Water Quality Management.

Toxicity Summary - Acetic acid, ethenyl ester, polymer with ethenol

Chemical and Physical Properties[1,2,3]	
CAS number	[redacted]
Molecular formula	(C4H6O2.C2H4O)x (This substance is a polymer)
Molecular weight	130.14 g/mol (monomer); polymer variable (UVCB)
Solubility in water	Water solubility expected to be low
Melting point	No data available
Boiling point	No data available
Vapour pressure	Expected to be negligible
Henrys law constant	No data available
Explosive potential	No data available
Flammability potential	No data available
Colour/Form	No data available
Overview	A Tier 1 Human Health and Environmental Assessment for this chemical has been conducted by NICNAS which concluded that it was low concern to human health and the environment and thus required no further assessment.
Environmental Fate [3]	
Soil/Water/Air	Polymers with a molecular weight greater than 1,000 g/mol generally have a negligible vapor pressure, which indicates that the chemical is likely to exist solely as particulate matter in the atmosphere. As particulate matter, atmospheric oxidation is not expected to be a significant route of environmental removal. Likewise, volatilization from water or moist soil is not expected to occur at an appreciable rate. Non-ionic polymers such as poly(vinyl acetate)-poly(vinyl alcohol) polymer are not expected to be highly soluble in water based on its predominantly hydrophobic structure. If discharged to the aquatic environment, this polymer is expected to partition to soil or sediment. It is not expected to be highly mobile if released to the soil compartment. Vinyl polymers not expected to undergo rapid degradation. In an OECD 302B (Zahn Wellens) test carried out using poly(vinyl acetate)-poly(vinyl alcohol) polymer, the test substance was found to be less than 10 % degraded after 28 days, indicating essentially no degradation. However, some bacterial species like Pseudomonads and Sphingomonads are known to efficiently degrade the substance. Additionally, some fungal species like Penicillium sp. And Geotrichum fermentans WF9101 have also been reported to degrade the substance efficiently. Microbial enzymes like oxidase, hydrolase, and dihydrogenase play an important role in the degradation of poly(vinyl acetate)-poly(vinyl alcohol) polymer. The high molecular weight of the polymer is expected to preclude or minimize bioaccumulation. Polymers with a number average molecular weight (NAMW) greater than 1,000 g/mol cannot cross biological membranes.
Human Health Toxicity Summary [1,2,3]	
Chronic Repeated Dose Toxicity	No data available.
Carcinogenicity	No data available.
Mutagenicity/ Genotoxicity	No data available.
Reproductive Toxicity /	No data available.

Developmental Toxicity/Teratogenicity	
Acute Toxicity	No data available.
Irritation	No data available.
Sensitisation	No data available.
Health Effects Summary	Poses no unreasonable risk to human health based on Tier I assessment under the NICNAS IMAP assessment framework.
Key Study/Critical Effect for Screening Criteria	No data available.
Ecological Toxicity [3]	
Aquatic Toxicity	No ecotoxicity data was identified. Poses no unreasonable risk to the environment based on Tier I assessment under the NICNAS IMAP assessment framework.
Determination of PNEC aquatic	Not determined.
Current Regulatory Controls [4,5,6,7]	
Australian Hazard Classification	No data available.
Australian Occupational Exposure Standards	No data available.
International Occupational Exposure Standards	No data available.
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	No data available.
PBT Assessment [3]	
P/vP Criteria fulfilled?	Yes. Poly(vinyl acetate)-poly(vinyl alcohol) polymer is not expected to be biodegradable. Thus, it meets the criteria for persistence.
B/vB criteria fulfilled?	No. Poly(vinyl acetate)-poly(vinyl alcohol) polymer is not expected to bioaccumulate. Polymers with a NAMW greater than 1,000 g/mol cannot cross biological membranes. Thus, it does not meet the screening criteria for bioaccumulation.
T criteria fulfilled?	No. There are no acute or chronic toxicity studies on poly(vinyl acetate)-poly(vinyl alcohol) polymer. However, the high molecular weight of the substance is expected to negate or limit the bioavailability of the substance thus minimizing toxic effects on environmental receptors.Thus, poly(vinyl acetate)-poly(vinyl alcohol) polymer does not meet the criteria for toxicity.
Overall conclusion	Not PBT
Revised	June 2022

References

1. National Industrial Chemicals Notification and Assessment Scheme (NICNAS). IMAP, Human Health Tier 1 Assessment. Retrieved 2022: https://www.industrialchemicals.gov.au/.

2. NCBI, 2022. National Center for Biotechnology Information. Available at: https://pubchem.ncbi.nlm.nih.gov/. Retrieved February 2022.
3. EHS Support, Poly(vinyl acetate) – Poly(vinyl alcohol) polymer. Available at: https://www.santos.com/wp-content/uploads/2021/08/Polyvinyl-acetate-polyvinyl-alcohol-polymer-June-2021.pdf. Retrieved June 2022.
4. HCIS, Hazardous Chemical Information System, Safe Work Australia, Retrieved February 2022: http://hcis.safeworkaustralia.gov.au/HazardousChemical.
5. ILO, International Labour Organisation, International Chemical Safety Cards (ICSCs), Retrieved February 2022: http://www.ilo.org/dyn/icsc/showcard.listcards3?p_lang=en.
6. ANZG, 2018. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia. Available at www.waterquality.gov.au/anz-guidelines.
7. NHMRC, 2018. Australian Drinking Water Guidelines 6, 2011, Version 3.5 Updated August 2018. National Water Quality Management.

Toxicity Summary - Calcium Carbonate

Chemical and Physical Properties[1,2,4]	
CAS number	[redacted]
Molecular formula	CH2O3.Ca -
Molecular weight	100.09 g/mol
Solubility in water	0.0166 g/L at 20oC (slightly soluble)
Melting point	825°C (decomposes) at 101.3 kPa
Boiling point	No data available
Vapour pressure	No data available
Henrys law constant	No data available
Explosive potential	No data available
Flammability potential	No data available
Colour/Form	White powder
Overview	Calcium carbonate is an inorganic compound, the most natural forms being chalk, limestone and marble. It is partially soluble in water, dissociating into calcium (Ca^{2+}) and carbonate (CO_3^{2-}) ions; both are ubiquitous in the environment. The ions will not adsorb on particulate matter or surfaces and will not accumulate in living tissues. Calcium carbonate is of low toxicity concern to aquatic and terrestrial organisms. A Tier 1 Human Health and Environmental Assessment for this chemical has been conducted by NICNAS which concluded that it was low concern to human health and the environment and thus required no further assessment.
Environmental Fate[2]	
Soil/Water/Air	Calcium carbonate, or $CaCO_3$, comprises more than 4% of the earth's crust and is found throughout the world. Its most natural forms are chalk, limestone, and marble, produced by the sedimentation of the shells of small fossilised snails, shellfish, and coral over millions of years. Calcium carbonate is partially soluble in water, dissociating into calcium (Ca^{2+}) and carbonate (CO_3^{2-}) ions. Both ions are ubiquitous in the environment. The addition of calcium carbonate to an aquatic ecosystem could result in a shift towards alkalinity and a tendency to increase the pH. The carbonate ions will react with water, forming bicarbonate (HCO_3^-) and hydroxide (OH^-) ions, until an equilibrium is reached. Ca^{2+} and CO_3^{2-} ions are not expected to adsorb on particulate matter or surfaces and will not accumulate in living tissues.
Human Health Toxicity Summary[3]	
Chronic Repeated Dose Toxicity	No systemic toxicological findings could be detected in rats after repeated administration of uncoated nano calcium carbonate by the oral route for a period of 90 days. The results of this study are read across to bulk calcium carbonate. Several potential adverse effects have been reported following calcium supplementation e.g. effects on kidney function, milk-alkali syndrome, kidney stones and interactions with minerals. However, these effects are more prevalent in those people suffering from renal insufficiency and following the ingestion of high doses of calcium. No systemic toxicity was observed in a 90-day inhalation study where rats were exposed to uncoated calcium carbonate at a maximum concentration of 0.399 mg/L, stated as the NOEC. The local effects observed at this level were limited to increased lung weights accompanied by increases in BAL-derived inflammation and cytotoxicity biomarkers, which were reversible in males but were not fully reversible in females within a 4-week recovery period. Hence the NOAEC for local effects was established as 0.212 mg/L and the LOAEC at 0.399 mg/L. The results of this study are read across to bulk calcium carbonate.

Carcinogenicity	Uncoated nano calcium carbonate is not expected to pose a risk of carcinogenicity.
Mutagenicity/ Genotoxicity	Uncoated nano calcium carbonate was negative in the following assays: In vitro gene mutation study in bacteria (OECD TG 471) using Salmonella typhimurium strains TA 98, TA 100, TA 1535 and TA 1537 and Escherichia coli WP2 uvrA with and without metabolic activation (S9). In vitro chromosome aberration study in mammalian cells (OECD TG 473) using human lymphocytes in the presence and absence of metabolic activation. In vitro gene mutation study in mammalian cells (OECD TG 476) using mouse lymphoma L5178Y cells in the presence and absence of metabolic activation. The results of these studies are read across to bulk calcium carbonate.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	Under the conditions of the OECD TG 422 study, uncoated nano calcium carbonate administered to male and female rats up to a dose level of 1000 mg/kg bw/day for a period of up to 48 days is not toxic to reproduction and has no effect on fertility or development. No treatment-related effects were observed for reproduction; hence, a NOEL for reproductive toxicity was considered to be 1000 mg/kg bw/day. The results of this study are read across to bulk calcium carbonate. The prenatal developmental toxicity study also demonstrated that calcium carbonate was neither foetotoxic nor teratogenic at the concentrations used. Since no adverse effects were noted at the highest dose level tested (1.25% Ca in diet), the NOAEL for teratogenic and maternal toxic effects in rats is in excess of 1.25% Ca, equivalent to approximately 1963 - 2188 mg/kg bw/day of calcium carbonate.
Acute Toxicity	Bulk calcium carbonate is not considered to be acutely harmful by the oral, dermal or inhalation routes.
Irritation	Bulk calcium carbonate is not considered to be irritating to the skin or eyes.
Sensitisation	Based on the results of an OECD TG 429 study performed using nano calcium carbonate and read across to bulk calcium carbonate, where the Stimulation Index was < 3, bulk calcium carbonate is considered to be a non-sensitiser
Health Effects Summary	This chemical has been identified by NICNAS to be of low concern to human health.
Key Study/Critical Effect for Screening Criteria	In the repeated dose toxicity study, NOAEC for local effects was established as 0.212 mg/L and the LOAEC at 0.399 mg/L.
Ecological Toxicity[4]	
Aquatic Toxicity	96 h EC50 for fish >100mg/L 48 h EC50 for Daphnia >100 mg/L 72 h ERC50 for algae >14 mg/L
Determination of PNEC aquatic	Experimental results are available for three trophic levels. Acute LC50 values are available for fish, invertebrates, and algae. On the basis that the data consists of short term results from three trophic levels, an assessment factor of 1000 has been applied to the lowest reported effect concentration of 14 mg/L for algae. The PNEC aquatic is 0.014 mg/L.
Current Regulatory Controls	
Australian Hazard Classification	No data available.
Australian Occupational Exposure Standards	No data available.
International Occupational Exposure Standards	No data available.
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No data available.

Aquatic Toxicity Guidelines	No data available.
PBT Assessment[1]	
P/vP Criteria fulfilled?	Not applicable (inorganic chemical, ionic species ubiquitous in environment)
B/vB criteria fulfilled?	Not applicable. Bioaccumulation is not applicable to these inorganic ions.
T criteria fulfilled?	Not applicable. Expected to have low toxicity to aquatic organisms.
Overall conclusion	Not PBT
Revised	July 2022

References

1. National Industrial Chemicals Notification and Assessment Scheme (NICNAS). IMAP, Human Health Tier 1 Assessment. Retrieved 2019: https://www.nicnas.gov.au
2. Department of the Environment and Energy 2017, National assessment of chemicals associated with coal seam gas extraction in Australia, prepared by the National Industrial Chemicals Notification and Assessment Scheme
3. ECHA REACH, Calcium carbonate, Retrieved 2022: https://echa.europa.eu/
4. EHS Support, Magnesium Oxide. Available at: https://www.santos.com/wp-content/uploads/2021/04/Calcium-Carbonate-March-2021.pdf. Retrieved June 2022.

Toxicity Summary - Cellulose (Organic Fibres)

Chemical and Physical Properties[1,2]	
CAS number	[redacted]
Molecular formula	$C_{12}H_{22}O_{11}$
Molecular weight	342.30
Solubility in water	Insoluble
Melting point	500 to 518 °F (Decomposes)
Boiling point	Decomposes
Vapour pressure	0 mm Hg (approx)
Henrys law constant	No data available.
Explosive potential	No data available.
Flammability potential	No data available.
Colour/Form	Odourless, white powdery fibres
Overview	The biopolymer composing the cell wall of vegetable tissues. Prepared by treating cotton with an organic solvent to de-wax it and removing pectic acids by extraction with a solution of sodium hydroxide. The principal fibre composing the cell wall of vegetable tissues (wood, cotton, flax, grass, etc.). Technical uses depend on the strength and flexibility of its fibres. Insoluble in water. Soluble with chemical degradation in sulfuric acid, and in concentrated solutions of zinc chloride. Soluble in aqueous solutions of cupric ammonium hydroxide. A Tier 1 Human Health and Environmental Assessment for this chemical has been conducted by NICNAS which concluded that it was low concern to human health and the environment and thus required no further assessment.
Environmental Fate	
Soil/Water/Air	No data available.
Human Health Toxicity Summary [1,2,3]	
Chronic Repeated Dose Toxicity	No data available.
Carcinogenicity	No data available.
Mutagenicity/ Genotoxicity	No data available.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	No data available.
Acute Toxicity	Inhalation LC50 (rat) > 5,800 mg/m^3/4h Oral LD50 (rat) >5 gm/kg Dermal LD50 (rat) >2 gm/kg
Irritation	Irritation to eyes, skin, mucous membrane
Sensitisation	No data available.
Health Effects Summary	Causes irritation to eyes, skin, mucous membrane.
Key Study/Critical Effect for Screening Criteria	The dermal rat acute toxicity LD50 >2 gm/kg was considered the most sensitive endpoint.
Ecological Toxicity	
Aquatic Toxicity	No data available.

	Poses no unreasonable risk to the environment based on Tier I assessment under the NICNAS IMAP assessment framework.
Determination of PNEC aquatic	No data available.
Current Regulatory Controls [3,4,5,6]	
Australian Hazard Classification	No data available.
Australian Occupational Exposure Standards	TWA = 10 mg/m^3
International Occupational Exposure Standards	No data available.
Australian Food Standards	No data available.
Australian Drinking Water Guidelines	No data available.
Aquatic Toxicity Guidelines	No data available.
PBT Assessment [1]	
P/vP Criteria fulfilled?	No. Expected to be biodegradable.
B/vB criteria fulfilled?	No. Not expected to bioaccumulate.
T criteria fulfilled?	No data available.
Overall conclusion	Not PBT
Revised	June 2022

References

1. National Industrial Chemicals Notification and Assessment Scheme (NICNAS). IMAP, Human Health Tier 1 Assessment. Retrieved 2022: https://www.industrialchemicals.gov.au/.
2. NCBI, 2022. National Center for Biotechnology Information. Available at: https://pubchem.ncbi.nlm.nih.gov/. Retrieved February 2022.
3. HCIS, Hazardous Chemical Information System, Safe Work Australia, Retrieved February 2022: http://hcis.safeworkaustralia.gov.au/HazardousChemical.
4. ILO, International Labour Organisation, International Chemical Safety Cards (ICSCs), Retrieved February 2022: http://www.ilo.org/dyn/icsc/showcard.listcards3?p_lang=en.
5. ANZG, 2018. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia. Available at www.waterquality.gov.au/anz-guidelines.
6. NHMRC, 2018. Australian Drinking Water Guidelines 6, 2011, Version 3.5 Updated August 2018. National Water Quality Management.

Toxicity Summary - Sodium Bromide

Chemical and Physical Properties[1,2]	
CAS number	7647-15-6
Molecular formula	NaBr
Molecular weight	102.89 g/mol
Solubility in water	946000 mg/L at 25C
Melting point	755 °C
Boiling point	1390 °C
Vapour pressure	0.000000018 hPa at 25 °C
Henrys law constant	No data available
Explosive potential	No data available
Flammability potential	Not flammable
Colour/Form	White crystals, granules, or powder
Overview	Sodium bromide is an inorganic sodium salt having bromide as the counterion. It is a bromide salt and an inorganic sodium salt. A Tier 1 Human Health and Environmental Assessment for this chemical has been conducted by NICNAS which concluded that it was low concern to the human health and the environment.
Environmental Fate [1]	
Soil/Water/Air	The chemical nature of the bromide ion is such that it cannot biodegrade. The bromide ion is also stable to photolysis and abiotic degradation. This is demonstrated by the presence of significant quantities in certain environmental systems, e.g. sea water and some soils. The high water solubility and negative charge of the ion suggest that this species will partition predominantly to the aqueous phase. The very low vapour pressure measured for sodium bromide indicates that the volatilisation of the ion into the atmosphere in quantities of concern will not occur. The very high water solubility of sodium bromide suggests that the log Pow is very low. This, together with the measured low BCF of 0.23 indicates that it is unlikely that sodium bromide will accumulate in biological membranes
Human Health Toxicity Summary [1,2]	
Chronic Repeated Dose Toxicity	Sodium bromide is an inorganic salt that dissociates to its composite ions in aqueous solutions at environmental pH and temperature. Comparison of the available data on the various bromide salts have shown that the bromide ion is the relevant ion for determination of the toxicological profile with simple cations such as potassium, sodium or ammonium, that are ubiquitous in nature, having little or no influence on the bromide ion properties. It is therefore justified to read-across data from other inorganic bromide salts to sodium bromide. Observations in a 4-week oral study in female rats (Van Logten M.J.et al., 1973) and a 90-day oral study in male and female rats (Van Logten M.J.et al., 1974) demonstrated that sodium bromide caused behavioural changes, growth reduction, increased thyroid and adrenals weights, and a dose-related disturbance of the endocrine system. The NO(A)EL for rats was 15 mg (Br-)/kg bw/day from the 90-day oral study. The results of an additional 90-day repeat dose study with sodium bromide (Van Logten M.J.et al., 1976) and a 90-day study with a similar salt, ammonium bromide (Barton S.J.et al., Inveresk Research, Report No. 18612) did not show any evidence of cellular change, even in potential target tissues such as the endocrine (thyroid) or neural systems, that could be considered preneoplastic change. Repeat dose studies in dogs were performed according to non-standard tests in which animals received 78 rising to 312 mg (Br-)/kg bw/day for 400 days (Rosenblum I., 1958). Signs of toxicity noted were stated as being comparable with signs noted in human after suffering bromide intoxication. Although no NO(A)EL

	was determined, the study author states that dogs receiving 78 mg (Br-)/kg/day showed no mortalities and only minimal signs of toxicity. The ion of concern for systemic toxicity is bromide. The study by Barton et al on ammonium bromide gives the lowest reliable NOAEL for bromide salts = 100 mg/kg bw/day. The NOAEL has been extrapolated to NaBr giving a final NOAEL for inorganic bromide salts of 95 mg/kg bw/day.
Carcinogenicity	Sodium bromide is not listed by the International Agency for Research on Cancer (IARC) as a carcinogen. Rats received KBr in food for 104 weeks in a testing regime approximating OECD guideline 453. No detrimental changes were seen in the clinical signs, mortality, food and water consumption, ophthalmoscopic examination, haematology, clinical chemistry, urinalysis or organ weights of the treated animals. There is no evidence for potential carcinogenicity.
Mutagenicity/ Genotoxicity	Sodium bromide is not considered to be genotoxic based on the available data.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	In a two-generation reproductive toxicity study in rats according to guideline OECD Guideline 416 (Two-Generation Reproduction Toxicity Study) There were no indicators of toxicity or adverse effects on reproductive parameters in either generation evaluated at 50mg/kg/day of sodium bromide. The NOAEL for parental toxicity, reproductive performance and pre-and postnatal development was therefore established as 50mg/kg/day
Acute Toxicity	Sodium bromide is not acutely toxic by the oral or dermal routes (Oral LD50 = 4200 mg/kg, dermal LD50 >2000 mg/kg). The inhalation study of sodium bromide is scientifically unjustified, since the bromide ion has a very low volatility based on the vapour pressure of 1.8 x 10-6Pa (Cowlyn T.C., 1991) and has a particle size which excludes inhalation (> 100 µm). Therefore exposure to significant quantities of bromide ions by direct inhalation is not likely to occur. Based on the experimental results, sodium bromide is not classified for acute toxicity by the oral or dermal routes.
Irritation	Sodium bromide is not classified as an irritant to skin or eyes.
Sensitisation	Sodium bromide is not classified as a skin sensitiser.
Health Effects Summary **Key Study/Critical Effect for Screening Criteria**	A Tier 1 Human Health Assessment for this chemical has been conducted by NICNAS which concluded that it Poses no unreasonable risk to human health based on Tier I assessment under the NICNAS IMAP assessment framework
Ecological Toxicity [1,2]	
Aquatic Toxicity	The effect of acute and chronic exposure to sodium bromide on aquatic organisms was observed in the studies reported here. Sodium bromide was found to be non-toxic to the aquatic environment. The short term toxicity to fish studies showed that the LD50 to the most sensitive species, Juvenile turbot, is >440 mg/L, according to OECD guideline 203. A number of chronic studies were performed with Poecilia reticulata and Oryzias latipes. The NOEC ranged from 10 to 3219 mg/L and 32 to 320 mg/L respectively. None of the validity criteria of the tests with the two species can be considered as fulfilled, as individual mortality and effect data were not given. The studies were not performed according to GLP. A considered number of studies with Daphnia magna are available. The toxicity data show that the sensitivity of Daphnia magna to the test substance is variable, with NOECs ranging from 2.8 to >117 mg/L sodium bromide.

	NOEC values were derived from acute and (semi) chronic toxicity tests with freshwater green algae, (cyano)bacteria and duckweed (Lemna minor). The test results show that the organisms have a similar toxicity to sodium bromide as the NOEC values ranged from 3200 mg/L to 4200 mg/L.
Determination of PNEC aquatic	A Tier 1 Environmental Risk Assessment for this chemical has been conducted by NICNAS which concluded that it is an inorganic substance comprising ions of low ecotoxicological concern. This chemical is not expected to pose an unreasonable risk to the environment provided that ANZECC water quality guidelines for physical and chemical stressors are not exceeded. Sodium bromide poses no unreasonable risk to the environment based on Tier I assessment under the NICNAS IMAP assessment framework.
Current Regulatory Controls	
Australian Hazard Classification	The chemical is not listed in the Hazardous Substances Information System (HSIS) (Safe Work Australia 2013).
Australian Occupational Exposure Standards	No specific exposure standards were available.
International Occupational Exposure Standards	No information available.
Australian Food Standards	No information available.
Australian Drinking Water Guidelines	No guidance values available.
Aquatic Toxicity Guidelines	No guidance values available.
PBT Assessment [1,2]	
P/vP Criteria fulfilled?	No. The substance is an inorganic compound and is not subject to biodegradation.
B/vB criteria fulfilled?	No. As the BCF is 0.23, it is not expected to be bioaccumulative.
T criteria fulfilled?	No. Chronic and acute toxicity data >1 mg/L, sodium bromide does not meet the screening criteria for toxicity.
Overall conclusion	Not PBT

References

1. ECHA REACH, Sodium bromide, Retrieved: https://echa.europa.eu/
2. National Industrial Chemicals Notification and Assessment Scheme (NICNAS). IMAP, Sodium Bromide. Retrieved: https://services.industrialchemicals.gov.au/search-assessments/?assessmentcasnumber=7647-15-6

Toxicity Summary - Sodium Hypochlorite

Chemical and Physical Properties[1,2,8,9]	
CAS number	7681-52-9
Molecular formula	CiO.Na
Molecular weight	74.4 g/mol
Solubility in water	29.3 g/100 g (0 deg C) in water
Melting point	-6 °C to -30 °C
Boiling point	96-120 °C (decomposes)
Vapour pressure	1.74–2.0 kPa (20 °C)
Henrys law constant	0.076 at 20 °C and 100 kPa
Explosive potential	Anhydrous Sodium Hypochlorite is very explosive.
Flammability potential	Non flammable
Colour/Form	Colourless or greenish yellow liquid with a chlorine-like odour.
Overview	Sodium Hypochlorite is commonly used as a household and laundry bleaching agent and as a bleaching agent in paper and pulp, in the textile industry and as a disinfectant for glass and ceramics. It is also used as a sanitizer in swimming pools and for water purification. Other uses include medicine and fungicides. Its extensive use is predominantly due to its strong oxidising potential. Although alkaline, sodium hypochlorite solution does not tend to cause corrosive damage unless present in large quantities or as concentrated solutions. Sodium hypochlorite may release small amounts of chlorine and hypochlorous acid when acidified, but usually in concentrations too small to cause any significant damage. This release of chlorine often causes problems when bleach is mixed with an acidic cleaning agent in the home or is diluted with hot water which results in the release of chlorine gas. This property requires suitable management to ensure release of chlorine does not occur in confined environments.
Environmental Fate[1,2]	
Soil/Water/Air	In water, sodium hypochlorite dissociates into the sodium cation and an equilibrium of chloride, HOCl, and ClO-. Overall, if released into the environment, sodium hypochlorite does not sorb to solid particles in the water column, is rapidly converted to lighter, readily degradable chlorinated compounds. Studies on the chlorinated by-products of sodium hypochlorite did not identify any bioaccumulative compounds. Hence sodium hypochlorite and associated by-products are not considered to be bioaccumulative in aquatic species or the food chain. The potential for migration to a receiving environment is considered to be low
Human Health Toxicity Summary [1,2,3,4,5,6,7,8]	
Chronic Repeated Dose Toxicity	<u>Oral</u> Several oral repeated dose toxicity studies were conducted in rats and mice. The main effects reported were decreases in body weights and absolute and relative organ weights. In one four-week oral repeated dose study, four groups of 10 male albino rats were given sodium hypochlorite solution in corn oil with the normal laboratory diet for 28 days (equivalent to 0, 2.7, 221 and 683 mg available chlorine per day). No deaths occurred during the study and no significant gross lesions were noted among treated rats when compared with controls. No differences in liver, kidney or testes weight were observed between the four groups. Adrenal weights in rats given 683 mg of available chlorine per day were statistically significantly increased (P>0.01) when compared with controls. The no observed adverse effect level (NOAEL) for sodium hypochlorite in this study was 221 mg/L available chlorine (Industrial Bio-test laboratories, 1970). In a 90-day oral study, groups of male and female Fischer 344 (F344) rats were given sodium hypochlorite dissolved in their drinking water at concentrations of 0, 0.05, 0.1, 0.2 or 0.4 % for 92 days (corresponding 0, 475, 950, 1900, 3800 mg/L available chlorine). Toxicity was assessed in terms of effects on body weight, organ weight, serum biochemistry and pathology. Both male and female rats given 3800 mg/L

	sodium hypochlorite showed a significant decrease in body weight gain and absolute weights of certain organs compared with controls. No remarkable pathological changes were observed among the treated rats. The NOAEL for sodium hypochlorite in the study was 0.2 % for male and female rats (44 and 97 mg/kg bw/day available chlorine, respectively, considering the drinking water intakes reported in the study) (Furukawa et al., 1980). In a two-year oral repeated dose study, groups of 50 male and 50 female F344 rats were given sodium hypochlorite dissolved in their drinking water for 104 weeks at concentrations of 0, 500 or 1000 ppm (0, 29 or 59 mg/kg bw/day as available chlorine) for males and 0, 1000 or 2000 ppm (0, 67 or 134 mg/kg bw/day as available chlorine) for females. Drinking water intake and food consumption were comparable among treated and control groups. A dose-related decrease in body weight gain was seen after 16 weeks of treatment in all treated groups of rats. This effect was accompanied by decreased absolute organ weights that, in some cases, were reflected in a decrease in relative organ weight (e.g. salivary glands and heart). The magnitude of the changes in both body and organ weights were small. Haematology and serum biochemical analysis did not show significant treatment-related changes for any parameter in either sex. No treatment-related non-neoplastic lesions were reported. The NOAELs for sodium hypochlorite in the study were 0.1 % (1000 ppm) corresponding to 59 mg/kg bw/day (available chlorine) for males and 67 mg/kg bw/day (available chlorine) for females (Hasegawa, 1986) <u>Dermal</u> The effect of the repeated administration of sodium hypochlorite solutions on the skin has been studied in the guinea-pigs. No effects were observed after guinea pigs were exposed to 0.125 % sodium hypochlorite solution for up to eight weeks (Wohlab & Wozniak, 1982). In another study, epidermal hyperplasia was observed following exposure to 0.1 % sodium hypochlorite solution eight hours/day for 14 days (Cotter et al., 1985). In a dermal carcinogenicity study, no treatment-related effects were observed in mice treated twice weekly for 51 weeks with a 1 % sodium hypochlorite solution (Kurokawa, 1984). <u>Inhalation</u> No repeated dose inhalation studies are available on sodium hypochlorite aerosol. A chlorine gas study in monkeys (Klonne et al., 1987) was not considered suitable for providing surrogate data for the quantitation of the potential effects of the sodium hypochlorite aerosol. This is because gaseous chlorine will only be released from a sodium hypochlorite solution on mixing with strong acids.
Carcinogenicity	Available data show no evidence of carcinogenicity of sodium hypochlorite in rodents. The potential carcinogenicity of sodium hypochlorite has been examined in F344 rats and in B6C3F1 mice (Hasegawa et al., 1986; Kurokawa et al., 1986; NTP, 1992) by long-term oral administration in drinking water. In one rat study (NTP, 1992), there was a slightly increased incidence in leukaemia in female rats. However, this was considered to be equivocal evidence of carcinogenicity based on a lack of a clear dose-response relationship and a relatively low incidence in the concurrent controls. An increase in lymphomas/leukaemias was seen in female Sprague Dawley (SD) rats in a two-year drinking water study (Soffritti et al., 1997), but with a lack of dose dependence. The co-carcinogenic properties of hypochlorite have been examined in female Sencar mice following initiation with dimethylbenzanthracene (Kurokawa et al., 1984) and in NMRI mice with benzopyrene (Pfeiffer, 1978). There was no carcinogenic effect due to topical application of sodium hypochlorite solution at different concentrations and no promoting effect of hypochlorite with either initiator. Overall, the available rodent studies are not sufficient to indicate a clear relationship between the oral administration of sodium hypochlorite and cancer. Equivocal evidence is reported in two studies (NTP, 1992; Soffritti et al., 1997) for association with leukaemia in female rats, but there is no evidence reported in other good quality studies.
Mutagenicity/	The available data indicate that sodium hypochlorite is not likely to be genotoxic.

Genotoxicity	Sodium hypochlorite was studied in several in vitro and in vivo mutagenicity assays (EU RAR, 2007). It gave mixed positive and negative results with bacterial mutation assays, chromosome aberrations tests and sister chromatid exchange (SCE) in mammalian cells. In vivo, sodium hypochlorite was without effect in four animal studies, including a well-conducted mouse micronucleus assay (Hayashi et al., 1988), suggesting that sodium hypochlorite is not mutagenic in vivo under the conditions tested.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	Sodium hypochlorite is not considered toxic to the reproductive system. In a sperm head abnormality test, sodium hypochlorite (pH 8.5, where hypochlorite anion predominates) was administered orally to B6C3F1 mice at doses of 0, 1.6, 4 and 8 mg chlorine/kg bw/day (Meier et al., 1985). A small increase in sperm head abnormalities was noted in the mid- and high-dose groups; however, these were independent of dose and only the mid dose group fell outside the highly variable background incidence of abnormalities. Sodium hypochlorite is not toxic to development. In a developmental toxicity study, female SD rats were exposed to 0, 0.1, 1, or 10 mg chlorine/kg bw/day (as hypochlorous acid) in drinking water for 2.5 months before mating and continuing throughout pregnancy until gestation day 20 (Abdel-Rahman et al., 1982). There were no significant effects on foetal viability or on foetal body weight, although skeletal anomalies were increased at 1 mg/kg/day and 10 mg/kg bw/day, and total soft tissue defects at 10 mg/kg/day, relative to controls. However, the observation that the incidence of foetal anomalies in the control group was higher than in the low-dose group, together with the absence of experimental detail (maternal body weight and water consumption data), limits the significance that can be attached to these findings.
Acute Toxicity	<u>Oral</u> Sodium hypochlorite has low acute oral toxicity in rats. A solution of sodium hypochlorite at a concentration of 12.5 % (available chlorine) caused no mortality up to the level of 5.8 g/kg in rats. Gastric lesions were found in all exposed animals when euthanised after 14 days of observation (CERB, 1985). In one study, five groups of 10 male Wistar rats each were given 20 mL/kg bw of different dilutions of chlorine bleach containing 12.5 % available chlorine. During the 14-day observation period, light to moderate sedation, diarrhoea, ataxia and increased breathing were recorded. Observed mortalities occurred in most cases within 24 hours of application. Pathology upon dissection included gas accumulation in the stomach and intestines, swelling of the liver, bleeding gastritis and enteritis. No symptoms were noted in the animals that survived. The median lethal dose (LD50) was determined to be 8.83 (8.2–9.51) g/kg bw, based on the 12.5 % available chlorine solution (or 626 mg/kg bw of sodium hypochlorite expressed as available chlorine) (Kaestner, 1981 in BIBRA, 1990). <u>Dermal</u> Acute dermal toxicity in rats was reported to be >2000 mg/kg bw for a 5.25 % available chlorine solution. No further details of the study are available (EU RAR, 2007). <u>Inhalation</u> Acute inhalation toxicity of sodium hypochlorite is low. The test was carried out in rats using an unspecified commercial solution of sodium hypochlorite. No deaths occurred and there were no signs of inactivity or lacrimation, and no significant gross pathological changes were reported (Industrial Bio-Test Laboratories Inc., 1970). The inhalation LC0 (concentration at which no mortality occurred) in rats was found to be >10.5 mg/L for a one-hour exposure. This study was considered of limited interest since gaseous chlorine can only be released from sodium hypochlorite solution on mixing with strong acids. The anion, ClO-, will not volatilise from aqueous solutions. Inhalation exposure of sodium hypochlorite is only possible if aerosols are formed.
Irritation	Can cause irritation of the eyes, skin, respiratory and gastrointestinal tract. Exposure to high levels can result in severe corrosive damage to the eyes, skin, respiratory and gastrointestinal tissues and can be fatal.

Sensitisation	Sodium hypochlorite is not considered to be a skin sensitiser. There was no evidence of delayed contact hypersensitivity in a Buehler Test with 8 % sodium hypochlorite in guinea pigs. In addition, 4.5 % sodium hypochlorite was negative when presented in two different surfactants in separate studies (unpublished data from Procter & Gamble, 1982 and 1985, cited in EU RAR, 2007).
Health Effects Summary	Sodium hypochlorite demonstrates low acute toxicity. It is corrosive to the skin, eyes and the gastrointestinal tract. Based on human and animal data, sodium hypochlorite concentrations over 5% are irritating to the skin and eye, while concentrations over 10% are corrosive. Aerosolised sodium hypochlorite is a respiratory irritant. The chemical is not a skin sensitiser. No systemic effects in animals are associated with repeated exposure to sodium hypochlorite at the tested dose levels. The critical study is a two-year drinking water study in rats, where no adverse effects were seen at a top dose of 13.6 to 14.2 mg chlorine/kg bw/day (NTP 1992). The available data, overall, indicate that it is not genotoxic. There is inadequate evidence for the carcinogenicity of sodium hypochlorite in animals and sodium hypochlorite is not considered to cause fertility or developmental effects. Overall, the main critical effect to human health of sodium hypochlorite is its corrosivity.
Key Study/Critical Effect for Screening Criteria	No adverse effects were observed from repeated exposures to the chemical at any dose tested, up to 13.6 mg/kg bw/day.
Ecological Toxicity [1,2,3,4,5]	
Aquatic Toxicity	Sodium hypochlorite is very toxic to aquatic organisms. The 96-hr LC50 of sodium hypochlorite to *Lepomis macrochirus* is 0.58 mg a.i./L. The 96-hr LC50 of sodium hypochlorite to *Oncorhynchus mykiss* is 0.20 mg a.i./L. The 48-hr EC50 of sodium hypochlorite to *Daphnia magna* is 0.141 mg active chlorine/L, and the NOEC is 0.05 mg active chlorine/L. The 48-hr EC50 of sodium hypochlorite to *Daphnia magna* is 0.04 mg active chlorine/L. The 24-hr EC50 of sodium hypochlorite to *Skeletonema costratum* is 0.095 mg/L, and the NOEC is 0.05 mg active chlorine/L. These two studies used a special design to mimic the situation of the effluent of steam electric generating plants into water. Six fish species were exposed to the pulses of a (calcium and sodium) hypochlorite solution (3 per day) for different time intervals (ranging from 24 to 168 hours) in a flow through arrangement streamed with tap water at different temperatures. It was observed that rainbow trout (*S. gairdneri*) and channel catfish (*I. punctatus*) were the most sensitive species in both studies, with a 120-hr LC50 of 50 µg TRC/L (at) and an 144-h LC50 = 33 µgTRC/L (at). At 96-hr, the LC50 for the trout was 60 µg TRC/L (at 12°C) and 64 µg TRC/L for the channel catfish (at 24°C). It should be noted that these are intermittent exposures. Long-term studies exist for saltwater, but not for freshwater, fish and invertebrates.
Determination of PNEC aquatic	Experimental results are available for three trophic levels. Acute E(L)C50 values are available for fish (0.2 mg a.i./L), Daphnia (0.04 mg active chlorine/L), and algae (0.095 mg/L). On the basis that the data consists of short-term results from three trophic levels, an assessment factor of 1,000 has been applied to the lowest reported effect concentration of 0.04 mg active chlorine/L for Daphnia to derive a PNECaquatic of 0.04 µg/L.
Current Regulatory Controls [8,9]	
Australian Hazard Classification	The chemical is classified as hazardous, with the following risk phrases for human health in the Hazardous Substances Information System (HSIS) (Safe Work Australia, 2014): • C; R34 (Corrosive), • R31 (Contact with acids liberates toxic gas).
Australian Occupational Exposure Standards	No specific exposure standards are available.
International Occupational Exposure Standards	The following exposure standards are identified (Galleria Chemica): • Short-term exposure limit (STEL): 2 mg/m^3 in countries such as the USA (American Industrial Hygiene Association). • Minimal risk levels for hazardous substances (MRLs): 2 mg/kg/day (USA, ATSDR)

Australian Food Standards	Sodium hypochlorite is listed in the Australia New Zealand Food Standards Code – Schedule 18 - Processing Aids – S18.05 Permitted processing aids for water (section 1.137) with a maximum permitted level of 5 mg/kg (available chlorine). The chemical is also listed in Schedule 18 – Processing Aids – S18.06 Permitted bleaching, washing and peeling agents – various foods (section 1.138) with a maximum permitted level of 1.0 mg/kg (available chlorine) (Food Standards Australia New Zealand 2013).
Australian Drinking Water Guidelines	Sodium hypochlorite is endorsed by the National Health and Medical Research Council (NHMRC) for use as a drinking water treatment chemical, with a guideline value of 3 mg/L (available chlorine) listed in the Australian Drinking Water Guidelines (NHMRC 2011).
Aquatic Toxicity Guidelines	No data found.
PBT Assessment	
P/vP Criteria fulfilled?	Not applicable (inorganic salt, ionic species ubiquitous in environment)
B/vB criteria fulfilled?	Not applicable (inorganic salt, ionic species ubiquitous in environment)
T criteria fulfilled?	Not applicable. Chronic toxicity data not available (acute data <0.1 mg/L), thus sodium hydroxide is potentially toxic.
Overall conclusion	Not PBT

References

1. European Union Risk Assessment Report, Sodium Hypochlorite, 2007 obtained from ECHA CHEM database for REACH registrations. http://apps.echa.europa.eu/registered/registeredsub.aspx
2. HSDB (n.d.). *Hazardous Substances Data Bank*. Retrieved 2015, from Toxnet, Toxicology Data Network, National Library of Medicine: http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB
3. SDA, 1997. Sodium Hypochlorite. Prepared by the Soap and Detergent Association
4. UK, 2007. Sodium Hypochlorite Toxicological Review. UK Health Protection Agency 2007
5. Bull S., 2007. Sodium Hypochlorite, Toxicological Overview. Prepared for the UK Health Protection Agency, CHAPD, HPA 2007, Version 1.
6. USEPA PAN Pesticides Database, http://www.pesticideinfo.org/Detail_Chemical.jsp?Rec_Id=PC34390
7. IARC (2011). Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man. Geneva: World Health Organization, International Agency for Research on Cancer, 1972-PRESENT. Available at http://monographs.iarc.fr/ENG/Classification/index.php
8. National Industrial Chemicals Notification and Assessment Scheme (NICNAS). IMAP, Human Health Tier II Assessment for Sodium hypochlorite: Retrieved 2019: https://www.nicnas.gov.au
9. Department of the Environment and Energy 2017, National assessment of chemicals associated with coal seam gas extraction in Australia, prepared by the National Industrial Chemicals Notification and Assessment Scheme

Toxicity Summary - Calcium hydroxide

Chemical and Physical Properties[1,2,3,4]	
CAS number	1305-62-0
Molecular formula	CaH2O2
Molecular weight	74.09
Solubility in water	1.73 g/L (20 °C)
Melting point	450 - 580 °C at 101.3 kPa
Boiling point	Decomposes at temperatures above 580 °C to give calcium oxide.
Vapour pressure	Negligible at 25 °C
Henrys law constant	No data available.
Explosive potential	Non-explosives
Flammability potential	Non-flammable
Colour/Form	Soft, white odourless crystalline powder
Overview	Calcium hydroxide is formed in an exothermic reaction when calcium oxide and water are combined. The chemical is an inorganic base, with a pH of 12.8 for a saturated solution at 25 °C (Clayton & Clayton, 1994). Since the constituent ions of calcium hydroxide (Ca2+ and OH-) are physiological components of the body and homeostatic mechanisms exist to regulate their levels, chronic systemic health effects from repeated dose exposure (e.g. carcinogenicity and reproductive toxicity) are not expected, apart from non-specific effects such as alkalosis. A Tier 1 Environmental Assessment for this chemical has been conducted by NICNAS which concluded that it was low concern to the environment.
Environmental Fate[1,3,4]	
Soil/Water/Air	When mixing calcium (di)hydroxide with water, the substance will be completely dissociated into its ions as the water solubility is relatively high compared to the environmental background concentration of calcium and due to dilution effects. Depending on the properties of the test medium, calcium (di)hydroxide will be strongly neutralised in the initial period after application, by formation of calcium carbonate.
Human Health Toxicity Summary [1,3,4]	
Chronic Repeated Dose Toxicity	Repeat dose studies for calcium hydroxide are not available. A number of repeat dose studies using analogues of calcium hydroxide (calcium carbonate, calcium gluconate) that investigate the effect of calcium ion on various metabolic functions in experimental animals are available. However, none of these studies are appropriate for derivation of a No Observed Adverse Effect Level (NOAEL) as they do not follow any international guidelines prescribed for NOAEL determination studies (REACH 2013)
Carcinogenicity	A long-term toxicity/carcinogenicity study with calcium lactate was undertaken in Fischer 344 (F344) rats (Maekawa et al. 1991). Calcium lactate, a food additive, was given in drinking water at levels of 0, 2.5 or 5% to groups of 50 male and 50 female rats for two years. The highest dose concentration of 5% corresponded to a calcium lactate dose of nearly 300 mg/kg bw/day in 250 g male rats. At the end of the dosing period, no specific dose-related changes in haematological or biochemical parameters were observed. Female rats of the high-dose group exhibited significantly higher kidney and brain weights although no histological changes were detected. A number of non-neoplastic lesions (myocardial fibrosis, bile-duct proliferation, hepatic microgranulomas and chronic nephropathy) were observed in all groups, with no difference in their incidence and / or degrees. None of the experimental groups showed any significant increase in the incidence of any specific tumours compared with the corresponding controls, neither was any positive trend noted in the occurrence of tumours. The authors of the study concluded that calcium lactate did not cause toxicity or carcinogenic activity in

	F344 rats. Based on the above observations, calcium hydroxide is not considered to be carcinogenic.
Mutagenicity/ Genotoxicity	Calcium hydroxide was not mutagenic in bacterial reverse mutation assays using Salmonella typhimurium strains TA100, TA1535, TA1537 and TA98 or other Escherichia coli strains, with and without metabolic activation (REACH 2013). The chromosome aberration assay with calcium hydroxide was also negative. Results from mammalian cell gene mutation assay are not available. Based on the bacterial reverse mutation assay results and chromosomal aberration assays, calcium hydroxide is not mutagenic.
Reproductive Toxicity / Developmental Toxicity/Teratogenicity	Developmental toxicity studies with calcium hydroxide are not available. Studies with related compounds, such as calcium oxide and calcium carbonate, did not show any developmental effects in rats (REACH 2013). Based on the available data, calcium hydroxide is not considered to be a developmental toxicant.
Acute Toxicity	The chemical has low acute toxicity based on results from animal tests following oral exposure. The median lethal dose (LD50) in female Wistar rats was >2000 mg/kg bw (REACH). The LD50 values in the range 4830–11140 mg/kg bw in rats have also been reported (Clayton & Clayton, 1994; ACGIH, 2001).
Irritation	Occupational exposure to the chemical was reported to cause respiratory irritation in humans. Based on the observations in animals and humans, and the high alkalinity of the chemical (pH = 12.8 for a saturated solution (Clayton & Clayton, 1994)), the chemical is considered to be a skin irritant, warranting hazard classification. The chemical is also considered to causes severe eye irritation. In an acute dermal irritation/corrosion study (according to the Organisation for Economic Cooperation and Development (OECD) test guideline (TG) 404), Himalayan rabbits (n = 3, sex not specified) were exposed (semi-occlusively) to 0.5 g of the chemical for four hours and observed at 24, 48 and 72 hours post-exposure. A mean erythema score of two was observed for two animals at all time-points and one animal also had a mean oedema score of one for all time-points. Erythema and oedema were reversible by 14 days after the termination of the study and it was concluded that the chemical was irritating to the skin (REACH). However, in another acute dermal irritation/corrosion study (OECD TG 404), New Zealand White rabbits (n = 3, sex not specified) exposed (semi-occlusive) to 0.5 g of the chemical for four hours and observed at 24, 48 and 72 hours post-exposure had erythema and oedema scores of zero at all time-points (REACH). In a long-term study in Swiss white mice (n = 53), an aqueous chewing tobacco extract that contained the chemical was painted on the ears of animals once daily for two years and the animals were assessed until their death. Thickening, hardening, partial ulceration, keratin-filled cysts and local infections were reported (Muir & Kirk, 1960). In an eye irritation study (OECD TG 405), New Zealand White rabbits (n = 3 males) were administered 0.1 mL of an 150 g/L suspension of the chemical into the conjunctival sac and examined at one, 24, 48 and 72 hours after administration. The mean scores for all animals were 0.8 for corneal opacity, 0.8 for iris lesions, 2.3 for conjunctival redness and 2.3 for chemosis. Corneal opacity and iritis were reversible by day 7 in all animals. Conjunctival redness and chemosis were reversible by day 8 in two rabbits, but not reversible within the 21-day observation period in one rabbit (REACH). One male New Zealand White rabbit was administered 100 mg of the chemical into the conjunctival sac of one eye and the animal was examined one hour after exposure (OECD TG 405). The corneal opacity score was four (total opacity) and the chemosis score was three, with the conjunctiva appearing necrotic and the iris not visible (REACH).

	In another eye irritation study (similar to OECD TG 405), New Zealand White rabbits (n = 6–9/dose) were administered the chemical at 0.01, 0.03 or 0.10 g onto the cornea and examined up to 21 days after exposure. No irritation scores were available, but it was reported that the experiment was terminated on day 14 for the mid and high dose groups due to severe eye irritation and injury that was judged as unlikely to reverse. In the low dose group, it took more than 21 days for the lesions to reverse (REACH).
Sensitisation	No data available.
Health Effects Summary	Calcium hydroxide has low acute oral and dermal toxicity, is a moderate skin irritant and a severe eye irritant. Calcium hydroxide is not genotoxic or carcinogenic and does not have any developmental effects in animals. Given the constituent ions of calcium hydroxide, systemic health effects from repeated exposures to calcium hydroxide are not expected. It is listed by the US Food and Drug Administration (FDA) as a Generally Recognised as Safe (GRAS) substance.
Key Study/Critical Effect for Screening Criteria	The critical health effects for risk characterisation include irritation effects (respiratory, dermal and ocular) due to the high alkalinity of the chemical. In an epidemiological study, no significant adverse effects were observed in lime-kiln workers exposed to 1.2 mg/m^3 lime dust (calcium oxide and calcium hydroxide). This atmospheric concentration was taken as an overall No-Observed-Adverse-Effect-Concentration (NOAEC) for calcium hydroxide and is used in this human health risk assessment. However, it should be noted that as this NOAEC represents an atmospheric concentration of the chemical in a workplace, the NOAEC value is likely to be conservative compared to a level that might be determined from laboratory studies.
Ecological Toxicity [2,3,4]	
Aquatic Toxicity	A Tier 1 Environmental Assessment for this chemical has been conducted by NICNAS which concluded that it was a reactive substance which rapidly converts into species of low ecotoxicological concern. This chemical, and its degradant species, are not expected to pose an unreasonable risk to the environment provided that ANZECC water quality guidelines for physical and chemical stressors are not exceeded. Acute fish = 356 mg/L (Measured)
Determination of PNEC aquatic	This chemical poses no unreasonable risk to the environment based on Tier I assessment under the NICNAS IMAP assessment framework.
Current Regulatory Controls[1,3]	
Australian Hazard Classification	The chemical is listed on the Hazardous Substances Information System (HSIS) (Safe Work Australia) due to having an assigned exposure standard. No risk phrases are assigned.
Australian Occupational Exposure Standards	The chemical has an exposure standard of 5 mg/m^3 time weighted average (TWA).
International Occupational Exposure Standards	The following exposure standards are identified (Galleria Chemica): • a TWA of 1–3 mg/m^3 in different countries such as Germany, Poland, Russia and Sweden; • a TWA of 5 mg/m^3 in different countries such as Bulgaria, Canada, Denmark, Egypt, Estonia, France, Greece, Hungary, Iceland, Indonesia, Ireland, Latvia, Malaysia, Malta, Mexico, Norway, Singapore, South Africa, Spain, Switzerland, Taiwan, Turkey, the United Kingdom and the USA; and • a short-term exposure limit (STEL) of 4–10 mg/m^3 in different countries such Canada, Poland and Sweden.
Australian Food Standards	Calcium hydroxide is allotted the following International Numbering System (INS) of food additives number: INS 526 (Food Standards Australia New Zealand 2013).
Australian Drinking Water Guidelines	Calcium hydroxide is used in water treatment to correct pH and adjust alkalinity, for coagulation optimisation, corrosion control and water softening. Typical

	calcium hydroxide concentrations used in drinking water treatment depend on the quality of the water to be treated, and the purpose of treatment (e.g. water softening, pH adjustment or alkalinity increase), and can vary from 5 to 500 mg/L (National Health and Medical Research Council (NHMRC) 2011).
Aquatic Toxicity Guidelines	No data available.
PBT Assessment	
P/vP Criteria fulfilled?	Not applicable (inorganic salt, ionic species ubiquitous in environment).
B/vB criteria fulfilled?	Not applicable. Bioaccumulation is not applicable to these inorganic ions; calcium and hydroxyl ions are ubiquitous and are present in most water, soil and sediment.
T criteria fulfilled?	Not applicable. Chronic toxicity data >1 mg/L in invertebrates, thus calcium hydroxide does not meet the screening criteria for toxicity.
Overall conclusion	Not PBT

References

1. National Industrial Chemicals Notification and Assessment Scheme (NICNAS). IMAP, Human Health Tier II Assessment for Calcium hydroxide (Ca(OH)2): Retrieved: https://www.nicnas.gov.au
2. National Industrial Chemicals Notification and Assessment Scheme (NICNAS). Calcium hydroxide (Ca(OH)2): Environment tier I assessment. Retrieved: https://services.industrialchemicals.gov.au/assessment-detail/?id=bc5d433e-f36b-1410-8924-008e64e216c7
3. Department of the Environment and Energy 2017, National assessment of chemicals associated with coal seam gas extraction in Australia, prepared by the National Industrial Chemicals Notification and Assessment Scheme
4. ECHA REACH, Calcium dihydroxide, Retrieved: https://echa.europa.eu/

Appendix J

SDS

SAFETY DATA SHEET

NewPerm™ NF

Issue Date 29-Jul-2016 **Revision Date** 07-Jul-2021 **Version** 1
EN

Section 1: IDENTIFICATION: PRODUCT INDENTIFIER AND CHEMICAL IDENTITY

0

Product identifier

Product Name NewPerm™ NF

Product Code NDF00503

Other means of identification

Pure substance/mixture Mixture

Recommended use of the chemical and restrictions on use

Recommended Use shale inhibitor

Uses advised against No information available

Details of manufacturer or importer

Supplier
Newpark Drilling Fluids (Australia) LTD
11 Alacrity Place
Henderson, WA, 6166
Australia

For further information, please contact

Contact Point Telephone: +61 8 9410 8200
Fax: +61 8 9410 8299
Website: www.newpark.com

Emergency telephone number

Emergency telephone number +(61)-290372994 (Australia); +(64)-98010034 (New Zealand)

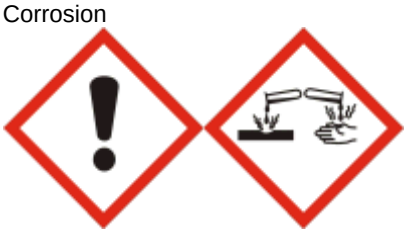
Section 2: HAZARD(S) IDENTIFICATION

GHS - Classification

Acute toxicity - Oral	Category 4 - (H302)
Acute toxicity - Dermal	Category 4 - (H312)
Skin corrosion/irritation	Category 1 - (H314)
Serious eye damage/eye irritation	Category 1 - (H318)
Skin sensitization	Category 1B - (H317)
Specific target organ toxicity (single exposure)	Category 3 - (H335)

Label elements

Exclamation mark
Corrosion



Signal word
Danger

Hazard statements
H302 - Harmful if swallowed
H312 - Harmful in contact with skin
H314 - Causes severe skin burns and eye damage
H317 - May cause an allergic skin reaction
H335 - May cause respiratory irritation

Precautionary Statements - Prevention
Wash face, hands and any exposed skin thoroughly after handling
Do not eat, drink or smoke when using this product
Wear protective gloves/protective clothing/eye protection/face protection
Do not breathe dust/fume/gas/mist/vapors/spray
Contaminated work clothing should not be allowed out of the workplace
Use only outdoors or in a well-ventilated area
Precautionary Statements - Response
Immediately call a POISON CENTER or doctor/physician
IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing
Immediately call a POISON CENTER or doctor/physician
Call a POISON CENTER or doctor/physician if you feel unwell
Wash contaminated clothing before reuse
IF ON SKIN (or hair): Remove/Take off immediately all contaminated clothing. Rinse skin with water/shower
If skin irritation or rash occurs: Get medical advice/attention
IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing
Immediately call a POISON CENTER or doctor/physician
Call a POISON CENTER or doctor/physician if you feel unwell
IF SWALLOWED: Call a POISON CENTER or doctor/physician if you feel unwell
Rinse mouth
Do NOT induce vomiting
Precautionary Statements - Storage
Store locked up
Store in a well-ventilated place. Keep container tightly closed
Precautionary Statements - Disposal
Dispose of contents/container to an approved waste disposal plant

Other hazards
Harmful to aquatic life
General Hazards
This substance does not meet the PBT/vPvB criteria of REACH, annex XIII

Section 3: COMPOSITION AND INFORMATION ON INGREDIENTS, IN ACCORDANCE WITH SCHEDULE 8

Substance

Not applicable

Mixture

Chemical name	CAS No.	Weight-%	REACH Registration Number
Hexanedinitrile, hydrogenated, high-boiling fraction	[redacted]	30-40	No data available

Additional information
The pH of the mixture is adjusted to pH 9-10 with Hydrochloric Acid (CAS 7647-01-0)

Section 4: FIRST AID MEASURES

Description of first aid measures

General advice Show this safety data sheet to the doctor in attendance. Immediate medical attention is required.

Emergency telephone number Poisons Information Center, Australia: 13 11 26
Poisons Information Center, New Zealand: 0800 764 766

Inhalation Remove to fresh air. If breathing has stopped, give artificial respiration. Get medical attention immediately. Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. If breathing is difficult, (trained personnel should) give oxygen. Delayed pulmonary edema may occur. Get immediate medical advice/attention.

Eye contact Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. Keep eye wide open while rinsing. Do not rub affected area. Remove contact lenses, if present and easy to do. Continue rinsing. Get immediate medical advice/attention.

Skin contact Wash off immediately with soap and plenty of water while removing all contaminated clothes and shoes. Get immediate medical advice/attention. May cause an allergic skin reaction.

Ingestion Do NOT induce vomiting. Clean mouth with water and drink afterwards plenty of water. Never give anything by mouth to an unconscious person. Get immediate medical advice/attention.

Self-protection of the first aider Ensure that medical personnel are aware of the material(s) involved, take precautions to protect themselves and prevent spread of contamination. Wear personal protective clothing (see section 8). Avoid contact with skin, eyes or clothing. Avoid direct contact with skin. Use barrier to give mouth-to-mouth resuscitation.

Most important symptoms and effects, both acute and delayed

Symptoms Burning sensation. Itching. Rashes. Hives.

Indication of any immediate medical attention and special treatment needed

Note to physicians Product is a corrosive material. Use of gastric lavage or emesis is contraindicated. Possible perforation of stomach or esophagus should be investigated. Do not give chemical antidotes. Asphyxia from glottal edema may occur. Marked decrease in blood pressure may occur with moist rales, frothy sputum, and high pulse pressure. May cause sensitization in susceptible persons. Treat symptomatically.

Section 5: FIREFIGHTING MEASURES

Suitable Extinguishing Media

Suitable extinguishing media Dry chemical, CO2, water spray or alcohol-resistant foam.

Unsuitable extinguishing media No information available.

Specific hazards arising from the chemical

The product causes burns of eyes, skin and mucous membranes. Thermal decomposition can lead to release of irritating and toxic gases and vapors. In the event of fire and/or explosion do not breathe fumes.

Hazardous combustion products Carbon oxides. Nitrogen oxides (NOx).

Special protective actions for fire-fighters

Special protective equipment for fire-fighters Firefighters should wear self-contained breathing apparatus and full firefighting turnout gear. Use personal protection equipment.

Hazchem code Not Listed.

Section 6: ACCIDENTAL RELEASE MEASURES

Personal precautions, protective equipment and emergency procedures

Personal precautions Avoid contact with skin, eyes or clothing. Ensure adequate ventilation. Use personal protective equipment as required. Attention! Corrosive material. Evacuate personnel to safe areas. Keep people away from and upwind of spill/leak.

Other Information Refer to protective measures listed in Sections 7 and 8.

For emergency responders Use personal protection recommended in Section 8.

Environmental precautions

Environmental precautions Prevent further leakage or spillage if safe to do so. Should not be released into the environment. Do not allow to enter into soil/subsoil. Prevent product from entering drains.

Methods and material for containment and cleaning up

Methods for containment Prevent further leakage or spillage if safe to do so.

Methods for cleaning up Pick up and transfer to properly labeled containers.

Precautions to prevent secondary hazards

Prevention of secondary hazards Clean contaminated objects and areas thoroughly observing environmental regulations.

Section 7: HANDLING AND STORAGE, INCLUDING HOW THE CHEMICAL MAY BE SAFELY USED

Precautions for safe handling

Advice on safe handling Handle in accordance with good industrial hygiene and safety practice. Wash thoroughly after handling. Wash contaminated clothing before reuse.

General hygiene considerations Avoid contact with skin, eyes or clothing. Wear suitable gloves and eye/face protection. Do not eat, drink or smoke when using this product. Remove and wash contaminated clothing and gloves, including the inside, before re-use. Contaminated work clothing should not be allowed out of the workplace. Regular cleaning of equipment, work area and clothing is recommended. Wash hands before breaks and immediately after handling the product.

Conditions for safe storage, including any incompatibilities

Storage Conditions Keep containers tightly closed in a dry, cool and well-ventilated place. Keep out of the reach of children. Store locked up. Protect from moisture. Store away from other materials.

Incompatible materials Strong oxidizing agents Aldehydes Halogens Acids Ketone Nitrates Halogenated compounds Phenols Isocyanates

Section 8: EXPOSURE CONTROLS AND PERSONAL PROTECTION

Control parameters

Exposure Limits

Biological occupational exposure limits Not applicable

Appropriate engineering controls

Engineering controls Showers
Eyewash stations
Ventilation systems.

Individual protection measures, such as personal protective equipment

Eye/face protection Face protection shield.

Skin and body protection Wear suitable protective clothing. Long sleeved clothing. Chemical resistant apron.

Hand protection Wear suitable gloves. Impervious gloves.

Respiratory protection In case of inadequate ventilation wear respiratory protection.

Environmental exposure controls Do not allow into any sewer, on the ground or into any body of water.

Section 9: PHYSICAL AND CHEMICAL PROPERTIES

Information on basic physical and chemical properties

Physical state	liquid		
Appearance	liquid	**Odor**	Pungent.
Color	brown	**Odor threshold**	No information available

Property	**Values**	**Remarks • Method**
pH	9.0 - 10.0	
Melting point / freezing point		No information available
Boiling point / boiling range	100 °C	
Flash point	> 100 °C	
Evaporation rate		No information available
Flammability (solid, gas)		Not applicable
Flammability Limit in Air		Not applicable
Upper flammability limit:		Not applicable
Lower flammability limit:		Not applicable
Vapor pressure		No data available
Vapor density		No data available
Relative density	1.00-1.10	
Water solubility	Soluble in water	
Solubility(ies)		No information available
Partition coefficient		No information available
Autoignition temperature		No information available
Decomposition temperature		No information available
Kinematic viscosity		
Dynamic viscosity		

Other Information

Softening point No information available
Molecular weight No information available

VOC Content (%)	14
Liquid Density	1.00-1.10 g/cm3
Bulk density	No information available
Particle Size	No information available
Particle Size Distribution	No information available

Section 10: STABILITY AND REACTIVITY

Reactivity

Reactivity No information available.

Chemical stability

Stability Stable under normal conditions.

Explosion data

Sensitivity to Mechanical Impact None.
Sensitivity to Static Discharge None.

Possibility of Hazardous Reactions

Possibility of hazardous reactions None under normal processing.

Conditions to avoid

Conditions to avoid Exposure to air or moisture over prolonged periods.

Incompatible materials

Incompatible materials Strong oxidizing agents. Aldehydes. Halogens. Acids. Ketone. Nitrates. Halogenated compounds. Phenols. Isocyanates.

Hazardous Decomposition Products

Hazardous Decomposition Products None known.

Section 11: TOXICOLOGICAL INFORMATION

Acute toxicity

Information on likely routes of exposure

Product Information

Inhalation Specific test data for the substance or mixture is not available. Corrosive by inhalation. (based on components). Inhalation of corrosive fumes/gases may cause coughing, choking, headache, dizziness, and weakness for several hours. Pulmonary edema may occur with tightness in the chest, shortness of breath, bluish skin, decreased blood pressure, and increased heart rate. Inhaled corrosive substances can lead to a toxic edema of the lungs. Pulmonary edema can be fatal. May cause irritation of respiratory tract.

Eye contact Specific test data for the substance or mixture is not available. Causes burns. (based on components). Corrosive to the eyes and may cause severe damage including blindness. Causes serious eye damage. May cause irreversible damage to eyes.

Skin contact Specific test data for the substance or mixture is not available. May cause irritation. May cause sensitization by skin contact. Repeated or prolonged skin contact may cause allergic reactions with susceptible persons. (based on components). May be absorbed through the skin in harmful amounts. Harmful in contact with skin.

Ingestion Specific test data for the substance or mixture is not available Causes burns (based on components) Ingestion causes burns of the upper digestive and respiratory tracts May cause severe burning pain in the mouth and stomach with vomiting and diarrhea of dark blood. Blood pressure may decrease. Brownish or yellowish stains may be seen around the mouth. Swelling of the throat may cause shortness of breath and choking May cause lung damage if swallowed May be fatal if swallowed and enters airways

Symptoms Redness. Burning. May cause blindness. Coughing and/ or wheezing. Itching. Rashes. Hives.

Numerical measures of toxicity - Product Information

The following values are calculated based on chapter 3.1 of the GHS document

ATEmix (oral) 1,922.60 mg/kg
ATEmix (dermal) 1,754.80 mg/kg ppm mg/l

Unknown acute toxicity 18 % of the mixture consists of ingredient(s) of unknown toxicity
18 % of the mixture consists of ingredient(s) of unknown acute oral toxicity
18 % of the mixture consists of ingredient(s) of unknown acute dermal toxicity
18 % of the mixture consists of ingredient(s) of unknown acute inhalation toxicity (gas)
18 % of the mixture consists of ingredient(s) of unknown acute inhalation toxicity (vapor)
18 % of the mixture consists of ingredient(s) of unknown acute inhalation toxicity (dust/mist)

Component Information

Chemical name	Oral LD50	Dermal LD50	Inhalation LC50
Hexanedinitrile, hydrogenated, high-boiling fraction	= 1500 mg/kg (Rat)	> 200 mg/kg (Rabbit)	-

See section 16 for terms and abbreviations

Delayed and immediate effects as well as chronic effects from short and long-term exposure

Skin corrosion/irritation MAY CAUSE SKIN IRRITATION.

Serious eye damage/eye irritation Classification based on data available for ingredients. Causes burns. Risk of serious damage to eyes.

Respiratory or skin sensitization May cause sensitization by skin contact.

Germ cell mutagenicity No information available.

Carcinogenicity No information available.

Reproductive toxicity No information available.

STOT - single exposure May cause respiratory irritation.

STOT - repeated exposure No information available.

Aspiration hazard No information available.

Section 12: ECOLOGICAL INFORMATION

Ecotoxicity

Ecotoxicity

Unknown aquatic toxicity 0 % of the mixture consists of component(s) of unknown hazards to the aquatic environment.

Persistence and degradability

Persistence and degradability Readily biodegradable.

Product Information			
Method	Exposure time	Value	Results
OECD Test No. 306: Biodegradability in Seawater	28 days	62.4% Biodegradation	Readily biodegradable

Bioaccumulative potential

Bioaccumulation There is no data for this product.

Component Information

Mobility

Mobility in soil No information available.

Mobility No information available.

Other adverse effects

Other adverse effects No information available.

Section 13: DISPOSAL CONSIDERATIONS

Waste treatment methods

Waste from residues/unused products Dispose of in accordance with local regulations. Dispose of waste in accordance with environmental legislation.

Contaminated packaging Do not reuse empty containers.

Section 14: TRANSPORT INFORMATION

ADG Not Regulated

IATA Not Regulated

IMDG Not Regulated

Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code
No information available

Section 15: REGULATORY INFORMATION

Regulatory information

National regulations

Australia
See section 8 for national exposure control parameters

Standard for Uniform Scheduling of Medicines and Poisons (SUSMP)
No poisons schedule number allocated

International Inventories

TSCA	Complies
DSL/NDSL	Complies
EINECS/ELINCS	Complies
ENCS	Does not comply
IECSC	Complies
KECL	Does not comply
PICCS	Does not comply
AICS	Complies
NZIoC	Complies

Legend:
TSCA - United States Toxic Substances Control Act Section 8(b) Inventory
DSL/NDSL - Canadian Domestic Substances List/Non-Domestic Substances List
EINECS/ELINCS - European Inventory of Existing Chemical Substances/European List of Notified Chemical Substances
ENCS - Japan Existing and New Chemical Substances
IECSC - China Inventory of Existing Chemical Substances
KECL - Korean Existing and Evaluated Chemical Substances
PICCS - Philippines Inventory of Chemicals and Chemical Substances
AICS - Australian Inventory of Chemical Substances
NZIoC - New Zealand Inventory of Chemicals

International Regulations

The Montreal Protocol on Substances that Deplete the Ozone Layer Not applicable

The Stockholm Convention on Persistent Organic Pollutants Not applicable

The Rotterdam Convention Not applicable

Brunei Poison List Not applicable.

Section 16: ANY OTHER RELEVANT INFORMATION

Issue Date 29-Jul-2016

Revision Date 07-Jul-2021

Revision Note
No information available.

Key or legend to abbreviations and acronyms used in the safety data sheet

Legend Section 8: EXPOSURE CONTROLS/PERSONAL PROTECTION

TWA	TWA (time-weighted average)	STEL	STEL (Short Term Exposure Limit)
Ceiling	Maximum limit value	*	Skin designation
C	Carcinogen		

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End of Safety Data Sheet

SAFETY DATA SHEET

NewZan™ D

A safety data sheet is not required for this product under Article 31 of REACH

Issuing Date 07-Jul-2016 **Revision Date** 11-Aug-2021 **Version** 1.9

SECTION 1: Identification of the substance/mixture and of the company/undertaking

1.1. Product identifier

Product Code NDF00020

Product Name NewZan™ D

EC No 234-394-2

CAS No [redacted]

Synonyms Xanthan Gum

Pure substance/mixture Substance

1.2. Relevant identified uses of the substance or mixture and uses advised against

Recommended Use Viscosifier

Uses advised against No information available

1.3. Details of the supplier of the safety data sheet

Supplier
Newpark Drilling Fluids S.p.A.
Via Salaria 1313/C
00138 ROMA (Italy)
For further information, please contact

Contact Point
Telephone: + 39 06 8856111
Fax: +39 06 8889363
Website: www.newpark.com

E-mail address hse-hqit@newpark.com

1.4. Emergency telephone number

Emergency Telephone - §45 - (EC)1272/2008	
Europe	**112**
Croatia	+385 1 7776 920 ; +385 01 2348 342 (Centar za kontrolu otrovanja, 24 sata)
France	+(33)-975181407
Germany	0800-181-7059; +(49)- 69643508409
Hungary	+(36)-18088425
Italy	800-789-767; +(39)-0245557031 Milano 24/24 Ospedale Niguarda Ca'grande Piazza ospedale maggiore 3 +39 0266101029

	Roma 24/24 Policlinico Gemelli Largo Agostino Gemelli 8 +39 063054343
Netherlands	+(31)-858880596
Romania	(+40)-37-6300026
Spain	900-868538; +(34)-931768545
Switzerland	145, (+41) 435082011
United Kingdom	+(44)-870-8200418

SECTION 2: Hazards identification

2.1. Classification of the substance or mixture

Regulation (EC) No 1272/2008
This substance is classified as not hazardous according to regulation (EC) 1272/2008 [CLP]

2.2. Label elements

This substance is classified as not hazardous according to regulation (EC) 1272/2008 [CLP]
Hazard statements
This substance is classified as not hazardous according to regulation (EC) 1272/2008 [CLP]

2.3. Other hazards

May form combustible dust concentrations in air.

This substance does not meet the PBT/vPvB criteria of REACH, annex XIII.

SECTION 3: Composition/information on ingredients

3.1 Substances

Chemical name	Weight-%	REACH registration number	EC No	Classification according to Regulation (EC) No. 1272/2008 [CLP]	Specific concentration limit (SCL)	M-Factor	M-Factor (long-term)
Xanthan Gum 11138-66-2	100	No data available	234-394-2	No data available	-	-	-

Full text of H- and EUH-phrases: see section 16

Acute Toxicity Estimate
No information available

This product does not contain candidate substances of very high concern at a concentration >=0.1% (Regulation (EC) No. 1907/2006 (REACH), Article 59)

SECTION 4: First aid measures

4.1. Description of first aid measures

Inhalation Remove to fresh air.

Eye contact Rinse thoroughly with plenty of water for at least 15 minutes, lifting lower and upper eyelids. Consult a physician.

Skin contact	Wash skin with soap and water. In the case of skin irritation or allergic reactions see a physician.
Ingestion	Rinse mouth.

4.2. Most important symptoms and effects, both acute and delayed

Symptoms	No information available.

4.3. Indication of any immediate medical attention and special treatment needed

Note to physicians	Treat symptomatically.

SECTION 5: Firefighting measures

5.1. Extinguishing media

Suitable Extinguishing Media	Dry chemical, CO2, sand, earth, water spray or regular foam.
Large Fire	CAUTION: Use of water spray when fighting fire may be inefficient.
Unsuitable extinguishing media	Do not scatter spilled material with high pressure water streams.

5.2. Special hazards arising from the substance or mixture

Specific hazards arising from the chemical	Fine dust dispersed in air may ignite. Material becomes extremely slippery when wet.
Hazardous combustion products	Carbon oxides.

5.3. Advice for firefighters

Special protective equipment and precautions for fire-fighters	Firefighters should wear self-contained breathing apparatus and full firefighting turnout gear. Use personal protection equipment.

SECTION 6: Accidental release measures

6.1. Personal precautions, protective equipment and emergency procedures

Personal precautions	Ensure adequate ventilation. Avoid generation of dust.
For emergency responders	Use personal protection recommended in Section 8.

6.2. Environmental precautions

Environmental precautions	See Section 12 for additional Ecological Information.

6.3. Methods and material for containment and cleaning up

Methods for containment	Prevent further leakage or spillage if safe to do so.
Methods for cleaning up	Use personal protective equipment as required. Avoid generation of dust. Sweep up and shovel into suitable containers for disposal.
Prevention of secondary hazards	Clean contaminated objects and areas thoroughly observing environmental regulations.

6.4. Reference to other sections

Reference to other sections	See section 8 for more information. See section 13 for more information.

SECTION 7: Handling and storage

7.1. Precautions for safe handling

Advice on safe handling Handle in accordance with good industrial hygiene and safety practice. Avoid generation of dust. Wash thoroughly after handling.

General hygiene considerations Handle in accordance with good industrial hygiene and safety practice.

7.2. Conditions for safe storage, including any incompatibilities

Storage Conditions Keep container tightly closed in a dry and well-ventilated place.

7.3. Specific end use(s)

Identified uses
Risk Management Methods (RMM) The information required is contained in this Safety Data Sheet.

SECTION 8: Exposure controls/personal protection

8.1. Control parameters

Exposure Limits This product, as supplied, does not contain any hazardous materials with occupational exposure limits established by the region specific regulatory bodies.

Biological occupational exposure limits
This product, as supplied, does not contain any hazardous materials with biological limits established by the region specific regulatory bodies.

Derived No Effect Level (DNEL) No information available.
Predicted No Effect Concentration (PNEC) No information available.

8.2. Exposure controls

Personal protective equipment

Eye/face protection Wear safety glasses with side shields (or goggles). Use eye protection according to EN 166, designed to protect against spray mists.

Skin and body protection Wear suitable protective clothing. (EN 340).

Respiratory protection No protective equipment is needed under normal use conditions. If exposure limits are exceeded or irritation is experienced, ventilation and evacuation may be required. (EN 136, EN 140, EN 141, EN 143, EN 149, EN 405).

General hygiene considerations Handle in accordance with good industrial hygiene and safety practice.

Environmental exposure controls No information available.

SECTION 9: Physical and chemical properties

9.1. Information on basic physical and chemical properties

Physical state	Solid
Appearance	Powder
Color	Off-white
Odor	Odorless.
Odor threshold	No information available

Property	**Values**	**Remarks • Method**
Melting point / freezing point		Not applicable
Boiling point / boiling range		Not applicable
Flammability (solid, gas)		No information available
Flammability Limit in Air		Not applicable
Upper flammability limit:		
Lower flammability limit:		
Flash point		Not applicable
Autoignition temperature		No information available
Decomposition temperature		No information available
pH		Not applicable
pH (as aqueous solution)		No information available
Kinematic viscosity		Not applicable
Dynamic viscosity		Not applicable
Water solubility	Soluble in water	
Solubility(ies)		No information available
Partition coefficient		No information available
Vapor pressure		No information available
Relative density	1.02-1.45	
Bulk density		
Liquid Density		
Vapor density		No information available
Particle characteristics		No information available
Particle Size		
Particle Size Distribution		

9.2. Other information

9.2.1. Information with regard to physical hazard classes

Explosives

Explosive properties	Fine dust dispersed in air, in sufficient concentrations, and in the presence of an ignition source is a potential dust explosion hazard
Oxidizing properties	Not applicable

9.2.2. Other safety characteristics

No information available Not applicable

SECTION 10: Stability and reactivity

10.1. Reactivity

Reactivity Not reactive under normal conditions.

10.2. Chemical stability

Stability Stable under normal conditions.

Explosion data

Sensitivity to mechanical impact	None.
Sensitivity to static discharge	Fine dust dispersed in air, in sufficient concentrations, and in the presence of an ignition source is a potential dust explosion hazard.

10.3. Possibility of hazardous reactions

Possibility of hazardous reactions None under normal processing.

10.4. Conditions to avoid

Conditions to avoid Incompatible materials. dust formation.

10.5. Incompatible materials

Incompatible materials Strong oxidizing agents.

10.6. Hazardous decomposition products

Hazardous Decomposition Products None known based on information supplied.

SECTION 11: Toxicological information

11.1. Information on hazard classes as defined in Regulation (EC) No 1272/2008

Information on likely routes of exposure

Product Information

Inhalation Specific test data for the substance or mixture is not available.

Eye contact Specific test data for the substance or mixture is not available.

Skin contact Specific test data for the substance or mixture is not available.

Ingestion Specific test data for the substance or mixture is not available.

Symptoms related to the physical, chemical and toxicological characteristics

Symptoms No information available.

Numerical measures of toxicity
No information available

Acute toxicity

Delayed and immediate effects as well as chronic effects from short and long-term exposure

Skin corrosion/irritation None known.

Serious eye damage/eye irritation None known.

Respiratory or skin sensitization None known.

Germ cell mutagenicity None known.

Carcinogenicity None known.

Reproductive toxicity None known.

STOT - single exposure None known.

STOT - repeated exposure None known.

Aspiration hazard Not applicable.

11.2. Information on other hazards

11.2.1. Endocrine disrupting properties

Endocrine disrupting properties No information available.

11.2.2. Other information

Other adverse effects No information available.

SECTION 12: Ecological information

12.1. Toxicity

Ecotoxicity The environmental impact of this product has not been fully investigated.

12.2. Persistence and degradability

Persistence and degradability No information available.

12.3. Bioaccumulative potential

Bioaccumulation No information available.

12.4. Mobility in soil

Mobility in soil No information available.

12.5. Results of PBT and vPvB assessment

PBT and vPvB assessment The product does not contain any substance(s) classified as PBT or vPvB.

12.6. Endocrine disrupting properties

Endocrine disrupting properties No information available.

12.7. Other adverse effects
No information available.

SECTION 13: Disposal considerations

13.1. Waste treatment methods

Waste from residues/unused products Dispose of in accordance with local regulations. Dispose of waste in accordance with environmental legislation.

Contaminated packaging Do not reuse empty containers.

Waste codes / waste designations according to EWC / AVV Waste codes should be assigned by the user based on the application for which the product was used.

SECTION 14: Transport information

IATA

14.1 UN number or ID number Not regulated
14.2 Proper shipping name Not Regulated
14.3 Transport hazard class(es) Not regulated
14.4 Packing group Not regulated
14.5 Environmental hazard Not applicable
14.6 Special precautions for user
Special Provisions None

IMDG

14.1 UN number or ID number Not regulated
14.2 Proper shipping name Not Regulated
14.3 Transport hazard class(es) Not regulated
14.4 Packing Group Not Regulated
14.5 Environmental hazard Not applicable
14.6 Special precautions for user
Special Provisions None
14.7 Maritime transport in bulk according to IMO instruments No information available

RID

14.1 UN/ID no Not Regulated
14.2 Proper shipping name Not Regulated
14.3 Transport hazard class(es) Not regulated
14.4 Packing Group Not Regulated
14.5 Environmental hazard Not applicable
14.6 Special precautions for user
Special Provisions None

ADR

14.1 UN number or ID number Not regulated
14.2 Proper shipping name Not Regulated
14.3 Transport hazard class(es) Not regulated
14.4 Packing Group Not Regulated
14.5 Environmental hazard Not applicable
14.6 Special precautions for user
Special Provisions None

SECTION 15: Regulatory information

15.1. Safety, health and environmental regulations/legislation specific for the substance or mixture

National regulations

Germany

Water hazard class (WGK) slightly hazardous to water (WGK 1)

European Union

Take note of Directive 98/24/EC on the protection of the health and safety of workers from the risks related to chemical agents at work.

Authorizations and/or restrictions on use:

This product does not contain substances subject to authorization (Regulation (EC) No. 1907/2006 (REACH), Annex XIV) This product does not contain substances subject to restriction (Regulation (EC) No. 1907/2006 (REACH), Annex XVII)

Persistent Organic Pollutants
Not applicable

Ozone-depleting substances (ODS) regulation (EC) 1005/2009
Not applicable

International Inventories

TSCA	Complies
DSL/NDSL	Complies
EINECS/ELINCS	Complies
ENCS	Complies
IECSC	Complies
KECL	Complies
PICCS	Complies
AICS	Complies
NZIoC	Complies

Legend:
TSCA - United States Toxic Substances Control Act Section 8(b) Inventory
DSL/NDSL - Canadian Domestic Substances List/Non-Domestic Substances List
EINECS/ELINCS - European Inventory of Existing Chemical Substances/European List of Notified Chemical Substances
ENCS - Japan Existing and New Chemical Substances
IECSC - China Inventory of Existing Chemical Substances
KECL - Korean Existing and Evaluated Chemical Substances
PICCS - Philippines Inventory of Chemicals and Chemical Substances
AICS - Australian Inventory of Chemical Substances

15.2. Chemical safety assessment

Chemical Safety Report None

SECTION 16: Other information

Key or legend to abbreviations and acronyms used in the safety data sheet

Legend
SVHC: Substances of Very High Concern for Authorization:

Legend Section 8: EXPOSURE CONTROLS/PERSONAL PROTECTION

TWA	TWA (time-weighted average)	STEL	STEL (Short Term Exposure Limit)
Ceiling	Maximum limit value	*	Skin designation

Key literature references and sources for data used to compile the SDS
Agency for Toxic Substances and Disease Registry (ATSDR)
U.S. Environmental Protection Agency ChemView Database
European Food Safety Authority (EFSA)
EPA (Environmental Protection Agency)
Acute Exposure Guideline Level(s) (AEGL(s))
U.S. Environmental Protection Agency Federal Insecticide, Fungicide, and Rodenticide Act
U.S. Environmental Protection Agency High Production Volume Chemicals
Food Research Journal
Hazardous Substance Database

International Uniform Chemical Information Database (IUCLID)
Japan GHS Classification
Australia National Industrial Chemicals Notification and Assessment Scheme (NICNAS)
NIOSH (National Institute for Occupational Safety and Health)
National Library of Medicine's ChemID Plus (NLM CIP)
National Library of Medicine's PubMed database (NLM PUBMED)
National Toxicology Program (NTP)
New Zealand's Chemical Classification and Information Database (CCID)
Organization for Economic Co-operation and Development Environment, Health, and Safety Publications
Organization for Economic Co-operation and Development High Production Volume Chemicals Program
Organization for Economic Co-operation and Development Screening Information Data Set
World Health Organization

Issuing Date 07-Jul-2016

Revision Date 11-Aug-2021

This material safety data sheet complies with the requirements of Regulation (EC) No. 1907/2006
Disclaimer
According to Regulation (EC) No 1272/2008 of the European Parliament and of the Council of 16 December 2008 on classification, labelling and packaging of substances and mixtures, amending and repealing Directives 67/548/EEC and 1999/45/EC, and amending Regulation (EC) No 1907/2006, as amended by Regulation (EU) No. 2015/830. This document is provided as an information resource relating exclusively to the product or material described herein. The information contained herein may not be applicable to other products/ materials or processes and may not be valid when this product/material is used in combination with any other product/material or process. The information provided in this document is compiled by Newpark Drilling Fluids LLC or its representatives from various sources including manufacturers, suppliers and other third-party sources, and is based on the information available as of the indicated date of preparation. As the conditions under which this product could be used will vary and may not be within the control of Newpark Drilling Fluids LLC there is no guarantee that the precautions outlined above will be sufficient for all individuals or situations. The buyer assumes all responsibility for using and handling the product in accordance with federal, state, provincial, or local regulations. For the product/ material described in this document, NO WARRANTY IS MADE, EXPRESS OR IMPLIED, OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR OTHERWISE.

End of Safety Data Sheet

NEWPARK DRILLING FLUIDS

SAFETY DATA SHEET

1. IDENTIFICATION OF THE MATERIAL AND SUPPLIER

1.1 Product identifier

Product name **OMYACARB**

Synonyms AGRICULTURAL LIME ● CALCIUM CARBONATE ● CHALK ● LIMESTONE ● OMYACARB 10 ● OMYACARB 2 ● OMYACARB 20 ● OMYACARB 40 ● OMYACARB 5

1.2 Uses and uses advised against

Uses BRIDGING AGENT ● DRILLING FLUID ADDITIVE ● WEIGHTING AGENT

1.3 Details of the supplier of the product

Supplier name **NEWPARK DRILLING FLUIDS (AUSTRALIA) LTD**

Address 11 Alacrity Place, Henderson, WA, 6166, AUSTRALIA

Telephone +61 8 9410 8200

Fax +61 8 9410 8299

Website www.newpark.com

1.4 Emergency telephone numbers

Emergency 1800 127 406 (Australia); +64 4 917 9888 (International)

2. HAZARDS IDENTIFICATION

2.1 Classification of the substance or mixture

NOT CLASSIFIED AS HAZARDOUS ACCORDING TO SAFE WORK AUSTRALIA CRITERIA

2.2 GHS Label elements

No signal word, pictograms, hazard or precautionary statements have been allocated.

2.3 Other hazards

No information provided.

3. COMPOSITION/ INFORMATION ON INGREDIENTS

3.1 Substances / Mixtures

Ingredient	CAS Number	EC Number	Content
LIMESTONE (CALCIUM CARBONATE)	[redacted]	215-279-6	>96%
QUARTZ (CRYSTALLINE SILICA)	[redacted]	238-878-4	<1%

4. FIRST AID MEASURES

4.1 Description of first aid measures

Eye If in eyes, hold eyelids apart and flush continuously with running water. Continue flushing until advised to stop by a Poisons Information Centre, a doctor, or for at least 15 minutes.

Inhalation If inhaled, remove from contaminated area. Apply artificial respiration if not breathing.

Skin If skin or hair contact occurs, remove contaminated clothing and flush skin and hair with running water.

Ingestion For advice, contact a Poisons Information Centre on 13 11 26 (Australia Wide) or a doctor (at once). If swallowed, do not induce vomiting.

First aid facilities Eye wash facilities should be available.

4.2 Most important symptoms and effects, both acute and delayed
See Section 11 for more detailed information on health effects and symptoms.

4.3 Immediate medical attention and special treatment needed
Treat symptomatically.

5. FIRE FIGHTING MEASURES

5.1 Extinguishing media
Use an extinguishing agent suitable for the surrounding fire.

5.2 Special hazards arising from the substance or mixture
Non flammable. May evolve toxic gases if strongly heated.

5.3 Advice for firefighters
No fire or explosion hazard exists.

5.4 Hazchem code
None allocated.

6. ACCIDENTAL RELEASE MEASURES

6.1 Personal precautions, protective equipment and emergency procedures
Wear Personal Protective Equipment (PPE) as detailed in section 8 of the SDS.

6.2 Environmental precautions
Prevent product from entering drains and waterways.

6.3 Methods of cleaning up
If spilt, collect and reuse where possible. If reuse is not possible, contain spillage, then collect and place in suitable containers for disposal. Avoid generating dust.

6.4 Reference to other sections
See Sections 8 and 13 for exposure controls and disposal.

7. HANDLING AND STORAGE

7.1 Precautions for safe handling
Before use carefully read the product label. Use of safe work practices are recommended to avoid eye or skin contact and inhalation. Observe good personal hygiene, including washing hands before eating. Prohibit eating, drinking and smoking in contaminated areas.

7.2 Conditions for safe storage, including any incompatibilities
Store in a cool, dry, well ventilated area, removed from incompatible substances and foodstuffs. Ensure containers are adequately labelled, protected from physical damage and sealed when not in use.

7.3 Specific end uses
No information provided.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

8.1 Control parameters

Exposure standards

Ingredient	Reference	TWA		STEL	
		ppm	mg/m³	ppm	mg/m³
Calcium carbonate (Limestone, Marble, Whiting)	SWA [AUS]	--	10	--	--
Quartz (respirable dust)	SWA [AUS]	--	0.05	--	--
Quartz (respirable dust) (Precautionary advice)	WorkSafe VIC	--	0.02	--	--

Biological limits

No biological limit values have been entered for this product.

8.2 Exposure controls

Engineering controls Avoid inhalation. Use in well ventilated areas. Where an inhalation risk exists, mechanical extraction ventilation is recommended. Maintain dust levels below the recommended exposure standard.

PPE

Eye / Face	Wear dust-proof goggles.
Hands	When using large quantities or where heavy contamination is likely, wear PVC or rubber gloves.
Body	When using large quantities or where heavy contamination is likely, wear coveralls.
Respiratory	Where an inhalation risk exists, wear a Class P1 (Particulate) respirator.



9. PHYSICAL AND CHEMICAL PROPERTIES

9.1 Information on basic physical and chemical properties

Appearance	OFF-WHITE POWDER
Odour	ODOURLESS
Flammability	NON FLAMMABLE
Flash point	NOT RELEVANT
Boiling point	NOT AVAILABLE
Melting point	825°C
Evaporation rate	NOT AVAILABLE
pH	NOT AVAILABLE
Vapour density	NOT AVAILABLE
Relative density	2.7
Solubility (water)	INSOLUBLE
Vapour pressure	NOT AVAILABLE
Upper explosion limit	NOT RELEVANT
Lower explosion limit	NOT RELEVANT
Partition coefficient	NOT AVAILABLE
Autoignition temperature	NOT AVAILABLE
Decomposition temperature	NOT AVAILABLE
Viscosity	NOT AVAILABLE
Explosive properties	NOT AVAILABLE
Oxidising properties	NOT AVAILABLE
Odour threshold	NOT AVAILABLE

10. STABILITY AND REACTIVITY

10.1 Reactivity
Calcium carbonate reacts with acids and acidic salts to generate gaseous carbon dioxide with effervescence (bubbling). The reaction with concentrated solutions of acids is rapid and exothermic. The effervesence can create extensive foaming. Ignites on contact with fluorine.

10.2 Chemical stability
Stable under recommended conditions of storage.

10.3 Possibility of hazardous reactions
Polymerization will not occur.

10.4 Conditions to avoid
Avoid heat, sparks, open flames and other ignition sources.

10.5 Incompatible materials
Incompatible with acids (e.g. nitric acid), fluorine, aluminium (hot) and ammonium salts.

10.6 Hazardous decomposition products
May evolve toxic gases if heated to decomposition.

11. TOXICOLOGICAL INFORMATION

11.1 Information on toxicological effects

Acute toxicity This product is expected to be of low acute toxicity. Under normal conditions of use, adverse health effects are not anticipated.

Information available for the ingredients:

Ingredient	Oral LD50	Dermal LD50	Inhalation LC50
LIMESTONE (CALCIUM CARBONATE)	> 5000 mg/kg (rat)	--	--

Skin Not classified as a skin irritant. Prolonged or repeated contact may result in mild irritation and rash.

Eye Not classified as an eye irritant. Contact may result in mild irritation, lacrimation and redness.

Sensitisation Not classified as causing skin or respiratory sensitisation.

Mutagenicity Insufficient data available to classify as a mutagen.

Carcinogenicity Crystalline silica is classified as carcinogenic to humans (IARC Group 1). However, there is a body of evidence supporting the fact that increased cancer risk would be limited to people already suffering from silicosis.

Reproductive Insufficient data available to classify as a reproductive toxin.

STOT - single exposure Not classified as causing organ damage from single exposure.

STOT - repeated exposure Not classified as causing organ damage from repeated exposure. Repeated exposure to crystalline silica may cause lung fibrosis (silicosis), however due to the low levels of respirable crystalline silica in this product, adverse health effects are not anticipated with normal use.

Aspiration Not relevant.

12. ECOLOGICAL INFORMATION

12.1 Toxicity
Calcium carbonate occurs naturally in a wide variety of substances including limestone, marble and egg shells. It is not anticipated to cause adverse environmental effects.

12.2 Persistence and degradability
Dissolved calcium carbonate dissociates into calcium and carbonate ions. Calcium ions will be assimilated by living organisms in the water and the carbonate will become part of the carbon cycle.

12.3 Bioaccumulative potential
This product does not bioaccumulate.

12.4 Mobility in soil

Due to its limited solubility, calcium carbonate precipitates and deposits on the sediment.

12.5 Other adverse effects

No information provided.

13. DISPOSAL CONSIDERATIONS

13.1 Waste treatment methods

Waste disposal Ensure product is covered with moist soil to prevent dust generation and dispose of to approved Council landfill. Contact the manufacturer/supplier for additional information (if required).

Legislation Dispose of in accordance with relevant local legislation.

14. TRANSPORT INFORMATION

NOT CLASSIFIED AS A DANGEROUS GOOD BY THE CRITERIA OF THE ADG CODE, IMDG OR IATA

	LAND TRANSPORT (ADG)	SEA TRANSPORT (IMDG / IMO)	AIR TRANSPORT (IATA / ICAO)
14.1 UN Number	None allocated.	None allocated.	None allocated.
14.2 Proper Shipping Name	None allocated.	None allocated.	None allocated.
14.3 Transport hazard class	None allocated.	None allocated.	None allocated.
14.4 Packing Group	None allocated.	None allocated.	None allocated.

14.5 Environmental hazards

No information provided.

14.6 Special precautions for user

Hazchem code None allocated.

15. REGULATORY INFORMATION

15.1 Safety, health and environmental regulations/legislation specific for the substance or mixture

Poison schedule A poison schedule number has not been allocated to this product using the criteria in the Standard for the Uniform Scheduling of Medicines and Poisons (SUSMP).

Classifications Safe Work Australia criteria is based on the Globally Harmonised System (GHS) of Classification and Labelling of Chemicals (GHS Revision 7).

Inventory listings **AUSTRALIA: AIIC (Australian Inventory of Industrial Chemicals)**
All components are listed on AIIC, or are exempt.

16. OTHER INFORMATION

Additional information

RESPIRATORS: In general the use of respirators should be limited and engineering controls employed to avoid exposure. If respiratory equipment must be worn ensure correct respirator selection and training is undertaken. Remember that some respirators may be extremely uncomfortable when used for long periods. The use of air powered or air supplied respirators should be considered where prolonged or repeated use is necessary.

EXPOSURE CONTROL: If utilised in a closed system the potential for over exposure is reduced. If not used in a closed system, local exhaust ventilation is recommended to control exposure. Provide eye wash and safety shower in close proximity to points of potential exposure. Where the potential for an inhalation risk exists, an approved respirator may be required. Do not eat, store, consume food, tobacco or drink in areas where product is used.

PERSONAL PROTECTIVE EQUIPMENT GUIDELINES:
The recommendation for protective equipment contained within this report is provided as a guide only. Factors such as form of product, method of application, working environment, quantity used, product concentration and the availability of engineering controls should be considered before final selection of personal protective equipment is made.

HEALTH EFFECTS FROM EXPOSURE:
It should be noted that the effects from exposure to this product will depend on several factors including: form of product; frequency and duration of use; quantity used; effectiveness of control measures; protective equipment used and method of application. Given that it is impractical to prepare a report which would encompass all possible scenarios, it is anticipated that users will assess the risks and apply control methods where appropriate.

Abbreviations

ACGIH	American Conference of Governmental Industrial Hygienists
CAS #	Chemical Abstract Service number - used to uniquely identify chemical compounds
CNS	Central Nervous System
EC No.	EC No - European Community Number
EMS	Emergency Schedules (Emergency Procedures for Ships Carrying Dangerous Goods)
GHS	Globally Harmonized System
GTEPG	Group Text Emergency Procedure Guide
IARC	International Agency for Research on Cancer
LC50	Lethal Concentration, 50% / Median Lethal Concentration
LD50	Lethal Dose, 50% / Median Lethal Dose
mg/m³	Milligrams per Cubic Metre
OEL	Occupational Exposure Limit
pH	relates to hydrogen ion concentration using a scale of 0 (high acidic) to 14 (highly alkaline).
ppm	Parts Per Million
STEL	Short-Term Exposure Limit
STOT-RE	Specific target organ toxicity (repeated exposure)
STOT-SE	Specific target organ toxicity (single exposure)
SUSMP	Standard for the Uniform Scheduling of Medicines and Poisons
SWA	Safe Work Australia
TLV	Threshold Limit Value
TWA	Time Weighted Average

Report status

This document has been compiled by RMT on behalf of the manufacturer, importer or supplier of the product and serves as their Safety Data Sheet ('SDS').

It is based on information concerning the product which has been provided to RMT by the manufacturer, importer or supplier or obtained from third party sources and is believed to represent the current state of knowledge as to the appropriate safety and handling precautions for the product at the time of issue. Further clarification regarding any aspect of the product should be obtained directly from the manufacturer, importer or supplier.

While RMT has taken all due care to include accurate and up-to-date information in this SDS, it does not provide any warranty as to accuracy or completeness. As far as lawfully possible, RMT accepts no liability for any loss, injury or damage (including consequential loss) which may be suffered or incurred by any person as a consequence of their reliance on the information contained in this SDS.

Prepared by

Risk Management Technologies
5 Ventnor Ave, West Perth
Western Australia 6005
Phone: +61 8 9322 1711
Fax: +61 8 9322 1794
Email: info@rmt.com.au
Web: www.rmtglobal.com

[End of SDS]

NEWPARK DRILLING FLUIDS

SAFETY DATA SHEET

1. IDENTIFICATION OF THE MATERIAL AND SUPPLIER

1.1 Product identifier

Product name **POTASSIUM CHLORIDE**

Synonyms KCL ● MURIATE OF POTASH ● POTASH ● SYLVITE

1.2 Uses and uses advised against

Uses DRILLING FLUID ADDITIVE ● FERTILISER ● INHIBITOR

1.3 Details of the supplier of the product

Supplier name **NEWPARK DRILLING FLUIDS (AUSTRALIA) LTD**

Address 11 Alacrity Place, Henderson, WA, 6166, AUSTRALIA

Telephone +61 8 9410 8200

Fax +61 8 9410 8299

Website www.newpark.com

1.4 Emergency telephone numbers

Emergency 1800 127 406 (Australia); +64 4 917 9888 (International)

2. HAZARDS IDENTIFICATION

2.1 Classification of the substance or mixture

NOT CLASSIFIED AS HAZARDOUS ACCORDING TO SAFE WORK AUSTRALIA CRITERIA

2.2 GHS Label elements

No signal word, pictograms, hazard or precautionary statements have been allocated.

2.3 Other hazards

No information provided.

3. COMPOSITION/ INFORMATION ON INGREDIENTS

3.1 Substances / Mixtures

Ingredient	CAS Number	EC Number	Content
POTASSIUM CHLORIDE	[redacted]	231-211-8	>97%

4. FIRST AID MEASURES

4.1 Description of first aid measures

Eye If in eyes, hold eyelids apart and flush continuously with running water. Continue flushing until advised to stop by a Poisons Information Centre, a doctor, or for at least 15 minutes.

Inhalation If inhaled, remove from contaminated area. Apply artificial respiration if not breathing.

Skin If skin or hair contact occurs, remove contaminated clothing and flush skin and hair with running water. Continue flushing with water until advised to stop by a Poisons Information Centre or a doctor.

Ingestion For advice, contact a Poisons Information Centre on 13 11 26 (Australia Wide) or a doctor (at once). If swallowed, do not induce vomiting.

First aid facilities Eye wash facilities should be available.

4.2 Most important symptoms and effects, both acute and delayed

Adverse effects not expected from this product under normal conditions of use.

4.3 Immediate medical attention and special treatment needed
Treat symptomatically.

5. FIRE FIGHTING MEASURES

5.1 Extinguishing media
Use an extinguishing agent suitable for the surrounding fire.

5.2 Special hazards arising from the substance or mixture
Non flammable. May evolve toxic gases (potassium oxides, chlorides) when heated to decomposition.

5.3 Advice for firefighters
Evacuate area and contact emergency services. Toxic gases may be evolved in a fire situation. Remain upwind and notify those downwind of hazard. Wear full protective equipment including Self Contained Breathing Apparatus (SCBA) when combating fire. Use waterfog to cool intact containers and nearby storage areas.

5.4 Hazchem code
None allocated.

6. ACCIDENTAL RELEASE MEASURES

6.1 Personal precautions, protective equipment and emergency procedures
Wear Personal Protective Equipment (PPE) as detailed in section 8 of the SDS.

6.2 Environmental precautions
Prevent product from entering drains and waterways.

6.3 Methods of cleaning up
Contain spillage, then collect and place in suitable containers for disposal. Avoid generating dust.

6.4 Reference to other sections
See Sections 8 and 13 for exposure controls and disposal.

7. HANDLING AND STORAGE

7.1 Precautions for safe handling
Before use carefully read the product label. Use of safe work practices are recommended to avoid eye or skin contact and inhalation. Observe good personal hygiene, including washing hands before eating. Prohibit eating, drinking and smoking in contaminated areas.

7.2 Conditions for safe storage, including any incompatibilities
Store in a cool, dry, well ventilated area, removed from incompatible substances and foodstuffs. Ensure containers are adequately labelled, protected from physical damage and sealed when not in use.

7.3 Specific end uses
No information provided.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

8.1 Control parameters
Exposure standards

No exposure standards have been entered for this product.

Biological limits

No biological limit values have been entered for this product.

8.2 Exposure controls
Engineering controls Avoid inhalation. Use in well ventilated areas. Where an inhalation risk exists, mechanical extraction ventilation is recommended.

PPE

Eye / Face	At high dust levels, wear dust-proof goggles.
Hands	With prolonged use, wear PVC or rubber or cotton gloves.
Body	With prolonged use, wear coveralls.
Respiratory	At high dust levels, wear a Class P1 (Particulate) respirator.

9. PHYSICAL AND CHEMICAL PROPERTIES

9.1 Information on basic physical and chemical properties

Appearance	WHITE SOLID
Odour	ODOURLESS
Flammability	NON FLAMMABLE
Flash point	NOT RELEVANT
Boiling point	1413°C
Melting point	773°C
Evaporation rate	NOT AVAILABLE
pH	NOT AVAILABLE
Vapour density	NOT AVAILABLE
Specific gravity	2.0
Solubility (water)	340 g/L @ 20°C
Vapour pressure	NOT AVAILABLE
Upper explosion limit	NOT RELEVANT
Lower explosion limit	NOT RELEVANT
Partition coefficient	NOT AVAILABLE
Autoignition temperature	NOT AVAILABLE
Decomposition temperature	NOT AVAILABLE
Viscosity	NOT AVAILABLE
Explosive properties	NOT AVAILABLE
Oxidising properties	NOT AVAILABLE
Odour threshold	NOT AVAILABLE

10. STABILITY AND REACTIVITY

10.1 Reactivity

Carefully review all information provided in sections 10.2 to 10.6.

10.2 Chemical stability

Stable under recommended conditions of storage.

10.3 Possibility of hazardous reactions

Polymerization will not occur.

10.4 Conditions to avoid

Avoid heat, sparks, open flames and other ignition sources.

10.5 Incompatible materials

Potassium chloride is not in general strongly reactive. Violent reaction with BrF3 and with a mixture of sulfuric acid potassium permanganate mixture (NTP, 1992). Reacts with concentrated sulfuric acid to generate fumes of hydrogen chloride. Incompatible with oxidising agents.

10.6 Hazardous decomposition products

May evolve toxic gases (potassium oxides, chlorides) when heated to decomposition.

11. TOXICOLOGICAL INFORMATION

11.1 Information on toxicological effects

Acute toxicity May be harmful if swallowed in large quantities. Additional toxicity data for potassium chloride:
LD50 (Intraperitoneal): 620 mg/kg (mouse)
LD50 (Intravenous): 117 mg/kg (mouse)
LDLo (Ingestion): 20 mg/kg (man)
LDLo (Intraperitoneal): 900 mg/kg (guinea pig)
LDLo (Intravenous): 77 mg/kg (guinea pig)

LDLo (Subcutaneous): 2120 mg/kg (frog)
TDLo (Ingestion): 60 mg/kg/days (woman)

Information available for the ingredients:

Ingredient	Oral LD50	Dermal LD50	Inhalation LC50
POTASSIUM CHLORIDE	2600 mg/kg (rat)	--	--

Skin Not classified as a skin irritant. Contact may result in mild irritation and rash.

Eye Contact may cause discomfort, lacrimation and redness.

Sensitisation Not classified as causing skin or respiratory sensitisation.

Mutagenicity No evidence of mutagenic effects.

Carcinogenicity No evidence of carcinogenic effects.

Reproductive No relevant or reliable studies were identified.

STOT - single exposure Acute potassium poisoning via ingestion is rare as a large single dose usually induces vomiting, and potassium is rapidly excreted by the body, however this product does have the potential to cause cardiovascular disorders.

STOT - repeated exposure Not classified as causing organ damage from repeated exposure.

Aspiration Not relevant.

12. ECOLOGICAL INFORMATION

12.1 Toxicity

In short-term acute toxicity tests with fish, daphnia and algae the following results were found (lowest test result values): Ictalurus punctulus 48h-LC50 = 720 mg/l; Daphnia magna: 48h-LC50 = 177 mg/l; Nitzschia linearis: 120 h-EC50 = 1337 mg/l. A chronic reproductive test with the invertebrate Daphnia magna gave a LOEC of 101 mg/l. All the studies compiled on the acute and chronic aquatic toxicity were > 100 mg/L. Thus it is concluded that KCl is not hazardous to freshwater organisms. Taking into considerations the background concentrations of KCl in seawater (380 mg/l K+ and 19,000 mg/l Cl-), it is concluded that there is no reason for further investigations of KCl on marine species. The low concern for the environment is supported by the absence of a bioaccumulation potential for the substance.

12.2 Persistence and degradability

Biodegradability does not pertain to inorganic substances.

12.3 Bioaccumulative potential

Does not bioaccumulate.

12.4 Mobility in soil

No impact if small amount is released to the soil.

12.5 Other adverse effects

No information provided.

13. DISPOSAL CONSIDERATIONS

13.1 Waste treatment methods

Waste disposal Collect and place in sealable containers and dispose of to an approved landfill site. Contact the manufacturer/supplier for additional information (if required).

Legislation Dispose of in accordance with relevant local legislation.

14. TRANSPORT INFORMATION

NOT CLASSIFIED AS A DANGEROUS GOOD BY THE CRITERIA OF THE ADG CODE, IMDG OR IATA

	LAND TRANSPORT (ADG)	SEA TRANSPORT (IMDG / IMO)	AIR TRANSPORT (IATA / ICAO)
14.1 UN Number	None allocated.	None allocated.	None allocated.
14.2 Proper Shipping Name	None allocated.	None allocated.	None allocated.
14.3 Transport hazard class	None allocated.	None allocated.	None allocated.
14.4 Packing Group	None allocated.	None allocated.	None allocated.

14.5 Environmental hazards

No information provided.

14.6 Special precautions for user

Hazchem code None allocated.

15. REGULATORY INFORMATION

15.1 Safety, health and environmental regulations/legislation specific for the substance or mixture

Poison schedule A poison schedule number has not been allocated to this product using the criteria in the Standard for the Uniform Scheduling of Medicines and Poisons (SUSMP).

Classifications Safework Australia criteria is based on the Globally Harmonised System (GHS) of Classification and Labelling of Chemicals.

Inventory listings **AUSTRALIA: AICS (Australian Inventory of Chemical Substances)**
All components are listed on AICS, or are exempt.

16. OTHER INFORMATION

Additional information

RESPIRATORS: In general the use of respirators should be limited and engineering controls employed to avoid exposure. If respiratory equipment must be worn ensure correct respirator selection and training is undertaken. Remember that some respirators may be extremely uncomfortable when used for long periods. The use of air powered or air supplied respirators should be considered where prolonged or repeated use is necessary.

PERSONAL PROTECTIVE EQUIPMENT GUIDELINES:
The recommendation for protective equipment contained within this report is provided as a guide only. Factors such as form of product, method of application, working environment, quantity used, product concentration and the availability of engineering controls should be considered before final selection of personal protective equipment is made.

HEALTH EFFECTS FROM EXPOSURE:
It should be noted that the effects from exposure to this product will depend on several factors including: form of product; frequency and duration of use; quantity used; effectiveness of control measures; protective equipment used and method of application. Given that it is impractical to prepare a report which would encompass all possible scenarios, it is anticipated that users will assess the risks and apply control methods where appropriate.

Abbreviations

ACGIH	American Conference of Governmental Industrial Hygienists
CAS #	Chemical Abstract Service number - used to uniquely identify chemical compounds
CNS	Central Nervous System
EC No.	EC No - European Community Number
EMS	Emergency Schedules (Emergency Procedures for Ships Carrying Dangerous Goods)
GHS	Globally Harmonized System
GTEPG	Group Text Emergency Procedure Guide
IARC	International Agency for Research on Cancer
LC50	Lethal Concentration, 50% / Median Lethal Concentration
LD50	Lethal Dose, 50% / Median Lethal Dose
mg/m³	Milligrams per Cubic Metre
OEL	Occupational Exposure Limit
pH	relates to hydrogen ion concentration using a scale of 0 (high acidic) to 14 (highly alkaline).
ppm	Parts Per Million
STEL	Short-Term Exposure Limit
STOT-RE	Specific target organ toxicity (repeated exposure)
STOT-SE	Specific target organ toxicity (single exposure)
SUSMP	Standard for the Uniform Scheduling of Medicines and Poisons
SWA	Safe Work Australia
TLV	Threshold Limit Value
TWA	Time Weighted Average

Report status

This document has been compiled by RMT on behalf of the manufacturer, importer or supplier of the product and serves as their Safety Data Sheet ('SDS').

It is based on information concerning the product which has been provided to RMT by the manufacturer, importer or supplier or obtained from third party sources and is believed to represent the current state of knowledge as to the appropriate safety and handling precautions for the product at the time of issue. Further clarification regarding any aspect of the product should be obtained directly from the manufacturer, importer or supplier.

While RMT has taken all due care to include accurate and up-to-date information in this SDS, it does not provide any warranty as to accuracy or completeness. As far as lawfully possible, RMT accepts no liability for any loss, injury or damage (including consequential loss) which may be suffered or incurred by any person as a consequence of their reliance on the information contained in this SDS.

Prepared by

Risk Management Technologies
5 Ventnor Ave, West Perth
Western Australia 6005
Phone: +61 8 9322 1711
Fax: +61 8 9322 1794
Email: info@rmt.com.au
Web: www.rmtglobal.com

[End of SDS]

NEWPARK DRILLING FLUIDS

SAFETY DATA SHEET

1. IDENTIFICATION OF THE MATERIAL AND SUPPLIER

1.1 Product identifier

Product name **SAPP**

Synonyms DISODIUM DIHYDROGEN PYROPHOSPHATE ● DISODIUM PYROPHOSPHATE

1.2 Uses and uses advised against

Uses ACIDIFIER ● BUFFERING AGENT

1.3 Details of the supplier of the product

Supplier name **NEWPARK DRILLING FLUIDS (AUSTRALIA) LTD**

Address 11 Alacrity Place, Henderson, WA, 6166, AUSTRALIA

Telephone +61 8 9410 8200

Fax +61 8 9410 8299

Website www.newpark.com

1.4 Emergency telephone numbers

Emergency 1800 127 406 (Australia); +64 4 917 9888 (International)

2. HAZARDS IDENTIFICATION

2.1 Classification of the substance or mixture

NOT CLASSIFIED AS HAZARDOUS ACCORDING TO SAFE WORK AUSTRALIA CRITERIA

2.2 GHS Label elements

No signal word, pictograms, hazard or precautionary statements have been allocated.

2.3 Other hazards

No information provided.

3. COMPOSITION/ INFORMATION ON INGREDIENTS

3.1 Substances / Mixtures

Ingredient	CAS Number	EC Number	Content
DISODIUM PYROPHOSPHATE	[redacted]	231-835-0	100%

4. FIRST AID MEASURES

4.1 Description of first aid measures

Eye If in eyes, hold eyelids apart and flush continuously with running water. Continue flushing until advised to stop by a Poisons Information Centre, a doctor, or for at least 15 minutes.

Inhalation If inhaled, remove from contaminated area. Apply artificial respiration if not breathing.

Skin If skin or hair contact occurs, remove contaminated clothing and flush skin and hair with running water.

Ingestion For advice, contact a Poisons Information Centre on 13 11 26 (Australia Wide) or a doctor (at once).

First aid facilities Eye wash facilities and safety shower should be available.

4.2 Most important symptoms and effects, both acute and delayed

See Section 11 for more detailed information on health effects and symptoms.

4.3 Immediate medical attention and special treatment needed
Treat symptomatically.

5. FIRE FIGHTING MEASURES

5.1 Extinguishing media
Use an extinguishing agent suitable for the surrounding fire.

5.2 Special hazards arising from the substance or mixture
Non flammable. May evolve toxic gases (phosphorus oxides) when heated to decomposition.

5.3 Advice for firefighters
Evacuate area and contact emergency services. Toxic gases may be evolved in a fire situation. Remain upwind and notify those downwind of hazard. Wear full protective equipment including Self Contained Breathing Apparatus (SCBA) when combating fire. Use waterfog to cool intact containers and nearby storage areas.

5.4 Hazchem code
None allocated.

6. ACCIDENTAL RELEASE MEASURES

6.1 Personal precautions, protective equipment and emergency procedures
Wear Personal Protective Equipment (PPE) as detailed in section 8 of the SDS. Ventilate area where possible.

6.2 Environmental precautions
Prevent product from entering drains and waterways.

6.3 Methods of cleaning up
Contain spillage, then collect and place in suitable containers for disposal. Avoid generating dust.

6.4 Reference to other sections
See Sections 8 and 13 for exposure controls and disposal.

7. HANDLING AND STORAGE

7.1 Precautions for safe handling
Before use carefully read the product label. Use of safe work practices are recommended to avoid eye or skin contact and inhalation. Observe good personal hygiene, including washing hands before eating. Prohibit eating, drinking and smoking in contaminated areas.

7.2 Conditions for safe storage, including any incompatibilities
Store in a cool, dry, well ventilated area, removed from incompatible substances and foodstuffs. Ensure containers are adequately labelled and tightly closed when not in use.

7.3 Specific end uses
No information provided.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

8.1 Control parameters
Exposure standards

Ingredient	Reference	TWA		STEL	
		ppm	mg/m³	ppm	mg/m³
Nuisance dust	SWA [AUS]	--	10	--	--

Biological limits

No biological limit values have been entered for this product.

8.2 Exposure controls
Engineering controls Avoid inhalation. Use in well ventilated areas.

PPE

Eye / Face	Wear dust-proof goggles.
Hands	Wear PVC or rubber gloves.
Body	When using large quantities or where heavy contamination is likely, wear coveralls.
Respiratory	Where an inhalation risk exists, wear a Class P1 (Particulate) respirator.



9. PHYSICAL AND CHEMICAL PROPERTIES

9.1 Information on basic physical and chemical properties

Appearance	WHITE POWDER
Odour	SLIGHT ODOUR
Flammability	NON FLAMMABLE
Flash point	NOT RELEVANT
Boiling point	NOT AVAILABLE
Melting point	> 600°C
Evaporation rate	NOT AVAILABLE
pH	4 - 5 (10% Solution)
Vapour density	NOT AVAILABLE
Specific gravity	1.35 - 1.41
Solubility (water)	119 g/L
Vapour pressure	NOT AVAILABLE
Upper explosion limit	NOT RELEVANT
Lower explosion limit	NOT RELEVANT
Partition coefficient	NOT AVAILABLE
Autoignition temperature	NOT AVAILABLE
Decomposition temperature	NOT AVAILABLE
Viscosity	NOT AVAILABLE
Explosive properties	NOT AVAILABLE
Oxidising properties	NOT AVAILABLE
Odour threshold	NOT AVAILABLE

10. STABILITY AND REACTIVITY

10.1 Reactivity

Carefully review all information provided in sections 10.2 to 10.6.

10.2 Chemical stability

Stable under recommended conditions of storage.

10.3 Possibility of hazardous reactions

Polymerization is not expected to occur.

10.4 Conditions to avoid

Avoid heat, sparks, open flames and other ignition sources.

10.5 Incompatible materials

Incompatible with oxidising agents (e.g. hypochlorites) and acids (e.g. nitric acid).

10.6 Hazardous decomposition products

May evolve toxic gases (phosphorus oxides) when heated to decomposition.

11. TOXICOLOGICAL INFORMATION

11.1 Information on toxicological effects

Acute toxicity Low toxicity. Ingestion of large quantities may result in nausea, vomiting and gastrointestinal irritation.

Ingestion of large quantities may also result in serious disturbances in calcium metabolism.

LD50 (Ingestion): 2650 mg/kg (mouse)
LD50 (Intraperitoneal): 1 g/kg (mouse)
LD50 (Intravenous): 59 mg/kg (mouse)
LD50 (Subcutaneous): 480 mg/kg (mouse)

Information available for the ingredients:

Ingredient	Oral LD50	Dermal LD50	Inhalation LC50
DISODIUM PYROPHOSPHATE	2650 mg/kg (mouse)	> 2000 mg/kg (rat)	> 0.58 mg/L/4hrs (rat)

Additional ingredient toxicity values:

DISODIUM PYROPHOSPHATE (7758-16-9)
LD50 (intraperitoneal) 1 g/kg (mouse)
LD50 (intravenous) 59 mg/kg (mouse)
LD50 (subcutaneous) 480 mg/kg (mouse)

Skin Low to moderate irritant. Prolonged or repeated contact may result in irritation and rash.

Eye Low to moderate irritant. Contact may result in mild irritation, lacrimation and redness.

Sensitisation Not classified as causing skin or respiratory sensitisation.

Mutagenicity Not classified as a mutagen.

Carcinogenicity Not classified as a carcinogen.

Reproductive Not classified as a reproductive toxin.

STOT - single exposure Low irritant. Over exposure may result in irritation of the nose and throat, with coughing.

STOT - repeated exposure Not classified as causing organ damage from repeated exposure.

Aspiration This product does not present an aspiration hazard.

12. ECOLOGICAL INFORMATION

12.1 Toxicity
No information provided.

12.2 Persistence and degradability
Biodegradability does not pertain to inorganic substances.

12.3 Bioaccumulative potential
Does not bioaccumulate.

12.4 Mobility in soil
No information provided.

12.5 Other adverse effects
No information provided.

13. DISPOSAL CONSIDERATIONS

13.1 Waste treatment methods

Waste disposal Dispose of to an approved landfill or waste processing site. Contact the manufacturer/supplier for additional information (if required).

Legislation Dispose of in accordance with relevant local legislation.

14. TRANSPORT INFORMATION

NOT CLASSIFIED AS A DANGEROUS GOOD BY THE CRITERIA OF THE ADG CODE, IMDG OR IATA

	LAND TRANSPORT (ADG)	SEA TRANSPORT (IMDG / IMO)	AIR TRANSPORT (IATA / ICAO)
14.1 UN Number	None allocated.	None allocated.	None allocated.
14.2 Proper Shipping Name	None allocated.	None allocated.	None allocated.
14.3 Transport hazard class	None allocated.	None allocated.	None allocated.
14.4 Packing Group	None allocated.	None allocated.	None allocated.

14.5 Environmental hazards

No information provided.

14.6 Special precautions for user

Hazchem code None allocated.

15. REGULATORY INFORMATION

15.1 Safety, health and environmental regulations/legislation specific for the substance or mixture

Poison schedule A poison schedule number has not been allocated to this product using the criteria in the Standard for the Uniform Scheduling of Medicines and Poisons (SUSMP).

Classifications Safework Australia criteria is based on the Globally Harmonised System (GHS) of Classification and Labelling of Chemicals.

Inventory listings **AUSTRALIA: AICS (Australian Inventory of Chemical Substances)**
All components are listed on AICS, or are exempt.

16. OTHER INFORMATION

Additional information

PERSONAL PROTECTIVE EQUIPMENT GUIDELINES:
The recommendation for protective equipment contained within this report is provided as a guide only. Factors such as form of product, method of application, working environment, quantity used, product concentration and the availability of engineering controls should be considered before final selection of personal protective equipment is made.

HEALTH EFFECTS FROM EXPOSURE:
It should be noted that the effects from exposure to this product will depend on several factors including: form of product; frequency and duration of use; quantity used; effectiveness of control measures; protective equipment used and method of application. Given that it is impractical to prepare a report which would encompass all possible scenarios, it is anticipated that users will assess the risks and apply control methods where appropriate.

Abbreviations

ACGIH	American Conference of Governmental Industrial Hygienists
CAS #	Chemical Abstract Service number - used to uniquely identify chemical compounds
CNS	Central Nervous System
EC No.	EC No - European Community Number
EMS	Emergency Schedules (Emergency Procedures for Ships Carrying Dangerous Goods)
GHS	Globally Harmonized System
GTEPG	Group Text Emergency Procedure Guide
IARC	International Agency for Research on Cancer
LC50	Lethal Concentration, 50% / Median Lethal Concentration
LD50	Lethal Dose, 50% / Median Lethal Dose
mg/m³	Milligrams per Cubic Metre
OEL	Occupational Exposure Limit
pH	relates to hydrogen ion concentration using a scale of 0 (high acidic) to 14 (highly alkaline).
ppm	Parts Per Million
STEL	Short-Term Exposure Limit
STOT-RE	Specific target organ toxicity (repeated exposure)
STOT-SE	Specific target organ toxicity (single exposure)
SUSMP	Standard for the Uniform Scheduling of Medicines and Poisons
SWA	Safe Work Australia
TLV	Threshold Limit Value
TWA	Time Weighted Average

Report status

This document has been compiled by RMT on behalf of the manufacturer, importer or supplier of the product and serves as their Safety Data Sheet ('SDS').

It is based on information concerning the product which has been provided to RMT by the manufacturer, importer or supplier or obtained from third party sources and is believed to represent the current state of knowledge as to the appropriate safety and handling precautions for the product at the time of issue. Further clarification regarding any aspect of the product should be obtained directly from the manufacturer, importer or supplier.

While RMT has taken all due care to include accurate and up-to-date information in this SDS, it does not provide any warranty as to accuracy or completeness. As far as lawfully possible, RMT accepts no liability for any loss, injury or damage (including consequential loss) which may be suffered or incurred by any person as a consequence of their reliance on the information contained in this SDS.

Prepared by

Risk Management Technologies
5 Ventnor Ave, West Perth
Western Australia 6005
Phone: +61 8 9322 1711
Fax: +61 8 9322 1794
Email: info@rmt.com.au
Web: www.rmtglobal.com

[End of SDS]

SAFETY DATA SHEET

AVAGLYCO LC

Issuing Date 16-Dec-2016 **Revision Date** 08-Nov-2021 **Version** 1.2

SECTION 1: Identification of the substance/mixture and of the company/undertaking

1.1. Product identifier

Product Code NDF00220

Product Name AVAGLYCO LC

Pure substance/mixture Substance

1.2. Relevant identified uses of the substance or mixture and uses advised against

Recommended Use shale stabilizer

Uses advised against No information available

1.3. Details of the supplier of the safety data sheet

Supplier
Newpark Drilling Fluids S.p.A.
Via Salaria 1313/C
00138 ROMA (Italy)
For further information, please contact

Contact Point Telephone: + 39 06 8856111
Fax: +39 06 8889363
Website: www.newpark.com

E-mail address hse-hqit@newpark.com

1.4. Emergency telephone number

Emergency Telephone - §45 - (EC)1272/2008	
Europe	**112**
Croatia	+385 1 7776 920 ; +385 01 2348 342 (Centar za kontrolu otrovanja, 24 sata)
France	+(33)-975181407
Germany	0800-181-7059; +(49)- 69643508409
Hungary	+(36)-18088425
Italy	800-789-767; +(39)-0245557031 Milano 24/24 Ospedale Niguarda Ca'grande Piazza ospedale maggiore 3 +39 0266101029 Roma 24/24 Policlinico Gemelli Largo Agostino Gemelli 8 +39 063054343
Netherlands	+(31)-858880596
Romania	(+40)-37-6300026
Spain	900-868538; +(34)-931768545

Switzerland	145, (+41) 435082011
United Kingdom	+(44)-870-8200418

SECTION 2: Hazards identification

2.1. Classification of the substance or mixture

Regulation (EC) No 1272/2008
This substance is classified as not hazardous according to regulation (EC) 1272/2008 [CLP]

2.2. Label elements

This substance is classified as not hazardous according to regulation (EC) 1272/2008 [CLP]
Hazard statements
This substance is classified as not hazardous according to regulation (EC) 1272/2008 [CLP]

2.3. Other hazards

No information available.

SECTION 3: Composition/information on ingredients

3.1 Substances

Full text of H- and EUH-phrases: see section 16

Acute Toxicity Estimate
No information available

This product does not contain candidate substances of very high concern at a concentration >=0.1% (Regulation (EC) No. 1907/2006 (REACH), Article 59)

SECTION 4: First aid measures

4.1. Description of first aid measures

Inhalation Remove to fresh air.

Eye contact Rinse thoroughly with plenty of water for at least 15 minutes, lifting lower and upper eyelids. Consult a physician.

Skin contact Wash skin with soap and water. In the case of skin irritation or allergic reactions see a physician.

Ingestion Do NOT induce vomiting. Clean mouth with water and drink afterwards plenty of water. Consult a physician if necessary.

4.2. Most important symptoms and effects, both acute and delayed

Symptoms No information available.

4.3. Indication of any immediate medical attention and special treatment needed

Note to physicians Treat symptomatically.

SECTION 5: Firefighting measures

5.1. Extinguishing media

Suitable Extinguishing Media Water spray or fog. Carbon dioxide (CO2).

Large Fire CAUTION: Use of water spray when fighting fire may be inefficient.

Unsuitable extinguishing media Do not scatter spilled material with high pressure water streams.

5.2. Special hazards arising from the substance or mixture

Specific hazards arising from the chemical No information available.

Hazardous combustion products Carbon oxides.

5.3. Advice for firefighters

Special protective equipment and precautions for fire-fighters Firefighters should wear self-contained breathing apparatus and full firefighting turnout gear. Use personal protection equipment.

SECTION 6: Accidental release measures

6.1. Personal precautions, protective equipment and emergency procedures

Personal precautions Ensure adequate ventilation. Keep people away from and upwind of spill/leak.

For emergency responders Use personal protection recommended in Section 8.

6.2. Environmental precautions

Environmental precautions See Section 12 for additional Ecological Information.

6.3. Methods and material for containment and cleaning up

Methods for containment Prevent further leakage or spillage if safe to do so.

Methods for cleaning up Take up mechanically, placing in appropriate containers for disposal.

Prevention of secondary hazards Clean contaminated objects and areas thoroughly observing environmental regulations.

6.4. Reference to other sections

Reference to other sections See section 8 for more information. See section 13 for more information.

SECTION 7: Handling and storage

7.1. Precautions for safe handling

Advice on safe handling Handle in accordance with good industrial hygiene and safety practice. Wash thoroughly after handling. Take off contaminated clothing and wash before reuse.

General hygiene considerations Handle in accordance with good industrial hygiene and safety practice.

7.2. Conditions for safe storage, including any incompatibilities

Storage Conditions Keep container tightly closed in a dry and well-ventilated place.

7.3. Specific end use(s)

Identified uses
Risk Management Methods (RMM) The information required is contained in this Safety Data Sheet.

SECTION 8: Exposure controls/personal protection

8.1. Control parameters

Exposure Limits This product, as supplied, does not contain any hazardous materials with occupational exposure limits established by the region specific regulatory bodies.

Biological occupational exposure limits
This product, as supplied, does not contain any hazardous materials with biological limits established by the region specific regulatory bodies.

Derived No Effect Level (DNEL) No information available.
Predicted No Effect Concentration (PNEC) No information available.

8.2. Exposure controls

Personal protective equipment

Eye/face protection No special protective equipment required.

Skin and body protection No special protective equipment required.

Respiratory protection No protective equipment is needed under normal use conditions. If exposure limits are exceeded or irritation is experienced, ventilation and evacuation may be required.

General hygiene considerations Handle in accordance with good industrial hygiene and safety practice.

Environmental exposure controls Do not allow into any sewer, on the ground or into any body of water.

SECTION 9: Physical and chemical properties

9.1. Information on basic physical and chemical properties

Physical state Liquid
Appearance liquid
Color clear
Odor Slight.
Odor threshold No information available

Property	Values	Remarks • Method
Melting point / freezing point		No information available
Boiling point / boiling range	> 100 °C	
Flammability (solid, gas)		No information available
Flammability Limit in Air		No information available
Upper flammability limit:		
Lower flammability limit:		
Flash point	> 150 °C	
Autoignition temperature		No information available
Decomposition temperature		No information available
pH	5 - 7	

pH (as aqueous solution)		No information available
Kinematic viscosity		No information available
Dynamic viscosity		No information available
Water solubility	Soluble in water	
Solubility(ies)		No information available
Partition coefficient		No information available
Vapor pressure		No information available
Relative density	0.980-1.020	
Bulk density		
Liquid Density	0.980-1.020	
Vapor density		No information available
Particle characteristics		No information available
Particle Size		
Particle Size Distribution		

9.2. Other information

9.2.1. Information with regard to physical hazard classes
Not applicable

9.2.2. Other safety characteristics
No information available

SECTION 10: Stability and reactivity

10.1. Reactivity

Reactivity No information available.

Remarks Not reactive under normal conditions.

10.2. Chemical stability

Stability Stable under normal conditions.

Explosion data
Sensitivity to mechanical impact None.
Sensitivity to static discharge None.

10.3. Possibility of hazardous reactions

Possibility of hazardous reactions None under normal processing.

10.4. Conditions to avoid

Conditions to avoid None known based on information supplied.

10.5. Incompatible materials

Incompatible materials None known based on information supplied.

10.6. Hazardous decomposition products

Hazardous Decomposition Products None known based on information supplied.

SECTION 11: Toxicological information

11.1. Information on hazard classes as defined in Regulation (EC) No 1272/2008

Information on likely routes of exposure

Product Information

Inhalation	Specific test data for the substance or mixture is not available.
Eye contact	Specific test data for the substance or mixture is not available.
Skin contact	Specific test data for the substance or mixture is not available.
Ingestion	Specific test data for the substance or mixture is not available.

Symptoms related to the physical, chemical and toxicological characteristics

Symptoms No information available.

Numerical measures of toxicity
No information available

Acute toxicity

Delayed and immediate effects as well as chronic effects from short and long-term exposure

Skin corrosion/irritation	No information available.
Serious eye damage/eye irritation	No information available.
Respiratory or skin sensitization	No information available.
Germ cell mutagenicity	No information available.
Carcinogenicity	No information available.
Reproductive toxicity	No information available.
STOT - single exposure	No information available.
STOT - repeated exposure	No information available.
Aspiration hazard	No information available.

11.2. Information on other hazards

11.2.1. Endocrine disrupting properties

Endocrine disrupting properties No information available.

11.2.2. Other information

Other adverse effects No information available.

SECTION 12: Ecological information

12.1. Toxicity

Ecotoxicity The environmental impact of this product has not been fully investigated.

Unknown aquatic toxicity Contains 100 % of components with unknown hazards to the aquatic environment.

12.2. Persistence and degradability

Persistence and degradability No information available.

12.3. Bioaccumulative potential

Bioaccumulation No information available.

12.4. Mobility in soil

Mobility in soil No information available.

12.5. Results of PBT and vPvB assessment

PBT and vPvB assessment No information available.

12.6. Endocrine disrupting properties

Endocrine disrupting properties No information available.

12.7. Other adverse effects
No information available.

SECTION 13: Disposal considerations

13.1. Waste treatment methods

Waste from residues/unused products Dispose of in accordance with local regulations. Dispose of waste in accordance with environmental legislation.

Contaminated packaging Do not reuse empty containers.

Waste codes / waste designations according to EWC / AVV Waste codes should be assigned by the user based on the application for which the product was used.

SECTION 14: Transport information

IATA

14.1 UN number or ID number	Not regulated
14.2 Proper shipping name	Not Regulated
14.3 Transport hazard class(es)	Not regulated
14.4 Packing group	Not regulated
14.5 Environmental hazard	Not applicable
14.6 Special precautions for user Special Provisions	None

IMDG

14.1 UN number or ID number	Not regulated
14.2 Proper shipping name	Not Regulated
14.3 Transport hazard class(es)	Not regulated
14.4 Packing Group	Not Regulated
14.5 Environmental hazard	Not applicable

14.6 Special precautions for user
Special Provisions None
14.7 Maritime transport in bulk according to IMO instruments No information available

RID
14.1 UN/ID no Not Regulated
14.2 Proper shipping name Not Regulated
14.3 Transport hazard class(es) Not regulated
14.4 Packing Group Not Regulated
14.5 Environmental hazard Not applicable
14.6 Special precautions for user
Special Provisions None

ADR
14.1 UN number or ID number Not regulated
14.2 Proper shipping name Not Regulated
14.3 Transport hazard class(es) Not regulated
14.4 Packing Group Not Regulated
14.5 Environmental hazard Not applicable
14.6 Special precautions for user
Special Provisions None

SECTION 15: Regulatory information

15.1. Safety, health and environmental regulations/legislation specific for the substance or mixture

Germany
Water hazard class (WGK) slightly hazardous to water (WGK 1)

Italy
-D. LGs. 81/2008 (single text on the protection of health and safety in the workplace) and subsequent amendments and Directive 2009/161/EU-assessment of chemical risk under title IX
-Legislative Decree 3 April 2006, no 152 (environmental standards)
-"Seveso III Directive" – Legislative Decree of 26 June 2015, n° 105 (Implementation of the Directive 2012/18/EU on the control of major-accident hazards involving dangerous substances)

European Union
Take note of Directive 98/24/EC on the protection of the health and safety of workers from the risks related to chemical agents at work.

Authorizations and/or restrictions on use:
This product does not contain substances subject to authorization (Regulation (EC) No. 1907/2006 (REACH), Annex XIV) This product does not contain substances subject to restriction (Regulation (EC) No. 1907/2006 (REACH), Annex XVII)

Persistent Organic Pollutants
Not applicable

Ozone-depleting substances (ODS) regulation (EC) 1005/2009
Not applicable

International Inventories

TSCA	Complies
DSL/NDSL	Complies
EINECS/ELINCS	Complies
ENCS	Complies
IECSC	Complies
KECL	Complies
PICCS	Complies
AICS	Complies
NZIoC	Complies

Legend:
TSCA - United States Toxic Substances Control Act Section 8(b) Inventory
DSL/NDSL - Canadian Domestic Substances List/Non-Domestic Substances List
EINECS/ELINCS - European Inventory of Existing Chemical Substances/European List of Notified Chemical Substances
ENCS - Japan Existing and New Chemical Substances
IECSC - China Inventory of Existing Chemical Substances
KECL - Korean Existing and Evaluated Chemical Substances
PICCS - Philippines Inventory of Chemicals and Chemical Substances
AICS - Australian Inventory of Chemical Substances

15.2. Chemical safety assessment

Chemical Safety Report No information available

SECTION 16: Other information

Key or legend to abbreviations and acronyms used in the safety data sheet

Legend
SVHC: Substances of Very High Concern for Authorization:

Legend Section 8: EXPOSURE CONTROLS/PERSONAL PROTECTION

TWA	TWA (time-weighted average)	STEL	STEL (Short Term Exposure Limit)
Ceiling	Maximum limit value	*	Skin designation

Key literature references and sources for data used to compile the SDS
Agency for Toxic Substances and Disease Registry (ATSDR)
U.S. Environmental Protection Agency ChemView Database
European Food Safety Authority (EFSA)
EPA (Environmental Protection Agency)
Acute Exposure Guideline Level(s) (AEGL(s))
U.S. Environmental Protection Agency Federal Insecticide, Fungicide, and Rodenticide Act
U.S. Environmental Protection Agency High Production Volume Chemicals
Food Research Journal
Hazardous Substance Database
International Uniform Chemical Information Database (IUCLID)
Japan GHS Classification
Australia National Industrial Chemicals Notification and Assessment Scheme (NICNAS)
NIOSH (National Institute for Occupational Safety and Health)
National Library of Medicine's ChemID Plus (NLM CIP)
National Library of Medicine’s PubMed database (NLM PUBMED)
National Toxicology Program (NTP)
New Zealand's Chemical Classification and Information Database (CCID)
Organization for Economic Co-operation and Development Environment, Health, and Safety Publications
Organization for Economic Co-operation and Development High Production Volume Chemicals Program
Organization for Economic Co-operation and Development Screening Information Data Set
World Health Organization

Issuing Date 16-Dec-2016

Revision Date 08-Nov-2021

This material safety data sheet complies with the requirements of Regulation (EC) No. 1907/2006
Disclaimer
According to Regulation (EC) No 1272/2008 of the European Parliament and of the Council of 16 December 2008 on classification, labelling and packaging of substances and mixtures, amending and repealing Directives 67/548/EEC and 1999/45/EC, and amending Regulation (EC) No 1907/2006, as amended by Regulation (EU) No. 2015/830. This document is provided as an information resource relating exclusively to the product or material described herein. The information contained herein may not be applicable to other products/ materials or processes and may not be valid when this product/material is used in combination with any other product/material or process. The information provided in this document is compiled by Newpark Drilling Fluids LLC or its representatives from various sources including manufacturers, suppliers and other third-party sources, and is based on the information available as of the indicated date of preparation. As the conditions under which this product could be used will vary and may not be within the control of Newpark Drilling Fluids LLC there is no guarantee that the precautions outlined above will be sufficient for all individuals or situations. The buyer assumes all responsibility for using and handling the product in accordance with federal, state, provincial, or local regulations. For the product/ material described in this document, NO WARRANTY IS MADE, EXPRESS OR IMPLIED, OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR OTHERWISE.

End of Safety Data Sheet

NEWPARK DRILLING FLUIDS

SAFETY DATA SHEET

1. IDENTIFICATION OF THE MATERIAL AND SUPPLIER

1.1 Product identifier

Product name **SODA ASH**

Synonyms SODA ASH DENSE ● SODIUM CARBONATE

1.2 Uses and uses advised against

Uses DRILLING AID

1.3 Details of the supplier of the product

Supplier name **NEWPARK DRILLING FLUIDS (AUSTRALIA) LTD**

Address 11 Alacrity Place, Henderson, WA, 6166, AUSTRALIA

Telephone +61 8 9410 8200

Fax +61 8 9410 8299

Website www.newpark.com

1.4 Emergency telephone numbers

Emergency 1800 127 406 (Australia); +64 4 917 9888 (International)

2. HAZARDS IDENTIFICATION

2.1 Classification of the substance or mixture

CLASSIFIED AS HAZARDOUS ACCORDING TO SAFE WORK AUSTRALIA CRITERIA

Physical Hazards

Not classified as a Physical Hazard

Health Hazards

Serious Eye Damage / Eye Irritation: Category 1
Specific Target Organ Toxicity (Single Exposure): Category 3 (Respiratory Irritation)

Environmental Hazards

Not classified as an Environmental Hazard

2.2 GHS Label elements

Signal word **DANGER**

Pictograms



Hazard statements

H318 Causes serious eye damage.
H335 May cause respiratory irritation.

Prevention statements

P261 Avoid breathing dust/fume/gas/mist/vapours/spray.
P271 Use only outdoors or in a well-ventilated area.
P280 Wear protective gloves/protective clothing/eye protection/face protection.

Response statements

P304 + P340	IF INHALED: Remove to fresh air and keep at rest in a position comfortable for breathing.
P305 + P351 + P338	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
P310	Immediately call a POISON CENTER or doctor/physician.

Storage statements

P403 + P233	Store in a well-ventilated place. Keep container tightly closed.
P405	Store locked up.

Disposal statements

P501	Dispose of contents/container in accordance with relevant regulations.

2.3 Other hazards

No information provided.

3. COMPOSITION/ INFORMATION ON INGREDIENTS

3.1 Substances / Mixtures

Ingredient	CAS Number	EC Number	Content
SODIUM CARBONATE	[redacted]	207-838-8	>97%

4. FIRST AID MEASURES

4.1 Description of first aid measures

Eye If in eyes, hold eyelids apart and flush continuously with running water. Continue flushing until advised to stop by a Poisons Information Centre, a doctor, or for at least 15 minutes.

Inhalation If inhaled, remove from contaminated area. Apply artificial respiration if not breathing.

Skin If skin or hair contact occurs, remove contaminated clothing and flush skin and hair with running water. Continue flushing with water until advised to stop by a Poisons Information Centre or a doctor.

Ingestion For advice, contact a Poisons Information Centre on 13 11 26 (Australia Wide) or a doctor (at once). If swallowed, do not induce vomiting.

First aid facilities Eye wash facilities should be available.

4.2 Most important symptoms and effects, both acute and delayed

Irritating to the eyes and skin.

4.3 Immediate medical attention and special treatment needed

Treat symptomatically.

5. FIRE FIGHTING MEASURES

5.1 Extinguishing media

Use an extinguishing agent suitable for the surrounding fire.

5.2 Special hazards arising from the substance or mixture

Non flammable. May evolve toxic gases if strongly heated.

5.3 Advice for firefighters

Treat as per requirements for surrounding fires. Evacuate area and contact emergency services. Remain upwind and notify those downwind of hazard. Wear full protective equipment including Self Contained Breathing Apparatus (SCBA) when combating fire. Use waterfog to cool intact containers and nearby storage areas.

5.4 Hazchem code

None allocated.

6. ACCIDENTAL RELEASE MEASURES

6.1 Personal precautions, protective equipment and emergency procedures

Wear Personal Protective Equipment (PPE) as detailed in section 8 of the SDS. Ventilate area where possible.

6.2 Environmental precautions
Prevent product from entering drains and waterways.

6.3 Methods of cleaning up
Contain spillage, then collect and place in suitable containers for disposal. Avoid generating dust.

6.4 Reference to other sections
See Sections 8 and 13 for exposure controls and disposal.

7. HANDLING AND STORAGE

7.1 Precautions for safe handling
Before use carefully read the product label. Use of safe work practices are recommended to avoid eye or skin contact and inhalation. Observe good personal hygiene, including washing hands before eating. Prohibit eating, drinking and smoking in contaminated areas.

7.2 Conditions for safe storage, including any incompatibilities
Store in a cool, dry, well ventilated area, removed from incompatible substances and foodstuffs. Ensure containers are adequately labelled, protected from physical damage and sealed when not in use. Check regularly for leaks or spills.

7.3 Specific end uses
No information provided.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

8.1 Control parameters
Exposure standards

Ingredient	Reference	TWA		STEL	
		ppm	mg/m³	ppm	mg/m³
Sodium Carbonate (total dust)	SWA [AUS]	--	10	--	--

Biological limits
No biological limit values have been entered for this product.

8.2 Exposure controls
Engineering controls Avoid inhalation. Use in well ventilated areas.

PPE

Eye / Face	Wear dust-proof goggles.
Hands	Wear PVC or rubber gloves.
Body	When using large quantities or where heavy contamination is likely, wear coveralls.
Respiratory	Where an inhalation risk exists, wear a Class P1 (Particulate) respirator.



9. PHYSICAL AND CHEMICAL PROPERTIES

9.1 Information on basic physical and chemical properties

Appearance	WHITE POWDER
Odour	ODOURLESS
Flammability	NON FLAMMABLE
Flash point	NOT RELEVANT
Boiling point	NOT AVAILABLE
Melting point	854°C
Evaporation rate	NOT AVAILABLE
pH	NOT AVAILABLE

9.1 Information on basic physical and chemical properties

Vapour density	NOT AVAILABLE
Specific gravity	2.533
Solubility (water)	170 g/L
Vapour pressure	NOT AVAILABLE
Upper explosion limit	NOT RELEVANT
Lower explosion limit	NOT RELEVANT
Partition coefficient	NOT AVAILABLE
Autoignition temperature	NOT AVAILABLE
Decomposition temperature	NOT AVAILABLE
Viscosity	NOT AVAILABLE
Explosive properties	NOT AVAILABLE
Oxidising properties	NOT AVAILABLE
Odour threshold	NOT AVAILABLE

10. STABILITY AND REACTIVITY

10.1 Reactivity

Carefully review all information provided in sections 10.2 to 10.6.

10.2 Chemical stability

Stable under recommended conditions of storage.

10.3 Possibility of hazardous reactions

Polymerization is not expected to occur.

10.4 Conditions to avoid

Avoid heat, sparks, open flames and other ignition sources.

10.5 Incompatible materials

Incompatible with oxidising agents (e.g. hypochlorites) and acids (e.g. nitric acid).

10.6 Hazardous decomposition products

May evolve toxic gases if heated to decomposition.

11. TOXICOLOGICAL INFORMATION

11.1 Information on toxicological effects

Acute toxicity May be harmful if swallowed.

Information available for the ingredients:

Ingredient	Oral LD50	Dermal LD50	Inhalation LC50
SODIUM CARBONATE	> 2000 mg/kg (rat) (NICNAS)	> 2000 mg/kg (rat) (NICNAS)	> 2000 mg/m³ (rat) (NICNAS)

Additional ingredient toxicity values:

SODIUM CARBONATE (497-19-8)

LD50 (intraperitoneal) 117 mg/kg (mouse)

LD50 (subcutaneous) 2210 mg/kg (mouse)

Skin Contact may result in irritation, redness, rash and dermatitis.

Eye Contact may result in irritation, lacrimation, pain, redness and possible permanent damage.

Sensitisation Not classified as causing skin or respiratory sensitisation.

Mutagenicity Not classified as a mutagen.

Carcinogenicity Not classified as a carcinogen.

Reproductive Not classified as a reproductive toxin.

STOT - single exposure Over exposure may result in irritation of the nose and throat, with coughing. High level exposure may result in breathing difficulties.

STOT - repeated exposure Not classified as causing organ damage from repeated exposure. Carbonate ions are neutralised under physiological conditions to form bicarbonate ions and/or carbon dioxide, which are major products of all human metabolic activities; therefore, systemic toxicity is not expected.

Aspiration Not classified as causing aspiration.

12. ECOLOGICAL INFORMATION

12.1 Toxicity

Fishes, Lepomis macrochirus, LC50, 96 h, 300 mg/l. Crustaceans, Ceriodaphnia dubia, EC50, 48 h, 200 - 227 mg/l.

12.2 Persistence and degradability

Not applicable for inorganic substances. The methods for determining the biological degradability are not applicable to inorganic substances.

12.3 Bioaccumulative potential

Not expected to bioaccumulate.

12.4 Mobility in soil

If sodium carbonate is emitted to soil it can escape to atmosphere as carbon dioxide, precipitate as a metal carbonate, form complexes or stay in solution.

12.5 Other adverse effects

WATER: If released to waterways, alkaline products may change the pH of the waterway. Fish will die if the pH reaches 10-11 (goldfish 10.9, bluegill 10.5). SOIL: May leach to groundwater with toxic effects on aquatic life as above. ATMOSPHERE: Not expected to reside in the atmosphere. Drops or particles released to atmosphere should be removed by gravity and/or be rained out.

13. DISPOSAL CONSIDERATIONS

13.1 Waste treatment methods

Waste disposal Collect without generating dust. Place in clean, sealed containers and dispose of to an approved landfill site. Contact the manufacturer/supplier for additional information (if required).

Legislation Dispose of in accordance with relevant local legislation.

14. TRANSPORT INFORMATION

NOT CLASSIFIED AS A DANGEROUS GOOD BY THE CRITERIA OF THE ADG CODE, IMDG OR IATA

	LAND TRANSPORT (ADG)	SEA TRANSPORT (IMDG / IMO)	AIR TRANSPORT (IATA / ICAO)
14.1 UN Number	None allocated.	None allocated.	None allocated.
14.2 Proper Shipping Name	None allocated.	None allocated.	None allocated.
14.3 Transport hazard class	None allocated.	None allocated.	None allocated.
14.4 Packing Group	None allocated.	None allocated.	None allocated.

14.5 Environmental hazards

No information provided.

14.6 Special precautions for user

Hazchem code None allocated.

15. REGULATORY INFORMATION

15.1 Safety, health and environmental regulations/legislation specific for the substance or mixture

Poison schedule A poison schedule number has not been allocated to this product using the criteria in the Standard for the Uniform Scheduling of Medicines and Poisons (SUSMP).

Classifications Safework Australia criteria is based on the Globally Harmonised System (GHS) of Classification and Labelling of Chemicals.

Inventory listings **AUSTRALIA: AICS (Australian Inventory of Chemical Substances)**
All components are listed on AICS, or are exempt.

16. OTHER INFORMATION

Additional information

PERSONAL PROTECTIVE EQUIPMENT GUIDELINES:
The recommendation for protective equipment contained within this report is provided as a guide only. Factors such as form of product, method of application, working environment, quantity used, product concentration and the availability of engineering controls should be considered before final selection of personal protective equipment is made.

HEALTH EFFECTS FROM EXPOSURE:
It should be noted that the effects from exposure to this product will depend on several factors including: form of product; frequency and duration of use; quantity used; effectiveness of control measures; protective equipment used and method of application. Given that it is impractical to prepare a report which would encompass all possible scenarios, it is anticipated that users will assess the risks and apply control methods where appropriate.

Abbreviations

ACGIH	American Conference of Governmental Industrial Hygienists
CAS #	Chemical Abstract Service number - used to uniquely identify chemical compounds
CNS	Central Nervous System
EC No.	EC No - European Community Number
EMS	Emergency Schedules (Emergency Procedures for Ships Carrying Dangerous Goods)
GHS	Globally Harmonized System
GTEPG	Group Text Emergency Procedure Guide
IARC	International Agency for Research on Cancer
LC50	Lethal Concentration, 50% / Median Lethal Concentration
LD50	Lethal Dose, 50% / Median Lethal Dose
mg/m³	Milligrams per Cubic Metre
OEL	Occupational Exposure Limit
pH	relates to hydrogen ion concentration using a scale of 0 (high acidic) to 14 (highly alkaline).
ppm	Parts Per Million
STEL	Short-Term Exposure Limit
STOT-RE	Specific target organ toxicity (repeated exposure)
STOT-SE	Specific target organ toxicity (single exposure)
SUSMP	Standard for the Uniform Scheduling of Medicines and Poisons
SWA	Safe Work Australia
TLV	Threshold Limit Value
TWA	Time Weighted Average

Report status

This document has been compiled by RMT on behalf of the manufacturer, importer or supplier of the product and serves as their Safety Data Sheet ('SDS').

It is based on information concerning the product which has been provided to RMT by the manufacturer, importer or supplier or obtained from third party sources and is believed to represent the current state of knowledge as to the appropriate safety and handling precautions for the product at the time of issue. Further clarification regarding any aspect of the product should be obtained directly from the manufacturer, importer or supplier.

While RMT has taken all due care to include accurate and up-to-date information in this SDS, it does not provide any warranty as to accuracy or completeness. As far as lawfully possible, RMT accepts no liability for any loss, injury or damage (including consequential loss) which may be suffered or incurred by any person as a consequence of their reliance on the information contained in this SDS.

Prepared by

Risk Management Technologies
5 Ventnor Ave, West Perth
Western Australia 6005
Phone: +61 8 9322 1711
Fax: +61 8 9322 1794
Email: info@rmt.com.au
Web: www.rmtglobal.com

[End of SDS]

NEWPARK DRILLING FLUIDS

SAFETY DATA SHEET

1. IDENTIFICATION OF THE MATERIAL AND SUPPLIER

1.1 Product identifier

Product name **SODIUM SULPHITE**

Synonyms SODIUM SULFITE

1.2 Uses and uses advised against

Uses ANTIOXIDANT ● FOOD PRESERVATIVE ● LABORATORY REAGENT ● PAPER INDUSTRY ● PHOTOGRAPHIC DEVELOPER ● REDUCING AGENT ● WATER TREATMENT

1.3 Details of the supplier of the product

Supplier name **NEWPARK DRILLING FLUIDS (AUSTRALIA) LTD**

Address 11 Alacrity Place, Henderson, WA, 6166, AUSTRALIA

Telephone +61 8 9410 8200

Fax +61 8 9410 8299

Website www.newpark.com

1.4 Emergency telephone numbers

Emergency 1800 127 406 (Australia); +64 4 917 9888 (International)

2. HAZARDS IDENTIFICATION

2.1 Classification of the substance or mixture

CLASSIFIED AS HAZARDOUS ACCORDING TO SAFE WORK AUSTRALIA CRITERIA

Physical Hazards

Not classified as a Physical Hazard

Health Hazards

Acute Toxicity: Oral: Category 4
Serious Eye Damage / Eye Irritation: Category 1
Contact with acids liberates toxic gas.

Environmental Hazards

Not classified as an Environmental Hazard

2.2 GHS Label elements

Signal word **DANGER**

Pictograms



Hazard statements

AUH031	Contact with acids liberates toxic gas.
H302	Harmful if swallowed.
H318	Causes serious eye damage.

Prevention statements

P264	Wash thoroughly after handling.
P270	Do not eat, drink or smoke when using this product.
P280	Wear protective gloves/protective clothing/eye protection/face protection/hearing protection.

Response statements

P305 + P351 + P338	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
P310	Immediately call a POISON CENTRE or doctor/physician.
P330	Rinse mouth.

Storage statements

None allocated.

Disposal statements

P501	Dispose of contents/container in accordance with relevant regulations.

2.3 Other hazards

No information provided.

3. COMPOSITION/ INFORMATION ON INGREDIENTS

3.1 Substances / Mixtures

Ingredient	CAS Number	EC Number	Content
SODIUM SULPHITE	[redacted]	231-821-4	>97%
SODIUM SULPHATE	[redacted]	231-820-9	<2.5%
SODIUM CARBONATE	[redacted]	207-838-8	<0.1%
WATER	[redacted]	231-791-2	<0.1%

4. FIRST AID MEASURES

4.1 Description of first aid measures

Eye	If in eyes, hold eyelids apart and flush continuously with running water. Continue flushing until advised to stop by a Poisons Information Centre, a doctor, or for at least 15 minutes.
Inhalation	If inhaled, remove from contaminated area. Apply artificial respiration if not breathing.
Skin	If skin or hair contact occurs, remove contaminated clothing and flush skin and hair with running water. Continue flushing with water until advised to stop by a Poisons Information Centre or a doctor.
Ingestion	For advice, contact a Poisons Information Centre on 13 11 26 (Australia Wide) or a doctor (at once). Urgent hospital treatment is likely to be needed. If swallowed, do not induce vomiting.
First aid facilities	Eye wash facilities and safety shower are recommended.

4.2 Most important symptoms and effects, both acute and delayed

See Section 11 for more detailed information on health effects and symptoms.

4.3 Immediate medical attention and special treatment needed

Treat symptomatically.

5. FIRE FIGHTING MEASURES

5.1 Extinguishing media

Use an extinguishing agent suitable for the surrounding fire.

5.2 Special hazards arising from the substance or mixture

Non flammable. May evolve sulphur oxides and sodium oxides when heated to decomposition.

5.3 Advice for firefighters

Evacuate area and contact emergency services. Toxic gases may be evolved in a fire situation. Remain upwind and notify those downwind of hazard. Wear full protective equipment including Self Contained Breathing Apparatus (SCBA) when combating fire.

5.4 Hazchem code

None allocated.

6. ACCIDENTAL RELEASE MEASURES

6.1 Personal precautions, protective equipment and emergency procedures
Wear Personal Protective Equipment (PPE) as detailed in section 8 of the SDS. Clear area of all unprotected personnel. Contact emergency services where appropriate.

6.2 Environmental precautions
Prevent product from entering drains and waterways.

6.3 Methods of cleaning up
Contain spillage, then collect and place in suitable containers for reuse or disposal. Avoid generating dust.

6.4 Reference to other sections
See Sections 8 and 13 for exposure controls and disposal.

7. HANDLING AND STORAGE

7.1 Precautions for safe handling
Before use carefully read the product label. Use of safe work practices are recommended to avoid eye or skin contact and inhalation. Observe good personal hygiene, including washing hands before eating. Prohibit eating, drinking and smoking in contaminated areas.

7.2 Conditions for safe storage, including any incompatibilities
Store in a cool, dry, well ventilated area, removed from incompatible substances and foodstuffs. Ensure containers are adequately labelled, protected from physical damage and sealed when not in use. Check regularly for leaks or spills.

7.3 Specific end uses
No information provided.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

8.1 Control parameters
Exposure standards

Ingredient	Reference	TWA		STEL	
		ppm	mg/m³	ppm	mg/m³
Sodium Carbonate (total dust)	SWA [AUS]	--	10	--	--

Biological limits
No biological limit values have been entered for this product.

8.2 Exposure controls
Engineering controls Avoid inhalation. Use in well ventilated areas. Where an inhalation risk exists, mechanical extraction ventilation is recommended.

PPE

Eye / Face	Wear dust-proof goggles.
Hands	Wear PVC or rubber gloves.
Body	When using large quantities or where heavy contamination is likely, wear coveralls.
Respiratory	Where an inhalation risk exists, wear a Class P1 (Particulate) respirator. At high dust levels, wear a Full-face Class P3 (Particulate) respirator.



9. PHYSICAL AND CHEMICAL PROPERTIES

9.1 Information on basic physical and chemical properties

Appearance	WHITE CRYSTALLINE SOLID
Odour	ODOURLESS
Flammability	NON FLAMMABLE

9.1 Information on basic physical and chemical properties

Flash point	NOT RELEVANT
Boiling point	NOT AVAILABLE
Melting point	NOT AVAILABLE
Evaporation rate	NOT AVAILABLE
pH	9.0 to 10.5
Vapour density	NOT AVAILABLE
Relative density	2.6
Solubility (water)	SOLUBLE
Vapour pressure	NOT AVAILABLE
Upper explosion limit	NOT RELEVANT
Lower explosion limit	NOT RELEVANT
Partition coefficient	NOT AVAILABLE
Autoignition temperature	NOT AVAILABLE
Decomposition temperature	NOT AVAILABLE
Viscosity	NOT AVAILABLE
Explosive properties	NOT AVAILABLE
Oxidising properties	NOT AVAILABLE
Odour threshold	NOT AVAILABLE

10. STABILITY AND REACTIVITY

10.1 Reactivity
Contact with acids liberates toxic gas.

10.2 Chemical stability
Stable under recommended conditions of storage.

10.3 Possibility of hazardous reactions
Polymerization is not expected to occur.

10.4 Conditions to avoid
Avoid heat, sparks, open flames and other ignition sources. Avoid exposure to air and moisture. Sensitive to air and moisture.

10.5 Incompatible materials
Incompatible with oxidising agents (e.g. hypochlorites) and acids (e.g. nitric acid). Strong reducing agent.

10.6 Hazardous decomposition products
May evolve sulphur oxides and sodium oxides when heated to decomposition.

11. TOXICOLOGICAL INFORMATION

11.1 Information on toxicological effects

Acute toxicity Harmful if swallowed.

Information available for the ingredients:

Ingredient	Oral LD50	Dermal LD50	Inhalation LC50
SODIUM SULPHITE	820 mg/kg (mouse); 3560 mg/kg (rat)	> 2000 mg/kg (rat)	> 5500 mg/m3/4hrs (rat)
SODIUM SULPHATE	5989 mg/kg (mouse)	--	--
SODIUM CARBONATE	> 2000 mg/kg (rat) (AICIS)	> 2000 mg/kg (rat) (AICIS)	> 2000 mg/m³ (rat) (AICIS)

Additional ingredient toxicity values:

SODIUM SULPHITE (7757-83-7)

LD50 (intraperitoneal)	950 mg/kg (mouse)
LD50 (intravenous)	175 mg/kg (mouse)
LDLo (intravenous)	400 mg/kg (cat)
LDLo (oral)	2825 mg/kg (rabbit)
LDLo (subcutaneous)	600 mg/kg (rabbit)

SODIUM SULPHATE (7757-82-6)

LD50 (intravenous)	1220 mg/kg (rabbit)
LDLo (intravenous)	1220 mg/kg (mouse)
TDLo (oral)	14 g/kg (mouse - 8-12 days pregnant)
TDLo (subcutaneous)	806 mg/kg/26 weeks intermittently (mouse)

SODIUM CARBONATE (497-19-8)

LD50 (intraperitoneal)	117 mg/kg (mouse)
LD50 (subcutaneous)	2210 mg/kg (mouse)

Skin Contact may result in irritation, redness, rash and dermatitis.

Eye Contact may result in irritation, lacrimation, pain, redness and possible serious eye damage.

Sensitisation Some individuals are hypersensitive to sulphites and may experience adverse reactions following exposure. Individuals known to be hypersensitive or with existing respiratory problems (eg asthma) are advised to avoid exposure.

Mutagenicity Not classified as a mutagen.

Carcinogenicity Not classified as a carcinogen.

Reproductive Not classified as a reproductive toxin.

STOT - single exposure Over exposure may result in mucous membrane irritation of the respiratory tract, with coughing.

STOT - repeated exposure Not classified as causing organ damage from repeated exposure.

Aspiration Not classified as causing aspiration.

12. ECOLOGICAL INFORMATION

12.1 Toxicity

No information provided.

12.2 Persistence and degradability

Biodegradability does not pertain to inorganic substances.

12.3 Bioaccumulative potential

This product does not bioaccumulate.

12.4 Mobility in soil

No information provided.

12.5 Other adverse effects

Avoid contamination of drains and waterways.

13. DISPOSAL CONSIDERATIONS

13.1 Waste treatment methods

Waste disposal Cover spill with soda ash or sodium bicarbonate. Mix and spray with water, may be effervescent. Wait until reaction is complete, scoop into a large beaker and cautiously add equal volume of sodium hypochlorite (reaction may be vigorous). Add more water, stir and allow to stand (~1hr). Dilute and neutralise. Absorb with sand/similar dispose of to an approved landfill site, or alternatively (for small amounts) flush to sewer with large excess of water.

Legislation Dispose of in accordance with relevant local legislation.

14. TRANSPORT INFORMATION

NOT CLASSIFIED AS A DANGEROUS GOOD BY THE CRITERIA OF THE ADG CODE, IMDG OR IATA

	LAND TRANSPORT (ADG)	SEA TRANSPORT (IMDG / IMO)	AIR TRANSPORT (IATA / ICAO)
14.1 UN Number	None allocated.	None allocated.	None allocated.
14.2 Proper Shipping Name	None allocated.	None allocated.	None allocated.
14.3 Transport hazard class	None allocated.	None allocated.	None allocated.
14.4 Packing Group	None allocated.	None allocated.	None allocated.

14.5 Environmental hazards

No information provided.

14.6 Special precautions for user

Hazchem code None allocated.

15. REGULATORY INFORMATION

15.1 Safety, health and environmental regulations/legislation specific for the substance or mixture

Poison schedule A poison schedule number has not been allocated to this product using the criteria in the Standard for the Uniform Scheduling of Medicines and Poisons (SUSMP).

Classifications Safe Work Australia criteria is based on the Globally Harmonised System (GHS) of Classification and Labelling of Chemicals (GHS Revision 7).

Inventory listings **AUSTRALIA: AIIC (Australian Inventory of Industrial Chemicals)**
All components are listed on AIIC, or are exempt.

16. OTHER INFORMATION

Additional information

RESPIRATORS: In general the use of respirators should be limited and engineering controls employed to avoid exposure. If respiratory equipment must be worn ensure correct respirator selection and training is undertaken. Remember that some respirators may be extremely uncomfortable when used for long periods. The use of air powered or air supplied respirators should be considered where prolonged or repeated use is necessary.

WORKPLACE CONTROLS AND PRACTICES: Unless a less toxic chemical can be substituted for a hazardous substance, ENGINEERING CONTROLS are the most effective way of reducing exposure. The best protection is to enclose operations and/or provide local exhaust ventilation at the site of chemical release. Isolating operations can also reduce exposure. Using respirators or protective equipment is less effective than the controls mentioned above, but is sometimes necessary.

PERSONAL PROTECTIVE EQUIPMENT GUIDELINES:
The recommendation for protective equipment contained within this report is provided as a guide only. Factors such as form of product, method of application, working environment, quantity used, product concentration and the availability of engineering controls should be considered before final selection of personal protective equipment is made.

HEALTH EFFECTS FROM EXPOSURE:
It should be noted that the effects from exposure to this product will depend on several factors including: form of product; frequency and duration of use; quantity used; effectiveness of control measures; protective equipment used and method of application. Given that it is impractical to prepare a report which would encompass all possible scenarios, it is anticipated that users will assess the risks and apply control methods where appropriate.

Abbreviations

ACGIH	American Conference of Governmental Industrial Hygienists
CAS #	Chemical Abstract Service number - used to uniquely identify chemical compounds
CNS	Central Nervous System
EC No.	EC No - European Community Number
EMS	Emergency Schedules (Emergency Procedures for Ships Carrying Dangerous Goods)
GHS	Globally Harmonized System
GTEPG	Group Text Emergency Procedure Guide
IARC	International Agency for Research on Cancer
LC50	Lethal Concentration, 50% / Median Lethal Concentration
LD50	Lethal Dose, 50% / Median Lethal Dose
mg/m³	Milligrams per Cubic Metre
OEL	Occupational Exposure Limit
pH	relates to hydrogen ion concentration using a scale of 0 (high acidic) to 14 (highly alkaline).
ppm	Parts Per Million
STEL	Short-Term Exposure Limit
STOT-RE	Specific target organ toxicity (repeated exposure)
STOT-SE	Specific target organ toxicity (single exposure)
SUSMP	Standard for the Uniform Scheduling of Medicines and Poisons
SWA	Safe Work Australia
TLV	Threshold Limit Value
TWA	Time Weighted Average

Report status

This document has been compiled by RMT on behalf of the manufacturer, importer or supplier of the product and serves as their Safety Data Sheet ('SDS').

It is based on information concerning the product which has been provided to RMT by the manufacturer, importer or supplier or obtained from third party sources and is believed to represent the current state of knowledge as to the appropriate safety and handling precautions for the product at the time of issue. Further clarification regarding any aspect of the product should be obtained directly from the manufacturer, importer or supplier.

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Prepared by

Risk Management Technologies
5 Ventnor Ave, West Perth
Western Australia 6005
Phone: +61 8 9322 1711
Fax: +61 8 9322 1794
Email: info@rmt.com.au
Web: www.rmtglobal.com

[End of SDS]

NEWPARK DRILLING FLUIDS

SAFETY DATA SHEET

1. IDENTIFICATION OF THE MATERIAL AND SUPPLIER

1.1 Product identifier

Product name **TRIETHANOLAMINE**

Synonym(s) TEA

1.2 Uses and uses advised against

Use(s) CHEMICAL INTERMEDIATE ● LABORATORY REAGENT ● SOLVENT

1.3 Details of the supplier of the product

Supplier name **NEWPARK DRILLING FLUIDS (AUSTRALIA) LTD**

Address 11 Alacrity Place, Henderson, WA, 6166, AUSTRALIA

Telephone +61 8 9410 8200

Fax +61 8 9410 8299

Website www.newpark.com

1.4 Emergency telephone number(s)

Emergency 1800 127 406 (Australia); +64 4 917 9888 (International)

2. HAZARDS IDENTIFICATION

2.1 Classification of the substance or mixture

CLASSIFIED AS HAZARDOUS ACCORDING TO SAFE WORK AUSTRALIA CRITERIA

GHS classification(s)
Skin Corrosion/Irritation: Category 2
Serious Eye Damage / Eye Irritation: Category 1
Specific Target Organ Systemic Toxicity (Single Exposure): Category 3
Specific Target Organ Systemic Toxicity (Repeated Exposure): Category 2

2.2 Label elements

Signal word **DANGER**

Pictogram(s)



Hazard statement(s)

H315	Causes skin irritation.
H318	Causes serious eye damage.
H335	May cause respiratory irritation.
H373	May cause damage to organs through prolonged or repeated exposure.

Prevention statement(s)

P260	Do not breathe dust/fume/gas/mist/vapours/spray.
P264	Wash thoroughly after handling.
P271	Use only outdoors or in a well-ventilated area.
P280	Wear protective gloves/protective clothing/eye protection/face protection.

Response statement(s)

P302 + P352	IF ON SKIN: Wash with plenty of soap and water.
P304 + P340	IF INHALED: Remove to fresh air and keep at rest in a position comfortable for breathing.
P305 + P351 + P338	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
P310	Immediately call a POISON CENTER or doctor/physician.
P314	Get medical advice/attention if you feel unwell.
P321	Specific treatment is advised - see first aid instructions.
P332 + P313	If skin irritation occurs: Get medical advice/ attention.
P362	Take off contaminated clothing and wash before re-use.

Storage statement(s)

P403 + P233	Store in a well-ventilated place. Keep container tightly closed.
P405	Store locked up.

Disposal statement(s)

P501	Dispose of contents/container in accordance with relevant regulations.

2.3 Other hazards

No information provided.

3. COMPOSITION/ INFORMATION ON INGREDIENTS

3.1 Substances / Mixtures

Ingredient	CAS Number	EC Number	Content
TRIETHANOLAMINE	[redacted]	203-049-8	>60%
DIETHANOLAMINE	[redacted]	203-868-0	>=10 to <=30%

4. FIRST AID MEASURES

4.1 Description of first aid measures

Eye If in eyes, hold eyelids apart and flush continuously with running water. Continue flushing until advised to stop by a Poisons Information Centre, a doctor, or for at least 15 minutes.

Inhalation If inhaled, remove from contaminated area. To protect rescuer, use a Type A (Organic vapour) respirator or an Air-line respirator (in poorly ventilated areas). Apply artificial respiration if not breathing.

Skin If skin or hair contact occurs, remove contaminated clothing and flush skin and hair with running water. Continue flushing with water until advised to stop by a Poisons Information Centre or a doctor.

Ingestion For advice, contact a Poisons Information Centre on 13 11 26 (Australia Wide) or a doctor (at once). If swallowed, do not induce vomiting. Rinse mouth out with water and give plenty of water to drink.

First aid facilities Eye wash facilities and safety shower should be available.

4.2 Most important symptoms and effects, both acute and delayed

Over exposure may result in irritation to the eyes, nose and respiratory system. May cause allergic contact dermatitis.

4.3 Immediate medical attention and special treatment needed

Treat symptomatically.

5. FIRE FIGHTING MEASURES

5.1 Extinguishing media

Dry agent, carbon dioxide, foam or water fog. Prevent contamination of drains and waterways.

5.2 Special hazards arising from the substance or mixture

Combustible. May evolve toxic gases (carbon/ nitrogen oxides, amines, ammonia, hydrocarbons) when heated to decomposition.

5.3 Advice for firefighters

Evacuate area and contact emergency services. Toxic gases may be evolved in a fire situation. Remain upwind and notify those downwind of hazard. Wear full protective equipment including Self Contained Breathing Apparatus (SCBA) when combating fire. Use waterfog to cool intact containers and nearby storage areas.

5.4 Hazchem code

None allocated.

6. ACCIDENTAL RELEASE MEASURES

6.1 Personal precautions, protective equipment and emergency procedures

Wear Personal Protective Equipment (PPE) as detailed in section 8 of the SDS. Clear area of all unprotected personnel. Ventilate area where possible. Contact emergency services where appropriate.

6.2 Environmental precautions

Prevent product from entering drains and waterways.

6.3 Methods of cleaning up

Contain spillage, then cover / absorb spill with non-combustible absorbent material (vermiculite, sand, or similar), collect and place in suitable containers for disposal.

6.4 Reference to other sections

See Sections 8 and 13 for exposure controls and disposal.

7. HANDLING AND STORAGE

7.1 Precautions for safe handling

Before use carefully read the product label. Use of safe work practices are recommended to avoid eye or skin contact and inhalation. Observe good personal hygiene, including washing hands before eating. Prohibit eating, drinking and smoking in contaminated areas.

7.2 Conditions for safe storage, including any incompatibilities

Store in a cool, dry, well ventilated area, removed from incompatible substances, heat or ignition sources and foodstuffs. Ensure containers are adequately labelled, protected from physical damage and sealed when not in use. Check regularly for leaks or spills. Store as a Class C2 Combustible Liquid (AS1940).

7.3 Specific end use(s)

No information provided.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

8.1 Control parameters

Exposure standards

Ingredient	Reference	TWA		STEL	
		ppm	mg/m³	ppm	mg/m³
Diethanolamine (h)	SWA (AUS)	3	13	--	--
Triethanolamine	SWA (AUS)	--	5	--	--

Biological limits

No biological limit values have been entered for this product.

8.2 Exposure controls

Engineering controls Avoid inhalation. Use in well ventilated areas. Where an inhalation risk exists, mechanical extraction ventilation is recommended. Maintain vapour levels below the recommended exposure standard.

PPE

Eye / Face Wear splash-proof goggles.

Hands Wear PVC or rubber gloves.

Body Wear coveralls.

Respiratory Where an inhalation risk exists, wear a Type A (Organic vapour) respirator. If spraying, wear a Type A-Class P1 (Organic gases/vapours and Particulate) respirator.



9. PHYSICAL AND CHEMICAL PROPERTIES

9.1 Information on basic physical and chemical properties

Appearance	CLEAR LIQUID
Odour	MILD AMMONIACAL ODOUR
Flammability	CLASS C2 COMBUSTIBLE
Flash point	190°C (cc)
Boiling point	335°C
Melting point	12°C
Evaporation rate	< 0.01 (n-Butyl acetate = 1)
pH	10.5 (1 % Solution)
Vapour density	4.80 (Air = 1)
Specific gravity	NOT AVAILABLE
Solubility (water)	SOLUBLE
Vapour pressure	< 1 kPa @ 20°C
Upper explosion limit	NOT AVAILABLE
Lower explosion limit	NOT AVAILABLE
Partition coefficient	NOT AVAILABLE
Autoignition temperature	NOT AVAILABLE
Decomposition temperature	NOT AVAILABLE
Viscosity	450 mPa·s @ 25°C
Explosive properties	NOT AVAILABLE
Oxidising properties	NOT AVAILABLE
Odour threshold	NOT AVAILABLE

9.2 Other information

Relative density	1.123

10. STABILITY AND REACTIVITY

10.1 Reactivity

Carefully review all information provided in sections 10.2 to 10.6.

10.2 Chemical stability

Stable under recommended conditions of storage.

10.3 Possibility of hazardous reactions

Hazardous polymerization is not expected to occur.

10.4 Conditions to avoid

Avoid heat, sparks, open flames and other ignition sources.

10.5 Incompatible materials

Incompatible with oxidising agents (e.g. hypochlorites), acids (e.g. nitric acid), nitrites, heat and ignition sources. Also incompatible with organic anhydrides, isocyanates, vinyl acetate, acrylates, substituted allyls, alkylene oxides, epichlorohydrin, aldehydes, copper, brass and aluminium.

10.6 Hazardous decomposition products

May evolve toxic gases (carbon/ nitrogen oxides, amines, ammonia, hydrocarbons) when heated to decomposition.

11. TOXICOLOGICAL INFORMATION

11.1 Information on toxicological effects

Acute toxicity May be harmful if swallowed, in contact with skin, and/or if inhaled.

Information available for the ingredient(s):

Ingredient	Oral Toxicity (LD50)	Dermal Toxicity (LD50)	Inhalation Toxicity (LC50)
TRIETHANOLAMINE	2200 mg/kg (rabbit)	> 20 mL/kg (rabbit)	--
DIETHANOLAMINE	620 uL/kg (rat)	7640 uL/kg (rabbit)	--

Additional ingredient toxicity value(s):

TRIETHANOLAMINE (102-71-6)

LD50 (intraperitoneal)	1450 mg/kg (mouse)
TDLo (oral)	16 g/kg/64 weeks (mouse - cancer)

DIETHANOLAMINE (111-42-2)

LD50 (intramuscular)	1500 mg/kg (rat)
LD50 (intraperitoneal)	120 mg/kg (rat)
LD50 (intravenous)	778 mg/kg (rat)
LD50 (subcutaneous)	2200 mg/kg (rat)
LDLo (oral)	3 g/kg (rat)

Skin	Contact may result in irritation, redness and rash.
Eye	Contact may result in irritation, lacrimation, pain and redness.
Sensitisation	Triethanolamine has been reported to cause allergic contact dermatitis. It is not known to cause respiratory sensitisation.
Mutagenicity	Insufficient data available to classify as a mutagen.
Carcinogenicity	Triethanolamine and diethanolamine are not classifiable as to carcinogenicity to humans (IARC Group 3).
Reproductive	Insufficient data available to classify as a reproductive toxin.
STOT - single exposure	Over exposure may result in irritation of the nose and throat, with coughing. High level exposure may result in breathing difficulties.
STOT - repeated exposure	Diethanolamine may cause damage to organs (liver) through prolonged and repeated exposure.
Aspiration	Not expected to present an aspiration hazard.

12. ECOLOGICAL INFORMATION

12.1 Toxicity

No information provided.

12.2 Persistence and degradability

No information provided.

12.3 Bioaccumulative potential

No information provided.

12.4 Mobility in soil

No information provided.

12.5 Other adverse effects

In soil and water, triethanolamine will biodegrade fairly rapidly following acclamation (half-life in the order of days to weeks). In soil, residual triethanolamine may leach to groundwater. LC50 (shrimp): > 100 ppm.

13. DISPOSAL CONSIDERATIONS

13.1 Waste treatment methods

Waste disposal	Reduce with sodium thiosulphate/ bisulphite (not strong reducing agent), acidify with 3M sulphuric acid. Scoop into a container of water and neutralise with soda ash. Absorb with sand or similar and dispose of to an approved landfill site. Contact the manufacturer/supplier for additional information (if required).
Legislation	Dispose of in accordance with relevant local legislation.

14. TRANSPORT INFORMATION

NOT CLASSIFIED AS A DANGEROUS GOOD BY THE CRITERIA OF THE ADG CODE, IMDG OR IATA

	LAND TRANSPORT (ADG)	SEA TRANSPORT (IMDG / IMO)	AIR TRANSPORT (IATA / ICAO)
14.1 UN Number	None allocated.	None allocated.	None allocated.
14.2 Proper Shipping Name	None allocated.	None allocated.	None allocated.
14.3 Transport hazard class	None allocated.	None allocated.	None allocated.
14.4 Packing Group	None allocated.	None allocated.	None allocated.

14.5 Environmental hazards

No information provided.

14.6 Special precautions for user

Hazchem code None allocated.

15. REGULATORY INFORMATION

15.1 Safety, health and environmental regulations/legislation specific for the substance or mixture

Poison schedule Classified as a Schedule 5 (S5) Standard for the Uniform Scheduling of Medicines and Poisons (SUSMP).

Classifications Safework Australia criteria is based on the Globally Harmonised System (GHS) of Classification and Labelling of Chemicals.

The classifications and phrases listed below are based on the Approved Criteria for Classifying Hazardous Substances [NOHSC: 1008(2004)].

Hazard codes	Xi	Irritant
	Xn	Harmful
Risk phrases	R37/38	Irritating to respiratory system and skin.
	R41	Risk of serious damage to eyes.
	R48/22	Harmful: danger of serious damage to health by prolonged exposure if swallowed.
Safety phrases	S25	Avoid contact with eyes.
	S26	In case of contact with eyes, rinse immediately with plenty of water and seek medical advice
	S39	Wear eye/face protection.

Inventory listing(s) **AUSTRALIA: AICS (Australian Inventory of Chemical Substances)**
All components are listed on AICS, or are exempt.

16. OTHER INFORMATION

Additional information

RESPIRATORS: In general the use of respirators should be limited and engineering controls employed to avoid exposure. If respiratory equipment must be worn ensure correct respirator selection and training is undertaken. Remember that some respirators may be extremely uncomfortable when used for long periods. The use of air powered or air supplied respirators should be considered where prolonged or repeated use is necessary.

PERSONAL PROTECTIVE EQUIPMENT GUIDELINES:
The recommendation for protective equipment contained within this report is provided as a guide only. Factors such as form of product, method of application, working environment, quantity used, product concentration and the availability of engineering controls should be considered before final selection of personal protective equipment is made.

HEALTH EFFECTS FROM EXPOSURE:
It should be noted that the effects from exposure to this product will depend on several factors including: form of product; frequency and duration of use; quantity used; effectiveness of control measures; protective equipment used and method of application. Given that it is impractical to prepare a report which would encompass all possible scenarios, it is anticipated that users will assess the risks and apply control methods where appropriate.

Abbreviations

ACGIH	American Conference of Governmental Industrial Hygienists
CAS #	Chemical Abstract Service number - used to uniquely identify chemical compounds
CNS	Central Nervous System
EC No.	EC No - European Community Number
EMS	Emergency Schedules (Emergency Procedures for Ships Carrying Dangerous Goods)
GHS	Globally Harmonized System
GTEPG	Group Text Emergency Procedure Guide
IARC	International Agency for Research on Cancer
LC50	Lethal Concentration, 50% / Median Lethal Concentration
LD50	Lethal Dose, 50% / Median Lethal Dose
mg/m³	Milligrams per Cubic Metre
OEL	Occupational Exposure Limit
pH	relates to hydrogen ion concentration using a scale of 0 (high acidic) to 14 (highly alkaline).
ppm	Parts Per Million
STEL	Short-Term Exposure Limit
STOT-RE	Specific target organ toxicity (repeated exposure)
STOT-SE	Specific target organ toxicity (single exposure)
SUSMP	Standard for the Uniform Scheduling of Medicines and Poisons
SWA	Safe Work Australia
TLV	Threshold Limit Value
TWA	Time Weighted Average

Report status

This document has been compiled by RMT on behalf of the manufacturer, importer or supplier of the product and serves as their Safety Data Sheet ('SDS').

It is based on information concerning the product which has been provided to RMT by the manufacturer, importer or supplier or obtained from third party sources and is believed to represent the current state of knowledge as to the appropriate safety and handling precautions for the product at the time of issue. Further clarification regarding any aspect of the product should be obtained directly from the manufacturer, importer or supplier.

While RMT has taken all due care to include accurate and up-to-date information in this SDS, it does not provide any warranty as to accuracy or completeness. As far as lawfully possible, RMT accepts no liability for any loss, injury or damage (including consequential loss) which may be suffered or incurred by any person as a consequence of their reliance on the information contained in this SDS.

Prepared by

Risk Management Technologies
5 Ventnor Ave, West Perth
Western Australia 6005
Phone: +61 8 9322 1711
Fax: +61 8 9322 1794
Email: info@rmt.com.au
Web: www.rmt.com.au

[End of SDS]

NEWPARK DRILLING FLUIDS

SAFETY DATA SHEET

1. IDENTIFICATION OF THE MATERIAL AND SUPPLIER

1.1 Product identifier

Product name **TOPSPOT**

Synonyms TOP SPOT

1.2 Uses and uses advised against

Uses SURFACTANT

1.3 Details of the supplier of the product

Supplier name **NEWPARK DRILLING FLUIDS (AUSTRALIA) LTD**

Address 11 Alacrity Place, Henderson, WA, 6166, AUSTRALIA

Telephone +61 8 9410 8200

Fax +61 8 9410 8299

Website www.newpark.com

1.4 Emergency telephone numbers

Emergency 1800 127 406 (Australia); +64 4 917 9888 (International)

2. HAZARDS IDENTIFICATION

2.1 Classification of the substance or mixture

NOT CLASSIFIED AS HAZARDOUS ACCORDING TO SAFE WORK AUSTRALIA CRITERIA

2.2 GHS Label elements

No signal word, pictograms, hazard or precautionary statements have been allocated.

2.3 Other hazards

No information provided.

3. COMPOSITION/ INFORMATION ON INGREDIENTS

3.1 Substances / Mixtures

Ingredient	CAS Number	EC Number	Content
SURFACTANT(S)	-	-	Not Available
NON HAZARDOUS INGREDIENTS	Not Available	Not Available	Remainder

4. FIRST AID MEASURES

4.1 Description of first aid measures

Eye If in eyes, hold eyelids apart and flush continuously with running water. Continue flushing until advised to stop by a Poisons Information Centre, a doctor, or for at least 15 minutes.

Inhalation If inhaled, remove from contaminated area. Apply artificial respiration if not breathing.

Skin If skin or hair contact occurs, remove contaminated clothing and flush skin and hair with running water. Continue flushing with water until advised to stop by a Poisons Information Centre or a doctor.

Ingestion For advice, contact a Poisons Information Centre on 13 11 26 (Australia Wide) or a doctor (at once). If swallowed, do not induce vomiting.

First aid facilities Eye wash facilities and safety shower should be available.

4.2 Most important symptoms and effects, both acute and delayed
Adverse effects not expected from this product under normal conditions of use.

4.3 Immediate medical attention and special treatment needed
Treat symptomatically.

5. FIRE FIGHTING MEASURES

5.1 Extinguishing media
Use an extinguishing agent suitable for the surrounding fire.

5.2 Special hazards arising from the substance or mixture
Non flammable. May evolve toxic gases if strongly heated.

5.3 Advice for firefighters
No fire or explosion hazard exists.

5.4 Hazchem code
None allocated.

6. ACCIDENTAL RELEASE MEASURES

6.1 Personal precautions, protective equipment and emergency procedures
Wear Personal Protective Equipment (PPE) as detailed in section 8 of the SDS.

6.2 Environmental precautions
Prevent product from entering drains and waterways.

6.3 Methods of cleaning up
Contain spillage, then cover / absorb spill with non-combustible absorbent material (vermiculite, sand, or similar), collect and place in suitable containers for disposal.

6.4 Reference to other sections
See Sections 8 and 13 for exposure controls and disposal.

7. HANDLING AND STORAGE

7.1 Precautions for safe handling
Before use carefully read the product label. Use of safe work practices are recommended to avoid eye or skin contact and inhalation. Observe good personal hygiene, including washing hands before eating. Prohibit eating, drinking and smoking in contaminated areas.

7.2 Conditions for safe storage, including any incompatibilities
Store in a cool, dry, well ventilated area, removed from incompatible substances and foodstuffs. Ensure containers are adequately labelled, protected from physical damage and sealed when not in use.

7.3 Specific end uses
No information provided.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

8.1 Control parameters
Exposure standards

No exposure standards have been entered for this product.

Biological limits

No biological limit values have been entered for this product.

8.2 Exposure controls
Engineering controls Avoid inhalation. Use in well ventilated areas.

PPE

Eye / Face	Wear splash-proof goggles.
Hands	Wear PVC or rubber gloves.
Body	When using large quantities or where heavy contamination is likely, wear coveralls. In a laboratory situation, wear a laboratory coat.
Respiratory	Not required under normal conditions of use.



9. PHYSICAL AND CHEMICAL PROPERTIES

9.1 Information on basic physical and chemical properties

Appearance	DARK AMBER COLOURED TO BLACK LIQUID
Odour	MILD ODOUR
Flammability	NON FLAMMABLE
Flash point	NOT RELEVANT
Boiling point	NOT AVAILABLE
Melting point	NOT AVAILABLE
Evaporation rate	NOT AVAILABLE
pH	NOT AVAILABLE
Vapour density	NOT AVAILABLE
Specific gravity	1.1 to 1.2
Solubility (water)	NOT AVAILABLE
Vapour pressure	NOT AVAILABLE
Upper explosion limit	NOT RELEVANT
Lower explosion limit	NOT RELEVANT
Partition coefficient	NOT AVAILABLE
Autoignition temperature	NOT AVAILABLE
Decomposition temperature	NOT AVAILABLE
Viscosity	NOT AVAILABLE
Explosive properties	NOT AVAILABLE
Oxidising properties	NOT AVAILABLE
Odour threshold	NOT AVAILABLE

10. STABILITY AND REACTIVITY

10.1 Reactivity

Carefully review all information provided in sections 10.2 to 10.6.

10.2 Chemical stability

Stable under recommended conditions of storage.

10.3 Possibility of hazardous reactions

Polymerization is not expected to occur.

10.4 Conditions to avoid

Avoid heat, sparks, open flames and other ignition sources.

10.5 Incompatible materials

Incompatible with oxidising agents (e.g. hypochlorites) and acids (e.g. nitric acid).

10.6 Hazardous decomposition products

May evolve toxic gases if heated to decomposition.

11. TOXICOLOGICAL INFORMATION

11.1 Information on toxicological effects

Acute toxicity	This product is expected to be of low acute toxicity. Under normal conditions of use, adverse health effects are not anticipated.
Skin	Not classified as a skin irritant. Contact may result in mild irritation.
Eye	Not classified as an eye irritant. Contact may cause discomfort, lacrimation and redness.
Sensitisation	Not classified as causing skin or respiratory sensitisation.
Mutagenicity	No evidence of mutagenic effects.
Carcinogenicity	No evidence of carcinogenic effects.
Reproductive	No relevant or reliable studies were identified.
STOT - single exposure	Not classified as causing organ damage from single exposure.
STOT - repeated exposure	Not classified as causing organ damage from repeated exposure.
Aspiration	This product does not present an aspiration hazard.

12. ECOLOGICAL INFORMATION

12.1 Toxicity

No information provided.

12.2 Persistence and degradability

No information provided.

12.3 Bioaccumulative potential

No information provided.

12.4 Mobility in soil

No information provided.

12.5 Other adverse effects

No information provided.

13. DISPOSAL CONSIDERATIONS

13.1 Waste treatment methods

Waste disposal	For small amounts, absorb with sand or similar and dispose of to an approved landfill site. Contact the manufacturer/supplier for additional information (if required). Ensure that appropriate personal protective equipment is used during disposal.
Legislation	Dispose of in accordance with relevant local legislation.

14. TRANSPORT INFORMATION

NOT CLASSIFIED AS A DANGEROUS GOOD BY THE CRITERIA OF THE ADG CODE, IMDG OR IATA

	LAND TRANSPORT (ADG)	SEA TRANSPORT (IMDG / IMO)	AIR TRANSPORT (IATA / ICAO)
14.1 UN Number	None allocated.	None allocated.	None allocated.
14.2 Proper Shipping Name	None allocated.	None allocated.	None allocated.
14.3 Transport hazard class	None allocated.	None allocated.	None allocated.
14.4 Packing Group	None allocated.	None allocated.	None allocated.

14.5 Environmental hazards

No information provided.

14.6 Special precautions for user

Hazchem code None allocated.

15. REGULATORY INFORMATION

15.1 Safety, health and environmental regulations/legislation specific for the substance or mixture

Poison schedule A poison schedule number has not been allocated to this product using the criteria in the Standard for the Uniform Scheduling of Medicines and Poisons (SUSMP).

Classifications Safework Australia criteria is based on the Globally Harmonised System (GHS) of Classification and Labelling of Chemicals.

Inventory listings **AUSTRALIA: AICS (Australian Inventory of Chemical Substances)**
All components are listed on AICS, or are exempt.

16. OTHER INFORMATION

Additional information

PERSONAL PROTECTIVE EQUIPMENT GUIDELINES:
The recommendation for protective equipment contained within this report is provided as a guide only. Factors such as form of product, method of application, working environment, quantity used, product concentration and the availability of engineering controls should be considered before final selection of personal protective equipment is made.

HEALTH EFFECTS FROM EXPOSURE:
It should be noted that the effects from exposure to this product will depend on several factors including: form of product; frequency and duration of use; quantity used; effectiveness of control measures; protective equipment used and method of application. Given that it is impractical to prepare a report which would encompass all possible scenarios, it is anticipated that users will assess the risks and apply control methods where appropriate.

Abbreviations

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OEL	Occupational Exposure Limit
pH	relates to hydrogen ion concentration using a scale of 0 (high acidic) to 14 (highly alkaline).
ppm	Parts Per Million
STEL	Short-Term Exposure Limit
STOT-RE	Specific target organ toxicity (repeated exposure)
STOT-SE	Specific target organ toxicity (single exposure)
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Prepared by

Risk Management Technologies
5 Ventnor Ave, West Perth
Western Australia 6005
Phone: +61 8 9322 1711
Fax: +61 8 9322 1794
Email: info@rmt.com.au
Web: www.rmtglobal.com

[End of SDS]

PRODUCT BULLETIN

TopSpot™

SPOTTING ADDITIVE

NEWPARK DRILLING FLUIDS
www.newparkdf.com

PRODUCT DESCRIPTION

TopSpot™ spotting additive is an environmentally friendly blend of organic surfactants designed to free differentially stuck pipe when using water-based drilling fluids. The product works by thinning or cracking the filter cake and by adding lubricity to the borehole-pipe interface, thereby reducing the "pull-out" force. It is shipped as a concentrate and can be easily and rapidly blended with freshwater, seawater or brine.

BENEFITS

TopSpot spotting fluid is an environmentally safe solution for freeing differentially stuck pipe, reducing the time, costs and potential hazards.

APPLICATION

TopSpot spotting additive is used in water-based drilling fluids whenever stuck pipe is encountered. The spotting fluid prepared with this additive can be weighted when necessary to maintain an equivalent hydrostatic head in the borehole. The used spot may be circulated out and either diverted or allowed to mix with the existing system. If the volume of the spot is large enough to cause more than a 110% dilution of the existing system, the spot should be diverted. Incorporation of less than 10% can be easily treated with conventional products. This product is safe for offshore applications and passes ecotoxicological tests, with LC50 results of ≥1,000,000 ppm in Generic Mud #7.

TREATMENT RECOMMENDATION

TopSpot spotting fluids are prepared by mixing 20% by volume TopSpot concentrate in either freshwater, seawater or brine. The fluids can be weighted with appropriate additions of XC Polymer and barite as specified in the accompanying table.

MATERIAL NEEDED FOR 50 BBL OF WEIGHTED SPOTTING FLUID

Desired Weight (lb/gal)	10	12	15	18
Freshwater or Seawater (bbl)	38	35	30	26
TopSpot (drum)	7	7	6	5
NewZan™ D (lb)	115	105	90	75
Barite (sack)	42	97	184	267

TYPICAL PHYSICAL PROPERTIES

Appearance..... Amber to black, viscous liquid

Flash Point..... 220° F (104°C)

Specific Gravity.....1.1-1.2 at 77°F (25°C)

HANDLING AND STORAGE

Avoid contact with skin and eyes. Store in a well-ventilated area. Use appropriate hygiene, clothing and personal protective equipment suitable for work being done. Review the SDS thoroughly before using this product.

PACKAGING

TopSpot spotting additive is available in 55-gallon (208-liter) drums and bulk quantities.

This document is supplied solely for informational purposes and Newpark Drilling Fluids makes no guarantees or warranties, either expressed or implied, with respect to the accuracy and use of this data.

All product warranties and guarantees shall be governed by the General Terms and Conditions.

SAFETY DATA SHEET

TrueScav™ HD

Issue Date 29-Aug-2018 **Revision Date** 29-Aug-2018 **Version** 1
EN

Section 1: IDENTIFICATION: PRODUCT INDENTIFIER AND CHEMICAL IDENTITY

Product identifier

Product Name TrueScav™ HD

Product Code NDF00394

Other means of identification

Recommended use of the chemical and restrictions on use

Recommended Use oxygen scavenger

Uses advised against No information available

Details of manufacturer or importer

Supplier
Newpark Drilling Fluids (Australia) LTD
11 Alacrity Place
Henderson, WA, 6166
Australia

For further information, please contact

Contact Point Telephone: +61 8 9410 8200
Fax: +61 8 9410 8299
Website: www.newpark.com

Emergency telephone number

Emergency telephone number +(61)-290372994 (Australia); +(64)-98010034 (New Zealand)

Section 2: HAZARD(S) IDENTIFICATION

GHS - Classification

Not a dangerous substance or mixture according to the Globally Harmonized System (GHS)

Label elements

Hazard statements
Not a dangerous substance or mixture according to the Globally Harmonized System (GHS)

Other hazards
General Hazards
No information available

Section 3: COMPOSITION AND INFORMATION ON INGREDIENTS, IN ACCORDANCE WITH SCHEDULE 8

Substance

Non-hazardous ingredients	Proprietary	>99

Section 4: FIRST AID MEASURES

Description of first aid measures

Emergency telephone number Poisons Information Center, Australia: 13 11 26
Poisons Information Center, New Zealand: 0800 764 766

Inhalation Remove to fresh air.

Eye contact Rinse thoroughly with plenty of water for at least 15 minutes, lifting lower and upper eyelids. Consult a physician.

Skin contact Wash skin with soap and water.

Ingestion Clean mouth with water and drink afterwards plenty of water.

Most important symptoms and effects, both acute and delayed

Symptoms No information available.

Indication of any immediate medical attention and special treatment needed

Note to physicians Treat symptomatically.

Section 5: FIREFIGHTING MEASURES

Suitable Extinguishing Media

Suitable extinguishing media Use extinguishing measures that are appropriate to local circumstances and the surrounding environment.

Unsuitable extinguishing media No information available.

Specific hazards arising from the chemical

Thermal decomposition can lead to release of irritating and toxic gases and vapors. Do not allow run-off from fire-fighting to enter drains or water courses.

Hazardous combustion products Carbon oxides.

Special protective actions for fire-fighters

Special protective equipment for fire-fighters Firefighters should wear self-contained breathing apparatus and full firefighting turnout gear. Use personal protection equipment.

Hazchem code Not Listed.

Section 6: ACCIDENTAL RELEASE MEASURES

Personal precautions, protective equipment and emergency procedures

Personal precautions Ensure adequate ventilation.

For emergency responders Use personal protection recommended in Section 8.

Environmental precautions

Environmental precautions See Section 12 for additional Ecological Information. Do not flush into surface water or sanitary sewer system. Prevent product from entering drains.

Methods and material for containment and cleaning up

Methods for containment Prevent further leakage or spillage if safe to do so.

Methods for cleaning up Pick up and transfer to properly labeled containers.

Precautions to prevent secondary hazards

Prevention of secondary hazards Clean contaminated objects and areas thoroughly observing environmental regulations.

Section 7: HANDLING AND STORAGE, INCLUDING HOW THE CHEMICAL MAY BE SAFELY USED

Precautions for safe handling

Advice on safe handling Handle in accordance with good industrial hygiene and safety practice. Avoid generation of dust. Wash thoroughly after handling. Wash contaminated clothing before reuse.

General hygiene considerations Do not eat, drink or smoke when using this product. Wash hands before breaks and after work.

Conditions for safe storage, including any incompatibilities

Storage Conditions Keep containers tightly closed in a dry, cool and well-ventilated place.

Incompatible materials Strong oxidizing agents

Section 8: EXPOSURE CONTROLS AND PERSONAL PROTECTION

Control parameters

Exposure Limits This product, as supplied, does not contain any hazardous materials with occupational exposure limits established by the region specific regulatory bodies.

Biological occupational exposure limits Not applicable

Appropriate engineering controls

Engineering controls Showers
Eyewash stations
Ventilation systems.

Individual protection measures, such as personal protective equipment

Eye/face protection Tight sealing safety goggles.

Skin and body protection Wear suitable protective clothing.

Respiratory protection In case of inadequate ventilation wear respiratory protection.

Environmental exposure controls Do not allow into any sewer, on the ground or into any body of water.

Section 9: PHYSICAL AND CHEMICAL PROPERTIES

Information on basic physical and chemical properties

Physical state	Solid		
Appearance	Powder	**Odor**	No information available.
Color	White	**Odor threshold**	No information available

Property	**Values**	**Remarks • Method**
pH	5 - 8	
Melting point / freezing point	160 °C	
Boiling point / boiling range		No information available
Flash point		No information available
Evaporation rate		No information available
Flammability (solid, gas)		No information available
Flammability Limit in Air		No information available
Upper flammability limit:		No data available
Lower flammability limit:		No data available
Vapor pressure		No data available
Vapor density		No data available
Relative density	1.2-1.7	
Water solubility	Soluble in water	
Solubility(ies)		No information available
Partition coefficient		No information available
Autoignition temperature		No information available
Decomposition temperature		No information available
Kinematic viscosity		Not applicable
Dynamic viscosity		Not applicable

Other Information

Softening point	No information available
Molecular weight	No information available
VOC Content (%)	No information available
Liquid Density	No information available
Bulk density	No information available
Particle Size	No information available
Particle Size Distribution	No information available

Section 10: STABILITY AND REACTIVITY

Reactivity

Reactivity Stable under normal conditions.

Chemical stability

Stability Stable under normal conditions.

Explosion data

Sensitivity to Mechanical Impact None.
Sensitivity to Static Discharge None.

Possibility of Hazardous Reactions

Possibility of hazardous reactions None under normal processing.

Conditions to avoid

Conditions to avoid None known based on information supplied.

Incompatible materials

Incompatible materials Strong oxidizing agents.

Hazardous Decomposition Products

Hazardous Decomposition Products None known based on information supplied.

Section 11: TOXICOLOGICAL INFORMATION

Acute toxicity

Information on likely routes of exposure

Product Information .

Inhalation Specific test data for the substance or mixture is not available.

Eye contact Specific test data for the substance or mixture is not available.

Skin contact Specific test data for the substance or mixture is not available.

Ingestion Specific test data for the substance or mixture is not available

Symptoms No information available.

Numerical measures of toxicity - Product Information

The following values are calculated based on chapter 3.1 of the GHS document

ATEmix (oral) 5,005.00 mg/kg

Unknown acute toxicity 100 % of the mixture consists of ingredient(s) of unknown toxicity

0 % of the mixture consists of ingredient(s) of unknown acute oral toxicity
100 % of the mixture consists of ingredient(s) of unknown acute dermal toxicity
100 % of the mixture consists of ingredient(s) of unknown acute inhalation toxicity (gas)
100 % of the mixture consists of ingredient(s) of unknown acute inhalation toxicity (vapor)
100 % of the mixture consists of ingredient(s) of unknown acute inhalation toxicity (dust/mist)

Component Information

See section 16 for terms and abbreviations

Delayed and immediate effects as well as chronic effects from short and long-term exposure

Skin corrosion/irritation None known.

Serious eye damage/eye irritation None known.

Respiratory or skin sensitization None known.

Germ cell mutagenicity None known.

Carcinogenicity None known.

Reproductive toxicity None known.

STOT - single exposure None known.

STOT - repeated exposure None known.

Aspiration hazard Not applicable.

Section 12: ECOLOGICAL INFORMATION

Ecotoxicity

Ecotoxicity The environmental impact of this product has not been fully investigated.

Unknown aquatic toxicity 100 % of the mixture consists of component(s) of unknown hazards to the aquatic environment.

Persistence and degradability

Persistence and degradability No information available.

Bioaccumulative potential

Bioaccumulation No information available.

Mobility

Mobility in soil No information available.

Mobility No information available.

Other adverse effects

Other adverse effects No information available.

Section 13: DISPOSAL CONSIDERATIONS

Waste treatment methods

Waste from residues/unused products Dispose of in accordance with local regulations. Dispose of waste in accordance with environmental legislation.

Contaminated packaging Do not reuse empty containers.

Section 14: TRANSPORT INFORMATION

ADG Not Regulated

IATA Not Regulated

IMDG Not Regulated

Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code
No information available

Section 15: REGULATORY INFORMATION

Regulatory information

National regulations

Australia
See section 8 for national exposure control parameters

Standard for Uniform Scheduling of Medicines and Poisons (SUSMP)
No poisons schedule number allocated

International Inventories

TSCA	Complies
DSL/NDSL	Complies
EINECS/ELINCS	Complies
ENCS	Complies
IECSC	Complies
KECL	Complies
PICCS	Complies
AICS	Complies
NZIoC	Complies

Legend:
TSCA - United States Toxic Substances Control Act Section 8(b) Inventory
DSL/NDSL - Canadian Domestic Substances List/Non-Domestic Substances List
EINECS/ELINCS - European Inventory of Existing Chemical Substances/European List of Notified Chemical Substances
ENCS - Japan Existing and New Chemical Substances
IECSC - China Inventory of Existing Chemical Substances
KECL - Korean Existing and Evaluated Chemical Substances
PICCS - Philippines Inventory of Chemicals and Chemical Substances
AICS - Australian Inventory of Chemical Substances
NZIoC - New Zealand Inventory of Chemicals

International Regulations

The Montreal Protocol on Substances that Deplete the Ozone Layer Not applicable

The Stockholm Convention on Persistent Organic Pollutants Not applicable

The Rotterdam Convention Not applicable

Section 16: ANY OTHER RELEVANT INFORMATION

Issue Date 29-Aug-2018

Revision Date 29-Aug-2018

Revision Note
No information available.

Key or legend to abbreviations and acronyms used in the safety data sheet

Legend Section 8: EXPOSURE CONTROLS/PERSONAL PROTECTION

TWA	TWA (time-weighted average)	STEL	STEL (Short Term Exposure Limit)
Ceiling	Maximum limit value	*	Skin designation
C	Carcinogen		

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End of Safety Data Sheet

SAFETY DATA SHEET

AVADEFOAM NS

Issue Date 18-Apr-2017 **Revision Date** 28-Mar-2019 **Version** 1
EN

Section 1: IDENTIFICATION: PRODUCT INDENTIFIER AND CHEMICAL IDENTITY

1

Product identifier

Product Name AVADEFOAM NS

Product Code NDF00251

Other means of identification

Pure substance/mixture Mixture

Recommended use of the chemical and restrictions on use

Recommended Use Defoamer

Uses advised against No information available

Details of manufacturer or importer

Supplier
Newpark Drilling Fluids (Australia) LTD
11 Alacrity Place
Henderson, WA, 6166
Australia

For further information, please contact

Contact Point Telephone: +61 8 9410 8200
Fax: +61 8 9410 8299
Website: www.newpark.com

Emergency telephone number

Emergency telephone number +(61)-290372994 (Australia); +(64)-98010034 (New Zealand)

Section 2: HAZARD(S) IDENTIFICATION

GHS - Classification

Not a dangerous substance or mixture according to the Globally Harmonized System (GHS)

Label elements

Hazard statements
Not a dangerous substance or mixture according to the Globally Harmonized System (GHS)

Other hazards

General Hazards

No information available

Section 3: COMPOSITION AND INFORMATION ON INGREDIENTS, IN ACCORDANCE WITH SCHEDULE 8

Substance

Not applicable

Mixture

Chemical name	CAS No	Weight-%
Non-hazardous ingredients	Proprietary	

Section 4: FIRST AID MEASURES

Description of first aid measures

Emergency telephone number Poisons Information Center, Australia: 13 11 26
Poisons Information Center, New Zealand: 0800 764 766

Inhalation Remove to fresh air.

Eye contact Rinse thoroughly with plenty of water for at least 15 minutes, lifting lower and upper eyelids. Consult a physician.

Skin contact Wash skin with soap and water.

Ingestion Clean mouth with water and drink afterwards plenty of water.

Most important symptoms and effects, both acute and delayed

Symptoms No information available.

Indication of any immediate medical attention and special treatment needed

Note to physicians Treat symptomatically.

Section 5: FIREFIGHTING MEASURES

Suitable Extinguishing Media

Suitable extinguishing media Water. Carbon dioxide (CO2).

Unsuitable extinguishing media No information available.

Specific hazards arising from the chemical

Thermal decomposition can lead to release of irritating and toxic gases and vapors. Do not allow run-off from fire-fighting to enter drains or water courses.

Hazardous combustion products Carbon oxides.

Special protective actions for fire-fighters

Special protective equipment for fire-fighters Firefighters should wear self-contained breathing apparatus and full firefighting turnout gear. Use personal protection equipment.

Hazchem code Not Listed.

Section 6: ACCIDENTAL RELEASE MEASURES

Personal precautions, protective equipment and emergency procedures

Personal precautions Ensure adequate ventilation.

For emergency responders Use personal protection recommended in Section 8.

Environmental precautions

Environmental precautions See Section 12 for additional Ecological Information. Do not flush into surface water or sanitary sewer system. Prevent product from entering drains.

Methods and material for containment and cleaning up

Methods for containment Prevent further leakage or spillage if safe to do so.

Methods for cleaning up Pick up and transfer to properly labeled containers.

Precautions to prevent secondary hazards

Prevention of secondary hazards Clean contaminated objects and areas thoroughly observing environmental regulations.

Section 7: HANDLING AND STORAGE, INCLUDING HOW THE CHEMICAL MAY BE SAFELY USED

Precautions for safe handling

Advice on safe handling Handle in accordance with good industrial hygiene and safety practice. Wash thoroughly after handling. Wash contaminated clothing before reuse.

General hygiene considerations Do not eat, drink or smoke when using this product. Wash hands before breaks and after work.

Conditions for safe storage, including any incompatibilities

Storage Conditions Keep containers tightly closed in a dry, cool and well-ventilated place.

Incompatible materials None known

Section 8: EXPOSURE CONTROLS AND PERSONAL PROTECTION

Control parameters

Exposure Limits This product, as supplied, does not contain any hazardous materials with occupational exposure limits established by the region specific regulatory bodies.

Biological occupational exposure limits Not applicable

Appropriate engineering controls

Engineering controls Showers
Eyewash stations
Ventilation systems.

Individual protection measures, such as personal protective equipment

Eye/face protection Tight sealing safety goggles.

Skin and body protection Wear suitable protective clothing.

Respiratory protection In case of inadequate ventilation wear respiratory protection.

Environmental exposure controls Do not allow into any sewer, on the ground or into any body of water.

Section 9: PHYSICAL AND CHEMICAL PROPERTIES

Information on basic physical and chemical properties

Physical state	Liquid		
Appearance	liquid	**Odor**	Slight.
Color	clear	**Odor threshold**	No information available

Property	**Values**	**Remarks • Method**
pH		No data available
Melting point / freezing point		No data available
Boiling point / boiling range		No data available
Flash point	> 100 °C	
Evaporation rate		No data available
Flammability (solid, gas)		Not applicable
Flammability Limit in Air		No information available
Upper flammability limit:		No data available
Lower flammability limit:		No data available
Vapor pressure		No data available
Vapor density		No data available
Relative density	0.95-0.97	
Water solubility	Insoluble in water	
Solubility(ies)		No data available
Partition coefficient		No data available
Autoignition temperature		No data available
Decomposition temperature		No data available
Kinematic viscosity		No data available
Dynamic viscosity		No data available

Other Information

Softening point	No information available
Molecular weight	No information available
VOC Content (%)	No information available
Liquid Density	0.95-0.97 g/cm3
Bulk density	No information available
Particle Size	No information available
Particle Size Distribution	No information available

Section 10: STABILITY AND REACTIVITY

Reactivity

Reactivity No information available.

Chemical stability

Stability Stable under normal conditions.

Explosion data

Sensitivity to Mechanical Impact None.

Sensitivity to Static Discharge None.

Possibility of Hazardous Reactions

Possibility of hazardous reactions None under normal processing.

Conditions to avoid

Conditions to avoid None known based on information supplied.

Incompatible materials

Incompatible materials None known.

Hazardous Decomposition Products

Hazardous Decomposition Products None known based on information supplied.

Section 11: TOXICOLOGICAL INFORMATION

Acute toxicity

Information on likely routes of exposure

Product Information .

Inhalation Specific test data for the substance or mixture is not available.

Eye contact Specific test data for the substance or mixture is not available.

Skin contact Specific test data for the substance or mixture is not available.

Ingestion Specific test data for the substance or mixture is not available

Symptoms No information available.

Numerical measures of toxicity - Product Information

The following values are calculated based on chapter 3.1 of the GHS document

ATEmix (oral) 10,010.00 mg/kg

Unknown acute toxicity 100 % of the mixture consists of ingredient(s) of unknown toxicity
95 % of the mixture consists of ingredient(s) of unknown acute oral toxicity
100 % of the mixture consists of ingredient(s) of unknown acute dermal toxicity
100 % of the mixture consists of ingredient(s) of unknown acute inhalation toxicity (gas)
100 % of the mixture consists of ingredient(s) of unknown acute inhalation toxicity (vapor)
100 % of the mixture consists of ingredient(s) of unknown acute inhalation toxicity (dust/mist)

See section 16 for terms and abbreviations

Delayed and immediate effects as well as chronic effects from short and long-term exposure

Skin corrosion/irritation No information available.

Serious eye damage/eye irritation No information available.

Respiratory or skin sensitization No information available.

Germ cell mutagenicity No information available.

Carcinogenicity No information available.

Reproductive toxicity No information available.

STOT - single exposure No information available.

STOT - repeated exposure No information available.

Aspiration hazard No information available.

Section 12: ECOLOGICAL INFORMATION

Ecotoxicity

Ecotoxicity The environmental impact of this product has not been fully investigated.

Unknown aquatic toxicity 95 % of the mixture consists of component(s) of unknown hazards to the aquatic environment.

Persistence and degradability

Persistence and degradability No information available.

Bioaccumulative potential

Bioaccumulation No information available.

Mobility

Mobility in soil No information available.

Mobility No information available.

Other adverse effects

Other adverse effects No information available.

Section 13: DISPOSAL CONSIDERATIONS

Waste treatment methods

Waste from residues/unused products Dispose of in accordance with local regulations. Dispose of waste in accordance with environmental legislation.

Contaminated packaging Do not reuse empty containers.

Section 14: TRANSPORT INFORMATION

ADG Not regulated

IATA Not regulated

IMDG Not regulated

Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code
No information available

Section 15: REGULATORY INFORMATION

Regulatory information

National regulations

Australia
See section 8 for national exposure control parameters

Standard for Uniform Scheduling of Medicines and Poisons (SUSMP)
No poisons schedule number allocated

International Inventories

TSCA	Complies
DSL/NDSL	Complies
EINECS/ELINCS	Complies
ENCS	Does not comply
IECSC	Complies
KECL	Complies
PICCS	Does not comply
AICS	Complies
NZIoC	Complies

Legend:
TSCA - United States Toxic Substances Control Act Section 8(b) Inventory
DSL/NDSL - Canadian Domestic Substances List/Non-Domestic Substances List
EINECS/ELINCS - European Inventory of Existing Chemical Substances/European List of Notified Chemical Substances
ENCS - Japan Existing and New Chemical Substances
IECSC - China Inventory of Existing Chemical Substances
KECL - Korean Existing and Evaluated Chemical Substances
PICCS - Philippines Inventory of Chemicals and Chemical Substances
AICS - Australian Inventory of Chemical Substances
NZIoC - New Zealand Inventory of Chemicals

International Regulations

Ozone-depleting substances (ODS) Not applicable

Persistent Organic Pollutants Not applicable

Export Notification requirements Not applicable

Section 16: ANY OTHER RELEVANT INFORMATION

Issue Date 18-Apr-2017

Revision Date 28-Mar-2019

Revision Note
No information available.

Key or legend to abbreviations and acronyms used in the safety data sheet

Legend Section 8: EXPOSURE CONTROLS/PERSONAL PROTECTION

TWA	TWA (time-weighted average)	STEL	STEL (Short Term Exposure Limit)
Ceiling	Maximum limit value	*	Skin designation
C	Carcinogen		

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End of Safety Data Sheet

SAFETY DATA SHEET

AVAPOLYMER 5050

Issue Date 12-Apr-2017 **Revision Date** 02-Aug-2017 **Version** 1
EN

Section 1: IDENTIFICATION: PRODUCT INDENTIFIER AND CHEMICAL IDENTITY

Product identifier

Product Name AVAPOLYMER 5050

Product Code NDF00252

Other means of identification

Pure substance/mixture Mixture

Recommended use of the chemical and restrictions on use

Recommended Use shale stabilizer

Uses advised against No information available

Details of manufacturer or importer

Supplier
Newpark Drilling Fluids (Australia) LTD
11 Alacrity Place
Henderson, WA, 6166
Australia

For further information, please contact

Contact Point Telephone: +61 8 9410 8200
Fax: +61 8 9410 8299
Website: www.newpark.com

Emergency telephone number

Emergency telephone number 1800 127 406 (Australia); +64 4 917 9888 (International)

Section 2: HAZARD(S) IDENTIFICATION

GHS - Classification

Not a dangerous substance or mixture according to the Globally Harmonized System (GHS)

Label elements

Hazard statements
Not a dangerous substance or mixture according to the Globally Harmonized System (GHS)

Other hazards

May be harmful in contact with skin

General Hazards

No information available

Section 3: COMPOSITION AND INFORMATION ON INGREDIENTS, IN ACCORDANCE WITH SCHEDULE 8

Substance

Not applicable

Mixture

Additional information

The product contains no substances which at their given concentration, are considered to be hazardous to health

Section 4: FIRST AID MEASURES

Description of first aid measures

Emergency telephone number	Poisons Information Center, Australia: 13 11 26 Poisons Information Center, New Zealand: 0800 764 766
Inhalation	Remove to fresh air.
Eye contact	Rinse thoroughly with plenty of water for at least 15 minutes, lifting lower and upper eyelids. Consult a physician.
Skin contact	Wash skin with soap and water.
Ingestion	Clean mouth with water and drink afterwards plenty of water.

Most important symptoms and effects, both acute and delayed

Symptoms	No information available.

Indication of any immediate medical attention and special treatment needed

Note to physicians	Treat symptomatically.

Section 5: FIREFIGHTING MEASURES

Suitable Extinguishing Media

Suitable extinguishing media

Water spray (fog). Carbon dioxide (CO2).

Unsuitable extinguishing media	No information available.

Specific hazards arising from the chemical

Thermal decomposition can lead to release of irritating and toxic gases and vapors. Do not allow run-off from fire-fighting to enter drains or water courses.

Hazardous combustion products	Carbon oxides.

Special protective actions for fire-fighters

Special protective equipment for fire-fighters	Firefighters should wear self-contained breathing apparatus and full firefighting turnout gear. Use personal protection equipment.

Hazchem code Not Listed.

Section 6: ACCIDENTAL RELEASE MEASURES

Personal precautions, protective equipment and emergency procedures

Personal precautions Ensure adequate ventilation.

For emergency responders Use personal protection recommended in Section 8.

Environmental precautions

Environmental precautions See Section 12 for additional Ecological Information. Do not flush into surface water or sanitary sewer system. Prevent product from entering drains.

Methods and material for containment and cleaning up

Methods for containment Prevent further leakage or spillage if safe to do so.

Methods for cleaning up Pick up and transfer to properly labeled containers.

Precautions to prevent secondary hazards

Prevention of secondary hazards Clean contaminated objects and areas thoroughly observing environmental regulations.

Section 7: HANDLING AND STORAGE, INCLUDING HOW THE CHEMICAL MAY BE SAFELY USED

Precautions for safe handling

Advice on safe handling Handle in accordance with good industrial hygiene and safety practice. Avoid generation of dust. Wash thoroughly after handling. Wash contaminated clothing before reuse.

General hygiene considerations Do not eat, drink or smoke when using this product. Wash hands before breaks and after work.

Conditions for safe storage, including any incompatibilities

Storage Conditions Keep containers tightly closed in a dry, cool and well-ventilated place.

Incompatible materials None known

Section 8: EXPOSURE CONTROLS AND PERSONAL PROTECTION

Control parameters

Exposure Limits This product, as supplied, does not contain any hazardous materials with occupational exposure limits established by the region specific regulatory bodies.

Biological occupational exposure limits Not applicable

Appropriate engineering controls

Engineering controls Showers
Eyewash stations
Ventilation systems.

Individual protection measures, such as personal protective equipment

Eye/face protection Tight sealing safety goggles.

Skin and body protection Wear suitable protective clothing.

Respiratory protection In case of inadequate ventilation wear respiratory protection.

Environmental exposure controls Do not allow into any sewer, on the ground or into any body of water.

Section 9: PHYSICAL AND CHEMICAL PROPERTIES

Information on basic physical and chemical properties

Physical state	Solid		
Appearance	powder	**Odor**	Slight.
Color	No information available	**Odor threshold**	No information available

Property	**Values**	**Remarks • Method**
pH	8.0 - 11.0	20 g/L solution
Melting point / freezing point		No data available
Boiling point / boiling range		No data available
Flash point		Not applicable
Evaporation rate		No data available
Flammability (solid, gas)		No data available
Flammability Limit in Air		No data available
Upper flammability limit:		No data available
Lower flammability limit:		No data available
Vapor pressure		No data available
Vapor density		No data available
Relative density		No data available
Water solubility	Soluble in water	
Solubility(ies)		No information available
Partition coefficient		No information available
Autoignition temperature		No data available
Decomposition temperature		No data available
Kinematic viscosity		Not applicable
Dynamic viscosity		Not applicable

Other Information

Softening point	No information available
Molecular weight	No information available
VOC Content (%)	No information available
Density	No information available
Bulk density	No information available
Particle Size	No information available
Particle Size Distribution	No information available

Section 10: STABILITY AND REACTIVITY

Reactivity

Reactivity Stable.

Chemical stability

Stability Stable under normal conditions.

Explosion data

Sensitivity to Mechanical Impact None.

Sensitivity to Static Discharge None.

Possibility of Hazardous Reactions

Possibility of hazardous reactions None under normal processing.

Conditions to avoid

Conditions to avoid None known based on information supplied.

Incompatible materials

Incompatible materials None known.

Hazardous Decomposition Products

Hazardous Decomposition Products None known based on information supplied.

Section 11: TOXICOLOGICAL INFORMATION

Acute toxicity

Information on likely routes of exposure

Product Information .

Inhalation Specific test data for the substance or mixture is not available.

Eye contact Specific test data for the substance or mixture is not available.

Skin contact Specific test data for the substance or mixture is not available.

Ingestion Specific test data for the substance or mixture is not available

Symptoms No information available.

Numerical measures of toxicity - Product Information

The following values are calculated based on chapter 3.1 of the GHS document

ATEmix (oral) 27,000.00 mg/kg
ATEmix (dermal) 2,002.00 mg/kg

Unknown acute toxicity 100 % of the mixture consists of ingredient(s) of unknown toxicity
40 % of the mixture consists of ingredient(s) of unknown acute oral toxicity
40 % of the mixture consists of ingredient(s) of unknown acute dermal toxicity
100 % of the mixture consists of ingredient(s) of unknown acute inhalation toxicity (gas)
100 % of the mixture consists of ingredient(s) of unknown acute inhalation toxicity (vapor)
100 % of the mixture consists of ingredient(s) of unknown acute inhalation toxicity (dust/mist)

See section 16 for terms and abbreviations

Delayed and immediate effects as well as chronic effects from short and long-term exposure

Skin corrosion/irritation No information available.

Serious eye damage/eye irritation No information available.

Respiratory or skin sensitization No information available.

Germ cell mutagenicity No information available.

Carcinogenicity No information available.

Reproductive toxicity	No information available.
STOT - single exposure	No information available.
STOT - repeated exposure	No information available.
Aspiration hazard	No information available.

Section 12: ECOLOGICAL INFORMATION

Ecotoxicity

Ecotoxicity	The environmental impact of this product has not been fully investigated.
Unknown aquatic toxicity	100 % of the mixture consists of component(s) of unknown hazards to the aquatic environment.

Persistence and degradability

Persistence and degradability	No information available.

Bioaccumulative potential

Bioaccumulation	No information available.

Mobility

Mobility in soil	No information available.
Mobility	No information available.

Other adverse effects

Other adverse effects	No information available.

Section 13: DISPOSAL CONSIDERATIONS

Waste treatment methods

Waste from residues/unused products	Dispose of in accordance with local regulations. Dispose of waste in accordance with environmental legislation.
Contaminated packaging	Do not reuse empty containers.

Section 14: TRANSPORT INFORMATION

ADG	Not regulated
IATA	Not regulated
IMDG	Not regulated

Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code
No information available

Section 15: REGULATORY INFORMATION

Regulatory information

National regulations

Australia
See section 8 for national exposure control parameters

Standard for Uniform Scheduling of Medicines and Poisons (SUSMP)
No poisons schedule number allocated

International Inventories

TSCA	Complies
DSL/NDSL	Complies
EINECS/ELINCS	Complies
ENCS	Complies
IECSC	Complies
KECL	Complies
PICCS	Complies
AICS	Complies
NZIoC	Complies

Legend:
TSCA - United States Toxic Substances Control Act Section 8(b) Inventory
DSL/NDSL - Canadian Domestic Substances List/Non-Domestic Substances List
EINECS/ELINCS - European Inventory of Existing Chemical Substances/European List of Notified Chemical Substances
ENCS - Japan Existing and New Chemical Substances
IECSC - China Inventory of Existing Chemical Substances
KECL - Korean Existing and Evaluated Chemical Substances
PICCS - Philippines Inventory of Chemicals and Chemical Substances
AICS - Australian Inventory of Chemical Substances
NZIoC - New Zealand Inventory of Chemicals

International Regulations

Ozone-depleting substances (ODS) Not applicable

Persistent Organic Pollutants Not applicable

Export Notification requirements Not applicable

Section 16: ANY OTHER RELEVANT INFORMATION

Issue Date 12-Apr-2017

Revision Date 02-Aug-2017

Revision Note
No information available.

Key or legend to abbreviations and acronyms used in the safety data sheet

Legend Section 8: EXPOSURE CONTROLS/PERSONAL PROTECTION

TWA	TWA (time-weighted average)	STEL	STEL (Short Term Exposure Limit)
Ceiling	Maximum limit value	*	Skin designation
C	Carcinogen		

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End of Safety Data Sheet

NEWPARK DRILLING FLUIDS

SAFETY DATA SHEET

1. IDENTIFICATION OF THE MATERIAL AND SUPPLIER

1.1 Product identifier

Product name **BARITE POWDER**

Synonyms BARITE (API 13A SECTION 7) ● NEWBAR ● RHEOBAR

1.2 Uses and uses advised against

Uses DRILLING FLUID ADDITIVE ● WEIGHTING AGENT

1.3 Details of the supplier of the product

Supplier name **NEWPARK DRILLING FLUIDS (AUSTRALIA) LTD**

Address 11 Alacrity Place, Henderson, WA, 6166, AUSTRALIA

Telephone +61 8 9410 8200

Fax +61 8 9410 8299

Website www.newpark.com

1.4 Emergency telephone numbers

Emergency 1800 127 406 (Australia); +64 4 917 9888 (International)

2. HAZARDS IDENTIFICATION

2.1 Classification of the substance or mixture

NOT CLASSIFIED AS HAZARDOUS ACCORDING TO SAFE WORK AUSTRALIA CRITERIA

2.2 GHS Label elements

No signal word, pictograms, hazard or precautionary statements have been allocated.

2.3 Other hazards

This product contains a small quantity of quartz, crystalline silica. Prolonged and repeated exposure to concentrations of crystalline silica exceeding the workplace exposure limit (WEL) may lead to chronic lung disease such as silicosis. IARC Monographs, Vol. 68, 1997, concludes that there is sufficient evidence that inhaled crystalline silica in the form of quartz or cristobalite from occupational sources causes cancer in humans. IARC Classification Group I.

3. COMPOSITION/ INFORMATION ON INGREDIENTS

3.1 Substances / Mixtures

Ingredient	CAS Number	EC Number	Content
BARIUM SULPHATE	[redacted]	231-784-4	>89%
QUARTZ (CRYSTALLINE SILICA)	[redacted]	238-878-4	<3%

4. FIRST AID MEASURES

4.1 Description of first aid measures

Eye If in eyes, hold eyelids apart and flush continuously with running water. Continue flushing until advised to stop by a Poisons Information Centre, a doctor, or for at least 15 minutes.

Inhalation If inhaled, remove from contaminated area. Apply artificial respiration if not breathing.

Skin If skin or hair contact occurs, remove contaminated clothing and flush skin and hair with running water. Continue flushing with water until advised to stop by a Poisons Information Centre or a doctor.

Ingestion For advice, contact a Poisons Information Centre on 13 11 26 (Australia Wide) or a doctor (at once).

First aid facilities Eye wash facilities should be available.

4.2 Most important symptoms and effects, both acute and delayed

Repeated exposure to crystalline silica may result in lung fibrosis (silicosis). Principal symptoms of silicosis are coughing and breathlessness. Crystalline silica is classified as carcinogenic to humans (IARC Group 1).

4.3 Immediate medical attention and special treatment needed

Treat symptomatically.

5. FIRE FIGHTING MEASURES

5.1 Extinguishing media

Use an extinguishing agent suitable for the surrounding fire.

5.2 Special hazards arising from the substance or mixture

Non flammable. May evolve toxic gases (sulphur oxides) when heated to decomposition.

5.3 Advice for firefighters

Evacuate area and contact emergency services. Toxic gases may be evolved in a fire situation. Remain upwind and notify those downwind of hazard. Wear full protective equipment including Self Contained Breathing Apparatus (SCBA) when combating fire. Use waterfog to cool intact containers and nearby storage areas.

5.4 Hazchem code

None allocated.

6. ACCIDENTAL RELEASE MEASURES

6.1 Personal precautions, protective equipment and emergency procedures

Wear Personal Protective Equipment (PPE) as detailed in section 8 of the SDS.

6.2 Environmental precautions

Prevent product from entering drains and waterways.

6.3 Methods of cleaning up

Contain spillage, then cover / absorb spill with non-combustible absorbent material (vermiculite, sand, or similar), collect and place in suitable containers for disposal.

6.4 Reference to other sections

See Sections 8 and 13 for exposure controls and disposal.

7. HANDLING AND STORAGE

7.1 Precautions for safe handling

Before use carefully read the product label. Use of safe work practices are recommended to avoid eye or skin contact and inhalation. Observe good personal hygiene, including washing hands before eating. Prohibit eating, drinking and smoking in contaminated areas.

7.2 Conditions for safe storage, including any incompatibilities

Store in a cool, dry, well ventilated area, removed from incompatible substances and foodstuffs. Ensure containers are adequately labelled, protected from physical damage and sealed when not in use.

7.3 Specific end uses

No information provided.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

8.1 Control parameters

Exposure standards

Ingredient	Reference	TWA		STEL	
		ppm	mg/m³	ppm	mg/m³
Barium sulphate	SWA [AUS]	--	10	--	--
Barium sulphate (inhalable)	SWA [Proposed]	--	4	--	--
Barium sulphate (respirable)	SWA [Proposed]	--	1.35	--	--
Quartz (respirable dust)	SWA [AUS]	--	0.1	--	--
Quartz (respirable dust)	SWA [Proposed]	--	0.05	--	--
Quartz (respirable dust)	WorkSafe VIC	--	0.05	--	--

Biological limits No Biological Limit Value allocated.

8.2 Exposure controls

Engineering controls Avoid inhalation. Use in well ventilated areas. Where an inhalation risk exists, mechanical extraction ventilation is recommended.

PPE

Eye / Face Wear dust-proof goggles.

Hands Wear PVC or rubber gloves.

Body When using large quantities or where heavy contamination is likely, wear coveralls.

Respiratory Where an inhalation risk exists, wear a Class P1 (Particulate) respirator.



9. PHYSICAL AND CHEMICAL PROPERTIES

9.1 Information on basic physical and chemical properties

Appearance	OFF-WHITE POWDER
Odour	ODOURLESS
Flammability	NON FLAMMABLE
Flash point	NOT RELEVANT
Boiling point	NOT RELEVANT
Melting point	> 1300°C
Evaporation rate	NOT RELEVANT
pH	8.2 (20% Slurry)
Vapour density	NOT RELEVANT
Specific gravity	4.20
Solubility (water)	INSOLUBLE
Vapour pressure	NOT RELEVANT
Upper explosion limit	NOT RELEVANT
Lower explosion limit	NOT RELEVANT
Partition coefficient	NOT RELEVANT
Autoignition temperature	NOT RELEVANT
Decomposition temperature	NOT RELEVANT
Viscosity	NOT RELEVANT
Explosive properties	NOT EXPLOSIVE
Oxidising properties	NON OXIDISING
Odour threshold	NOT RELEVANT

9.2 Other information

Bulk density ~1.5 kg/L

10. STABILITY AND REACTIVITY

10.1 Reactivity
Carefully review all information provided in sections 10.2 to 10.6.

10.2 Chemical stability
Stable under recommended conditions of storage.

10.3 Possibility of hazardous reactions
Polymerization is not expected to occur.

10.4 Conditions to avoid
Avoid heat, sparks, open flames and other ignition sources.

10.5 Incompatible materials
Incompatible with oxidising agents (e.g. hypochlorites), acids (e.g. nitric acid), alkalis (e.g. sodium hydroxide), heat and ignition sources.

10.6 Hazardous decomposition products
May evolve toxic gases (sulphur oxides) when heated to decomposition.

11. TOXICOLOGICAL INFORMATION

11.1 Information on toxicological effects

Acute toxicity Based on available data, the classification criteria are not met.

Information available for the ingredients:

Ingredient	Oral LD50	Dermal LD50	Inhalation LC50
BARIUM SULPHATE	> 5000 mg/kg (rat)	> 2000 mg/kg (rat)	--

Skin Contact may result in irritation, redness, pain and rash.

Eye Contact may result in irritation, lacrimation, pain, redness and blurring or dimness of vision.

Sensitisation Not classified as causing skin or respiratory sensitisation.

Mutagenicity Not classified as a mutagen.

Carcinogenicity Crystalline silica is classified as carcinogenic to humans (IARC Group 1). However, there is a body of evidence supporting the fact that increased cancer risk would be limited to people already suffering from silicosis.

Reproductive Not classified as a reproductive toxin.

STOT - single exposure Over exposure may result in irritation of the nose and throat, coughing, dizziness, drowsiness and headache.

STOT - repeated exposure Repeated exposure to respirable silica may result in pulmonary fibrosis (silicosis). Silicosis is a fibronodular lung disease caused by deposition in the lungs of fine respirable particles of crystalline silica. Principal symptoms of silicosis are coughing and breathlessness.

Aspiration Not classified as causing aspiration.

12. ECOLOGICAL INFORMATION

12.1 Toxicity
Fish Toxicity: LC50 (Rainbow trout) > 7500 ppm/96hrs; LC50 (Fresh Water Trout) > 21,000 ppm/96hrs; LC50 (Salt Water Stickel Back) > 56,000 ppm/96hrs.

12.2 Persistence and degradability
Barium sulphate (major ingredient of barite (60-100%)) is insoluble in water and not biodegradable.

12.3 Bioaccumulative potential
Not expected to bioaccumulate.

12.4 Mobility in soil
No information provided.

12.5 Other adverse effects
This product is not anticipated to cause adverse effects to animal or plant life if released to the environment in small quantities.

13. DISPOSAL CONSIDERATIONS

13.1 Waste treatment methods

Waste disposal Dispose of to an approved landfill or waste processing site. Contact the manufacturer/supplier for additional information (if required).

Legislation Dispose of in accordance with relevant local legislation.

14. TRANSPORT INFORMATION

NOT CLASSIFIED AS A DANGEROUS GOOD BY THE CRITERIA OF THE ADG CODE, IMDG OR IATA

	LAND TRANSPORT (ADG)	SEA TRANSPORT (IMDG / IMO)	AIR TRANSPORT (IATA / ICAO)
14.1 UN Number	None allocated.	None allocated.	None allocated.
14.2 Proper Shipping Name	None allocated.	None allocated.	None allocated.
14.3 Transport hazard class	None allocated.	None allocated.	None allocated.
14.4 Packing Group	None allocated.	None allocated.	None allocated.

14.5 Environmental hazards

No information provided.

14.6 Special precautions for user

Hazchem code None allocated.

15. REGULATORY INFORMATION

15.1 Safety, health and environmental regulations/legislation specific for the substance or mixture

Poison schedule A poison schedule number has not been allocated to this product using the criteria in the Standard for the Uniform Scheduling of Medicines and Poisons (SUSMP).

Classifications Safework Australia criteria is based on the Globally Harmonised System (GHS) of Classification and Labelling of Chemicals.

Inventory listings **AUSTRALIA: AICS (Australian Inventory of Chemical Substances)**
All components are listed on AICS, or are exempt.

16. OTHER INFORMATION

Additional information

RESPIRATORS: In general the use of respirators should be limited and engineering controls employed to avoid exposure. If respiratory equipment must be worn ensure correct respirator selection and training is undertaken. Remember that some respirators may be extremely uncomfortable when used for long periods. The use of air powered or air supplied respirators should be considered where prolonged or repeated use is necessary.

PERSONAL PROTECTIVE EQUIPMENT GUIDELINES:
The recommendation for protective equipment contained within this report is provided as a guide only. Factors such as form of product, method of application, working environment, quantity used, product concentration and the availability of engineering controls should be considered before final selection of personal protective equipment is made.

HEALTH EFFECTS FROM EXPOSURE:
It should be noted that the effects from exposure to this product will depend on several factors including: form of product; frequency and duration of use; quantity used; effectiveness of control measures; protective equipment used and method of application. Given that it is impractical to prepare a report which would encompass all possible scenarios, it is anticipated that users will assess the risks and apply control methods where appropriate.

Abbreviations

ACGIH	American Conference of Governmental Industrial Hygienists
CAS #	Chemical Abstract Service number - used to uniquely identify chemical compounds
CNS	Central Nervous System
EC No.	EC No - European Community Number
EMS	Emergency Schedules (Emergency Procedures for Ships Carrying Dangerous Goods)
GHS	Globally Harmonized System
GTEPG	Group Text Emergency Procedure Guide
IARC	International Agency for Research on Cancer
LC50	Lethal Concentration, 50% / Median Lethal Concentration
LD50	Lethal Dose, 50% / Median Lethal Dose
mg/m³	Milligrams per Cubic Metre
OEL	Occupational Exposure Limit
pH	relates to hydrogen ion concentration using a scale of 0 (high acidic) to 14 (highly alkaline).
ppm	Parts Per Million
STEL	Short-Term Exposure Limit
STOT-RE	Specific target organ toxicity (repeated exposure)
STOT-SE	Specific target organ toxicity (single exposure)
SUSMP	Standard for the Uniform Scheduling of Medicines and Poisons
SWA	Safe Work Australia
TLV	Threshold Limit Value
TWA	Time Weighted Average

Report status

This document has been compiled by RMT on behalf of the manufacturer, importer or supplier of the product and serves as their Safety Data Sheet ('SDS').

It is based on information concerning the product which has been provided to RMT by the manufacturer, importer or supplier or obtained from third party sources and is believed to represent the current state of knowledge as to the appropriate safety and handling precautions for the product at the time of issue. Further clarification regarding any aspect of the product should be obtained directly from the manufacturer, importer or supplier.

While RMT has taken all due care to include accurate and up-to-date information in this SDS, it does not provide any warranty as to accuracy or completeness. As far as lawfully possible, RMT accepts no liability for any loss, injury or damage (including consequential loss) which may be suffered or incurred by any person as a consequence of their reliance on the information contained in this SDS.

Prepared by

Risk Management Technologies
5 Ventnor Ave, West Perth
Western Australia 6005
Phone: +61 8 9322 1711
Fax: +61 8 9322 1794
Email: info@rmt.com.au
Web: www.rmtglobal.com

[End of SDS]

NEWPARK DRILLING FLUIDS

SAFETY DATA SHEET

1. IDENTIFICATION OF THE MATERIAL AND SUPPLIER

1.1 Product identifier

Product name **CALCIUM CHLORIDE POWDER 94-97%**

Synonyms CALCIUM CHLORIDE ANHYDRATE

1.2 Uses and uses advised against

Uses CONCRETE CONDITIONER ● DESICCANT ● DUST CONTROL AGENT ● FOOD ADDITIVE ● INDUSTRIAL APPLICATIONS

1.3 Details of the supplier of the product

Supplier name **NEWPARK DRILLING FLUIDS (AUSTRALIA) LTD**

Address 11 Alacrity Place, Henderson, WA, 6166, AUSTRALIA

Telephone +61 8 9410 8200

Fax +61 8 9410 8299

Website www.newpark.com

1.4 Emergency telephone numbers

Emergency 1800 127 406 (Australia); +64 4 917 9888 (International)

2. HAZARDS IDENTIFICATION

2.1 Classification of the substance or mixture

CLASSIFIED AS HAZARDOUS ACCORDING TO SAFE WORK AUSTRALIA CRITERIA

Physical Hazards

Not classified as a Physical Hazard

Health Hazards

Serious Eye Damage / Eye Irritation: Category 2A

Environmental Hazards

Not classified as an Environmental Hazard

2.2 GHS Label elements

Signal word **WARNING**

Pictograms



Hazard statements

H319 Causes serious eye irritation.

Prevention statements

P264 Wash thoroughly after handling.

P280 Wear protective gloves/protective clothing/eye protection/face protection.

Response statements

P305 + P351 + P338 IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.

P337 + P313 If eye irritation persists: Get medical advice/attention.

Storage statements
None allocated.

Disposal statements
None allocated.

2.3 Other hazards
No information provided.

3. COMPOSITION/ INFORMATION ON INGREDIENTS

3.1 Substances / Mixtures

Ingredient	CAS Number	EC Number	Content
CALCIUM CHLORIDE ANHYDROUS	[redacted]	233-140-8	94 to 97%
SODIUM CHLORIDE	[redacted]	231-598-3	1 to 5%
WATER	[redacted]	231-791-2	1%

4. FIRST AID MEASURES

4.1 Description of first aid measures

Eye If in eyes, hold eyelids apart and flush continuously with running water. Continue flushing until advised to stop by a Poisons Information Centre, a doctor, or for at least 15 minutes.

Inhalation If inhaled, remove from contaminated area. Apply artificial respiration if not breathing.

Skin If skin or hair contact occurs, remove contaminated clothing and flush skin and hair with running water. Continue flushing with water until advised to stop by a Poisons Information Centre or a doctor.

Ingestion For advice, contact a Poisons Information Centre on 13 11 26 (Australia Wide) or a doctor (at once). If swallowed, do not induce vomiting.

First aid facilities Eye wash facilities and safety shower should be available.

4.2 Most important symptoms and effects, both acute and delayed
Irritating to the eyes and skin.

4.3 Immediate medical attention and special treatment needed
Treat symptomatically.

5. FIRE FIGHTING MEASURES

5.1 Extinguishing media
Use an extinguishing agent suitable for the surrounding fire.

5.2 Special hazards arising from the substance or mixture
Non flammable. May evolve toxic gases (chlorides) when heated to decomposition.

5.3 Advice for firefighters
Treat as per requirements for surrounding fires. Evacuate area and contact emergency services. Remain upwind and notify those downwind of hazard. Wear full protective equipment including Self Contained Breathing Apparatus (SCBA) when combating fire. Use waterfog to cool intact containers and nearby storage areas.

5.4 Hazchem code
None allocated.

6. ACCIDENTAL RELEASE MEASURES

6.1 Personal precautions, protective equipment and emergency procedures
Wear Personal Protective Equipment (PPE) as detailed in section 8 of the SDS. Clear area of all unprotected personnel. Contact emergency services where appropriate.

6.2 Environmental precautions
Prevent product from entering drains and waterways.

6.3 Methods of cleaning up
Contain spillage, then collect and place in suitable containers for reuse or disposal. Avoid generating dust.

6.4 Reference to other sections
See Sections 8 and 13 for exposure controls and disposal.

7. HANDLING AND STORAGE

7.1 Precautions for safe handling
Before use carefully read the product label. Use of safe work practices are recommended to avoid eye or skin contact and inhalation. Observe good personal hygiene, including washing hands before eating. Prohibit eating, drinking and smoking in contaminated areas.

7.2 Conditions for safe storage, including any incompatibilities
Store in a cool, dry, well ventilated area, removed from incompatible substances, heat or ignition sources and foodstuffs. Ensure containers are adequately labelled, protected from physical damage and sealed when not in use.

7.3 Specific end uses
No information provided.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

8.1 Control parameters
Exposure standards

No exposure standards have been entered for this product.

Biological limits No Biological Limit Value allocated.

8.2 Exposure controls
Engineering controls Avoid inhalation. Use in well ventilated areas. Where an inhalation risk exists, mechanical extraction ventilation is recommended. Maintain dust levels below the recommended exposure standard.

PPE

Eye / Face	Wear dust-proof goggles.
Hands	Wear PVC or rubber gloves.
Body	When using large quantities or where heavy contamination is likely, wear coveralls.
Respiratory	Where an inhalation risk exists, wear a Class P1 (Particulate) respirator.



9. PHYSICAL AND CHEMICAL PROPERTIES

9.1 Information on basic physical and chemical properties

Appearance	WHITE POWDER
Odour	ODOURLESS
Flammability	NON FLAMMABLE
Flash point	NOT RELEVANT
Boiling point	> 1600°C
Melting point	772°C
Evaporation rate	NOT RELEVANT
pH	7.0 to 9.0
Vapour density	NOT AVAILABLE
Specific gravity	2.15
Solubility (water)	590 kg/m³ (Approximately)
Vapour pressure	NOT AVAILABLE
Upper explosion limit	NOT RELEVANT
Lower explosion limit	NOT RELEVANT

9.1 Information on basic physical and chemical properties

Partition coefficient	NOT AVAILABLE
Autoignition temperature	NOT AVAILABLE
Decomposition temperature	NOT AVAILABLE
Viscosity	NOT AVAILABLE
Explosive properties	NOT AVAILABLE
Oxidising properties	NOT AVAILABLE
Odour threshold	NOT AVAILABLE

10. STABILITY AND REACTIVITY

10.1 Reactivity

Carefully review all information provided in sections 10.2 to 10.6.

10.2 Chemical stability

Stable under recommended conditions of storage.

10.3 Possibility of hazardous reactions

Polymerization is not expected to occur.

10.4 Conditions to avoid

Avoid contact with incompatible substances.

10.5 Incompatible materials

Incompatible with acids (e.g. nitric acid), methyl vinyl ether, zinc/ galvanised metals, bromine trifluoride, boron oxide and calcium oxide. May react exothermically with water (i.e. releasing heat).

10.6 Hazardous decomposition products

May evolve toxic gases (chlorides) when heated to decomposition.

11. TOXICOLOGICAL INFORMATION

11.1 Information on toxicological effects

Acute toxicity

Based on available data, the classification criteria are not met. Toxicity Data available for the ingredients:
CALCIUM CHLORIDE ANHYDROUS (10043-52-4):
LD50 (Ingestion): 1000 mg/kg (rat)
LD50 (Intraperitoneal): 210 mg/kg (mouse)
LD50 (Intravenous): 42 mg/kg (mouse)
LD50 (Subcutaneous): 823 mg/kg (mouse)
LDLo (Ingestion): 1384 mg/kg (rabbit)
LDLo (Intravenous): 150 mg/kg (guinea pig)
LDLo (Subcutaneous): 249 mg/kg (cat)
TDLo (Intravenous): 20 mg/kg/1 hour (woman)
SODIUM CHLORIDE (7647-14-5):
LC50 (Inhalation): > 42000 mg/m3/1 hour (rat)
LD50 (Ingestion): 3000 mg/kg (rat)
LD50 (Intraperitoneal): 2602 mg/kg (mouse)
LD50 (Intravenous): 645 mg/kg (mouse)
LD50 (Skin): > 10000 mg/kg (rabbit)
LD50 (Subcutaneous): 3000 mg/kg (mouse)
LDLo (Ingestion): 8000 mg/kg (rabbit)
LDLo (Intravenous): 300 mg/kg (guinea pig)
LDLo (Subcutaneous): 2160 mg/kg (guinea pig)
TDLo (Ingestion): 12357 mg/kg (human)

Information available for the ingredients:

Ingredient	Oral LD50	Dermal LD50	Inhalation LC50
CALCIUM CHLORIDE ANHYDROUS	2301 mg/kg (rat)	> 5000 mg/kg (rabbit)	--
SODIUM CHLORIDE	3000 mg/kg (rat)	> 10000 mg/kg (rabbit)	> 42000 mg/m³/1 hour (rat)

Additional ingredient toxicity values:

SODIUM CHLORIDE (7647-14-5)

LD50 (intraperitoneal)	2602 mg/kg (mouse)
LD50 (intravenous)	645 mg/kg (mouse)
LD50 (subcutaneous)	3000 mg/kg (mouse)
LDLo (intravenous)	300 mg/kg (guinea pig)
LDLo (oral)	8000 mg/kg (rabbit)
LDLo (subcutaneous)	2160 mg/kg (guinea pig)
TDLo (oral)	12357 mg/kg (human)

Skin	Not classified as a skin irritant. Contact may result in mechanical irritation, redness and rash.
Eye	Causes serious eye irritation. Contact may result in irritation, lacrimation, pain and redness.
Sensitisation	Not classified as causing skin or respiratory sensitisation.
Mutagenicity	Insufficient data available to classify as a mutagen.
Carcinogenicity	Insufficient data available to classify as a carcinogen.
Reproductive	Insufficient data available to classify as a reproductive toxin.
STOT - single exposure	Not classified as causing organ damage from single exposure.
STOT - repeated exposure	Not classified as causing organ damage from repeated exposure.
Aspiration	This product does not present an aspiration hazard.

12. ECOLOGICAL INFORMATION

12.1 Toxicity

No information provided.

12.2 Persistence and degradability

Biodegradability does not pertain to inorganic substances.

12.3 Bioaccumulative potential

This product does not bioaccumulate.

12.4 Mobility in soil

No information provided.

12.5 Other adverse effects

No information provided.

13. DISPOSAL CONSIDERATIONS

13.1 Waste treatment methods

Waste disposal	Ensure product is covered with moist soil to prevent dust generation and dispose of to approved Council landfill. Contact the manufacturer/supplier for additional information (if required).
Legislation	Dispose of in accordance with relevant local legislation.

14. TRANSPORT INFORMATION

NOT CLASSIFIED AS A DANGEROUS GOOD BY THE CRITERIA OF THE ADG CODE, IMDG OR IATA

	LAND TRANSPORT (ADG)	SEA TRANSPORT (IMDG / IMO)	AIR TRANSPORT (IATA / ICAO)
14.1 UN Number	None allocated.	None allocated.	None allocated.
14.2 Proper Shipping Name	None allocated.	None allocated.	None allocated.
14.3 Transport hazard class	None allocated.	None allocated.	None allocated.
14.4 Packing Group	None allocated.	None allocated.	None allocated.

14.5 Environmental hazards

No information provided.

14.6 Special precautions for user

Hazchem code None allocated.

15. REGULATORY INFORMATION

15.1 Safety, health and environmental regulations/legislation specific for the substance or mixture

Poison schedule A poison schedule number has not been allocated to this product using the criteria in the Standard for the Uniform Scheduling of Medicines and Poisons (SUSMP).

Classifications Safework Australia criteria is based on the Globally Harmonised System (GHS) of Classification and Labelling of Chemicals.

Inventory listings **AUSTRALIA: AICS (Australian Inventory of Chemical Substances)**
All components are listed on AICS, or are exempt.

16. OTHER INFORMATION

Additional information

RESPIRATORS: In general the use of respirators should be limited and engineering controls employed to avoid exposure. If respiratory equipment must be worn ensure correct respirator selection and training is undertaken. Remember that some respirators may be extremely uncomfortable when used for long periods. The use of air powered or air supplied respirators should be considered where prolonged or repeated use is necessary.

PERSONAL PROTECTIVE EQUIPMENT GUIDELINES:
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HEALTH EFFECTS FROM EXPOSURE:
It should be noted that the effects from exposure to this product will depend on several factors including: form of product; frequency and duration of use; quantity used; effectiveness of control measures; protective equipment used and method of application. Given that it is impractical to prepare a report which would encompass all possible scenarios, it is anticipated that users will assess the risks and apply control methods where appropriate.

Abbreviations

ACGIH	American Conference of Governmental Industrial Hygienists
CAS #	Chemical Abstract Service number - used to uniquely identify chemical compounds
CNS	Central Nervous System
EC No.	EC No - European Community Number
EMS	Emergency Schedules (Emergency Procedures for Ships Carrying Dangerous Goods)
GHS	Globally Harmonized System
GTEPG	Group Text Emergency Procedure Guide
IARC	International Agency for Research on Cancer
LC50	Lethal Concentration, 50% / Median Lethal Concentration
LD50	Lethal Dose, 50% / Median Lethal Dose
mg/m³	Milligrams per Cubic Metre
OEL	Occupational Exposure Limit
pH	relates to hydrogen ion concentration using a scale of 0 (high acidic) to 14 (highly alkaline).
ppm	Parts Per Million
STEL	Short-Term Exposure Limit
STOT-RE	Specific target organ toxicity (repeated exposure)
STOT-SE	Specific target organ toxicity (single exposure)
SUSMP	Standard for the Uniform Scheduling of Medicines and Poisons
SWA	Safe Work Australia
TLV	Threshold Limit Value
TWA	Time Weighted Average

Report status

This document has been compiled by RMT on behalf of the manufacturer, importer or supplier of the product and serves as their Safety Data Sheet ('SDS').

It is based on information concerning the product which has been provided to RMT by the manufacturer, importer or supplier or obtained from third party sources and is believed to represent the current state of knowledge as to the appropriate safety and handling precautions for the product at the time of issue. Further clarification regarding any aspect of the product should be obtained directly from the manufacturer, importer or supplier.

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Prepared by

Risk Management Technologies
5 Ventnor Ave, West Perth
Western Australia 6005
Phone: +61 8 9322 1711
Fax: +61 8 9322 1794
Email: info@rmt.com.au
Web: www.rmtglobal.com

[End of SDS]

NEWPARK DRILLING FLUIDS

SAFETY DATA SHEET

1. IDENTIFICATION OF THE MATERIAL AND SUPPLIER

1.1 Product identifier

Product name **CAUSTIC SODA**

Synonyms SODIUM HYDROXIDE SOLID

1.2 Uses and uses advised against

Uses MANUFACTURE OF CHEMICALS ● REAGENT ● SCRUBBING AGENT

1.3 Details of the supplier of the product

Supplier name **NEWPARK DRILLING FLUIDS (AUSTRALIA) LTD**

Address 11 Alacrity Place, Henderson, WA, 6166, AUSTRALIA

Telephone +61 8 9410 8200

Fax +61 8 9410 8299

Website www.newpark.com

1.4 Emergency telephone numbers

Emergency 1800 127 406 (Australia); +64 4 917 9888 (International)

2. HAZARDS IDENTIFICATION

2.1 Classification of the substance or mixture

CLASSIFIED AS HAZARDOUS ACCORDING TO SAFE WORK AUSTRALIA CRITERIA

Physical Hazards

Not classified as a Physical Hazard

Health Hazards

Skin Corrosion/Irritation: Category 1A

Environmental Hazards

Not classified as an Environmental Hazard

2.2 GHS Label elements

Signal word **DANGER**

Pictograms



Hazard statements

H314 Causes severe skin burns and eye damage.

Prevention statements

P260 Do not breathe dust/fume/gas/mist/vapours/spray.
P264 Wash thoroughly after handling.
P280 Wear protective gloves/protective clothing/eye protection/face protection.

Response statements

P301 + P330 + P331	IF SWALLOWED: Rinse mouth. Do NOT induce vomiting.
P303 + P361 + P353	IF ON SKIN (or hair): Remove/Take off immediately all contaminated clothing. Rinse skin with water/shower.
P304 + P340	IF INHALED: Remove to fresh air and keep at rest in a position comfortable for breathing.
P305 + P351 + P338	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
P310	Immediately call a POISON CENTER or doctor/physician.
P321	Specific treatment is advised - see first aid instructions.
P363	Wash contaminated clothing before reuse.

Storage statements

P405	Store locked up.

Disposal statements

P501	Dispose of contents/container in accordance with relevant regulations.

2.3 Other hazards

No information provided.

3. COMPOSITION/ INFORMATION ON INGREDIENTS

3.1 Substances / Mixtures

Ingredient	CAS Number	EC Number	Content
SODIUM HYDROXIDE	[redacted]	215-185-5	>99%

4. FIRST AID MEASURES

4.1 Description of first aid measures

Eye If in eyes, hold eyelids apart and flush continuously with running water. Continue flushing until advised to stop by a Poisons Information Centre, a doctor, or for at least 15 minutes.

Inhalation If inhaled, remove from contaminated area. To protect rescuer, use an Air-line respirator where an inhalation risk exists. Apply artificial respiration if not breathing.

Skin If skin or hair contact occurs, remove contaminated clothing and flush skin and hair with running water. Continue flushing with water until advised to stop by a Poisons Information Centre or a doctor.

Ingestion For advice, contact a Poisons Information Centre on 13 11 26 (Australia Wide) or a doctor (at once). If swallowed, do not induce vomiting.

First aid facilities Eye wash facilities and safety shower should be available.

4.2 Most important symptoms and effects, both acute and delayed

Causes severe skin burns and eye damage.

4.3 Immediate medical attention and special treatment needed

CORROSIVE POISONING TREATMENT: Immediate treatment preferably in a hospital is mandatory. In treating corrosive poisoning, DO NOT INDUCE VOMITING; DO NOT ATTEMPT GASTRIC LAVAGE; and DO NOT ATTEMPT TO NEUTRALISE THE CORROSIVE SUBSTANCE. Vomiting will increase the severity of damage to the oesophagus as the corrosive substance will again come in contact with it. Attempting gastric lavage may result in perforating either the oesophagus or stomach. Immediately dilute the corrosive substance by having the patient drink milk or water. If the trachea has been damaged tracheostamy may be required. For oesophageal burns begin broad-spectrum antibiotics and corticosteroid therapy. Intravenous fluids will be required if oesophageal or gastric damage prevents ingestion of liquids. Long-range therapy will be directed toward preventing or treating oesophageal scars and strictures.

5. FIRE FIGHTING MEASURES

5.1 Extinguishing media

Use an extinguishing agent suitable for the surrounding fire. Use carbon dioxide or suitable dry chemical extinguisher. Do NOT use water.

5.2 Special hazards arising from the substance or mixture

Non flammable. May evolve flammable hydrogen gas in contact with some metals. Direct contact with water can produce a violent exothermic reaction.

5.3 Advice for firefighters

Treat as per requirements for surrounding fires. Evacuate area and contact emergency services. Remain upwind and notify those downwind of hazard. Wear full protective equipment including Self Contained Breathing Apparatus (SCBA) when combating fire. Use waterfog to cool intact containers and nearby storage areas.

5.4 Hazchem code

2X

2 Fine Water Spray.

X Wear liquid-tight chemical protective clothing and breathing apparatus. Contain spill and run-off.

6. ACCIDENTAL RELEASE MEASURES

6.1 Personal precautions, protective equipment and emergency procedures

Wear Personal Protective Equipment (PPE) as detailed in section 8 of the SDS. Allow only trained personnel wearing appropriate protective equipment to be involved in spill response. Avoid accidents, clean up immediately. Increase ventilation. Avoid walking through spilled product as it is slippery when spilt. Isolate the danger area. Use clean, non-sparking tools and equipment. Shut off all possible sources of ignition.

6.2 Environmental precautions

Prevent product from entering drains and waterways.

6.3 Methods of cleaning up

Mechanically collect as much of the spill as possible. Absorb with sand, earth or clay. Transfer to suitable, labelled, corrosion-resistant containers and dispose of promptly as hazardous waste. Spill on areas other than pavement, dirt or sand may be handled by removing the affected soils and placing into approved containers.

6.4 Reference to other sections

See Sections 8 and 13 for exposure controls and disposal.

7. HANDLING AND STORAGE

7.1 Precautions for safe handling

Ensure an eye bath and safety shower are available and ready for use. Observe good personal hygiene practices and recommended procedures. Wash thoroughly after handling. Take precautionary measures against static discharges by bonding and grounding equipment. Avoid contact with eyes, skin and clothing. Do not inhale product vapours. Avoid prolonged or repeated exposure. Do not smoke, eat or drink when handling product. Product can react violently with water and acids. Caustic solution generates heat when further diluted with water. Concentrations greater than 40%, the heat generated can raise temperatures above the boiling point resulting in sporadic, violent eruptions or spattering. Emergency showers and eye-washes must be available. When used in its various applications, the product must be prevented from coming into uncontrolled direct contact with other products such as acids and metals. Never neutralise the solid product.

7.2 Conditions for safe storage, including any incompatibilities

Store in a cool, dry, well-ventilated area. Keep containers tightly closed when not in use. Inspect regularly for deficiencies such as damage or leaks. Protect against physical damage. Store away from incompatible materials as listed in section 10. Store away from aluminium, tin, zinc and alloys (bronzes), chrome and lead. Protect from damp and kept apart from acids, halogenated hydrocarbons, nitroparaffins, etc. The floor must be waterproof and anti-slip. A water supply or source must be provided in the place of storage. Emergency showers and eye-washes must be available. Special conditions: Prevent the product from becoming damp or erated. Hygroscopic product. Becomes carbonated in contact with the air or moisture.

7.3 Specific end uses

No information provided.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

8.1 Control parameters

Exposure standards

Ingredient	Reference	TWA		STEL	
		ppm	mg/m³	ppm	mg/m³
Sodium hydroxide (peak limitation)	SWA [AUS]	--	2 (Peak)	--	--

Biological limits

No biological limit values have been entered for this product.

8.2 Exposure controls

Engineering controls Avoid inhalation. Use in well ventilated areas. Where an inhalation risk exists, mechanical extraction ventilation is recommended. Maintain dust levels below the recommended exposure standard.

PPE

Eye / Face	Wear a faceshield and dust-proof goggles.
Hands	Wear PVC or rubber gloves.
Body	Wear coveralls and rubber boots and a PVC apron.
Respiratory	Where an inhalation risk exists, wear a Class P1 (Particulate) respirator. At high dust levels, wear an Air-line respirator or a Full-face Class P3 (Particulate) respirator.



9. PHYSICAL AND CHEMICAL PROPERTIES

9.1 Information on basic physical and chemical properties

Appearance	WHITE DELIQUESCENT PEARLS
Odour	ODOURLESS
Flammability	NON FLAMMABLE
Flash point	NOT RELEVANT
Boiling point	1390°C
Melting point	318°C
Evaporation rate	NOT AVAILABLE
pH	13.5 (1 % solution)
Vapour density	NOT AVAILABLE
Specific gravity	2.12
Solubility (water)	1110 kg/m³ @ 20°C
Vapour pressure	NOT AVAILABLE
Upper explosion limit	NOT RELEVANT
Lower explosion limit	NOT RELEVANT
Partition coefficient	NOT AVAILABLE
Autoignition temperature	NOT AVAILABLE
Decomposition temperature	NOT AVAILABLE
Viscosity	NOT AVAILABLE
Explosive properties	NOT AVAILABLE
Oxidising properties	NOT AVAILABLE
Odour threshold	NOT AVAILABLE

10. STABILITY AND REACTIVITY

10.1 Reactivity

Highly exothermal reaction with strong acids. Reacts dangerously with acetic acid, allyl chloride, chlorine trifluoride, chloroform, methylic alcohol, chloronitrotoluene, chlorosulphonic acid, glyoxal, cyanohydrin, hydrochloric acid, hydrofluoric acid, hydroquinone, nitric acid, sulphuric acid and oleum, nitropropane, phosphorous, propiolactone, phosphorous pentoxide, tetrachlorobenzene, tetrahydrofuran, etc. Caustic soda forms salts with nitromethane and nitroparaffins that explode on impact. Heat is generated when mixed with water. Spattering and boiling can occur. Caustic soda solution reacts readily with various reducing sugars (ie: fructose, glactose, maltose, dry whey solids) to produce carbon monoxide. Caustic soda forms salts with nitromethane and nitroparaffins that explode on impact. Reacts with aluminium, tin, zinc and their alloys, copper, lead, etc. giving off hydrogen.

10.2 Chemical stability

Stable under recommended conditions of storage.

10.3 Possibility of hazardous reactions

Polymerization is not expected to occur.

10.4 Conditions to avoid

Avoid heat, sparks, open flames and other ignition sources.

10.5 Incompatible materials

Incompatible with oxidising agents (e.g. hypochlorites), acids (e.g. nitric acid), metals, heat and ignition sources.

10.6 Hazardous decomposition products

Reacts with aluminium, tin, zinc and their alloys, copper, lead, etc. giving off hydrogen. When the product decomposes, toxic sodium oxide gases are evolved.

11. TOXICOLOGICAL INFORMATION

11.1 Information on toxicological effects

Acute toxicity

Highly corrosive. This product has the potential to cause serious adverse health effects. Use safe work practices to avoid eye or skin contact and inhalation. Over exposure may result in severe burns with corrosive tissue damage. Upon dilution, the potential for corrosive effects may be reduced.

SODIUM HYDROXIDE (1310-73-2):
LD50 (Intraperitoneal): 40 mg/kg (mouse)
LDLo (Ingestion): 1.57 mg/kg (human)

Additional ingredient toxicity values:

SODIUM HYDROXIDE (1310-73-2)

LD50 (intraperitoneal)	40 mg/kg (mouse)
LDLo (oral)	500 mg/kg (rabbit)

Skin

Causes severe burns. Contact may result in irritation, redness, pain, rash, dermatitis and skin burns.

Eye

Causes severe burns. Contact may result in irritation, lacrimation, pain, redness and corneal burns with possible permanent eye damage.

Sensitisation

Not classified as causing skin or respiratory sensitisation.

Mutagenicity

Insufficient data available to classify as a mutagen. Both the in vitro and the in vivo genetic toxicity tests indicated no evidence of mutagenic activity. Furthermore the substance is not expected to be systemically available in the body under normal handling and use conditions and for this reason additional testing is considered unnecessary (EU RAR, 2007).

Carcinogenicity

Not classified as a carcinogen. Insufficient data available to classify as a carcinogen. Systemic carcinogenicity is not expected to occur because the substance is not expected to be systemically available in the body under normal handling and use conditions.

Reproductive

Not classified as a reproductive toxin. Insufficient data available to classify as a reproductive toxin. The substance is not expected to be systemically available in the body under normal handling and use conditions and for this reason it can be stated that the substance will not reach the foetus nor reach male and female reproductive organs. The substance is not expected to be systemically available in the body under normal handling and use conditions and for this reason additional testing is considered unnecessary.

STOT - single exposure

Over exposure may result in irritation of the nose and throat, with coughing. High level exposure may result in breathing difficulties.

STOT - repeated exposure

Not classified as causing organ damage from repeated exposure.

Aspiration

This product does not present an aspiration hazard.

12. ECOLOGICAL INFORMATION

12.1 Toxicity

EC50 Ceriodaphnia: 40 mg/L.

No other valid studies available. The hazard of NaOH for the environment is caused by the hydroxyl ion (pH effect). For this reason the effect of NaOH on the organisms depends on the buffer capacity of the aquatic or terrestrial ecosystem (see also 3.1.2). Also the variation in acute toxicity for aquatic organisms can be explained for a significant extent by the variation in buffer capacity of the test medium. LC50 values ranged between 33 and 189 mg/L.

12.2 Persistence and degradability

Readily biodegradable. NaOH is a strong alkaline substance that dissociates completely in water to Na+ and OH-. High water solubility and low vapour pressure indicate that NaOH will be found predominantly in aquatic environment. This implies that it will not adsorb on particulate matter or surfaces. Atmospheric emissions as aerosols are rapidly neutralized by carbon dioxide and the salts will be washed out by rain.

12.3 Bioaccumulative potential

Does not bioaccumulate. Considering its high water solubility, NaOH is not expected to bioconcentrate in organisms. In addition, sodium is a naturally-occurring element that is prevalent in the environment and to which organisms are exposed regularly, for which they have some capacity to regulate the concentration in the organism.

12.4 Mobility in soil

High water solubility and mobility

12.5 Other adverse effects

WATER: If released to waterways, alkaline products may change the pH of the waterway. Fish will die if the pH reaches 10-11 (goldfish 10.9, bluegill 10.5). SOIL: May leach to groundwater with toxic effects on aquatic life as above. ATMOSPHERE: Not expected to reside in the atmosphere. Drops or particles released to atmosphere should be removed by gravity and/or be rained out.

13. DISPOSAL CONSIDERATIONS

13.1 Waste treatment methods

Waste disposal Collect without generating dust. Place in clean, sealed containers and dispose of to an approved landfill site. Contact the manufacturer/supplier for additional information (if required). The product can be neutralised using highly diluted hydrochloric acid, which should be added very slowly by specialised personnel wearing proper protection. Never neutralise the solid product.

Legislation Dispose of in accordance with relevant local legislation.

14. TRANSPORT INFORMATION

CLASSIFIED AS A DANGEROUS GOOD BY THE CRITERIA OF THE ADG CODE



	LAND TRANSPORT (ADG)	SEA TRANSPORT (IMDG / IMO)	AIR TRANSPORT (IATA / ICAO)
14.1 UN Number	1823	1823	1823
14.2 Proper Shipping Name	SODIUM HYDROXIDE, SOLID	SODIUM HYDROXIDE, SOLID	SODIUM HYDROXIDE, SOLID
14.3 Transport hazard class	8	8	8
14.4 Packing Group	II	II	II

14.5 Environmental hazards

No information provided.

14.6 Special precautions for user

Hazchem code 2X

GTEPG 8A1

EmS F-A, S-B

15. REGULATORY INFORMATION

15.1 Safety, health and environmental regulations/legislation specific for the substance or mixture

Poison schedule Classified as a Schedule 6 (S6) Standard for the Uniform Scheduling of Medicines and Poisons (SUSMP).

Classifications Safework Australia criteria is based on the Globally Harmonised System (GHS) of Classification and Labelling of Chemicals.

Inventory listings **AUSTRALIA: AICS (Australian Inventory of Chemical Substances)**
All components are listed on AICS, or are exempt.

16. OTHER INFORMATION

Additional information

PERSONAL PROTECTIVE EQUIPMENT GUIDELINES:
The recommendation for protective equipment contained within this report is provided as a guide only. Factors such as form of product, method of application, working environment, quantity used, product concentration and the availability of engineering controls should be considered before final selection of personal protective equipment is made.

HEALTH EFFECTS FROM EXPOSURE:
It should be noted that the effects from exposure to this product will depend on several factors including: form of product; frequency and duration of use; quantity used; effectiveness of control measures; protective equipment used and method of application. Given that it is impractical to prepare a report which would encompass all possible scenarios, it is anticipated that users will assess the risks and apply control methods where appropriate.

Abbreviations

ACGIH	American Conference of Governmental Industrial Hygienists
CAS #	Chemical Abstract Service number - used to uniquely identify chemical compounds
CNS	Central Nervous System
EC No.	EC No - European Community Number
EMS	Emergency Schedules (Emergency Procedures for Ships Carrying Dangerous Goods)
GHS	Globally Harmonized System
GTEPG	Group Text Emergency Procedure Guide
IARC	International Agency for Research on Cancer
LC50	Lethal Concentration, 50% / Median Lethal Concentration
LD50	Lethal Dose, 50% / Median Lethal Dose
mg/m³	Milligrams per Cubic Metre
OEL	Occupational Exposure Limit
pH	relates to hydrogen ion concentration using a scale of 0 (high acidic) to 14 (highly alkaline).
ppm	Parts Per Million
STEL	Short-Term Exposure Limit
STOT-RE	Specific target organ toxicity (repeated exposure)
STOT-SE	Specific target organ toxicity (single exposure)
SUSMP	Standard for the Uniform Scheduling of Medicines and Poisons
SWA	Safe Work Australia
TLV	Threshold Limit Value
TWA	Time Weighted Average

Report status

This document has been compiled by RMT on behalf of the manufacturer, importer or supplier of the product and serves as their Safety Data Sheet ('SDS').

It is based on information concerning the product which has been provided to RMT by the manufacturer, importer or supplier or obtained from third party sources and is believed to represent the current state of knowledge as to the appropriate safety and handling precautions for the product at the time of issue. Further clarification regarding any aspect of the product should be obtained directly from the manufacturer, importer or supplier.

While RMT has taken all due care to include accurate and up-to-date information in this SDS, it does not provide any warranty as to accuracy or completeness. As far as lawfully possible, RMT accepts no liability for any loss, injury or damage (including consequential loss) which may be suffered or incurred by any person as a consequence of their reliance on the information contained in this SDS.

Prepared by

Risk Management Technologies
5 Ventnor Ave, West Perth
Western Australia 6005
Phone: +61 8 9322 1711
Fax: +61 8 9322 1794
Email: info@rmt.com.au
Web: www.rmtglobal.com

[End of SDS]

NEWPARK DRILLING FLUIDS

SAFETY DATA SHEET

1. IDENTIFICATION OF THE MATERIAL AND SUPPLIER

1.1 Product identifier

Product name **CIRCAL**

Synonyms CALCIUM CARBONATE ● LIMESTONE ● MARBLE ● OMYACARB ● RHEOCARB

1.2 Uses and uses advised against

Uses DRILLING FLUID ADDITIVE ● WEIGHTING AGENT

1.3 Details of the supplier of the product

Supplier name **NEWPARK DRILLING FLUIDS (AUSTRALIA) LTD**

Address 11 Alacrity Place, Henderson, WA, 6166, AUSTRALIA

Telephone +61 8 9410 8200

Fax +61 8 9410 8299

Website www.newpark.com

1.4 Emergency telephone numbers

Emergency 1800 127 406 (Australia); +64 4 917 9888 (International)

2. HAZARDS IDENTIFICATION

2.1 Classification of the substance or mixture

NOT CLASSIFIED AS HAZARDOUS ACCORDING TO SAFE WORK AUSTRALIA CRITERIA

2.2 GHS Label elements

No signal word, pictograms, hazard or precautionary statements have been allocated.

2.3 Other hazards

No information provided.

3. COMPOSITION/ INFORMATION ON INGREDIENTS

3.1 Substances / Mixtures

Ingredient	CAS Number	EC Number	Content
CALCIUM CARBONATE	[redacted]	207-439-9	>96%
QUARTZ (CRYSTALLINE SILICA)	[redacted]	238-878-4	<1%

4. FIRST AID MEASURES

4.1 Description of first aid measures

Eye If in eyes, hold eyelids apart and flush continuously with running water. Continue flushing until advised to stop by a Poisons Information Centre, a doctor, or for at least 15 minutes.

Inhalation If inhaled, remove from contaminated area. Apply artificial respiration if not breathing.

Skin If skin or hair contact occurs, remove contaminated clothing and flush skin and hair with running water.

Ingestion For advice, contact a Poisons Information Centre on 13 11 26 (Australia Wide) or a doctor (at once). If swallowed, do not induce vomiting.

First aid facilities Eye wash facilities and safety shower should be available.

4.2 Most important symptoms and effects, both acute and delayed
May cause irritation to the eyes, skin and respiratory system.

4.3 Immediate medical attention and special treatment needed
Treat symptomatically.

5. FIRE FIGHTING MEASURES

5.1 Extinguishing media
Use an extinguishing agent suitable for the surrounding fire.

5.2 Special hazards arising from the substance or mixture
Non flammable. May evolve toxic gases if strongly heated.

5.3 Advice for firefighters
No fire or explosion hazard exists.

5.4 Hazchem code
None allocated.

6. ACCIDENTAL RELEASE MEASURES

6.1 Personal precautions, protective equipment and emergency procedures
Wear Personal Protective Equipment (PPE) as detailed in section 8 of the SDS.

6.2 Environmental precautions
Prevent product from entering drains and waterways.

6.3 Methods of cleaning up
If spilt, collect and reuse where possible. If reuse is not possible, contain spillage, then collect and place in suitable containers for disposal. Avoid generating dust.

6.4 Reference to other sections
See Sections 8 and 13 for exposure controls and disposal.

7. HANDLING AND STORAGE

7.1 Precautions for safe handling
Before use carefully read the product label. Use of safe work practices are recommended to avoid eye or skin contact and inhalation. Observe good personal hygiene, including washing hands before eating. Prohibit eating, drinking and smoking in contaminated areas.

7.2 Conditions for safe storage, including any incompatibilities
Store in a cool, dry, well ventilated area, removed from incompatible substances and foodstuffs. Ensure containers are adequately labelled, protected from physical damage and sealed when not in use.

7.3 Specific end uses
No information provided.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

8.1 Control parameters
Exposure standards

Ingredient	Reference	TWA		STEL	
		ppm	mg/m³	ppm	mg/m³
Calcium carbonate (Limestone, Marble, Whiting)	SWA [AUS]	--	10	--	--
Quartz (respirable dust)	SWA [AUS]	--	0.1	--	--

Biological limits No Biological Limit Value allocated.

8.2 Exposure controls

Engineering controls Avoid inhalation. Use in well ventilated areas. Where an inhalation risk exists, mechanical extraction ventilation is recommended. Maintain dust levels below the recommended exposure standard.

PPE

Eye / Face	Wear dust-proof goggles.
Hands	When using large quantities or where heavy contamination is likely, wear PVC or rubber gloves.
Body	When using large quantities or where heavy contamination is likely, wear coveralls.
Respiratory	Where an inhalation risk exists, wear a Class P1 (Particulate) respirator.



9. PHYSICAL AND CHEMICAL PROPERTIES

9.1 Information on basic physical and chemical properties

Appearance	OFF-WHITE POWDER
Odour	ODOURLESS
Flammability	NON FLAMMABLE
Flash point	NOT RELEVANT
Boiling point	NOT AVAILABLE
Melting point	825°C
Evaporation rate	NOT AVAILABLE
pH	9
Vapour density	NOT AVAILABLE
Specific gravity	2.7
Solubility (water)	INSOLUBLE
Vapour pressure	NOT AVAILABLE
Upper explosion limit	NOT RELEVANT
Lower explosion limit	NOT RELEVANT
Partition coefficient	NOT AVAILABLE
Autoignition temperature	NOT AVAILABLE
Decomposition temperature	840°C
Viscosity	NOT AVAILABLE
Explosive properties	NOT AVAILABLE
Oxidising properties	NOT AVAILABLE
Odour threshold	NOT AVAILABLE

10. STABILITY AND REACTIVITY

10.1 Reactivity

Calcium carbonate reacts with acids and acidic salts to generate gaseous carbon dioxide with effervescence (bubbling). The reaction with concentrated solutions of acids is rapid and exothermic. The effervesence can create extensive foaming. Ignites on contact with fluorine.

10.2 Chemical stability

Stable under recommended conditions of storage.

10.3 Possibility of hazardous reactions

Polymerization will not occur.

10.4 Conditions to avoid

Avoid heat, sparks, open flames and other ignition sources.

10.5 Incompatible materials

Incompatible with acids (e.g. nitric acid), fluorine, aluminium (hot) and ammonium salts. Incompatible with oxidising agents (e.g. hypochlorites).

10.6 Hazardous decomposition products

May evolve toxic gases if heated to decomposition.

11. TOXICOLOGICAL INFORMATION

11.1 Information on toxicological effects

Acute toxicity This product is expected to be of low toxicity. Based on available data, the classification criteria are not met. LD50 (Ingestion) = 6450 mg/kg (rat).

Information available for the ingredients:

Ingredient	Oral LD50	Dermal LD50	Inhalation LC50
CALCIUM CARBONATE	> 2000 mg/kg (rat)	> 2000 mg/kg (rat)	> 3.0 mg/L

Skin Not classified as a skin irritant. Contact may result in mild irritation, redness, pain and rash.

Eye Contact may result in irritation, lacrimation, pain and redness.

Sensitisation Not classified as causing skin or respiratory sensitisation.

Mutagenicity Not classified as a mutagen.

Carcinogenicity Not classified as a carcinogen. Crystalline silica is classified as carcinogenic to humans (IARC Group 1).

Reproductive Not classified as a reproductive toxin.

STOT - single exposure Not classified as causing organ damage from single exposure. However, over exposure may result in irritation of the nose and throat, with coughing. High level exposure may result in breathing difficulties.

STOT - repeated exposure Not classified as causing organ damage from repeated exposure. Chronic exposure to respirable silica may result in pulmonary fibrosis (silicosis). However, given the low levels present, over exposure is not anticipated.

Aspiration Not relevant.

12. ECOLOGICAL INFORMATION

12.1 Toxicity

Calcium carbonate occurs naturally in a wide variety of substances including limestone, marble and egg shells. It is not anticipated to cause adverse environmental effects.

12.2 Persistence and degradability

Dissolved calcium carbonate dissociates into calcium and carbonate ions. Calcium ions will be assimilated by living organisms in the water and the carbonate will become part of the carbon cycle.

12.3 Bioaccumulative potential

This product does not bioaccumulate.

12.4 Mobility in soil

Due to its limited solubility, calcium carbonate precipitates and deposits on the sediment.

12.5 Other adverse effects

Avoid contamination of drains and waterways.

13. DISPOSAL CONSIDERATIONS

13.1 Waste treatment methods

Waste disposal Ensure product is covered with moist soil to prevent dust generation and dispose of to approved Council landfill. Contact the manufacturer/supplier for additional information (if required).

Legislation Dispose of in accordance with relevant local legislation.

14. TRANSPORT INFORMATION

NOT CLASSIFIED AS A DANGEROUS GOOD BY THE CRITERIA OF THE ADG CODE, IMDG OR IATA

	LAND TRANSPORT (ADG)	SEA TRANSPORT (IMDG / IMO)	AIR TRANSPORT (IATA / ICAO)
14.1 UN Number	None allocated.	None allocated.	None allocated.
14.2 Proper Shipping Name	None allocated.	None allocated.	None allocated.
14.3 Transport hazard class	None allocated.	None allocated.	None allocated.
14.4 Packing Group	None allocated.	None allocated.	None allocated.

14.5 Environmental hazards

No information provided.

14.6 Special precautions for user

Hazchem code None allocated.

15. REGULATORY INFORMATION

15.1 Safety, health and environmental regulations/legislation specific for the substance or mixture

Poison schedule A poison schedule number has not been allocated to this product using the criteria in the Standard for the Uniform Scheduling of Medicines and Poisons (SUSMP).

Classifications Safework Australia criteria is based on the Globally Harmonised System (GHS) of Classification and Labelling of Chemicals.

Inventory listings **AUSTRALIA: AICS (Australian Inventory of Chemical Substances)**
All components are listed on AICS, or are exempt.

16. OTHER INFORMATION

Additional information

RESPIRATORS: In general the use of respirators should be limited and engineering controls employed to avoid exposure. If respiratory equipment must be worn ensure correct respirator selection and training is undertaken. Remember that some respirators may be extremely uncomfortable when used for long periods. The use of air powered or air supplied respirators should be considered where prolonged or repeated use is necessary.

EXPOSURE CONTROL: If utilised in a closed system the potential for over exposure is reduced. If not used in a closed system, local exhaust ventilation is recommended to control exposure. Provide eye wash and safety shower in close proximity to points of potential exposure. Where the potential for an inhalation risk exists, an approved respirator may be required. Do not eat, store, consume food, tobacco or drink in areas where product is used.

PERSONAL PROTECTIVE EQUIPMENT GUIDELINES:
The recommendation for protective equipment contained within this report is provided as a guide only. Factors such as form of product, method of application, working environment, quantity used, product concentration and the availability of engineering controls should be considered before final selection of personal protective equipment is made.

HEALTH EFFECTS FROM EXPOSURE:
It should be noted that the effects from exposure to this product will depend on several factors including: form of product; frequency and duration of use; quantity used; effectiveness of control measures; protective equipment used and method of application. Given that it is impractical to prepare a report which would encompass all possible scenarios, it is anticipated that users will assess the risks and apply control methods where appropriate.

Abbreviations

ACGIH	American Conference of Governmental Industrial Hygienists
CAS #	Chemical Abstract Service number - used to uniquely identify chemical compounds
CNS	Central Nervous System
EC No.	EC No - European Community Number
EMS	Emergency Schedules (Emergency Procedures for Ships Carrying Dangerous Goods)
GHS	Globally Harmonized System
GTEPG	Group Text Emergency Procedure Guide
IARC	International Agency for Research on Cancer
LC50	Lethal Concentration, 50% / Median Lethal Concentration
LD50	Lethal Dose, 50% / Median Lethal Dose
mg/m³	Milligrams per Cubic Metre
OEL	Occupational Exposure Limit
pH	relates to hydrogen ion concentration using a scale of 0 (high acidic) to 14 (highly alkaline).
ppm	Parts Per Million
STEL	Short-Term Exposure Limit
STOT-RE	Specific target organ toxicity (repeated exposure)
STOT-SE	Specific target organ toxicity (single exposure)
SUSMP	Standard for the Uniform Scheduling of Medicines and Poisons
SWA	Safe Work Australia
TLV	Threshold Limit Value
TWA	Time Weighted Average

Report status

This document has been compiled by RMT on behalf of the manufacturer, importer or supplier of the product and serves as their Safety Data Sheet ('SDS').

It is based on information concerning the product which has been provided to RMT by the manufacturer, importer or supplier or obtained from third party sources and is believed to represent the current state of knowledge as to the appropriate safety and handling precautions for the product at the time of issue. Further clarification regarding any aspect of the product should be obtained directly from the manufacturer, importer or supplier.

While RMT has taken all due care to include accurate and up-to-date information in this SDS, it does not provide any warranty as to accuracy or completeness. As far as lawfully possible, RMT accepts no liability for any loss, injury or damage (including consequential loss) which may be suffered or incurred by any person as a consequence of their reliance on the information contained in this SDS.

Prepared by

Risk Management Technologies
5 Ventnor Ave, West Perth
Western Australia 6005
Phone: +61 8 9322 1711
Fax: +61 8 9322 1794
Email: info@rmt.com.au
Web: www.rmtglobal.com

[End of SDS]

NEWPARK DRILLING FLUIDS

SAFETY DATA SHEET

1. IDENTIFICATION OF THE MATERIAL AND SUPPLIER

1.1 Product identifier

Product name **CITRIC ACID**

Synonyms 2-HYDROXY-1,2,3-PROPANETRICARBOXYLIC ACID ● CITRIC ACID ANHYDROUS ● CITRIC ACID MONOHYDRATE

1.2 Uses and uses advised against

Uses INDUSTRIAL APPLICATIONS

1.3 Details of the supplier of the product

Supplier name **NEWPARK DRILLING FLUIDS (AUSTRALIA) LTD**

Address 11 Alacrity Place, Henderson, WA, 6166, AUSTRALIA

Telephone +61 8 9410 8200

Fax +61 8 9410 8299

Website www.newpark.com

1.4 Emergency telephone numbers

Emergency 1800 127 406 (Australia); +64 4 917 9888 (International)

2. HAZARDS IDENTIFICATION

2.1 Classification of the substance or mixture

CLASSIFIED AS HAZARDOUS ACCORDING TO SAFE WORK AUSTRALIA CRITERIA

Physical Hazards

Not classified as a Physical Hazard

Health Hazards

Skin Corrosion/Irritation: Category 2
Serious Eye Damage / Eye Irritation: Category 2A
Specific Target Organ Toxicity (Single Exposure): Category 3 (Respiratory Irritation)

Environmental Hazards

Not classified as an Environmental Hazard

2.2 GHS Label elements

Signal word **WARNING**

Pictograms



Hazard statements

H315	Causes skin irritation.
H319	Causes serious eye irritation.
H335	May cause respiratory irritation.

Prevention statements

P261	Avoid breathing dust/fume/gas/mist/vapours/spray.
P264	Wash thoroughly after handling.
P271	Use only outdoors or in a well-ventilated area.
P280	Wear protective gloves/protective clothing/eye protection/face protection.

Response statements

P302 + P352	IF ON SKIN: Wash with plenty of soap and water.
P304 + P340	IF INHALED: Remove to fresh air and keep at rest in a position comfortable for breathing.
P305 + P351 + P338	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
P312	Call a POISON CENTER or doctor/physician if you feel unwell.
P321	Specific treatment is advised - see first aid instructions.
P362	Take off contaminated clothing and wash before re-use.

Storage statements

P403 + P233	Store in a well-ventilated place. Keep container tightly closed.
P405	Store locked up.

Disposal statements

P501	Dispose of contents/container in accordance with relevant regulations.

2.3 Other hazards

No information provided.

3. COMPOSITION/ INFORMATION ON INGREDIENTS

3.1 Substances / Mixtures

Ingredient	CAS Number	EC Number	Content
CITRIC ACID	[redacted]	201-069-1	>99%
WATER	[redacted]	231-791-2	<1%

4. FIRST AID MEASURES

4.1 Description of first aid measures

Eye If in eyes, hold eyelids apart and flush continuously with running water. Continue flushing until advised to stop by a Poisons Information Centre, a doctor, or for at least 15 minutes.

Inhalation If inhaled, remove from contaminated area. Apply artificial respiration if not breathing.

Skin If skin or hair contact occurs, remove contaminated clothing and flush skin and hair with running water. Continue flushing with water until advised to stop by a Poisons Information Centre or a doctor.

Ingestion For advice, contact a Poisons Information Centre on 13 11 26 (Australia Wide) or a doctor (at once). If swallowed, do not induce vomiting.

First aid facilities Eye wash facilities and safety shower should be available.

4.2 Most important symptoms and effects, both acute and delayed

Irritating to the eyes, skin and respiratory system.

4.3 Immediate medical attention and special treatment needed

Treat symptomatically.

5. FIRE FIGHTING MEASURES

5.1 Extinguishing media

Dry agent, carbon dioxide, foam or water fog. Prevent contamination of drains or waterways.

5.2 Special hazards arising from the substance or mixture

Combustible. May evolve carbon oxides and hydrocarbons when heated to decomposition.

5.3 Advice for firefighters

Evacuate area and contact emergency services. Toxic gases may be evolved in a fire situation. Remain upwind and notify those downwind of hazard. Wear full protective equipment including Self Contained Breathing Apparatus (SCBA) when combating fire. Use waterfog to cool intact containers and nearby storage areas.

5.4 Hazchem code

None allocated.

6. ACCIDENTAL RELEASE MEASURES

6.1 Personal precautions, protective equipment and emergency procedures
Wear Personal Protective Equipment (PPE) as detailed in section 8 of the SDS. Ventilate area where possible.

6.2 Environmental precautions
Prevent product from entering drains and waterways.

6.3 Methods of cleaning up
Contain spillage, then collect and place in suitable containers for disposal. Avoid generating dust.

6.4 Reference to other sections
See Sections 8 and 13 for exposure controls and disposal.

7. HANDLING AND STORAGE

7.1 Precautions for safe handling
Before use carefully read the product label. Use of safe work practices are recommended to avoid eye or skin contact and inhalation. Observe good personal hygiene, including washing hands before eating. Prohibit eating, drinking and smoking in contaminated areas.

7.2 Conditions for safe storage, including any incompatibilities
Store in a cool, dry, well ventilated area, removed from moisture, incompatible substances and foodstuffs. Ensure containers are adequately labelled, protected from physical damage and sealed when not in use.

7.3 Specific end uses
No information provided.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

8.1 Control parameters
Exposure standards

No exposure standards have been entered for this product.

Biological limits No Biological Limit Value allocated.

8.2 Exposure controls
Engineering controls Avoid inhalation. Use in well ventilated areas. Where an inhalation risk exists, mechanical extraction ventilation is recommended. Maintain dust levels below the recommended exposure standard.

PPE

Eye / Face	Wear dust-proof goggles.
Hands	Wear PVC or rubber gloves.
Body	When using large quantities or where heavy contamination is likely, wear coveralls.
Respiratory	At high dust levels, wear a Class P1 (Particulate) respirator.



9. PHYSICAL AND CHEMICAL PROPERTIES

9.1 Information on basic physical and chemical properties

Appearance	WHITE CRYSTALLINE POWDER
Odour	ODOURLESS
Flammability	COMBUSTIBLE
Flash point	174°C
Boiling point	175°C (Decomposes)
Melting point	153°C

9.1 Information on basic physical and chemical properties

Evaporation rate	NOT AVAILABLE
pH	2.2 (0.1M Solution)
Vapour density	NOT AVAILABLE
Specific gravity	1.665
Solubility (water)	1330 kg/m³ @ 20°C
Vapour pressure	NOT AVAILABLE
Upper explosion limit	NOT AVAILABLE
Lower explosion limit	NOT AVAILABLE
Partition coefficient	NOT AVAILABLE
Autoignition temperature	345°C
Decomposition temperature	NOT AVAILABLE
Viscosity	NOT AVAILABLE
Explosive properties	NOT AVAILABLE
Oxidising properties	NOT AVAILABLE
Odour threshold	NOT AVAILABLE

10. STABILITY AND REACTIVITY

10.1 Reactivity

Carefully review all information provided in sections 10.2 to 10.6.

10.2 Chemical stability

Stable under recommended conditions of storage.

10.3 Possibility of hazardous reactions

Polymerization is not expected to occur.

10.4 Conditions to avoid

Avoid heat, sparks, open flames and other ignition sources.

10.5 Incompatible materials

Incompatible with oxidising agents (e.g. hypochlorites) and alkalis (e.g. sodium hydroxide).

10.6 Hazardous decomposition products

May evolve carbon oxides and hydrocarbons when heated to decomposition.

11. TOXICOLOGICAL INFORMATION

11.1 Information on toxicological effects

Acute toxicity

Based on available data, the classification criteria are not met.
LD50 (Ingestion): 3000 mg/kg (rat)
LD50 (Intraperitoneal): 290 mg/kg (rat)
LD50 (Intravenous): 42 mg/kg (mouse)
LDLo (Ingestion): 7000 mg/kg (rabbit)

Information available for the ingredients:

Ingredient	Oral LD50	Dermal LD50	Inhalation LC50
CITRIC ACID	3000 mg/kg (rat)	> 2000 mg/kg (rat)	--

Additional ingredient toxicity values:

CITRIC ACID (77-92-9)

LD50 (intraperitoneal)	290 mg/kg (rat)
LD50 (intravenous)	42 mg/kg (mouse)
LDLo (oral)	7000 mg/kg (rabbit)

Skin Irritating to the skin. Contact may result in irritation, redness, rash and dermatitis.

Eye Irritating to the eyes. Contact may result in irritation, lacrimation, pain and redness. May result in burns with prolonged contact.

Sensitisation Not classified as causing skin or respiratory sensitisation. However, citric acid has the potential to cause allergic effects.

Mutagenicity Insufficient data available to classify as a mutagen.

Carcinogenicity	Insufficient data available to classify as a carcinogen.
Reproductive	Insufficient data available to classify as a reproductive toxin.
STOT - single exposure	Irritating to the respiratory system. Over exposure may result in irritation of the nose and throat, with coughing.
STOT - repeated exposure	Not classified as causing organ damage from repeated exposure.
Aspiration	This product does not present an aspiration hazard.

12. ECOLOGICAL INFORMATION

12.1 Toxicity

LC50 (Leuciscus idus melanotus): 440 mg/L/48hrs.
LC50 (Daphnia magna (Water flea)): 1.535 mg/L/24hrs.

12.2 Persistence and degradability

This product is readily biodegradable.

12.3 Bioaccumulative potential

This product does not bioaccumulate.

12.4 Mobility in soil

Citric acid is expected to have very high mobility in soil (HSDB).

12.5 Other adverse effects

No information provided.

13. DISPOSAL CONSIDERATIONS

13.1 Waste treatment methods

Waste disposal	Neutralise with lime, anion exchanger or similar. For small amounts, absorb with sand or similar and dispose of to an approved landfill site. Contact the manufacturer/supplier for additional information (if required).
Legislation	Dispose of in accordance with relevant local legislation.

14. TRANSPORT INFORMATION

NOT CLASSIFIED AS A DANGEROUS GOOD BY THE CRITERIA OF THE ADG CODE, IMDG OR IATA

	LAND TRANSPORT (ADG)	SEA TRANSPORT (IMDG / IMO)	AIR TRANSPORT (IATA / ICAO)
14.1 UN Number	None allocated.	None allocated.	None allocated.
14.2 Proper Shipping Name	None allocated.	None allocated.	None allocated.
14.3 Transport hazard class	None allocated.	None allocated.	None allocated.
14.4 Packing Group	None allocated.	None allocated.	None allocated.

14.5 Environmental hazards

No information provided.

14.6 Special precautions for user

Hazchem code None allocated.

15. REGULATORY INFORMATION

15.1 Safety, health and environmental regulations/legislation specific for the substance or mixture

Poison schedule	A poison schedule number has not been allocated to this product using the criteria in the Standard for the Uniform Scheduling of Medicines and Poisons (SUSMP).
Classifications	Safework Australia criteria is based on the Globally Harmonised System (GHS) of Classification and Labelling of Chemicals.

Inventory listings **AUSTRALIA: AICS (Australian Inventory of Chemical Substances)**
All components are listed on AICS, or are exempt.

16. OTHER INFORMATION

Additional information

PERSONAL PROTECTIVE EQUIPMENT GUIDELINES:
The recommendation for protective equipment contained within this report is provided as a guide only. Factors such as form of product, method of application, working environment, quantity used, product concentration and the availability of engineering controls should be considered before final selection of personal protective equipment is made.

HEALTH EFFECTS FROM EXPOSURE:
It should be noted that the effects from exposure to this product will depend on several factors including: form of product; frequency and duration of use; quantity used; effectiveness of control measures; protective equipment used and method of application. Given that it is impractical to prepare a report which would encompass all possible scenarios, it is anticipated that users will assess the risks and apply control methods where appropriate.

Abbreviations

ACGIH	American Conference of Governmental Industrial Hygienists
CAS #	Chemical Abstract Service number - used to uniquely identify chemical compounds
CNS	Central Nervous System
EC No.	EC No - European Community Number
EMS	Emergency Schedules (Emergency Procedures for Ships Carrying Dangerous Goods)
GHS	Globally Harmonized System
GTEPG	Group Text Emergency Procedure Guide
IARC	International Agency for Research on Cancer
LC50	Lethal Concentration, 50% / Median Lethal Concentration
LD50	Lethal Dose, 50% / Median Lethal Dose
mg/m³	Milligrams per Cubic Metre
OEL	Occupational Exposure Limit
pH	relates to hydrogen ion concentration using a scale of 0 (high acidic) to 14 (highly alkaline).
ppm	Parts Per Million
STEL	Short-Term Exposure Limit
STOT-RE	Specific target organ toxicity (repeated exposure)
STOT-SE	Specific target organ toxicity (single exposure)
SUSMP	Standard for the Uniform Scheduling of Medicines and Poisons
SWA	Safe Work Australia
TLV	Threshold Limit Value
TWA	Time Weighted Average

Report status

This document has been compiled by RMT on behalf of the manufacturer, importer or supplier of the product and serves as their Safety Data Sheet ('SDS').

It is based on information concerning the product which has been provided to RMT by the manufacturer, importer or supplier or obtained from third party sources and is believed to represent the current state of knowledge as to the appropriate safety and handling precautions for the product at the time of issue. Further clarification regarding any aspect of the product should be obtained directly from the manufacturer, importer or supplier.

While RMT has taken all due care to include accurate and up-to-date information in this SDS, it does not provide any warranty as to accuracy or completeness. As far as lawfully possible, RMT accepts no liability for any loss, injury or damage (including consequential loss) which may be suffered or incurred by any person as a consequence of their reliance on the information contained in this SDS.

Prepared by

Risk Management Technologies
5 Ventnor Ave, West Perth
Western Australia 6005
Phone: +61 8 9322 1711
Fax: +61 8 9322 1794
Email: info@rmt.com.au
Web: www.rmtglobal.com

[End of SDS]

SAFETY DATA SHEET

CleanTrol™ HD

A safety data sheet is not required for this product under Article 31 of REACH

Issuing Date 12-Jun-2019 **Revision Date** 12-Nov-2021 **Version** 1.1

SECTION 1: Identification of the substance/mixture and of the company/undertaking

1.1. Product identifier

Product Code NDF00549

Product Name CleanTrol™ HD

EC No 232-679-6

CAS No [redacted]

Chemical Name Starch

Pure substance/mixture Substance

1.2. Relevant identified uses of the substance or mixture and uses advised against

Recommended Use Fluid loss control additive

Uses advised against No information available

1.3. Details of the supplier of the safety data sheet

Supplier
Newpark Drilling Fluids S.p.A.
Via Salaria 1313/C
00138 ROMA (Italy)
For further information, please contact

Contact Point Telephone: + 39 06 8856111
Fax: +39 06 8889363
Website: www.newpark.com

E-mail address hse-hqit@newpark.com

1.4. Emergency telephone number

Emergency Telephone - §45 - (EC)1272/2008	
Europe	**112**
Croatia	+385 1 7776 920 ; +385 01 2348 342 (Centar za kontrolu otrovanja, 24 sata)
France	+(33)-975181407
Germany	0800-181-7059; +(49)- 69643508409
Hungary	+(36)-18088425
Italy	800-789-767; +(39)-0245557031 Milano 24/24 Ospedale Niguarda Ca'grande Piazza ospedale maggiore 3 +39 0266101029

	Roma 24/24 Policlinico Gemelli Largo Agostino Gemelli 8 +39 063054343
Netherlands	+(31)-858880596
Romania	(+40)-37-6300026
Spain	900-868538; +(34)-931768545
Switzerland	145, (+41) 435082011
United Kingdom	+(44)-870-8200418

SECTION 2: Hazards identification

2.1. Classification of the substance or mixture

Regulation (EC) No 1272/2008
This substance is classified as not hazardous according to regulation (EC) 1272/2008 [CLP]

2.2. Label elements

This substance is classified as not hazardous according to regulation (EC) 1272/2008 [CLP]
Hazard statements
This substance is classified as not hazardous according to regulation (EC) 1272/2008 [CLP]

2.3. Other hazards

No information available.

SECTION 3: Composition/information on ingredients

3.1 Substances

Chemical name	Weight-%	REACH registration number	EC No	Classification according to Regulation (EC) No. 1272/2008 [CLP]	Specific concentration limit (SCL)	M-Factor	M-Factor (long-term)
Starch 9005-25-8	>95	No data available	232-679-6	No data available	-	-	-

Full text of H- and EUH-phrases: see section 16

Acute Toxicity Estimate
No information available

This product does not contain candidate substances of very high concern at a concentration >=0.1% (Regulation (EC) No. 1907/2006 (REACH), Article 59)

SECTION 4: First aid measures

4.1. Description of first aid measures

Inhalation Remove to fresh air.

Eye contact Rinse thoroughly with plenty of water for at least 15 minutes, lifting lower and upper eyelids. Consult a physician.

Skin contact Wash skin with soap and water. In the case of skin irritation or allergic reactions see a physician.

Ingestion Clean mouth with water and drink afterwards plenty of water.

4.2. Most important symptoms and effects, both acute and delayed

Symptoms No information available.

4.3. Indication of any immediate medical attention and special treatment needed

Note to physicians Treat symptomatically.

SECTION 5: Firefighting measures

5.1. Extinguishing media

Suitable Extinguishing Media Use extinguishing measures that are appropriate to local circumstances and the surrounding environment.

Large Fire CAUTION: Use of water spray when fighting fire may be inefficient.

Unsuitable extinguishing media Do not scatter spilled material with high pressure water streams.

5.2. Special hazards arising from the substance or mixture

Specific hazards arising from the chemical No information available.

Hazardous combustion products Carbon oxides.

5.3. Advice for firefighters

Special protective equipment and precautions for fire-fighters Firefighters should wear self-contained breathing apparatus and full firefighting turnout gear. Use personal protection equipment.

SECTION 6: Accidental release measures

6.1. Personal precautions, protective equipment and emergency procedures

Personal precautions Ensure adequate ventilation.

For emergency responders Use personal protection recommended in Section 8.

6.2. Environmental precautions

Environmental precautions See Section 12 for additional Ecological Information.

6.3. Methods and material for containment and cleaning up

Methods for containment Prevent further leakage or spillage if safe to do so.

Methods for cleaning up Take up mechanically, placing in appropriate containers for disposal.

Prevention of secondary hazards Clean contaminated objects and areas thoroughly observing environmental regulations.

6.4. Reference to other sections

Reference to other sections See section 8 for more information. See section 13 for more information.

SECTION 7: Handling and storage

7.1. Precautions for safe handling

Advice on safe handling Ensure adequate ventilation.

General hygiene considerations Handle in accordance with good industrial hygiene and safety practice.

7.2. Conditions for safe storage, including any incompatibilities

Storage Conditions Keep container tightly closed in a dry and well-ventilated place.

7.3. Specific end use(s)

Identified uses
Risk Management Methods (RMM) The information required is contained in this Safety Data Sheet.

SECTION 8: Exposure controls/personal protection

8.1. Control parameters

Exposure Limits This product, as supplied, does not contain any hazardous materials with occupational exposure limits established by the region specific regulatory bodies.

Chemical name	European Union	Austria	Belgium	Bulgaria	Croatia
Starch 9005-25-8	-	-	TWA: 10 mg/m³	TWA: 10.0 mg/m³	TWA: 4 mg/m³ TWA: 10 mg/m³
Chemical name	Cyprus	Czech Republic	Denmark	Estonia	Finland
Starch 9005-25-8	-	TWA: 4.0 mg/m³	-	-	-
Chemical name	France	Germany	Germany MAK	Greece	Hungary
Starch 9005-25-8	-	-	-	TWA: 10 mg/m³ TWA: 5 mg/m³	-
Chemical name	Ireland	Italy	Italy REL	Latvia	Lithuania
Starch 9005-25-8	TWA: 10 mg/m³ TWA: 4 mg/m³ STEL: 30 mg/m³ STEL: 12 mg/m³	-	TWA: 10 mg/m³	-	-
Chemical name	Portugal	Romania	Slovakia	Slovenia	Spain
Starch 9005-25-8	TWA: 10 mg/m³	-	-	-	TWA: 10 mg/m³

Chemical name	Sweden	Switzerland	United Kingdom
Starch 9005-25-8	-	TWA: 3 mg/m³	TWA: 10 mg/m³ TWA: 4 mg/m³ STEL: 30 mg/m³ STEL: 12 mg/m³

Biological occupational exposure limits
This product, as supplied, does not contain any hazardous materials with biological limits established by the region specific regulatory bodies.

Derived No Effect Level (DNEL) No information available.
Predicted No Effect Concentration (PNEC) No information available.

8.2. Exposure controls

Personal protective equipment

Eye/face protection Tight sealing safety goggles.

Skin and body protection Wear suitable protective clothing.

Respiratory protection When workers are facing concentrations above the exposure limit they must use appropriate certified respirators.

General hygiene considerations Handle in accordance with good industrial hygiene and safety practice.

Environmental exposure controls No information available.

SECTION 9: Physical and chemical properties

9.1. Information on basic physical and chemical properties

Physical state	Solid
Appearance	Powder
Color	Off-white
Odor	No information available.
Odor threshold	No information available

Property	Values	Remarks • Method
Melting point / freezing point		No information available
Boiling point / boiling range		No information available
Flammability (solid, gas)		No information available
Flammability Limit in Air		No information available
Upper flammability limit:		
Lower flammability limit:		
Flash point		No information available
Autoignition temperature		No information available
Decomposition temperature		No information available
pH	5 - 8	4% solution
pH (as aqueous solution)		No information available
Kinematic viscosity		No information available
Dynamic viscosity		No information available
Water solubility	Soluble in water	
Solubility(ies)		No information available
Partition coefficient		No information available
Vapor pressure		No information available
Relative density		No information available
Bulk density	30-40 lb/ft3	
Liquid Density		
Vapor density		No information available
Particle characteristics		No information available
Particle Size		
Particle Size Distribution		

9.2. Other information

9.2.1. Information with regard to physical hazard classes
Not applicable

9.2.2. Other safety characteristics
No information available

SECTION 10: Stability and reactivity

10.1. Reactivity

Reactivity Not reactive under normal conditions.

10.2. Chemical stability

Stability Stable under normal conditions.

Explosion data
Sensitivity to mechanical impact None.
Sensitivity to static discharge None.

10.3. Possibility of hazardous reactions

Possibility of hazardous reactions None under normal processing.

10.4. Conditions to avoid

Conditions to avoid dust formation.

10.5. Incompatible materials

Incompatible materials Strong oxidizing agents.

10.6. Hazardous decomposition products

Hazardous Decomposition Products None known based on information supplied.

SECTION 11: Toxicological information

11.1. Information on hazard classes as defined in Regulation (EC) No 1272/2008

Information on likely routes of exposure

Product Information

Inhalation Specific test data for the substance or mixture is not available.

Eye contact Specific test data for the substance or mixture is not available.

Skin contact Specific test data for the substance or mixture is not available.

Ingestion Specific test data for the substance or mixture is not available.

Symptoms related to the physical, chemical and toxicological characteristics

Symptoms No information available.

Numerical measures of toxicity
No information available

Acute toxicity

0 % of the mixture consists of ingredient(s) of unknown acute oral toxicity.
0 % of the mixture consists of ingredient(s) of unknown acute dermal toxicity.
0 % of the mixture consists of ingredient(s) of unknown acute inhalation toxicity (gas).
0 % of the mixture consists of ingredient(s) of unknown acute inhalation toxicity (vapor).
0 % of the mixture consists of ingredient(s) of unknown acute inhalation toxicity (dust/mist).

Delayed and immediate effects as well as chronic effects from short and long-term exposure

Skin corrosion/irritation No information available.

Serious eye damage/eye irritation No information available.

Respiratory or skin sensitization None known.

Germ cell mutagenicity None known.

Carcinogenicity None known.

Reproductive toxicity None known.

STOT - single exposure No information available.

STOT - repeated exposure No information available.

Aspiration hazard Not applicable.

11.2. Information on other hazards

11.2.1. Endocrine disrupting properties

Endocrine disrupting properties No information available.

11.2.2. Other information

Other adverse effects No information available.

SECTION 12: Ecological information

12.1. Toxicity

Ecotoxicity The environmental impact of this product has not been fully investigated.

Unknown aquatic toxicity Contains 0 % of components with unknown hazards to the aquatic environment.

12.2. Persistence and degradability

Persistence and degradability No information available.

12.3. Bioaccumulative potential

Bioaccumulation No information available.

12.4. Mobility in soil

Mobility in soil No information available.

12.5. Results of PBT and vPvB assessment

PBT and vPvB assessment This substance is not considered to be persistent, bioaccumulating nor toxic (PBT).

12.6. Endocrine disrupting properties

Endocrine disrupting properties No information available.

12.7. Other adverse effects
No information available.

SECTION 13: Disposal considerations

13.1. Waste treatment methods

Waste from residues/unused products Dispose of in accordance with local regulations. Dispose of waste in accordance with environmental legislation.

Contaminated packaging Do not reuse empty containers.

Waste codes / waste designations according to EWC / AVV Waste codes should be assigned by the user based on the application for which the product was used.

SECTION 14: Transport information

IATA

14.1 UN number or ID number	Not regulated
14.2 Proper shipping name	Not Regulated
14.3 Transport hazard class(es)	Not regulated
14.4 Packing group	Not regulated
14.5 Environmental hazard	Not applicable
14.6 Special precautions for user Special Provisions	None

IMDG

14.1 UN number or ID number	Not regulated
14.2 Proper shipping name	Not Regulated
14.3 Transport hazard class(es)	Not regulated
14.4 Packing Group	Not Regulated
14.5 Environmental hazard	Not applicable
14.6 Special precautions for user Special Provisions	None
14.7 Maritime transport in bulk according to IMO instruments	No information available

RID

14.1 UN/ID no	Not Regulated
14.2 Proper shipping name	Not Regulated
14.3 Transport hazard class(es)	Not regulated
14.4 Packing Group	Not Regulated
14.5 Environmental hazard	Not applicable
14.6 Special precautions for user Special Provisions	None

ADR

14.1 UN number or ID number	Not regulated
14.2 Proper shipping name	Not Regulated
14.3 Transport hazard class(es)	Not regulated
14.4 Packing Group	Not Regulated
14.5 Environmental hazard	Not applicable
14.6 Special precautions for user Special Provisions	None

SECTION 15: Regulatory information

15.1. Safety, health and environmental regulations/legislation specific for the substance or mixture

Water hazard class (WGK) slightly hazardous to water (WGK 1)

Italy
-D. LGs. 81/2008 (single text on the protection of health and safety in the workplace) and subsequent amendments and Directive 2009/161/EU-assessment of chemical risk under title IX
-Legislative Decree 3 April 2006, no 152 (environmental standards)
-"Seveso III Directive" – Legislative Decree of 26 June 2015, n° 105 (Implementation of the Directive 2012/18/EU on the control of major-accident hazards involving dangerous substances)

European Union
Take note of Directive 98/24/EC on the protection of the health and safety of workers from the risks related to chemical agents at work.

Authorizations and/or restrictions on use:
This product does not contain substances subject to authorization (Regulation (EC) No. 1907/2006 (REACH), Annex XIV) This product does not contain substances subject to restriction (Regulation (EC) No. 1907/2006 (REACH), Annex XVII)

Persistent Organic Pollutants
Not applicable

Ozone-depleting substances (ODS) regulation (EC) 1005/2009
Not applicable

International Inventories

TSCA	Complies
DSL/NDSL	Complies
EINECS/ELINCS	Complies
ENCS	Complies
IECSC	Complies
KECL	Complies
PICCS	Complies
AICS	Complies
NZIoC	Complies

Legend:
TSCA - United States Toxic Substances Control Act Section 8(b) Inventory
DSL/NDSL - Canadian Domestic Substances List/Non-Domestic Substances List
EINECS/ELINCS - European Inventory of Existing Chemical Substances/European List of Notified Chemical Substances
ENCS - Japan Existing and New Chemical Substances
IECSC - China Inventory of Existing Chemical Substances
KECL - Korean Existing and Evaluated Chemical Substances
PICCS - Philippines Inventory of Chemicals and Chemical Substances
AICS - Australian Inventory of Chemical Substances

15.2. Chemical safety assessment

Chemical Safety Report A Chemical Safety Assessment is not required for this substance

SECTION 16: Other information

Key or legend to abbreviations and acronyms used in the safety data sheet

Legend
SVHC: Substances of Very High Concern for Authorization:

Legend Section 8: EXPOSURE CONTROLS/PERSONAL PROTECTION

TWA	TWA (time-weighted average)	STEL	STEL (Short Term Exposure Limit)
Ceiling	Maximum limit value	*	Skin designation

Key literature references and sources for data used to compile the SDS
Agency for Toxic Substances and Disease Registry (ATSDR)
U.S. Environmental Protection Agency ChemView Database
European Food Safety Authority (EFSA)
EPA (Environmental Protection Agency)
Acute Exposure Guideline Level(s) (AEGL(s))
U.S. Environmental Protection Agency Federal Insecticide, Fungicide, and Rodenticide Act
U.S. Environmental Protection Agency High Production Volume Chemicals
Food Research Journal
Hazardous Substance Database
International Uniform Chemical Information Database (IUCLID)
Japan GHS Classification
Australia National Industrial Chemicals Notification and Assessment Scheme (NICNAS)
NIOSH (National Institute for Occupational Safety and Health)
National Library of Medicine's ChemID Plus (NLM CIP)
National Library of Medicine’s PubMed database (NLM PUBMED)
National Toxicology Program (NTP)
New Zealand's Chemical Classification and Information Database (CCID)
Organization for Economic Co-operation and Development Environment, Health, and Safety Publications
Organization for Economic Co-operation and Development High Production Volume Chemicals Program
Organization for Economic Co-operation and Development Screening Information Data Set
World Health Organization

Issuing Date 12-Jun-2019

Revision Date 12-Nov-2021

This material safety data sheet complies with the requirements of Regulation (EC) No. 1907/2006
Disclaimer
According to Regulation (EC) No 1272/2008 of the European Parliament and of the Council of 16 December 2008 on classification, labelling and packaging of substances and mixtures, amending and repealing Directives 67/548/EEC and 1999/45/EC, and amending Regulation (EC) No 1907/2006, as amended by Regulation (EU) No. 2015/830. This document is provided as an information resource relating exclusively to the product or material described herein. The information contained herein may not be applicable to other products/ materials or processes and may not be valid when this product/material is used in combination with any other product/material or process. The information provided in this document is compiled by Newpark Drilling Fluids LLC or its representatives from various sources including manufacturers, suppliers and other third-party sources, and is based on the information available as of the indicated date of preparation. As the conditions under which this product could be used will vary and may not be within the control of Newpark Drilling Fluids LLC there is no guarantee that the precautions outlined above will be sufficient for all individuals or situations. The buyer assumes all responsibility for using and handling the product in accordance with federal, state, provincial, or local regulations. For the product/ material described in this document, NO WARRANTY IS MADE, EXPRESS OR IMPLIED, OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR OTHERWISE.

End of Safety Data Sheet

SAFETY DATA SHEET

CleanVis™

Issue Date 12-Dec-2019 **Revision date** 13-Apr-2022 **Version** 1
EN

Section 1: IDENTIFICATION: PRODUCT INDENTIFIER AND CHEMICAL IDENTITY

Product identifier

Product Name CleanVis™

Product Code NDF00653

Other means of identification

CAS No [redacted]

Chemical Name Xanthan Gum

Recommended use of the chemical and restrictions on use

Recommended Use Viscosifier

Uses advised against No information available

Details of manufacturer or importer

Supplier
Newpark Drilling Fluids (Australia) LTD
11 Alacrity Place
Henderson, WA, 6166
Australia

For further information, please contact

Contact Point Telephone: +61 8 9410 8200
Fax: +61 8 9410 8299
Website: www.newpark.com

Emergency telephone number

Emergency telephone number +(61)-290372994 (Australia); +(64)-98010034 (New Zealand)

Section 2: HAZARD(S) IDENTIFICATION

GHS - Classification

Not a dangerous substance or mixture according to the Globally Harmonized System (GHS)

Label elements

Hazard statements
Not a dangerous substance or mixture according to the Globally Harmonized System (GHS)

Other hazards which do not result in classification

General Hazards

May form combustible dust concentrations in air

This substance does not meet the PBT/vPvB criteria of REACH, annex XIII

Section 3: COMPOSITION AND INFORMATION ON INGREDIENTS, IN ACCORDANCE WITH SCHEDULE 8

Substance

Chemical name	CAS No	Weight-%	REACH registration number
Xanthan Gum	[redacted]	100	Exempt

Section 4: FIRST AID MEASURES

Description of first aid measures

Emergency telephone number Poisons Information Center, Australia: 13 11 26
Poisons Information Center, New Zealand: 0800 764 766

Inhalation Remove to fresh air.

Eye contact Rinse thoroughly with plenty of water for at least 15 minutes, lifting lower and upper eyelids. Consult a physician.

Skin contact Wash skin with soap and water.

Ingestion Clean mouth with water and drink afterwards plenty of water.

Most important symptoms and effects, both acute and delayed

Symptoms No information available.

Indication of any immediate medical attention and special treatment needed

Note to physicians Treat symptomatically.

Section 5: FIREFIGHTING MEASURES

Suitable Extinguishing Media

Suitable extinguishing media Use extinguishing measures that are appropriate to local circumstances and the surrounding environment.

Unsuitable extinguishing media No information available.

Specific hazards arising from the chemical

Thermal decomposition can lead to release of irritating and toxic gases and vapors. Do not allow run-off from fire-fighting to enter drains or water courses.

Hazardous combustion products Carbon oxides.

Special protective actions for fire-fighters

Special protective equipment for fire-fighters Firefighters should wear self-contained breathing apparatus and full firefighting turnout gear. Use personal protection equipment.

Hazchem code Not Listed.

Section 6: ACCIDENTAL RELEASE MEASURES

Personal precautions, protective equipment and emergency procedures

Personal precautions Ensure adequate ventilation.

For emergency responders Use personal protection recommended in Section 8.

Environmental precautions

Environmental precautions See Section 12 for additional Ecological Information. Do not flush into surface water or sanitary sewer system. Prevent product from entering drains.

Methods and material for containment and cleaning up

Methods for containment Prevent further leakage or spillage if safe to do so.

Methods for cleaning up Pick up and transfer to properly labeled containers.

Precautions to prevent secondary hazards

Prevention of secondary hazards Clean contaminated objects and areas thoroughly observing environmental regulations.

Section 7: HANDLING AND STORAGE, INCLUDING HOW THE CHEMICAL MAY BE SAFELY USED

Precautions for safe handling

Advice on safe handling Handle in accordance with good industrial hygiene and safety practice. Avoid generation of dust. Wash thoroughly after handling. Wash contaminated clothing before reuse.

General hygiene considerations Do not eat, drink or smoke when using this product. Wash hands before breaks and after work.

Conditions for safe storage, including any incompatibilities

Storage Conditions Keep containers tightly closed in a dry, cool and well-ventilated place.

Section 8: EXPOSURE CONTROLS AND PERSONAL PROTECTION

Control parameters

Exposure Limits This product, as supplied, does not contain any hazardous materials with occupational exposure limits established by the region specific regulatory bodies.

Biological occupational exposure limits Not applicable

Appropriate engineering controls

Engineering controls Showers
Eyewash stations
Ventilation systems.

Individual protection measures, such as personal protective equipment

Eye/face protection Tight sealing safety goggles.

Skin and body protection Wear suitable protective clothing.

Respiratory protection In case of inadequate ventilation wear respiratory protection.

Environmental exposure controls Do not allow into any sewer, on the ground or into any body of water.

Section 9: PHYSICAL AND CHEMICAL PROPERTIES

Information on basic physical and chemical properties

Physical state	Solid		
Appearance	Powder	**Odor**	No information available.
Color	White to Tan	**Odor threshold**	No information available

Property	**Values**	**Remarks • Method**
pH		No information available
Melting point / freezing point		No information available
Boiling point / boiling range		No information available
Flash point		No information available
Evaporation rate		No information available
Flammability (solid, gas)		No information available
Flammability Limit in Air		No information available
Upper flammability limit:		No data available
Lower flammability limit:		No data available
Vapor pressure		No data available
Vapor density		No data available
Relative density	1.02-1.45	
Water solubility	Soluble in water	
Solubility(ies)		No information available
Partition coefficient		No information available
Autoignition temperature		No information available
Hyphen		No information available
Kinematic viscosity		Not applicable
Dynamic viscosity		Not applicable

Other information

Softening point	No information available
Molecular weight	No information available
VOC Content (%)	No information available
Liquid Density	No information available
Bulk density	No information available
Particle Size	No information available
Particle Size Distribution	No information available

Section 10: STABILITY AND REACTIVITY

Reactivity

Reactivity No information available.

Chemical stability

Stability Stable under normal conditions.

Explosion data

Sensitivity to Mechanical Impact None.

Sensitivity to Static Discharge None.

Possibility of hazardous reactions

Possibility of hazardous reactions None under normal processing.

Conditions to avoid

Conditions to avoid None known based on information supplied.

Incompatible materials

Incompatible materials None known based on information supplied.

Hazardous decomposition products

Hazardous Decomposition Products None known based on information supplied.

Section 11: TOXICOLOGICAL INFORMATION

Acute toxicity

Information on likely routes of exposure

Product Information .

Inhalation Specific test data for the substance or mixture is not available.

Eye contact Specific test data for the substance or mixture is not available.

Skin contact Specific test data for the substance or mixture is not available.

Ingestion Specific test data for the substance or mixture is not available

Symptoms No information available.

Numerical measures of toxicity - Product Information

Unknown acute toxicity 100 % of the mixture consists of ingredient(s) of unknown toxicity
100 % of the mixture consists of ingredient(s) of unknown acute oral toxicity
100 % of the mixture consists of ingredient(s) of unknown acute dermal toxicity
100 % of the mixture consists of ingredient(s) of unknown acute inhalation toxicity (gas)
100 % of the mixture consists of ingredient(s) of unknown acute inhalation toxicity (vapor)
100 % of the mixture consists of ingredient(s) of unknown acute inhalation toxicity (dust/mist)

See section 16 for terms and abbreviations

Delayed and immediate effects as well as chronic effects from short and long-term exposure

Skin corrosion/irritation No information available.

Serious eye damage/eye irritation No information available.

Respiratory or skin sensitization No information available.

Germ cell mutagenicity No information available.

Carcinogenicity No information available.

Reproductive toxicity No information available.

STOT - single exposure	No information available.
STOT - repeated exposure	No information available.
Aspiration hazard	No information available.

Section 12: ECOLOGICAL INFORMATION

Ecotoxicity

Ecotoxicity	The environmental impact of this product has not been fully investigated.
Unknown aquatic toxicity	100 % of the mixture consists of component(s) of unknown hazards to the aquatic environment.

Persistence and degradability

Persistence and degradability	Readily biodegradable.

Bioaccumulative potential

Bioaccumulation	No information available.

Mobility

Mobility in soil	No information available.
Mobility	No information available.

Other adverse effects

Other adverse effects	No information available.

Section 13: DISPOSAL CONSIDERATIONS

Waste treatment methods

Waste from residues/unused products	Dispose of in accordance with local regulations. Dispose of waste in accordance with environmental legislation.
Contaminated packaging	Do not reuse empty containers.

Section 14: TRANSPORT INFORMATION

ADG Not regulated

IATA

IMDG Not Regulated

Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code
No information available

Section 15: REGULATORY INFORMATION

Regulatory information

National regulations

Australia
See section 8 for national exposure control parameters

Standard for Uniform Scheduling of Medicines and Poisons (SUSMP)
No poisons schedule number allocated

International Inventories

TSCA	Complies
DSL/NDSL	Complies
EINECS/ELINCS	Complies
ENCS	Complies
IECSC	Complies
PICCS	Complies
AICS	Complies
NZIoC	Complies

Legend:
TSCA - United States Toxic Substances Control Act Section 8(b) Inventory
DSL/NDSL - Canadian Domestic Substances List/Non-Domestic Substances List
EINECS/ELINCS - European Inventory of Existing Chemical Substances/European List of Notified Chemical Substances
ENCS - Japan Existing and New Chemical Substances
IECSC - China Inventory of Existing Chemical Substances
KECL - Korean Existing and Evaluated Chemical Substances
PICCS - Philippines Inventory of Chemicals and Chemical Substances
AICS - Australian Inventory of Chemical Substances
NZIoC - New Zealand Inventory of Chemicals

International Regulations

The Montreal Protocol on Substances that Deplete the Ozone Layer Not applicable

The Stockholm Convention on Persistent Organic Pollutants Not applicable

The Rotterdam Convention Not applicable

Brunei Poison List Not applicable.

Section 16: ANY OTHER RELEVANT INFORMATION

Issue Date 12-Dec-2019

Revision date 13-Apr-2022

Revision Note
No information available.

Key or legend to abbreviations and acronyms used in the safety data sheet

Legend Section 8: EXPOSURE CONTROLS/PERSONAL PROTECTION

TWA	TWA (time-weighted average)	STEL	STEL (Short Term Exposure Limit)
Ceiling	Maximum limit value	*	Skin designation
C	Carcinogen		

Disclaimer

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End of Safety Data Sheet

NEWPARK DRILLING FLUIDS

SAFETY DATA SHEET

1. IDENTIFICATION OF THE MATERIAL AND SUPPLIER

1.1 Product identifier

Product name **DEFOAM AP 400**

Synonyms DEFOAMER

1.2 Uses and uses advised against

Uses TREATMENT OF FOAMING IN DRILLING FLUIDS

1.3 Details of the supplier of the product

Supplier name **NEWPARK DRILLING FLUIDS (AUSTRALIA) LTD**

Address 11 Alacrity Place, Henderson, WA, 6166, AUSTRALIA

Telephone +61 8 9410 8200

Fax +61 8 9410 8299

Website www.newpark.com

1.4 Emergency telephone numbers

Emergency 1800 127 406 (Australia); +64 4 917 9888 (International)

2. HAZARDS IDENTIFICATION

2.1 Classification of the substance or mixture

NOT CLASSIFIED AS HAZARDOUS ACCORDING TO SAFE WORK AUSTRALIA CRITERIA

2.2 GHS Label elements

No signal word, pictograms, hazard or precautionary statements have been allocated.

2.3 Other hazards

No information provided.

3. COMPOSITION/ INFORMATION ON INGREDIENTS

3.1 Substances / Mixtures

Ingredient	CAS Number	EC Number	Content
POLYETHYLENE GLYCOL	[redacted]	500-038-2	45 to 60%
OCTAN-2-OL	[redacted]	204-667-0	40 to 55%

4. FIRST AID MEASURES

4.1 Description of first aid measures

Eye If in eyes, hold eyelids apart and flush continuously with running water. Continue flushing until advised to stop by a Poisons Information Centre, a doctor, or for at least 15 minutes.

Inhalation If inhaled, remove from contaminated area. Apply artificial respiration if not breathing.

Skin If skin or hair contact occurs, remove contaminated clothing and flush skin and hair with running water. Continue flushing with water until advised to stop by a Poisons Information Centre or a doctor.

Ingestion For advice, contact a Poisons Information Centre on 13 11 26 (Australia Wide) or a doctor (at once).

First aid facilities None allocated.

4.2 Most important symptoms and effects, both acute and delayed
Adverse effects not expected from this product under normal conditions of use.

4.3 Immediate medical attention and special treatment needed
Treat symptomatically.

5. FIRE FIGHTING MEASURES

5.1 Extinguishing media
Use an extinguishing agent suitable for the surrounding fire.

5.2 Special hazards arising from the substance or mixture
Non flammable. May evolve carbon oxides and hydrocarbons when heated to decomposition.

5.3 Advice for firefighters
Treat as per requirements for surrounding fires. Evacuate area and contact emergency services. Remain upwind and notify those downwind of hazard. Wear full protective equipment including Self Contained Breathing Apparatus (SCBA) when combating fire. Use waterfog to cool intact containers and nearby storage areas.

5.4 Hazchem code
None allocated.

6. ACCIDENTAL RELEASE MEASURES

6.1 Personal precautions, protective equipment and emergency procedures
Wear Personal Protective Equipment (PPE) as detailed in section 8 of the SDS. Clear area of all unprotected personnel. Ventilate area where possible. Contact emergency services where appropriate.

6.2 Environmental precautions
Prevent product from entering drains and waterways.

6.3 Methods of cleaning up
Contain spillage, then cover / absorb spill with non-combustible absorbent material (vermiculite, sand, or similar), collect and place in suitable containers for disposal. Eliminate all sources of ignition.

6.4 Reference to other sections
See Sections 8 and 13 for exposure controls and disposal.

7. HANDLING AND STORAGE

7.1 Precautions for safe handling
Before use carefully read the product label. Use of safe work practices are recommended to avoid eye or skin contact and inhalation. Observe good personal hygiene, including washing hands before eating. Prohibit eating, drinking and smoking in contaminated areas.

7.2 Conditions for safe storage, including any incompatibilities
Store in a cool, dry, well ventilated area, removed from incompatible substances, heat or ignition sources and foodstuffs. Ensure containers are adequately labelled, protected from physical damage and sealed when not in use. Check regularly for leaks or spills. Large storage areas should have appropriate ventilation systems.

7.3 Specific end uses
No information provided.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

8.1 Control parameters
Exposure standards

No exposure standards have been entered for this product.

Biological limits

No biological limit values have been entered for this product.

8.2 Exposure controls

Engineering controls Avoid inhalation. Use in well ventilated areas.

PPE

Eye / Face	Wear splash-proof goggles.
Hands	Wear PVC or rubber gloves.
Body	When using large quantities or where heavy contamination is likely, wear coveralls.
Respiratory	Where an inhalation risk exists, wear a Type A (Organic vapour) respirator.



9. PHYSICAL AND CHEMICAL PROPERTIES

9.1 Information on basic physical and chemical properties

Appearance	CLEAR COLOURLESS LIQUID
Odour	ODOURLESS
Flammability	NON FLAMMABLE
Flash point	NOT RELEVANT
Boiling point	100°C to 102°C
Melting point	NOT AVAILABLE
Evaporation rate	NOT AVAILABLE
pH	7 to 8
Vapour density	NOT AVAILABLE
Specific gravity	1.00 to 1.17
Solubility (water)	SOLUBLE
Vapour pressure	NOT AVAILABLE
Upper explosion limit	NOT RELEVANT
Lower explosion limit	NOT RELEVANT
Partition coefficient	NOT AVAILABLE
Autoignition temperature	NOT AVAILABLE
Decomposition temperature	NOT AVAILABLE
Viscosity	NOT AVAILABLE
Explosive properties	NOT AVAILABLE
Oxidising properties	NOT AVAILABLE
Odour threshold	NOT AVAILABLE

9.2 Other information

Freezing point	-7°C to 0°C

10. STABILITY AND REACTIVITY

10.1 Reactivity

Carefully review all information provided in sections 10.2 to 10.6.

10.2 Chemical stability

Stable under recommended conditions of storage.

10.3 Possibility of hazardous reactions

Polymerization is not expected to occur.

10.4 Conditions to avoid

Avoid heat, sparks, open flames and other ignition sources.

10.5 Incompatible materials

Incompatible with oxidising agents (e.g. hypochlorites), acids (e.g. nitric acid), heat and ignition sources.

10.6 Hazardous decomposition products

May evolve carbon oxides and hydrocarbons when heated to decomposition.

11. TOXICOLOGICAL INFORMATION

11.1 Information on toxicological effects

Acute toxicity This product is expected to be of low acute toxicity. Under normal conditions of use, adverse health effects are not anticipated.

Information available for the ingredients:

Ingredient	Oral LD50	Dermal LD50	Inhalation LC50
POLYETHYLENE GLYCOL	> 15,000 mg/kg (rat)	> 20,000 mg/kg (rabbit)	--
OCTAN-2-OL	--	2000 mg/kg (rat)	--

Skin Not classified as a skin irritant. Contact may cause temporary mild skin irritation.

Eye Not classified as an eye irritant. Contact may cause discomfort, lacrimation and redness.

Sensitisation Not classified as causing skin or respiratory sensitisation.

Mutagenicity Not classified as a mutagen.

Carcinogenicity Not classified as a carcinogen.

Reproductive Not classified as a reproductive toxin.

STOT - single exposure Not classified as causing organ damage from single exposure.

STOT - repeated exposure Not classified as causing organ damage from repeated exposure.

Aspiration Not classified as causing aspiration.

12. ECOLOGICAL INFORMATION

12.1 Toxicity

No information provided.

12.2 Persistence and degradability

No information provided.

12.3 Bioaccumulative potential

No information provided.

12.4 Mobility in soil

No information provided.

12.5 Other adverse effects

No information provided.

13. DISPOSAL CONSIDERATIONS

13.1 Waste treatment methods

Waste disposal Dispose of to an approved landfill or waste processing site. Contact the manufacturer/supplier for additional information (if required).

Legislation Dispose of in accordance with relevant local legislation.

14. TRANSPORT INFORMATION

NOT CLASSIFIED AS A DANGEROUS GOOD BY THE CRITERIA OF THE ADG CODE, IMDG OR IATA

	LAND TRANSPORT (ADG)	SEA TRANSPORT (IMDG / IMO)	AIR TRANSPORT (IATA / ICAO)
14.1 UN Number	None allocated.	None allocated.	None allocated.
14.2 Proper Shipping Name	None allocated.	None allocated.	None allocated.
14.3 Transport hazard class	None allocated.	None allocated.	None allocated.
14.4 Packing Group	None allocated.	None allocated.	None allocated.

14.5 Environmental hazards

No information provided.

14.6 Special precautions for user

Hazchem code None allocated.

15. REGULATORY INFORMATION

15.1 Safety, health and environmental regulations/legislation specific for the substance or mixture

Poison schedule A poison schedule number has not been allocated to this product using the criteria in the Standard for the Uniform Scheduling of Medicines and Poisons (SUSMP).

Classifications Safework Australia criteria is based on the Globally Harmonised System (GHS) of Classification and Labelling of Chemicals.

Inventory listings **AUSTRALIA: AICS (Australian Inventory of Chemical Substances)**
All components are listed on AICS, or are exempt.

16. OTHER INFORMATION

Additional information

PERSONAL PROTECTIVE EQUIPMENT GUIDELINES:
The recommendation for protective equipment contained within this report is provided as a guide only. Factors such as form of product, method of application, working environment, quantity used, product concentration and the availability of engineering controls should be considered before final selection of personal protective equipment is made.

HEALTH EFFECTS FROM EXPOSURE:
It should be noted that the effects from exposure to this product will depend on several factors including: form of product; frequency and duration of use; quantity used; effectiveness of control measures; protective equipment used and method of application. Given that it is impractical to prepare a report which would encompass all possible scenarios, it is anticipated that users will assess the risks and apply control methods where appropriate.

Abbreviations

ACGIH	American Conference of Governmental Industrial Hygienists
CAS #	Chemical Abstract Service number - used to uniquely identify chemical compounds
CNS	Central Nervous System
EC No.	EC No - European Community Number
EMS	Emergency Schedules (Emergency Procedures for Ships Carrying Dangerous Goods)
GHS	Globally Harmonized System
GTEPG	Group Text Emergency Procedure Guide
IARC	International Agency for Research on Cancer
LC50	Lethal Concentration, 50% / Median Lethal Concentration
LD50	Lethal Dose, 50% / Median Lethal Dose
mg/m³	Milligrams per Cubic Metre
OEL	Occupational Exposure Limit
pH	relates to hydrogen ion concentration using a scale of 0 (high acidic) to 14 (highly alkaline).
ppm	Parts Per Million
STEL	Short-Term Exposure Limit
STOT-RE	Specific target organ toxicity (repeated exposure)
STOT-SE	Specific target organ toxicity (single exposure)
SUSMP	Standard for the Uniform Scheduling of Medicines and Poisons
SWA	Safe Work Australia
TLV	Threshold Limit Value
TWA	Time Weighted Average

Report status

This document has been compiled by RMT on behalf of the manufacturer, importer or supplier of the product and serves as their Safety Data Sheet ('SDS').

It is based on information concerning the product which has been provided to RMT by the manufacturer, importer or supplier or obtained from third party sources and is believed to represent the current state of knowledge as to the appropriate safety and handling precautions for the product at the time of issue. Further clarification regarding any aspect of the product should be obtained directly from the manufacturer, importer or supplier.

While RMT has taken all due care to include accurate and up-to-date information in this SDS, it does not provide any warranty as to accuracy or completeness. As far as lawfully possible, RMT accepts no liability for any loss, injury or damage (including consequential loss) which may be suffered or incurred by any person as a consequence of their reliance on the information contained in this SDS.

Prepared by

Risk Management Technologies
5 Ventnor Ave, West Perth
Western Australia 6005
Phone: +61 8 9322 1711
Fax: +61 8 9322 1794
Email: info@rmt.com.au
Web: www.rmtglobal.com

[End of SDS]

NEWPARK DRILLING FLUIDS

SAFETY DATA SHEET

1. IDENTIFICATION OF THE MATERIAL AND SUPPLIER

1.1 Product identifier

Product name **DYNAFIBER (TM) AP (F, M, C)**

Synonyms DYNAFIBER ● NDFT 376 ● NDFT 377

1.2 Uses and uses advised against

Uses LOST CIRCULATION MATERIAL

1.3 Details of the supplier of the product

Supplier name **NEWPARK DRILLING FLUIDS (AUSTRALIA) LTD**

Address 11 Alacrity Place, Henderson, WA, 6166, AUSTRALIA

Telephone +61 8 9410 8200

Fax +61 8 9410 8299

Website www.newpark.com

1.4 Emergency telephone numbers

Emergency 1800 127 406 (Australia); +64 4 917 9888 (International)

2. HAZARDS IDENTIFICATION

2.1 Classification of the substance or mixture

NOT CLASSIFIED AS HAZARDOUS ACCORDING TO SAFE WORK AUSTRALIA CRITERIA

2.2 GHS Label elements

No signal word, pictograms, hazard or precautionary statements have been allocated.

2.3 Other hazards

No information provided.

3. COMPOSITION/ INFORMATION ON INGREDIENTS

3.1 Substances / Mixtures

Ingredient	CAS Number	EC Number	Content
ORGANIC FIBRE(S)	[redacted]	232-674-9	100%

4. FIRST AID MEASURES

4.1 Description of first aid measures

Eye If in eyes, hold eyelids apart and flush continuously with running water. Continue flushing until advised to stop by a Poisons Information Centre, a doctor, or for at least 15 minutes.

Inhalation If inhaled, remove from contaminated area. Apply artificial respiration if not breathing.

Skin If skin or hair contact occurs, remove contaminated clothing and flush skin and hair with running water. Continue flushing with water until advised to stop by a Poisons Information Centre or a doctor.

Ingestion For advice, contact a Poisons Information Centre on 13 11 26 (Australia Wide) or a doctor (at once). Due to product form and application, ingestion is considered unlikely.

First aid facilities None allocated.

4.2 Most important symptoms and effects, both acute and delayed

See Section 11 for more detailed information on health effects and symptoms.

4.3 Immediate medical attention and special treatment needed
Treat symptomatically.

5. FIRE FIGHTING MEASURES

5.1 Extinguishing media
Dry agent, carbon dioxide, foam or water fog. Prevent contamination of drains or waterways.

5.2 Special hazards arising from the substance or mixture
Combustible. May evolve carbon oxides and hydrocarbons when heated to decomposition.

5.3 Advice for firefighters
Evacuate area and contact emergency services. Toxic gases may be evolved in a fire situation. Remain upwind and notify those downwind of hazard. Wear full protective equipment including Self Contained Breathing Apparatus (SCBA) when combating fire. Use waterfog to cool intact containers and nearby storage areas.

5.4 Hazchem code
None allocated.

6. ACCIDENTAL RELEASE MEASURES

6.1 Personal precautions, protective equipment and emergency procedures
Wear Personal Protective Equipment (PPE) as detailed in section 8 of the SDS. Clear area of all unprotected personnel. Contact emergency services where appropriate.

6.2 Environmental precautions
Prevent product from entering drains and waterways.

6.3 Methods of cleaning up
Contain spillage, then collect and place in suitable containers for reuse or disposal. Avoid generating dust.

6.4 Reference to other sections
See Sections 8 and 13 for exposure controls and disposal.

7. HANDLING AND STORAGE

7.1 Precautions for safe handling
Before use carefully read the product label. Use of safe work practices are recommended to avoid eye or skin contact and inhalation. Observe good personal hygiene, including washing hands before eating. Prohibit eating, drinking and smoking in contaminated areas.

7.2 Conditions for safe storage, including any incompatibilities
Store in a cool, dry, well ventilated area, removed from incompatible substances, heat or ignition sources and foodstuffs. Ensure containers are adequately labelled, protected from physical damage and sealed when not in use. Check regularly for leaks or spills. Large storage areas should have appropriate ventilation systems.

7.3 Specific end uses
No information provided.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

8.1 Control parameters
Exposure standards

Ingredient	Reference	TWA		STEL	
		ppm	mg/m³	ppm	mg/m³
Cellulose (paper fibre) (a)	SWA [AUS]	--	10	--	--

Biological limits
No biological limit values have been entered for this product.

8.2 Exposure controls

Engineering controls Avoid inhalation. Use in well ventilated areas. Where an inhalation risk exists, mechanical explosion proof extraction ventilation is recommended. Maintain dust levels below the recommended exposure standard.

PPE

Eye / Face	Wear dust-proof goggles.
Hands	Wear PVC or rubber gloves.
Body	Not required under normal conditions of use.
Respiratory	Where an inhalation risk exists, wear a Class P1 (Particulate) respirator.



9. PHYSICAL AND CHEMICAL PROPERTIES

9.1 Information on basic physical and chemical properties

Appearance	YELLOW TO BROWN SOLID
Odour	SLIGHT ODOUR
Flammability	COMBUSTIBLE
Flash point	NOT AVAILABLE
Boiling point	NOT AVAILABLE
Melting point	NOT AVAILABLE
Evaporation rate	NOT AVAILABLE
pH	7 to 8
Vapour density	NOT AVAILABLE
Relative density	0.9 to 1.2
Solubility (water)	INSOLUBLE
Vapour pressure	NOT AVAILABLE
Upper explosion limit	NOT AVAILABLE
Lower explosion limit	NOT AVAILABLE
Partition coefficient	NOT AVAILABLE
Autoignition temperature	NOT AVAILABLE
Decomposition temperature	NOT AVAILABLE
Viscosity	NOT AVAILABLE
Explosive properties	NOT AVAILABLE
Oxidising properties	NOT AVAILABLE
Odour threshold	NOT AVAILABLE

10. STABILITY AND REACTIVITY

10.1 Reactivity

Carefully review all information provided in sections 10.2 to 10.6.

10.2 Chemical stability

Stable under recommended conditions of storage.

10.3 Possibility of hazardous reactions

Polymerization is not expected to occur.

10.4 Conditions to avoid

Avoid heat, sparks, open flames and other ignition sources.

10.5 Incompatible materials

Incompatible with oxidising agents (e.g. hypochlorites), acids (e.g. nitric acid), heat and ignition sources.

10.6 Hazardous decomposition products

May evolve carbon oxides and hydrocarbons when heated to decomposition.

11. TOXICOLOGICAL INFORMATION

11.1 Information on toxicological effects

Acute toxicity This product is expected to be of low acute toxicity. Under normal conditions of use, adverse health effects are not anticipated.

Information available for the ingredients:

Ingredient	Oral LD50	Dermal LD50	Inhalation LC50
ORGANIC FIBRE(S)	> 5000 mg/kg (rat)	> 2000 mg/kg (rabbit)	> 5800 mg/m³/4 hours (rat)

Skin Not classified as a skin irritant. Skin irritation is not anticipated under normal conditions of use.

Eye Not classified as an eye irritant. Eye irritation is not anticipated under normal conditions of use.

Sensitisation Not classified as causing skin or respiratory sensitisation.

Mutagenicity Not classified as a mutagen.

Carcinogenicity Not classified as a carcinogen.

Reproductive Not classified as a reproductive toxin.

STOT - single exposure Not classified as causing organ damage from single exposure.

STOT - repeated exposure Not classified as causing organ damage from repeated exposure.

Aspiration Not relevant.

12. ECOLOGICAL INFORMATION

12.1 Toxicity

No information provided.

12.2 Persistence and degradability

No information provided.

12.3 Bioaccumulative potential

No information provided.

12.4 Mobility in soil

No information provided.

12.5 Other adverse effects

No information provided.

13. DISPOSAL CONSIDERATIONS

13.1 Waste treatment methods

Waste disposal Reuse or recycle where possible. Alternatively, ensure product is covered with moist soil to prevent dust generation and dispose of to an approved landfill site. Contact the manufacturer/supplier for additional information (if required).

Legislation Dispose of in accordance with relevant local legislation.

14. TRANSPORT INFORMATION

NOT CLASSIFIED AS A DANGEROUS GOOD BY THE CRITERIA OF THE ADG CODE, IMDG OR IATA

	LAND TRANSPORT (ADG)	SEA TRANSPORT (IMDG / IMO)	AIR TRANSPORT (IATA / ICAO)
14.1 UN Number	None allocated.	None allocated.	None allocated.
14.2 Proper Shipping Name	None allocated.	None allocated.	None allocated.
14.3 Transport hazard class	None allocated.	None allocated.	None allocated.
14.4 Packing Group	None allocated.	None allocated.	None allocated.

14.5 Environmental hazards

No information provided.

14.6 Special precautions for user

Hazchem code None allocated.

15. REGULATORY INFORMATION

15.1 Safety, health and environmental regulations/legislation specific for the substance or mixture

Poison schedule A poison schedule number has not been allocated to this product using the criteria in the Standard for the Uniform Scheduling of Medicines and Poisons (SUSMP).

Classifications Safe Work Australia criteria is based on the Globally Harmonised System (GHS) of Classification and Labelling of Chemicals (GHS Revision 7).

Inventory listings **AUSTRALIA: AIIC (Australian Inventory of Industrial Chemicals)**
All components are listed on AIIC, or are exempt.

16. OTHER INFORMATION

Additional information

EXPOSURE STANDARDS - TIME WEIGHTED AVERAGES: Exposure standards are established on the premise of an 8 hour work period of normal intensity, under normal climatic conditions and where a 16 hour break between shifts exists to enable the body to eliminate absorbed contaminants. In the following circumstances, exposure standards must be reduced: Strenuous work conditions; hot, humid climates; high altitude conditions; extended shifts (which increase the exposure period and shorten the period of recuperation).

COMBUSTIBLE - EXPLOSIVE CARBONACEOUS DUST: Carbonaceous/organic dusts have the potential, with dispersion, to present an explosion hazard if an ignition source exists. All equipment used to handle, transfer or store this product MUST BE cleaned thoroughly prior to cutting, welding, drilling or exposure to any other form of heat or ignition sources. If bulk stored, containers should be ventilated on a routine basis to avoid vapour accumulation (where applicable, eg for flocculants).

PERSONAL PROTECTIVE EQUIPMENT GUIDELINES:
The recommendation for protective equipment contained within this report is provided as a guide only. Factors such as form of product, method of application, working environment, quantity used, product concentration and the availability of engineering controls should be considered before final selection of personal protective equipment is made.

HEALTH EFFECTS FROM EXPOSURE:
It should be noted that the effects from exposure to this product will depend on several factors including: form of product; frequency and duration of use; quantity used; effectiveness of control measures; protective equipment used and method of application. Given that it is impractical to prepare a report which would encompass all possible scenarios, it is anticipated that users will assess the risks and apply control methods where appropriate.

Abbreviations

ACGIH	American Conference of Governmental Industrial Hygienists
CAS #	Chemical Abstract Service number - used to uniquely identify chemical compounds
CNS	Central Nervous System
EC No.	EC No - European Community Number
EMS	Emergency Schedules (Emergency Procedures for Ships Carrying Dangerous Goods)
GHS	Globally Harmonized System
GTEPG	Group Text Emergency Procedure Guide
IARC	International Agency for Research on Cancer
LC50	Lethal Concentration, 50% / Median Lethal Concentration
LD50	Lethal Dose, 50% / Median Lethal Dose
mg/m³	Milligrams per Cubic Metre
OEL	Occupational Exposure Limit
pH	relates to hydrogen ion concentration using a scale of 0 (high acidic) to 14 (highly alkaline).
ppm	Parts Per Million
STEL	Short-Term Exposure Limit
STOT-RE	Specific target organ toxicity (repeated exposure)
STOT-SE	Specific target organ toxicity (single exposure)
SUSMP	Standard for the Uniform Scheduling of Medicines and Poisons
SWA	Safe Work Australia
TLV	Threshold Limit Value
TWA	Time Weighted Average

Report status

This document has been compiled by RMT on behalf of the manufacturer, importer or supplier of the product and serves as their Safety Data Sheet ('SDS').

It is based on information concerning the product which has been provided to RMT by the manufacturer, importer or supplier or obtained from third party sources and is believed to represent the current state of knowledge as to the appropriate safety and handling precautions for the product at the time of issue. Further clarification regarding any aspect of the product should be obtained directly from the manufacturer, importer or supplier.

While RMT has taken all due care to include accurate and up-to-date information in this SDS, it does not provide any warranty as to accuracy or completeness. As far as lawfully possible, RMT accepts no liability for any loss, injury or damage (including consequential loss) which may be suffered or incurred by any person as a consequence of their reliance on the information contained in this SDS.

Prepared by

Risk Management Technologies
5 Ventnor Ave, West Perth
Western Australia 6005
Phone: +61 8 9322 1711
Fax: +61 8 9322 1794
Email: info@rmt.com.au
Web: www.rmtglobal.com

[End of SDS]

SAFETY DATA SHEET

EvoCon® E

NDF00576 **Revision Date** 02-Aug-2019 **Version** 1

Section 1: IDENTIFICATION OF THE SUBSTANCE/MIXTURE AND OF THE COMPANY/UNDERTAKING

1.1. Product identifier

Product Code NDF00576
Product Name EvoCon® E

Contains Poly(oxy-1,2-ethanediyl), alpha-octyl-omega-hydroxy-

1.2. Relevant identified uses of the substance or mixture and uses advised against

Recommended Use Lubricant

Uses advised against No information available

1.3. Details of the supplier of the safety data sheet

Supplier
Newpark Drilling Fluids (Australia) LTD
11 Alacrity Place
Henderson, WA, 6166
Australia

For further information, please contact

Contact Point
Telephone: +61 8 9410 8200
Fax: +61 8 9410 8299
Website: www.newpark.com

1.4. Emergency telephone number

Emergency telephone number 1800 127 406 (Australia); +64 4 917 9888 (International)

Section 2: HAZARDS IDENTIFICATION

2.1. Classification of the substance or mixture

Regulation (EC) No 1272/2008

Serious eye damage/eye irritation	Category 1 - (H318)

Classification according to Directive 67/548/EEC or 1999/45/EC
Full text of R-phrases: see section 16

Hazard symbols
Not dangerous

2.2. Label elements

Product identifier
Contains Poly(oxy-1,2-ethanediyl), alpha-octyl-omega-hydroxy-



Signal word
Danger

Hazard statements
H318 - Causes serious eye damage
H227 - Combustible liquid

Precautionary Statements - EU (§28, 1272/2008)
P280 - Wear eye protection/ face protection
P305 + P351 + P338 - IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing
P310 - Immediately call a POISON CENTER or doctor

2.3. Other hazards
No information available

Section 3: COMPOSITION/INFORMATION ON INGREDIENTS

3.1 Substances

Chemical name	CAS No.	Weight-%	Classification according to Directive 67/548/EEC or 1999/45/EC	Classification according to Regulation (EC) No. 1272/2008 [CLP]
Poly(oxy-1,2-ethanediyl), alpha-octyl-omega-hydroxy-	[redacted]	70-90	-	Eye Dam. 1 (H318)

Full text of R-phrases: see section 16

Full text of H- and EUH-phrases: see section 16

Section 4: FIRST AID MEASURES

4.1. Description of first aid measures

Inhalation Remove to fresh air.

Skin contact Wash off immediately with soap and plenty of water while removing all contaminated clothes and shoes.

Eye contact Rinse thoroughly with plenty of water for at least 15 minutes, lifting lower and upper eyelids. Consult a physician.

Ingestion Clean mouth with water and drink afterwards plenty of water.

4.2. Most important symptoms and effects, both acute and delayed

Symptoms No information available.

4.3. Indication of any immediate medical attention and special treatment needed

Note to physicians Treat symptomatically.

Section 5: FIRE FIGHTING MEASURES

5.1. Extinguishing media

Suitable extinguishing media
Use extinguishing measures that are appropriate to local circumstances and the surrounding environment.

Small Fire	Dry chemical or CO2.
Large Fire	Move containers from fire area if you can do it without risk. Water spray or fog.

Unsuitable extinguishing media
No information available

5.2. Special hazards arising from the substance or mixture

Thermal decomposition can lead to release of irritating and toxic gases and vapors

5.3. Advice for firefighters

Wear self-contained breathing apparatus and protective suit. Use personal protective equipment as required.

Section 6: ACCIDENTAL RELEASE MEASURES

6.1. Personal precautions, protective equipment and emergency procedures

Personal precautions
Ensure adequate ventilation, especially in confined areas.

For emergency responders
Use personal protection recommended in Section 8.

6.2. Environmental precautions

See Section 12 for additional Ecological Information.

6.3. Methods and material for containment and cleaning up

Methods for containment	Prevent further leakage or spillage if safe to do so.
Methods for cleaning up	Take up mechanically, placing in appropriate containers for disposal.

6.4. Reference to other sections

See section 13 for more information.

Section 7: HANDLING AND STORAGE

7.1. Precautions for safe handling

Advice on safe handling
Ensure adequate ventilation, especially in confined areas.

General Hygiene Considerations
Handle in accordance with good industrial hygiene and safety practice.

7.2. Conditions for safe storage, including any incompatibilities

Storage Conditions
Keep container tightly closed in a dry and well-ventilated place.

7.3. Specific end use(s)

Risk Management Methods (RMM)
The information required is contained in this Material Safety Data Sheet.

Section 8: EXPOSURE CONTROLS/PERSONAL PROTECTION

8.1. Control parameters

Derived No Effect Level (DNEL)	No information available
Predicted No Effect Concentration (PNEC)	No information available.

8.2. Exposure controls

Engineering Controls	Ensure adequate ventilation, especially in confined areas.
Personal protective equipment	
Eye/face protection	Tight sealing safety goggles.
Skin and body protection	Suitable protective clothing.
Environmental exposure controls	No information available.

Section 9: PHYSICAL AND CHEMICAL PROPERTIES

9.1. Information on basic physical and chemical properties

Physical state	Liquid		
Appearance	liquid	**Odor**	Alcohol
Color	yellow	**Odor threshold**	No data available

Property	**Values**	**Remarks • Method**
pH	4.5 - 7.5	
Melting point / freezing point		No data available
Boiling point / boiling range	> 90 °C / > 194 °F	
Flash point	> 93 °C / > 199.4 °F	
Evaporation rate		No data available
Flammability (solid, gas)		No data available
Flammability Limit in Air		
Upper flammability limit:		No data available
Lower flammability limit:		No data available
Vapor pressure		No data available
Vapor density		No data available
Specific Gravity	1.005	
Water solubility	Dispersible	
Solubility(ies)		No information available
Partition coefficient		No data available
Autoignition temperature		No data available

Decomposition temperature		No data available
Kinematic viscosity	>70 cSt@25deg C	
Dynamic viscosity		No data available
Explosive properties	Not an explosive	
Oxidizing properties	Not applicable	

9.2. Other information

Softening point	Not applicable
Molecular weight	No data available
VOC Content (%)	Not applicable
Liquid Density	No data available
Bulk density	No information available

Section 10: STABILITY AND REACTIVITY

10.1. Reactivity

Stable under normal conditions.

10.2. Chemical stability

Stable under normal conditions.

Explosion data

Sensitivity to Mechanical Impact	None.
Sensitivity to Static Discharge	None.

10.3. Possibility of hazardous reactions

Possibility of Hazardous Reactions
None under normal processing.

10.4. Conditions to avoid

Extremes of temperature and direct sunlight.

10.5. Incompatible materials

Strong acids. Strong bases.

10.6. Hazardous decomposition products

None under normal use conditions.

Section 11: TOXICOLOGICAL INFORMATION

11.1. Information on toxicological effects

Acute toxicity

Product Information
Product does not present an acute toxicity hazard based on known or supplied information.

National Regulations	No data available.
Eye contact	No data available.
Skin contact	No data available.
Ingestion	No data available.

Skin corrosion/irritation No information available.

Serious eye damage/eye irritation	No information available.
Sensitization	No information available.
Germ cell mutagenicity	No information available.
Carcinogenicity	No information available.
Reproductive toxicity	No information available.
STOT - single exposure	No information available.
STOT - repeated exposure	No information available.
Aspiration hazard	No information available.

Section 12: ECOLOGICAL INFORMATION

12.1. Toxicity

12.2. Persistence and degradability

No information available.

12.3. Bioaccumulative potential

No information available.

12.4. Mobility in soil

Mobility in soil
No information available.

12.5. Results of PBT and vPvB assessment

No information available.

12.6. Other adverse effects

No information available

Section 13: DISPOSAL CONSIDERATIONS

13.1. Waste treatment methods

Waste from residues/unused products	Disposal should be in accordance with applicable regional, national and local laws and regulations.
Contaminated packaging	Improper disposal or reuse of this container may be dangerous and illegal.

Section 14: TRANSPORT INFORMATION

IMDG

14.1 UN/ID no	OTHER SHIPPING INFORMATION: This product when tested according to ASTM D4206 does not sustain combustion andaccording to 49 CFR 173.120(b)(3) is not regulated as a combustible liquid
14.2 Proper shipping name	OTHER SHIPPING INFORMATION: This product when tested according to ASTM D4206 does not sustain combustion andaccording to 49 CFR 173.120(b)(3) is not regulated as a combustible liquid
14.3 Hazard Class	OTHER SHIPPING INFORMATION: This product when tested according to ASTM D4206 does not sustain combustion andaccording to 49 CFR 173.120(b)(3) is not regulated as a combustible liquid
14.4 Packing Group	OTHER SHIPPING INFORMATION: This product when tested according to ASTM D4206 does not sustain combustion andaccording to 49 CFR 173.120(b)(3) is not regulated as a combustible liquid
14.5 Marine pollutant	Not applicable
14.6 Special Provisions	None
14.7 Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code	No information available

RID

14.1 UN/ID no	OTHER SHIPPING INFORMATION: This product when tested according to ASTM D4206 does not sustain combustion andaccording to 49 CFR 173.120(b)(3) is not regulated as a combustible liquid
14.2 Proper shipping name	OTHER SHIPPING INFORMATION: This product when tested according to ASTM D4206 does not sustain combustion andaccording to 49 CFR 173.120(b)(3) is not regulated as a combustible liquid
14.3 Hazard Class	OTHER SHIPPING INFORMATION: This product when tested according to ASTM D4206 does not sustain combustion andaccording to 49 CFR 173.120(b)(3) is not regulated as a combustible liquid
14.4 Packing Group	OTHER SHIPPING INFORMATION: This product when tested according to ASTM D4206 does not sustain combustion andaccording to 49 CFR 173.120(b)(3) is not regulated as a combustible liquid
14.5 Environmental hazard	Not applicable
14.6 Special Provisions	None

ADR

14.1 UN/ID no	OTHER SHIPPING INFORMATION: This product when tested according to ASTM D4206 does not sustain combustion andaccording to 49 CFR 173.120(b)(3) is not regulated as a combustible liquid
14.2 Proper shipping name	OTHER SHIPPING INFORMATION: This product when tested according to ASTM D4206 does not sustain combustion andaccording to 49 CFR 173.120(b)(3) is not regulated as a combustible liquid
14.3 Hazard Class	OTHER SHIPPING INFORMATION: This product when tested according to ASTM D4206 does not sustain combustion andaccording to 49 CFR 173.120(b)(3) is not regulated as a combustible liquid
14.4 Packing Group	OTHER SHIPPING INFORMATION: This product when tested according to ASTM D4206 does not sustain combustion andaccording to 49 CFR 173.120(b)(3) is not regulated as a combustible liquid
14.5 Environmental hazard	Not applicable
14.6 Special Provisions	None

ICAO (air)

14.1 UN/ID no	OTHER SHIPPING INFORMATION: This product when tested according to ASTM D4206 does not sustain combustion andaccording to 49 CFR 173.120(b)(3) is not regulated as a combustible liquid
14.2 Proper shipping name	OTHER SHIPPING INFORMATION: This product when tested according to ASTM D4206 does not sustain combustion andaccording to 49 CFR 173.120(b)(3) is not regulated as a combustible liquid
14.3 Hazard Class	OTHER SHIPPING INFORMATION: This product when tested according to ASTM D4206 does not sustain combustion andaccording to 49 CFR 173.120(b)(3) is not regulated as a combustible liquid
14.4 Packing Group	OTHER SHIPPING INFORMATION: This product when tested according to ASTM D4206 does not sustain combustion andaccording to 49 CFR 173.120(b)(3) is not regulated as a combustible liquid

14.5 Environmental hazard	Not applicable
14.6 Special Provisions	None

IATA

14.1 UN/ID no	OTHER SHIPPING INFORMATION: This product when tested according to ASTM D4206 does not sustain combustion andaccording to 49 CFR 173.120(b)(3) is not regulated as a combustible liquid
14.2 Proper shipping name	OTHER SHIPPING INFORMATION: This product when tested according to ASTM D4206 does not sustain combustion andaccording to 49 CFR 173.120(b)(3) is not regulated as a combustible liquid
14.3 Hazard Class	OTHER SHIPPING INFORMATION: This product when tested according to ASTM D4206 does not sustain combustion andaccording to 49 CFR 173.120(b)(3) is not regulated as a combustible liquid
14.4 Packing Group	OTHER SHIPPING INFORMATION: This product when tested according to ASTM D4206 does not sustain combustion andaccording to 49 CFR 173.120(b)(3) is not regulated as a combustible liquid
14.5 Environmental hazard	Not applicable
14.6 Special Provisions	None

HAZCHEM Emergency Action Code
No information available

Section 15: REGULATORY INFORMATION

15.1. Safety, health and environmental regulations/legislation specific for the substance or mixture

National regulations

Australia
See section 8 for national exposure control parameters

Carcinogenicity

International Inventories

TSCA	Complies
DSL/NDSL	Complies
EINECS/ELINCS	Complies
ENCS	Complies
IECSC	Complies
KECL	Complies
PICCS	Does not comply
AICS	Complies
NZIoC	Complies

Legend:
TSCA - United States Toxic Substances Control Act Section 8(b) Inventory
DSL/NDSL - Canadian Domestic Substances List/Non-Domestic Substances List
EINECS/ELINCS - European Inventory of Existing Chemical Substances/European List of Notified Chemical Substances
ENCS - Japan Existing and New Chemical Substances
IECSC - China Inventory of Existing Chemical Substances
KECL - Korean Existing and Evaluated Chemical Substances
PICCS - Philippines Inventory of Chemicals and Chemical Substances
AICS - Australian Inventory of Chemical Substances
NZIoC - New Zealand Inventory of Chemicals

15.2. Chemical safety assessment

No information available

Section 16: OTHER INFORMATION

Full text of R-phrases referred to under sections 2 and 3
No information available

Full text of H-Statements referred to under section 3
H318 - Causes serious eye damage

Revision Date 02-Aug-2019

This material safety data sheet complies with the requirements of Regulation (EC) No. 1907/2006

Disclaimer
According to Regulation (EC) No 1272/2008 of the European Parliament and of the Council of 16 December 2008 on classification, labelling and packaging of substances and mixtures, amending and repealing Directives 67/548/EEC and 1999/45/EC, and amending Regulation (EC) No 1907/2006, as amended by Regulation (EU) No. 2015/830.
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End of Safety Data Sheet

SAFETY DATA SHEET

EvoLube® G

NDF00150 **Revision Date** 30-Jul-2019 **Version** 1

Section 1: IDENTIFICATION OF THE SUBSTANCE/MIXTURE AND OF THE COMPANY/UNDERTAKING

1.1. Product identifier

Product Code NDF00150
Product Name EvoLube® G

Contains Petroleum distillates, hydrotreated light

1.2. Relevant identified uses of the substance or mixture and uses advised against

Recommended Use Lubricant

Uses advised against No information available

1.3. Details of the supplier of the safety data sheet

Supplier
Newpark Drilling Fluids (Australia) LTD
11 Alacrity Place
Henderson, WA, 6166
Australia

For further information, please contact

Contact Point
Telephone: +61 8 9410 8200
Fax: +61 8 9410 8299
Website: www.newpark.com

1.4. Emergency telephone number

Emergency telephone number 1800 127 406 (Australia); +64 4 917 9888 (International)

Section 2: HAZARDS IDENTIFICATION

2.1. Classification of the substance or mixture

Regulation (EC) No 1272/2008

Aspiration hazard	Category 1 - (H304)
Specific target organ toxicity (single exposure)	Category 3 - (H336)
Chronic aquatic toxicity	Category 2 - (H411)

Classification according to Directive 67/548/EEC or 1999/45/EC
Full text of R-phrases: see section 16

Hazard symbols
Xn - Harmful

R-code(s)
Xn;R65

2.2. Label elements

Product identifier

Contains Petroleum distillates, hydrotreated light



Signal word
Danger

Hazard statements
H304 - May be fatal if swallowed and enters airways
H336 - May cause drowsiness or dizziness
H411 - Toxic to aquatic life with long lasting effects
H335 - May cause respiratory irritation

Precautionary Statements - EU (§28, 1272/2008)
P301 + P310 - IF SWALLOWED: Immediately call a POISON CENTER or doctor/physician
P331 - Do NOT induce vomiting

2.3. Other hazards
Harmful to aquatic life

Section 3: COMPOSITION/INFORMATION ON INGREDIENTS

3.1 Substances

Chemical name	CAS No.	Weight-%	Classification according to Directive 67/548/EEC or 1999/45/EC	Classification according to Regulation (EC) No. 1272/2008 [CLP]
Petroleum distillates, hydrotreated light	[redacted]	15-40	Xn; R65	Asp. Tox. 1 (H304)

Full text of R-phrases: see section 16

Full text of H- and EUH-phrases: see section 16

Section 4: FIRST AID MEASURES

4.1. Description of first aid measures

General advice If symptoms persist, call a physician. Do not breathe dust/fume/gas/mist/vapors/spray. Do not get in eyes, on skin, or on clothing.

Inhalation Remove to fresh air. Call a physician. If breathing is irregular or stopped, administer artificial respiration. Avoid direct contact with skin. Use barrier to give mouth-to-mouth resuscitation.

Skin contact Wash skin with soap and water. Remove contaminated clothing and shoes. Wash contaminated clothing before reuse. Get medical attention if irritation develops and persists.

Eye contact Immediately flush with plenty of water. After initial flushing, remove any contact lenses and continue flushing for at least 15 minutes. Keep eye wide open while rinsing. If symptoms persist, call a physician.

Ingestion Do NOT induce vomiting. Rinse mouth. Drink plenty of water. If symptoms persist, call a physician.

Self-protection of the first aider Use personal protective equipment as required.

4.2. Most important symptoms and effects, both acute and delayed

Symptoms No information available.

4.3. Indication of any immediate medical attention and special treatment needed

Note to physicians Treat symptomatically.

Section 5: FIRE FIGHTING MEASURES

5.1. Extinguishing media

Suitable extinguishing media
Use extinguishing measures that are appropriate to local circumstances and the surrounding environment.

Unsuitable extinguishing media
No information available

5.2. Special hazards arising from the substance or mixture

Thermal decomposition can lead to release of irritating and toxic gases and vapors

Hazardous combustion products Carbon oxides.

5.3. Advice for firefighters

Wear self-contained breathing apparatus and protective suit. Use personal protective equipment as required.

Section 6: ACCIDENTAL RELEASE MEASURES

6.1. Personal precautions, protective equipment and emergency procedures

Personal precautions
Ensure adequate ventilation, especially in confined areas. Keep people away from and upwind of spill/leak.

For emergency responders
In the case of vapor formation use a respirator with an approved filter.

6.2. Environmental precautions

Prevent entry into waterways, sewers, basements or confined areas. Do not flush into surface water or sanitary sewer system. See Section 12 for additional Ecological Information.

6.3. Methods and material for containment and cleaning up

Methods for containment Prevent further leakage or spillage if safe to do so. Dike to collect large liquid spills.

Methods for cleaning up Use personal protective equipment as required. Use a non-combustible material like vermiculite or sand to soak up the product and place into a container for later disposal. Use clean non-sparking tools to collect absorbed material.

6.4. Reference to other sections

See section 13 for more information.

Section 7: HANDLING AND STORAGE

7.1. Precautions for safe handling

Advice on safe handling
Wash contaminated clothing before reuse. Handle in accordance with good industrial hygiene and safety practice. Wash thoroughly after handling.

General Hygiene Considerations
Handle in accordance with good industrial hygiene and safety practice.

7.2. Conditions for safe storage, including any incompatibilities

Storage Conditions
Keep container tightly closed in a dry and well-ventilated place. Keep out of the reach of children.

7.3. Specific end use(s)

Risk Management Methods (RMM)
The information required is contained in this Material Safety Data Sheet.

Section 8: EXPOSURE CONTROLS/PERSONAL PROTECTION

8.1. Control parameters

Chemical name	Australia	European Union	United Kingdom	France	Spain	Germany
Petroleum distillates, hydrotreated light 64742-47-8		-	-	-	-	TWA: 5 mg/m³ TWA: 50 ppm TWA: 350 mg/m³ Ceiling / Peak: 20 mg/m³ Ceiling / Peak: 100 ppm Ceiling / Peak: 700 mg/m³

Chemical name	Austria	Switzerland	Poland	Norway	Ireland
Petroleum distillates, hydrotreated light 64742-47-8	-	TWA: 50 ppm TWA: 350 mg/m³ TWA: 5 mg/m³ STEL: 100 ppm STEL: 700 mg/m³	-	-	-

Derived No Effect Level (DNEL) No information available

Predicted No Effect Concentration (PNEC) No information available.

8.2. Exposure controls

Engineering Controls Ensure adequate ventilation, especially in confined areas.

Personal protective equipment

Eye/face protection Tight sealing safety goggles.

Skin and body protection Suitable protective clothing.

Environmental exposure controls Do not allow into any sewer, on the ground or into any body of water.

Section 9: PHYSICAL AND CHEMICAL PROPERTIES

9.1. Information on basic physical and chemical properties

Physical state	liquid		
Appearance	No information available	**Odor**	No information available
Color	yellow to dark amber	**Odor threshold**	No data available

Property	**Values**	**Remarks • Method**
pH		No data available
Melting point / freezing point		No data available
Boiling point / boiling range		No data available
Flash point	> 107 °C / > 225 °F	
Evaporation rate		No data available
Flammability (solid, gas)		No data available
Flammability Limit in Air		
Upper flammability limit:		No data available
Lower flammability limit:		No data available
Vapor pressure		No data available
Vapor density		No data available
Specific Gravity	0.87-0.90	
Water solubility	Partially soluble	
Solubility(ies)		No information available
Partition coefficient		No data available
Autoignition temperature		No data available
Decomposition temperature		No data available
Kinematic viscosity		No data available
Dynamic viscosity		No data available
Explosive properties	Not an explosive	
Oxidizing properties	Not applicable	

9.2. Other information

Softening point	Not applicable
Molecular weight	No data available
VOC Content (%)	Not applicable
Liquid Density	No data available
Bulk density	No information available

Section 10: STABILITY AND REACTIVITY

10.1. Reactivity

Stable under normal conditions.

10.2. Chemical stability

Stable under normal conditions.

Explosion data

Sensitivity to Mechanical Impact	None.
Sensitivity to Static Discharge	None.

10.3. Possibility of hazardous reactions

Possibility of Hazardous Reactions
None under normal processing.

10.4. Conditions to avoid

Extremes of temperature and direct sunlight. Incompatible materials.

10.5. Incompatible materials

Strong oxidizing agents.

10.6. Hazardous decomposition products

None under normal use conditions.

Section 11: TOXICOLOGICAL INFORMATION

11.1. Information on toxicological effects

Acute toxicity

Product Information

Product does not present an acute toxicity hazard based on known or supplied information.

National Regulations	No data available.
Eye contact	No data available.
Skin contact	No data available.
Ingestion	No data available.

Unknown acute toxicity 0 % of the mixture consists of ingredient(s) of unknown toxicity.

The following values are calculated based on chapter 3.1 of the GHS document

ATEmix (oral)	6,873.00 mg/kg
ATEmix (dermal)	5,614.00 mg/kg
ATEmix (inhalation-dust/mist)	14.86 mg/l

Component Information

Skin corrosion/irritation Irritating to skin.

Serious eye damage/eye irritation No information available.

Sensitization None known.

Germ cell mutagenicity None known.

Carcinogenicity No information available.

Reproductive toxicity None known.

STOT - single exposure No information available.

STOT - repeated exposure No information available.

Symptoms Vapors may cause drowsiness and dizziness.

Aspiration hazard None known.

Section 12: ECOLOGICAL INFORMATION

12.1. Toxicity

Contains 0 % of components with unknown hazards to the aquatic environment

Chemical name	Algae/aquatic plants	Fish	Crustacea
Petroleum distillates, hydrotreated light	-	45: 96 h Pimephales promelas mg/L LC50 flow-through 2.2: 96 h Lepomis macrochirus mg/L LC50 static 2.4: 96 h Oncorhynchus mykiss mg/L LC50 static	4720: 96 h Den-dronereides heteropoda mg/L LC50

12.2. Persistence and degradability

No information available.

12.3. Bioaccumulative potential

.

12.4. Mobility in soil

Mobility in soil
No information available.

12.5. Results of PBT and vPvB assessment

No information available.

Chemical name	PBT and vPvB assessment
Petroleum distillates, hydrotreated light	The substance is not PBT / vPvB

12.6. Other adverse effects

No information available

Section 13: DISPOSAL CONSIDERATIONS

13.1. Waste treatment methods

Waste from residues/unused products Disposal should be in accordance with applicable regional, national and local laws and regulations.

Contaminated packaging Improper disposal or reuse of this container may be dangerous and illegal.

Other Information Waste codes should be assigned by the user based on the application for which the product was used.

Section 14: TRANSPORT INFORMATION

IMDG

14.1 UN/ID no Not regulated
14.2 Proper shipping name Not regulated
14.3 Hazard Class Not regulated
14.4 Packing Group Not regulated
14.5 Marine pollutant Not applicable
14.6 Special Provisions None
14.7 Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code No information available

RID

14.1 UN/ID no	Not regulated
14.2 Proper shipping name	Not regulated
14.3 Hazard Class	Not regulated
14.4 Packing Group	Not regulated
14.5 Environmental hazard	Not applicable
14.6 Special Provisions	None

ADR

14.1 UN/ID no	Not regulated
14.2 Proper shipping name	Not regulated
14.3 Hazard Class	Not regulated
14.4 Packing Group	Not regulated
14.5 Environmental hazard	Not applicable
14.6 Special Provisions	None

ICAO (air)

14.1 UN/ID no	Not regulated
14.2 Proper shipping name	Not regulated
14.3 Hazard Class	Not regulated
14.4 Packing Group	Not regulated
14.5 Environmental hazard	Not applicable
14.6 Special Provisions	None

IATA

14.1 UN/ID no	Not regulated
14.2 Proper shipping name	Not regulated
14.3 Hazard Class	Not regulated
14.4 Packing Group	Not regulated
14.5 Environmental hazard	Not applicable
14.6 Special Provisions	None

HAZCHEM Emergency Action Code
No information available

Section 15: REGULATORY INFORMATION

15.1. Safety, health and environmental regulations/legislation specific for the substance or mixture

National regulations

Australia
See section 8 for national exposure control parameters

Carcinogenicity

International Inventories

TSCA	Complies
DSL/NDSL	Complies
EINECS/ELINCS	Complies
ENCS	Does not comply
IECSC	Complies
KECL	Complies
PICCS	Complies
AICS	Complies
NZIoC	Complies

Legend:
TSCA - United States Toxic Substances Control Act Section 8(b) Inventory

DSL/NDSL - Canadian Domestic Substances List/Non-Domestic Substances List
EINECS/ELINCS - European Inventory of Existing Chemical Substances/European List of Notified Chemical Substances
ENCS - Japan Existing and New Chemical Substances
IECSC - China Inventory of Existing Chemical Substances
KECL - Korean Existing and Evaluated Chemical Substances
PICCS - Philippines Inventory of Chemicals and Chemical Substances
AICS - Australian Inventory of Chemical Substances
NZIoC - New Zealand Inventory of Chemicals

15.2. Chemical safety assessment

No information available

Section 16: OTHER INFORMATION

Full text of R-phrases referred to under sections 2 and 3
R65 - Harmful: may cause lung damage if swallowed

Full text of H-Statements referred to under section 3
H304 - May be fatal if swallowed and enters airways

Revision Date 30-Jul-2019

This material safety data sheet complies with the requirements of Regulation (EC) No. 1907/2006

Disclaimer
According to Regulation (EC) No 1272/2008 of the European Parliament and of the Council of 16 December 2008 on classification, labelling and packaging of substances and mixtures, amending and repealing Directives 67/548/EEC and 1999/45/EC, and amending Regulation (EC) No 1907/2006, as amended by Regulation (EU) No. 2015/830.
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End of Safety Data Sheet

SAFETY DATA SHEET

GageTrol™

Issue Date 15-Mar-2017 **Revision date** 23-Mar-2022 **Version** 1.1
EN

Section 1: IDENTIFICATION: PRODUCT INDENTIFIER AND CHEMICAL IDENTITY

Product identifier

Product Name GageTrol™

Product Code NDF00018

Other means of identification

Pure substance/mixture Substance

Recommended use of the chemical and restrictions on use

Recommended Use filtration control agent

Uses advised against No information available

Details of manufacturer or importer

Supplier
Newpark Drilling Fluids (Australia) LTD
11 Alacrity Place
Henderson, WA, 6166
Australia

For further information, please contact

Contact Point Telephone: +61 8 9410 8200
Fax: +61 8 9410 8299
Website: www.newpark.com

Emergency telephone number

Emergency telephone number +(61)-290372994 (Australia); +(64)-98010034 (New Zealand)

Section 2: HAZARD(S) IDENTIFICATION

GHS - Classification

Not a dangerous substance or mixture according to the Globally Harmonized System (GHS)

Label elements

Hazard statements
Not a dangerous substance or mixture according to the Globally Harmonized System (GHS)

Other hazards which do not result in classification

General Hazards

This substance does not meet the PBT/vPvB criteria of REACH, annex XIII

Section 3: COMPOSITION AND INFORMATION ON INGREDIENTS, IN ACCORDANCE WITH SCHEDULE 8

Substance

Chemical name	CAS No	Weight-%
Non-hazardous ingredients	-	100

Section 4: FIRST AID MEASURES

Description of first aid measures

Emergency telephone number Poisons Information Center, Australia: 13 11 26
Poisons Information Center, New Zealand: 0800 764 766

Inhalation Remove to fresh air.

Eye contact Rinse thoroughly with plenty of water for at least 15 minutes, lifting lower and upper eyelids. Consult a physician.

Skin contact Wash skin with soap and water.

Ingestion Clean mouth with water and drink afterwards plenty of water.

Most important symptoms and effects, both acute and delayed

Symptoms No information available.

Indication of any immediate medical attention and special treatment needed

Note to physicians Treat symptomatically.

Section 5: FIREFIGHTING MEASURES

Suitable Extinguishing Media

Suitable extinguishing media Dry chemical, CO2, water spray or regular foam.

Unsuitable extinguishing media No information available.

Specific hazards arising from the chemical

Thermal decomposition can lead to release of irritating and toxic gases and vapors. Do not allow run-off from fire-fighting to enter drains or water courses.

Hazardous combustion products Carbon oxides.

Special protective actions for fire-fighters

Special protective equipment for fire-fighters Firefighters should wear self-contained breathing apparatus and full firefighting turnout gear. Use personal protection equipment.

Hazchem code Not Listed.

Section 6: ACCIDENTAL RELEASE MEASURES

Personal precautions, protective equipment and emergency procedures

Personal precautions Ensure adequate ventilation.

For emergency responders Use personal protection recommended in Section 8.

Environmental precautions

Environmental precautions See Section 12 for additional Ecological Information. Do not flush into surface water or sanitary sewer system. Prevent product from entering drains.

Methods and material for containment and cleaning up

Methods for containment Prevent further leakage or spillage if safe to do so.

Methods for cleaning up Pick up and transfer to properly labeled containers.

Precautions to prevent secondary hazards

Prevention of secondary hazards Clean contaminated objects and areas thoroughly observing environmental regulations.

Section 7: HANDLING AND STORAGE, INCLUDING HOW THE CHEMICAL MAY BE SAFELY USED

Precautions for safe handling

Advice on safe handling Handle in accordance with good industrial hygiene and safety practice. Avoid generation of dust. Wash thoroughly after handling. Wash contaminated clothing before reuse.

General hygiene considerations Do not eat, drink or smoke when using this product. Wash hands before breaks and after work.

Conditions for safe storage, including any incompatibilities

Storage Conditions Keep containers tightly closed in a dry, cool and well-ventilated place.

Incompatible materials Strong oxidizing agents Strong acids

Section 8: EXPOSURE CONTROLS AND PERSONAL PROTECTION

Control parameters

Exposure Limits This product, as supplied, does not contain any hazardous materials with occupational exposure limits established by the region specific regulatory bodies.

Biological occupational exposure limits Not applicable

Appropriate engineering controls

Engineering controls Showers
Eyewash stations
Ventilation systems.

Individual protection measures, such as personal protective equipment

Eye/face protection Tight sealing safety goggles.

Skin and body protection Wear suitable protective clothing.

Respiratory protection In case of inadequate ventilation wear respiratory protection.

Environmental exposure controls Do not allow into any sewer, on the ground or into any body of water.

Section 9: PHYSICAL AND CHEMICAL PROPERTIES

Information on basic physical and chemical properties

Physical state	Solid		
Appearance	Powder	**Odor**	Slight.
Color	Off-white	**Odor threshold**	No information available

Property	**Values**	**Remarks • Method**
pH	9.0 - 10.5	4% solution
Melting point / freezing point		Not applicable
Boiling point / boiling range		Not applicable
Flash point		Not applicable
Evaporation rate		No information available
Flammability (solid, gas)		No information available
Flammability Limit in Air		No information available
Upper flammability limit:		No data available
Lower flammability limit:		No data available
Vapor pressure		No data available
Vapor density		No data available
Relative density	1.5	
Water solubility	Soluble in water	
Solubility(ies)		No information available
Partition coefficient		No information available
Autoignition temperature		No information available
Hyphen		No information available
Kinematic viscosity		Not applicable
Dynamic viscosity		Not applicable

Other information

Softening point	No information available
Molecular weight	No information available
VOC Content (%)	No information available
Liquid Density	No information available
Bulk density	30-45 lb/ft3 (480-720 kg/m^3)
Particle Size	No information available
Particle Size Distribution	No information available

Section 10: STABILITY AND REACTIVITY

Reactivity

Reactivity No information available.

Chemical stability

Stability Stable under normal conditions.

Explosion data

Sensitivity to Mechanical Impact None.
Sensitivity to Static Discharge None.

Possibility of hazardous reactions

Possibility of hazardous reactions None under normal processing.

Conditions to avoid

Conditions to avoid None known based on information supplied.

Incompatible materials

Incompatible materials Strong oxidizing agents. Strong acids.

Hazardous decomposition products

Hazardous Decomposition Products None known based on information supplied.

Section 11: TOXICOLOGICAL INFORMATION

Acute toxicity

Information on likely routes of exposure

Product Information .

Inhalation Specific test data for the substance or mixture is not available.

Eye contact Specific test data for the substance or mixture is not available.

Skin contact Specific test data for the substance or mixture is not available.

Ingestion Specific test data for the substance or mixture is not available

Symptoms No information available.

Numerical measures of toxicity - Product Information

Unknown acute toxicity 100 % of the mixture consists of ingredient(s) of unknown toxicity
100 % of the mixture consists of ingredient(s) of unknown acute oral toxicity
100 % of the mixture consists of ingredient(s) of unknown acute dermal toxicity
100 % of the mixture consists of ingredient(s) of unknown acute inhalation toxicity (gas)
100 % of the mixture consists of ingredient(s) of unknown acute inhalation toxicity (vapor)
100 % of the mixture consists of ingredient(s) of unknown acute inhalation toxicity (dust/mist)

See section 16 for terms and abbreviations

Delayed and immediate effects as well as chronic effects from short and long-term exposure

Skin corrosion/irritation No information available.

Serious eye damage/eye irritation No information available.

Respiratory or skin sensitization No information available.

Germ cell mutagenicity No information available.

Carcinogenicity No information available.

Reproductive toxicity No information available.

STOT - single exposure No information available.

STOT - repeated exposure No information available.

Aspiration hazard No information available.

Section 12: ECOLOGICAL INFORMATION

Ecotoxicity

Ecotoxicity The environmental impact of this product has not been fully investigated.

Unknown aquatic toxicity 0 % of the mixture consists of component(s) of unknown hazards to the aquatic environment.

Persistence and degradability

Persistence and degradability No information available.

Bioaccumulative potential

Bioaccumulation No information available.

Mobility

Mobility in soil No information available.

Mobility No information available.

Other adverse effects

Other adverse effects No information available.

Section 13: DISPOSAL CONSIDERATIONS

Waste treatment methods

Waste from residues/unused products Dispose of in accordance with local regulations. Dispose of waste in accordance with environmental legislation.

Contaminated packaging Do not reuse empty containers.

Section 14: TRANSPORT INFORMATION

ADG Not regulated

IATA Not Regulated

IMDG Not Regulated

Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code
No information available

Section 15: REGULATORY INFORMATION

Regulatory information

National regulations

Australia
See section 8 for national exposure control parameters

Standard for Uniform Scheduling of Medicines and Poisons (SUSMP)
No poisons schedule number allocated

International Inventories

TSCA	Complies
DSL/NDSL	Complies
EINECS/ELINCS	Complies
ENCS	Complies
IECSC	Complies
PICCS	Complies
AICS	Complies
NZIoC	Complies

Legend:
TSCA - United States Toxic Substances Control Act Section 8(b) Inventory
DSL/NDSL - Canadian Domestic Substances List/Non-Domestic Substances List
EINECS/ELINCS - European Inventory of Existing Chemical Substances/European List of Notified Chemical Substances
ENCS - Japan Existing and New Chemical Substances
IECSC - China Inventory of Existing Chemical Substances
KECL - Korean Existing and Evaluated Chemical Substances
PICCS - Philippines Inventory of Chemicals and Chemical Substances
AICS - Australian Inventory of Chemical Substances
NZIoC - New Zealand Inventory of Chemicals

International Regulations

The Montreal Protocol on Substances that Deplete the Ozone Layer Not applicable

The Stockholm Convention on Persistent Organic Pollutants Not applicable

The Rotterdam Convention Not applicable

Brunei Poison List Not applicable.

Section 16: ANY OTHER RELEVANT INFORMATION

Issue Date 15-Mar-2017

Revision date 23-Mar-2022

Revision Note
No information available.

Key or legend to abbreviations and acronyms used in the safety data sheet

Legend Section 8: EXPOSURE CONTROLS/PERSONAL PROTECTION

TWA	TWA (time-weighted average)	STEL	STEL (Short Term Exposure Limit)
Ceiling	Maximum limit value	*	Skin designation
C	Carcinogen		

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End of Safety Data Sheet

SAFETY DATA SHEET

Idcide G50

Issue Date 31-May-2021 **Revision Date** 01-Jun-2021 **Version** 1.1
EN

Section 1: IDENTIFICATION: PRODUCT INDENTIFIER AND CHEMICAL IDENTITY

Product identifier

Product Name Idcide G50

Product Code NDF00800

Other means of identification

UN Number UN2922

Recommended use of the chemical and restrictions on use

Recommended Use biocide

Uses advised against No information available

Details of manufacturer or importer

Supplier
Newpark Drilling Fluids (Australia) LTD
11 Alacrity Place
Henderson, WA, 6166
Australia

For further information, please contact

Contact Point Telephone: +61 8 9410 8200
Fax: +61 8 9410 8299
Website: www.newpark.com

Emergency telephone number

Emergency telephone number +(61)-290372994 (Australia); +(64)-98010034 (New Zealand)

Section 2: HAZARD(S) IDENTIFICATION

GHS - Classification

Acute toxicity - Oral	Category 3 - (H301)
Acute toxicity - Inhalation (Dusts/Mists)	Category 2 - (H330)
Skin corrosion/irritation	Category 1 - (H314)
Serious eye damage/eye irritation	Category 1 - (H318)
Respiratory sensitization	Category 1 - (H334)
Skin sensitization	Category 1 - (H317)
Specific target organ toxicity (single exposure)	Category 3 - (H335)
Acute aquatic toxicity	Category 1 - (H400)
Chronic aquatic toxicity	Category 2 - (H411)

Label elements

Skull and crossbones
Health hazard
Corrosion
Environment



Signal word
Danger

Hazard statements
H302 - Harmful if swallowed
H314 - Causes severe skin burns and eye damage
H317 - May cause an allergic skin reaction
H330 - Fatal if inhaled
H334 - May cause allergy or asthma symptoms or breathing difficulties if inhaled
H371 - May cause damage to organs
AUH071 - Corrosive to the respiratory tract

Precautionary Statements - Prevention
Wash face, hands and any exposed skin thoroughly after handling
Do not eat, drink or smoke when using this product
Do not breathe dust/fume/gas/mist/vapors/spray
Use only outdoors or in a well-ventilated area
Wear respiratory protection
Wear protective gloves/protective clothing/eye protection/face protection
In case of inadequate ventilation wear respiratory protection
Contaminated work clothing should not be allowed out of the workplace
Avoid release to the environment
Precautionary Statements - Response
Immediately call a POISON CENTER or doctor/physician
IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing
Immediately call a POISON CENTER or doctor/physician
IF ON SKIN (or hair): Remove/Take off immediately all contaminated clothing. Rinse skin with water/shower
Wash contaminated clothing before reuse
If skin irritation or rash occurs: Get medical advice/attention
IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing
Immediately call a POISON CENTER or doctor/physician
IF SWALLOWED: Call a POISON CENTER or doctor/physician if you feel unwell
Rinse mouth
Do NOT induce vomiting
Collect spillage
Precautionary Statements - Storage
Store in a well-ventilated place. Keep container tightly closed
Store locked up
Precautionary Statements - Disposal
Dispose of contents/container to an approved waste disposal plant

Other hazards
May be harmful in contact with skin
Very toxic to aquatic life with long lasting effects
Very toxic to aquatic life
General Hazards
No information available

Section 3: COMPOSITION AND INFORMATION ON INGREDIENTS, IN ACCORDANCE WITH SCHEDULE 8

Substance

Not applicable

Mixture

Chemical name	CAS No.	Weight-%	REACH Registration Number
Glutaraldehyde	[redacted]	>=50	01-2119455549-26-XXXX
Methyl alcohol	[redacted]	<=2	01-2119433307-44-XXXX

Chemical name	CAS No	Weight-%
Non-hazardous ingredients	Proprietary	Balance

Section 4: FIRST AID MEASURES

Description of first aid measures

General advice
Immediate medical attention is required. Show this safety data sheet to the doctor in attendance.

Emergency telephone number
Poisons Information Center, Australia: 13 11 26
Poisons Information Center, New Zealand: 0800 764 766

Inhalation
Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. If breathing is difficult, (trained personnel should) give oxygen. Delayed pulmonary edema may occur. May cause allergic respiratory reaction. If breathing has stopped, give artificial respiration. Get medical attention immediately. Avoid direct contact with skin. Use barrier to give mouth-to-mouth resuscitation. Get immediate medical advice/attention. Remove to fresh air.

Eye contact
Get immediate medical advice/attention. Remove contact lenses, if present and easy to do. Continue rinsing. Keep eye wide open while rinsing. Do not rub affected area. Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes.

Skin contact
Wash off immediately with soap and plenty of water while removing all contaminated clothes and shoes. Get immediate medical advice/attention. May cause an allergic skin reaction.

Ingestion
May produce an allergic reaction. Get immediate medical advice/attention. Do NOT induce vomiting. Clean mouth with water and drink afterwards plenty of water. Never give anything by mouth to an unconscious person.

Self-protection of the first aider
Do not breathe vapor or mist. Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. Ensure that medical personnel are aware of the material(s) involved, take precautions to protect themselves and prevent spread of contamination. Avoid contact with skin, eyes or clothing. Use personal protective equipment as required. See section 8 for more information.

Most important symptoms and effects, both acute and delayed

Symptoms
Difficulty in breathing. Burning sensation. May cause allergy or asthma symptoms or breathing difficulties if inhaled. Coughing and/ or wheezing. Itching. Rashes. Hives.

Indication of any immediate medical attention and special treatment needed

Note to physicians
Product is a corrosive material. Use of gastric lavage or emesis is contraindicated.

Possible perforation of stomach or esophagus should be investigated. Do not give chemical antidotes. Asphyxia from glottal edema may occur. Marked decrease in blood pressure may occur with moist rales, frothy sputum, and high pulse pressure. May cause sensitization in susceptible persons. Treat symptomatically.

Section 5: FIREFIGHTING MEASURES

Suitable Extinguishing Media

Suitable extinguishing media Use extinguishing measures that are appropriate to local circumstances and the surrounding environment.

Unsuitable extinguishing media No information available.

Specific hazards arising from the chemical

The product causes burns of eyes, skin and mucous membranes. Thermal decomposition can lead to release of irritating and toxic gases and vapors. In the event of fire and/or explosion do not breathe fumes.

Hazardous combustion products Carbon oxides.

Special protective actions for fire-fighters

Special protective equipment for fire-fighters Firefighters should wear self-contained breathing apparatus and full firefighting turnout gear. Use personal protection equipment.

Hazchem code 2X

Section 6: ACCIDENTAL RELEASE MEASURES

Personal precautions, protective equipment and emergency procedures

Personal precautions Do not breathe vapor or mist. Attention! Corrosive material. Avoid contact with skin, eyes or clothing. Keep people away from and upwind of spill/leak. Ensure adequate ventilation. Use personal protective equipment as required. Evacuate personnel to safe areas.

Other Information Refer to protective measures listed in Sections 7 and 8.

For emergency responders Use personal protection recommended in Section 8.

Environmental precautions

Environmental precautions Should not be released into the environment. Do not allow to enter into soil/subsoil. Prevent product from entering drains. Prevent further leakage or spillage if safe to do so.

Methods and material for containment and cleaning up

Methods for containment Prevent further leakage or spillage if safe to do so.

Methods for cleaning up Pick up and transfer to properly labeled containers.

Precautions to prevent secondary hazards

Prevention of secondary hazards Clean contaminated objects and areas thoroughly observing environmental regulations.

Section 7: HANDLING AND STORAGE, INCLUDING HOW THE CHEMICAL MAY BE SAFELY USED

Precautions for safe handling

Advice on safe handling Handle in accordance with good industrial hygiene and safety practice. Wash thoroughly after handling. Wash contaminated clothing before reuse.

General hygiene considerations Do not breathe vapor or mist. Contaminated work clothing should not be allowed out of the workplace. Regular cleaning of equipment, work area and clothing is recommended. Wash hands before breaks and immediately after handling the product. Avoid contact with skin, eyes or clothing. Wear suitable gloves and eye/face protection. Do not eat, drink or smoke when using this product. Remove and wash contaminated clothing and gloves, including the inside, before re-use.

Conditions for safe storage, including any incompatibilities

Storage Conditions Protect from moisture. Store away from other materials. Keep containers tightly closed in a dry, cool and well-ventilated place. Keep out of the reach of children. Store locked up.

Incompatible materials Strong oxidizing agents Strong acids Strong bases Incompatible with strong acids and bases Incompatible with oxidizing agents

Section 8: EXPOSURE CONTROLS AND PERSONAL PROTECTION

Control parameters

Exposure Limits

Chemical name	Australia
Glutaraldehyde 111-30-8	0.1 ppm Peak 0.41 mg/m^3 Peak
Methyl alcohol 67-56-1	200 ppm 262 mg/m^3 250 ppm STEL 328 mg/m^3 STEL

Biological occupational exposure limits Not applicable

Appropriate engineering controls

Engineering controls Showers
Eyewash stations
Ventilation systems.

Individual protection measures, such as personal protective equipment

Eye/face protection Face protection shield.

Skin and body protection Long sleeved clothing. Chemical resistant apron. Wear suitable protective clothing.

Hand protection Impervious gloves. Wear suitable gloves.

Respiratory protection When workers are facing concentrations above the exposure limit they must use appropriate certified respirators.

Environmental exposure controls Do not allow into any sewer, on the ground or into any body of water.

Section 9: PHYSICAL AND CHEMICAL PROPERTIES

Information on basic physical and chemical properties

Physical state	liquid		
Appearance	liquid	**Odor**	Pungent.
Color	colorless to light yellow	**Odor threshold**	No information available

Property	Values	Remarks • Method
pH	3.0 - 5.0	
Melting point / freezing point		
Boiling point / boiling range	101.5 °C	
Flash point		No information available
Evaporation rate		No information available
Flammability (solid, gas)		No information available
Flammability Limit in Air		No information available
Upper flammability limit:		No data available
Lower flammability limit:		No data available
Vapor pressure		No data available
Vapor density		No data available
Relative density	1.115-1.136	
Water solubility	Soluble in water	
Solubility(ies)		No information available
Partition coefficient		No information available
Autoignition temperature		No information available
Decomposition temperature		No information available
Kinematic viscosity		
Dynamic viscosity		

Other Information	
Softening point	No information available
Molecular weight	No information available
VOC Content (%)	51
Liquid Density	No information available
Bulk density	No information available
Particle Size	No information available
Particle Size Distribution	No information available

Section 10: STABILITY AND REACTIVITY

Reactivity

Reactivity No information available.

Chemical stability

Stability Stable under normal conditions.

Explosion data

Sensitivity to Mechanical Impact None.

Sensitivity to Static Discharge None.

Possibility of Hazardous Reactions

Possibility of hazardous reactions None under normal processing.

Conditions to avoid

Conditions to avoid Excessive heat. Exposure to air or moisture over prolonged periods.

Incompatible materials

Incompatible materials Strong oxidizing agents. Strong acids. Strong bases. Incompatible with strong acids and bases. Incompatible with oxidizing agents.

Incompatible materials Acids. Bases. Oxidizing agent.

Hazardous Decomposition Products

Hazardous Decomposition Products Thermal decomposition can lead to release of irritating and toxic gases and vapors.

Section 11: TOXICOLOGICAL INFORMATION

Acute toxicity

Information on likely routes of exposure

Product Information

Inhalation	Fatal if inhaled. Corrosive by inhalation. Inhalation of corrosive fumes/gases may cause coughing, choking, headache, dizziness, and weakness for several hours. Pulmonary edema may occur with tightness in the chest, shortness of breath, bluish skin, decreased blood pressure, and increased heart rate. Inhaled corrosive substances can lead to a toxic edema of the lungs. Pulmonary edema can be fatal. Specific test data for the substance or mixture is not available. May cause sensitization in susceptible persons. (based on components).
Eye contact	Causes burns. (based on components). Corrosive to the eyes and may cause severe damage including blindness. Specific test data for the substance or mixture is not available. Causes serious eye damage. May cause irreversible damage to eyes.
Skin contact	May cause irritation. May cause sensitization by skin contact. Specific test data for the substance or mixture is not available. Repeated or prolonged skin contact may cause allergic reactions with susceptible persons. (based on components). May be harmful in contact with skin.
Ingestion	Causes burns Ingestion causes burns of the upper digestive and respiratory tracts May cause severe burning pain in the mouth and stomach with vomiting and diarrhea of dark blood. Blood pressure may decrease. Brownish or yellowish stains may be seen around the mouth. Swelling of the throat may cause shortness of breath and choking May cause lung damage if swallowed May be fatal if swallowed and enters airways May cause additional affects as listed under "Inhalation" Specific test data for the substance or mixture is not available (based on components)
Symptoms	Difficulty in breathing. Redness. Burning. May cause blindness. Symptoms of allergic reaction may include rash, itching, swelling, trouble breathing, tingling of the hands and feet, dizziness, lightheadedness, chest pain, muscle pain, or flushing. Coughing and/ or wheezing. Itching. Rashes. Hives.

Numerical measures of toxicity - Product Information

The following values are calculated based on chapter 3.1 of the GHS document

ATEmix (oral)	479.80 mg/kg
ATEmix (dermal)	3,214.30 mg/kg
ATEmix (inhalation-vapor)	3,181,980.5200 mg/l
ATEmix (inhalation-dust/mist)	0.100 mg/l

Unknown acute toxicity 0 % of the mixture consists of ingredient(s) of unknown toxicity

0 % of the mixture consists of ingredient(s) of unknown acute oral toxicity
0 % of the mixture consists of ingredient(s) of unknown acute dermal toxicity
0 % of the mixture consists of ingredient(s) of unknown acute inhalation toxicity (gas)
0 % of the mixture consists of ingredient(s) of unknown acute inhalation toxicity (vapor)
0 % of the mixture consists of ingredient(s) of unknown acute inhalation toxicity (dust/mist)

Component Information

Chemical name	Oral LD50	Dermal LD50	Inhalation LC50

Glutaraldehyde	= 252 mg/kg (Rat)	= 1800 mg/kg (Rabbit)	= 23.5 ppm (Rat) 4 h = 40.1 ppm (Rat) 4 h
Methyl alcohol	= 6200 mg/kg (Rat)	= 15840 mg/kg (Rabbit)	= 22500 ppm (Rat) 8 h

See section 16 for terms and abbreviations

Delayed and immediate effects as well as chronic effects from short and long-term exposure

Skin corrosion/irritation MAY CAUSE SKIN IRRITATION.

Serious eye damage/eye irritation Classification based on data available for ingredients. Causes burns. Risk of serious damage to eyes.

Respiratory or skin sensitization May cause sensitization by inhalation. May cause sensitization by skin contact.

Germ cell mutagenicity No information available.

Carcinogenicity No information available.

Reproductive toxicity No information available.

STOT - single exposure Based on the classification criteria of the Globally Harmonized System as adopted in the country or region with which this safety data sheet complies, this product has been determined to cause systemic target organ toxicity from acute exposure. (STOT SE). May cause damage to organs if swallowed.

STOT - repeated exposure No information available.

Aspiration hazard No information available.

Section 12: ECOLOGICAL INFORMATION

Ecotoxicity

Ecotoxicity

Unknown aquatic toxicity 0 % of the mixture consists of component(s) of unknown hazards to the aquatic environment.

Chemical name	Algae/aquatic plants	Fish	Toxicity to microorganisms	Crustacea
Glutaraldehyde	0.61: 72 h Desmodesmus subspicatus mg/L EC50 0.84: 96 h Desmodesmus subspicatus mg/L EC50	2.6 - 4.8: 96 h Oncorhynchus mykiss mg/L LC50 flow-through 7.8 - 13: 96 h Oncorhynchus mykiss mg/L LC50 static 7.8 - 22: 96 h Lepomis macrochirus mg/L LC50 static 5.4: 96 h Pimephales promelas mg/L LC50 static	-	0.56 - 1.0: 48 h Daphnia magna mg/L EC50 Static 14: 48 h Daphnia magna mg/L EC50
Methyl alcohol	-	13500 - 17600: 96 h Lepomis macrochirus mg/L LC50 flow-through 18 - 20: 96 h Oncorhynchus mykiss mL/L LC50 static 19500 - 20700: 96 h Oncorhynchus mykiss	EC50 = 39000 mg/L 25 min EC50 = 40000 mg/L 15 min EC50 = 43000 mg/L 5 min	-

		mg/L LC50 flow-through 28200: 96 h Pimephales promelas mg/L LC50 flow-through 100: 96 h Pimephales promelas mg/L LC50 static		

Persistence and degradability

Persistence and degradability No information available.

Bioaccumulative potential

Bioaccumulation

Component Information

Chemical name	Partition coefficient
Glutaraldehyde	0.22
Methyl alcohol	-0.77

Mobility

Mobility in soil No information available.

Mobility No information available.

Other adverse effects

Other adverse effects No information available.

Section 13: DISPOSAL CONSIDERATIONS

Waste treatment methods

Waste from residues/unused products Dispose of in accordance with local regulations. Dispose of waste in accordance with environmental legislation.

Contaminated packaging Do not reuse empty containers.

Section 14: TRANSPORT INFORMATION

ADG Not Regulated
UN Number UN2922
Proper shipping name Corrosive liquid, toxic, n.o.s. (Contains Glutaraldehyde)
Hazard Class 8
Subsidiary hazard class 6.1
Packing Group II

Hazchem code 2X

IATA
UN/ID no UN2922
Proper shipping name Corrosive liquid, toxic, n.o.s. (Contains Glutaraldehyde)
Hazard Class 8
Subsidiary hazard class 6.1
Packing Group II

IMDG
UN/ID no UN2922

Proper shipping name	Corrosive liquid, toxic, n.o.s. (Contains Glutaraldehyde)
Hazard Class	8
Subsidiary hazard class	6.1
Packing Group	II
EmS-No	F-A, S-A
Marine pollutant	Yes

Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code
No information available

Section 15: REGULATORY INFORMATION

Regulatory information

National regulations

Australia
See section 8 for national exposure control parameters

Standard for Uniform Scheduling of Medicines and Poisons (SUSMP)
No poisons schedule number allocated

Major hazard (accident/incident planning) regulation
Verify that license requirements are met

Hazardous chemical	Threshold quantity (T)
Materials that meet the criteria for Toxic in table 15.3	200

International Inventories

TSCA	Complies
DSL/NDSL	Complies
EINECS/ELINCS	Complies
ENCS	Complies
IECSC	Complies
KECL	Complies
PICCS	Complies
AICS	Complies
NZIoC	Complies

Legend:
TSCA - United States Toxic Substances Control Act Section 8(b) Inventory
DSL/NDSL - Canadian Domestic Substances List/Non-Domestic Substances List
EINECS/ELINCS - European Inventory of Existing Chemical Substances/European List of Notified Chemical Substances
ENCS - Japan Existing and New Chemical Substances
IECSC - China Inventory of Existing Chemical Substances
KECL - Korean Existing and Evaluated Chemical Substances
PICCS - Philippines Inventory of Chemicals and Chemical Substances
AICS - Australian Inventory of Chemical Substances
NZIoC - New Zealand Inventory of Chemicals

International Regulations

The Montreal Protocol on Substances that Deplete the Ozone Layer Not applicable

The Stockholm Convention on Persistent Organic Pollutants Not applicable

The Rotterdam Convention Not applicable

Brunei Poison List Not applicable.

Section 16: ANY OTHER RELEVANT INFORMATION

Issue Date 31-May-2021

Revision Date 01-Jun-2021

Revision Note
No information available.

Key or legend to abbreviations and acronyms used in the safety data sheet

Legend Section 8: EXPOSURE CONTROLS/PERSONAL PROTECTION

TWA	TWA (time-weighted average)	STEL	STEL (Short Term Exposure Limit)
Ceiling	Maximum limit value	*	Skin designation
C	Carcinogen		

Disclaimer

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End of Safety Data Sheet

SAFETY DATA SHEET

Idcide G50

Issue Date 31-May-2021 **Revision Date** 01-Jun-2021 **Version** 1.1
EN

Section 1: IDENTIFICATION: PRODUCT INDENTIFIER AND CHEMICAL IDENTITY

Product identifier

Product Name Idcide G50

Product Code NDF00800

Other means of identification

UN Number UN2922

Recommended use of the chemical and restrictions on use

Recommended Use biocide

Uses advised against No information available

Details of manufacturer or importer

Supplier
Newpark Drilling Fluids (Australia) LTD
11 Alacrity Place
Henderson, WA, 6166
Australia

For further information, please contact

Contact Point Telephone: +61 8 9410 8200
Fax: +61 8 9410 8299
Website: www.newpark.com

Emergency telephone number

Emergency telephone number +(61)-290372994 (Australia); +(64)-98010034 (New Zealand)

Section 2: HAZARD(S) IDENTIFICATION

GHS - Classification

Acute toxicity - Oral	Category 3 - (H301)
Acute toxicity - Inhalation (Dusts/Mists)	Category 2 - (H330)
Skin corrosion/irritation	Category 1 - (H314)
Serious eye damage/eye irritation	Category 1 - (H318)
Respiratory sensitization	Category 1 - (H334)
Skin sensitization	Category 1 - (H317)
Specific target organ toxicity (single exposure)	Category 3 - (H335)
Acute aquatic toxicity	Category 1 - (H400)
Chronic aquatic toxicity	Category 2 - (H411)

Label elements

Skull and crossbones
Health hazard
Corrosion
Environment



Signal word
Danger

Hazard statements
H302 - Harmful if swallowed
H314 - Causes severe skin burns and eye damage
H317 - May cause an allergic skin reaction
H330 - Fatal if inhaled
H334 - May cause allergy or asthma symptoms or breathing difficulties if inhaled
H371 - May cause damage to organs
AUH071 - Corrosive to the respiratory tract

Precautionary Statements - Prevention
Wash face, hands and any exposed skin thoroughly after handling
Do not eat, drink or smoke when using this product
Do not breathe dust/fume/gas/mist/vapors/spray
Use only outdoors or in a well-ventilated area
Wear respiratory protection
Wear protective gloves/protective clothing/eye protection/face protection
In case of inadequate ventilation wear respiratory protection
Contaminated work clothing should not be allowed out of the workplace
Avoid release to the environment
Precautionary Statements - Response
Immediately call a POISON CENTER or doctor/physician
IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing
Immediately call a POISON CENTER or doctor/physician
IF ON SKIN (or hair): Remove/Take off immediately all contaminated clothing. Rinse skin with water/shower
Wash contaminated clothing before reuse
If skin irritation or rash occurs: Get medical advice/attention
IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing
Immediately call a POISON CENTER or doctor/physician
IF SWALLOWED: Call a POISON CENTER or doctor/physician if you feel unwell
Rinse mouth
Do NOT induce vomiting
Collect spillage
Precautionary Statements - Storage
Store in a well-ventilated place. Keep container tightly closed
Store locked up
Precautionary Statements - Disposal
Dispose of contents/container to an approved waste disposal plant

Other hazards
May be harmful in contact with skin
Very toxic to aquatic life with long lasting effects
Very toxic to aquatic life
General Hazards
No information available

Section 3: COMPOSITION AND INFORMATION ON INGREDIENTS, IN ACCORDANCE WITH SCHEDULE 8

Substance

Not applicable

Mixture

Chemical name	CAS No.	Weight-%	REACH Registration Number
Glutaraldehyde	[redacted]	>=50	01-2119455549-26-XXXX
Methyl alcohol	[redacted]	<=2	01-2119433307-44-XXXX

Chemical name	CAS No	Weight-%
Non-hazardous ingredients	Proprietary	Balance

Section 4: FIRST AID MEASURES

Description of first aid measures

General advice Immediate medical attention is required. Show this safety data sheet to the doctor in attendance.

Emergency telephone number Poisons Information Center, Australia: 13 11 26
Poisons Information Center, New Zealand: 0800 764 766

Inhalation Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. If breathing is difficult, (trained personnel should) give oxygen. Delayed pulmonary edema may occur. May cause allergic respiratory reaction. If breathing has stopped, give artificial respiration. Get medical attention immediately. Avoid direct contact with skin. Use barrier to give mouth-to-mouth resuscitation. Get immediate medical advice/attention. Remove to fresh air.

Eye contact Get immediate medical advice/attention. Remove contact lenses, if present and easy to do. Continue rinsing. Keep eye wide open while rinsing. Do not rub affected area. Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes.

Skin contact Wash off immediately with soap and plenty of water while removing all contaminated clothes and shoes. Get immediate medical advice/attention. May cause an allergic skin reaction.

Ingestion May produce an allergic reaction. Get immediate medical advice/attention. Do NOT induce vomiting. Clean mouth with water and drink afterwards plenty of water. Never give anything by mouth to an unconscious person.

Self-protection of the first aider Do not breathe vapor or mist. Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. Ensure that medical personnel are aware of the material(s) involved, take precautions to protect themselves and prevent spread of contamination. Avoid contact with skin, eyes or clothing. Use personal protective equipment as required. See section 8 for more information.

Most important symptoms and effects, both acute and delayed

Symptoms Difficulty in breathing. Burning sensation. May cause allergy or asthma symptoms or breathing difficulties if inhaled. Coughing and/ or wheezing. Itching. Rashes. Hives.

Indication of any immediate medical attention and special treatment needed

Note to physicians Product is a corrosive material. Use of gastric lavage or emesis is contraindicated.

Possible perforation of stomach or esophagus should be investigated. Do not give chemical antidotes. Asphyxia from glottal edema may occur. Marked decrease in blood pressure may occur with moist rales, frothy sputum, and high pulse pressure. May cause sensitization in susceptible persons. Treat symptomatically.

Section 5: FIREFIGHTING MEASURES

Suitable Extinguishing Media

Suitable extinguishing media Use extinguishing measures that are appropriate to local circumstances and the surrounding environment.

Unsuitable extinguishing media No information available.

Specific hazards arising from the chemical

The product causes burns of eyes, skin and mucous membranes. Thermal decomposition can lead to release of irritating and toxic gases and vapors. In the event of fire and/or explosion do not breathe fumes.

Hazardous combustion products Carbon oxides.

Special protective actions for fire-fighters

Special protective equipment for fire-fighters Firefighters should wear self-contained breathing apparatus and full firefighting turnout gear. Use personal protection equipment.

Hazchem code 2X

Section 6: ACCIDENTAL RELEASE MEASURES

Personal precautions, protective equipment and emergency procedures

Personal precautions Do not breathe vapor or mist. Attention! Corrosive material. Avoid contact with skin, eyes or clothing. Keep people away from and upwind of spill/leak. Ensure adequate ventilation. Use personal protective equipment as required. Evacuate personnel to safe areas.

Other Information Refer to protective measures listed in Sections 7 and 8.

For emergency responders Use personal protection recommended in Section 8.

Environmental precautions

Environmental precautions Should not be released into the environment. Do not allow to enter into soil/subsoil. Prevent product from entering drains. Prevent further leakage or spillage if safe to do so.

Methods and material for containment and cleaning up

Methods for containment Prevent further leakage or spillage if safe to do so.

Methods for cleaning up Pick up and transfer to properly labeled containers.

Precautions to prevent secondary hazards

Prevention of secondary hazards Clean contaminated objects and areas thoroughly observing environmental regulations.

Section 7: HANDLING AND STORAGE, INCLUDING HOW THE CHEMICAL MAY BE SAFELY USED

Precautions for safe handling

Advice on safe handling Handle in accordance with good industrial hygiene and safety practice. Wash thoroughly after handling. Wash contaminated clothing before reuse.

General hygiene considerations Do not breathe vapor or mist. Contaminated work clothing should not be allowed out of the workplace. Regular cleaning of equipment, work area and clothing is recommended. Wash hands before breaks and immediately after handling the product. Avoid contact with skin, eyes or clothing. Wear suitable gloves and eye/face protection. Do not eat, drink or smoke when using this product. Remove and wash contaminated clothing and gloves, including the inside, before re-use.

Conditions for safe storage, including any incompatibilities

Storage Conditions Protect from moisture. Store away from other materials. Keep containers tightly closed in a dry, cool and well-ventilated place. Keep out of the reach of children. Store locked up.

Incompatible materials Strong oxidizing agents Strong acids Strong bases Incompatible with strong acids and bases Incompatible with oxidizing agents

Section 8: EXPOSURE CONTROLS AND PERSONAL PROTECTION

Control parameters

Exposure Limits

Chemical name	Australia
Glutaraldehyde 111-30-8	0.1 ppm Peak 0.41 mg/m^3 Peak
Methyl alcohol 67-56-1	200 ppm 262 mg/m^3 250 ppm STEL 328 mg/m^3 STEL

Biological occupational exposure limits Not applicable

Appropriate engineering controls

Engineering controls Showers
Eyewash stations
Ventilation systems.

Individual protection measures, such as personal protective equipment

Eye/face protection Face protection shield.

Skin and body protection Long sleeved clothing. Chemical resistant apron. Wear suitable protective clothing.

Hand protection Impervious gloves. Wear suitable gloves.

Respiratory protection When workers are facing concentrations above the exposure limit they must use appropriate certified respirators.

Environmental exposure controls Do not allow into any sewer, on the ground or into any body of water.

Section 9: PHYSICAL AND CHEMICAL PROPERTIES

Information on basic physical and chemical properties

Physical state	liquid		
Appearance	liquid	**Odor**	Pungent.
Color	colorless to light yellow	**Odor threshold**	No information available

Property	Values	Remarks • Method
pH	3.0 - 5.0	
Melting point / freezing point		
Boiling point / boiling range	101.5 °C	
Flash point		No information available
Evaporation rate		No information available
Flammability (solid, gas)		No information available
Flammability Limit in Air		No information available
Upper flammability limit:		No data available
Lower flammability limit:		No data available
Vapor pressure		No data available
Vapor density		No data available
Relative density	1.115-1.136	
Water solubility	Soluble in water	
Solubility(ies)		No information available
Partition coefficient		No information available
Autoignition temperature		No information available
Decomposition temperature		No information available
Kinematic viscosity		
Dynamic viscosity		

Other Information	
Softening point	No information available
Molecular weight	No information available
VOC Content (%)	51
Liquid Density	No information available
Bulk density	No information available
Particle Size	No information available
Particle Size Distribution	No information available

Section 10: STABILITY AND REACTIVITY

Reactivity

Reactivity No information available.

Chemical stability

Stability Stable under normal conditions.

Explosion data

Sensitivity to Mechanical Impact None.

Sensitivity to Static Discharge None.

Possibility of Hazardous Reactions

Possibility of hazardous reactions None under normal processing.

Conditions to avoid

Conditions to avoid Excessive heat. Exposure to air or moisture over prolonged periods.

Incompatible materials

Incompatible materials Strong oxidizing agents. Strong acids. Strong bases. Incompatible with strong acids and bases. Incompatible with oxidizing agents.

Incompatible materials Acids. Bases. Oxidizing agent.

Hazardous Decomposition Products

Hazardous Decomposition Products Thermal decomposition can lead to release of irritating and toxic gases and vapors.

Section 11: TOXICOLOGICAL INFORMATION

Acute toxicity

Information on likely routes of exposure

Product Information

Inhalation	Fatal if inhaled. Corrosive by inhalation. Inhalation of corrosive fumes/gases may cause coughing, choking, headache, dizziness, and weakness for several hours. Pulmonary edema may occur with tightness in the chest, shortness of breath, bluish skin, decreased blood pressure, and increased heart rate. Inhaled corrosive substances can lead to a toxic edema of the lungs. Pulmonary edema can be fatal. Specific test data for the substance or mixture is not available. May cause sensitization in susceptible persons. (based on components).
Eye contact	Causes burns. (based on components). Corrosive to the eyes and may cause severe damage including blindness. Specific test data for the substance or mixture is not available. Causes serious eye damage. May cause irreversible damage to eyes.
Skin contact	May cause irritation. May cause sensitization by skin contact. Specific test data for the substance or mixture is not available. Repeated or prolonged skin contact may cause allergic reactions with susceptible persons. (based on components). May be harmful in contact with skin.
Ingestion	Causes burns Ingestion causes burns of the upper digestive and respiratory tracts May cause severe burning pain in the mouth and stomach with vomiting and diarrhea of dark blood. Blood pressure may decrease. Brownish or yellowish stains may be seen around the mouth. Swelling of the throat may cause shortness of breath and choking May cause lung damage if swallowed May be fatal if swallowed and enters airways May cause additional affects as listed under "Inhalation" Specific test data for the substance or mixture is not available (based on components)
Symptoms	Difficulty in breathing. Redness. Burning. May cause blindness. Symptoms of allergic reaction may include rash, itching, swelling, trouble breathing, tingling of the hands and feet, dizziness, lightheadedness, chest pain, muscle pain, or flushing. Coughing and/ or wheezing. Itching. Rashes. Hives.

Numerical measures of toxicity - Product Information

The following values are calculated based on chapter 3.1 of the GHS document

ATEmix (oral)	479.80 mg/kg
ATEmix (dermal)	3,214.30 mg/kg
ATEmix (inhalation-vapor)	3,181,980.5200 mg/l
ATEmix (inhalation-dust/mist)	0.100 mg/l

Unknown acute toxicity 0 % of the mixture consists of ingredient(s) of unknown toxicity

0 % of the mixture consists of ingredient(s) of unknown acute oral toxicity
0 % of the mixture consists of ingredient(s) of unknown acute dermal toxicity
0 % of the mixture consists of ingredient(s) of unknown acute inhalation toxicity (gas)
0 % of the mixture consists of ingredient(s) of unknown acute inhalation toxicity (vapor)
0 % of the mixture consists of ingredient(s) of unknown acute inhalation toxicity (dust/mist)

Component Information

Chemical name	Oral LD50	Dermal LD50	Inhalation LC50

Glutaraldehyde	= 252 mg/kg (Rat)	= 1800 mg/kg (Rabbit)	= 23.5 ppm (Rat) 4 h = 40.1 ppm (Rat) 4 h
Methyl alcohol	= 6200 mg/kg (Rat)	= 15840 mg/kg (Rabbit)	= 22500 ppm (Rat) 8 h

See section 16 for terms and abbreviations

Delayed and immediate effects as well as chronic effects from short and long-term exposure

Skin corrosion/irritation MAY CAUSE SKIN IRRITATION.

Serious eye damage/eye irritation Classification based on data available for ingredients. Causes burns. Risk of serious damage to eyes.

Respiratory or skin sensitization May cause sensitization by inhalation. May cause sensitization by skin contact.

Germ cell mutagenicity No information available.

Carcinogenicity No information available.

Reproductive toxicity No information available.

STOT - single exposure Based on the classification criteria of the Globally Harmonized System as adopted in the country or region with which this safety data sheet complies, this product has been determined to cause systemic target organ toxicity from acute exposure. (STOT SE). May cause damage to organs if swallowed.

STOT - repeated exposure No information available.

Aspiration hazard No information available.

Section 12: ECOLOGICAL INFORMATION

Ecotoxicity

Ecotoxicity

Unknown aquatic toxicity 0 % of the mixture consists of component(s) of unknown hazards to the aquatic environment.

Chemical name	Algae/aquatic plants	Fish	Toxicity to microorganisms	Crustacea
Glutaraldehyde	0.61: 72 h Desmodesmus subspicatus mg/L EC50 0.84: 96 h Desmodesmus subspicatus mg/L EC50	2.6 - 4.8: 96 h Oncorhynchus mykiss mg/L LC50 flow-through 7.8 - 13: 96 h Oncorhynchus mykiss mg/L LC50 static 7.8 - 22: 96 h Lepomis macrochirus mg/L LC50 static 5.4: 96 h Pimephales promelas mg/L LC50 static	-	0.56 - 1.0: 48 h Daphnia magna mg/L EC50 Static 14: 48 h Daphnia magna mg/L EC50
Methyl alcohol	-	13500 - 17600: 96 h Lepomis macrochirus mg/L LC50 flow-through 18 - 20: 96 h Oncorhynchus mykiss mL/L LC50 static 19500 - 20700: 96 h Oncorhynchus mykiss	EC50 = 39000 mg/L 25 min EC50 = 40000 mg/L 15 min EC50 = 43000 mg/L 5 min	-

		mg/L LC50 flow-through 28200: 96 h Pimephales promelas mg/L LC50 flow-through 100: 96 h Pimephales promelas mg/L LC50 static		

Persistence and degradability

Persistence and degradability No information available.

Bioaccumulative potential

Bioaccumulation

Component Information

Chemical name	Partition coefficient
Glutaraldehyde	0.22
Methyl alcohol	-0.77

Mobility

Mobility in soil No information available.

Mobility No information available.

Other adverse effects

Other adverse effects No information available.

Section 13: DISPOSAL CONSIDERATIONS

Waste treatment methods

Waste from residues/unused products Dispose of in accordance with local regulations. Dispose of waste in accordance with environmental legislation.

Contaminated packaging Do not reuse empty containers.

Section 14: TRANSPORT INFORMATION

ADG Not Regulated
UN Number UN2922
Proper shipping name Corrosive liquid, toxic, n.o.s. (Contains Glutaraldehyde)
Hazard Class 8
Subsidiary hazard class 6.1
Packing Group II

Hazchem code 2X

IATA
UN/ID no UN2922
Proper shipping name Corrosive liquid, toxic, n.o.s. (Contains Glutaraldehyde)
Hazard Class 8
Subsidiary hazard class 6.1
Packing Group II

IMDG
UN/ID no UN2922

Proper shipping name	Corrosive liquid, toxic, n.o.s. (Contains Glutaraldehyde)
Hazard Class	8
Subsidiary hazard class	6.1
Packing Group	II
EmS-No	F-A, S-A
Marine pollutant	Yes

Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code
No information available

Section 15: REGULATORY INFORMATION

Regulatory information

National regulations

Australia
See section 8 for national exposure control parameters

Standard for Uniform Scheduling of Medicines and Poisons (SUSMP)
No poisons schedule number allocated

Major hazard (accident/incident planning) regulation
Verify that license requirements are met

Hazardous chemical	Threshold quantity (T)
Materials that meet the criteria for Toxic in table 15.3	200

International Inventories

TSCA	Complies
DSL/NDSL	Complies
EINECS/ELINCS	Complies
ENCS	Complies
IECSC	Complies
KECL	Complies
PICCS	Complies
AICS	Complies
NZIoC	Complies

Legend:
TSCA - United States Toxic Substances Control Act Section 8(b) Inventory
DSL/NDSL - Canadian Domestic Substances List/Non-Domestic Substances List
EINECS/ELINCS - European Inventory of Existing Chemical Substances/European List of Notified Chemical Substances
ENCS - Japan Existing and New Chemical Substances
IECSC - China Inventory of Existing Chemical Substances
KECL - Korean Existing and Evaluated Chemical Substances
PICCS - Philippines Inventory of Chemicals and Chemical Substances
AICS - Australian Inventory of Chemical Substances
NZIoC - New Zealand Inventory of Chemicals

International Regulations

The Montreal Protocol on Substances that Deplete the Ozone Layer Not applicable

The Stockholm Convention on Persistent Organic Pollutants Not applicable

The Rotterdam Convention Not applicable

Brunei Poison List Not applicable.

Section 16: ANY OTHER RELEVANT INFORMATION

Issue Date 31-May-2021

Revision Date 01-Jun-2021

Revision Note
No information available.

Key or legend to abbreviations and acronyms used in the safety data sheet

Legend Section 8: EXPOSURE CONTROLS/PERSONAL PROTECTION

TWA	TWA (time-weighted average)	STEL	STEL (Short Term Exposure Limit)
Ceiling	Maximum limit value	*	Skin designation
C	Carcinogen		

Disclaimer

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End of Safety Data Sheet

SAFETY DATA SHEET

INCORR

Issue Date 28-Sep-2016 **Revision Date** 04-Jan-2018 **Version** 2
EN

Section 1: IDENTIFICATION: PRODUCT INDENTIFIER AND CHEMICAL IDENTITY

Product identifier

Product Name INCORR

Product Code NDF00204

Other means of identification

Pure substance/mixture Mixture

Recommended use of the chemical and restrictions on use

Recommended Use Corrosion inhibitor

Uses advised against No information available

Details of manufacturer or importer

Supplier
Newpark Drilling Fluids (Australia) LTD
11 Alacrity Place
Henderson, WA, 6166
Australia

For further information, please contact

Contact Point Telephone: +61 8 9410 8200
Fax: +61 8 9410 8299
Website: www.newpark.com

Emergency telephone number

Emergency telephone number 1800 127 406 (Australia); +64 4 917 9888 (International)

Section 2: HAZARD(S) IDENTIFICATION

GHS - Classification

Serious eye damage/eye irritation	Category 2 - (H319)

Label elements



Signal word
Warning

Hazard statements
H319 - Causes serious eye irritation

Precautionary Statements - Prevention
Wash face, hands and any exposed skin thoroughly after handling
Wear protective gloves/protective clothing/eye protection/face protection
IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing
If eye irritation persists: Get medical advice/attention

Other hazards
General Hazards
No information available

Section 3: COMPOSITION AND INFORMATION ON INGREDIENTS, IN ACCORDANCE WITH SCHEDULE 8

Substance

Not applicable

Mixture

Chemical Name	CAS No	Weight-%
Ethanol, 2,2'-oxybis-, reaction products with ammonia, morpholine derivatives residues	[redacted]	10-30
Poly(oxy-1,2-ethanediyl), alpha-hydro-omega-hydroxy-, mono(2-(4,5-dihydro-2-nortall-oil alkyl-1H-imidazol-1-yl)ethyl) ethers	[redacted]	5-10
Acetic acid	[redacted]	1-5
Non-hazardous ingredients	Proprietary	Balance

Section 4: FIRST AID MEASURES

Description of first aid measures

Emergency telephone number Poisons Information Center, Australia: 13 11 26
Poisons Information Center, New Zealand: 0800 764 766

Inhalation Remove to fresh air.

Eye contact Rinse thoroughly with plenty of water for at least 15 minutes, lifting lower and upper eyelids. Consult a physician.

Skin contact Wash skin with soap and water.

Ingestion Clean mouth with water and drink afterwards plenty of water.

Most important symptoms and effects, both acute and delayed

Symptoms No information available.

Indication of any immediate medical attention and special treatment needed

Note to physicians Treat symptomatically.

Section 5: FIREFIGHTING MEASURES

Suitable Extinguishing Media

Suitable extinguishing media
Carbon dioxide (CO2). Water spray (fog).

Unsuitable extinguishing media No information available.

Specific hazards arising from the chemical

Thermal decomposition can lead to release of irritating and toxic gases and vapors. Do not allow run-off from fire-fighting to enter drains or water courses.

Hazardous combustion products Carbon oxides. Nitrogen oxides (NOx).

Special protective actions for fire-fighters

Special protective equipment for fire-fighters Firefighters should wear self-contained breathing apparatus and full firefighting turnout gear. Use personal protection equipment.

Hazchem code Not Listed.

Section 6: ACCIDENTAL RELEASE MEASURES

Personal precautions, protective equipment and emergency procedures

Personal precautions Ensure adequate ventilation.

For emergency responders Use personal protection recommended in Section 8.

Environmental precautions

Environmental precautions See Section 12 for additional Ecological Information. Do not flush into surface water or sanitary sewer system. Prevent product from entering drains.

Methods and material for containment and cleaning up

Methods for containment Prevent further leakage or spillage if safe to do so.

Methods for cleaning up Pick up and transfer to properly labeled containers.

Precautions to prevent secondary hazards

Prevention of secondary hazards Clean contaminated objects and areas thoroughly observing environmental regulations.

Section 7: HANDLING AND STORAGE, INCLUDING HOW THE CHEMICAL MAY BE SAFELY USED

Precautions for safe handling

Advice on safe handling Wash contaminated clothing before reuse. Handle in accordance with good industrial hygiene and safety practice. Wash thoroughly after handling.

General hygiene considerations Do not eat, drink or smoke when using this product. Wash hands before breaks and after work.

Conditions for safe storage, including any incompatibilities

Storage Conditions Keep containers tightly closed in a dry, cool and well-ventilated place.

Incompatible materials Strong oxidizing agents

Section 8: EXPOSURE CONTROLS AND PERSONAL PROTECTION

Control parameters

Exposure Limits .

Chemical Name	Australia
Acetic acid 64-19-7	10 ppm 25 mg/m^3 15 ppm STEL 37 mg/m^3 STEL

Biological occupational exposure limits Not applicable

Appropriate engineering controls

Engineering controls Showers
Eyewash stations
Ventilation systems.

Individual protection measures, such as personal protective equipment

Eye/face protection Tight sealing safety goggles.

Skin and body protection Wear suitable protective clothing.

Respiratory protection In case of inadequate ventilation wear respiratory protection.

Environmental exposure controls Do not allow into any sewer, on the ground or into any body of water.

Section 9: PHYSICAL AND CHEMICAL PROPERTIES

Information on basic physical and chemical properties

Physical state	Liquid		
Appearance	liquid	**Odor**	Slight.
Color	No information available	**Odor threshold**	No information available

Property	**Values**	**Remarks • Method**
pH	7 - 9	
Melting point / freezing point		No information available
Boiling point / boiling range	100 °C	
Flash point	> 100 °C	
Evaporation rate		No information available
Flammability (solid, gas)		Not applicable
Flammability Limit in Air		No information available
Upper flammability limit:		No data available
Lower flammability limit:		No data available
Vapor pressure		No data available
Vapor density		No data available
Relative density	0.95-1.05	
Water solubility	Soluble in water	
Solubility(ies)		No information available
Partition coefficient		No information available
Autoignition temperature		No information available
Decomposition temperature		No information available
Kinematic viscosity		
Dynamic viscosity		

Other Information

Softening point	No information available
Molecular weight	No information available
VOC Content (%)	No information available
Density	No information available
Bulk density	No information available
Particle Size	No information available
Particle Size Distribution	No information available

Section 10: STABILITY AND REACTIVITY

Reactivity

Reactivity No information available.

Chemical stability

Stability Stable under normal conditions.

Explosion data
Sensitivity to Mechanical Impact None.
Sensitivity to Static Discharge None.

Possibility of Hazardous Reactions

Possibility of hazardous reactions None under normal processing.

Conditions to avoid

Conditions to avoid None known based on information supplied.

Incompatible materials

Incompatible materials Strong oxidizing agents.

Hazardous Decomposition Products

Hazardous Decomposition Products None known based on information supplied.

Section 11: TOXICOLOGICAL INFORMATION

Acute toxicity

Information on likely routes of exposure

Product Information .

Inhalation Specific test data for the substance or mixture is not available.

Eye contact Specific test data for the substance or mixture is not available.

Skin contact Specific test data for the substance or mixture is not available.

Ingestion Specific test data for the substance or mixture is not available

Symptoms No information available.

Numerical measures of toxicity - Product Information

The following values are calculated based on chapter 3.1 of the GHS document
ATEmix (oral) 7,023.00 mg/kg

ATEmix (dermal) 26,500.00 mg/kg
ATEmix (inhalation-dust/mist) 285.00 mg/l

Unknown acute toxicity 28 % of the mixture consists of ingredient(s) of unknown toxicity
5 % of the mixture consists of ingredient(s) of unknown acute oral toxicity
25 % of the mixture consists of ingredient(s) of unknown acute dermal toxicity
28 % of the mixture consists of ingredient(s) of unknown acute inhalation toxicity (gas)
28 % of the mixture consists of ingredient(s) of unknown acute inhalation toxicity (vapor)
25 % of the mixture consists of ingredient(s) of unknown acute inhalation toxicity (dust/mist)

Component Information

Chemical Name	Oral LD50	Dermal LD50	Inhalation LC50
Ethanol, 2,2'-oxybis-, reaction products with ammonia, morpholine derivatives residues	= 1500 mg/kg (Rat)	-	-
Acetic acid	= 3310 mg/kg (Rat)	= 1060 mg/kg (Rabbit)	= 11.4 mg/L (Rat) 4 h

See section 16 for terms and abbreviations

Delayed and immediate effects as well as chronic effects from short and long-term exposure

Skin corrosion/irritation Irritating to skin.

Serious eye damage/eye irritation Risk of serious damage to eyes.

Respiratory or skin sensitization May cause an allergic skin reaction.

Germ cell mutagenicity No information available.

Carcinogenicity No information available.

Reproductive toxicity No information available.

STOT - single exposure No information available.

STOT - repeated exposure No information available.

Aspiration hazard No information available.

Section 12: ECOLOGICAL INFORMATION

Ecotoxicity

Ecotoxicity The environmental impact of this product has not been fully investigated.

Unknown aquatic toxicity 5 % of the mixture consists of component(s) of unknown hazards to the aquatic environment.

Chemical Name	Algae/aquatic plants	Fish	Toxicity to microorganisms	Crustacea
Acetic acid	-	75: 96 h Lepomis macrochirus mg/L LC50 static 79: 96 h Pimephales promelas mg/L LC50 static	EC50 = 8.8 mg/L 15 min EC50 = 8.8 mg/L 25 min EC50 = 8.8 mg/L 5 min	47: 24 h Daphnia magna mg/L EC50 65: 48 h Daphnia magna mg/L EC50 Static

Persistence and degradability

Persistence and degradability No information available.

Bioaccumulative potential

Bioaccumulation .

Component Information

Chemical Name	Partition coefficient
Acetic acid	-0.31

Mobility

Mobility in soil No information available.

Mobility No information available.

Other adverse effects

Other adverse effects No information available.

Section 13: DISPOSAL CONSIDERATIONS

Waste treatment methods

Waste from residues/unused products Dispose of in accordance with local regulations. Dispose of waste in accordance with environmental legislation.

Contaminated packaging Do not reuse empty containers.

Section 14: TRANSPORT INFORMATION

ADG Not regulated

IATA Not regulated

IMDG Not regulated

Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code
No information available

Section 15: REGULATORY INFORMATION

Regulatory information

National regulations

Australia
See section 8 for national exposure control parameters

Standard for Uniform Scheduling of Medicines and Poisons (SUSMP)
No poisons schedule number allocated

International Inventories

TSCA	Complies
DSL/NDSL	Complies
EINECS/ELINCS	Complies

ENCS	Does not comply
IECSC	Does not comply
KECL	Does not comply
PICCS	Does not comply
AICS	Does not comply
NZIoC	Does not comply

Legend:
TSCA - United States Toxic Substances Control Act Section 8(b) Inventory
DSL/NDSL - Canadian Domestic Substances List/Non-Domestic Substances List
EINECS/ELINCS - European Inventory of Existing Chemical Substances/European List of Notified Chemical Substances
ENCS - Japan Existing and New Chemical Substances
IECSC - China Inventory of Existing Chemical Substances
KECL - Korean Existing and Evaluated Chemical Substances
PICCS - Philippines Inventory of Chemicals and Chemical Substances
AICS - Australian Inventory of Chemical Substances
NZIoC - New Zealand Inventory of Chemicals

International Regulations

Ozone-depleting substances (ODS) Not applicable

Persistent Organic Pollutants Not applicable

Export Notification requirements Not applicable

Section 16: ANY OTHER RELEVANT INFORMATION

Issue Date 28-Sep-2016

Revision Date 04-Jan-2018

Revision Note
No information available.

Key or legend to abbreviations and acronyms used in the safety data sheet

Legend Section 8: EXPOSURE CONTROLS/PERSONAL PROTECTION

TWA	TWA (time-weighted average)	STEL	STEL (Short Term Exposure Limit)
Ceiling	Maximum limit value	*	Skin designation
C	Carcinogen		

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End of Safety Data Sheet

NEWPARK DRILLING FLUIDS

SAFETY DATA SHEET

1. IDENTIFICATION OF THE MATERIAL AND SUPPLIER

1.1 Product identifier

Product name **MAGNESIUM OXIDE**

Synonyms CALCINED MAGNESIA ● MAGNESIA ● MAGOXI16 / 27 - PRODUCT CODE

1.2 Uses and uses advised against

Uses DRILLING FLUID ADDITIVE ● PH INDICATOR

1.3 Details of the supplier of the product

Supplier name **NEWPARK DRILLING FLUIDS (AUSTRALIA) LTD**

Address 11 Alacrity Place, Henderson, WA, 6166, AUSTRALIA

Telephone +61 8 9410 8200

Fax +61 8 9410 8299

Website www.newpark.com

1.4 Emergency telephone numbers

Emergency 1800 127 406 (Australia); +64 4 917 9888 (International)

2. HAZARDS IDENTIFICATION

2.1 Classification of the substance or mixture

NOT CLASSIFIED AS HAZARDOUS ACCORDING TO SAFE WORK AUSTRALIA CRITERIA

2.2 GHS Label elements

No signal word, pictograms, hazard or precautionary statements have been allocated.

2.3 Other hazards

No information provided.

3. COMPOSITION/ INFORMATION ON INGREDIENTS

3.1 Substances / Mixtures

Ingredient	CAS Number	EC Number	Content
MAGNESIUM OXIDE	[redacted]	215-171-9	>94%
CALCIUM OXIDE	[redacted]	215-138-9	<3.5%
SILICON DIOXIDE (SILICA, AMORPHOUS)	[redacted]	231-545-4	<2.5%

4. FIRST AID MEASURES

4.1 Description of first aid measures

Eye If in eyes, hold eyelids apart and flush continuously with running water. Continue flushing until advised to stop by a Poisons Information Centre, a doctor, or for at least 15 minutes.

Inhalation If inhaled, remove from contaminated area. Apply artificial respiration if not breathing.

Skin If skin or hair contact occurs, remove contaminated clothing and flush skin and hair with running water. Continue flushing with water until advised to stop by a Poisons Information Centre or a doctor.

Ingestion For advice, contact a Poisons Information Centre on 13 11 26 (Australia Wide) or a doctor (at once). If swallowed, do not induce vomiting.

First aid facilities Eye wash facilities and safety shower should be available.

4.2 Most important symptoms and effects, both acute and delayed
See Section 11 for more detailed information on health effects and symptoms.

4.3 Immediate medical attention and special treatment needed
Treat symptomatically.

5. FIRE FIGHTING MEASURES

5.1 Extinguishing media
Use an extinguishing agent suitable for the surrounding fire.

5.2 Special hazards arising from the substance or mixture
Non flammable. May evolve magnesium oxides when heated to decomposition.

5.3 Advice for firefighters
Treat as per requirements for surrounding fires. Evacuate area and contact emergency services. Remain upwind and notify those downwind of hazard. Wear full protective equipment including Self Contained Breathing Apparatus (SCBA) when combating fire. Use waterfog to cool intact containers and nearby storage areas.

5.4 Hazchem code
None allocated.

6. ACCIDENTAL RELEASE MEASURES

6.1 Personal precautions, protective equipment and emergency procedures
Wear Personal Protective Equipment (PPE) as detailed in section 8 of the SDS. Ventilate area where possible.

6.2 Environmental precautions
Prevent product from entering drains and waterways.

6.3 Methods of cleaning up
Contain spillage, then collect and place in suitable containers for disposal. Avoid generating dust.

6.4 Reference to other sections
See Sections 8 and 13 for exposure controls and disposal.

7. HANDLING AND STORAGE

7.1 Precautions for safe handling
Before use carefully read the product label. Use of safe work practices are recommended to avoid eye or skin contact and inhalation. Observe good personal hygiene, including washing hands before eating. Prohibit eating, drinking and smoking in contaminated areas.

7.2 Conditions for safe storage, including any incompatibilities
Store in a cool, dry, well ventilated area, removed from incompatible substances and foodstuffs. Ensure product is adequately labelled, protected from physical damage and sealed when not in use.

7.3 Specific end uses
No information provided.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

8.1 Control parameters
Exposure standards

Ingredient	Reference	TWA		STEL	
		ppm	mg/m³	ppm	mg/m³
Calcium oxide	SWA [AUS]	--	2	--	--
Calcium oxide	SWA [Proposed]	--	1	--	--
Fumed silica (respirable dust)	SWA [AUS]	--	2	--	--
Magnesium oxide (fume)	SWA [AUS]	--	10	--	--

Biological limits
No biological limit values have been entered for this product.

8.2 Exposure controls

Engineering controls Avoid inhalation. Use in well ventilated areas. Where an inhalation risk exists, mechanical extraction ventilation is recommended.

PPE

Eye / Face	Wear dust-proof goggles.
Hands	Wear PVC or rubber gloves.
Body	Not required under normal conditions of use.
Respiratory	Where an inhalation risk exists, wear a Class P1 (Particulate) respirator.



9. PHYSICAL AND CHEMICAL PROPERTIES

9.1 Information on basic physical and chemical properties

Appearance	WHITE GRANULES
Odour	ODOURLESS
Flammability	NON FLAMMABLE
Flash point	NOT RELEVANT
Boiling point	3600°C
Melting point	2800°C
Evaporation rate	NOT AVAILABLE
pH	NOT AVAILABLE
Vapour density	NOT AVAILABLE
Specific gravity	3.6 - 3.7
Solubility (water)	SLIGHTLY SOLUBLE
Vapour pressure	NOT AVAILABLE
Upper explosion limit	NOT RELEVANT
Lower explosion limit	NOT RELEVANT
Partition coefficient	NOT AVAILABLE
Autoignition temperature	NOT AVAILABLE
Decomposition temperature	NOT AVAILABLE
Viscosity	NOT AVAILABLE
Explosive properties	NOT AVAILABLE
Oxidising properties	NOT AVAILABLE
Odour threshold	NOT AVAILABLE

9.2 Other information

% Volatiles	0 %

10. STABILITY AND REACTIVITY

10.1 Reactivity
Carefully review all information provided in sections 10.2 to 10.6.

10.2 Chemical stability
Stable under recommended conditions of storage.

10.3 Possibility of hazardous reactions
Polymerization is not expected to occur.

10.4 Conditions to avoid
Avoid heat, sparks, open flames and other ignition sources.

10.5 Incompatible materials

Incompatible (violently) with interhalogens (e.g. bromine pentafluoride, chlorine trifluoride) and phosphorus pentachloride. May ignite or explode when heated with aluminium powder. Also incompatible with acids (e.g. nitric acid) and dampness as material hydrates.

10.6 Hazardous decomposition products

May evolve magnesium oxides when heated to decomposition.

11. TOXICOLOGICAL INFORMATION

11.1 Information on toxicological effects

Acute toxicity Based on available data, the classification criteria are not met.

Information available for the ingredients:

Ingredient	Oral LD50	Dermal LD50	Inhalation LC50
SILICON DIOXIDE (SILICA, AMORPHOUS)	3160 mg/kg (rat)	--	--

Skin Contact may result in irritation, redness, rash and dermatitis.

Eye Contact may result in irritation, lacrimation, pain and redness.

Sensitisation Not classified as causing skin or respiratory sensitisation.

Mutagenicity Not classified as a mutagen.

Carcinogenicity Not classified as a carcinogen.

Reproductive Not classified as a reproductive toxin.

STOT - single exposure Not classified as causing organ damage from single exposure. However, over exposure may result in irritation of the nose and throat, with coughing.

STOT - repeated exposure Not classified as causing organ damage from repeated exposure.

Aspiration Not classified as causing aspiration.

12. ECOLOGICAL INFORMATION

12.1 Toxicity

No information provided.

12.2 Persistence and degradability

The methods for determining the biological degradability are not applicable to inorganic substances.

12.3 Bioaccumulative potential

Not expected to bioaccumulate.

12.4 Mobility in soil

No information provided.

12.5 Other adverse effects

No information provided.

13. DISPOSAL CONSIDERATIONS

13.1 Waste treatment methods

Waste disposal For small amounts, cover with moist sand, vermiculite or similar to avoid dust hazard and dispose of to an approved landfill site. Contact the manufacturer/supplier for additional information if disposing of large quantities (if required).

Legislation Dispose of in accordance with relevant local legislation.

14. TRANSPORT INFORMATION

NOT CLASSIFIED AS A DANGEROUS GOOD BY THE CRITERIA OF THE ADG CODE, IMDG OR IATA

	LAND TRANSPORT (ADG)	SEA TRANSPORT (IMDG / IMO)	AIR TRANSPORT (IATA / ICAO)
14.1 UN Number	None allocated.	None allocated.	None allocated.
14.2 Proper Shipping Name	None allocated.	None allocated.	None allocated.
14.3 Transport hazard class	None allocated.	None allocated.	None allocated.
14.4 Packing Group	None allocated.	None allocated.	None allocated.

14.5 Environmental hazards

No information provided.

14.6 Special precautions for user

Hazchem code None allocated.

15. REGULATORY INFORMATION

15.1 Safety, health and environmental regulations/legislation specific for the substance or mixture

Poison schedule A poison schedule number has not been allocated to this product using the criteria in the Standard for the Uniform Scheduling of Medicines and Poisons (SUSMP).

Classifications Safework Australia criteria is based on the Globally Harmonised System (GHS) of Classification and Labelling of Chemicals.

Inventory listings **AUSTRALIA: AICS (Australian Inventory of Chemical Substances)**
All components are listed on AICS, or are exempt.

16. OTHER INFORMATION

Additional information

EXPOSURE STANDARDS - TIME WEIGHTED AVERAGES: Exposure standards are established on the premise of an 8 hour work period of normal intensity, under normal climatic conditions and where a 16 hour break between shifts exists to enable the body to eliminate absorbed contaminants. In the following circumstances, exposure standards must be reduced: Strenuous work conditions; hot, humid climates; high altitude conditions; extended shifts (which increase the exposure period and shorten the period of recuperation).

RESPIRATORS: In general the use of respirators should be limited and engineering controls employed to avoid exposure. If respiratory equipment must be worn ensure correct respirator selection and training is undertaken. Remember that some respirators may be extremely uncomfortable when used for long periods. The use of air powered or air supplied respirators should be considered where prolonged or repeated use is necessary.

PERSONAL PROTECTIVE EQUIPMENT GUIDELINES:
The recommendation for protective equipment contained within this report is provided as a guide only. Factors such as form of product, method of application, working environment, quantity used, product concentration and the availability of engineering controls should be considered before final selection of personal protective equipment is made.

HEALTH EFFECTS FROM EXPOSURE:
It should be noted that the effects from exposure to this product will depend on several factors including: form of product; frequency and duration of use; quantity used; effectiveness of control measures; protective equipment used and method of application. Given that it is impractical to prepare a report which would encompass all possible scenarios, it is anticipated that users will assess the risks and apply control methods where appropriate.

Abbreviations

ACGIH	American Conference of Governmental Industrial Hygienists
CAS #	Chemical Abstract Service number - used to uniquely identify chemical compounds
CNS	Central Nervous System
EC No.	EC No - European Community Number
EMS	Emergency Schedules (Emergency Procedures for Ships Carrying Dangerous Goods)
GHS	Globally Harmonized System
GTEPG	Group Text Emergency Procedure Guide
IARC	International Agency for Research on Cancer
LC50	Lethal Concentration, 50% / Median Lethal Concentration
LD50	Lethal Dose, 50% / Median Lethal Dose
mg/m³	Milligrams per Cubic Metre
OEL	Occupational Exposure Limit
pH	relates to hydrogen ion concentration using a scale of 0 (high acidic) to 14 (highly alkaline).
ppm	Parts Per Million
STEL	Short-Term Exposure Limit
STOT-RE	Specific target organ toxicity (repeated exposure)
STOT-SE	Specific target organ toxicity (single exposure)
SUSMP	Standard for the Uniform Scheduling of Medicines and Poisons
SWA	Safe Work Australia
TLV	Threshold Limit Value
TWA	Time Weighted Average

Report status

This document has been compiled by RMT on behalf of the manufacturer, importer or supplier of the product and serves as their Safety Data Sheet ('SDS').

It is based on information concerning the product which has been provided to RMT by the manufacturer, importer or supplier or obtained from third party sources and is believed to represent the current state of knowledge as to the appropriate safety and handling precautions for the product at the time of issue. Further clarification regarding any aspect of the product should be obtained directly from the manufacturer, importer or supplier.

While RMT has taken all due care to include accurate and up-to-date information in this SDS, it does not provide any warranty as to accuracy or completeness. As far as lawfully possible, RMT accepts no liability for any loss, injury or damage (including consequential loss) which may be suffered or incurred by any person as a consequence of their reliance on the information contained in this SDS.

Prepared by

Risk Management Technologies
5 Ventnor Ave, West Perth
Western Australia 6005
Phone: +61 8 9322 1711
Fax: +61 8 9322 1794
Email: info@rmt.com.au
Web: www.rmtglobal.com

[End of SDS]

SAFETY DATA SHEET

NDFT 325

Issue Date 11-Jul-2019 **Revision Date** 14-Sep-2020 **Version** 2.1

1. IDENTIFICATION

Product identifier

Product Name NDFT 325

Other means of identification

Product Code NDF00247

UN/ID no UN 1993

Synonyms None

Recommended use of the chemical and restrictions on use

Recommended Use Corrosion inhibitor

Uses advised against No information available

Details of the supplier of the safety data sheet

Supplier
Newpark Drilling Fluids
635 6th Avenue S.W.
Suite 300
Calgary, AB T2P 0T5

Emergency telephone number

Emergency Telephone Chemtrec - US +1 (800) 424-9300
Chemtrec - International +1 (703) 527-3887

2. HAZARDS IDENTIFICATION

Classification

Skin corrosion/irritation	Category 1 - (H314)
Serious eye damage/eye irritation	Category 1 - (H318)
Flammable liquids	Category 3

Label elements

Danger

Hazard statements
Causes severe skin burns and eye damage
Flammable liquid and vapor



Appearance liquid **Physical state** liquid **Odor** No information available

Precautionary Statements - Prevention
Do not breathe dusts or mists
Wash face, hands and any exposed skin thoroughly after handling
Wear protective gloves/protective clothing/eye protection/face protection
Keep away from heat, hot surfaces, sparks, open flames and other ignition sources. No smoking
Keep container tightly closed
Ground/bond container and receiving equipment
Use explosion-proof electrical/ ventilating / lighting/ . / equipment
Use only non-sparking tools
Take precautionary measures against static discharge

Precautionary Statements - Response
Immediately call a POISON CENTER or doctor
Eyes
IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing
Immediately call a POISON CENTER or doctor
Skin
IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water/ shower
Wash contaminated clothing before reuse
Inhalation
IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing
Ingestion
IF SWALLOWED: Rinse mouth. DO NOT induce vomiting
Fire
In case of fire: Use CO2, dry chemical, or foam to extinguish

Precautionary Statements - Storage
Store locked up
Store in a well-ventilated place. Keep cool

Precautionary Statements - Disposal
Dispose of contents/container to an approved waste disposal plant

Other Information
May be harmful if swallowed. May be harmful in contact with skin. Harmful to aquatic life with long lasting effects.

Unknown acute toxicity 65 % of the mixture consists of ingredient(s) of unknown toxicity
0 % of the mixture consists of ingredient(s) of unknown acute oral toxicity
43 % of the mixture consists of ingredient(s) of unknown acute dermal toxicity
65 % of the mixture consists of ingredient(s) of unknown acute inhalation toxicity (gas)
48 % of the mixture consists of ingredient(s) of unknown acute inhalation toxicity (vapor)
60 % of the mixture consists of ingredient(s) of unknown acute inhalation toxicity (dust/mist)

3. COMPOSITION/INFORMATION ON INGREDIENTS

Substance

Not applicable.

Mixture

Chemical name	CAS No.	Weight-%	Hazardous Material Information Review Act registry number (HMIRA registry #)	Date HMIRA filed and date exemption granted (if applicable)
Amine 2	Trade Secret	28-30	-	-
Ethanamine, N-ethyl-N-hydroxy-	[redacted]	17-19	-	-
Amine 1	Trade Secret	10-13	-	-
Ethanolamine	[redacted]	4-5	-	-

4. FIRST AID MEASURES

Description of first aid measures

General advice Immediate medical attention is required. Show this safety data sheet to the doctor in attendance.

Inhalation Remove to fresh air. If breathing has stopped, give artificial respiration. Get medical attention immediately. If not breathing, give artificial respiration. Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. If breathing is difficult, (trained personnel should) give oxygen. Delayed pulmonary edema may occur. Get immediate medical advice/attention. Get medical attention immediately if symptoms occur.

Eye contact Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. Keep eye wide open while rinsing. Do not rub affected area. Remove contact lenses, if present and easy to do. Continue rinsing. Get immediate medical advice/attention.

Skin contact Wash off immediately with soap and plenty of water while removing all contaminated clothes and shoes. Get immediate medical advice/attention. Wash off immediately with soap and plenty of water for at least 15 minutes. Get medical attention if irritation develops and persists.

Ingestion Immediate medical attention is required. Do NOT induce vomiting. Clean mouth with water and drink afterwards plenty of water. Never give anything by mouth to an unconscious person. Get immediate medical advice/attention. Call a physician.

Self-protection of the first aider Remove all sources of ignition. Ensure that medical personnel are aware of the material(s) involved, take precautions to protect themselves and prevent spread of contamination. Use personal protective equipment as required. See section 8 for more information. Avoid contact with skin, eyes or clothing. Avoid direct contact with skin. Use barrier to give mouth-to-mouth resuscitation. Wear personal protective clothing (see section 8).

Most important symptoms and effects, both acute and delayed

Symptoms Burning sensation.

Indication of any immediate medical attention and special treatment needed

Note to physicians Product is a corrosive material. Use of gastric lavage or emesis is contraindicated. Possible perforation of stomach or esophagus should be investigated. Do not give chemical antidotes. Asphyxia from glottal edema may occur. Marked decrease in blood pressure may occur with moist rales, frothy sputum, and high pulse pressure.

5. FIRE-FIGHTING MEASURES

Suitable Extinguishing Media	Dry chemical. Carbon dioxide (CO2). Water spray. Alcohol resistant foam.
Unsuitable extinguishing media	CAUTION: Use of water spray when fighting fire may be inefficient.
Specific hazards arising from the chemical	Risk of ignition. Keep product and empty container away from heat and sources of ignition. In the event of fire, cool tanks with water spray. Fire residues and contaminated fire extinguishing water must be disposed of in accordance with local regulations. The product causes burns of eyes, skin and mucous membranes. Thermal decomposition can lead to release of irritating gases and vapors.
Hazardous combustion products	Carbon oxides. Nitrogen oxides (NOx).
Explosion data	
Sensitivity to Mechanical Impact	None.
Sensitivity to Static Discharge	Yes.
Special protective equipment and precautions for fire-fighters	Firefighters should wear self-contained breathing apparatus and full firefighting turnout gear. Use personal protection equipment.

6. ACCIDENTAL RELEASE MEASURES

Personal precautions, protective equipment and emergency procedures

Personal precautions	Evacuate personnel to safe areas. Use personal protective equipment as required. See section 8 for more information. Avoid contact with skin, eyes or clothing. Ensure adequate ventilation. Keep people away from and upwind of spill/leak. ELIMINATE all ignition sources (no smoking, flares, sparks or flames in immediate area). Pay attention to flashback. Take precautionary measures against static discharges. All equipment used when handling the product must be grounded. Do not touch or walk through spilled material. Attention! Corrosive material.
Other Information	Ventilate the area. Refer to protective measures listed in Sections 7 and 8.

Environmental precautions

Environmental precautions	Refer to protective measures listed in Sections 7 and 8. Prevent further leakage or spillage if safe to do so. Prevent product from entering drains. Should not be released into the environment. Do not allow to enter into soil/subsoil.

Methods and material for containment and cleaning up

Methods for containment	Stop leak if you can do it without risk. Do not touch or walk through spilled material. A vapor suppressing foam may be used to reduce vapors. Dike far ahead of spill to collect runoff water. Keep out of drains, sewers, ditches and waterways. Absorb with earth, sand or other non-combustible material and transfer to containers for later disposal.
Methods for cleaning up	Take precautionary measures against static discharges. Dam up. Soak up with inert absorbent material. Pick up and transfer to properly labeled containers.
Prevention of secondary hazards	Clean contaminated objects and areas thoroughly observing environmental regulations.

7. HANDLING AND STORAGE

Precautions for safe handling

Advice on safe handling	Use personal protection equipment. Avoid contact with skin and eyes. Avoid breathing vapors or mists. Keep away from heat, hot surfaces, sparks, open flames and other ignition sources. No smoking. Take precautionary measures against static discharges. Use grounding and bonding connection when transferring this material to prevent static

discharge, fire or explosion. Use with local exhaust ventilation. Use spark-proof tools and explosion-proof equipment. Keep in an area equipped with sprinklers. Use according to package label instructions. Handle in accordance with good industrial hygiene and safety practice. Avoid contact with skin, eyes or clothing. Ensure adequate ventilation. In case of insufficient ventilation, wear suitable respiratory equipment. Handle product only in closed system or provide appropriate exhaust ventilation. Do not eat, drink or smoke when using this product. Take off contaminated clothing and wash before reuse.

Conditions for safe storage, including any incompatibilities

Storage Conditions Keep containers tightly closed in a dry, cool and well-ventilated place. Keep away from heat, sparks, flame and other sources of ignition (i.e., pilot lights, electric motors and static electricity). Keep in properly labeled containers. Do not store near combustible materials. Keep in an area equipped with sprinklers. Store in accordance with the particular national regulations. Store in accordance with local regulations. Protect from moisture. Store locked up. Keep out of the reach of children. Store away from other materials.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Control parameters

Exposure Limits .

Chemical name	ACGIH TLV	OSHA PEL	NIOSH IDLH
Ethanamine, N-ethyl-N-hydroxy- 3710-84-7	TWA: 2 ppm	-	-
Amine 1	TWA: 5 mg/m³	-	-
Ethanolamine 141-43-5	STEL: 6 ppm TWA: 3 ppm	TWA: 3 ppm TWA: 6 mg/m³ (vacated) TWA: 3 ppm (vacated) TWA: 8 mg/m³ (vacated) STEL: 6 ppm (vacated) STEL: 15 mg/m³	IDLH: 30 ppm TWA: 3 ppm TWA: 8 mg/m³ STEL: 6 ppm STEL: 15 mg/m³

Chemical name	Alberta	British Columbia	Ontario TWA	Quebec
Ethanamine, N-ethyl-N-hydroxy- 3710-84-7			TWA: 2 ppm	
Amine 1	TWA: 5 mg/m³	TWA: 5 mg/m³	TWA: 0.5 ppm TWA: 3.1 mg/m³	TWA: 5 mg/m³
Ethanolamine 141-43-5	TWA: 3 ppm TWA: 7.5 mg/m³ STEL: 6 ppm STEL: 15 mg/m³	TWA: 3 ppm STEL: 6 ppm	TWA: 3 ppm STEL: 6 ppm	TWA: 3 ppm TWA: 7.5 mg/m³ STEL: 6 ppm STEL: 15 mg/m³

Other Information Vacated limits revoked by the Court of Appeals decision in AFL-CIO v. OSHA, 965 F.2d 962 (11th Cir., 1992).

Appropriate engineering controls

Engineering controls Showers
Eyewash stations
Ventilation systems.

Individual protection measures, such as personal protective equipment

Eye/face protection Tight sealing safety goggles. Face protection shield.

Hand protection Wear suitable gloves. Impervious gloves.

Skin and body protection	Wear suitable protective clothing. Long sleeved clothing. Chemical resistant apron. Antistatic boots.
Respiratory protection	No protective equipment is needed under normal use conditions. If exposure limits are exceeded or irritation is experienced, ventilation and evacuation may be required.
General hygiene considerations	Do not eat, drink or smoke when using this product. Contaminated work clothing should not be allowed out of the workplace. Regular cleaning of equipment, work area and clothing is recommended. Wash hands before breaks and immediately after handling the product. Wash hands before breaks and after work. Avoid contact with skin, eyes or clothing. Wear suitable gloves and eye/face protection. Remove and wash contaminated clothing and gloves, including the inside, before re-use.

9. PHYSICAL AND CHEMICAL PROPERTIES

Information on basic physical and chemical properties

Physical state	liquid		
Appearance	liquid	**Color**	brown
Odor	No information available	**Odor threshold**	No information available

Property	**Values**	**Remarks • Method**
pH	11.5	
Melting point / freezing point	-20 °C / -4 °F	
Boiling point / boiling range		No information available
Flash point	> 40 °C / > 104 °F	
Evaporation rate		No information available
Flammability (solid, gas)		No information available
Flammability Limit in Air		No information available
Upper flammability limit:		
Lower flammability limit:		
Vapor pressure		No information available
Vapor density		No information available
Specific Gravity	1.00 - 1.10	
Water solubility		No information available
Solubility in other solvents		No information available
Partition coefficient		No information available
Autoignition temperature		No information available
Decomposition temperature		No information available
Kinematic viscosity		No information available
Dynamic viscosity		No information available
Explosive properties	No information available	
Oxidizing properties	No information available	

Other Information

Softening point	No information available
Molecular weight	No information available
VOC Content (%)	No information available
Liquid Density	1.04-1.06 g/cm3
Bulk density	No information available

10. STABILITY AND REACTIVITY

Reactivity	No information available.
Chemical stability	Stable under normal conditions.
Possibility of Hazardous Reactions	None under normal processing.
Conditions to avoid	Heat, flames and sparks. Exposure to air or moisture over prolonged periods.

Incompatible materials Acids. Bases. Oxidizing agent. Strong acids. Strong bases. Strong oxidizing agents.

Hazardous Decomposition Products Thermal decomposition can lead to release of irritating and toxic gases and vapors.

11. TOXICOLOGICAL INFORMATION

Information on likely routes of exposure

Product Information

Inhalation Specific test data for the substance or mixture is not available. Corrosive by inhalation. (based on components). Inhalation of corrosive fumes/gases may cause coughing, choking, headache, dizziness, and weakness for several hours. Pulmonary edema may occur with tightness in the chest, shortness of breath, bluish skin, decreased blood pressure, and increased heart rate. Inhaled corrosive substances can lead to a toxic edema of the lungs. Pulmonary edema can be fatal.

Eye contact Specific test data for the substance or mixture is not available. Causes burns. (based on components). Corrosive to the eyes and may cause severe damage including blindness. Severely irritating to eyes. Causes serious eye damage. May cause burns. May cause irreversible damage to eyes.

Skin contact Specific test data for the substance or mixture is not available. May cause irritation. May be harmful in contact with skin.

Ingestion Specific test data for the substance or mixture is not available. Causes burns. (based on components). Ingestion causes burns of the upper digestive and respiratory tracts. May cause severe burning pain in the mouth and stomach with vomiting and diarrhea of dark blood. Blood pressure may decrease. Brownish or yellowish stains may be seen around the mouth. Swelling of the throat may cause shortness of breath and choking. May cause lung damage if swallowed. May be fatal if swallowed and enters airways. Ingestion may cause irritation to mucous membranes. Ingestion may cause gastrointestinal irritation, nausea, vomiting and diarrhea. May be harmful if swallowed.

Information on toxicological effects

Symptoms Redness. Burning. May cause blindness. Coughing and/ or wheezing.

Numerical measures of toxicity

Acute toxicity

The following values are calculated based on chapter 3.1 of the GHS document .

ATEmix (oral)	2,961.00
ATEmix (dermal)	3,235.00
ATEmix (inhalation-dust/mist)	12.00
ATEmix (inhalation-vapor)	34.00

Unknown acute toxicity 65 % of the mixture consists of ingredient(s) of unknown toxicity
0 % of the mixture consists of ingredient(s) of unknown acute oral toxicity
43 % of the mixture consists of ingredient(s) of unknown acute dermal toxicity
65 % of the mixture consists of ingredient(s) of unknown acute inhalation toxicity (gas)
48 % of the mixture consists of ingredient(s) of unknown acute inhalation toxicity (vapor)
60 % of the mixture consists of ingredient(s) of unknown acute inhalation toxicity (dust/mist)

Component Information

Chemical name	Oral LD50	Dermal LD50	Inhalation LC50
Amine 2	= 1500 mg/kg (Rat)	-	-
Ethanamine, N-ethyl-N-hydroxy-3710-84-7	= 2190 mg/kg (Rat)	= 1300 mg/kg (Rabbit)	= 11.44 mg/L (Rat) 4 h

Amine 1	= 4190 mg/kg (Rat)	> 20000 mg/kg (Rabbit)	-
Ethanolamine 141-43-5	= 1720 mg/kg (Rat)	= 1000 mg/kg (Rabbit)	-

Delayed and immediate effects as well as chronic effects from short and long-term exposure

Skin corrosion/irritation MAY CAUSE SKIN IRRITATION.

Component Information					
Amine 2					
Method	Species	Exposure route	Effective dose	Exposure time	Results
OECD 404	Rabbit	Dermal		4 hours	non-irritant

Serious eye damage/eye irritation Classification based on data available for ingredients. Causes burns. Risk of serious damage to eyes.

Component Information					
Amine 2					
Method	Species	Exposure route	Effective dose	Exposure time	Results
OPPTS: 870.2400	Rabbit	Eye			Irritant

Respiratory or skin sensitization No information available.

Component Information			
Amine 2			
Method	Species	Exposure route	Results
OECD 406	Guinea pig	Dermal	Not a skin sensitizer

Germ cell mutagenicity No information available.

Component Information		
Amine 2		
Method	Species	Results
OECD 474	in vivo	Not mutagenic

Carcinogenicity No information available.

Chemical name	ACGIH	IARC	NTP	OSHA
Amine 1	-	Group 3	-	-

Reproductive toxicity No information available.

STOT - single exposure No information available.

STOT - repeated exposure No information available.

Target Organ Effects Central nervous system, Eyes, Respiratory system, Skin.

Aspiration hazard No information available.

12. ECOLOGICAL INFORMATION

Ecotoxicity The environmental impact of this product has not been fully investigated.

Chemical name	Algae/aquatic plants	Fish	Toxicity to microorganisms	Crustacea
Amine 2	-	45: 96 h Oncorhynchus mykiss mg/L LC50 semi-static	-	-

Amine 1	169: 96 h Desmodesmus subspicatus mg/L EC50 216: 72 h Desmodesmus subspicatus mg/L EC50	10600 - 13000: 96 h Pimephales promelas mg/L LC50 flow-through 450 - 1000: 96 h Lepomis macrochirus mg/L LC50 static 1000: 96 h Pimephales promelas mg/L LC50 static	-	-
Ethanolamine 141-43-5	15: 72 h Desmodesmus subspicatus mg/L EC50	114 - 196: 96 h Oncorhynchus mykiss mg/L LC50 static 300 - 1000: 96 h Lepomis macrochirus mg/L LC50 static 227: 96 h Pimephales promelas mg/L LC50 flow-through 3684: 96 h Brachydanio rerio mg/L LC50 static 200: 96 h Oncorhynchus mykiss mg/L LC50 flow-through	EC50 = 110 mg/L 17 h EC50 = 12200 mg/L 2 h EC50 = 13.7 mg/L 30 min	65: 48 h Daphnia magna mg/L EC50

Persistence and degradability No information available.

Component Information			
Ethanolamine (141-43-5)			
Method	Exposure time	Value	Results
OECD Test No. 301A: Ready Biodegradability: DOC Die-Away Test (TG 301 A)	21 days	90	Readily biodegradable

Bioaccumulation .

Chemical name	Partition coefficient
Amine 1	-2.53
Ethanolamine 141-43-5	-1.91

Other adverse effects No information available.

13. DISPOSAL CONSIDERATIONS

Waste treatment methods

Waste from residues/unused products Should not be released into the environment. Dispose of in accordance with local regulations. Dispose of waste in accordance with environmental legislation.

Contaminated packaging Empty containers pose a potential fire and explosion hazard. Do not cut, puncture of weld containers.

US EPA Waste Number D001.

14. TRANSPORT INFORMATION

DOT

UN/ID no	UN 1993
Proper shipping name	Flammable liquid, n.o.s. (Contains Ethanamine,N-ethyl-N-hydroxy,)
Hazard class	3
Packing Group	III

TDG

UN/ID no	UN 1993
Proper shipping name	Flammable liquid, n.o.s. (Contains Ethanamine,N-ethyl-N-hydroxy,)
Hazard Class	3
Packing Group	III

IATA

UN/ID no	UN 1993
Proper shipping name	Flammable liquid, n.o.s. (Contains Ethanamine,N-ethyl-N-hydroxy,)
Hazard Class	3
Packing Group	III

IMDG

UN/ID no	UN 1993
Proper shipping name	Flammable liquid, n.o.s. (Contains Ethanamine,N-ethyl-N-hydroxy,)
Hazard Class	3
Packing Group	III

15. REGULATORY INFORMATION

Regulatory information

International Regulations

The Montreal Protocol on Substances that Deplete the Ozone Layer	Not applicable
The Stockholm Convention on Persistent Organic Pollutants	Not applicable
The Rotterdam Convention	Not applicable

International Inventories

TSCA	Complies
DSL/NDSL	Complies
EINECS/ELINCS	Complies
ENCS	Does not comply
IECSC	Complies
KECL	Does not comply
PICCS	Does not comply
AICS	Complies
NZIoC	Complies

Legend:
TSCA - United States Toxic Substances Control Act Section 8(b) Inventory
DSL/NDSL - Canadian Domestic Substances List/Non-Domestic Substances List
EINECS/ELINCS - European Inventory of Existing Chemical Substances/European List of Notified Chemical Substances
ENCS - Japan Existing and New Chemical Substances
IECSC - China Inventory of Existing Chemical Substances
KECL - Korean Existing and Evaluated Chemical Substances
PICCS - Philippines Inventory of Chemicals and Chemical Substances
AICS - Australian Inventory of Chemical Substances
NZIoC - New Zealand Inventory of Chemicals

US Federal Regulations

SARA 313
Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 (SARA). This product does not contain any chemicals which are subject to the reporting requirements of the Act and Title 40 of the Code of Federal Regulations, Part 372.

SARA 311/312 Hazard Categories

Acute health hazard	Yes
Chronic Health Hazard	Yes
Fire hazard	Yes
Sudden release of pressure hazard	No
Reactive Hazard	No

CWA (Clean Water Act)
This product does not contain any substances regulated as pollutants pursuant to the Clean Water Act (40 CFR 122.21 and 40 CFR 122.42).

CERCLA
This material, as supplied, does not contain any substances regulated as hazardous substances under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) (40 CFR 302) or the Superfund Amendments and Reauthorization Act (SARA) (40 CFR 355). There may be specific reporting requirements at the local, regional, or state level pertaining to releases of this material.

US State Regulations

California Proposition 65
This product does not contain any Proposition 65 chemicals.

U.S. State Right-to-Know Regulations

US State Regulations

Chemical name	New Jersey	Massachusetts	Pennsylvania
hydroxylamine 2	X	Not reviewed	X
Ethanolamine 141-43-5	X	X	X

U.S. EPA Label Information

EPA Pesticide Registration Number Not applicable

16. OTHER INFORMATION

NFPA	**Health hazards** 3	**Flammability** 2	**Instability** 0	**Physical and chemical properties** -
HMIS	**Health hazards** 3	**Flammability** 2	**Physical hazards** 0	**Personal protection** X

Issue Date 11-Jul-2019

Revision Date 14-Sep-2020

Revision Note No information available.

Disclaimer

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End of Safety Data Sheet

NEWPARK DRILLING FLUIDS

SAFETY DATA SHEET

1. IDENTIFICATION OF THE MATERIAL AND SUPPLIER

1.1 Product identifier

Product name **NEWPAC LV/RD**

Synonyms NEWPAC RD ● POLICELL RG ● RHEOPAC LV ● RHEOPAC R ● RHEOPAC R/LV/UL/RD/LVD ● RHEOPAC UL

1.2 Uses and uses advised against

Uses DRILLING FLUID ADDITIVE

1.3 Details of the supplier of the product

Supplier name **NEWPARK DRILLING FLUIDS (AUSTRALIA) LTD**

Address 11 Alacrity Place, Henderson, WA, 6166, AUSTRALIA

Telephone +61 8 9410 8200

Fax +61 8 9410 8299

Website www.newpark.com

1.4 Emergency telephone numbers

Emergency 1800 127 406 (Australia); +64 4 917 9888 (International)

2. HAZARDS IDENTIFICATION

2.1 Classification of the substance or mixture

NOT CLASSIFIED AS HAZARDOUS ACCORDING TO SAFE WORK AUSTRALIA CRITERIA

2.2 GHS Label elements

No signal word, pictograms, hazard or precautionary statements have been allocated.

2.3 Other hazards

No information provided.

3. COMPOSITION/ INFORMATION ON INGREDIENTS

3.1 Substances / Mixtures

Ingredient	CAS Number	EC Number	Content
SODIUM CARBOXYMETHYL CELLULOSE	[redacted]	618-378-6	>88%
SODIUM CHLORIDE	[redacted]	231-598-3	<1.8%
WATER	[redacted]	231-791-2	<10%
SODIUM GLYCOLATE	[redacted]	212-730-9	<0.7%

4. FIRST AID MEASURES

4.1 Description of first aid measures

Eye If in eyes, hold eyelids apart and flush continuously with running water. Continue flushing until advised to stop by a Poisons Information Centre, a doctor, or for at least 15 minutes.

Inhalation If inhaled, remove from contaminated area. Apply artificial respiration if not breathing.

Skin If skin or hair contact occurs, remove contaminated clothing and flush skin and hair with running water. Continue flushing with water until advised to stop by a Poisons Information Centre or a doctor.

Ingestion For advice, contact a Poisons Information Centre on 13 11 26 (Australia Wide) or a doctor (at once). If

swallowed, do not induce vomiting. Ingestion is considered unlikely due to product form.

First aid facilities Normal washroom facilities should be available.

4.2 Most important symptoms and effects, both acute and delayed

Adverse effects not expected from this product under normal conditions of use.

4.3 Immediate medical attention and special treatment needed

Treat symptomatically.

5. FIRE FIGHTING MEASURES

5.1 Extinguishing media

Dry agent, carbon dioxide, foam or water fog. Prevent contamination of drains or waterways.

5.2 Special hazards arising from the substance or mixture

Combustible. May evolve toxic gases (carbon oxides, hydrocarbons) when heated to decomposition. Finely divided dust may form explosive mixtures with air.

5.3 Advice for firefighters

Evacuate area and contact emergency services. Toxic gases may be evolved in a fire situation. Remain upwind and notify those downwind of hazard. Wear full protective equipment including Self Contained Breathing Apparatus (SCBA) when combating fire. Use waterfog to cool intact containers and nearby storage areas.

5.4 Hazchem code

None allocated.

6. ACCIDENTAL RELEASE MEASURES

6.1 Personal precautions, protective equipment and emergency procedures

Wear Personal Protective Equipment (PPE) as detailed in section 8 of the SDS. Clear area of all unprotected personnel. Contact emergency services where appropriate.

6.2 Environmental precautions

Prevent product from entering drains and waterways.

6.3 Methods of cleaning up

Contain spillage, then collect and place in suitable containers for reuse or disposal. Avoid generating dust.

6.4 Reference to other sections

See Sections 8 and 13 for exposure controls and disposal.

7. HANDLING AND STORAGE

7.1 Precautions for safe handling

Before use carefully read the product label. Use of safe work practices are recommended to avoid eye or skin contact and inhalation. Observe good personal hygiene, including washing hands before eating. Prohibit eating, drinking and smoking in contaminated areas.

7.2 Conditions for safe storage, including any incompatibilities

Store in a cool, dry, well ventilated area, removed from incompatible substances and foodstuffs. Ensure containers are adequately labelled and tightly closed when not in use.

7.3 Specific end uses

No information provided.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

8.1 Control parameters

Exposure standards

No exposure standards have been entered for this product.

Biological limits

No biological limit values have been entered for this product.

8.2 Exposure controls

Engineering controls Avoid inhalation. Use in well ventilated areas. Maintain dust levels below the recommended exposure standard.

PPE

Eye / Face	Wear dust-proof goggles.
Hands	Wear PVC or rubber gloves.
Body	When using large quantities or where heavy contamination is likely, wear coveralls.
Respiratory	Where an inhalation risk exists, wear a Class P1 (Particulate) respirator.



9. PHYSICAL AND CHEMICAL PROPERTIES

9.1 Information on basic physical and chemical properties

Appearance	WHITE OR YELLOWISH POWDER/GRANULES
Odour	SLIGHT ODOUR
Flammability	COMBUSTIBLE
Flash point	NOT AVAILABLE
Boiling point	NOT AVAILABLE
Melting point	NOT AVAILABLE
Evaporation rate	NOT AVAILABLE
pH	6.0 to 8.5 (1 % solution)
Vapour density	NOT AVAILABLE
Solubility (water)	SOLUBLE
Vapour pressure	NOT AVAILABLE
Upper explosion limit	NOT AVAILABLE
Lower explosion limit	NOT AVAILABLE
Partition coefficient	NOT AVAILABLE
Autoignition temperature	NOT AVAILABLE
Decomposition temperature	NOT AVAILABLE
Viscosity	NOT AVAILABLE
Explosive properties	NOT AVAILABLE
Oxidising properties	NOT AVAILABLE
Odour threshold	NOT AVAILABLE

10. STABILITY AND REACTIVITY

10.1 Reactivity

Carefully review all information provided in sections 10.2 to 10.6.

10.2 Chemical stability

Stable under recommended conditions of storage.

10.3 Possibility of hazardous reactions

Polymerization is not expected to occur.

10.4 Conditions to avoid

Avoid heat, sparks, open flames and other ignition sources.

10.5 Incompatible materials

Incompatible with oxidising agents (e.g. hypochlorites) and acids (e.g. nitric acid).

10.6 Hazardous decomposition products

May evolve toxic gases (carbon oxides, hydrocarbons) when heated to decomposition.

11. TOXICOLOGICAL INFORMATION

11.1 Information on toxicological effects

Acute toxicity

This product is expected to be of low acute toxicity. Under normal conditions of use, adverse health effects are not anticipated.
Toxicity Data available on the ingredients:
SODIUM CARBOXYMETHYL CELLULOSE (9004-32-4)
LD50 (Ingestion): 16000 mg/kg (guinea pig)
LD50 (Skin): > 2000 mg/kg (rabbit)
TDLo (Ingestion): 140 mg/kg (rat)
SODIUM CHLORIDE (7647-14-5)
LC50 (Inhalation): > 42000 mg/m3/1 hour (rat)
LD50 (Ingestion): 3000 mg/kg (rat)
LD50 (Intraperitoneal): 2602 mg/kg (mouse)
LD50 (Intravenous): 645 mg/kg (mouse)
LD50 (Skin): > 10000 mg/kg (rabbit)
LD50 (Subcutaneous): 3000 mg/kg (mouse)
LDLo (Ingestion): 8000 mg/kg (rabbit)
LDLo (Intravenous): 300 mg/kg (guinea pig)
LDLo (Subcutaneous): 2160 mg/kg (guinea pig)
TDLo (Ingestion): 12357 mg/kg (human)
SODIUM GLYCOLATE (2836-32-0)
LD50 (Ingestion): 6700 mg/kg (mouse)
LDLo (Ingestion): 500 mg/kg (cat)

Information available for the ingredients:

Ingredient	Oral LD50	Dermal LD50	Inhalation LC50
SODIUM CARBOXYMETHYL CELLULOSE	16000 mg/kg (guinea pig)	> 2000 mg/kg (rabbit)	--
SODIUM CHLORIDE	3000 mg/kg (rat)	> 10000 mg/kg (rabbit)	> 42000 mg/m³/1 hour (rat)
SODIUM GLYCOLATE	6700 mg/kg (mouse)	--	--

Additional ingredient toxicity values:

SODIUM CARBOXYMETHYL CELLULOSE (9004-32-4)
TDLo (oral) 140 mg/kg (rat)

SODIUM CHLORIDE (7647-14-5)
LD50 (intraperitoneal) 2602 mg/kg (mouse)
LD50 (intravenous) 645 mg/kg (mouse)
LD50 (subcutaneous) 3000 mg/kg (mouse)
LDLo (intravenous) 300 mg/kg (guinea pig)
LDLo (oral) 8000 mg/kg (rabbit)
LDLo (subcutaneous) 2160 mg/kg (guinea pig)
TDLo (oral) 12357 mg/kg (human)

SODIUM GLYCOLATE (2836-32-0)
LDLo (oral) 500 mg/kg (cat)

Skin Not classified as a skin irritant. Contact may result in mild irritation.

Eye Not classified as an eye irritant. Contact may cause discomfort, lacrimation and redness.

Sensitisation Not classified as causing skin or respiratory sensitisation.

Mutagenicity No evidence of mutagenic effects.

Carcinogenicity No evidence of carcinogenic effects.

Reproductive No relevant or reliable studies were identified.

STOT - single exposure Not classified as causing organ damage from single exposure.

STOT - repeated exposure Not classified as causing organ damage from repeated exposure.

Aspiration This product does not present an aspiration hazard.

12. ECOLOGICAL INFORMATION

12.1 Toxicity

LC50 (Fresh Water Trout) > 21,000 ppm/96hrs.
LC50 (Salt Water Stickel Back) > 56,000 ppm/96hrs.

12.2 Persistence and degradability

No information provided.

12.3 Bioaccumulative potential

Not expected to bioaccumulate.

12.4 Mobility in soil

No information provided.

12.5 Other adverse effects

This product is not anticipated to cause adverse effects to animal or plant life if released to the environment in small quantities.

13. DISPOSAL CONSIDERATIONS

13.1 Waste treatment methods

Waste disposal Ensure product is covered with moist soil to prevent dust generation and dispose of to approved Council landfill. Contact the manufacturer/supplier for additional information (if required).

Legislation Dispose of in accordance with relevant local legislation.

14. TRANSPORT INFORMATION

NOT CLASSIFIED AS A DANGEROUS GOOD BY THE CRITERIA OF THE ADG CODE, IMDG OR IATA

	LAND TRANSPORT (ADG)	SEA TRANSPORT (IMDG / IMO)	AIR TRANSPORT (IATA / ICAO)
14.1 UN Number	None allocated.	None allocated.	None allocated.
14.2 Proper Shipping Name	None allocated.	None allocated.	None allocated.
14.3 Transport hazard class	None allocated.	None allocated.	None allocated.
14.4 Packing Group	None allocated.	None allocated.	None allocated.

14.5 Environmental hazards

No information provided.

14.6 Special precautions for user

Hazchem code None allocated.

15. REGULATORY INFORMATION

15.1 Safety, health and environmental regulations/legislation specific for the substance or mixture

Poison schedule A poison schedule number has not been allocated to this product using the criteria in the Standard for the Uniform Scheduling of Medicines and Poisons (SUSMP).

Classifications Safe Work Australia criteria is based on the Globally Harmonised System (GHS) of Classification and Labelling of Chemicals (GHS Revision 7).

Inventory listings **AUSTRALIA: AIIC (Australian Inventory of Industrial Chemicals)**
All components are listed on AIIC, or are exempt.

16. OTHER INFORMATION

Additional information

RESPIRATORS: In general the use of respirators should be limited and engineering controls employed to avoid exposure. If respiratory equipment must be worn ensure correct respirator selection and training is undertaken. Remember that some respirators may be extremely uncomfortable when used for long periods. The use of air powered or air supplied respirators should be considered where prolonged or repeated use is necessary.

PERSONAL PROTECTIVE EQUIPMENT GUIDELINES:
The recommendation for protective equipment contained within this report is provided as a guide only. Factors such as form of product, method of application, working environment, quantity used, product concentration and the availability of engineering controls should be considered before final selection of personal protective equipment is made.

HEALTH EFFECTS FROM EXPOSURE:
It should be noted that the effects from exposure to this product will depend on several factors including: form of product; frequency and duration of use; quantity used; effectiveness of control measures; protective equipment used and method of application. Given that it is impractical to prepare a report which would encompass all possible scenarios, it is anticipated that users will assess the risks and apply control methods where appropriate.

Abbreviations

ACGIH	American Conference of Governmental Industrial Hygienists
CAS #	Chemical Abstract Service number - used to uniquely identify chemical compounds
CNS	Central Nervous System
EC No.	EC No - European Community Number
EMS	Emergency Schedules (Emergency Procedures for Ships Carrying Dangerous Goods)
GHS	Globally Harmonized System
GTEPG	Group Text Emergency Procedure Guide
IARC	International Agency for Research on Cancer
LC50	Lethal Concentration, 50% / Median Lethal Concentration
LD50	Lethal Dose, 50% / Median Lethal Dose
mg/m³	Milligrams per Cubic Metre
OEL	Occupational Exposure Limit
pH	relates to hydrogen ion concentration using a scale of 0 (high acidic) to 14 (highly alkaline).
ppm	Parts Per Million
STEL	Short-Term Exposure Limit
STOT-RE	Specific target organ toxicity (repeated exposure)
STOT-SE	Specific target organ toxicity (single exposure)
SUSMP	Standard for the Uniform Scheduling of Medicines and Poisons
SWA	Safe Work Australia
TLV	Threshold Limit Value
TWA	Time Weighted Average

Report status

This document has been compiled by RMT on behalf of the manufacturer, importer or supplier of the product and serves as their Safety Data Sheet ('SDS').

It is based on information concerning the product which has been provided to RMT by the manufacturer, importer or supplier or obtained from third party sources and is believed to represent the current state of knowledge as to the appropriate safety and handling precautions for the product at the time of issue. Further clarification regarding any aspect of the product should be obtained directly from the manufacturer, importer or supplier.

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Prepared by

Risk Management Technologies
5 Ventnor Ave, West Perth
Western Australia 6005
Phone: +61 8 9322 1711
Fax: +61 8 9322 1794
Email: info@rmt.com.au
Web: www.rmtglobal.com

[End of SDS]

HALLIBURTON

SAFETY DATA SHEET

OXYGON™

Revision Date: 25-Mar-2020 **Revision Number:** 31

1. Product Identifier & Identity for the Chemical

Statement of Hazardous Nature Non-Hazardous according to the criteria of the 3rd Revised Edition of the Globally Harmonised System of Classification and Labelling of Chemicals (GHS), Non-Dangerous Goods according to the criteria of ADG.

1.1. Product Identifier

Product Name OXYGON™

Other means of Identification

Synonyms None

Hazardous Material Number: HM003723

Recommended use of the chemical and restrictions on use

Recommended Use Oxygen Scavenger

Uses advised against No information available

Supplier's name, address and phone number

Manufacturer/Supplier Halliburton Australia Pty. Ltd.
15 Marriott Road, Jandakot, WA 6164
Australia
ACN Number: 009 000 775
Telephone Number: + 61 1 800 686 951
Fax Number: 61 (08) 9455 5300

E-mail Address fdunexchem@halliburton.com

Emergency phone number

+ 61 1 800 686 951
Global Incident Response Access Code: 334305
Contract Number: 14012

Australian Poisons Information Centre
24 Hour Service: - 13 11 26
Police or Fire Brigade: - 000 (exchange): - 1100

2. Hazard Identification

Statement of Hazardous Nature Non-Hazardous according to the criteria of the 3rd Revised Edition of the Globally Harmonised System of Classification and Labelling of Chemicals (GHS), Non-Dangerous Goods according to the criteria of ADG.

Classification of the hazardous chemical

Not classified

Label elements, including precautionary statements

Hazard Pictograms

Signal Word Not Hazardous

Hazard Statements: Not Classified

Precautionary Statements

Prevention None
Response None
Storage None
Disposal None

Contains

Substances	**CAS Number**
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA

Other hazards which do not result in classification
This substance is not considered to be persistent, bioaccumulating nor toxic (PBT).
This substance is not considered to be very persistent nor very bioaccumulating (vPvB).

For the full text of the H-phrases mentioned in this Section, see Section 16

3. Composition/information on Ingredients

Substances	CAS Number	PERCENT (w/w)	GHS Classification - Australia
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	60 - 100%	Not classified

4. First aid measures

Description of necessary first aid measures

Inhalation If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.

Eyes In case of contact, immediately flush eyes with plenty of water for at least 15 minutes and get medical attention if irritation persists.

Skin Wash with soap and water. Get medical attention if irritation persists.

Ingestion Under normal conditions, first aid procedures are not required.

Symptoms caused by exposure
No significant hazards expected.

Medical Attention and Special Treatment
Notes to Physician Treat symptomatically

5. Fire Fighting Measures

Suitable extinguishing equipment
Suitable Extinguishing Media
All standard fire fighting media
Extinguishing media which must not be used for safety reasons
None known.

Specific hazards arising from the chemical
Special exposure hazards in a fire
Not applicable

Special protective equipment and precautions for fire fighters
Special protective equipment for firefighters

Full protective clothing and approved self-contained breathing apparatus required for fire fighting personnel.

6. Accidental release measures

6.1. Personal precautions, protective equipment and emergency procedures

Use appropriate protective equipment. Avoid creating and breathing dust. Avoid contact with skin, eyes and clothing. Ensure adequate ventilation.

6.2. Environmental precautions

Prevent from entering sewers, waterways, or low areas.

6.3. Methods and material for containment and cleaning up

Scoop up and remove.

7. Handling and storage

7.1. Precautions for safe handling

Handling Precautions

Avoid creating or inhaling dust. Avoid contact with eyes, skin, or clothing. Ensure adequate ventilation. Wash hands after use. Launder contaminated clothing before reuse. Use appropriate protective equipment.

Hygiene Measures

Handle in accordance with good industrial hygiene and safety practice.

7.2. Conditions for safe storage, including any incompatibilities

Storage Information

Store away from oxidizers. Store in a cool, dry location. Product has a shelf life of 36 months.

Other Guidelines

No information available

8. Exposure Controls/Personal Protection

Control parameters - exposure standards, biological monitoring

Exposure Limits

Substances	CAS Number	Australia NOHSC	ACGIH TLV-TWA
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	Not applicable	Not applicable

Appropriate engineering controls

Engineering Controls Use in a well ventilated area.

Personal protective equipment (PPE)

Personal Protective Equipment If engineering controls and work practices cannot prevent excessive exposures, the selection and proper use of personal protective equipment should be determined by an industrial hygienist or other qualified professional based on the specific application of this product.

Respiratory Protection If engineering controls and work practices cannot keep exposure below occupational exposure limits or if exposure is unknown, wear a NIOSH certified, European Standard EN 149, AS/NZS 1715:2009, or equivalent respirator when using this product. Selection of and instruction on using all personal protective equipment, including respirators, should be performed by an Industrial Hygienist or other qualified professional. Dust/mist respirator. (N95, P2/P3)

Hand Protection Normal work gloves.

Skin Protection Normal work coveralls.

Eye Protection Wear safety glasses or goggles to protect against exposure.

Other Precautions None known.

Environmental Exposure Controls Do not allow material to contaminate ground water system.

9. Physical and Chemical Properties

9.1. Information on basic physical and chemical properties

Physical State: Solid Powder
Color White
Odor: Odorless
Odor Threshold: No information available

Property Remarks/ - Method	Values
pH:	5.5-8 (5%)
Freezing Point / Range	No data available
Melting Point / Range	No data available
Pour Point / Range	No data available
Boiling Point / Range	No data available
Flash Point	No data available
Upper flammability limit	0.5 oz/ft3
Lower flammability limit	0.28 oz/ft3
Evaporation rate	No data available
Vapor Pressure	No data available
Vapor Density	No data available
Specific Gravity	1.2
Water Solubility	Soluble in water
Solubility in other solvents	No data available
Partition coefficient: n-octanol/water	No data available
Autoignition Temperature	640 °C / 1184 °F
Decomposition Temperature	No data available
Viscosity	No data available
Explosive Properties	No information available
Oxidizing Properties	No information available

9.2. Other information

VOC Content (%)	No data available
Bulk Density	45-65 lbs/ft3

10. Stability and Reactivity

10.1. Reactivity
Not expected to be reactive.
10.2. Chemical stability
Stable
10.3. Possibility of hazardous reactions
Will Not Occur
10.4. Conditions to avoid
None anticipated
10.5. Incompatible materials
Strong oxidizers.
10.6. Hazardous decomposition products
Carbon monoxide and carbon dioxide.

11. Toxicological Information

Information on routes of exposure
Principle Route of Exposure Eye or skin contact, inhalation.

Symptoms related to exposure
Most Important Symptoms/Effects
No significant hazards expected.

Toxicology data for the components

Substances	CAS Number	LD50 Oral	LD50 Dermal	LC50 Inhalation

Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	No data available	No data available	No data available

Immediate, delayed and chronic health effects from exposure

Inhalation May cause mild respiratory irritation.
Eye Contact May cause mechanical irritation to eye.
Skin Contact None known.
Ingestion None known.

Chronic Effects/Carcinogenicity No data available to indicate product or components present at greater than 0.1% are chronic health hazards.

Exposure Levels
No data available

Interactive effects
None known.

Data limitations
No data available

12. Ecological Information

Ecotoxicity

Substance Ecotoxicity Data

Substances	CAS Number	Toxicity to Algae	Toxicity to Fish	Toxicity to Microorganisms	Toxicity to Invertebrates
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	No information available	No information available	No information available	No information available

12.2. Persistence and degradability

Substances	CAS Number	Persistence and Degradability
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	No information available

12.3. Bioaccumulative potential

Substances	CAS Number	Bioaccumulation
Contains no hazardous substances in concentrations above cut-off values according to	NA	No information available

the competent authority		

12.4. Mobility in soil

Substances	CAS Number	Mobility
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	No information available

12.6. Other adverse effects

Endocrine Disruptor Information

This product does not contain any known or suspected endocrine disruptors

13. Disposal Considerations

Safe handling and disposal methods

Bury in a licensed landfill according to federal, state, and local regulations.

Disposal of any contaminated packaging

Follow all applicable national or local regulations.

Environmental regulations

Not applicable

14. Transport Information

Transportation Information

Australia ADG

UN Number	Not restricted
UN proper shipping name:	Not restricted
Transport Hazard Class(es):	Not applicable
Packing Group:	Not applicable
Environmental Hazards:	Not applicable

IMDG/IMO

UN Number	Not restricted
UN proper shipping name:	Not restricted
Transport Hazard Class(es):	Not applicable
Packing Group:	Not applicable
Environmental Hazards:	Not applicable

IATA/ICAO

UN Number	Not restricted
UN proper shipping name:	Not restricted
Transport Hazard Class(es):	Not applicable
Packing Group:	Not applicable
Environmental Hazards:	Not applicable

Special precautions during transport

None

HazChem Code

None Allocated

15. Regulatory Information

Safety, health and environmental regulations specific for the product

International Inventories

Australian AICS Inventory All components are listed on the AICS or are subject to a relevant exemption, permit, or

	assessment certificate.
New Zealand Inventory of Chemicals	All components are listed on the NZIoC or are subject to a relevant exemption, permit, or assessment certificate.
US TSCA Inventory	All components listed on inventory or are exempt.
Canadian Domestic Substances List (DSL)	All components listed on inventory or are exempt.

Poisons Schedule number
None Allocated

International Agreements

Montreal Protocol - Ozone Depleting Substances:	Does not apply.
Stockholm Convention - Persistent Organic Pollutants:	Does not apply
Rotterdam Convention - Prior Informed Consent:	Does not apply.
Basel Convention - Hazardous Waste:	Does not apply.

16. Other information

Date of preparation or review

Revision Date: 25-Mar-2020

Revision Note
SDS sections updated:
2

Full text of H-Statements referred to under sections 2 and 3
None

Additional information

For additional information on the use of this product, contact your local Halliburton representative.

For questions about the Safety Data Sheet for this or other Halliburton products, contact Chemical Stewardship at 1-580-251-4335.

Key abreviations or acronyms used
bw – body weight
CAS – Chemical Abstracts Service
EC50 – Effective Concentration 50%
LC50 – Lethal Concentration 50%
LD50 – Lethal Dose 50%
LL50 – Lethal Loading 50%
mg/kg – milligram/kilogram
mg/L – milligram/liter
NOEC – No Observed Effect Concentration
OEL – Occupational Exposure Limit
PBT – Persistent Bioaccumulative and Toxic
ppm – parts per million
STEL – Short Term Exposure Limit
TWA – Time-Weighted Average
vPvB – very Persistent and very Bioaccumulative
h - hour
mg/m^3 - milligram/cubic meter
mm - millimeter
mmHg - millimeter mercury
w/w - weight/weight
d - day

Key literature references and sources for data
www.ChemADVISOR.com/
NZ CCID

Disclaimer Statement

This information is furnished without warranty, expressed or implied, as to accuracy or completeness. The information is obtained from various sources including the manufacturer and other third party sources. The information may not be valid under all conditions nor if this material is used in combination with other materials or in any process. Final determination of suitability of any material is the sole responsibility of the user.

End of Safety Data Sheet

NEWPARK DRILLING FLUIDS

SAFETY DATA SHEET

1. IDENTIFICATION OF THE MATERIAL AND SUPPLIER

1.1 Product identifier

Product name **POLYDRILL**

Synonyms POLY DRILL

1.2 Uses and uses advised against

Uses ADDITIVE ● DRILLING FLUID ADDITIVE

1.3 Details of the supplier of the product

Supplier name **NEWPARK DRILLING FLUIDS (AUSTRALIA) LTD**

Address 11 Alacrity Place, Henderson, WA, 6166, AUSTRALIA

Telephone +61 8 9410 8200

Fax +61 8 9410 8299

Website http://www.newpark.com

1.4 Emergency telephone numbers

Emergency 1800 127 406 (Australia); +64 4 917 9888 (International)

2. HAZARDS IDENTIFICATION

2.1 Classification of the substance or mixture

NOT CLASSIFIED AS HAZARDOUS ACCORDING TO SAFE WORK AUSTRALIA CRITERIA

2.2 GHS Label elements

No signal word, pictograms, hazard or precautionary statements have been allocated.

2.3 Other hazards

No information provided.

3. COMPOSITION/ INFORMATION ON INGREDIENTS

3.1 Substances / Mixtures

Ingredient	CAS Number	EC Number	Content
SULPHONATED ORGANIC POLYMER	-	-	100%

4. FIRST AID MEASURES

4.1 Description of first aid measures

Eye If in eyes, hold eyelids apart and flush continuously with running water. Continue flushing until advised to stop by a Poisons Information Centre, a doctor, or for at least 15 minutes.

Inhalation If inhaled, remove from contaminated area. Apply artificial respiration if not breathing.

Skin If skin or hair contact occurs, remove contaminated clothing and flush skin and hair with running water. Continue flushing with water until advised to stop by a Poisons Information Centre or a doctor.

Ingestion For advice, contact a Poisons Information Centre on 13 11 26 (Australia Wide) or a doctor (at once). If swallowed, do not induce vomiting. Ingestion is considered unlikely due to product form.

First aid facilities Eye wash facilities and safety shower should be available.

4.2 Most important symptoms and effects, both acute and delayed

Adverse effects not expected from this product under normal conditions of use.

4.3 Immediate medical attention and special treatment needed
Treat symptomatically.

5. FIRE FIGHTING MEASURES

5.1 Extinguishing media
Dry agent, carbon dioxide, foam or water fog. Prevent contamination of drains or waterways.

5.2 Special hazards arising from the substance or mixture
Combustible. May evolve toxic gases (carbon oxides, hydrocarbons) when heated to decomposition. Finely divided dust may form explosive mixtures with air.

5.3 Advice for firefighters
Evacuate area and contact emergency services. Toxic gases may be evolved in a fire situation. Remain upwind and notify those downwind of hazard. Wear full protective equipment including Self Contained Breathing Apparatus (SCBA) when combating fire. Use waterfog to cool intact containers and nearby storage areas.

5.4 Hazchem code
None allocated.

6. ACCIDENTAL RELEASE MEASURES

6.1 Personal precautions, protective equipment and emergency procedures
Wear Personal Protective Equipment (PPE) as detailed in section 8 of the SDS. Clear area of all unprotected personnel. Contact emergency services where appropriate.

6.2 Environmental precautions
Prevent product from entering drains and waterways.

6.3 Methods of cleaning up
Contain spillage, then collect and place in suitable containers for reuse or disposal. Avoid generating dust.

6.4 Reference to other sections
See Sections 8 and 13 for exposure controls and disposal.

7. HANDLING AND STORAGE

7.1 Precautions for safe handling
Before use carefully read the product label. Use of safe work practices are recommended to avoid eye or skin contact and inhalation. Observe good personal hygiene, including washing hands before eating. Prohibit eating, drinking and smoking in contaminated areas.

7.2 Conditions for safe storage, including any incompatibilities
Store in a cool, dry, well ventilated area, removed from incompatible substances and foodstuffs. Ensure containers are adequately labelled and tightly closed when not in use.

7.3 Specific end uses
No information provided.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

8.1 Control parameters
Exposure standards

No exposure standards have been entered for this product.

Biological limits

No biological limit values have been entered for this product.

8.2 Exposure controls
Engineering controls Avoid inhalation. Use in well ventilated areas.

PPE

Eye / Face	Wear dust-proof goggles.
Hands	Wear PVC or rubber gloves.
Body	When using large quantities or where heavy contamination is likely, wear coveralls.
Respiratory	Where an inhalation risk exists, wear a Class P1 (Particulate) respirator.



9. PHYSICAL AND CHEMICAL PROPERTIES

9.1 Information on basic physical and chemical properties

Appearance	RED BROWN POWDER
Odour	CHARACTERISTIC ODOUR
Flammability	COMBUSTIBLE
Flash point	NOT RELEVANT
Boiling point	> 370°C
Melting point	NOT AVAILABLE
Evaporation rate	NOT AVAILABLE
pH	7 to 9 (150 g/L)
Vapour density	NOT AVAILABLE
Relative density	1.8
Solubility (water)	320 g/L
Vapour pressure	NOT AVAILABLE
Upper explosion limit	NOT RELEVANT
Lower explosion limit	NOT RELEVANT
Partition coefficient	NOT AVAILABLE
Autoignition temperature	NOT AVAILABLE
Decomposition temperature	NOT AVAILABLE
Viscosity	NOT AVAILABLE
Explosive properties	NOT AVAILABLE
Oxidising properties	NOT AVAILABLE
Odour threshold	NOT AVAILABLE

10. STABILITY AND REACTIVITY

10.1 Reactivity

Carefully review all information provided in sections 10.2 to 10.6.

10.2 Chemical stability

Stable under recommended conditions of storage.

10.3 Possibility of hazardous reactions

Polymerization is not expected to occur.

10.4 Conditions to avoid

Avoid heat, sparks, open flames and other ignition sources.

10.5 Incompatible materials

Incompatible with oxidising agents (e.g. hypochlorites) and acids (e.g. nitric acid).

10.6 Hazardous decomposition products

May evolve toxic gases (carbon oxides, hydrocarbons) when heated to decomposition.

11. TOXICOLOGICAL INFORMATION

11.1 Information on toxicological effects

Acute toxicity Acute oral toxicity: LD50 (rat) > 5000 mg/kg (low toxicity). Under normal conditions of use, adverse health

effects are not anticipated.

Information available for the ingredients:

Ingredient	Oral LD50	Dermal LD50	Inhalation LC50
SULPHONATED ORGANIC POLYMER	> 5000 mg/kg (rat)	--	--

Skin Not classified as a skin irritant. Contact may result in mild irritation.

Eye Not classified as an eye irritant. Contact may cause discomfort, lacrimation and redness.

Sensitisation Not classified as causing skin or respiratory sensitisation.

Mutagenicity No evidence of mutagenic effects.

Carcinogenicity No evidence of carcinogenic effects.

Reproductive No relevant or reliable studies were identified.

STOT - single exposure Not classified as causing organ damage from single exposure.

STOT - repeated exposure Not classified as causing organ damage from repeated exposure.

Aspiration This product does not present an aspiration hazard.

12. ECOLOGICAL INFORMATION

12.1 Toxicity

Oncorhynchus mykiss (Rainbow Trout) LC 50 (96 Hr) is 4,430 mg/L.
Pseudomonas putida EC 10 (growth inhibition) is > 32,000 mg/L.

12.2 Persistence and degradability

This product is not readily biodegradable.

12.3 Bioaccumulative potential

No information provided.

12.4 Mobility in soil

No information provided.

12.5 Other adverse effects

No information provided.

13. DISPOSAL CONSIDERATIONS

13.1 Waste treatment methods

Waste disposal Ensure product is covered with moist soil to prevent dust generation and dispose of to approved Council landfill. Contact the manufacturer/supplier for additional information (if required).

Legislation Dispose of in accordance with relevant local legislation.

14. TRANSPORT INFORMATION

NOT CLASSIFIED AS A DANGEROUS GOOD BY THE CRITERIA OF THE ADG CODE, IMDG OR IATA

	LAND TRANSPORT (ADG)	SEA TRANSPORT (IMDG / IMO)	AIR TRANSPORT (IATA / ICAO)
14.1 UN Number	None allocated.	None allocated.	None allocated.
14.2 Proper Shipping Name	None allocated.	None allocated.	None allocated.
14.3 Transport hazard class	None allocated.	None allocated.	None allocated.
14.4 Packing Group	None allocated.	None allocated.	None allocated.

14.5 Environmental hazards

No information provided.

14.6 Special precautions for user

Hazchem code None allocated.

15. REGULATORY INFORMATION

15.1 Safety, health and environmental regulations/legislation specific for the substance or mixture

Poison schedule A poison schedule number has not been allocated to this product using the criteria in the Standard for the Uniform Scheduling of Medicines and Poisons (SUSMP).

Classifications Safe Work Australia criteria is based on the Globally Harmonised System (GHS) of Classification and Labelling of Chemicals (GHS Revision 7).

Inventory listings **AUSTRALIA: AIIC (Australian Inventory of Industrial Chemicals)**
All components are listed on AIIC, or are exempt.

16. OTHER INFORMATION

Additional information

RESPIRATORS: In general the use of respirators should be limited and engineering controls employed to avoid exposure. If respiratory equipment must be worn ensure correct respirator selection and training is undertaken. Remember that some respirators may be extremely uncomfortable when used for long periods. The use of air powered or air supplied respirators should be considered where prolonged or repeated use is necessary.

PERSONAL PROTECTIVE EQUIPMENT GUIDELINES:
The recommendation for protective equipment contained within this report is provided as a guide only. Factors such as form of product, method of application, working environment, quantity used, product concentration and the availability of engineering controls should be considered before final selection of personal protective equipment is made.

HEALTH EFFECTS FROM EXPOSURE:
It should be noted that the effects from exposure to this product will depend on several factors including: form of product; frequency and duration of use; quantity used; effectiveness of control measures; protective equipment used and method of application. Given that it is impractical to prepare a report which would encompass all possible scenarios, it is anticipated that users will assess the risks and apply control methods where appropriate.

Abbreviations

ACGIH	American Conference of Governmental Industrial Hygienists
CAS #	Chemical Abstract Service number - used to uniquely identify chemical compounds
CNS	Central Nervous System
EC No.	EC No - European Community Number
EMS	Emergency Schedules (Emergency Procedures for Ships Carrying Dangerous Goods)
GHS	Globally Harmonized System
GTEPG	Group Text Emergency Procedure Guide
IARC	International Agency for Research on Cancer
LC50	Lethal Concentration, 50% / Median Lethal Concentration
LD50	Lethal Dose, 50% / Median Lethal Dose
mg/m³	Milligrams per Cubic Metre
OEL	Occupational Exposure Limit
pH	relates to hydrogen ion concentration using a scale of 0 (high acidic) to 14 (highly alkaline).
ppm	Parts Per Million
STEL	Short-Term Exposure Limit
STOT-RE	Specific target organ toxicity (repeated exposure)
STOT-SE	Specific target organ toxicity (single exposure)
SUSMP	Standard for the Uniform Scheduling of Medicines and Poisons
SWA	Safe Work Australia
TLV	Threshold Limit Value
TWA	Time Weighted Average

Report status

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Prepared by

Risk Management Technologies
5 Ventnor Ave, West Perth
Western Australia 6005
Phone: +61 8 9322 1711
Fax: +61 8 9322 1794
Email: info@rmt.com.au
Web: www.rmtglobal.com

[End of SDS]

SAFETY DATA SHEET

EvoLube® TR

NDF00132 **Revision Date** 22-Oct-2015 **Version** 1

1. IDENTIFICATION

Product identifier
Product Name EvoLube® TR

Recommended use of the chemical and restrictions on use
Recommended Use Lubricant

Details of the supplier of the safety data sheet
Supplier
Newpark Drilling Fluids LLC
21920 Merchants Way
Katy, Texas 77449
Tel: +1 (800)-444-0682
http://www.newpark.com/

Emergency telephone number
Emergency Telephone Chemtrec - US +1 (800) 424-9300
Chemtrec - International +1 (703) 527-3887

2. HAZARDS IDENTIFICATION

Classification

OSHA Regulatory Status
This chemical is considered hazardous by the 2012 OSHA Hazard Communication Standard (29 CFR 1910.1200)

Acute toxicity - Oral	Category 4 - (H302)
Acute toxicity - Inhalation (Dusts/Mists)	Category 4 - (H332)
Serious eye damage/eye irritation	Category 1 - (H318)
Carcinogenicity	Category 2 - (H351)
Specific target organ toxicity (repeated exposure)	Category 2 - (H373)

Label elements

Emergency Overview

Danger

Hazard statements
H302 - Harmful if swallowed
H318 - Causes serious eye damage
H332 - Harmful if inhaled
H351 - Suspected of causing cancer
H373 - May cause damage to organs through prolonged or repeated exposure



Appearance No information available **Physical state** liquid **Odor** No information available

Precautionary statements
P264 - Wash face, hands and any exposed skin thoroughly after handling
P270 - Do not eat, drink or smoke when using this product
P301 + P312 - IF SWALLOWED: Call a POISON CENTER or doctor/physician if you feel unwell
P330 - Rinse mouth
P261 - Avoid breathing dust/fume/gas/mist/vapors/spray
P271 - Use only outdoors or in a well-ventilated area
P304 + P340 - IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing
P312 - Call a POISON CENTER or doctor/physician if you feel unwell
P305 + P351 + P338 - IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing
P310 - Immediately call a POISON CENTER or doctor/physician
P201 - Obtain special instructions before use
P202 - Do not handle until all safety precautions have been read and understood
P281 - Use personal protective equipment as required
P308 + P313 - IF exposed or concerned: Get medical advice/attention
P405 - Store locked up
P260 - Do not breathe dust/fume/gas/mist/vapors/spray
P314 - Get medical advice/attention if you feel unwell
P501 - Dispose of contents/ container to an approved waste disposal plant
P280 - Wear protective gloves/protective clothing/eye protection/face protection
P501 - Dispose of contents/container to industrial incineration plant

Hazards not otherwise classified (HNOC)
Not applicable

Other Information
May be harmful in contact with skin. Causes mild skin irritation.

Unknown acute toxicity 84 % of the mixture consists of ingredient(s) of unknown toxicity

3. COMPOSITION/INFORMATION ON INGREDIENTS

Substance

Chemical Name	CAS No.	Weight-%
Triethylene glycol, monobutyl ether	143-22-6	7 - 13*
2-Butoxyethanol	111-76-2	3 - 7*
Diethanolamine	111-42-2	1 - 5*

*The exact percentage (concentration) of composition has been withheld as a trade secret.

4. FIRST AID MEASURES

Description of first aid measures

General advice In case of accident or unwellness, seek medical advice immediately (show directions for use or safety data sheet if possible).

Eye contact Immediately flush with plenty of water. After initial flushing, remove any contact lenses and continue flushing for at least 15 minutes. Keep eyes wide open while rinsing. If symptoms persist, call a physician.

Skin contact Wash skin with soap and water. Remove contaminated clothing and shoes. Wash contaminated clothing before reuse. Get medical attention if irritation develops and persists.

Inhalation Remove to fresh air. If not breathing, give artificial respiration. If symptoms persist, call a physician.

Ingestion Clean mouth with water and drink afterwards plenty of water. Never give anything by mouth to an unconscious person. Do not induce vomiting without medical advice. If symptoms persist, call a physician.

Self-protection of the first aider Use personal protective equipment as required.

Most important symptoms and effects, both acute and delayed

Symptoms No information available.

Indication of any immediate medical attention and special treatment needed

Note to physicians Treat symptomatically.

5. FIRE-FIGHTING MEASURES

Suitable extinguishing media
Use extinguishing measures that are appropriate to local circumstances and the surrounding environment.

Unsuitable extinguishing media CAUTION: Use of water spray when fighting fire may be inefficient.

Specific hazards arising from the chemical
No information available.

Hazardous combustion products Carbon oxides, Nitrogen oxides (NOx)

Explosion data
Sensitivity to Mechanical Impact None.
Sensitivity to Static Discharge None.

Protective equipment and precautions for firefighters
As in any fire, wear self-contained breathing apparatus pressure-demand, MSHA/NIOSH (approved or equivalent) and full protective gear.

6. ACCIDENTAL RELEASE MEASURES

Personal precautions, protective equipment and emergency procedures

Personal precautions Ensure adequate ventilation, especially in confined areas. Keep people away from and upwind of spill/leak.

For emergency responders In the case of vapor formation use a respirator with an approved filter.

Environmental precautions

Environmental precautions See Section 12 for additional Ecological Information.

Methods and material for containment and cleaning up

Methods for containment Prevent further leakage or spillage if safe to do so. Dike to collect large liquid spills.

Methods for cleaning up Use personal protective equipment as required. Use a non-combustible material like vermiculite or sand to soak up the product and place into a container for later disposal. Use clean non-sparking tools to collect absorbed material.

7. HANDLING AND STORAGE

Precautions for safe handling

Advice on safe handling Handle in accordance with good industrial hygiene and safety practice. Wash thoroughly after handling. Wash contaminated clothing before reuse.

Conditions for safe storage, including any incompatibilities

Storage Conditions Keep containers tightly closed in a dry, cool and well-ventilated place.

Incompatible materials Strong acids. Strong oxidizing agents.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Control parameters

Exposure Guidelines .

Chemical Name	ACGIH TLV	OSHA PEL	NIOSH IDLH
2-Butoxyethanol 111-76-2	TWA: 20 ppm	TWA: 50 ppm TWA: 240 mg/m^3 (vacated) TWA: 25 ppm (vacated) TWA: 120 mg/m^3 (vacated) S* S*	IDLH: 700 ppm TWA: 5 ppm TWA: 24 mg/m^3
Diethanolamine 111-42-2	TWA: 1 mg/m^3 inhalable fraction and vapor S*	(vacated) TWA: 3 ppm (vacated) TWA: 15 mg/m^3	TWA: 3 ppm TWA: 15 mg/m^3

NIOSH IDLH Immediately Dangerous to Life or Health

Other Information Vacated limits revoked by the Court of Appeals decision in AFL-CIO v. OSHA, 965 F.2d 962 (11th Cir., 1992).

Appropriate engineering controls

Engineering Controls Showers
Eyewash stations
Ventilation systems.

Individual protection measures, such as personal protective equipment

Eye/face protection Tight sealing safety goggles.

Skin and body protection Wear protective gloves and protective clothing.

Respiratory protection If exposure limits are exceeded or irritation is experienced, NIOSH/MSHA approved respiratory protection should be worn. Positive-pressure supplied air respirators may be required for high airborne contaminant concentrations. Respiratory protection must be provided in accordance with current local regulations.

General Hygiene Considerations Handle in accordance with good industrial hygiene and safety practice.

9. PHYSICAL AND CHEMICAL PROPERTIES

Information on basic physical and chemical properties

Physical state	liquid		
Appearance	No information available	**Odor**	No information available
Color	clear to Pale yellow	**Odor threshold**	No information available

Property	**Values**	**Remarks • Method**
pH	8.9	5% solution
Melting point / freezing point	No information available	
Boiling point / boiling range	No information available	
Flash point	> 93 °C / > 200 °F	
Evaporation rate	No information available	
Flammability (solid, gas)	No information available	
Flammability Limit in Air		
Upper flammability limit:	No information available	
Lower flammability limit:	No information available	
Vapor pressure	No information available	
Vapor density	No information available	
Specific Gravity	0.94	
Water solubility	No information available	
Solubility in other solvents	No information available	
Partition coefficient	No information available	
Autoignition temperature	No information available	
Decomposition temperature	No information available	
Kinematic viscosity	No information available	
Dynamic viscosity	No information available	
Explosive properties	No information available	
Oxidizing properties	No information available	

Other Information

Softening point	No information available
Molecular weight	No information available
VOC Content (%)	No information available
Density	No information available
Bulk density	No information available

10. STABILITY AND REACTIVITY

Reactivity
No data available

Chemical stability
Stable under recommended storage conditions.

Possibility of Hazardous Reactions
Hazardous polymerization does not occur.

Conditions to avoid
Extremes of temperature and direct sunlight. Incompatible materials.

Incompatible materials
Strong acids. Strong oxidizing agents.

Hazardous Decomposition Products
None known based on information supplied.

11. TOXICOLOGICAL INFORMATION

Information on likely routes of exposure

Product Information No data available

Inhalation No data available.

Eye contact No data available.

Skin contact No data available.

Ingestion No data available.

Chemical Name	Oral LD50	Dermal LD50	Inhalation LC50
Triethylene glycol, monobutyl ether 143-22-6	= 5300 mg/kg (Rat)	= 3480 mg/kg (Rabbit)	-
2-Butoxyethanol 111-76-2	= 470 mg/kg (Rat)	= 99 mg/kg (Rabbit)	= 450 ppm (Rat) 4 h
Diethanolamine 111-42-2	= 620 µL/kg (Rat) = 0.62 mL/kg (Rat)	= 7640 µL/kg (Rabbit)	-

Information on toxicological effects

Symptoms No information available.

Delayed and immediate effects as well as chronic effects from short and long-term exposure

Sensitization No information available.
Germ cell mutagenicity No information available.
Carcinogenicity The table below indicates whether each agency has listed any ingredient as a carcinogen.

Chemical Name	ACGIH	IARC	NTP	OSHA
2-Butoxyethanol 111-76-2	A3	Group 3	-	-
Diethanolamine 111-42-2	A3	Group 2B	-	X

ACGIH (American Conference of Governmental Industrial Hygienists)
A3 - Animal Carcinogen
IARC (International Agency for Research on Cancer)
Group 2B - Possibly Carcinogenic to Humans
Not classifiable as a human carcinogen
OSHA (Occupational Safety and Health Administration of the US Department of Labor)
X - Present

Reproductive toxicity No information available.
STOT - single exposure No information available.
STOT - repeated exposure No information available.
Chronic toxicity May cause adverse effects on the bone marrow and blood-forming system. May cause adverse liver effects.
Target Organ Effects blood, Central nervous system, Eyes, Hematopoietic System, kidney, liver, Respiratory system, Skin.
Aspiration hazard No information available.

Numerical measures of toxicity - Product Information

The following values are calculated based on chapter 3.1 of the GHS document

ATEmix (oral) 500.00 mg/kg
ATEmix (dermal) 2,022.00 mg/kg mg/l
ATEmix (inhalation-dust/mist) 1.50 mg/l
ATEmix (inhalation-vapor) 450.00 mg/l

12. ECOLOGICAL INFORMATION

Ecotoxicity

84 % of the mixture consists of component(s) of unknown hazards to the aquatic environment

Chemical Name	Algae/aquatic plants	Fish	Crustacea

Triethylene glycol, monobutyl ether 143-22-6	500: 72 h Desmodesmus subspicatus mg/L EC50	2200 - 4600: 96 h Leuciscus idus mg/L LC50 static 2400: 96 h Pimephales promelas mg/L LC50 static 2400: 96 h Pimephales promelas mg/L LC50	500: 48 h Daphnia magna mg/L EC50
2-Butoxyethanol 111-76-2	-	2950: 96 h Lepomis macrochirus mg/L LC50 1490: 96 h Lepomis macrochirus mg/L LC50 static	1000: 48 h Daphnia magna mg/L EC50 1698 - 1940: 24 h Daphnia magna mg/L EC50
Diethanolamine 111-42-2	7.8: 72 h Desmodesmus subspicatus mg/L EC50 2.1 - 2.3: 96 h Pseudokirchneriella subcapitata mg/L EC50	4460 - 4980: 96 h Pimephales promelas mg/L LC50 flow-through 1200 - 1580: 96 h Pimephales promelas mg/L LC50 static 600 - 1000: 96 h Lepomis macrochirus mg/L LC50 static	55: 48 h Daphnia magna mg/L EC50

Persistence and degradability
No information available.

Bioaccumulation
No information available.

Mobility
No information available.

Chemical Name	Partition coefficient
Triethylene glycol, monobutyl ether 143-22-6	0.51
2-Butoxyethanol 111-76-2	0.81
Diethanolamine 111-42-2	-2.18

Other adverse effects No information available

13. DISPOSAL CONSIDERATIONS

Waste treatment methods

Disposal of wastes Disposal should be in accordance with applicable regional, national and local laws and regulations.

Contaminated packaging Do not reuse container. Dispose of in accordance with federal, state and local regulations.

14. TRANSPORT INFORMATION

DOT Not regulated.

TDG Not regulated

MEX Not regulated

ICAO (air) Not regulated

IATA Not regulated

IMDG Not regulated

RID Not regulated

ADR Not regulated

ADN Not regulated

15. REGULATORY INFORMATION

International Inventories

TSCA	Complies
DSL/NDSL	Complies
EINECS/ELINCS	Complies
ENCS	Does not comply
IECSC	Complies
KECL	Complies
PICCS	Complies
AICS	Complies
NZIoC	Complies

Legend:

TSCA - United States Toxic Substances Control Act Section 8(b) Inventory
DSL/NDSL - Canadian Domestic Substances List/Non-Domestic Substances List
EINECS/ELINCS - European Inventory of Existing Chemical Substances/European List of Notified Chemical Substances
ENCS - Japan Existing and New Chemical Substances
IECSC - China Inventory of Existing Chemical Substances
KECL - Korean Existing and Evaluated Chemical Substances
PICCS - Philippines Inventory of Chemicals and Chemical Substances
AICS - Australian Inventory of Chemical Substances
NZIoC - New Zealand Inventory of Chemicals

US Federal Regulations

SARA 313

Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 (SARA). This product contains a chemical or chemicals which are subject to the reporting requirements of the Act and Title 40 of the Code of Federal Regulations, Part 372

Chemical Name	SARA 313 - Threshold Values %
Triethylene glycol, monobutyl ether - 143-22-6	1.0
2-Butoxyethanol - 111-76-2	1.0
Diethanolamine - 111-42-2	1.0

SARA 311/312 Hazard Categories

Acute health hazard	Yes
Chronic Health Hazard	Yes
Fire hazard	No
Sudden release of pressure hazard	No
Reactive Hazard	No

CWA (Clean Water Act)

This product does not contain any substances regulated as pollutants pursuant to the Clean Water Act (40 CFR 122.21 and 40 CFR 122.42)

CERCLA

This material, as supplied, contains one or more substances regulated as a hazardous substance under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) (40 CFR 302)

Chemical Name	Hazardous Substances RQs	CERCLA/SARA RQ	Reportable Quantity (RQ)
Diethanolamine 111-42-2	100 lb	-	RQ 100 lb final RQ RQ 45.4 kg final RQ

US State Regulations

California Proposition 65

This product contains the following Proposition 65 chemicals

Chemical Name	California Proposition 65
Diethanolamine - 111-42-2	Carcinogen

U.S. State Right-to-Know Regulations

Chemical Name	New Jersey	Massachusetts	Pennsylvania
Vegetable oil	-	-	X
Triethylene glycol, monobutyl ether 143-22-6	X	-	X
2-Butoxyethanol 111-76-2	X	X	X
Diethanolamine 111-42-2	X	X	X

U.S. EPA Label Information
EPA Pesticide Registration Number Not applicable

Canada

This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all the information required by the CPR
WHMIS Hazard Class

D2A - Very toxic materials 

16. OTHER INFORMATION, INCLUDING DATE OF PREPARATION OF THE LAST REVISION

NFPA		HMIS	
Health hazards	2	**Health hazards**	2
Flammability	1	**Flammability**	1
Instability	0	**Physical hazards**	0
Physical and Chemical Properties	-	**Personal protection**	X



Revision Date 22-Oct-2015

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End of Safety Data Sheet

RADIAGREEN EBL

Safety Data Sheet

according to Regulation (EC) No. 1907/2006 (REACH) with its amendment Regulation (EU) 2015/830

OLEON is a registered trademark. - RADIAGREEN is a registered trademark of Oleon NV.

Issue date: 31/07/2021 Revision date: 08/03/2021 Supersedes version of: 08/03/2021 Version: 2.19

SECTION 1: Identification of the substance/mixture and of the company/undertaking

1.1. Product identifier

Product form : Mixture (UVCB)

Generic name : RADIAGREEN EBL

REACH number : all the ingredients of this product in the scope of Regulation 1907/2006/EC (REACH), if not exempted, have been registered.

C&L notification reference no : all the ingredients of this product in the scope of Regulation 1272/2008/EC (CLP), if not exempted, have been notified to the C&L Inventory.

1.2. Relevant identified uses of the substance or mixture and uses advised against

1.2.1. Relevant identified uses

Main use category : Industrial use

1.2.2. Uses advised against

No additional information available

1.3. Details of the supplier of the safety data sheet

OLEON N.V.
Assenedestraat 2
9940 Ertvelde - Belgium
T +32 9 341 10 11 - F +32 9 341 10 00
info@oleon.com - www.oleon.com
E-mail address of competent person responsible for the SDS : sds@oleon.com

1.4. Emergency telephone number

Emergency number : 24/7 EMERGENCY NUMBER (SGS ERS; Oleon contract nr 76858)
+32 3 575 55 55 (worldwide); +1 888 765 6554 (USA tollfree)

Country	Official advisory body	Address	Emergency number	Comment
	World directory of poisons centres (Yellow Tox) WHO-OMS	Website	http://www.who.int/gho/phe/chemical_safety/poisons_centres/en/	

SECTION 2: Hazards identification

2.1. Classification of the substance or mixture

Classification according to Regulation (EC) No. 1272/2008 [CLP]

Serious eye damage/eye irritation Not classified — Conclusive but not sufficient for classification

Full text of H- and EUH-statements: see section 16

Adverse physicochemical, human health and environmental effects

Not classified as dangerous according to the criteria of Australian NOHSC (not hazardous; not dangerous goods). According to ABNT NBR 14725-2, no labeling obligation.

2.2. Label elements

Labelling according to Regulation (EC) No. 1272/2008 [CLP]

EUH-statements : EUH210 - Safety data sheet available on request.

2.3. Other hazards

Other hazards which do not result in classification : None under normal conditions.

SECTION 3: Composition/information on ingredients

3.1. Substances

Not applicable

3.2. Mixtures

Name	Product identifier	%	Classification according to Regulation (EC) No. 1272/2008 [CLP]
Fatty esters (Constituent)		> 60	Not classified
Specialities (Constituent)		< 40	Not classified

SECTION 4: First aid measures

4.1. Description of first aid measures

First-aid measures general : If you feel unwell, seek medical advice.

First-aid measures after inhalation : Remove victim to fresh air. Respiratory problems: consult a doctor/medical service.

First-aid measures after skin contact : Rinse with water. Soap may be used. Take victim to a doctor if irritation persists.

First-aid measures after eye contact : Rinse with water. Consult an ophtalmologist if irritation persists.

First-aid measures after ingestion : Rinse mouth thoroughly with water. Call a poison center or a doctor if you feel unwell.

4.2. Most important symptoms and effects, both acute and delayed

Symptoms/effects : Unlikely to cause harmful effects.

4.3. Indication of any immediate medical attention and special treatment needed

No supplementary information available.

SECTION 5: Firefighting measures

5.1. Extinguishing media

Suitable extinguishing media : AFFF foam. BC powder. Carbon dioxide. Dry sand. Dry chemical powder. Adapt extinguishing media to the environment.

Unsuitable extinguishing media : Solid water jet ineffective as extinguishing medium.

5.2. Special hazards arising from the substance or mixture

Fire hazard : DIRECT FIRE HAZARD: Combustible. INDIRECT FIRE HAZARD: Heating increases the fire hazard. Temperature above flashpoint: higher fire/explosion hazard.

Explosion hazard : No direct explosion hazard.

Reactivity in case of fire : On burning: release of (carbon monoxide - carbon dioxide).

5.3. Advice for firefighters

Other information : No supplementary information available.

SECTION 6: Accidental release measures

6.1. Personal precautions, protective equipment and emergency procedures

General measures : Mark the danger area. Exposure to heat: have neighbourhood close doors and windows. Exposure to fire/heat: consider evacuation. Wash contaminated clothes.

6.1.1. For non-emergency personnel

Protective equipment : See "Material-Handling" to select protective clothing.

6.1.2. For emergency responders

Protective equipment : Use protective measures listed in Section 8.

6.2. Environmental precautions

Prevent soil and water pollution.

6.3. Methods and material for containment and cleaning up

Methods for cleaning up : Clean contaminated surfaces with an excess of water and soap solution. Take up liquid spill into inert absorbent material, e.g.: dry sand/earth/vermiculite or powdered limestone.

Other information : No supplementary information available.

6.4. Reference to other sections

Handle waste materials in accordance with the provisions of Section 13.

SECTION 7: Handling and storage

7.1. Precautions for safe handling

Precautions for safe handling	: Smoking, eating and drinking should be prohibited in areas of storage and use.
Handling temperature	: ≥ 10 °C above melting point
Hygiene measures	: Wash hands before break and at end of works. Good standard of personal hygiene.

7.2. Conditions for safe storage, including any incompatibilities

Information on mixed storage	: KEEP SUBSTANCE AWAY FROM: heat sources.
Storage area	: Keep container in a well-ventilated place. Store at ambient temperature. Keep out of direct sunlight. Meet the legal requirements.
Special rules on packaging	: SPECIAL REQUIREMENTS: closing. correctly labelled. meet the legal requirements.
Packaging materials	: No supplementary information available.

7.3. Specific end use(s)

No additional information available

SECTION 8: Exposure controls/personal protection

8.1. Control parameters

No additional information available

8.2. Exposure controls

Personal protective equipment:

Gloves. Protective clothing. Safety glasses.

Materials for protective clothing:
GIVE GOOD RESISTANCE: nitrile rubber

Personal protective equipment symbol(s):



Other information:

NOHSC Exposure Standards: no exposure standard applicable according to HSIS.

SECTION 9: Physical and chemical properties

9.1. Information on basic physical and chemical properties

Physical state	: Liquid
Appearance (room temperature)	: Liquid.
Colour	: Yellow to amber.
Odour	: Sweet. characteristic.
Odour threshold	: No data available
pH	: 5 – 8
Relative evaporation rate (butylacetate=1)	: No data available
Melting point	: < -15 °C
Freezing point	: No data available
Boiling point	: > 250 °C
Flash point	: > 200 °C (ASTM D92)
Auto-ignition temperature	: > 300 °C
Decomposition temperature	: > Flash point
Flammability (solid, gas)	: No data available
Vapour pressure	: No supplementary information available
Relative vapour density at 20 °C	: No data available
Relative density	: No data available

Density	: ca. 983.2 kg/m³ (20°C) ca. 969.3 kg/m³ (40°C) ca. 927.7 kg/m³ (100°C)
Solubility	: Insoluble in water.
Partition coefficient n-octanol/water (Log Pow)	: > 5
Viscosity, kinematic	: No data available
Viscosity, dynamic	: No data available
Explosive properties	: Product is not explosive.
Oxidising properties	: No data available
Explosive limits	: No data available

9.2. Other information

VOC content	: < 0.1 % (1999/13/EC; 2004/42/EC; 2010/75/EU)
Other properties	: Oily. Soluble in oils/fats. soluble in most organic solvents. Insoluble in water.

SECTION 10: Stability and reactivity

10.1. Reactivity

On burning: release of (carbon monoxide - carbon dioxide).

10.2. Chemical stability

Stable under normal conditions.

10.3. Possibility of hazardous reactions

No additional information available

10.4. Conditions to avoid

No supplementary information available.

10.5. Incompatible materials

No supplementary information available.

10.6. Hazardous decomposition products

No supplementary information available.

SECTION 11: Toxicological information

11.1. Information on toxicological effects

Acute toxicity (oral)	: Not classified
Acute toxicity (dermal)	: Not classified
Acute toxicity (inhalation)	: Not classified

RADIAGREEN EBL	
LD50 oral rat	> 5000 mg/kg Non-toxic

Fatty esters	
LD50 oral rat	> 5000 mg/kg Non-toxic

Specialities	
LD50 oral rat	> 2000 mg/kg
LD50 dermal rabbit	> 2000 mg/kg

Skin corrosion/irritation	: Not classified pH: 5 – 8
Serious eye damage/irritation	: Not classified pH: 5 – 8
Respiratory or skin sensitisation	: Not classified
Germ cell mutagenicity	: Not classified
Carcinogenicity	: Not classified
Reproductive toxicity	: Not classified

STOT-single exposure	: Not classified
STOT-repeated exposure	: Not classified
Aspiration hazard	: Not classified

SECTION 12: Ecological information

12.1. Toxicity

Ecology - general	: According to literature: no environmental hazard.
Ecology - air	: No supplementary information available.
Ecology - water	: No bioaccumulation data available
Hazardous to the aquatic environment, short-term (acute)	: Not classified
Hazardous to the aquatic environment, long-term (chronic)	: Not classified

12.2. Persistence and degradability

Fatty esters	
Biodegradation	88.1 % (OECD 301B- BfB report OL58506.01.01 - 02/2006)

12.3. Bioaccumulative potential

RADIAGREEN EBL	
Partition coefficient n-octanol/water (Log Pow)	> 5

Fatty esters	
Partition coefficient n-octanol/water (Log Pow)	> 5

12.4. Mobility in soil

No additional information available

12.5. Results of PBT and vPvB assessment

No additional information available

12.6. Other adverse effects

No additional information available

SECTION 13: Disposal considerations

13.1. Waste treatment methods

Disposal	: Prevent dispersion by covering with dry absorbent,Scoop solid spill into closing containers,Scoop absorbed substance into closing containers,Clean contaminated surfaces with an excess of water and soap solution,Wash clothing and equipment after handling
Regional legislation (waste)	: No supplementary information available.
Ecology - waste materials	: Do not discharge into drains or the environment. Remove to an authorized waste treatment plant.
European List of Waste (LoW) code	: No supplementary information available

SECTION 14: Transport information

In accordance with ADR / IMDG / IATA / ADN / RID

ADR	IMDG	IATA	ADN	RID
14.1. UN number				
Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
14.2. UN proper shipping name				
Not classified as dangerous in the meaning of transport regulations (including Australian DG Code)	Not applicable	Not applicable	Not applicable	Not applicable

14.3. Transport hazard class(es)				
Not applicable	-	Not applicable	Not applicable	Not applicable
14.4. Packing group				
Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
14.5. Environmental hazards				
Dangerous for the environment : No	Dangerous for the environment : No Marine pollutant : No	Dangerous for the environment : No	Dangerous for the environment : No	Dangerous for the environment : No
Marine pollutant: no				

14.6. Special precautions for user

Overland transport

Transport regulations (ADR) : Not subject

Transport by sea

Transport regulations (IMDG) : Not subject

Air transport

Transport regulations (IATA) : Not subject

Inland waterway transport

No data available

Rail transport

Transport regulations (RID) : Not subject

14.7. Transport in bulk according to Annex II of Marpol and the IBC Code

Not applicable

SECTION 15: Regulatory information

15.1. Safety, health and environmental regulations/legislation specific for the substance or mixture

15.1.1. EU-Regulations

Contains no REACH substances with Annex XVII restrictions

Contains no substance on the REACH candidate list

Contains no REACH Annex XIV substances

Contains no substance subject to Regulation (EU) No 649/2012 of the European Parliament and of the Council of 4 July 2012 concerning the export and import of hazardous chemicals.

Contains no substance subject to Regulation (EU) No 2019/1021 of the European Parliament and of the Council of 20 June 2019 on persistent organic pollutants

VOC content : < 0.1 % (1999/13/EC; 2004/42/EC; 2010/75/EU)

15.1.2. National regulations

Chemical inventories : Compliant with AICS, DSL, EU REACh, IECSC, NZIoC

KKDIK number (Turkey) : all the ingredients of this product in the scope of KKDIK, if not exempted, have been (pre-)registered.

Germany

Regulatory reference : Not classified according to Regulation Governing Systems for Handling Substances Hazardous to Waters (AwSV)

Hazardous Incident Ordinance (12. BImSchV) : Is not subject of the 12. BImSchV (Hazardous Incident Ordinance)

Netherlands

ABM category : B(4) - low hazard for aquatic organisms

SZW-lijst van kankerverwekkende stoffen : None of the components are listed

SZW-lijst van mutagene stoffen	: None of the components are listed
SZW-lijst van reprotoxische stoffen – Borstvoeding	: None of the components are listed
SZW-lijst van reprotoxische stoffen – Vruchtbaarheid	: None of the components are listed
SZW-lijst van reprotoxische stoffen – Ontwikkeling	: None of the components are listed

Denmark

Danish product registration number	: 3462615

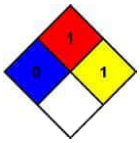
Switzerland

Storage class (LK)	: LK 10/12 - Liquids

15.2. Chemical safety assessment

No additional information available

SECTION 16: Other information

Training advice	: No supplementary information available.
SDS changed sections	: 15 - Regulatory information
SDS Reason for revision	: No supplementary information available
Chem. inventories legend	: AICS = Australian Inventory of Chemical Substances DSL = Canadian Domestic Sustances List ECST = Existing Chemical Substances Inventory of Taiwan EU REACh = European Union REACH Regulation 1907/2006 IECSC = Inventory of Existing Chemicals Substances in China KECL = Korean Existing Chemical List NZIoC = New Zealand Inventory of Chemicals TSCA = USA Toxic Substances Control Act VNCI = Vietnam National Chemicals Inventory
NFPA health hazard	: 0 - Materials that, under emergency conditions, would offer no hazard beyond that of ordinary combustible materials.
NFPA fire hazard	: 1 - Materials that must be preheated before ignition can occur.
NFPA reactivity	: 1 - Materials that in themselves are normally stable but can become unstable at elevated temperatures and pressures.
NFPA image	: 
Other information	: No supplementary information available.

Full text of H- and EUH-statements:	
EUH210	Safety data sheet available on request.
Eye Dam./Irrit. Not classified	Serious eye damage/eye irritation Not classified

SDS EU Oleon Annex II

This information is based on our current knowledge and is intended to describe the product for the purposes of health, safety and environmental requirements only. It should not therefore be construed as guaranteeing any specific property of the product.

RADIAGREEN EME SALT

Safety Data Sheet

according to Regulation (EC) No. 1907/2006 (REACH) with its amendment Regulation (EU) 2015/830

OLEON is a registered trademark. - RADIAGREEN is a registered trademark of Oleon NV.

Issue date: 31/07/2021 Revision date: 15/03/2021 Supersedes version of: 15/03/2021 Version: 2.17

SECTION 1: Identification of the substance/mixture and of the company/undertaking

1.1. Product identifier

Product form : Mixture

Generic name : RADIAGREEN EME SALT

REACH number : all the ingredients of this product in the scope of Regulation 1907/2006/EC (REACH), if not exempted, have been registered.

C&L notification reference no : all the ingredients of this product in the scope of Regulation 1272/2008/EC (CLP), if not exempted, have been notified to the C&L Inventory.

1.2. Relevant identified uses of the substance or mixture and uses advised against

1.2.1. Relevant identified uses

Main use category : Industrial use

1.2.2. Uses advised against

No additional information available

1.3. Details of the supplier of the safety data sheet

OLEON N.V.
Assenedestraat 2
9940 Ertvelde - Belgium
T +32 9 341 10 11 - F +32 9 341 10 00
info@oleon.com - www.oleon.com
E-mail address of competent person responsible for the SDS : sds@oleon.com

1.4. Emergency telephone number

Emergency number : 24/7 EMERGENCY NUMBER (SGS ERS; Oleon contract nr 76858)
+32 3 575 55 55 (worldwide); +1 888 765 6554 (USA tollfree)

Country	Official advisory body	Address	Emergency number	Comment
	World directory of poisons centres (Yellow Tox) WHO-OMS	Website	http://www.who.int/gho/phe/chemical_safety/poisons_centres/en/	

SECTION 2: Hazards identification

2.1. Classification of the substance or mixture

Classification according to Regulation (EC) No. 1272/2008 [CLP]

Serious eye damage/eye irritation Not classified — Conclusive but not sufficient for classification

Full text of H- and EUH-statements: see section 16

Adverse physicochemical, human health and environmental effects

Not classified as dangerous according to the criteria of Australian NOHSC (not hazardous; not dangerous goods). According to ABNT NBR 14725-2, no labeling obligation.

2.2. Label elements

Labelling according to Regulation (EC) No. 1272/2008 [CLP]

No labelling applicable

2.3. Other hazards

Other hazards which do not result in classification : None under normal conditions.

SECTION 3: Composition/information on ingredients

3.1. Substances

Not applicable

3.2. Mixtures

Name	Product identifier	%	Classification according to Regulation (EC) No. 1272/2008 [CLP]
Fatty esters (Constituent)		> 60	Not classified
Specialities (Constituent)		< 40	Not classified

SECTION 4: First aid measures

4.1. Description of first aid measures

First-aid measures general : If you feel unwell, seek medical advice.

First-aid measures after inhalation : Remove victim to fresh air. Respiratory problems: consult a doctor/medical service.

First-aid measures after skin contact : Rinse with water. Soap may be used. Take victim to a doctor if irritation persists.

First-aid measures after eye contact : Rinse with water. Consult an ophtalmologist if irritation persists.

First-aid measures after ingestion : Rinse mouth thoroughly with water. Call a poison center or a doctor if you feel unwell.

4.2. Most important symptoms and effects, both acute and delayed

Symptoms/effects : Unlikely to cause harmful effects.

4.3. Indication of any immediate medical attention and special treatment needed

No supplementary information available.

SECTION 5: Firefighting measures

5.1. Extinguishing media

Suitable extinguishing media : AFFF foam. BC powder. Carbon dioxide. Dry sand. Dry chemical powder. Adapt extinguishing media to the environment.

Unsuitable extinguishing media : Solid water jet ineffective as extinguishing medium.

5.2. Special hazards arising from the substance or mixture

Fire hazard : DIRECT FIRE HAZARD: Combustible. INDIRECT FIRE HAZARD: Heating increases the fire hazard. Temperature above flashpoint: higher fire/explosion hazard.

Explosion hazard : No direct explosion hazard.

Reactivity in case of fire : On burning: release of (carbon monoxide - carbon dioxide).

5.3. Advice for firefighters

Other information : No supplementary information available.

SECTION 6: Accidental release measures

6.1. Personal precautions, protective equipment and emergency procedures

General measures : Mark the danger area. Exposure to heat: have neighbourhood close doors and windows. Exposure to fire/heat: consider evacuation. Wash contaminated clothes.

6.1.1. For non-emergency personnel

Protective equipment : See "Material-Handling" to select protective clothing.

6.1.2. For emergency responders

Protective equipment : Use protective measures listed in Section 8.

6.2. Environmental precautions

Prevent soil and water pollution.

6.3. Methods and material for containment and cleaning up

Methods for cleaning up : Clean contaminated surfaces with an excess of water and soap solution. Take up liquid spill into inert absorbent material, e.g.: dry sand/earth/vermiculite or powdered limestone.

Other information : No supplementary information available.

6.4. Reference to other sections

Handle waste materials in accordance with the provisions of Section 13.

SECTION 7: Handling and storage

7.1. Precautions for safe handling

Precautions for safe handling	: Smoking, eating and drinking should be prohibited in areas of storage and use.
Handling temperature	: ≥ 10 °C above melting point
Hygiene measures	: Wash hands before break and at end of works. Good standard of personal hygiene.

7.2. Conditions for safe storage, including any incompatibilities

Information on mixed storage	: KEEP SUBSTANCE AWAY FROM: heat sources.
Storage area	: Keep container in a well-ventilated place. Store at ambient temperature. Keep out of direct sunlight. Meet the legal requirements.
Special rules on packaging	: SPECIAL REQUIREMENTS: closing. correctly labelled. meet the legal requirements.
Packaging materials	: No supplementary information available.

7.3. Specific end use(s)

No additional information available

SECTION 8: Exposure controls/personal protection

8.1. Control parameters

No additional information available

8.2. Exposure controls

Personal protective equipment:

Gloves. Protective clothing. Safety glasses.

Materials for protective clothing:
GIVE GOOD RESISTANCE: nitrile rubber

Personal protective equipment symbol(s):



Other information:

NOHSC Exposure Standards: no exposure standard applicable according to HSIS.

SECTION 9: Physical and chemical properties

9.1. Information on basic physical and chemical properties

Physical state	: Liquid
Appearance (room temperature)	: Liquid.
Colour	: Yellow to amber.
Odour	: Sweet. characteristic.
Odour threshold	: No data available
pH	: 5 – 8
Relative evaporation rate (butylacetate=1)	: No data available
Melting point	: < -10 °C
Freezing point	: No data available
Boiling point	: > 250 °C
Flash point	: > 200 °C (ASTM D92)
Auto-ignition temperature	: > 300 °C
Decomposition temperature	: > Flash point
Flammability (solid, gas)	: No data available
Vapour pressure	: No supplementary information available
Relative vapour density at 20 °C	: No data available
Relative density	: No data available

Density	: ca. 1002.4 kg/m³ (20°C) ca. 987.5 kg/m³ (40°C) ca. 942.6 kg/m³ (100°C)
Solubility	: Insoluble in water.
Partition coefficient n-octanol/water (Log Pow)	: > 5
Viscosity, kinematic	: ca. 120 mm²/s (40°C)
Viscosity, dynamic	: No data available
Explosive properties	: Product is not explosive.
Oxidising properties	: No data available
Explosive limits	: No data available

9.2. Other information

VOC content	: < 0.1 % (1999/13/EC; 2004/42/EC; 2010/75/EU)
Other properties	: Oily. Soluble in oils/fats. soluble in most organic solvents. Insoluble in water.

SECTION 10: Stability and reactivity

10.1. Reactivity
On burning: release of (carbon monoxide - carbon dioxide).

10.2. Chemical stability
Stable under normal conditions.

10.3. Possibility of hazardous reactions
No additional information available

10.4. Conditions to avoid
No supplementary information available.

10.5. Incompatible materials
No supplementary information available.

10.6. Hazardous decomposition products
No supplementary information available.

SECTION 11: Toxicological information

11.1. Information on toxicological effects

Acute toxicity (oral)	: Not classified
Acute toxicity (dermal)	: Not classified
Acute toxicity (inhalation)	: Not classified

RADIAGREEN EME SALT	
LD50 oral rat	> 5000 mg/kg Non-toxic

Fatty esters	
LD50 oral rat	> 5000 mg/kg Non-toxic

Specialities	
LD50 oral rat	> 2000 mg/kg
LD50 dermal rabbit	> 2000 mg/kg

Skin corrosion/irritation	: Not classified pH: 5 – 8
Serious eye damage/irritation	: Not classified pH: 5 – 8
Respiratory or skin sensitisation	: Not classified
Germ cell mutagenicity	: Not classified
Carcinogenicity	: Not classified
Reproductive toxicity	: Not classified

STOT-single exposure	: Not classified
STOT-repeated exposure	: Not classified
Aspiration hazard	: Not classified

RADIAGREEN EME SALT	
Viscosity, kinematic	ca. 120 mm^2/s (40°C)

SECTION 12: Ecological information

12.1. Toxicity

Ecology - general	: According to literature: no environmental hazard.
Ecology - air	: No supplementary information available.
Ecology - water	: No bioaccumulation data available
Hazardous to the aquatic environment, short-term (acute)	: Not classified
Hazardous to the aquatic environment, long-term (chronic)	: Not classified

12.2. Persistence and degradability

Fatty esters	
Biodegradation	88.1 % (OECD 301B- BfB report OL58506.01.01 - 02/2006)

12.3. Bioaccumulative potential

RADIAGREEN EME SALT	
Partition coefficient n-octanol/water (Log Pow)	> 5

Fatty esters	
Partition coefficient n-octanol/water (Log Pow)	> 5

12.4. Mobility in soil

No additional information available

12.5. Results of PBT and vPvB assessment

No additional information available

12.6. Other adverse effects

No additional information available

SECTION 13: Disposal considerations

13.1. Waste treatment methods

Disposal	: Prevent dispersion by covering with dry absorbent,Scoop solid spill into closing containers,Scoop absorbed substance into closing containers,Clean contaminated surfaces with an excess of water and soap solution,Wash clothing and equipment after handling
Regional legislation (waste)	: No supplementary information available.
Ecology - waste materials	: Do not discharge into drains or the environment. Remove to an authorized waste treatment plant.
European List of Waste (LoW) code	: No supplementary information available

SECTION 14: Transport information

In accordance with ADR / IMDG / IATA / ADN / RID

ADR	IMDG	IATA	ADN	RID
14.1. UN number				
UN No dangerous good in sense of transport regulations (including Australian DG Code)	Not applicable	Not applicable	Not applicable	Not applicable

14.2. UN proper shipping name				
Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
Transport document description				
UN No dangerous good in sense of transport regulations (including Australian DG Code)	Not applicable	Not applicable	Not applicable	Not applicable
14.3. Transport hazard class(es)				
Not applicable	-	Not applicable	Not applicable	Not applicable
14.4. Packing group				
Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
14.5. Environmental hazards				
Dangerous for the environment : No	Dangerous for the environment : No Marine pollutant : No	Dangerous for the environment : No	Dangerous for the environment : No	Dangerous for the environment : No
Marine pollutant: no				

14.6. Special precautions for user

Overland transport

Transport regulations (ADR) : Not subject

Transport by sea

Transport regulations (IMDG) : Not subject

Air transport

Transport regulations (IATA) : Not subject

Inland waterway transport

No data available

Rail transport

Transport regulations (RID) : Not subject

14.7. Transport in bulk according to Annex II of Marpol and the IBC Code

Not applicable

SECTION 15: Regulatory information

15.1. Safety, health and environmental regulations/legislation specific for the substance or mixture

15.1.1. EU-Regulations

Contains no REACH substances with Annex XVII restrictions

Contains no substance on the REACH candidate list

Contains no REACH Annex XIV substances

Contains no substance subject to Regulation (EU) No 649/2012 of the European Parliament and of the Council of 4 July 2012 concerning the export and import of hazardous chemicals.

Contains no substance subject to Regulation (EU) No 2019/1021 of the European Parliament and of the Council of 20 June 2019 on persistent organic pollutants

VOC content : < 0.1 % (1999/13/EC; 2004/42/EC; 2010/75/EU)

15.1.2. National regulations

Chemical inventories : Compliant with AICS, DSL, EU REACh, IECSC, NZIoC

KKDIK number (Turkey) : all the ingredients of this product in the scope of KKDIK, if not exempted, have been (pre-)registered.

Germany

Regulatory reference	: Not classified according to Regulation Governing Systems for Handling Substances Hazardous to Waters (AwSV)
Hazardous Incident Ordinance (12. BImSchV)	: Is not subject of the 12. BImSchV (Hazardous Incident Ordinance)

Netherlands

ABM category	: A(4) - low hazard for aquatic organisms, may have longterm hazardous effects in aquatic environment
SZW-lijst van kankerverwekkende stoffen	: None of the components are listed
SZW-lijst van mutagene stoffen	: None of the components are listed
SZW-lijst van reprotoxische stoffen – Borstvoeding	: None of the components are listed
SZW-lijst van reprotoxische stoffen – Vruchtbaarheid	: None of the components are listed
SZW-lijst van reprotoxische stoffen – Ontwikkeling	: None of the components are listed

Denmark

Danish product registration number	: 2319737

Switzerland

Storage class (LK)	: LK 10/12 - Liquids

15.2. Chemical safety assessment

No additional information available

SECTION 16: Other information

Training advice	: No supplementary information available.
SDS changed sections	: 15 - Regulatory information
SDS Reason for revision	: No supplementary information available
Chem. inventories legend	: AICS = Australian Inventory of Chemical Substances DSL = Canadian Domestic Sustances List ECST = Existing Chemical Substances Inventory of Taiwan EU REACh = European Union REACH Regulation 1907/2006 IECSC = Inventory of Existing Chemicals Substances in China KECL = Korean Existing Chemical List NZIoC = New Zealand Inventory of Chemicals TSCA = USA Toxic Substances Control Act VNCI = Vietnam National Chemicals Inventory
Other information	: No supplementary information available.

Full text of H- and EUH-statements:	
Eye Dam./Irrit. Not classified	Serious eye damage/eye irritation Not classified

SDS EU Oleon Annex II

This information is based on our current knowledge and is intended to describe the product for the purposes of health, safety and environmental requirements only. It should not therefore be construed as guaranteeing any specific property of the product.

HALLIBURTON

SAFETY DATA SHEET

SODIUM BROMIDE BRINE

Revision Date: 11-Feb-2021 **Revision Number:** 35

1. Product Identifier & Identity for the Chemical

Statement of Hazardous Nature Non-Hazardous according to the criteria of the 3rd Revised Edition of the Globally Harmonised System of Classification and Labelling of Chemicals (GHS), Non-Dangerous Goods according to the criteria of ADG.

1.1. Product Identifier

Product Name SODIUM BROMIDE BRINE

Other means of Identification

Synonyms None

Hazardous Material Number: HM003762

Recommended use of the chemical and restrictions on use

Recommended Use Additive

Uses advised against No information available

Supplier's name, address and phone number

Manufacturer/Supplier Halliburton Australia Pty. Ltd.
15 Marriott Road, Jandakot, WA 6164
Australia
ACN Number: 009 000 775
Telephone Number: + 61 1 800 686 951
Fax Number: 61 (08) 9455 5300

E-mail Address fdunexchem@halliburton.com

Emergency phone number

+ 61 1 800 686 951
Global Incident Response Access Code: 334305
Contract Number: 14012

Australian Poisons Information Centre
24 Hour Service: - 13 11 26
Police or Fire Brigade: - 000 (exchange): - 1100

2. Hazard Identification

Statement of Hazardous Nature Non-Hazardous according to the criteria of the 3rd Revised Edition of the Globally Harmonised System of Classification and Labelling of Chemicals (GHS), Non-Dangerous Goods according to the criteria of ADG.

Classification of the hazardous chemical

Not classified

Label elements, including precautionary statements

Hazard Pictograms

Signal Word Not Hazardous

Hazard Statements: Not Classified

Precautionary Statements

Prevention None
Response None
Storage None
Disposal None

Contains

Substances	**CAS Number**
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA

Other hazards which do not result in classification
This mixture contains no substance considered to be persistent, bioaccumulating nor toxic (PBT).
This mixture contains no substance considered to be very persistent nor very bioaccumulating (vPvB).

For the full text of the H-phrases mentioned in this Section, see Section 16

3. Composition/information on Ingredients

Substances	CAS Number	PERCENT (w/w)	GHS Classification - Australia
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	NF	Not classified

4. First aid measures

Description of necessary first aid measures
Inhalation If inhaled, move victim to fresh air and seek medical attention.
Eyes In case of contact, immediately flush eyes with plenty of water for at least 15 minutes and get medical attention if irritation persists.
Skin Wash with soap and water. Get medical attention if irritation persists.
Ingestion Do NOT induce vomiting. Give nothing by mouth. Obtain immediate medical attention.

Symptoms caused by exposure
No significant hazards expected.

Medical Attention and Special Treatment
Notes to Physician Treat symptomatically

5. Fire Fighting Measures

Suitable extinguishing equipment
Suitable Extinguishing Media
All standard fire fighting media
Extinguishing media which must not be used for safety reasons
None known.

Specific hazards arising from the chemical
Special exposure hazards in a fire
Decomposition in fire may produce harmful gases.

Special protective equipment and precautions for fire fighters
Special protective equipment for firefighters

Full protective clothing and approved self-contained breathing apparatus required for fire fighting personnel.

6. Accidental release measures

6.1. Personal precautions, protective equipment and emergency procedures
Use appropriate protective equipment. Avoid contact with skin, eyes and clothing.

6.2. Environmental precautions
Prevent from entering sewers, waterways, or low areas.

6.3. Methods and material for containment and cleaning up
Isolate spill and stop leak where safe. Contain spill with sand or other inert materials. Scoop up and remove.

7. Handling and storage

7.1. Precautions for safe handling
Handling Precautions
Avoid contact with eyes, skin, or clothing. Wash hands after use. Launder contaminated clothing before reuse. Ensure adequate ventilation. Use appropriate protective equipment.
Hygiene Measures
Handle in accordance with good industrial hygiene and safety practice.

7.2. Conditions for safe storage, including any incompatibilities
Storage Information
Store away from oxidizers. Store away from acids. Store in a cool, dry location. Keep container closed when not in use.
Other Guidelines
No information available

8. Exposure Controls/Personal Protection

Control parameters - exposure standards, biological monitoring
Exposure Limits

Substances	CAS Number	Australia NOHSC	ACGIH TLV-TWA
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	Not applicable	Not applicable

Appropriate engineering controls
Engineering Controls Use in a well ventilated area.

Personal protective equipment (PPE)
Personal Protective Equipment If engineering controls and work practices cannot prevent excessive exposures, the selection and proper use of personal protective equipment should be determined by an industrial hygienist or other qualified professional based on the specific application of this product.
Respiratory Protection If engineering controls and work practices cannot keep exposure below occupational exposure limits or if exposure is unknown, wear a NIOSH certified, European Standard EN 149, AS/NZS 1715:2009, or equivalent respirator when using this product. Selection of and instruction on using all personal protective equipment, including respirators, should be performed by an Industrial Hygienist or other qualified professional. Dust/mist respirator. (N95, P2/P3)
Hand Protection Normal work gloves.
Skin Protection Normal work coveralls.
Eye Protection Chemical goggles; also wear a face shield if splashing hazard exists.
Other Precautions None known.
Environmental Exposure Controls Do not allow material to contaminate ground water system.

9. Physical and Chemical Properties

9.1. Information on basic physical and chemical properties

Physical State:	Liquid	**Color**	Clear colorless
Odor:	Odorless	**Odor Threshold:**	No information available

Property Remarks/ - Method	Values
pH:	No data available
Freezing Point / Range	No data available
Melting Point / Range	No data available
Pour Point / Range	No data available
Boiling Point / Range	No data available
Flash Point	No data available
Evaporation rate	No data available
Vapor Pressure	No data available
Vapor Density	No data available
Specific Gravity	1.44 - 1.5
Water Solubility	Soluble in water
Solubility in other solvents	No data available
Partition coefficient: n-octanol/water	No data available
Autoignition Temperature	No data available
Decomposition Temperature	No data available
Viscosity	No data available
Explosive Properties	No information available
Oxidizing Properties	No information available

9.2. Other information

VOC Content (%) No data available

10. Stability and Reactivity

10.1. Reactivity

Not expected to be reactive.

10.2. Chemical stability

Stable

10.3. Possibility of hazardous reactions

Will Not Occur

10.4. Conditions to avoid

None anticipated

10.5. Incompatible materials

Strong oxidizers.

10.6. Hazardous decomposition products

Carbon monoxide and carbon dioxide.

11. Toxicological Information

Information on routes of exposure

Principle Route of Exposure Eye or skin contact, inhalation.

Symptoms related to exposure

Most Important Symptoms/Effects

No significant hazards expected.

Toxicology data for the components

Substances	CAS Number	LD50 Oral	LD50 Dermal	LC50 Inhalation
Contains no hazardous substances in concentrations above cut-off values according	NA	No data available	No data available	No data available

to the competent authority				

Immediate, delayed and chronic health effects from exposure

Inhalation May cause mild respiratory irritation.
Eye Contact May cause mechanical irritation to eye.
Skin Contact None known.
Ingestion Irritation of the mouth, throat, and stomach.

Chronic Effects/Carcinogenicity No data available to indicate product or components present at greater than 0.1% are chronic health hazards.

Exposure Levels
No data available

Interactive effects
Skin disorders. Central nervous system disorders.

Data limitations
No data available

12. Ecological Information

Ecotoxicity

Substance Ecotoxicity Data

Substances	CAS Number	Toxicity to Algae	Toxicity to Fish	Toxicity to Microorganisms	Toxicity to Invertebrates
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	No information available	No information available	No information available	No information available

12.2. Persistence and degradability

Substances	CAS Number	Persistence and Degradability
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	No information available

12.3. Bioaccumulative potential

Substances	CAS Number	Bioaccumulation
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	No information available

12.4. Mobility in soil

Substances	CAS Number	Mobility
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	No information available

12.6. Other adverse effects

Endocrine Disruptor Information

This product does not contain any known or suspected endocrine disruptors

13. Disposal Considerations

Safe handling and disposal methods

Disposal should be made in accordance with federal, state, and local regulations.

Disposal of any contaminated packaging

Follow all applicable national or local regulations.

Environmental regulations

Not applicable

14. Transport Information

Transportation Information

Australia ADG

UN Number	Not restricted
UN proper shipping name:	Not restricted
Transport Hazard Class(es):	Not applicable
Packing Group:	Not applicable
Environmental Hazards:	Not applicable

IMDG/IMO

UN Number	Not restricted
UN proper shipping name:	Not restricted
Transport Hazard Class(es):	Not applicable
Packing Group:	Not applicable
Environmental Hazards:	Not applicable

IATA/ICAO

UN Number	Not restricted
UN proper shipping name:	Not restricted
Transport Hazard Class(es):	Not applicable
Packing Group:	Not applicable
Environmental Hazards:	Not applicable

Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code

Not applicable

Special precautions during transport

None

HazChem Code

None Allocated

15. Regulatory Information

Safety, health and environmental regulations specific for the product

International Inventories

Australian AICS Inventory	All components are listed on the AIIC or are subject to a relevant exemption, permit, or assessment certificate.
New Zealand Inventory of	All components are listed on the NZIoC or are subject to a relevant exemption, permit, or

Chemicals	assessment certificate.
US TSCA Inventory	All components listed on inventory or are exempt.
Canadian Domestic Substances List (DSL)	All components listed on inventory or are exempt.

Poisons Schedule number
None Allocated

International Agreements

Montreal Protocol - Ozone Depleting Substances:	Does not apply.
Stockholm Convention - Persistent Organic Pollutants:	Does not apply
Rotterdam Convention - Prior Informed Consent:	Does not apply.
Basel Convention - Hazardous Waste:	Does not apply.

16. Other information

Date of preparation or review

Revision Date: 11-Feb-2021

Revision Note
SDS sections updated:
2

Full text of H-Statements referred to under sections 2 and 3
None

Additional information

For additional information on the use of this product, contact your local Halliburton representative.

For questions about the Safety Data Sheet for this or other Halliburton products, contact Chemical Stewardship at 1-580-251-4335.

Key abreviations or acronyms used
bw – body weight
CAS – Chemical Abstracts Service
EC50 – Effective Concentration 50%
LC50 – Lethal Concentration 50%
LD50 – Lethal Dose 50%
LL50 – Lethal Loading 50%
mg/kg – milligram/kilogram
mg/L – milligram/liter
NOEC – No Observed Effect Concentration
OEL – Occupational Exposure Limit
PBT – Persistent Bioaccumulative and Toxic
ppm – parts per million
STEL – Short Term Exposure Limit
TWA – Time-Weighted Average
vPvB – very Persistent and very Bioaccumulative
h - hour
mg/m^3 - milligram/cubic meter
mm - millimeter
mmHg - millimeter mercury
w/w - weight/weight
d - day

Key literature references and sources for data
www.ChemADVISOR.com/

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End of Safety Data Sheet

HALLIBURTON

SAFETY DATA SHEET

ALDACIDE® G ANTIMICROBIAL

Revision Date: 13-Oct-2017 **Revision Number:** 2

1. Product Identifier & Identity for the Chemical

Statement of Hazardous Nature Hazardous according to the criteria of the 3rd Revised Edition of the Globally Harmonised System of Classification and Labelling of Chemicals (GHS), Dangerous Goods according to the criteria of ADG.

1.1. Product Identifier

Product Name ALDACIDE® G ANTIMICROBIAL

Other means of Identification

Synonyms None

Hazardous Material Number: HB003462

Recommended use of the chemical and restrictions on use

Recommended Use Biocide

Uses advised against No information available

Supplier's name, address and phone number

Manufacturer/Supplier Halliburton Australia Pty. Ltd.
15 Marriott Road, Jandakot, WA 6164
Australia
ACN Number: 009 000 775
Telephone Number: + 61 1 800 686 951
Fax Number: 61 (08) 9455 5300

E-mail Address fdunexchem@halliburton.com

Emergency phone number

+ 61 1 800 686 951
Global Incident Response Access Code: 334305
Contract Number: 14012

Australian Poisons Information Centre
24 Hour Service: - 13 11 26
Police or Fire Brigade: - 000 (exchange): - 1100

2. Hazard Identification

Statement of Hazardous Nature Hazardous according to the criteria of the 3rd Revised Edition of the Globally Harmonised System of Classification and Labelling of Chemicals (GHS), Dangerous Goods according to the criteria of ADG.

Classification of the hazardous chemical

Acute Oral Toxicity	Category 4 - H302
Acute inhalation toxicity - vapor	Category 3 - H331
Skin Corrosion/Irritation	Category 1 - H314
Serious Eye Damage/Irritation	Category 1 - H318
Respiratory Sensitization	Category 1 - H334
Skin Sensitization	Category 1 - H317
Reproductive Toxicity	Category 1B - H360
Specific Target Organ Toxicity - (Single Exposure)	Category 3 - H335
Acute Aquatic Toxicity	Category 1 - H400

Chronic Aquatic Toxicity	Category 3 - H412

Label elements, including precautionary statements

Hazard Pictograms



Signal Word DANGER

Hazard Statements:
H302 - Harmful if swallowed
H314 - Causes severe skin burns and eye damage
H317 - May cause an allergic skin reaction
H318 - Causes serious eye damage
H331 - Toxic if inhaled
H334 - May cause allergy or asthma symptoms or breathing difficulties if inhaled
H335 - May cause respiratory irritation
H360 - May damage fertility or the unborn child
H400 - Very toxic to aquatic life
H412 - Harmful to aquatic life with long lasting effects

Precautionary Statements

Prevention
P201 - Obtain special instructions before use
P202 - Do not handle until all safety precautions have been read and understood
P260 - Do not breathe dust/fume/gas/mist/vapors/spray
P264 - Wash face, hands and any exposed skin thoroughly after handling
P270 - Do not eat, drink or smoke when using this product
P271 - Use only outdoors or in a well-ventilated area
P272 - Contaminated work clothing should not be allowed out of the workplace
P273 - Avoid release to the environment
P280 - Wear protective gloves/protective clothing/eye protection/face protection
P281 - Use personal protective equipment as required
P285 - In case of inadequate ventilation wear respiratory protection

Response
P301 + P312 - IF SWALLOWED: Call a POISON CENTER or doctor/physician if you feel unwell
P330 - Rinse mouth
P303 + P361 + P353 - IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water [or shower].
P363 - Wash contaminated clothing before reuse
P304 + P340 - IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing
P310 - Immediately call a POISON CENTER or doctor/physician
P305 + P351 + P338 - IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing
P391 - Collect spillage

Storage
P403 + P233 - Store in a well-ventilated place. Keep container tightly closed
P405 - Store locked up

Disposal
P501 - Dispose of contents/container in accordance with local/regional/national/international regulations

Contains

Substances	**CAS Number**
Glutaraldehyde	111-30-8
Methanol	67-56-1

Other hazards which do not result in classification
This mixture contains no substance considered to be persistent, bioaccumulating nor toxic (PBT).

This mixture contains no substance considered to be very persistent nor very bioaccumulating (vPvB).

For the full text of the H-phrases mentioned in this Section, see Section 16

3. Composition/information on Ingredients

Substances	CAS Number	PERCENT (w/w)	GHS Classification - Australia
Glutaraldehyde	111-30-8	10 - 30%	Acute Tox. 3 (H301) Acute Tox. 2 (H330) Skin Corr. 1B (H314) Eye Corr. 1 (H318) Resp. Sens. 1 (H334) Skin Sens. 1 (H317) STOT SE 3 (H335) Aquatic Acute 1 (H400) Aquatic Chronic 2 (H411)
Methanol	67-56-1	0.1 - 1%	Acute Tox. 3 (H301) Acute Tox. 3 (H311) Acute Tox. 3 (H331) Repr. 1B (H360) STOT SE 1 (H370) Flam. Liq. 2 (H225)

4. First aid measures

Description of necessary first aid measures

Inhalation If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.

Eyes Immediately flush eyes with large amounts of water for at least 30 minutes. Seek prompt medical attention.

Skin In case of contact, immediately flush skin with plenty of soap and water for at least 30 minutes and remove contaminated clothing, shoes and leather goods immediately. Get medical attention immediately.

Ingestion Do NOT induce vomiting. Give nothing by mouth. Obtain immediate medical attention.

Symptoms caused by exposure

Causes severe eye irritation which may damage tissue. Causes severe skin irritation with tissue destruction. May cause allergic skin reaction. May cause allergic respiratory reaction. May cause respiratory irritation. Harmful if swallowed. Toxic if inhaled. Potential reproductive hazard. May cause birth defects.

Medical Attention and Special Treatment

Notes to Physician Treat symptomatically

5. Fire Fighting Measures

Suitable extinguishing equipment

Suitable Extinguishing Media

Water fog, carbon dioxide, foam, dry chemical.

Extinguishing media which must not be used for safety reasons

None known.

Specific hazards arising from the chemical

Special exposure hazards in a fire

Decomposition in fire may produce harmful gases.

Special protective equipment and precautions for fire fighters

Special protective equipment for firefighters
Full protective clothing and approved self-contained breathing apparatus required for fire fighting personnel.

6. Accidental release measures

6.1. Personal precautions, protective equipment and emergency procedures
Use appropriate protective equipment. Ensure adequate ventilation. Avoid breathing vapors. Avoid contact with skin, eyes and clothing. Evacuate all persons from the area. Use only competent persons for cleanup.

6.2. Environmental precautions
Prevent from entering sewers, waterways, or low areas.

6.3. Methods and material for containment and cleaning up
Isolate spill and stop leak where safe. Contain spill with sand or other inert materials. Scoop up and remove.

7. Handling and storage

7.1. Precautions for safe handling
Handling Precautions
Use appropriate protective equipment. Ensure adequate ventilation. Avoid breathing vapors. Avoid breathing mist. Avoid contact with eyes, skin, or clothing. Wash hands after use. Launder contaminated clothing before reuse.
Hygiene Measures
Handle in accordance with good industrial hygiene and safety practice.

7.2. Conditions for safe storage, including any incompatibilities
Storage Information
Store away from acids. Store away from alkalis. Store in a well ventilated area. Keep container closed when not in use. Store locked up. Product has a shelf life of 36 months.
Other Guidelines
No information available

8. Exposure Controls/Personal Protection

Control parameters - exposure standards, biological monitoring
Exposure Limits

Substances	CAS Number	Australia NOHSC	ACGIH TLV-TWA
Glutaraldehyde	111-30-8	0.1 ppm	Not applicable
Methanol	67-56-1	TWA: 200 ppm TWA: 262 mg/m^3 STEL: 250 ppm STEL: 328 mg/m^3	TWA: 200 ppm STEL: 250 ppm

Appropriate engineering controls
Engineering Controls Use in a well ventilated area. Local exhaust ventilation should be used in areas without good cross ventilation. If vapors are strong enough to be irritating to the nose or eyes, the TLV is probably being exceeded and special ventilation or respiratory protection maybe required.

Personal protective equipment (PPE)
Personal Protective Equipment If engineering controls and work practices cannot prevent excessive exposures, the selection and proper use of personal protective equipment should be determined by an industrial hygienist or other qualified professional based on the specific application of this product.
Respiratory Protection If engineering controls and work practices cannot keep exposure below occupational exposure limits or if exposure is unknown, wear a NIOSH certified, European Standard EN 149, AS/NZS 1715:2009, or equivalent respirator when using this product. Selection of and instruction on using all personal protective equipment, including respirators, should be performed by an Industrial Hygienist or other qualified professional.
Organic vapor respirator.

Hand Protection	Use gloves which are suitable for the chemicals present in this product as well as other environmental factors in the workplace.
Skin Protection	Wear impervious protective clothing, including boots, gloves, lab coat, apron, rain jacket, pants or coverall, as appropriate, to prevent skin contact.
Eye Protection	Chemical goggles; also wear a face shield if splashing hazard exists.
Other Precautions	Eyewash fountains and safety showers must be easily accessible.
Environmental Exposure Controls	Do not allow material to contaminate ground water system

9. Physical and Chemical Properties

9.1. Information on basic physical and chemical properties

Physical State:	Liquid	**Color**	Clear light yellow
Odor:	Sharp	**Odor Threshold:**	No information available

Property Remarks/ - Method	Values
pH:	3.1-4.5
Freezing Point / Range	(-5) - (-10) °C
Melting Point / Range	No data available
Boiling Point / Range	100.5 °C / 213 °F
Flash Point	No data available
Evaporation rate	0.9
Vapor Pressure	0.2 mmHg
Vapor Density	0.8
Specific Gravity	1.064
Water Solubility	Soluble in water
Solubility in other solvents	No data available
Partition coefficient: n-octanol/water	-0.333
Autoignition Temperature	> 275 °C / > 527 °F
Decomposition Temperature	No data available
Viscosity	No data available
Explosive Properties	No information available
Oxidizing Properties	No information available

9.2. Other information

VOC Content (%)	No data available

10. Stability and Reactivity

10.1. Reactivity
Not expected to be reactive.
10.2. Chemical stability
Stable
10.3. Possibility of hazardous reactions
Will Not Occur
10.4. Conditions to avoid
Keep away from heat, sparks and flame.
10.5. Incompatible materials
Strong acids. Strong alkalis.
10.6. Hazardous decomposition products
Carbon monoxide and carbon dioxide.

11. Toxicological Information

Information on routes of exposure

Principle Route of Exposure	Eye or skin contact, inhalation; Ingestion.

Symptoms related to exposure

Most Important Symptoms/Effects

Causes severe eye irritation which may damage tissue. Causes severe skin irritation with tissue destruction. May cause allergic skin reaction. May cause allergic respiratory reaction. May cause respiratory irritation. Harmful if

swallowed. Toxic if inhaled. Potential reproductive hazard. May cause birth defects.

Toxicology data for the components

Substances	CAS Number	LD50 Oral	LD50 Dermal	LC50 Inhalation
Glutaraldehyde	111-30-8	50 mg/kg (Guinea Pig)	560 µL/kg (Rabbit)	0.28-0.5 mg/L (Rat) 4h
Methanol	67-56-1	300 mg/kg-bw (human) < 790 to 13,000 mg/kg (rat)	1000 mg/kg-bw (human) 17,100 mg/kg (rabbit)	10 mg/L (human, 4h, vapor)

Immediate, delayed and chronic health effects from exposure

Inhalation Toxic if inhaled. Causes severe respiratory irritation. May cause allergic respiratory reaction. Inhalation of vapors may result in skin sensitization.

Eye Contact Causes severe eye irritation which may damage tissue.

Skin Contact Causes severe burns. May cause an allergic skin reaction.

Ingestion Harmful if swallowed. Causes burns of the mouth, throat and stomach.

Chronic Effects/Carcinogenicity Prolonged or repeated exposure can cause delayed kidney damage.

Exposure Levels
No data available

Interactive effects
Skin disorders. Lung disorders. Liver disorders.

Data limitations
No data available

Substances	CAS Number	Skin corrosion/irritation
Glutaraldehyde	111-30-8	Causes severe skin irritation with tissue destruction. (Rabbit)
Methanol	67-56-1	Non-irritating to the skin (Rabbit)

Substances	CAS Number	Serious eye damage/irritation
Glutaraldehyde	111-30-8	Causes severe eye irritation which may damage tissue. (Rabbit)
Methanol	67-56-1	Non-irritating to the eye (Rabbit)

Substances	CAS Number	Skin Sensitization
Glutaraldehyde	111-30-8	Skin sensitizer in guinea pig.
Methanol	67-56-1	Did not cause sensitization on laboratory animals (guinea pig)

Substances	CAS Number	Respiratory Sensitization
Glutaraldehyde	111-30-8	May cause sensitization by inhalation
Methanol	67-56-1	No information available

Substances	CAS Number	Mutagenic Effects
Glutaraldehyde	111-30-8	In vivo tests did not show mutagenic effects.
Methanol	67-56-1	The weight of evidence from available in vitro and in vivo studies indicates that this substance is not expected to be mutagenic.

Substances	CAS Number	Carcinogenic Effects
Glutaraldehyde	111-30-8	Did not show carcinogenic effects in animal experiments
Methanol	67-56-1	No data of sufficient quality are available.

Substances	CAS Number	Reproductive toxicity
Glutaraldehyde	111-30-8	Not a confirmed teratogen or embryotoxin.
Methanol	67-56-1	Experiments have shown reproductive toxicity effects on laboratory animals

Substances	CAS Number	STOT - single exposure
Glutaraldehyde	111-30-8	No information available
Methanol	67-56-1	May cause disorder and damage to the Central Nervous System (CNS)

Substances	CAS Number	STOT - repeated exposure
Glutaraldehyde	111-30-8	May cause disorder and damage to the Kidney

Methanol	67-56-1	No data of sufficient quality are available.

Substances	CAS Number	Aspiration hazard
Glutaraldehyde	111-30-8	Not applicable
Methanol	67-56-1	Not applicable

12. Ecological Information

Ecotoxicity

Substance Ecotoxicity Data

Substances	CAS Number	Toxicity to Algae	Toxicity to Fish	Toxicity to Microorganisms	Toxicity to Invertebrates
Glutaraldehyde	111-30-8	EC50(72h): 0.61 mg/L (Desmodesmus subspicatus) EC50(72h): 0.5 mg/L (Skeletonema costatum)	LC50(96h): 10 mg/L (Lepomis macrochirus) NOEC(97d): 1.6 mg/L (Oncorhynchus mykiss) LC50(96h): 3.5 mg/L (Oncorhynchus mykiss) LC50(96h): 60 mg/L (Scophthalmus maximus)	EC50 (17h) 6.65 mg/L (Pseudomonas putida)	EC50(48h): 0.35 mg/L (Daphnia magna) EC50(48h): 0.7 mg/L (Acartia tonsa) NOEC(21d): 0.13 mg/L (Daphnia magna) EC50(48h): 0.1 mg/L (Acartia tonsa)
Methanol	67-56-1	EC50 (96 h) =22000 mg/L (Pseudokirchnerella subcapitata) NOEC (8 d) =8000 mg/L (Scenedesmus quadricauda)	LC50 (96 h) =15400 mg/L (Lepomis macrochirus) EC50 (200 h) =14536 mg/L (Oryzias latipes)	IC50 (3h) > 1000 mg/L (activated sludge)	EC50 (96 h) =18260 mg/L (Dapnia magna) NOEC (21 d) =208 mg/L (Dapnia magna)

12.2. Persistence and degradability

Readily biodegradable

Substances	CAS Number	Persistence and Degradability
Glutaraldehyde	111-30-8	Readily biodegradable (75% @ 28d)
Methanol	67-56-1	Readily biodegradable (95% @ 20d)

12.3. Bioaccumulative potential

Does not bioaccumulate.

Substances	CAS Number	Log Pow
Glutaraldehyde	111-30-8	-0.36
Methanol	67-56-1	Not Bioaccumulative; BCF=1

12.4. Mobility in soil

Substances	CAS Number	Mobility
Glutaraldehyde	111-30-8	Potential for mobility in soil is high (Koc between 50 and 150). Given its very low Henry'sconstant (3.3E-08 atm*m3/mole; 25 °C Measured), volatilization from natural bodies of water or moist soil is not expected to be an important fate process.
Methanol	67-56-1	No information available

12.6. Other adverse effects

Endocrine Disruptor Information

This product does not contain any known or suspected endocrine disruptors

13. Disposal Considerations

Safe handling and disposal methods

Disposal should be made in accordance with federal, state, and local regulations.

Disposal of any contaminated packaging

Follow all applicable national or local regulations.

Environmental regulations

Not applicable

14. Transport Information

Transportation Information

Australia ADG

UN Number	UN3265
UN proper shipping name:	Corrosive Liquid, Acidic, Organic, N.O.S. (Contains Glutaraldehyde)
Transport Hazard Class(es):	8
Packing Group:	II
Environmental Hazards:	Marine Pollutant

IMDG/IMO

UN Number	UN3265
UN proper shipping name:	Corrosive Liquid, Acidic, Organic, N.O.S. (Contains Glutaraldehyde)
Transport Hazard Class(es):	8
Packing Group:	II
Environmental Hazards:	Marine Pollutant
EMS:	EmS F-A, S-B

IATA/ICAO

UN Number	UN3265
UN proper shipping name:	Corrosive Liquid, Acidic, Organic, N.O.S. (Contains Glutaraldehyde)
Transport Hazard Class(es):	8
Packing Group:	II
Environmental Hazards:	Marine Pollutant

Special precautions during transport

None

HazChem Code

2X

15. Regulatory Information

Safety, health and environmental regulations specific for the product

International Inventories

Australian AICS Inventory	All components are listed on the AICS or are subject to a relevant exemption, permit, or assessment certificate.
New Zealand Inventory of Chemicals	All components are listed on the NZIoC or are subject to a relevant exemption, permit, or assessment certificate.
EINECS (European Inventory of Existing Chemical Substances)	This product, and all its components, complies with EINECS
US TSCA Inventory	All components listed on inventory or are exempt.
Canadian Domestic Substances List (DSL)	All components listed on inventory or are exempt.

Poisons Schedule number

S6

International Agreements

Montreal Protocol - Ozone Depleting Substances:	Does not apply
Stockholm Convention - Persistent Organic Pollutants:	Does not apply
Rotterdam Convention - Prior Informed Consent:	Does not apply
Basel Convention - Hazardous Waste:	Does not apply

16. Other information

Date of preparation or review

Revision Date: 13-Oct-2017

Revision Note

Full text of H-Statements referred to under sections 2 and 3
H301 - Toxic if swallowed
H302 - Harmful if swallowed
H314 - Causes severe skin burns and eye damage
H317 - May cause an allergic skin reaction
H318 - Causes serious eye damage
H330 - Fatal if inhaled
H331 - Toxic if inhaled
H334 - May cause allergy or asthma symptoms or breathing difficulties if inhaled
H335 - May cause respiratory irritation
H400 - Very toxic to aquatic life
H411 - Toxic to aquatic life with long lasting effects
H412 - Harmful to aquatic life with long lasting effects

Additional information

For additional information on the use of this product, contact your local Halliburton representative.

For questions about the Safety Data Sheet for this or other Halliburton products, contact Chemical Stewardship at 1-580-251-4335.

Key abreviations or acronyms used
bw – body weight
CAS – Chemical Abstracts Service
EC50 – Effective Concentration 50%
LC50 – Lethal Concentration 50%
LD50 – Lethal Dose 50%
LL50 – Lethal Loading 50%
mg/kg – milligram/kilogram
mg/L – milligram/liter
NOEC – No Observed Effect Concentration
OEL – Occupational Exposure Limit
PBT – Persistent Bioaccumulative and Toxic
ppm – parts per million
STEL – Short Term Exposure Limit
TWA – Time-Weighted Average
vPvB – very Persistent and very Bioaccumulative
h - hour
mg/m^3 - milligram/cubic meter
mm - millimeter
mmHg - millimeter mercury
w/w - weight/weight
d - day

Key literature references and sources for data
www.ChemADVISOR.com/
NZ CCID

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End of Safety Data Sheet

SDS no. PID18698
Version 2
Revision date 04/Feb/2019
Supersedes date None

Safety Data Sheet
ALPINE SPOTTING BEADS*

1. Identification of the Substance/Preparation and of the Company/Undertaking

1.1 Product identifier

Product name ALPINE SPOTTING BEADS*

Product code PID18698

1.2 Relevant identified uses of the substance or mixture and uses advised against

Recommended Use Lubricant.

Uses advised against Consumer use

1.3 Details of the supplier of the safety data sheet

Supplier
ALPINE SPECIALTY CHEMICALS
A Business Unit of M-I L.L.C.
P.O. Box 42842
Houston, TX 77242
www.alpinespecialtychemicals.com
Telephone: 1 281-561-1511

E-mail address MISDS@slb.com

Prepared by
Global Regulatory Compliance - Chemicals (GRC - Chemicals)

1.4 Emergency Telephone Number

Emergency telephone (24 Hour) Asia Pacific +65 3158 1074, Europe +44 (0) 1235 239 670, Middle East and Africa +44 (0) 1235 239 671, USA +1 281 561 1600, Canada +1 800 579 7421, Argentina: +54 11 5984 3690, Brazil : 0800-720-8000/0800-777-2323 (WGRA)

2. Hazards Identification

2.1 Classification of the substance or mixture

GHS - Classification

Health hazards

Reproductive toxicity	Category 2
Specific target organ toxicity - Repeated exposure	Category 1

Environmental hazards Not classified

Physical Hazards Not classified

2.2 Label elements



Signal word
DANGER

Hazard Statements
H361 - Suspected of damaging fertility or the unborn child
H372 - Causes damage to organs through prolonged or repeated exposure

Precautionary Statements
P260 - Do not breathe dust/fume/gas/mist/vapors/spray
P201 - Obtain special instructions before use
P202 - Do not handle until all safety precautions have been read and understood
P308 + P313 - IF exposed or concerned: Get medical advice/attention

P264 - Wash face, hands and any exposed skin thoroughly after handling
P270 - Do not eat, drink or smoke when using this product
P405 - Store locked up
P501 - Dispose of contents/ container to an approved waste disposal plant

Unknown acute toxicity 94% of the mixture consists of ingredient(s) of unknown toxicity.

3. Composition/information on Ingredients

3.1 Substances

Not applicable

3.2 Mixtures

Not applicable

Chemical Name	CAS No	Weight-%
Styrene	100-42-5	0 - 3

Comments
The exact percentage (concentration) of composition has been withheld as a trade secret The product contains other ingredients which do not contribute to the overall classification.

4. First Aid Measures

4.1 First aid measures

Inhalation	If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.
Ingestion	Rinse mouth. Do not induce vomiting without medical advice. Never give anything by mouth to an unconscious person. Get medical attention if symptoms occur.
Skin contact	Wash skin thoroughly with soap and water. Get medical attention if irritation persists.
Eye Contact	Promptly wash eyes with lots of water while lifting eye lids. Remove contact lenses, if worn. Get medical attention if any discomfort continues.

4.2. Most important symptoms and effects, both acute and delayed

General advice	The severity of the symptoms described will vary dependant of the concentration and the length of exposure. If adverse symptoms develop, the casualty should be transferred to hospital as soon as possible.
Symptoms	
Inhalation	Please see Section 11. Toxicological Information for further information.
Ingestion	Please see Section 11. Toxicological Information for further information.
Skin contact	Please see Section 11. Toxicological Information for further information.
Eye contact	Please see Section 11. Toxicological Information for further information.

4.3 Indication of any immediate medical attention and special treatment needed

Notes to physician	Treat symptomatically

5. Fire-Fighting Measures

5.1 Extinguishing media

Suitable extinguishing media
Water Fog, Alcohol Foam, CO_2, Dry Chemical.

Extinguishing media which must not be used for safety reasons
None known.

5.2. Special hazards arising from the substance or mixture

Unusual fire and explosion hazards
None known.

5.3 Advice for firefighters

Special protective equipment for fire-fighters
As in any fire, wear self-contained breathing apparatus and full protective gear.

Special Fire-Fighting Procedures
Containers close to fire should be removed immediately or cooled with water.

6. Accidental Release Measures

6.1. Personal precautions, protective equipment and emergency procedures

Use personal protective equipment. See also section 8. If spilled, take caution, as material can cause surfaces to become very slippery.

6.2 Environmental precautions

The product should not be allowed to enter drains, water courses or the soil.

Environmental exposure controls
Avoid release to the environment. Local authorities should be advised if significant spillages cannot be contained.

6.3 Methods and material for containment and cleaning up

Methods for containment
Cover powder spill with plastic sheet or tarp to minimize spreading. Prevent further leakage or spillage if safe to do so.

Methods for cleaning up
Sweep up and shovel into suitable containers for disposal. After cleaning, flush away traces with water.

6.4 Reference to other sections

See section 13 for more information.

7. Handling and Storage

7.1 Precautions for safe handling

Handling
Handle in accordance with good industrial hygiene and safety practice. Avoid contact with skin and eyes. Avoid dust formation. If spilled, take caution, as material can cause surfaces to become very slippery. Not to be used by pregnant workers and workers who have recently given birth or who are breastfeeding.

7.2 Conditions for safe storage, including any incompatibilities

Technical measures/precautions Ensure adequate ventilation. Keep airborne concentrations below exposure limits.

Storage precautions Keep containers tightly closed in a dry, cool and well-ventilated place. Protect from moisture. Avoid contact with:. Strong oxidizing agents.

Packaging materials Use specially constructed containers only.

8. Exposure Controls/Personal Protection

8.1 Control parameters

Chemical Name	ACGIH TLV	OSHA PEL	Argentina - Occupational Exposure Limits - TWAs (CMPs)	Brazil - Occupational Exposure Limits - TWAs (LTs)	Mexico - Occupational Exposure Limits - TWAs (LMPE-PPTs)
Styrene	20 ppm	100 ppm TWA 200 ppm C	20 ppm TWA	78 ppm TWA LT; 328 mg/m³ TWA LT	50 ppm TWA VLE-PPT; 215 mg/m³ TWA VLE-PPT

IDLH (Immediately Dangerous to Life or Health)
This product contains substance(s) classified as Immediately Dangerous to Life or Health (IDLH) by the US National Institute for Occupational Safety and Health (NIOSH). The purpose of establishing an IDLH value is to ensure that the worker can escape from a given contaminated environment in the event of failure of the most protective respiratory protection equipment. In the event of failure of respiratory protection equipment every effort should be made to exit immediately.

Chemical Name	IDLH (Immediately Dangerous to Life or Health)
Styrene 100-42-5	700 ppm IDLH

8.2 Exposure controls

A risk assessment is recommended to be performed by a qualified and trained personnel to analyze the worksite and recommends the appropriate controls such as engineering controls, work practice controls, and administrative controls as primary means of reducing employee exposure. When there is a remaining hazards after applying the primary controls, Personal Protective Equipment (PPE) must be used.

All chemical Personal Protective Equipment (PPE) should be selected based on an assessment of both the chemical hazard present and the risk of exposure to those hazards. The PPE recommendations below are based on an assessment of the chemical hazards associated with this product. Where this product is used in a mixture with other products or fluids, additional hazards may be created and as such further assessment of risk may be required. The risk of exposure and need of respiratory protection will vary from workplace to workplace and should be assessed by the user in each situation.

Engineering Controls
Ensure adequate ventilation. Mechanical ventilation or local exhaust ventilation is required.

Personal protective equipment

Eye protection	Safety glasses with side-shields.
Hand protection	Use protective gloves made of: Nitrile Neoprene Frequent change is advisable
Respiratory Protection	All respiratory protection equipment should be used within a comprehensive respiratory protection program that meets the requirements of 29 CFR 1910.134 (U.S. OSHA Respiratory Protection Standard) or local equivalent.If exposed to airborne mist/aerosol of this product, use an organic vapor cartridge with a P-95 pre-filter attached. In work environments containing oil mist/aerosol, use an organic vapor cartridge with a P-95 pre-filter attached.If exposed to vapors from this product, use a NIOSH/MSHA-approved respirator with an organic vapor cartridge.
Skin and body protection	Wear suitable protective clothing, Eye wash and emergency shower must be available at the work place.
Hygiene Measures	Wash hands before eating, drinking or smoking, Remove and wash contaminated clothing before re-use.

9. Physical and Chemical Properties

9.1 Information on basic physical and chemical properties

Physical state	Solid
Appearance	No information available
Color	Various
Odor	Odorless
Odor threshold	Not applicable

Property	Values	Remarks
pH		
pH @ dilution		
Melting / freezing point	No information available	
Boiling point/range	No information available	

Flash point	No information available	PMCC
Evaporation rate (BuAc =1)	No information available	
Flammability (solid, gas)	Not applicable	
Flammability Limit in Air		
Upper flammability limit	No information available	
Lower flammability limit	No information available	
Vapor pressure	No information available	
Vapor density	No information available	
Specific gravity	1.08 - 1.50	
Bulk density	No information available	
Water solubility	Insoluble in water	
Solubility in other solvents	No information available	
Autoignition temperature	No information available	
Decomposition temperature	No information available	
Kinematic viscosity	No information available	
Dynamic viscosity	No information available	
log Pow	No information available	
Explosive properties	None known	
Oxidizing properties	None known.	

9.2 Other information

Pour point	No information available
Molecular weight	No information available
VOC content(%)	None
Density	No information available

Comments
The data listed above are typical physical and chemical properties and should not be construed as product specification.

10. Stability and Reactivity

10.1 Reactivity

No specific reactivity hazards associated with this product.

10.2 Chemical stability

Stable under normal temperature conditions and recommended use.

10.3 Possibility of Hazardous Reactions

Hazardous polymerization
Hazardous polymerization does not occur.

10.4 Conditions to avoid

Protect from moisture.

10.5 Incompatible materials

Strong oxidizing agents.

10.6 Hazardous decomposition products

See Section 5.2.

11. Toxicological Information

11.1 Information on toxicological effects

Acute toxicity

Inhalation Inhalation of dust in high concentration may cause irritation of respiratory system.

Eye contact Dust may cause mechanical irritation.

Skin contact Prolonged contact may cause redness and irritation. Components of the product may be absorbed into the body through the skin.

Ingestion Ingestion may cause stomach discomfort.

Chemical Name	LD50 Oral	LD50 Dermal	LC50 Inhalation
Styrene	= 1000 mg/kg (Rat)	No data available	= 11.7 mg/L (Rat) 4 h

Chemical Name	IARC Group 1 or 2	ACGIH - Carcinogens	OSHA listed carcinogens	NTP
Styrene	Group 2B; Monograph 82 [2002] 2B Group 2B; Monograph 60 [1994]	A4 Not Classifiable as a Human Carcinogen	Present	Reasonably Anticipated To Be A Human Carcinogen

Sensitization This product does not contain any components suspected to be sensitizing.

Mutagenic effects This product does not contain any known or suspected mutagens.

Carcinogenicity This product does not contain any known or suspected carcinogens.

Reproductive toxicity Product is or contains a chemical which is a known or suspected reproductive hazard.

Developmental toxicity Not known to cause birth defects or have a deleterious effect on a developing fetus.

Routes of exposure Inhalation.

Routes of entry Inhalation. Skin absorption.

Specific target organ toxicity - Single exposure Not classified

Specific target organ toxicity - Repeated exposure Category 1.

Target organ effects Hearing organs.

Aspiration hazard Not applicable.

12. Ecological Information

12.1 Toxicity

Toxicity to algae
This product is not considered toxic to algae.

Toxicity to fish
This product is not considered toxic to fish.

Toxicity to daphnia and other aquatic invertebrates
This product is not considered toxic to invertebrates.

Chemical Name	Toxicity to fish	Toxicity to algae	Toxicity to daphnia and other aquatic invertebrates
Styrene	19.03 - 33.53 mg/L LC50 Lepomis macrochirus 96 h 6.75 - 14.5 mg/L LC50 Pimephales promelas 96 h 58.75 - 95.32 mg/L LC50 Poecilia reticulata 96 h 3.24 - 4.99 mg/L LC50 Pimephales promelas 96 h	= 1.4 mg/L EC50 Pseudokirchneriella subcapitata 72 h = 0.72 mg/L EC50 Pseudokirchneriella subcapitata 96 h 0.46 - 4.3 mg/L EC50 Pseudokirchneriella subcapitata 72 h 0.15 - 3.2 mg/L EC50 Pseudokirchneriella subcapitata 96 h	3.3 - 7.4 mg/L EC50 Daphnia magna 48 h

12.2 Persistence and degradability

Not readily biodegradable.

12.3 Bioaccumulative potential

Bioaccumulation is unlikely.

12.4 Mobility

Insoluble in water.

12.5 Results of PBT and vPvB assessment

This preparation contains no substance considered to be persistent, bioaccumulating nor toxic (PBT)
This preparation contains no substance considered to be very persistent nor very bioaccumulating (vPvB)

12.6 Other adverse effects.

None known.

Endocrine disruptor information

13. Disposal Considerations

13.1 Waste treatment methods

Disposal Method Disposal should be made in accordance with federal, state and local regulations.

Contaminated packaging Empty containers should be taken for local recycling, recovery or waste disposal.

14. Transport information

14.1. UN number

UN No. (DOT) Not regulated
UN No. (MT/ANTT) Not regulated
UN No. (TDG) Not regulated
UN/ID No. (ADR/RID/ADN/ADG) Not regulated
UN No. (IMDG/ANTAQ) Not regulated

UN No. (ICAO/ANAC)	Not regulated
UN No. (DPC)	Not regulated

14.2. UN proper shipping name
The product is not covered by international regulation on the transport of dangerous goods

14.3 Hazard class(es)

DOT Hazard class	Not regulated
ANTT Hazard class	Not regulated
TDG Hazard class	Not regulated
ADR/RID/ADN/ADG Hazard class	Not regulated
IMDG/ANTAQ Hazard class	Not regulated
ICAO/ANAC Hazard class/division	Not regulated
DPC Hazard class	Not regulated

14.4 Packing group

DOT Packing group	Not regulated
ANTT Packing group	Not regulated
TDG Packing group	Not regulated
ADR/RID/ADN/ADG Packing group	Not regulated
IMDG/ANTAQ Packing group	Not regulated
ICAO/ANAC Packing group	Not regulated
DPC Packing group	Not regulated

14.5 Environmental hazard
No

14.6 Special precautions
Not applicable

14.7 Transport in bulk according to Annex I/II of MARPOL 73/78 and the IBC Code
Please contact MISDS@slb.com for info regarding transport in Bulk.

15. Regulatory Information

International inventories

USA (TSCA)	Complies
Canada (DSL)	Complies
Philippines (PICCS)	Complies
Japan (ENCS)	Complies
China (IECSC)	Complies
Australia (AICS)	Complies
Korean (KECL)	Complies
New Zealand (NZIoC)	Complies

Europe - REACH
All products supplied from the European Economic Area (EEA) are compliant with the REACH Regulation EC 1907/2006.For products supplied from the EEA, Schlumberger and/or its suppliers have pre-registered and is registering all of the substances that it and/or its suppliers manufactures in or imports into the EEA that are subject to Title II of the REACH Regulation. All products supplied from outside the EEA are subject to REACH only if imported into the EEA. The importer of the products must comply with REACH for each imported substance. Contact REACH@slb.com for REACH information.

U.S. Federal and State Regulations

SARA 311/312 Hazard Categories
Should this product meet EPCRA 311/312 Tier reporting criteria at 40 CFR 370, refer to Section 2 of this SDS for appropriate classifications. Under the amended regulations at 40 CFR 370, EPCRA 311/312 Tier II reporting for the 2017 calendar year will need to be consistent with updated hazard classifications.

Chemical Name	SARA 302 / TPQs	SARA 313	CERCLA RQ
Styrene	N/A	0.1 %	1000 lb final RQ 454 kg final RQ

California Proposition 65

WARNING



This product can expose you to chemicals including those listed below, which is [are] known to the State of California to cause cancer, birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov

Chemical Name	California Proposition 65
Styrene 100-42-5	Cancer

16. Other Information

Revision date	04/Feb/2019
Version	2
This SDS has been revised in the following section(s)	1, 2, 3, 8, 11, 15, 16
HMIS classification	
Health	1*
Flammability	1
Physical hazard	0
PPE	E

*A mark of M-I L.L.C., a Schlumberger Company

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HALLIBURTON

SAFETY DATA SHEET

BaraCor® 95

Revision Date: 18-Jun-2020 **Revision Number:** 49

1. Product Identifier & Identity for the Chemical

Statement of Hazardous Nature Hazardous according to the criteria of the 3rd Revised Edition of the Globally Harmonised System of Classification and Labelling of Chemicals (GHS), Dangerous Goods according to the criteria of ADG.

1.1. Product Identifier

Product Name BaraCor® 95

Other means of Identification

Synonyms None

Hazardous Material Number: HM003499

Recommended use of the chemical and restrictions on use

Recommended Use pH Control

Uses advised against No information available

Supplier's name, address and phone number

Manufacturer/Supplier Halliburton Australia Pty. Ltd.
15 Marriott Road, Jandakot, WA 6164
Australia
ACN Number: 009 000 775
Telephone Number: + 61 1 800 686 951
Fax Number: 61 (08) 9455 5300

E-mail Address fdunexchem@halliburton.com

Emergency phone number

+ 61 1 800 686 951
Global Incident Response Access Code: 334305
Contract Number: 14012

Australian Poisons Information Centre
24 Hour Service: - 13 11 26
Police or Fire Brigade: - 000 (exchange): - 1100

2. Hazard Identification

Statement of Hazardous Nature Hazardous according to the criteria of the 3rd Revised Edition of the Globally Harmonised System of Classification and Labelling of Chemicals (GHS), Dangerous Goods according to the criteria of ADG.

Classification of the hazardous chemical

Acute Oral Toxicity	Category 4 - H302
Acute toxicity - Dermal	Category 4 - H312
Acute inhalation toxicity - vapor	Category 4 - H332
Skin Corrosion/Irritation	Category 1 - H314
Serious Eye Damage/Irritation	Category 1 - H318
Specific Target Organ Toxicity - (Single Exposure)	Category 3 - H335
Acute Aquatic Toxicity	Category 3 - H402
Chronic Aquatic Toxicity	Category 3 - H412

Label elements, including precautionary statements

Hazard Pictograms



Signal Word DANGER

Hazard Statements:
H302 - Harmful if swallowed
H312 - Harmful in contact with skin
H314 - Causes severe skin burns and eye damage
H318 - Causes serious eye damage
H332 - Harmful if inhaled
H335 - May cause respiratory irritation
H402 - Harmful to aquatic life
H412 - Harmful to aquatic life with long lasting effects

Precautionary Statements

Prevention
P260 - Do not breathe dust/fume/gas/mist/vapors/spray
P264 - Wash face, hands and any exposed skin thoroughly after handling
P270 - Do not eat, drink or smoke when using this product
P271 - Use only outdoors or in a well-ventilated area
P273 - Avoid release to the environment
P280 - Wear protective gloves/protective clothing/eye protection/face protection

Response
P301 + P312 - IF SWALLOWED: Call a POISON CENTER or doctor/physician if you feel unwell
P330 - Rinse mouth
P302 + P352 - IF ON SKIN: Wash with plenty of water.
P312 - Call a POISON CENTER/doctor/physician if you feel unwell
P363 - Wash contaminated clothing before reuse
P304 + P340 - IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing
P301 + P330 + P331 - IF SWALLOWED: rinse mouth. Do NOT induce vomiting
P303 + P361 + P353 - IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water [or shower].
P310 - Immediately call a POISON CENTER or doctor/physician
P305 + P351 + P338 - IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing
P391 - Collect spillage

Storage
P403 + P233 - Store in a well-ventilated place. Keep container tightly closed
P405 - Store locked up

Disposal
P501 - Dispose of contents/container in accordance with local/regional/national/international regulations

Contains

Substances	**CAS Number**
Monoethanolamine	141-43-5

Other hazards which do not result in classification
This mixture contains no substance considered to be persistent, bioaccumulating nor toxic (PBT).
This mixture contains no substance considered to be very persistent nor very bioaccumulating (vPvB).

For the full text of the H-phrases mentioned in this Section, see Section 16

3. Composition/information on Ingredients

Substances	CAS Number	PERCENT (w/w)	GHS Classification - Australia
Monoethanolamine	141-43-5	60 - 100%	Acute Tox. 4 (H302) Acute Tox. 4 (H312) Acute Tox. 4 (H332) Skin Corr. 1B (H314) Eye Corr. 1 (H318) STOT SE 3 (H335) Aquatic Acute 2 (H401) Aquatic Chronic 3 (H412) Flam. Liq. 4 (H227)

4. First aid measures

Description of necessary first aid measures

Inhalation If inhaled, move victim to fresh air and seek medical attention.

Eyes Immediately flush eyes with large amounts of water for at least 30 minutes. Seek prompt medical attention.

Skin In case of contact, immediately flush skin with plenty of soap and water for at least 30 minutes and remove contaminated clothing, shoes and leather goods immediately. Get medical attention immediately.

Ingestion Do NOT induce vomiting. Give nothing by mouth. Obtain immediate medical attention.

Symptoms caused by exposure

Causes severe skin burns and eye damage. May cause respiratory irritation. Harmful if inhaled. Harmful in contact with skin. Harmful if swallowed.

Medical Attention and Special Treatment

Notes to Physician Treat symptomatically

5. Fire Fighting Measures

Suitable extinguishing equipment

Suitable Extinguishing Media

Water fog, carbon dioxide, foam, dry chemical.

Extinguishing media which must not be used for safety reasons

None known.

Specific hazards arising from the chemical

Special exposure hazards in a fire

Use water spray to cool fire exposed surfaces. Closed containers may explode in fire. Decomposition in fire may produce harmful gases. Do not allow runoff to enter waterways.

Special protective equipment and precautions for fire fighters

Special protective equipment for firefighters

Full protective clothing and approved self-contained breathing apparatus required for fire fighting personnel.

6. Accidental release measures

6.1. Personal precautions, protective equipment and emergency procedures

Use appropriate protective equipment. Avoid contact with skin, eyes and clothing. Avoid breathing vapors. Ensure adequate ventilation. Evacuate all persons from the area.

6.2. Environmental precautions

Prevent from entering sewers, waterways, or low areas. Consult local authorities.

6.3. Methods and material for containment and cleaning up

Isolate spill and stop leak where safe. Contain spill with sand or other inert materials. Scoop up and remove.

7. Handling and storage

7.1. Precautions for safe handling

Handling Precautions

Use appropriate protective equipment. Avoid contact with eyes, skin, or clothing. Avoid breathing vapors. Ensure adequate ventilation. Wash hands after use. Launder contaminated clothing before reuse.

Hygiene Measures

Handle in accordance with good industrial hygiene and safety practice.

7.2. Conditions for safe storage, including any incompatibilities

Storage Information

Store away from acids. Store away from oxidizers. Store in a cool well ventilated area. Keep container closed when not in use. Product has a shelf life of 36 months.

Other Guidelines

No information available

8. Exposure Controls/Personal Protection

Control parameters - exposure standards, biological monitoring

Exposure Limits

Substances	CAS Number	Australia NOHSC	ACGIH TLV-TWA
Monoethanolamine	141-43-5	TWA: 3 ppm TWA: 7.5 mg/m^3 STEL: 6 ppm STEL: 15 mg/m^3	TWA: 3 ppm STEL: 6 ppm

Appropriate engineering controls

Engineering Controls Use in a well ventilated area. Local exhaust ventilation should be used in areas without good cross ventilation.

Personal protective equipment (PPE)

Personal Protective Equipment If engineering controls and work practices cannot prevent excessive exposures, the selection and proper use of personal protective equipment should be determined by an industrial hygienist or other qualified professional based on the specific application of this product.

Respiratory Protection If engineering controls and work practices cannot keep exposure below occupational exposure limits or if exposure is unknown, wear a NIOSH certified, European Standard EN 149, AS/NZS 1715:2009, or equivalent respirator when using this product. Selection of and instruction on using all personal protective equipment, including respirators, should be performed by an Industrial Hygienist or other qualified professional. In high concentrations, supplied air respirator or a self-contained breathing apparatus. (EN137:2006, 2)

Hand Protection Chemical-resistant protective gloves (EN 374) Suitable materials for longer, direct contact (recommended: protection index 6, corresponding to > 480 minutes permeation time as per EN 374): Nitrile gloves. (>= 8 mm thickness)

This information is based on literature references and on information provided by glove manufacturers, or is derived by analogy with similar substances. Please note that in practice the working life of chemical-resistant protective gloves may be considerably shorter than the permeation time determined in accordance with EN 374 as a result of the many influencing factors (e.g. temperature). If signs of wear and tear are noticed then the gloves should be replaced. Manufacturer's directions for use should be observed because of great diversity of types.

Skin Protection Rubber apron. Rubber boots.

Eye Protection Chemical goggles; also wear a face shield if splashing hazard exists.

Other Precautions Eyewash fountains and safety showers must be easily accessible.

Environmental Exposure Controls No information available

9. Physical and Chemical Properties

9.1. Information on basic physical and chemical properties

Physical State: Liquid
Color Colorless
Odor: Amine
Odor Threshold: No information available

Property Remarks/ - Method	Values
pH:	12
Freezing Point / Range	-13 °C
Melting Point / Range	No data available
Pour Point / Range	No data available
Boiling Point / Range	130 °C / 266 °F
Flash Point	96 °C / 205 °F (PMCC)
Evaporation rate	0.1
Vapor Pressure	0.2 mmHg @ 20°C
Vapor Density	2.1 (air = 1)
Specific Gravity	1.02
Water Solubility	Miscible with water
Solubility in other solvents	No data available
Partition coefficient: n-octanol/water	-1.9
Autoignition Temperature	No data available
Decomposition Temperature	No data available
Viscosity	No data available
Explosive Properties	No information available
Oxidizing Properties	No information available

9.2. Other information

VOC Content (%) No data available

10. Stability and Reactivity

10.1. Reactivity
Not expected to be reactive.
10.2. Chemical stability
Stable
10.3. Possibility of hazardous reactions
Will Not Occur
10.4. Conditions to avoid
None anticipated
10.5. Incompatible materials
Strong acids. Strong oxidizers.
10.6. Hazardous decomposition products
Ammonia. Carbon monoxide and carbon dioxide. Hydrocarbons.

11. Toxicological Information

Information on routes of exposure
Principle Route of Exposure Eye or skin contact, inhalation.

Symptoms related to exposure

Most Important Symptoms/Effects

Causes severe skin burns and eye damage. May cause respiratory irritation. Harmful if inhaled. Harmful in contact with skin. Harmful if swallowed.

Toxicology data for the components

Substances	CAS Number	LD50 Oral	LD50 Dermal	LC50 Inhalation
Monoethanolamine	141-43-5	1089 mg/kg-bw (rat)	1025 mg/kg-bw (rabbit)	>1.3 mg/L (rat, 6 h, vapor) (saturated)

Immediate, delayed and chronic health effects from exposure

Inhalation Harmful if inhaled. Causes severe respiratory irritation.
Eye Contact Causes eye damage.
Skin Contact Harmful in contact with skin. Causes severe burns.
Ingestion Harmful if swallowed. Causes burns of the mouth, throat and stomach.

Chronic Effects/Carcinogenicity No data available to indicate product or components present at greater than 0.1% are chronic health hazards.

Exposure Levels
No data available

Interactive effects
Skin disorders. Lung disorders. Liver and kidney disorders.

Data limitations
No data available

Substances	CAS Number	Skin corrosion/irritation
Monoethanolamine	141-43-5	Skin, rabbit: Corrosive to skin Causes severe skin burns

Substances	CAS Number	Serious eye damage/irritation
Monoethanolamine	141-43-5	Eye, rabbit: Corrosive to eyes Causes severe eye irritation. Will damage tissue.

Substances	CAS Number	Skin Sensitization
Monoethanolamine	141-43-5	Did not cause sensitization on laboratory animals (guinea pig)

Substances	CAS Number	Respiratory Sensitization
Monoethanolamine	141-43-5	No information available

Substances	CAS Number	Mutagenic Effects
Monoethanolamine	141-43-5	In vivo tests did not show mutagenic effects.

Substances	CAS Number	Carcinogenic Effects
Monoethanolamine	141-43-5	No data of sufficient quality are available.

Substances	CAS Number	Reproductive toxicity
Monoethanolamine	141-43-5	Animal testing did not show any effects on fertility. Did not show teratogenic effects in animal experiments.

Substances	CAS Number	STOT - single exposure
Monoethanolamine	141-43-5	May cause respiratory irritation.

Substances	CAS Number	STOT - repeated exposure
Monoethanolamine	141-43-5	No significant toxicity observed in animal studies at concentration requiring classification.

Substances	CAS Number	Aspiration hazard
Monoethanolamine	141-43-5	Not applicable

12. Ecological Information

Ecotoxicity

Substance Ecotoxicity Data

Substances	CAS Number	Toxicity to Algae	Toxicity to Fish	Toxicity to Microorganisms	Toxicity to Invertebrates
Monoethanolamine	141-43-5	EC50 (72 h) =2.5 mg/L (Pseudokirchneriella subcapitata) EC50 (72 h) =24.7 mg/L	LC50 (96 h) =170 mg/L (Carassius auratus) NOEC (14 d) >100 mg/L (Oryzias latipes)	No information available	EC50 (48 h) =65 mg/L (Daphnia magna) NOEC (21 d) =0.85 mg/L (Daphnia magna)

		(Phaeodactylum tricornutum)			

12.2. Persistence and degradability

Substances	CAS Number	Persistence and Degradability
Monoethanolamine	141-43-5	Readily biodegradable (92% @ 28d)

12.3. Bioaccumulative potential

Substances	CAS Number	Bioaccumulation
Monoethanolamine	141-43-5	Log Pow =-1.91

12.4. Mobility in soil

Substances	CAS Number	Mobility
Monoethanolamine	141-43-5	KOC = 0.2725 KOC = 1.167

12.6. Other adverse effects

Endocrine Disruptor Information

This product does not contain any known or suspected endocrine disruptors

13. Disposal Considerations

Safe handling and disposal methods

Disposal should be made in accordance with federal, state, and local regulations.

Disposal of any contaminated packaging

Follow all applicable national or local regulations.

Environmental regulations

Not applicable

14. Transport Information

Transportation Information

Australia ADG

UN Number UN2491
UN proper shipping name: Ethanolamine Solution
Transport Hazard Class(es): 8
Packing Group: III
Environmental Hazards: Not applicable

IMDG/IMO

UN Number UN2491
UN proper shipping name: Ethanolamine Solution
Transport Hazard Class(es): 8
Packing Group: III
Environmental Hazards: Not applicable
EMS: EmS F-A, S-B

IATA/ICAO

UN Number UN2491
UN proper shipping name: Ethanolamine Solution
Transport Hazard Class(es): 8
Packing Group: III
Environmental Hazards: Not applicable

Special precautions during transport

None

HazChem Code
2X

15. Regulatory Information

Safety, health and environmental regulations specific for the product

International Inventories

Australian AICS Inventory	All components are listed on the AICS or are subject to a relevant exemption, permit, or assessment certificate.
New Zealand Inventory of Chemicals	All components are listed on the NZIoC or are subject to a relevant exemption, permit, or assessment certificate.
US TSCA Inventory	All components listed on inventory or are exempt.
Canadian Domestic Substances List (DSL)	All components listed on inventory or are exempt.

Poisons Schedule number
None Allocated

International Agreements

Montreal Protocol - Ozone Depleting Substances:	Does not apply.
Stockholm Convention - Persistent Organic Pollutants:	Does not apply
Rotterdam Convention - Prior Informed Consent:	Does not apply.
Basel Convention - Hazardous Waste:	Does not apply.

16. Other information

Date of preparation or review

Revision Date: 18-Jun-2020

Revision Note
SDS sections updated:
2

Full text of H-Statements referred to under sections 2 and 3
H302 - Harmful if swallowed
H312 - Harmful in contact with skin
H314 - Causes severe skin burns and eye damage
H332 - Harmful if inhaled
H335 - May cause respiratory irritation
H412 - Harmful to aquatic life with long lasting effects

Additional information

For additional information on the use of this product, contact your local Halliburton representative.

For questions about the Safety Data Sheet for this or other Halliburton products, contact Chemical Stewardship at 1-580-251-4335.

Key abreviations or acronyms used
bw – body weight
CAS – Chemical Abstracts Service
EC50 – Effective Concentration 50%
LC50 – Lethal Concentration 50%
LD50 – Lethal Dose 50%
LL50 – Lethal Loading 50%
mg/kg – milligram/kilogram
mg/L – milligram/liter

NOEC – No Observed Effect Concentration
OEL – Occupational Exposure Limit
PBT – Persistent Bioaccumulative and Toxic
ppm – parts per million
STEL – Short Term Exposure Limit
TWA – Time-Weighted Average
vPvB – very Persistent and very Bioaccumulative
h - hour
mg/m^3 - milligram/cubic meter
mm - millimeter
mmHg - millimeter mercury
w/w - weight/weight
d - day

Key literature references and sources for data
www.ChemADVISOR.com/

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End of Safety Data Sheet

HALLIBURTON

SAFETY DATA SHEET

BaraCor® W-991

Revision Date: 18-Jan-2022 **Revision Number:** 4

1. Product Identifier & Identity for the Chemical

Statement of Hazardous Nature Non-Hazardous according to the criteria of the 7th Revised Edition of the Globally Harmonised System of Classification and Labelling of Chemicals (GHS), Non-Dangerous Goods according to the criteria of ADG.

1.1. Product Identifier

Product Name BaraCor® W-991

Other means of Identification

Synonyms None

Hazardous Material Number: HM009362

Recommended use of the chemical and restrictions on use

Recommended Use Corrosion Inhibitor

Uses advised against No information available

Supplier's name, address and phone number

Manufacturer/Supplier Halliburton Australia Pty. Ltd.
15 Marriott Road, Jandakot, WA 6164
Australia
ACN Number: 009 000 775
Telephone Number: + 61 1 800 686 951
Fax Number: 61 (08) 9455 5300

E-mail Address fdunexchem@halliburton.com

Emergency phone number

+ 61 1 800 686 951
Global Incident Response Access Code: 334305
Contract Number: 14012

Australian Poisons Information Centre
24 Hour Service: - 13 11 26
Police or Fire Brigade: - 000 (exchange): - 1100

2. Hazard Identification

Statement of Hazardous Nature Non-Hazardous according to the criteria of the 7th Revised Edition of the Globally Harmonised System of Classification and Labelling of Chemicals (GHS), Non-Dangerous Goods according to the criteria of ADG.

Classification of the hazardous chemical

Not classified

Label elements, including precautionary statements

Hazard Pictograms

Signal Word Not Hazardous

Hazard Statements: Not Classified

Precautionary Statements

Prevention None
Response None
Storage None
Disposal None

Contains

Substances	**CAS Number**
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA

Other hazards which do not result in classification
None known

For the full text of the H-phrases mentioned in this Section, see Section 16

3. Composition/information on Ingredients

Substances	CAS Number	PERCENT (w/w)	GHS Classification - Australia
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	60 - 100%	Not classified

4. First aid measures

Description of necessary first aid measures

Inhalation If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.

Eyes In case of contact, immediately flush eyes with plenty of water for at least 15 minutes and get medical attention if irritation persists.

Skin Flush skin with large amounts of water. If irritation persists, get medical attention.

Ingestion Rinse mouth with water many times. Get medical attention, if symptoms occur

Symptoms caused by exposure
No significant hazards expected.

Medical Attention and Special Treatment
Notes to Physician Treat symptomatically

5. Fire Fighting Measures

Suitable extinguishing equipment
Suitable Extinguishing Media
All standard fire fighting media
Extinguishing media which must not be used for safety reasons
Do NOT spray pool fires directly with water. A solid stream of water directed into hot burning liquid can cause splattering.

Specific hazards arising from the chemical
Special exposure hazards in a fire
Decomposition in fire may produce harmful gases.

Special protective equipment and precautions for fire fighters
Special protective equipment for firefighters
Full protective clothing and approved self-contained breathing apparatus required for fire fighting personnel.

6. Accidental release measures

6.1. Personal precautions, protective equipment and emergency procedures
Use appropriate protective equipment. Ensure adequate ventilation. Avoid contact with skin, eyes and clothing. Do not breathe dust/fume/gas/mist/vapors/spray.

6.2. Environmental precautions
None known.

6.3. Methods and material for containment and cleaning up
Dike far ahead of liquid spill for later disposal. Soak up with inert absorbent material. Pick up and transfer to properly labeled containers.

7. Handling and storage

7.1. Precautions for safe handling
Handling Precautions
Use appropriate protective equipment. Ensure adequate ventilation. Avoid contact with eyes, skin, or clothing.
Hygiene Measures
Handle in accordance with good industrial hygiene and safety practice.

7.2. Conditions for safe storage, including any incompatibilities
Storage Information
Store in a cool well ventilated area.
Other Guidelines
No information available

8. Exposure Controls/Personal Protection

Control parameters - exposure standards, biological monitoring
Exposure Limits

Substances	CAS Number	Australia NOHSC	ACGIH TLV-TWA
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	Not applicable	Not applicable

Appropriate engineering controls

Engineering Controls	Use approved industrial ventilation and local exhaust as required to maintain exposures below applicable exposure limits.

Personal protective equipment (PPE)

Personal Protective Equipment	If engineering controls and work practices cannot prevent excessive exposures, the selection and proper use of personal protective equipment should be determined by an industrial hygienist or other qualified professional based on the specific application of this product.
Respiratory Protection	If engineering controls and work practices cannot keep exposure below occupational exposure limits or if exposure is unknown, wear a NIOSH certified, European Standard EN 149, AS/NZS 1715:2009, or equivalent respirator when using this product. Selection of and instruction on using all personal protective equipment, including respirators, should be performed by an Industrial Hygienist or other qualified professional.
Hand Protection	Use gloves which are suitable for the chemicals present in this product as well as other environmental factors in the workplace.
Skin Protection	Not normally necessary.
Eye Protection	Wear safety glasses or goggles to protect against exposure.
Other Precautions	None known.
Environmental Exposure Controls	No information available

9. Physical and Chemical Properties

9.1. Information on basic physical and chemical properties

Physical State: Liquid
Color Red brown
Odor: Characteristic
Odor Threshold: No information available

Property Remarks/ - Method	Values
pH:	7 - 9 (1 % solution)
Freezing Point / Range	No data available
Melting Point / Range	No data available
Pour Point / Range	No data available
Boiling Point / Range	No data available
Flash Point	> 121 °C / > 250 °F (PMCC)
Evaporation rate	No data available
Vapor Pressure	No data available
Vapor Density	No data available
Specific Gravity	1.24 - 1.34
Water Solubility	No data available
Solubility in other solvents	No data available
Partition coefficient: n-octanol/water	No data available
Autoignition Temperature	No data available
Decomposition Temperature	No data available
Viscosity	No data available
Explosive Properties	No information available
Oxidizing Properties	No information available

9.2. Other information

VOC Content (%) No data available

10. Stability and Reactivity

10.1. Reactivity
Not expected to be reactive.
10.2. Chemical stability
Stable
10.3. Possibility of hazardous reactions
Will Not Occur
10.4. Conditions to avoid
None anticipated
10.5. Incompatible materials
Strong oxidizers.
10.6. Hazardous decomposition products
Carbon oxides. Oxides of phosphorus. Phosphines. Oxides of nitrogen.

11. Toxicological Information

Information on routes of exposure
Principle Route of Exposure Eye or skin contact, inhalation.

Symptoms related to exposure
Most Important Symptoms/Effects
No significant hazards expected.

Toxicology data for the components

Substances	CAS Number	LD50 Oral	LD50 Dermal	LC50 Inhalation
Contains no hazardous substances in concentrations above	NA	No data available	No data available	No data available

cut-off values according to the competent authority				

Immediate, delayed and chronic health effects from exposure

Inhalation May cause mild respiratory irritation.
Eye Contact May cause mild eye irritation.
Skin Contact May cause mild skin irritation.
Ingestion May cause abdominal pain, vomiting, nausea, and diarrhea.

Chronic Effects/Carcinogenicity No data available to indicate product or components present at greater than 0.1% are chronic health hazards.

Exposure Levels
No data available

Interactive effects
No data available

Data limitations
No data available

12. Ecological Information

Ecotoxicity

Substance Ecotoxicity Data

Substances	CAS Number	Toxicity to Algae	Toxicity to Fish	Toxicity to Microorganisms	Toxicity to Invertebrates
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	No information available	No information available	No information available	No information available

12.2. Persistence and degradability

Substances	CAS Number	Persistence and Degradability
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	No information available

12.3. Bioaccumulative potential

Substances	CAS Number	Bioaccumulation
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	No information available

12.4. Mobility in soil

Substances	CAS Number	Mobility
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	No information available

12.6. Other adverse effects

Endocrine Disruptor Information

This product does not contain any known or suspected endocrine disruptors

13. Disposal Considerations

Safe handling and disposal methods

Dispose in accordance with local regulations.

Disposal of any contaminated packaging

Follow all applicable national or local regulations.

Environmental regulations

Not applicable

14. Transport Information

Transportation Information

Australia ADG

UN Number	Not restricted
UN proper shipping name:	Not restricted
Transport Hazard Class(es):	Not applicable
Packing Group:	Not applicable
Environmental Hazards:	Not applicable

IMDG/IMO

UN Number	Not restricted
UN proper shipping name:	Not restricted
Transport Hazard Class(es):	Not applicable
Packing Group:	Not applicable
Environmental Hazards:	Not applicable

IATA/ICAO

UN Number	Not restricted
UN proper shipping name:	Not restricted
Transport Hazard Class(es):	Not applicable
Packing Group:	Not applicable
Environmental Hazards:	Not applicable

Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code

Not applicable

Special precautions during transport

None

HazChem Code

None Allocated

15. Regulatory Information

Safety, health and environmental regulations specific for the product

International Inventories

Australian AICS Inventory	All components are listed on the AIIC or are subject to a relevant exemption, permit, or assessment certificate.

New Zealand Inventory of Chemicals	All components are listed on the NZIoC or are subject to a relevant exemption, permit, or assessment certificate.
US TSCA Inventory	All components listed on inventory or are exempt.
Canadian Domestic Substances List (DSL)	All components listed on inventory or are exempt.

Poisons Schedule number
None Allocated

International Agreements

Montreal Protocol - Ozone Depleting Substances:	Does not apply.
Stockholm Convention - Persistent Organic Pollutants:	Does not apply
Rotterdam Convention - Prior Informed Consent:	Does not apply.
Basel Convention - Hazardous Waste:	Does not apply.

16. Other information

Date of preparation or review

Revision Date: 18-Jan-2022

Revision Note
Initial Release

Full text of H-Statements referred to under sections 2 and 3
None

Additional information: For additional information on the use of this product, contact your local Halliburton representative.

For questions about the Safety Data Sheet for this or other Halliburton products, contact Chemical Stewardship at 1-580-251-4335.

Key abreviations or acronyms used
bw – body weight
CAS – Chemical Abstracts Service
EC50 – Effective Concentration 50%
LC50 – Lethal Concentration 50%
LD50 – Lethal Dose 50%
LL50 – Lethal Loading 50%
mg/kg – milligram/kilogram
mg/L – milligram/liter
NOEC – No Observed Effect Concentration
OEL – Occupational Exposure Limit
PBT – Persistent Bioaccumulative and Toxic
ppm – parts per million
STEL – Short Term Exposure Limit
TWA – Time-Weighted Average
vPvB – very Persistent and very Bioaccumulative
h - hour
mg/m^3 - milligram/cubic meter
mm - millimeter
mmHg - millimeter mercury
w/w - weight/weight
d - day

Key literature references and sources for data
www.ChemADVISOR.com/

Disclaimer Statement

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End of Safety Data Sheet

HALLIBURTON

SAFETY DATA SHEET

BaraScav™ W-480

Revision Date: 24-Oct-2017 **Revision Number:** 3

1. Product Identifier & Identity for the Chemical

Statement of Hazardous Nature Hazardous according to the criteria of the 3rd Revised Edition of the Globally Harmonised System of Classification and Labelling of Chemicals (GHS), Non-Dangerous Goods according to the criteria of ADG.

1.1. Product Identifier

Product Name BaraScav™ W-480

Other means of Identification

Synonyms None

Hazardous Material Number: HM008410

Recommended use of the chemical and restrictions on use

Recommended Use Hydrogen Sulfide Scavenger

Uses advised against Consumer use

Supplier's name, address and phone number

Manufacturer/Supplier Halliburton Australia Pty. Ltd.
15 Marriott Road, Jandakot, WA 6164
Australia
ACN Number: 009 000 775
Telephone Number: + 61 1 800 686 951
Fax Number: 61 (08) 9455 5300

E-mail Address fdunexchem@halliburton.com

Emergency phone number

+ 61 1 800 686 951
Global Incident Response Access Code: 334305
Contract Number: 14012

Australian Poisons Information Centre
24 Hour Service: - 13 11 26
Police or Fire Brigade: - 000 (exchange): - 1100

2. Hazard Identification

Statement of Hazardous Nature Hazardous according to the criteria of the 3rd Revised Edition of the Globally Harmonised System of Classification and Labelling of Chemicals (GHS), Non-Dangerous Goods according to the criteria of ADG.

Classification of the hazardous chemical

Acute inhalation toxicity - vapor	Category 4 - H332
Serious Eye Damage/Irritation	Category 2 - H319
Skin Sensitization	Category 1 - H317
Specific Target Organ Toxicity - (Single Exposure)	Category 3 - H335
Specific Target Organ Toxicity - (Repeated Exposure)	Category 1 - H372
Acute Aquatic Toxicity	Category 3 - H402

Label elements, including precautionary statements

Hazard Pictograms



Signal Word DANGER

Hazard Statements:
H317 - May cause an allergic skin reaction
H319 - Causes serious eye irritation
H332 - Harmful if inhaled
H335 - May cause respiratory irritation
H372 - Causes damage to organs through prolonged or repeated exposure
H402 - Harmful to aquatic life

Precautionary Statements

Prevention
P260 - Do not breathe dust/fume/gas/mist/vapors/spray
P264 - Wash face, hands and any exposed skin thoroughly after handling
P270 - Do not eat, drink or smoke when using this product
P271 - Use only outdoors or in a well-ventilated area
P272 - Contaminated work clothing should not be allowed out of the workplace
P273 - Avoid release to the environment
P280 - Wear protective gloves/eye protection/face protection

Response
P302 + P352 - IF ON SKIN: Wash with plenty of water.
P333 + P313 - If skin irritation or rash occurs: Get medical advice/attention
P363 - Wash contaminated clothing before reuse
P304 + P340 - IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing
P312 - Call a POISON CENTER/doctor/physician if you feel unwell
P305 + P351 + P338 - IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing
P337 + P313 - If eye irritation persists: Get medical advice/attention
P314 - Get medical attention/advice if you feel unwell

Storage
P403 + P233 - Store in a well-ventilated place. Keep container tightly closed
P405 - Store locked up

Disposal
P501 - Dispose of contents/container in accordance with local/regional/national/international regulations

Contains

Substances	**CAS Number**
Hexahydro-1,3,5-tris(2-hydroxyethyl)-s-triazine	4719-04-4

Other hazards which do not result in classification
This mixture contains no substance considered to be persistent, bioaccumulating nor toxic (PBT).
This mixture contains no substance considered to be very persistent nor very bioaccumulating (vPvB).

For the full text of the H-phrases mentioned in this Section, see Section 16

3. Composition/information on Ingredients

Substances	CAS Number	PERCENT (w/w)	GHS Classification - Australia
Hexahydro-1,3,5-tris(2-hydroxyethyl)-s-triazine	4719-04-4	10 - 30%	Acute Tox. 4 (H302) Acute Tox. 2 (H330) Skin Sens. 1 (H317) STOT SE 3 (H335)

			STOT RE 1 (H372) Aquatic Acute 2 (H401)

4. First aid measures

Description of necessary first aid measures

Inhalation If inhaled, move victim to fresh air and seek medical attention.

Eyes In case of contact, or suspected contact, immediately flush eyes with plenty of water for at least 15 minutes and get medical attention immediately after flushing.

Skin Wash with soap and water. Remove contaminated clothing and launder before reuse. Get medical attention if irritation persists.

Ingestion Rinse mouth with water many times. Get medical attention if symptoms occur

Symptoms caused by exposure

Causes eye irritation. May cause allergic skin reaction. May cause respiratory irritation. Harmful if inhaled. May cause damage to organs through prolonged or repeated exposure.

Medical Attention and Special Treatment

Notes to Physician Treat symptomatically

5. Fire Fighting Measures

Suitable extinguishing equipment

Suitable Extinguishing Media

Water fog, carbon dioxide, foam, dry chemical.

Extinguishing media which must not be used for safety reasons

None known.

Specific hazards arising from the chemical

Special exposure hazards in a fire

Decomposition in fire may produce harmful gases.

Special protective equipment and precautions for fire fighters

Special protective equipment for firefighters

Full protective clothing and approved self-contained breathing apparatus required for fire fighting personnel.

6. Accidental release measures

6.1. Personal precautions, protective equipment and emergency procedures

Use appropriate protective equipment. Avoid breathing vapors. Avoid contact with skin, eyes and clothing. Ensure adequate ventilation.

6.2. Environmental precautions

Prevent from entering sewers, waterways, or low areas.

6.3. Methods and material for containment and cleaning up

Isolate spill and stop leak where safe. Contain spill with sand or other inert materials. Scoop up and remove.

7. Handling and storage

7.1. Precautions for safe handling

Handling Precautions

Avoid contact with eyes, skin, or clothing. Avoid breathing vapors. Ensure adequate ventilation. Wash hands after use. Launder contaminated clothing before reuse. Use appropriate protective equipment.

Hygiene Measures

Handle in accordance with good industrial hygiene and safety practice.

7.2. Conditions for safe storage, including any incompatibilities

Storage Information
Store away from oxidizers. Store away from acids. Store away from direct sunlight. Keep container closed when not in use.
Other Guidelines
No information available

8. Exposure Controls/Personal Protection

Control parameters - exposure standards, biological monitoring
Exposure Limits

Substances	CAS Number	Australia NOHSC	ACGIH TLV-TWA
Hexahydro-1,3,5-tris(2-hydroxyethyl)-s-triazine	4719-04-4	Not applicable	Not applicable

Appropriate engineering controls
Engineering Controls Use approved industrial ventilation and local exhaust as required to maintain exposures below applicable exposure limits. Ensure adequate ventilation, especially in confined areas

Personal protective equipment (PPE)
Personal Protective Equipment If engineering controls and work practices cannot prevent excessive exposures, the selection and proper use of personal protective equipment should be determined by an industrial hygienist or other qualified professional based on the specific application of this product.
Respiratory Protection If engineering controls and work practices cannot keep exposure below occupational exposure limits or if exposure is unknown, wear a NIOSH certified, European Standard EN 149, AS/NZS 1715:2009, or equivalent respirator when using this product. Selection of and instruction on using all personal protective equipment, including respirators, should be performed by an Industrial Hygienist or other qualified professional.
Organic vapor respirator.

Hand Protection Use gloves which are suitable for the chemicals present in this product as well as other environmental factors in the workplace.
Skin Protection Wear protective clothing appropriate for the work environment.
Eye Protection Chemical goggles; also wear a face shield if splashing hazard exists.
Other Precautions None known.
Environmental Exposure Controls Do not allow material to contaminate ground water system

9. Physical and Chemical Properties

9.1. Information on basic physical and chemical properties
Physical State: Liquid
Odor: Characteristic
Color Clear light yellow
Odor Threshold: No information available

Property Remarks/ - Method	Values
pH:	9.5 - 11
Freezing Point / Range	-35 °C
Melting Point / Range	No data available
Boiling Point / Range	100 °C / 212 °F
Flash Point	> 100 °C / > 212 °F PMCC
Evaporation rate	No data available
Vapor Pressure	17.5 mmHg @ 20°C
Vapor Density	No data available
Specific Gravity	1.02 - 1.05
Water Solubility	Miscible with water
Solubility in other solvents	No data available
Partition coefficient: n-octanol/water	No data available
Autoignition Temperature	> 200 °C / > 392 °F
Decomposition Temperature	No data available
Viscosity	No data available
Explosive Properties	No information available
Oxidizing Properties	No information available

9.2. Other information

VOC Content (%) No data available

10. Stability and Reactivity

10.1. Reactivity

Not expected to be reactive.

10.2. Chemical stability

Stable

10.3. Possibility of hazardous reactions

Will Not Occur

10.4. Conditions to avoid

Avoid contact with metals such as aluminum, tin, lead, brass, bronze, copper, and zinc. Keep away from heat, sparks and flame.

10.5. Incompatible materials

Strong oxidizers. Reducing agents. Strong acids.

10.6. Hazardous decomposition products

Acetic acid. Oxides of nitrogen. Oxides of sulfur. Formaldehyde. Carbon monoxide and carbon dioxide.

11. Toxicological Information

Information on routes of exposure

Principle Route of Exposure Eye or skin contact, inhalation. Ingestion.

Symptoms related to exposure

Most Important Symptoms/Effects

Causes eye irritation. May cause allergic skin reaction. May cause respiratory irritation. Harmful if inhaled. May cause damage to organs through prolonged or repeated exposure.

Toxicology data for the components

Substances	CAS Number	LD50 Oral	LD50 Dermal	LC50 Inhalation
Hexahydro-1,3,5-tris(2-hydroxyethyl)-s-triazine	4719-04-4	763 mg/kg (Rat) 1000 mg/kg (Rat)	2000 mg/kg (Rat) > 4000 mg/kg (Rat) > 3500 mg/kg (Rabbit)	0.371 mg/L (Rat) 4h

Immediate, delayed and chronic health effects from exposure

Inhalation Harmful if inhaled. May cause respiratory irritation.

Eye Contact Causes eye irritation.

Skin Contact May cause an allergic skin reaction. May cause mild skin irritation.

Ingestion May cause abdominal pain, vomiting, nausea, and diarrhea.

Chronic Effects/Carcinogenicity Prolonged or repeated exposure may cause lung damage.

Exposure Levels

No data available

Interactive effects

Skin disorders.

Data limitations

No data available

Substances	CAS Number	Skin corrosion/irritation
Hexahydro-1,3,5-tris(2-hydroxyethyl)-s-triazine	4719-04-4	Not irritating to skin in rabbits.

Substances	CAS Number	Serious eye damage/irritation
Hexahydro-1,3,5-tris(2-hydroxyethyl)-s-triazine	4719-04-4	Eye, rabbit: Causes mild eye irritation.

Substances	CAS Number	Skin Sensitization
Hexahydro-1,3,5-tris(2-hydroxyethyl)-s-triazine	4719-04-4	Skin sensitizer in guinea pig.

Substances	CAS Number	Respiratory Sensitization
Hexahydro-1,3,5-tris(2-hydroxyethyl)-s-triazine	4719-04-4	No information available

Substances	CAS Number	Mutagenic Effects
Hexahydro-1,3,5-tris(2-hydroxyethyl)-s-triazine	4719-04-4	While some in vitro tests were positive and/or equivocal, in vivo results were negative.

Substances	CAS Number	Carcinogenic Effects
Hexahydro-1,3,5-tris(2-hydroxyethyl)-s-triazine	4719-04-4	No data of sufficient quality are available.

Substances	CAS Number	Reproductive toxicity
Hexahydro-1,3,5-tris(2-hydroxyethyl)-s-triazine	4719-04-4	Did not show teratogenic effects in animal experiments. Animal testing did not show any effects on fertility.

Substances	CAS Number	STOT - single exposure
Hexahydro-1,3,5-tris(2-hydroxyethyl)-s-triazine	4719-04-4	May cause respiratory irritation.

Substances	CAS Number	STOT - repeated exposure
Hexahydro-1,3,5-tris(2-hydroxyethyl)-s-triazine	4719-04-4	Causes damage to organs through prolonged or repeated exposure: (Lungs)

Substances	CAS Number	Aspiration hazard
Hexahydro-1,3,5-tris(2-hydroxyethyl)-s-triazine	4719-04-4	Not applicable

12. Ecological Information

Ecotoxicity

Product Ecotoxicity Data

Harmful to aquatic life

Substance Ecotoxicity Data

Substances	CAS Number	Toxicity to Algae	Toxicity to Fish	Toxicity to Microorganisms	Toxicity to Invertebrates
Hexahydro-1,3,5-tris(2-hydroxyethyl)-s-triazine	4719-04-4	EC50 (72h) 6.66 mg/L (Desmodesmus subspicatus)	LC50 (96h) 16.07 mg/L (Brachydanio rerio)	EC50 (0.5h) 550 mg/L (Activated sludge, domestic)	EC50 (48h) 11.9 mg/L (Daphnia magna)

12.2. Persistence and degradability

Substances	CAS Number	Persistence and Degradability
Hexahydro-1,3,5-tris(2-hydroxyethyl)-s-triazine	4719-04-4	Readily biodegradable (90-100% @ 8d)

12.3. Bioaccumulative potential

Substances	CAS Number	Log Pow
Hexahydro-1,3,5-tris(2-hydroxyethyl)-s-triazine	4719-04-4	-2

12.4. Mobility in soil

Substances	CAS Number	Mobility
Hexahydro-1,3,5-tris(2-hydroxyethyl)-s-triazine	4719-04-4	No information available

12.6. Other adverse effects

Endocrine Disruptor Information

This product does not contain any known or suspected endocrine disruptors

13. Disposal Considerations

Safe handling and disposal methods
Follow all applicable community, national or regional regulations regarding waste management methods.

Disposal of any contaminated packaging
Follow all applicable national or local regulations.

Environmental regulations
Not applicable

14. Transport Information

Transportation Information

Australia ADG

UN Number	Not restricted
UN proper shipping name:	Not restricted
Transport Hazard Class(es):	Not applicable
Packing Group:	Not applicable
Environmental Hazards:	Not applicable

IMDG/IMO

UN Number	Not restricted
UN proper shipping name:	Not restricted
Transport Hazard Class(es):	Not applicable
Packing Group:	Not applicable
Environmental Hazards:	Not applicable

IATA/ICAO

UN Number	Not restricted
UN proper shipping name:	Not restricted
Transport Hazard Class(es):	Not applicable
Packing Group:	Not applicable
Environmental Hazards:	Not applicable

Special precautions during transport
None

HazChem Code
None Allocated

15. Regulatory Information

Safety, health and environmental regulations specific for the product

International Inventories

Australian AICS Inventory	All components are listed on the AICS or are subject to a relevant exemption, permit, or assessment certificate.
New Zealand Inventory of Chemicals	All components are listed on the NZIoC or are subject to a relevant exemption, permit, or assessment certificate.
EINECS (European Inventory of Existing Chemical Substances)	This product, and all its components, complies with EINECS
US TSCA Inventory	All components listed on inventory or are exempt.
Canadian Domestic Substances List (DSL)	All components listed on inventory or are exempt.

Poisons Schedule number
None Allocated

International Agreements

Montreal Protocol - Ozone Depleting Substances:	Does not apply
Stockholm Convention - Persistent Organic Pollutants:	Does not apply
Rotterdam Convention - Prior Informed Consent:	Does not apply
Basel Convention - Hazardous Waste:	Does not apply

16. Other information

Date of preparation or review

Revision Date: 24-Oct-2017

Revision Note
SDS sections updated:
2

Full text of H-Statements referred to under sections 2 and 3
H302 - Harmful if swallowed
H317 - May cause an allergic skin reaction
H319 - Causes serious eye irritation
H330 - Fatal if inhaled
H332 - Harmful if inhaled
H335 - May cause respiratory irritation
H372 - Causes damage to organs through prolonged or repeated exposure
H401 - Toxic to aquatic life
H402 - Harmful to aquatic life

Additional information

For additional information on the use of this product, contact your local Halliburton representative.

For questions about the Safety Data Sheet for this or other Halliburton products, contact Chemical Stewardship at 1-580-251-4335.

Key abreviations or acronyms used
bw – body weight
CAS – Chemical Abstracts Service
EC50 – Effective Concentration 50%
LC50 – Lethal Concentration 50%
LD50 – Lethal Dose 50%
LL50 – Lethal Loading 50%
mg/kg – milligram/kilogram
mg/L – milligram/liter
NOEC – No Observed Effect Concentration
OEL – Occupational Exposure Limit
PBT – Persistent Bioaccumulative and Toxic
ppm – parts per million
STEL – Short Term Exposure Limit
TWA – Time-Weighted Average
vPvB – very Persistent and very Bioaccumulative
h - hour
mg/m^3 - milligram/cubic meter
mm - millimeter
mmHg - millimeter mercury
w/w - weight/weight
d - day

Key literature references and sources for data
www.ChemADVISOR.com/
OSHA
ECHA C&L

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End of Safety Data Sheet

HALLIBURTON

SAFETY DATA SHEET

CALCIUM CHLORIDE - POWDER

Revision Date: 15-Mar-2022 **Revision Number:** 44

1. Product Identifier & Identity for the Chemical

Statement of Hazardous Nature Hazardous according to the criteria of the 7th Revised Edition of the Globally Harmonised System of Classification and Labelling of Chemicals (GHS), Non-Dangerous Goods according to the criteria of ADG.

1.1. Product Identifier

Product Name CALCIUM CHLORIDE - POWDER

Other means of Identification

Synonyms None

Hazardous Material Number: HM001502

Recommended use of the chemical and restrictions on use

Recommended Use Accelerator

Uses advised against No information available

Supplier's name, address and phone number

Manufacturer/Supplier Halliburton Australia Pty. Ltd.
15 Marriott Road, Jandakot, WA 6164
Australia
ACN Number: 009 000 775
Telephone Number: + 61 1 800 686 951
Fax Number: 61 (08) 9455 5300

E-mail Address fdunexchem@halliburton.com

Emergency phone number

+ 61 1 800 686 951
Global Incident Response Access Code: 334305
Contract Number: 14012

Australian Poisons Information Centre
24 Hour Service: - 13 11 26
Police or Fire Brigade: - 000 (exchange): - 1100

2. Hazard Identification

Statement of Hazardous Nature Hazardous according to the criteria of the 7th Revised Edition of the Globally Harmonised System of Classification and Labelling of Chemicals (GHS), Non-Dangerous Goods according to the criteria of ADG.

Classification of the hazardous chemical

Serious Eye Damage/Irritation	Category 2 - H319

Label elements, including precautionary statements

Hazard Pictograms



Signal Word WARNING

Hazard Statements: H319 - Causes serious eye irritation

Precautionary Statements

Prevention P264 - Wash face, hands and any exposed skin thoroughly after handling
P280 - Wear eye protection/face protection

Response P305 + P351 + P338 - IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing
P337 + P313 - If eye irritation persists: Get medical advice/attention

Storage None

Disposal None

Contains

Substances	**CAS Number**
Calcium chloride, dihydrate	10035-04-8

Other hazards which do not result in classification

This substance is not considered to be persistent, bioaccumulating nor toxic (PBT).
This substance is not considered to be very persistent nor very bioaccumulating (vPvB).

For the full text of the H-phrases mentioned in this Section, see Section 16

3. Composition/information on Ingredients

Substances	CAS Number	PERCENT (w/w)	GHS Classification - Australia
Calcium chloride, dihydrate	10035-04-8	60 - 100%	Eye Irrit. 2A (H319)

4. First aid measures

Description of necessary first aid measures

Inhalation If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.

Eyes In case of contact, or suspected contact, immediately flush eyes with plenty of water for at least 15 minutes and get medical attention immediately after flushing.

Skin In case of contact, immediately flush skin with plenty of soap and water for at least 15 minutes. Get medical attention. Remove contaminated clothing and launder before reuse.

Ingestion Do NOT induce vomiting. Give nothing by mouth. Obtain immediate medical attention.

Symptoms caused by exposure

Causes eye irritation. Causes mild skin irritation. May be harmful if swallowed.

Medical Attention and Special Treatment

Notes to Physician Treat symptomatically

5. Fire Fighting Measures

Suitable extinguishing equipment

Suitable Extinguishing Media

All standard fire fighting media Water fog, carbon dioxide, foam, dry chemical.

Extinguishing media which must not be used for safety reasons

None known.

Specific hazards arising from the chemical

Special exposure hazards in a fire

None anticipated

Special protective equipment and precautions for fire fighters

Special protective equipment for firefighters

Full protective clothing and approved self-contained breathing apparatus required for fire fighting personnel.

6. Accidental release measures

6.1. Personal precautions, protective equipment and emergency procedures

Use appropriate protective equipment. Avoid creating and breathing dust. Avoid contact with skin, eyes and clothing. Ensure adequate ventilation.

6.2. Environmental precautions

Prevent from entering sewers, waterways, or low areas.

6.3. Methods and material for containment and cleaning up

Scoop up and remove.

7. Handling and storage

7.1. Precautions for safe handling

Handling Precautions

Use appropriate protective equipment. Avoid contact with eyes, skin, or clothing. Avoid creating or inhaling dust. Ensure adequate ventilation. Wash hands after use. Launder contaminated clothing before reuse.

Hygiene Measures

Handle in accordance with good industrial hygiene and safety practice.

7.2. Conditions for safe storage, including any incompatibilities

Storage Information

Store in a cool, dry location.

Other Guidelines

No information available

8. Exposure Controls/Personal Protection

Control parameters - exposure standards, biological monitoring

Exposure Limits

Substances	CAS Number	Australia NOHSC	ACGIH TLV-TWA
Calcium chloride, dihydrate	10035-04-8	Not applicable	Not applicable

Appropriate engineering controls

Engineering Controls Use in a well ventilated area.

Personal protective equipment (PPE)

Personal Protective Equipment If engineering controls and work practices cannot prevent excessive exposures, the selection and proper use of personal protective equipment should be determined by an industrial hygienist or other qualified professional based on the specific application of this product.

Respiratory Protection If engineering controls and work practices cannot keep exposure below occupational

	exposure limits or if exposure is unknown, wear a NIOSH certified, European Standard EN 149, AS/NZS 1715:2009, or equivalent respirator when using this product. Selection of and instruction on using all personal protective equipment, including respirators, should be performed by an Industrial Hygienist or other qualified professional. Dust/mist respirator. (N95, P2/P3)
Hand Protection	Normal work gloves.
Skin Protection	Normal work coveralls.
Eye Protection	Dust proof goggles.
Other Precautions	None known.
Environmental Exposure Controls	Do not allow material to contaminate ground water system.

9. Physical and Chemical Properties

9.1. Information on basic physical and chemical properties

Physical State:	Solid	**Color**	White
Odor:	Odorless	**Odor Threshold:**	No information available

Property Remarks/ - Method	Values
pH:	10
Freezing Point / Range	No data available
Melting Point / Range	No data available
Pour Point / Range	No data available
Boiling Point / Range	No data available
Flash Point	No data available
Evaporation rate	No data available
Vapor Pressure	-
Vapor Density	No data available
Specific Gravity	2.1
Water Solubility	Soluble in water
Solubility in other solvents	No data available
Partition coefficient: n-octanol/water	No data available
Autoignition Temperature	No data available
Decomposition Temperature	No data available
Viscosity	No data available
Explosive Properties	No information available
Oxidizing Properties	No information available

9.2. Other information

Molecular Weight	147.02 (g/mole)
VOC Content (%)	No data available

10. Stability and Reactivity

10.1. Reactivity
Not expected to be reactive.
10.2. Chemical stability
Stable
10.3. Possibility of hazardous reactions
Will Not Occur
10.4. Conditions to avoid
None anticipated
10.5. Incompatible materials
None known.
10.6. Hazardous decomposition products
None known.

11. Toxicological Information

Information on routes of exposure

Principle Route of Exposure Eye or skin contact, inhalation.

Symptoms related to exposure

Most Important Symptoms/Effects

Causes eye irritation. Causes mild skin irritation. May be harmful if swallowed.

Toxicology data for the components

Substances	CAS Number	LD50 Oral	LD50 Dermal	LC50 Inhalation
Calcium chloride, dihydrate	10035-04-8	2301 mg/kg (Rat)	> 5000 mg/kg (Rabbit)	No data available

Immediate, delayed and chronic health effects from exposure

Inhalation May cause mild respiratory irritation.

Eye Contact Causes eye irritation.

Skin Contact Causes mild skin irritation.

Ingestion May be harmful if swallowed. Irritation of the mouth, throat, and stomach.

Chronic Effects/Carcinogenicity No data available to indicate product or components present at greater than 0.1% are chronic health hazards.

Exposure Levels

No data available

Interactive effects

Skin disorders.

Data limitations

No data available

Substances	CAS Number	Skin corrosion/irritation
Calcium chloride, dihydrate	10035-04-8	Causes mild skin irritation (Rabbit)

Substances	CAS Number	Serious eye damage/irritation
Calcium chloride, dihydrate	10035-04-8	May cause moderate to severe eye irritation. (Rabbit)

Substances	CAS Number	Skin Sensitization
Calcium chloride, dihydrate	10035-04-8	No data of sufficient quality are available.

Substances	CAS Number	Respiratory Sensitization
Calcium chloride, dihydrate	10035-04-8	No information available

Substances	CAS Number	Mutagenic Effects
Calcium chloride, dihydrate	10035-04-8	In vitro tests did not show mutagenic effects.

Substances	CAS Number	Carcinogenic Effects
Calcium chloride, dihydrate	10035-04-8	No information available

Substances	CAS Number	Reproductive toxicity
Calcium chloride, dihydrate	10035-04-8	Animal testing did not show any effects on fertility. Did not show teratogenic effects in animal experiments.

Substances	CAS Number	STOT - single exposure
Calcium chloride, dihydrate	10035-04-8	No significant toxicity observed in animal studies at concentration requiring classification.

Substances	CAS Number	STOT - repeated exposure
Calcium chloride, dihydrate	10035-04-8	No significant toxicity observed in animal studies at concentration requiring classification.

Substances	CAS Number	Aspiration hazard
Calcium chloride, dihydrate	10035-04-8	Not applicable

12. Ecological Information

Ecotoxicity

Substance Ecotoxicity Data

Substances	CAS Number	Toxicity to Algae	Toxicity to Fish	Toxicity to Microorganisms	Toxicity to Invertebrates
Calcium chloride, dihydrate	10035-04-8	EC50 (72h) 2900 mg/L (Pseudokirchnerella subcapitata) EC50 (72h) >4000 mg/L (Pseudokirchnerella subcapitata)	LC50 (96h) 4630 mg/L (Pimephales promelas)	NOEC 2000 mg/L (Activated sludge, industrial)	EC50 (48h) 1285 mg/L (Daphnia magna) EC16 (21d) 320 mg/L (Daphnia magna) ErC50 (21d) 610 mg/L (Daphnia magna) LC50 (48h) 1285 mg/L (Daphnia magna) LC50 (48h) 2400 mg/L (Daphia magna)

12.2. Persistence and degradability

Substances	CAS Number	Persistence and Degradability
Calcium chloride, dihydrate	10035-04-8	The methods for determining biodegradability are not applicable to inorganic substances.

12.3. Bioaccumulative potential

Substances	CAS Number	Bioaccumulation
Calcium chloride, dihydrate	10035-04-8	No information available

12.4. Mobility in soil

Substances	CAS Number	Mobility
Calcium chloride, dihydrate	10035-04-8	No information available

12.6. Other adverse effects

Endocrine Disruptor Information

This product does not contain any known or suspected endocrine disruptors

13. Disposal Considerations

Safe handling and disposal methods

Bury in a licensed landfill according to federal, state, and local regulations.

Disposal of any contaminated packaging

Follow all applicable national or local regulations. Contaminated packaging may be disposed of by: rendering packaging incapable of containing any substance, or treating packaging to remove residual contents, or treating packaging to make sure the residual contents are no longer hazardous, or by disposing of packaging into commercial waste collection.

Environmental regulations

Not applicable

14. Transport Information

Transportation Information

Australia ADG

UN Number Not restricted
UN proper shipping name: Not restricted
Transport Hazard Class(es): Not applicable
Packing Group: Not applicable
Environmental Hazards: Not applicable

IMDG/IMO

UN Number	Not restricted
UN proper shipping name:	Not restricted
Transport Hazard Class(es):	Not applicable
Packing Group:	Not applicable
Environmental Hazards:	Not applicable

IATA/ICAO

UN Number	Not restricted
UN proper shipping name:	Not restricted
Transport Hazard Class(es):	Not applicable
Packing Group:	Not applicable
Environmental Hazards:	Not applicable

Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code
Not applicable

Special precautions during transport
None

HazChem Code
None Allocated

15. Regulatory Information

Safety, health and environmental regulations specific for the product

International Inventories

Australian AICS Inventory	All components are listed on the AIIC or are subject to a relevant exemption, permit, or assessment certificate.
New Zealand Inventory of Chemicals	All components are listed on the NZIoC or are subject to a relevant exemption, permit, or assessment certificate.
US TSCA Inventory	All components listed on inventory or are exempt.
Canadian Domestic Substances List (DSL)	All components listed on inventory or are exempt.

Poisons Schedule number
None Allocated

International Agreements

Montreal Protocol - Ozone Depleting Substances:	Does not apply.
Stockholm Convention - Persistent Organic Pollutants:	Does not apply
Rotterdam Convention - Prior Informed Consent:	Does not apply.
Basel Convention - Hazardous Waste:	Does not apply.

16. Other information

Date of preparation or review

Revision Date: 15-Mar-2022

Revision Note
SDS sections updated:
2

Full text of H-Statements referred to under sections 2 and 3
H319 - Causes serious eye irritation

Additional information: For additional information on the use of this product, contact your local Halliburton representative.

For questions about the Safety Data Sheet for this or other Halliburton products, contact Chemical Stewardship at 1-580-251-4335.

Key abreviations or acronyms used

bw – body weight
CAS – Chemical Abstracts Service
EC50 – Effective Concentration 50%
LC50 – Lethal Concentration 50%
LD50 – Lethal Dose 50%
LL50 – Lethal Loading 50%
mg/kg – milligram/kilogram
mg/L – milligram/liter
NOEC – No Observed Effect Concentration
OEL – Occupational Exposure Limit
PBT – Persistent Bioaccumulative and Toxic
ppm – parts per million
STEL – Short Term Exposure Limit
TWA – Time-Weighted Average
vPvB – very Persistent and very Bioaccumulative
h - hour
mg/m^3 - milligram/cubic meter
mm - millimeter
mmHg - millimeter mercury
w/w - weight/weight
d - day

Key literature references and sources for data

www.ChemADVISOR.com/
OSHA
ECHA C&L
NZ CCID

Disclaimer Statement

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End of Safety Data Sheet

HALLIBURTON

SAFETY DATA SHEET

DCA-16001

Revision Date: 05-Jul-2017 **Revision Number:** 11

1. Product Identifier & Identity for the Chemical

Statement of Hazardous Nature Non-Hazardous according to the criteria of the 3rd Revised Edition of the Globally Harmonised System of Classification and Labelling of Chemicals (GHS), Non-Dangerous Goods according to the criteria of ADG.

1.1. Product Identifier

Product Name DCA-16001

Other means of Identification

Synonyms None

Hazardous Material Number: HM007655

Recommended use of the chemical and restrictions on use

Recommended Use Clay Stabilization Agent

Uses advised against No information available

Supplier's name, address and phone number

Manufacturer/Supplier Halliburton Australia Pty. Ltd.
15 Marriott Road, Jandakot, WA 6164
Australia
ACN Number: 009 000 775
Telephone Number: + 61 1 800 686 951
Fax Number: 61 (08) 9455 5300

E-mail Address fdunexchem@halliburton.com

Emergency phone number

+ 61 1 800 686 951
Global Incident Response Access Code: 334305
Contract Number: 14012

Australian Poisons Information Centre
24 Hour Service: - 13 11 26
Police or Fire Brigade: - 000 (exchange): - 1100

2. Hazard Identification

Statement of Hazardous Nature Non-Hazardous according to the criteria of the 3rd Revised Edition of the Globally Harmonised System of Classification and Labelling of Chemicals (GHS), Non-Dangerous Goods according to the criteria of ADG.

Classification of the hazardous chemical

Not classified

Label elements, including precautionary statements

Hazard Pictograms

Signal Word Not Hazardous

Hazard Statements: Not Classified

Precautionary Statements

Prevention	None
Response	None
Storage	None
Disposal	None

Contains

Substances	**CAS Number**
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA

Other hazards which do not result in classification

This mixture contains no substance considered to be persistent, bioaccumulating nor toxic (PBT).
This mixture contains no substance considered to be very persistent nor very bioaccumulating (vPvB).

For the full text of the H-phrases mentioned in this Section, see Section 16

3. Composition/information on Ingredients

Substances	CAS Number	PERCENT (w/w)	GHS Classification - Australia
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	60 - 100%	Not classified

4. First aid measures

Description of necessary first aid measures

Inhalation	If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.
Eyes	In case of contact, immediately flush eyes with plenty of water for at least 15 minutes and get medical attention if irritation persists.
Skin	Wash with soap and water. Get medical attention if irritation persists.
Ingestion	Do NOT induce vomiting. Give nothing by mouth. Obtain immediate medical attention.

Symptoms caused by exposure

No significant hazards expected.

Medical Attention and Special Treatment

Notes to Physician	Treat symptomatically

5. Fire Fighting Measures

Suitable extinguishing equipment

Suitable Extinguishing Media

All standard fire fighting media

Extinguishing media which must not be used for safety reasons

None known.

Specific hazards arising from the chemical

Special exposure hazards in a fire

Not applicable

Special protective equipment and precautions for fire fighters

Special protective equipment for firefighters

Full protective clothing and approved self-contained breathing apparatus required for fire fighting personnel.

6. Accidental release measures

6.1. Personal precautions, protective equipment and emergency procedures
Use appropriate protective equipment. Avoid contact with skin, eyes and clothing. Avoid breathing vapors. Ensure adequate ventilation.

6.2. Environmental precautions
Prevent from entering sewers, waterways, or low areas.

6.3. Methods and material for containment and cleaning up
Isolate spill and stop leak where safe. Contain spill with sand or other inert materials. Scoop up and remove.

7. Handling and storage

7.1. Precautions for safe handling
Handling Precautions
Avoid contact with eyes, skin, or clothing. Avoid breathing vapors. Ensure adequate ventilation. Wash hands after use. Launder contaminated clothing before reuse. Use appropriate protective equipment.
Hygiene Measures
Handle in accordance with good industrial hygiene and safety practice.

7.2. Conditions for safe storage, including any incompatibilities
Storage Information
Store in a cool, dry location. Keep container closed when not in use. Product has a shelf life of 24 months.
Other Guidelines
No information available

8. Exposure Controls/Personal Protection

Control parameters - exposure standards, biological monitoring
Exposure Limits

Substances	CAS Number	Australia NOHSC	ACGIH TLV-TWA
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	Not applicable	Not applicable

Appropriate engineering controls
Engineering Controls Use in a well ventilated area.

Personal protective equipment (PPE)
Personal Protective Equipment If engineering controls and work practices cannot prevent excessive exposures, the selection and proper use of personal protective equipment should be determined by an industrial hygienist or other qualified professional based on the specific application of this product.
Respiratory Protection Not normally necessary.

Hand Protection Rubber gloves.
Skin Protection Normal work coveralls.
Eye Protection Wear safety glasses or goggles to protect against exposure.
Other Precautions None known.
Environmental Exposure Controls Do not allow material to contaminate ground water system

9. Physical and Chemical Properties

9.1. Information on basic physical and chemical properties

Physical State:	Liquid	**Color**	White
Odor:	Mild amine	**Odor Threshold:**	No information available

Property Remarks/ - Method	Values
pH:	7-9
Freezing Point / Range	No data available
Melting Point / Range	No data available
Boiling Point / Range	No data available
Flash Point	No data available
Evaporation rate	No data available
Vapor Pressure	No data available
Vapor Density	No data available
Specific Gravity	1.07 - 1.091
Water Solubility	Soluble in water
Solubility in other solvents	No data available
Partition coefficient: n-octanol/water	No data available
Autoignition Temperature	No data available
Decomposition Temperature	No data available
Viscosity	No data available
Explosive Properties	No information available
Oxidizing Properties	No information available

9.2. Other information

VOC Content (%) No data available

10. Stability and Reactivity

10.1. Reactivity

Not expected to be reactive.

10.2. Chemical stability

Stable

10.3. Possibility of hazardous reactions

Will Not Occur

10.4. Conditions to avoid

Avoid contact with metals such as aluminum, tin, lead, brass, bronze, copper, and zinc.

10.5. Incompatible materials

Strong oxidizers.

10.6. Hazardous decomposition products

Oxides of nitrogen. Hydrogen chloride. Carbon monoxide and carbon dioxide.

11. Toxicological Information

Information on routes of exposure

Symptoms related to exposure

Most Important Symptoms/Effects

No significant hazards expected.

Toxicology data for the components

Substances	CAS Number	LD50 Oral	LD50 Dermal	LC50 Inhalation
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	No data available	No data available	No data available

Immediate, delayed and chronic health effects from exposure

Inhalation None known.

Eye Contact None known.
Skin Contact None known.
Ingestion None known.

Chronic Effects/Carcinogenicity No data available to indicate product or components present at greater than 0.1% are chronic health hazards.

Exposure Levels
No data available

Interactive effects
None known.

Data limitations
No data available

12. Ecological Information

Ecotoxicity

Substance Ecotoxicity Data

Substances	CAS Number	Toxicity to Algae	Toxicity to Fish	Toxicity to Microorganisms	Toxicity to Invertebrates
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	No information available	No information available	No information available	No information available

12.2. Persistence and degradability
Expected to be readily biodegradable

Substances	CAS Number	Persistence and Degradability
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	No information available

12.3. Bioaccumulative potential
Does not bioaccumulate.

Substances	CAS Number	Log Pow
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	No information available

12.4. Mobility in soil

Substances	CAS Number	Mobility
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	No information available

12.6. Other adverse effects
Endocrine Disruptor Information

This product does not contain any known or suspected endocrine disruptors

13. Disposal Considerations

Safe handling and disposal methods
Disposal should be made in accordance with federal, state, and local regulations.

Disposal of any contaminated packaging
Follow all applicable national or local regulations.

Environmental regulations
Not applicable

14. Transport Information

Transportation Information

Australia ADG

UN Number	Not restricted
UN proper shipping name:	Not restricted
Transport Hazard Class(es):	Not applicable
Packing Group:	Not applicable
Environmental Hazards:	Not applicable

IMDG/IMO

UN Number	Not restricted
UN proper shipping name:	Not restricted
Transport Hazard Class(es):	Not applicable
Packing Group:	Not applicable
Environmental Hazards:	Not applicable

IATA/ICAO

UN Number	Not restricted
UN proper shipping name:	Not restricted
Transport Hazard Class(es):	Not applicable
Packing Group:	Not applicable
Environmental Hazards:	Not applicable

Special precautions during transport
None

HazChem Code
None Allocated

15. Regulatory Information

Safety, health and environmental regulations specific for the product

International Inventories

Australian AICS Inventory	All components are listed on the AICS or are subject to a relevant exemption, permit, or assessment certificate.
New Zealand Inventory of Chemicals	All components are listed on the NZIoC or are subject to a relevant exemption, permit, or assessment certificate.
EINECS (European Inventory of Existing Chemical Substances)	This product, and all its components, complies with EINECS
US TSCA Inventory	All components listed on inventory or are exempt.
Canadian Domestic Substances List (DSL)	All components listed on inventory or are exempt.

Poisons Schedule number
None Allocated

International Agreements

Montreal Protocol - Ozone Depleting Substances:	Does not apply
Stockholm Convention - Persistent Organic Pollutants:	Does not apply
Rotterdam Convention - Prior Informed Consent:	Does not apply
Basel Convention - Hazardous Waste:	Does not apply

16. Other information

Date of preparation or review

Revision Date: 05-Jul-2017

Revision Note
SDS sections updated:
2

Full text of H-Statements referred to under sections 2 and 3
None

Additional information

For additional information on the use of this product, contact your local Halliburton representative.

For questions about the Safety Data Sheet for this or other Halliburton products, contact Chemical Stewardship at 1-580-251-4335.

Key abreviations or acronyms used

bw – body weight
CAS – Chemical Abstracts Service
EC50 – Effective Concentration 50%
LC50 – Lethal Concentration 50%
LD50 – Lethal Dose 50%
LL50 – Lethal Loading 50%
mg/kg – milligram/kilogram
mg/L – milligram/liter
NOEC – No Observed Effect Concentration
OEL – Occupational Exposure Limit
PBT – Persistent Bioaccumulative and Toxic
ppm – parts per million
STEL – Short Term Exposure Limit
TWA – Time-Weighted Average
vPvB – very Persistent and very Bioaccumulative
h - hour
mg/m^3 - milligram/cubic meter
mm - millimeter
mmHg - millimeter mercury
w/w - weight/weight
d - day

Key literature references and sources for data
www.ChemADVISOR.com/

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End of Safety Data Sheet

HALLIBURTON

SAFETY DATA SHEET

DCA-17001

Revision Date: 09-Nov-2017 **Revision Number:** 16

1. Product Identifier & Identity for the Chemical

Statement of Hazardous Nature Hazardous according to the criteria of the 3rd Revised Edition of the Globally Harmonised System of Classification and Labelling of Chemicals (GHS), Dangerous Goods according to the criteria of ADG.

1.1. Product Identifier

Product Name DCA-17001

Other means of Identification

Synonyms None

Hazardous Material Number: HM007659

Recommended use of the chemical and restrictions on use

Recommended Use Corrosion Inhibitor

Uses advised against No information available

Supplier's name, address and phone number

Manufacturer/Supplier Halliburton Australia Pty. Ltd.
15 Marriott Road, Jandakot, WA 6164
Australia
ACN Number: 009 000 775
Telephone Number: + 61 1 800 686 951
Fax Number: 61 (08) 9455 5300

E-mail Address fdunexchem@halliburton.com

Emergency phone number

+ 61 1 800 686 951
Global Incident Response Access Code: 334305
Contract Number: 14012

Australian Poisons Information Centre
24 Hour Service: - 13 11 26
Police or Fire Brigade: - 000 (exchange): - 1100

2. Hazard Identification

Statement of Hazardous Nature Hazardous according to the criteria of the 3rd Revised Edition of the Globally Harmonised System of Classification and Labelling of Chemicals (GHS), Dangerous Goods according to the criteria of ADG.

Classification of the hazardous chemical

Acute Oral Toxicity	Category 4 - H302
Skin Corrosion/Irritation	Category 2 - H315
Serious Eye Damage/Irritation	Category 1 - H318
Skin Sensitization	Category 1 - H317
Reproductive Toxicity	Category 1B - H360
Specific Target Organ Toxicity - (Single Exposure)	Category 1 - H370
Specific Target Organ Toxicity - (Repeated Exposure)	Category 2 - H373
Acute Aquatic Toxicity	Category 2 - H401
Flammable liquids.	Category 3 - H226

Label elements, including precautionary statements

Hazard Pictograms



Signal Word DANGER

Hazard Statements:

H226 - Flammable liquid and vapor
H302 - Harmful if swallowed
H315 - Causes skin irritation
H317 - May cause an allergic skin reaction
H318 - Causes serious eye damage
H360 - May damage fertility or the unborn child
H370 - Causes damage to organs
H373 - May cause damage to organs through prolonged or repeated exposure
H401 - Toxic to aquatic life

Precautionary Statements

Prevention

P201 - Obtain special instructions before use
P202 - Do not handle until all safety precautions have been read and understood
P210 - Keep away from heat, hot surfaces, sparks, open flames and other ignition sources. No smoking.
P233 - Keep container tightly closed
P240 - Ground and bond container and receiving equipment.
P241 - Use explosion-proof electrical/ventilating/lighting/equipment
P242 - Use only non-sparking tools
P243 - Take action to prevent static discharges.
P260 - Do not breathe dust/fume/gas/mist/vapors/spray
P264 - Wash face, hands and any exposed skin thoroughly after handling
P270 - Do not eat, drink or smoke when using this product
P272 - Contaminated work clothing should not be allowed out of the workplace
P273 - Avoid release to the environment
P280 - Wear protective gloves/protective clothing/eye protection/face protection
P281 - Use personal protective equipment as required

Response

P301 + P312 - IF SWALLOWED: Call a POISON CENTER or doctor/physician if you feel unwell
P330 - Rinse mouth
P302 + P352 - IF ON SKIN: Wash with plenty of water.
P333 + P313 - If skin irritation or rash occurs: Get medical advice/attention
P362 + P364 - Take off contaminated clothing and wash before reuse
P305 + P351 + P338 - IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing
P310 - Immediately call a POISON CENTER or doctor/physician
P307 + P311 - IF exposed: Call a POISON CENTER or doctor/physician
P314 - Get medical attention/advice if you feel unwell
P370 + P378 - In case of fire: Use water spray for extinction

Storage

P403 + P235 - Store in a well-ventilated place. Keep cool
P405 - Store locked up

Disposal P501 - Dispose of contents/container in accordance with local/regional/national/international regulations

Contains

Substances	**CAS Number**
Diethylene glycol	111-46-6
Cinnamaldehyde	104-55-2
Amine oxides, cocoalkyldimethyl	61788-90-7
Methanol	67-56-1
Benzaldehyde	100-52-7
Alcohols, C12-16, ethoxylated	68551-12-2
Sodium iodide	7681-82-5

Other hazards which do not result in classification

This mixture contains no substance considered to be persistent, bioaccumulating nor toxic (PBT).
This mixture contains no substance considered to be very persistent nor very bioaccumulating (vPvB).

For the full text of the H-phrases mentioned in this Section, see Section 16

3. Composition/information on Ingredients

Substances	**CAS Number**	**PERCENT (w/w)**	**GHS Classification - Australia**
Diethylene glycol	111-46-6	30 - 60%	Acute Tox. 4 (H302) STOT RE 2 (H373)
Cinnamaldehyde	104-55-2	30 - 60%	Acute Tox. 4 (H312) Skin Irrit. 2 (H315) Skin Sens. 1 (H317) Aquatic Acute 2 (H401)
Amine oxides, cocoalkyldimethyl	61788-90-7	10 - 30%	Acute Tox. 4 (H302) Skin Irrit. 2 (H315) Eye Corr. 1 (H318) Aquatic Acute 1 (H400)
Methanol	67-56-1	10 - 30%	Acute Tox. 3 (H301) Acute Tox. 3 (H311) Acute Tox. 3 (H331) Repr. 1B (H360) STOT SE 1 (H370) Flam. Liq. 2 (H225)
Benzaldehyde	100-52-7	5 - 10%	Acute Tox. 4 (H302) Acute Tox. 4 (H332) Aquatic Acute 2 (H401) Flam. Liq. 4 (H227)
Alcohols, C12-16, ethoxylated	68551-12-2	1 - 5%	Acute Tox. 4 (H302) Skin Irrit. 2 (H315) Eye Corr. 1 (H318) Aquatic Acute 1 (H400) Aquatic Chronic 3 (H412)
Sodium iodide	7681-82-5	1 - 5%	Skin Irrit. 2 (H315) Eye Irrit. 2 (H319) STOT SE 3 (H335) STOT RE 1 (H372)

4. First aid measures

Description of necessary first aid measures

Inhalation If inhaled, move victim to fresh air and seek medical attention.

Eyes In case of contact, or suspected contact, immediately flush eyes with plenty of water for at least 15 minutes and get medical attention immediately after flushing.

Skin In case of contact, immediately flush skin with plenty of soap and water for at least 15 minutes. Get medical attention. Remove contaminated clothing and launder before reuse.

Ingestion Get immediate medical attention. Do NOT induce vomiting. Give nothing by mouth. Obtain immediate medical attention.

Symptoms caused by exposure

Causes severe eye irritation which may damage tissue. Causes skin irritation. May cause allergic skin reaction. Harmful if swallowed. May cause damage to internal organs. May cause damage to organs through prolonged or repeated exposure. Potential reproductive hazard. May cause birth defects.

Medical Attention and Special Treatment

Notes to Physician Treat symptomatically

5. Fire Fighting Measures

Suitable extinguishing equipment

Suitable Extinguishing Media

Carbon dioxide, dry chemical, foam.

Extinguishing media which must not be used for safety reasons

None known.

Specific hazards arising from the chemical

Special exposure hazards in a fire

May be ignited by heat, sparks or flames Use water spray to cool fire exposed surfaces. Closed containers may explode in fire. Decomposition in fire may produce harmful gases. Runoff to sewer may cause fire or explosion hazard.

Special protective equipment and precautions for fire fighters

Special protective equipment for firefighters

Full protective clothing and approved self-contained breathing apparatus required for fire fighting personnel.

6. Accidental release measures

6.1. Personal precautions, protective equipment and emergency procedures

Remove sources of ignition. Use appropriate protective equipment. Wear self-contained breathing apparatus in enclosed areas. Avoid breathing vapors. Avoid contact with skin, eyes and clothing. Ensure adequate ventilation.

6.2. Environmental precautions

Prevent from entering sewers, waterways, or low areas.

6.3. Methods and material for containment and cleaning up

Isolate spill and stop leak where safe. Remove ignition sources and work with non-sparking tools. Contain spill with sand or other inert materials. Scoop up and remove.

7. Handling and storage

7.1. Precautions for safe handling

Handling Precautions

Remove sources of ignition. Ensure adequate ventilation. Avoid breathing vapors. Avoid contact with eyes, skin, or clothing. Wash hands after use. Launder contaminated clothing before reuse. Ground and bond containers when transferring from one container to another. Use appropriate protective equipment.

Hygiene Measures

Handle in accordance with good industrial hygiene and safety practice.

7.2. Conditions for safe storage, including any incompatibilities

Storage Information

Store away from oxidizers. Keep from heat, sparks, and open flames. Store in a well ventilated area. Store locked up. Keep container closed when not in use. Product has a shelf life of 60 months.

Other Guidelines

No information available

8. Exposure Controls/Personal Protection

Control parameters - exposure standards, biological monitoring

Exposure Limits

Substances	CAS Number	Australia NOHSC	ACGIH TLV-TWA
Diethylene glycol	111-46-6	TWA: 23 ppm TWA: 100 mg/m³	Not applicable
Cinnamaldehyde	104-55-2	Not applicable	Not applicable
Amine oxides, cocoalkyldimethyl	61788-90-7	Not applicable	Not applicable
Methanol	67-56-1	TWA: 200 ppm TWA: 262 mg/m³ STEL: 250 ppm STEL: 328 mg/m³	TWA: 200 ppm STEL: 250 ppm
Benzaldehyde	100-52-7	Not applicable	Not applicable
Alcohols, C12-16, ethoxylated	68551-12-2	Not applicable	Not applicable
Sodium iodide	7681-82-5	Not applicable	TWA: 0.01 ppm

Appropriate engineering controls

Engineering Controls Use in a well ventilated area. Local exhaust ventilation should be used in areas without good cross ventilation.

Personal protective equipment (PPE)

Personal Protective Equipment If engineering controls and work practices cannot prevent excessive exposures, the selection and proper use of personal protective equipment should be determined by an industrial hygienist or other qualified professional based on the specific application of this product.

Respiratory Protection If engineering controls and work practices cannot keep exposure below occupational exposure limits or if exposure is unknown, wear a NIOSH certified, European Standard EN 149, AS/NZS 1715:2009, or equivalent respirator when using this product. Selection of and instruction on using all personal protective equipment, including respirators, should be performed by an Industrial Hygienist or other qualified professional.
Positive pressure self-contained breathing apparatus if methanol is released.

Hand Protection Chemical-resistant protective gloves (EN 374) Suitable materials for longer, direct contact (recommended: protection index 6, corresponding to > 480 minutes permeation time as per EN 374): Butyl rubber gloves. (>= 0.7 mm thickness)
This information is based on literature references and on information provided by glove manufacturers, or is derived by analogy with similar substances. Please note that in practice the working life of chemical-resistant protective gloves may be considerably shorter than the permeation time determined in accordance with EN 374 as a result of the many influencing factors (e.g. temperature). If signs of wear and tear are noticed then the gloves should be replaced. Manufacturer's directions for use should be observed because of great diversity of types.

Skin Protection Rubber apron.

Eye Protection Chemical goggles; also wear a face shield if splashing hazard exists.

Other Precautions Eyewash fountains and safety showers must be easily accessible.

Environmental Exposure Controls Do not allow material to contaminate ground water system

9. Physical and Chemical Properties

9.1. Information on basic physical and chemical properties

Physical State: Liquid
Color Yellow-orange
Odor: Cinnamon
Odor Threshold: No information available

Property	Values	Remarks/ - Method
pH:	6.85 (10%)	
Freezing Point / Range	-21 °C	
Melting Point / Range	No data available	
Boiling Point / Range	No data available	
Flash Point	28.9 °C / 84 °F	PMCC
Evaporation rate	No data available	

Vapor Pressure	No data available
Vapor Density	No data available
Specific Gravity	1.015
Water Solubility	Soluble in water
Solubility in other solvents	No data available
Partition coefficient: n-octanol/water	No data available
Autoignition Temperature	No data available
Decomposition Temperature	No data available
Viscosity	No data available
Explosive Properties	No information available
Oxidizing Properties	No information available

9.2. Other information

VOC Content (%) No data available

10. Stability and Reactivity

10.1. Reactivity

Not expected to be reactive.

10.2. Chemical stability

Stable

10.3. Possibility of hazardous reactions

Will Not Occur

10.4. Conditions to avoid

Keep away from heat, sparks and flame.

10.5. Incompatible materials

Strong oxidizers.

10.6. Hazardous decomposition products

Ammonia. Oxides of nitrogen. Hydrocarbons. Carbon monoxide and carbon dioxide.

11. Toxicological Information

Information on routes of exposure

Principle Route of Exposure Eye or skin contact, inhalation.

Symptoms related to exposure

Most Important Symptoms/Effects

Causes severe eye irritation which may damage tissue. Causes skin irritation. May cause allergic skin reaction. Harmful if swallowed. May cause damage to internal organs. May cause damage to organs through prolonged or repeated exposure. Potential reproductive hazard. May cause birth defects.

Toxicology data for the components

Substances	CAS Number	LD50 Oral	LD50 Dermal	LC50 Inhalation
Diethylene glycol	111-46-6	12565 - 19600 mg/kg (Rat)	11890 - 13300 mg/kg (Rabbit)	> 4.6 mg/L (Rat) 4h
Cinnamaldehyde	104-55-2	2220 mg/kg (rat)	620 mg/kg (rabbit)	No data available
Amine oxides, cocoalkyldimethyl	61788-90-7	846 - 3873 mg/kg (Rat) 1000-1250 mg/kg (Rat)	4290 mg/kg (Rabbit)	No data available
Methanol	67-56-1	300 mg/kg-bw (human) < 790 to 13,000 mg/kg (rat)	1000 mg/kg-bw (human) 17,100 mg/kg (rabbit)	10 mg/L (human, 4h, vapor)
Benzaldehyde	100-52-7	1430 mg/kg (rat)	No information available	>1 <5 mg/L air (Rat, 4h, mist)
Alcohols, C12-16, ethoxylated	68551-12-2	1600 mg/kg	No data available	No data available
Sodium iodide	7681-82-5	4340 mg/kg (Rat) 3118 mg/kg (Rats) (Similar substance)	No data available	LCLo: 50000 mg/m³ (Mouse) 2h

Immediate, delayed and chronic health effects from exposure

Product Information Based on the collective toxicity of product ingredients, the mixture should be considered to cause the following:

Inhalation May cause respiratory irritation. May cause central nervous system depression including headache, dizziness, drowsiness, incoordination, slowed reaction time, slurred speech, giddiness and unconsciousness.

Eye Contact Causes severe eye irritation which may damage tissue.

Skin Contact Causes skin irritation. May cause an allergic skin reaction.

Ingestion Harmful if swallowed. May cause central nervous system depression including headache, dizziness, drowsiness, muscular weakness, incoordination, slowed reaction time, fatigue blurred vision, slurred speech, giddiness, tremors and convulsions. May cause liver and kidney damage.

Chronic Effects/Carcinogenicity Prolonged or repeated exposure may cause reproductive system damage. Prolonged or repeated exposure may cause embryo and fetus toxicity.

Exposure Levels
No data available

Interactive effects
Skin disorders. Eye ailments.

Data limitations
No data available

Substances	CAS Number	Skin corrosion/irritation
Diethylene glycol	111-46-6	Non-irritating to the skin (Rabbit)
Cinnamaldehyde	104-55-2	Causes severe irritation and or burns (human)
Amine oxides, cocoalkyldimethyl	61788-90-7	Skin, rabbit: Causes moderate skin irritation.
Methanol	67-56-1	Non-irritating to the skin (Rabbit)
Benzaldehyde	100-52-7	Non-irritating to the skin (Rabbit)
Alcohols, C12-16, ethoxylated	68551-12-2	Causes skin irritation.
Sodium iodide	7681-82-5	Moderate dermal irritant (Rabbit)

Substances	CAS Number	Serious eye damage/irritation
Diethylene glycol	111-46-6	Non-irritating to the eye (Rabbit)
Cinnamaldehyde	104-55-2	Mild eye irritant. (human) (8 % solution)
Amine oxides, cocoalkyldimethyl	61788-90-7	Corrosive to eyes
Methanol	67-56-1	Non-irritating to the eye (Rabbit)
Benzaldehyde	100-52-7	Non-irritating to the eye (Rabbit)
Alcohols, C12-16, ethoxylated	68551-12-2	Causes severe eye irritation which may damage tissue.
Sodium iodide	7681-82-5	Moderately irritating to the eyes (Rabbit)

Substances	CAS Number	Skin Sensitization
Diethylene glycol	111-46-6	Did not cause sensitization on laboratory animals (guinea pig)
Cinnamaldehyde	104-55-2	Skin sensitizer in guinea pig.
Amine oxides, cocoalkyldimethyl	61788-90-7	No information available
Methanol	67-56-1	Did not cause sensitization on laboratory animals (guinea pig)
Benzaldehyde	100-52-7	Not sensitizing in Guinea Pigs (Guinea Pig Maximisation Test and Open Epicutaneous Test, Sensitizing in Draize Test and Freund's Complete Adjuvant Test)
Alcohols, C12-16, ethoxylated	68551-12-2	Did not cause sensitization on laboratory animals
Sodium iodide	7681-82-5	Patch test on human volunteers did not demonstrate sensitization properties

Substances	CAS Number	Respiratory Sensitization
Diethylene glycol	111-46-6	No information available
Cinnamaldehyde	104-55-2	No information available
Amine oxides, cocoalkyldimethyl	61788-90-7	No information available
Methanol	67-56-1	No information available
Benzaldehyde	100-52-7	No information available
Alcohols, C12-16, ethoxylated	68551-12-2	No information available

Sodium iodide	7681-82-5	No information available

Substances	CAS Number	Mutagenic Effects
Diethylene glycol	111-46-6	In vitro tests did not show mutagenic effects. In vivo tests did not show mutagenic effects.
Cinnamaldehyde	104-55-2	In vitro tests did not show mutagenic effects.
Amine oxides, cocoalkyldimethyl	61788-90-7	In vitro tests did not show mutagenic effects. In vivo tests did not show mutagenic effects. (similar substances)
Methanol	67-56-1	The weight of evidence from available in vitro and in vivo studies indicates that this substance is not expected to be mutagenic.
Benzaldehyde	100-52-7	Not mutagenic in AMES Test. Negative in the chromosomal aberration assay In vitro tests have shown mutagenic effects In vivo tests did not show mutagenic effects.
Alcohols, C12-16, ethoxylated	68551-12-2	Not regarded as mutagenic.
Sodium iodide	7681-82-5	In vitro tests did not show mutagenic effects. (similar substances)

Substances	CAS Number	Carcinogenic Effects
Diethylene glycol	111-46-6	Did not show carcinogenic effects in animal experiments (Rat)
Cinnamaldehyde	104-55-2	No information available
Amine oxides, cocoalkyldimethyl	61788-90-7	No information available
Methanol	67-56-1	No data of sufficient quality are available.
Benzaldehyde	100-52-7	Did not show carcinogenic effects in animal experiments (Rat) There was some evidence of carcinogenic activity in the forestomachs of mice.
Alcohols, C12-16, ethoxylated	68551-12-2	Not regarded as carcinogenic.
Sodium iodide	7681-82-5	No information available

Substances	CAS Number	Reproductive toxicity
Diethylene glycol	111-46-6	Animal testing did not show any effects on fertility. Did not show teratogenic effects in animal experiments.
Cinnamaldehyde	104-55-2	Did not show teratogenic effects in animal experiments.
Amine oxides, cocoalkyldimethyl	61788-90-7	Did not show teratogenic effects in animal experiments. When tested at maternally toxic doses, no adverse effects on teratogenicity or development were observed.
Methanol	67-56-1	Experiments have shown reproductive toxicity effects on laboratory animals
Benzaldehyde	100-52-7	Animal testing did not show any effects on fertility. Did not show teratogenic effects in animal experiments. (similar substances)
Alcohols, C12-16, ethoxylated	68551-12-2	Not regarded as a reproductive and developmental toxicant.
Sodium iodide	7681-82-5	Animal testing did not show any effects on fertility.

Substances	CAS Number	STOT - single exposure
Diethylene glycol	111-46-6	No significant toxicity observed in animal studies at concentration requiring classification.
Cinnamaldehyde	104-55-2	No information available
Amine oxides, cocoalkyldimethyl	61788-90-7	May cause respiratory irritation.
Methanol	67-56-1	May cause disorder and damage to the Central Nervous System (CNS)
Benzaldehyde	100-52-7	May cause respiratory irritation.
Alcohols, C12-16, ethoxylated	68551-12-2	No significant toxicity observed in animal studies at concentration requiring classification.
Sodium iodide	7681-82-5	No information available

Substances	CAS Number	STOT - repeated exposure
Diethylene glycol	111-46-6	Causes damage to organs through prolonged or repeated exposure: Kidney
Cinnamaldehyde	104-55-2	No significant toxicity observed in animal studies at concentration requiring classification.
Amine oxides, cocoalkyldimethyl	61788-90-7	No data of sufficient quality are available.
Methanol	67-56-1	No data of sufficient quality are available.
Benzaldehyde	100-52-7	No significant toxicity observed in animal studies at concentration requiring classification.
Alcohols, C12-16, ethoxylated	68551-12-2	No significant toxicity observed in animal studies at concentration requiring classification.
Sodium iodide	7681-82-5	Causes damage to organs through prolonged or repeated exposure: (Thyroid)

Substances	CAS Number	Aspiration hazard
Diethylene glycol	111-46-6	No information available
Cinnamaldehyde	104-55-2	Not applicable
Amine oxides, cocoalkyldimethyl	61788-90-7	No information available

Methanol	67-56-1	Not applicable
Benzaldehyde	100-52-7	Not applicable
Alcohols, C12-16, ethoxylated	68551-12-2	Not applicable
Sodium iodide	7681-82-5	Not applicable

12. Ecological Information

Ecotoxicity

Substance Ecotoxicity Data

Substances	CAS Number	Toxicity to Algae	Toxicity to Fish	Toxicity to Microorganisms	Toxicity to Invertebrates
Diethylene glycol	111-46-6	TGK (8d) 2700 mg/L (Scenedesmus quadricauda)	LC50 75200 mg/L (Pimephales promelas)	EC20 (30m) > 1995 mg/L (domestic activated sludge)	EC50 84000 mg/L (Daphnia magna) EC50 >10000 mg/L (Daphnia magna)
Cinnamaldehyde	104-55-2	EC50 (72 h) 2.1 mg/L (Skeletonema costatum)	LC50 (96 h) 2.38 mg/L (Scophthalmus maximus)	IC50 (48h) 131.2 mg/L (Tetrahymena pyriformis)	LC50 (48 h) 1.4 mg/L (Acartia tonsa)
Amine oxides, cocoalkyldimethyl	61788-90-7	ErC50 (72h) 0.29 mg/L (Selenastrum capricornutum) ErC50 (72h) 0.0235 mg/L (Scendesmus subspicatus) (similar substance)	LC50 (96h) 1.0–3.4 mg/L (Brachydanio rerio) LC50 (96h) 13.0 (Salmo gairdneri) LC50 (96h) 0.1-1 mg/L (Brachydanio rerio)	EC50 (3h) 240 mg/L (Pseudomonas putida) EC50 (3h) 13 mg/L (Activated sludge)	EC50 (48h) 2.9 mg/L (Daphnia magna) EC50 (48h) 0.083 mg/L (Daphnia magna) (similar substance)
Methanol	67-56-1	EC50 (96 h) =22000 mg/L (Pseudokirchnerella subcapitata) NOEC (8 d) =8000 mg/L (Scenedesmus quadricauda)	LC50 (96 h) =15400 mg/L (Lepomis macrochirus) EC50 (200 h) =14536 mg/L (Oryzias latipes)	IC50 (3h) > 1000 mg/L (activated sludge)	EC50 (96 h) =18260 mg/L (Dapnia magna) NOEC (21 d) =208 mg/L (Dapnia magna)
Benzaldehyde	100-52-7	NOEC (8d) 20 mg/L (Microcystis aeruginosa) NOEC (8d) 132 mg/L	LC50 (96 h) 1.07 mg/L (Lepomis macrochirus)	IC50 (3 h) 740 mg/L (Activated sludge)	EC50 (24 h) 50 mg/L (Daphnia magna)
Alcohols, C12-16, ethoxylated	68551-12-2	EC50 0.7 mg/L (Selenastrum capricornutum)	No information available	No information available	0.39 mg/L (Daphnia Magna)
Sodium iodide	7681-82-5	7 d Tox threshold: 2370 mg/L (Scenedesmus quadricauda, biomass) EC50(72h): 2588.7 mg/L (Skeletonema costatum)	LC50(96h): 3780 mg/L (Oncorhynchus mykiss) LC50(96h): > 100 mg/L (Scopthalmus maximus)	No information available	EC50(48h): 1.27 mg/L (Daphnia magna) EC50(48h): 575 mg/L (Acartia tonsa)

12.2. Persistence and degradability

No data is available on the product itself

Substances	CAS Number	Persistence and Degradability
Diethylene glycol	111-46-6	Readily biodegradable (90-100% @ 28d)
Cinnamaldehyde	104-55-2	Predicted to be readily biodegradable.
Amine oxides, cocoalkyldimethyl	61788-90-7	Readily biodegradable (81% @ 28d)
Methanol	67-56-1	Readily biodegradable (95% @ 20d)
Benzaldehyde	100-52-7	Readily biodegradable (>=95% @ 28d)
Alcohols, C12-16, ethoxylated	68551-12-2	No information available
Sodium iodide	7681-82-5	Not applicable

12.3. Bioaccumulative potential

No data is available on the product itself

Substances	CAS Number	Log Pow
Diethylene glycol	111-46-6	BCF: 100 (Leuciscus idus melanotus)
Cinnamaldehyde	104-55-2	Log Pow =1.4
Amine oxides, cocoalkyldimethyl	61788-90-7	Log Kow = 7.5
Methanol	67-56-1	Not Bioaccumulative; BCF=1
Benzaldehyde	100-52-7	Log Pow =1.1
Alcohols, C12-16, ethoxylated	68551-12-2	No information available
Sodium iodide	7681-82-5	-1.301

12.4. Mobility in soil

Substances	CAS Number	Mobility
Diethylene glycol	111-46-6	No information available
Cinnamaldehyde	104-55-2	No information available
Amine oxides, cocoalkyldimethyl	61788-90-7	No information available
Methanol	67-56-1	No information available
Benzaldehyde	100-52-7	No information available
Alcohols, C12-16, ethoxylated	68551-12-2	No information available
Sodium iodide	7681-82-5	No information available

12.6. Other adverse effects

Endocrine Disruptor Information

This product does not contain any known or suspected endocrine disruptors

13. Disposal Considerations

Safe handling and disposal methods

Incineration recommended in approved incinerator according to federal, state, and local regulations. Substance should NOT be deposited into a sewage facility.

Disposal of any contaminated packaging

Follow all applicable national or local regulations. Contaminated packaging may be disposed of by: rendering packaging incapable of containing any substance, or treating packaging to remove residual contents, or treating packaging to make sure the residual contents are no longer hazardous, or by disposing of packaging into commercial waste collection.

Environmental regulations

Not applicable

14. Transport Information

Transportation Information

Australia ADG

UN Number UN1993
UN proper shipping name: Flammable Liquid, N.O.S. (Contains Methanol)
Transport Hazard Class(es): 3
Packing Group: III
Environmental Hazards: Not applicable

IMDG/IMO

UN Number UN1993
UN proper shipping name: Flammable Liquid, N.O.S. (Contains Methanol)
Transport Hazard Class(es): 3
Packing Group: III
Environmental Hazards: Not applicable
EMS: EmS F-E, S-E

IATA/ICAO

UN Number UN1993
UN proper shipping name: Flammable Liquid, N.O.S. (Contains Methanol)
Transport Hazard Class(es): 3
Packing Group: III
Environmental Hazards: Not applicable

Special precautions during transport

None

HazChem Code

•3Y

15. Regulatory Information

Safety, health and environmental regulations specific for the product

International Inventories

Australian AICS Inventory	All components are listed on the AICS or are subject to a relevant exemption, permit, or assessment certificate.
New Zealand Inventory of Chemicals	All components are listed on the NZIoC or are subject to a relevant exemption, permit, or assessment certificate.
EINECS (European Inventory of Existing Chemical Substances)	This product does not comply with EINECS
US TSCA Inventory	All components listed on inventory or are exempt.
Canadian Domestic Substances List (DSL)	All components listed on inventory or are exempt.

Poisons Schedule number

None Allocated

International Agreements

Montreal Protocol - Ozone Depleting Substances:	Does not apply
Stockholm Convention - Persistent Organic Pollutants:	Does not apply
Rotterdam Convention - Prior Informed Consent:	Does not apply
Basel Convention - Hazardous Waste:	Does not apply

16. Other information

Date of preparation or review

Revision Date: 09-Nov-2017

Revision Note

SDS sections updated:
14

Full text of H-Statements referred to under sections 2 and 3

H225 - Highly flammable liquid and vapor
H226 - Flammable liquid and vapor
H227 - Combustible liquid
H301 - Toxic if swallowed
H302 - Harmful if swallowed
H311 - Toxic in contact with skin
H312 - Harmful in contact with skin
H315 - Causes skin irritation
H317 - May cause an allergic skin reaction
H318 - Causes serious eye damage
H319 - Causes serious eye irritation
H331 - Toxic if inhaled
H332 - Harmful if inhaled
H335 - May cause respiratory irritation
H370 - Causes damage to organs
H372 - Causes damage to organs through prolonged or repeated exposure
H373 - May cause damage to organs through prolonged or repeated exposure
H400 - Very toxic to aquatic life
H401 - Toxic to aquatic life
H412 - Harmful to aquatic life with long lasting effects

Additional information

For additional information on the use of this product, contact your local Halliburton representative.

For questions about the Safety Data Sheet for this or other Halliburton products, contact Chemical Stewardship at 1-580-251-4335.

Key abreviations or acronyms used

bw – body weight
CAS – Chemical Abstracts Service
EC50 – Effective Concentration 50%
LC50 – Lethal Concentration 50%
LD50 – Lethal Dose 50%
LL50 – Lethal Loading 50%
mg/kg – milligram/kilogram
mg/L – milligram/liter
NOEC – No Observed Effect Concentration
OEL – Occupational Exposure Limit
PBT – Persistent Bioaccumulative and Toxic
ppm – parts per million
STEL – Short Term Exposure Limit
TWA – Time-Weighted Average
vPvB – very Persistent and very Bioaccumulative
h - hour
mg/m^3 - milligram/cubic meter
mm - millimeter
mmHg - millimeter mercury
w/w - weight/weight
d - day

Key literature references and sources for data

www.ChemADVISOR.com/
NZ CCID

Disclaimer Statement

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End of Safety Data Sheet

HALLIBURTON

SAFETY DATA SHEET

DCA-19001

Revision Date: 05-Jul-2016 **Revision Number:** 20

1. Product Identifier & Identity for the Chemical

Statement of Hazardous Nature Hazardous according to the criteria of the 3rd Revised Edition of the Globally Harmonised System of Classification and Labelling of Chemicals (GHS), Non-Dangerous Goods according to the criteria of ADG.

1.1. Product Identifier

Product Name DCA-19001

Other means of Identification

Synonyms None

Hazardous Material Number: HM007662

Recommended use of the chemical and restrictions on use

Recommended Use Crosslinker

Uses advised against No information available

Supplier's name, address and phone number

Manufacturer/Supplier Halliburton Australia Pty. Ltd.
15 Marriott Road
Jandakot
WA 6164
Australia

ACN Number: 009 000 775
Telephone Number: + 61 1 800 686 951
Fax Number: 61 (08) 9455 5300

E-mail Address fdunexchem@halliburton.com

Emergency phone number

+ 61 1 800 686 951

Australian Poisons Information Centre
24 Hour Service: - 13 11 26
Police or Fire Brigade: - 000 (exchange): - 1100

2. Hazard Identification

Statement of Hazardous Nature Hazardous according to the criteria of the 3rd Revised Edition of the Globally Harmonised System of Classification and Labelling of Chemicals (GHS), Non-Dangerous Goods according to the criteria of ADG.

Classification of the hazardous chemical

Serious Eye Damage/Irritation	Category 2 - H319
Reproductive Toxicity	Category 2 - H361

Label elements, including precautionary statements

Hazard pictograms



Signal Word Danger

Hazard Statements:
H319 - Causes serious eye irritation
H361 - Suspected of damaging fertility or the unborn child

Precautionary Statements

Prevention
P201 - Obtain special instructions before use
P202 - Do not handle until all safety precautions have been read and understood
P264 - Wash face, hands and any exposed skin thoroughly after handling
P280 - Wear eye protection/face protection
P281 - Use personal protective equipment as required

Response
P305 + P351 + P338 - IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing
P337 + P313 - If eye irritation persists: Get medical advice/attention
P308 + P313 - IF exposed or concerned: Get medical advice/attention

Storage
P405 - Store locked up

Disposal
P501 - Dispose of contents/container in accordance with local/regional/national/international regulations

Contains

Substances	**CAS Number**
Disodium octaborate tetrahydrate	12008-41-2

Other hazards which do not result in classification
This substance is not considered to be persistent, bioaccumulating nor toxic (PBT).
This substance is not considered to be very persistent nor very bioaccumulating (vPvB).

For the full text of the H-phrases mentioned in this Section, see Section 16

3. Composition/information on Ingredients

Substances	CAS Number	PERCENT (w/w)	GHS Classification - Australia
Disodium octaborate tetrahydrate	12008-41-2	60 - 100%	Eye Irrit. 2A (H319) Repr. 2 (H361)

4. First aid measures

Description of necessary first aid measures

Inhalation If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.

Eyes In case of contact, immediately flush eyes with plenty of water for at least 15 minutes and get medical attention if irritation persists.

Skin Wash with soap and water. Get medical attention if irritation persists.

Ingestion Do NOT induce vomiting. Give nothing by mouth. Obtain immediate medical attention.

Symptoms caused by exposure
Causes eye irritation Potential reproductive hazard. May cause birth defects.

Medical Attention and Special Treatment
Notes to Physician Treat symptomatically

5. Fire Fighting Measures

Suitable extinguishing equipment
Suitable Extinguishing Media
Water fog, carbon dioxide, foam, dry chemical.
Extinguishing media which must not be used for safety reasons
None known.

Specific hazards arising from the chemical
Special exposure hazards in a fire
None anticipated

Special protective equipment and precautions for fire fighters
Special protective equipment for firefighters
Full protective clothing and approved self-contained breathing apparatus required for fire fighting personnel.

6. Accidental release measures

6.1. Personal precautions, protective equipment and emergency procedures
Use appropriate protective equipment. Avoid creating and breathing dust. Avoid contact with skin, eyes and clothing. Ensure adequate ventilation. Evacuate all persons from the area.

6.2. Environmental precautions
Prevent from entering sewers, waterways, or low areas.

6.3. Methods and material for containment and cleaning up
Scoop up and remove.

7. Handling and storage

7.1. Precautions for safe handling
Handling Precautions
Avoid creating or inhaling dust. Ensure adequate ventilation. Avoid contact with eyes, skin, or clothing. Use appropriate protective equipment.
Hygiene Measures
Handle in accordance with good industrial hygiene and safety practice.

7.2. Conditions for safe storage, including any incompatibilities
Storage Information
Store in a cool, dry location. Product has a shelf life of 60 months.
Other Guidelines
No information available

8. Exposure Controls/Personal Protection

Control parameters - exposure standards, biological monitoring
Exposure Limits

Substances	CAS Number	Australia NOHSC	ACGIH TLV-TWA
Disodium octaborate tetrahydrate	12008-41-2	Not applicable	2 mg/m^3

Appropriate engineering controls
Engineering Controls Use in a well ventilated area.

Personal protective equipment (PPE)

Personal Protective Equipment	If engineering controls and work practices cannot prevent excessive exposures, the selection and proper use of personal protective equipment should be determined by an industrial hygienist or other qualified professional based on the specific application of this product.
Respiratory Protection	If engineering controls and work practices cannot keep exposure below occupational exposure limits or if exposure is unknown, wear a NIOSH certified, European Standard EN 149, AS/NZS 1715:2009, or equivalent respirator when using this product. Selection of and instruction on using all personal protective equipment, including respirators, should be performed by an Industrial Hygienist or other qualified professional. Dust/mist respirator. (N95, P2/P3)
Hand Protection	Impervious rubber gloves.
Skin Protection	Normal work coveralls.
Eye Protection	Dust proof goggles.
Other Precautions	None known.
Environmental Exposure Controls	Do not allow material to contaminate ground water system

9. Physical and Chemical Properties

9.1. Information on basic physical and chemical properties

Physical State:	Solid	**Color**	White
Odor:	Odorless	**Odor Threshold:**	No information available

Property Remarks/ - Method	Values
pH:	7.3
Freezing Point / Range	No data available
Melting Point / Range	> 1000 °C
Boiling Point / Range	No data available
Flash Point	No data available
Evaporation rate	No data available
Vapor Pressure	9.9E-17 pa @ 25°C
Vapor Density	No data available
Specific Gravity	1.7
Water Solubility	Soluble in water
Solubility in other solvents	No data available
Partition coefficient: n-octanol/water	No data available
Autoignition Temperature	No data available
Decomposition Temperature	No data available
Viscosity	No data available
Explosive Properties	No information available
Oxidizing Properties	No information available

9.2. Other information

VOC Content (%)	No data available

10. Stability and Reactivity

10.1. Reactivity
Not expected to be reactive.
10.2. Chemical stability
Stable
10.3. Possibility of hazardous reactions
Will Not Occur
10.4. Conditions to avoid
None anticipated
10.5. Incompatible materials
None known.
10.6. Hazardous decomposition products
None known.

11. Toxicological Information

Information on routes of exposure

Principle Route of Exposure Eye or skin contact, inhalation.

Symptoms related to exposure

Most Important Symptoms/Effects

Causes eye irritation Potential reproductive hazard. May cause birth defects.

Numerical measures of toxicity

Toxicology data for the components

Substances	CAS Number	LD50 Oral	LD50 Dermal	LC50 Inhalation
Disodium octaborate tetrahydrate	12008-41-2	2550 mg/kg-bw (rat) (similar substance)	>2000 mg/kg-bw (rat) (similar substance)	>2 mg/L (dust, rat, 4 h) (similar substance)

Immediate, delayed and chronic health effects from exposure

Inhalation May cause respiratory irritation.

Eye Contact Causes eye irritation.

Skin Contact May cause mild skin irritation.

Ingestion May cause abdominal pain, vomiting, nausea, and diarrhea.

Chronic Effects/Carcinogenicity Prolonged or repeated exposure may cause reproductive system damage. Prolonged or repeated exposure may cause embryo and fetus toxicity.

Exposure Levels

No data available

Interactive effects

None known.

Data limitations

No data available

Substances	CAS Number	Skin corrosion/irritation
Disodium octaborate tetrahydrate	12008-41-2	Not irritating to skin in rabbits. (similar substances)

Substances	CAS Number	Serious eye damage/irritation
Disodium octaborate tetrahydrate	12008-41-2	Eye, rabbit: Causes moderate eye irritation

Substances	CAS Number	Skin Sensitization
Disodium octaborate tetrahydrate	12008-41-2	Did not cause sensitization on laboratory animals (guinea pig)

Substances	CAS Number	Respiratory Sensitization
Disodium octaborate tetrahydrate	12008-41-2	No information available

Substances	CAS Number	Mutagenic Effects
Disodium octaborate tetrahydrate	12008-41-2	In vitro tests did not show mutagenic effects. In vivo tests did not show mutagenic effects. (similar substances)

Substances	CAS Number	Carcinogenic Effects
Disodium octaborate tetrahydrate	12008-41-2	Did not show carcinogenic effects in animal experiments (similar substances)

Substances	CAS Number	Reproductive toxicity
Disodium octaborate tetrahydrate	12008-41-2	May impair fertility May cause birth defects (similar substances)

Substances	CAS Number	STOT - single exposure

Disodium octaborate tetrahydrate	12008-41-2	No significant toxicity observed in animal studies at concentration requiring classification. (similar substances)

Substances	CAS Number	STOT - repeated exposure
Disodium octaborate tetrahydrate	12008-41-2	No significant toxicity observed in animal studies at concentration requiring classification. (similar substances)

Substances	CAS Number	Aspiration hazard
Disodium octaborate tetrahydrate	12008-41-2	Not applicable

12. Ecological Information

Ecotoxicity

Product Ecotoxicity Data

No data available

Substance Ecotoxicity Data

Substances	CAS Number	Toxicity to Algae	Toxicity to Fish	Toxicity to Microorganisms	Toxicity to Invertebrates
Disodium octaborate tetrahydrate	12008-41-2	EC10 (3 d) 96.5 mg/L (Pseudokirchneriella subcapitata)	LC50 (96 h) 314.6 mg/L (Pimephales promelas) NOEC (34 d) 25.2 mg/L (Danio rerio)	EC50 (3 h) >39371 mg/L (activated sludge)	NOEC (21 d) 42.5 mg/L (Daphnia magna)

12.2. Persistence and degradability

Substances	CAS Number	Persistence and Degradability
Disodium octaborate tetrahydrate	12008-41-2	The methods for determining biodegradability are not applicable to inorganic substances.

12.3. Bioaccumulative potential

Substances	CAS Number	Log Pow
Disodium octaborate tetrahydrate	12008-41-2	No information available

12.4. Mobility in soil

Substances	CAS Number	Mobility
Disodium octaborate tetrahydrate	12008-41-2	No information available

12.6. Other adverse effects

Endocrine Disruptor Information

This product does not contain any known or suspected endocrine disruptors

13. Disposal Considerations

Safe handling and disposal methods

Bury in a licensed landfill according to federal, state, and local regulations.

Disposal of any contaminated packaging

Follow all applicable national or local regulations.

Environmental regulations

Not applicable

14. Transport Information

Transportation Information

Australia ADG

UN Number	Not restricted
UN proper shipping name:	Not restricted
Transport Hazard Class(es):	Not applicable
Packing Group:	Not applicable
Environmental Hazards:	Not applicable

IMDG/IMO

UN Number	Not restricted
UN proper shipping name:	Not restricted
Transport Hazard Class(es):	Not applicable
Packing Group:	Not applicable
Environmental Hazards:	Not applicable

IATA/ICAO

UN Number	Not restricted
UN proper shipping name:	Not restricted
Transport Hazard Class(es):	Not applicable
Packing Group:	Not applicable
Environmental Hazards:	Not applicable

Special precautions during transport
None

HazChem Code
None Allocated

15. Regulatory Information

Safety, health and environmental regulations specific for the product

International Inventories

Australian AICS Inventory	All components are listed on the AICS or are subject to a relevant exemption, permit, or assessment certificate.
New Zealand Inventory of Chemicals	All components are listed on the NZIoC or are subject to a relevant exemption, permit, or assessment certificate.
EINECS (European Inventory of Existing Chemical Substances)	This product, and all its components, complies with EINECS
US TSCA Inventory	All components listed on inventory or are exempt.
Canadian Domestic Substances List (DSL)	All components listed on inventory or are exempt.

Poisons Schedule number
S5

International Agreements

Montreal Protocol - Ozone Depleting Substances:	Does not apply
Stolkhom Convention - Persistent Organic Pollutants:	Does not apply
Rotterdam Convention - Prior Informed Consent:	Does not apply
Basel Convention - Hazardous Waste:	Does not apply

16. Other information

Date of preparation or review

Revision Date: 05-Jul-2016

Revision Note
SDS sections updated: 2

Full text of H-Statements referred to under sections 2 and 3
H319 - Causes serious eye irritation

H361 - Suspected of damaging fertility or the unborn child

Additional information

For additional information on the use of this product, contact your local Halliburton representative.

For questions about the Safety Data Sheet for this or other Halliburton products, contact Chemical Stewardship at 1-580-251-4335.

Key abreviations or acronyms used

bw – body weight
CAS – Chemical Abstracts Service
EC50 – Effective Concentration 50%
LC50 – Lethal Concentration 50%
LD50 – Lethal Dose 50%
LL50 – Lethal Loading 50%
mg/kg – milligram/kilogram
mg/L – milligram/liter
NOEC – No Observed Effect Concentration
OEL – Occupational Exposure Limit
PBT – Persistent Bioaccumulative and Toxic
ppm – parts per million
STEL – Short Term Exposure Limit
TWA – Time-Weighted Average
vPvB – very Persistent and very Bioaccumulative
h - hour
mg/m^3 - milligram/cubic meter
mm - millimeter
mmHg - millimeter mercury
w/w - weight/weight
d - day

Key literature references and sources for data

www.ChemADVISOR.com/
OSHA
ECHA C&L

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End of Safety Data Sheet

HALLIBURTON

SAFETY DATA SHEET

DCA-19002

Revision Date: 05-Jul-2016 **Revision Number:** 19

1. Product Identifier & Identity for the Chemical

Statement of Hazardous Nature Hazardous according to the criteria of the 3rd Revised Edition of the Globally Harmonised System of Classification and Labelling of Chemicals (GHS), Non-Dangerous Goods according to the criteria of ADG.

1.1. Product Identifier

Product Name DCA-19002

Other means of Identification

Synonyms None

Hazardous Material Number: HM007663

Recommended use of the chemical and restrictions on use

Recommended Use Crosslinker

Uses advised against No information available

Supplier's name, address and phone number

Manufacturer/Supplier Halliburton Australia Pty. Ltd.
15 Marriott Road
Jandakot
WA 6164
Australia

ACN Number: 009 000 775
Telephone Number: + 61 1 800 686 951
Fax Number: 61 (08) 9455 5300

E-mail Address fdunexchem@halliburton.com

Emergency phone number

+ 61 1 800 686 951

Australian Poisons Information Centre
24 Hour Service: - 13 11 26
Police or Fire Brigade: - 000 (exchange): - 1100

2. Hazard Identification

Statement of Hazardous Nature Hazardous according to the criteria of the 3rd Revised Edition of the Globally Harmonised System of Classification and Labelling of Chemicals (GHS), Non-Dangerous Goods according to the criteria of ADG.

Classification of the hazardous chemical

Serious Eye Damage/Irritation	Category 2 - H319
Reproductive Toxicity	Category 1B - H360
Specific Target Organ Toxicity - (Repeated Exposure)	Category 1 - H372

Label elements, including precautionary statements

Hazard pictograms



Signal Word Danger

Hazard Statements:
H319 - Causes serious eye irritation
H360 - May damage fertility or the unborn child
H372 - Causes damage to organs through prolonged or repeated exposure

Precautionary Statements

Prevention
P201 - Obtain special instructions before use
P202 - Do not handle until all safety precautions have been read and understood
P260 - Do not breathe dust/fume/gas/mist/vapors/spray
P264 - Wash face, hands and any exposed skin thoroughly after handling
P270 - Do not eat, drink or smoke when using this product
P280 - Wear eye protection/face protection
P281 - Use personal protective equipment as required

Response
P305 + P351 + P338 - IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing
P337 + P313 - If eye irritation persists: Get medical advice/attention
P308 + P313 - IF exposed or concerned: Get medical advice/attention
P314 - Get medical attention/advice if you feel unwell

Storage
P405 - Store locked up

Disposal
P501 - Dispose of contents/container in accordance with local/regional/national/international regulations

Contains

Substances	**CAS Number**
Ulexite	1319-33-1
Ethylene glycol	107-21-1
Crystalline silica, quartz	14808-60-7

Other hazards which do not result in classification
This mixture contains no substance considered to be persistent, bioaccumulating nor toxic (PBT).
This mixture contains no substance considered to be very persistent nor very bioaccumulating (vPvB).

For the full text of the H-phrases mentioned in this Section, see Section 16

3. Composition/information on Ingredients

Substances	CAS Number	PERCENT (w/w)	GHS Classification - Australia
Ulexite	1319-33-1	30 - 60%	Eye Irrit. 2A (H319) Repr. 1 (H360)
Ethylene glycol	107-21-1	10 - 30%	Acute Tox. 4 (H302) STOT RE 1 (H372)
Crystalline silica, quartz	14808-60-7	1 - 5%	Carc. 2 (H351) STOT RE 1 (H372)

4. First aid measures

Description of necessary first aid measures

Inhalation If inhaled, move victim to fresh air and seek medical attention.

Eyes	Immediately flush eyes with large amounts of water for at least 15 minutes. Get immediate medical attention.
Skin	Wash off immediately with soap and plenty of water for at least 15 minutes while removing all contaminated clothing and shoes.
Ingestion	Do NOT induce vomiting. Give nothing by mouth. Obtain immediate medical attention.

Symptoms caused by exposure

Causes eye irritation Potential reproductive hazard. May cause birth defects. Prolonged or repeated exposure may cause damage to organs. Breathing crystalline silica can cause lung disease, including silicosis and lung cancer. Crystalline silica has also been associated with scleroderma and kidney disease.

Medical Attention and Special Treatment

Notes to Physician Treat symptomatically

5. Fire Fighting Measures

Suitable extinguishing equipment

Suitable Extinguishing Media

Water fog, carbon dioxide, foam, dry chemical.

Extinguishing media which must not be used for safety reasons

None known.

Specific hazards arising from the chemical

Special exposure hazards in a fire

Decomposition in fire may produce harmful gases.

Special protective equipment and precautions for fire fighters

Special protective equipment for firefighters

Full protective clothing and approved self-contained breathing apparatus required for fire fighting personnel.

6. Accidental release measures

6.1. Personal precautions, protective equipment and emergency procedures

Use appropriate protective equipment. Avoid contact with skin, eyes and clothing. Avoid breathing vapors. Ensure adequate ventilation. Evacuate all persons from the area.

6.2. Environmental precautions

Prevent from entering sewers, waterways, or low areas. Consult local authorities.

6.3. Methods and material for containment and cleaning up

Contain spill with sand or other inert materials. Scoop up and remove. Isolate spill and stop leak where safe.

7. Handling and storage

7.1. Precautions for safe handling

Handling Precautions

Avoid contact with eyes, skin, or clothing. Avoid breathing vapors. Avoid breathing mist. This product contains quartz, cristobalite, and/or tridymite which may become airborne without a visible cloud if this product becomes dry. Avoid breathing or creating dust. Use only with adequate ventilation to keep exposures below recommended exposure limits. Wear a NIOSH certified, European Standard EN 149, or equivalent respirator when using dried product. Ensure adequate ventilation. Material is slippery underfoot. Use appropriate protective equipment.

Hygiene Measures

Handle in accordance with good industrial hygiene and safety practice.

7.2. Conditions for safe storage, including any incompatibilities

Storage Information

Store away from oxidizers. Store in a cool well ventilated area. Keep container closed when not in use.

Other Guidelines

No information available

8. Exposure Controls/Personal Protection

Control parameters - exposure standards, biological monitoring

Exposure Limits

Substances	CAS Number	Australia NOHSC	ACGIH TLV-TWA
Ulexite	1319-33-1	Not applicable	Not applicable
Ethylene glycol	107-21-1	TWA: 10 mg/m³ TWA: 20 ppm TWA: 52 mg/m³ STEL: 40 ppm STEL: 104 mg/m³	Ceiling: 100 mg/m³ (aerosol only)
Crystalline silica, quartz	14808-60-7	TWA: 0.1 mg/m³	TWA: 0.025 mg/m³

Appropriate engineering controls

Engineering Controls Use in a well ventilated area.

Personal protective equipment (PPE)

Personal Protective Equipment If engineering controls and work practices cannot prevent excessive exposures, the selection and proper use of personal protective equipment should be determined by an industrial hygienist or other qualified professional based on the specific application of this product.

Respiratory Protection If engineering controls and work practices cannot keep exposure below occupational exposure limits or if exposure is unknown, wear a NIOSH certified, European Standard EN 149, AS/NZS 1715:2009, or equivalent respirator when using this product. Selection of and instruction on using all personal protective equipment, including respirators, should be performed by an Industrial Hygienist or other qualified professional.
Organic vapor respirator.

Hand Protection Rubber gloves.
Skin Protection Rubber apron.
Eye Protection Chemical goggles; also wear a face shield if splashing hazard exists.
Other Precautions None known.
Environmental Exposure Controls Do not allow material to contaminate ground water system

9. Physical and Chemical Properties

9.1. Information on basic physical and chemical properties

Physical State: Liquid
Odor: Odorless
Color Milky white
Odor Threshold: No information available

Property Remarks/ - Method	Values
pH:	6.5 - 7.5
Freezing Point / Range	-34 °C
Melting Point / Range	No data available
Boiling Point / Range	No data available
Flash Point	No data available
Evaporation rate	No data available
Vapor Pressure	No data available
Vapor Density	No data available
Specific Gravity	1.45
Water Solubility	Soluble in water
Solubility in other solvents	No data available
Partition coefficient: n-octanol/water	No data available
Autoignition Temperature	No data available
Decomposition Temperature	No data available
Viscosity	No data available
Explosive Properties	No information available
Oxidizing Properties	No information available

9.2. Other information

VOC Content (%) No data available

10. Stability and Reactivity

10.1. Reactivity

Not expected to be reactive.

10.2. Chemical stability

Stable

10.3. Possibility of hazardous reactions

Will Not Occur

10.4. Conditions to avoid

None anticipated

10.5. Incompatible materials

Strong oxidizers.

10.6. Hazardous decomposition products

Carbon monoxide and carbon dioxide.

11. Toxicological Information

Information on routes of exposure

Principle Route of Exposure Eye or skin contact, inhalation.

Symptoms related to exposure

Most Important Symptoms/Effects

Causes eye irritation Potential reproductive hazard. May cause birth defects. Prolonged or repeated exposure may cause damage to organs. Breathing crystalline silica can cause lung disease, including silicosis and lung cancer. Crystalline silica has also been associated with scleroderma and kidney disease.

Numerical measures of toxicity

Toxicology data for the components

Substances	CAS Number	LD50 Oral	LD50 Dermal	LC50 Inhalation
Ulexite	1319-33-1	3493-6080 mg/kg (Rat) (similar substance) 3450 mg/kg (Male Rat) (similar substance)	> 2000 mg/kg (Rabbit) (similar substance)	> 2 mg/L (Rat) 4h (similar substance) > 2.12 mg/L (Rat) 4h (similar substance) > 2.04 mg/L (Rat) 4h (similar substance)
Ethylene glycol	107-21-1	4000 mg/kg (Rat) 7712 mg/kg (Rat) > 10000 mg/kg (Rat) 1670 mg/kg (Cat) 1400 – 1600 mg/kg (Human)	9530 µL/kg (Rabbit) > 3500 mg/kg (Mouse)	> 2.5 mg/L (Rat) 6h (saturated concentration)
Crystalline silica, quartz	14808-60-7	> 15000 mg/kg (human)	No information available	No data available

Immediate, delayed and chronic health effects from exposure

Inhalation May cause respiratory irritation. In high air concentrations: May cause central nervous system depression including headache, dizziness, drowsiness, incoordination, slowed reaction time, slurred speech, giddiness and unconsciousness. Inhaled crystalline silica in the form of quartz or cristobalite from occupational sources is carcinogenic to humans (IARC, Group 1). There is sufficient evidence in experimental animals for the carcinogenicity of tridymite (IARC, Group 2A).

Breathing silica dust may cause irritation of the nose, throat, and respiratory passages. Breathing silica dust may not cause noticeable injury or illness even though permanent lung damage may be occurring. Inhalation of dust may also have serious chronic health effects (See "Chronic Effects/Carcinogenicity" subsection below).

Eye Contact Causes eye irritation.

Skin Contact May cause mild skin irritation.

Ingestion May be harmful if swallowed. In large amounts: May cause abdominal pain, vomiting,

nausea, and diarrhea. May cause heart, kidney and brain disorders.

Chronic Effects/Carcinogenicity Prolonged or repeated exposure may cause embryo and fetus toxicity. Prolonged or repeated exposure may cause reproductive system damage. Repeated overexposure may cause liver and kidney effects. Silicosis: Excessive inhalation of respirable crystalline silica dust may cause a progressive, disabling, and sometimes-fatal lung disease called silicosis. Symptoms include cough, shortness of breath, wheezing, non-specific chest illness, and reduced pulmonary function. This disease is exacerbated by smoking. Individuals with silicosis are predisposed to develop tuberculosis.

See "Inhalation" subsection above with respect to silicosis, cancer status and other data with possible relevance to human health. There is some evidence that breathing respirable crystalline silica or the disease silicosis is associated with an increased incidence of significant disease endpoints such as scleroderma (an immune system disorder manifested by scarring of the lungs, skin, and other internal organs) and kidney disease.

Exposure Levels
No data available

Interactive effects
Eye ailments. Skin disorders. Liver and kidney disorders. Individuals with respiratory disease, including but not limited to asthma and bronchitis, or subject to eye irritation, should not be exposed to quartz dust.

Data limitations
No data available

Substances	CAS Number	Skin corrosion/irritation
Ulexite	1319-33-1	Non-irritating to the skin (Rabbit) (similar substances)
Ethylene glycol	107-21-1	Non-irritating to the skin (Rabbit)
Crystalline silica, quartz	14808-60-7	Non-irritating to the skin

Substances	CAS Number	Serious eye damage/irritation
Ulexite	1319-33-1	Causes moderate eye irritation (Rabbit) (similar substances)
Ethylene glycol	107-21-1	Non-irritating to the eye (Rabbit)
Crystalline silica, quartz	14808-60-7	Mechanical irritation of the eyes is possible. No information available

Substances	CAS Number	Skin Sensitization
Ulexite	1319-33-1	Did not cause sensitization on laboratory animals (guinea pig) (similar substances)
Ethylene glycol	107-21-1	Did not cause sensitization on laboratory animals (guinea pig) Patch test on human volunteers did not demonstrate sensitization properties
Crystalline silica, quartz	14808-60-7	No information available.

Substances	CAS Number	Respiratory Sensitization
Ulexite	1319-33-1	No information available
Ethylene glycol	107-21-1	No information available
Crystalline silica, quartz	14808-60-7	No information available

Substances	CAS Number	Mutagenic Effects
Ulexite	1319-33-1	In vitro tests did not show mutagenic effects (similar substances)
Ethylene glycol	107-21-1	In vitro tests did not show mutagenic effects. In vivo tests did not show mutagenic effects.
Crystalline silica, quartz	14808-60-7	Not regarded as mutagenic.

Substances	CAS Number	Carcinogenic Effects
Ulexite	1319-33-1	Did not show carcinogenic effects in animal experiments (similar substances)
Ethylene glycol	107-21-1	Did not show carcinogenic effects in animal experiments
Crystalline silica, quartz	14808-60-7	Contains crystalline silica which may cause silicosis, a delayed and progressive lung disease. The IARC and NTP have determined there is sufficient evidence in humans of the carcinogenicity of crystalline silica with repeated respiratory exposure. Based on available scientific evidence, this

		substance is a threshold carcinogen with a mode of action involving indirect genotoxicity secondary to lung injury.

Substances	CAS Number	Reproductive toxicity
Ulexite	1319-33-1	Experiments have shown reproductive toxicity effects on laboratory animals (similar substances)
Ethylene glycol	107-21-1	Fetotoxic and teratogenic effects observed in experimental animals at concentrations that did not produce maternal toxicity.
Crystalline silica, quartz	14808-60-7	No information available

Substances	CAS Number	STOT - single exposure
Ulexite	1319-33-1	None under normal use conditions
Ethylene glycol	107-21-1	No significant toxicity observed in animal studies at concentration requiring classification.
Crystalline silica, quartz	14808-60-7	No significant toxicity observed in animal studies at concentration requiring classification.

Substances	CAS Number	STOT - repeated exposure
Ulexite	1319-33-1	None under normal use conditions
Ethylene glycol	107-21-1	Causes damage to organs through prolonged or repeated exposure: (Kidney)
Crystalline silica, quartz	14808-60-7	Causes damage to organs through prolonged or repeated exposure if inhaled: (Lungs)

Substances	CAS Number	Aspiration hazard
Ulexite	1319-33-1	Not applicable
Ethylene glycol	107-21-1	No information available
Crystalline silica, quartz	14808-60-7	Not applicable

12. Ecological Information

Ecotoxicity

Product Ecotoxicity Data

No data available

Substance Ecotoxicity Data

Substances	CAS Number	Toxicity to Algae	Toxicity to Fish	Toxicity to Microorganisms	Toxicity to Invertebrates
Ulexite	1319-33-1	EC50 (72h) 1398.64 mg/L (Skeletonema costatum)	LC50 (96h) > 320 mg/L (Scophthalmus maximus) LC50 (96h) > 1100 mg/L (Oncorhynchus mykiss) LC50 (96h) > 1021 mg/L (Lepomis macrochirus) LD50 (28d) 65 mg/L (Oncorhynchus mykiss)	No information available	EC50 (48h) 7341.67 mg/L (Acartia tonsa) EC50 (48h) 133 mg/L (Daphnia magna)
Ethylene glycol	107-21-1	EC50 6500 - 13000 mg/L (Pseudokirchneriella subcapitata) TGK (8d) > 10000 mg/L (Scenedesmus quadricauda)	LC50 41000 mg/L (Oncorhynchus mykiss) LC50 (96h) 72860 mg/L (Pimephales promelas) NOEC (7d) 15380 mg/L (mortality) (Pimephales promelas)	TTC (16h) > 10000 mg/L (Pseudomonas putida) EC20 (30 m) > 1995 mg/L (activated sludge, domestic) (similar substance)	EC50 46300 mg/L (Daphnia magna) EC50 (48h) >100 mg/L (Daphnia magna) NOEC (7d) 8590 mg/L (reproduction) (Ceriodaphnia dubia)
Crystalline silica, quartz	14808-60-7	EC50 (72 h) =440 mg/L (Selenastrum capricornutum)	LL0 (96 h) =10000 mg/L (Danio rerio)	No information available	LL50 (24 h) >10000 mg/L (Daphnia magna)

12.2. Persistence and degradability

Substances	CAS Number	Persistence and Degradability
Ulexite	1319-33-1	The methods for determining biodegradability are not applicable to inorganic substances.
Ethylene glycol	107-21-1	Readily biodegradable (100% @ 10d)
Crystalline silica, quartz	14808-60-7	The methods for determining biodegradability are not applicable to inorganic substances.

12.3. Bioaccumulative potential

Substances	CAS Number	Log Pow

Ulexite	1319-33-1	0.175
Ethylene glycol	107-21-1	-1.36
Crystalline silica, quartz	14808-60-7	No information available

12.4. Mobility in soil

Substances	CAS Number	Mobility
Ulexite	1319-33-1	No information available
Ethylene glycol	107-21-1	No information available
Crystalline silica, quartz	14808-60-7	No information available

12.6. Other adverse effects

Endocrine Disruptor Information

This product does not contain any known or suspected endocrine disruptors

13. Disposal Considerations

Safe handling and disposal methods

Disposal should be made in accordance with federal, state, and local regulations.

Disposal of any contaminated packaging

Follow all applicable national or local regulations.

Environmental regulations

Not applicable

14. Transport Information

Transportation Information

Australia ADG

UN Number	Not restricted
UN proper shipping name:	Not restricted
Transport Hazard Class(es):	Not applicable
Packing Group:	Not applicable
Environmental Hazards:	Not applicable

IMDG/IMO

UN Number	Not restricted
UN proper shipping name:	Not restricted
Transport Hazard Class(es):	Not applicable
Packing Group:	Not applicable
Environmental Hazards:	Not applicable

IATA/ICAO

UN Number	Not restricted
UN proper shipping name:	Not restricted
Transport Hazard Class(es):	Not applicable
Packing Group:	Not applicable
Environmental Hazards:	Not applicable

Special precautions during transport

None

HazChem Code

None Allocated

15. Regulatory Information

Safety, health and environmental regulations specific for the product

International Inventories

Australian AICS Inventory	All components are listed on the AICS or are subject to a relevant exemption, permit, or assessment certificate.
New Zealand Inventory of Chemicals	All components are listed on the NZIoC or are subject to a relevant exemption, permit, or assessment certificate.
EINECS (European Inventory of Existing Chemical Substances)	This product, and all its components, complies with EINECS
US TSCA Inventory	All components listed on inventory or are exempt.
Canadian Domestic Substances List (DSL)	All components listed on inventory or are exempt.

Poisons Schedule number

None Allocated

International Agreements

Montreal Protocol - Ozone Depleting Substances:	Does not apply
Stolkhom Convention - Persistent Organic Pollutants:	Does not apply
Rotterdam Convention - Prior Informed Consent:	Does not apply
Basel Convention - Hazardous Waste:	Does not apply

16. Other information

Date of preparation or review

Revision Date: 05-Jul-2016

Revision Note

SDS sections updated: 2

Full text of H-Statements referred to under sections 2 and 3

H302 - Harmful if swallowed
H319 - Causes serious eye irritation
H351 - Suspected of causing cancer if inhaled
H360 - May damage fertility or the unborn child
H372 - Causes damage to organs through prolonged or repeated exposure if swallowed
H372 - Causes damage to organs through prolonged or repeated exposure if inhaled

Additional information

For additional information on the use of this product, contact your local Halliburton representative.

For questions about the Safety Data Sheet for this or other Halliburton products, contact Chemical Stewardship at 1-580-251-4335.

Key abreviations or acronyms used

bw – body weight
CAS – Chemical Abstracts Service
EC50 – Effective Concentration 50%
LC50 – Lethal Concentration 50%
LD50 – Lethal Dose 50%
LL50 – Lethal Loading 50%
mg/kg – milligram/kilogram
mg/L – milligram/liter
NOEC – No Observed Effect Concentration
OEL – Occupational Exposure Limit
PBT – Persistent Bioaccumulative and Toxic
ppm – parts per million
STEL – Short Term Exposure Limit
TWA – Time-Weighted Average
vPvB – very Persistent and very Bioaccumulative
h - hour
mg/m^3 - milligram/cubic meter
mm - millimeter

mmHg - millimeter mercury
w/w - weight/weight
d - day

Key literature references and sources for data
www.ChemADVISOR.com/
OSHA
ECHA C&L

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End of Safety Data Sheet

HALLIBURTON

SAFETY DATA SHEET

DCA-23001

Revision Date: 30-Sep-2015 **Revision Number:** 10

1. Product Identifier & Identity for the Chemical

Statement of Hazardous Nature Non-Hazardous according to the criteria of the 3rd Revised Edition of the Globally Harmonised System of Classification and Labelling of Chemicals (GHS), Non-Dangerous Goods according to the criteria of ADG.

1.1. Product Identifier

Product Name DCA-23001

Other means of Identification

Synonyms: None

Product Code: HM007701

Recommended use of the chemical and restrictions on use

Recommended Use Friction Reducer

Uses Advised Against No information available

Supplier's name, address and phone number

Manufacturer/Supplier Halliburton Australia Pty. Ltd.
15 Marriott Road
Jandakot
WA 6164
Australia

ACN Number: 009 000 775
Telephone Number: + 61 1 800 686 951
Fax Number: 61 (08) 9455 5300

E-Mail address: fdunexchem@halliburton.com

Emergency phone number

+ 61 1 800 686 951

Australian Poisons Information Centre

24 Hour Service: - 13 11 26

Police or Fire Brigade: - 000 (exchange): - 1100

2. Hazard Identification

Statement of Hazardous Nature Non-Hazardous according to the criteria of the 3rd Revised Edition of the Globally Harmonised System of Classification and Labelling of Chemicals (GHS), Non-Dangerous Goods according to the criteria of ADG.

Classification of the hazardous chemical

Not classified

Label elements, including precautionary statements

Hazard Pictograms

Signal Word Not Hazardous

Hazard Statements Not Classified

Precautionary Statements

Prevention None

Response None

Storage None

Disposal None

Contains

Substances	**CAS Number**
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA

Other hazards which do not result in classification

This mixture contains no substance considered to be persistent, bioaccumulating nor toxic (PBT).
This mixture contains no substance considered to be very persistent nor very bioaccumulating (vPvB).

Australia Classification

For the full text of the H-phrases mentioned in this Section, see Section 16

Classification Not Classified
Risk Phrases None

3. Composition/information on Ingredients

Substances	CAS Number	PERCENT (w/w)	GHS Classification - Australia
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	60 - 100%	Not Applicable

4. First aid measures

Description of necessary first aid measures

Inhalation If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.

Eyes Immediately flush eyes with large amounts of water for at least 15 minutes. Get immediate medical attention.

Skin Wash with soap and water. Get medical attention if irritation persists.

Ingestion Do NOT induce vomiting. Give nothing by mouth. Obtain immediate medical attention.

Symptoms caused by exposure

No significant hazards expected.

Medical Attention and Special Treatment

Notes to Physician Treat symptomatically

5. Fire Fighting Measures

Suitable extinguishing equipment

Suitable Extinguishing Media

All standard fire fighting media

Extinguishing media which must not be used for safety reasons

None known.

Specific hazards arising from the chemical
Special Exposure Hazards
Not applicable.

Special protective equipment and precautions for fire fighters
Special Protective Equipment for Fire-Fighters
Full protective clothing and approved self-contained breathing apparatus required for fire fighting personnel.

6. Accidental release measures

6.1. Personal precautions, protective equipment and emergency procedures
Use appropriate protective equipment. Avoid creating and breathing dust. Avoid contact with skin, eyes and clothing. Ensure adequate ventilation.

6.2. Environmental precautions
Prevent from entering sewers, waterways, or low areas.

6.3. Methods and material for containment and cleaning up
Scoop up and remove.

7. Handling and storage

7.1. Precautions for Safe Handling
Handling Precautions
Avoid contact with eyes, skin, or clothing. Avoid creating or inhaling dust. Ensure adequate ventilation. Ground and bond containers when transferring from one container to another. Slippery when wet. Wash hands after use. Launder contaminated clothing before reuse. Use appropriate protective equipment.
Hygiene Measures
Handle in accordance with good industrial hygiene and safety practice.

7.2. Conditions for safe storage, including any incompatibilities
Storage Information
Store in a cool, dry location. Keep container closed when not in use. Keep from heat, sparks, and open flames. Product has a shelf life of 24 months.
Other Guidelines
No information available

8. Exposure Controls/Personal Protection

Control parameters - exposure standards, biological monitoring
Exposure Limits

Substances	CAS Number	Australia NOHSC	ACGIH TLV-TWA
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	Not applicable	Not applicable

Appropriate engineering controls
Engineering Controls Use in a well ventilated area.

Personal protective equipment (PPE)
Respiratory Protection If engineering controls and work practices cannot keep exposure below occupational exposure limits or if exposure is unknown, wear a NIOSH certified, European Standard EN 149, AS/NZS 1715:2009, or equivalent respirator when using this product. Selection of and instruction on using all personal protective equipment, including respirators, should be performed by an Industrial Hygienist or other qualified professional.

Hand Protection Normal work gloves.
Skin Protection Normal work coveralls.

Eye Protection	Wear safety glasses or goggles to protect against exposure.
Other Precautions	None known.
Environmental Exposure Controls	Do not allow material to contaminate ground water system

9. Physical and Chemical Properties

9.1. Information on basic physical and chemical properties

Physical State:	Powder	**Color:**	White
Odor:	Slight	**Odor Threshold:**	No information available

Property Remarks/ - Method	Values
pH:	9
Freezing Point/Range	No data available
Melting Point/Range	No data available
Boiling Point/Range	No data available
Flash Point	No data available
Evaporation rate	No data available
Vapor Pressure	No data available
Vapor Density	No data available
Specific Gravity	2
Water Solubility	Soluble in water
Solubility in other solvents	No data available
Partition coefficient: n-octanol/water	No data available
Autoignition Temperature	No data available
Decomposition Temperature	No data available
Viscosity	No data available
Explosive Properties	No information available
Oxidizing Properties	No information available

9.2. Other information

VOC Content (%)	No data available

10. Stability and Reactivity

10.1. Reactivity
Not expected to be reactive.
10.2. Chemical Stability
Stable
10.3. Possibility of Hazardous Reactions
Will Not Occur
10.4. Conditions to Avoid
None anticipated
10.5. Incompatible Materials
Strong oxidizers.
10.6. Hazardous Decomposition Products
Carbon monoxide and carbon dioxide. Ammonia.

11. Toxicological Information

Information on routes of exposure
Principle Route of Exposure Eye or skin contact, inhalation.

Sympotoms related to exposure
Most Important Symptoms/Effects
No significant hazards expected.

Numerical measures of toxicity

Toxicology data for the components

Substances	CAS Number	LD50 Oral	LD50 Dermal	LC50 Inhalation
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	No data available	No data available	No data available

Immediate, delayed and chronic health effects from exposure

Inhalation May cause mild respiratory irritation.
Eye Contact May cause mild eye irritation.
Skin Contact May cause mild skin irritation.
Ingestion Large doses may cause nausea, vomiting and diarrhea.

Chronic Effects/Carcinogenicity No data available to indicate product or components present at greater than 0.1% are chronic health hazards.

Exposure Levels
No data available

Interactive effects
Respiratory disorders. Skin disorders.

Data limitations
No data available

12. Ecological Information

Ecotoxicity
Product Ecotoxicity Data
No data available

Substance Ecotoxicity Data

Substances	CAS Number	Toxicity to Algae	Toxicity to Fish	Toxicity to Microorganisms	Toxicity to Invertebrates
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	No information available	No information available	No information available	No information available

12.2. Persistence and degradability

Substances	CAS Number	Persistence and Degradability
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	No information available

12.3. Bioaccumulative potential

Substances	CAS Number	Log Pow
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	No information available

12.4. Mobility in soil

Substances	CAS Number	Mobility
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	No information available

12.6. Other adverse effects

Endocrine Disruptor Information

This product does not contain any known or suspected endocrine disruptors

13. Disposal Considerations

Safe handling and disposal methods

Bury in a licensed landfill according to federal, state, and local regulations.

Disposal of any contaminated packaging

Follow all applicable national or local regulations.

Environmental regulations

Not applicable

14. Transport Information

Transportation Information

UN Number: Not restricted
UN Proper Shipping Name: Not restricted
Transport Hazard Class(es): Not applicable
Packing Group: Not applicable
Environmental Hazards: Not applicable

Special precautions during transport

None

HazChem Code

None Allocated

15. Regulatory Information

Safety, health and environmental regulations specific for the product

International Inventories

Australian AICS Inventory All components listed on inventory or are exempt.
New Zealand Inventory of Chemicals All components listed on inventory or are exempt.
EINECS Inventory This product, and all its components, complies with EINECS
US TSCA Inventory All components listed on inventory or are exempt.
Canadian DSL Inventory All components listed on inventory or are exempt.

Poisons Schedule number

None Allocated

16. Other information

Date of preparation or review

Revision Date: 30-Sep-2015

Revision Note
SDS sections updated: 2

Full text of R-phrases referred to under Sections 2 and 3
None

Full text of H-Statements referred to under sections 2 and 3
None

Additional information

For additional information on the use of this product, contact your local Halliburton representative.

For questions about the Safety Data Sheet for this or other Halliburton products, contact Chemical Stewardship at 1-580-251-4335.

Key abreviations or acronyms used

bw – body weight CAS – Chemical Abstracts Service EC50 – Effective Concentration 50% LC50 – Lethal Concentration 50% LD50 – Lethal Dose 50% LL50 – Lethal Loading 50% mg/kg – milligram/kilogram mg/L – milligram/liter NOEC – No Observed Effect Concentration OEL – Occupational Exposure Limit PBT – Persistent Bioaccumulative and Toxic ppm – parts per million STEL – Short Term Exposure Limit TWA – Time-Weighted Average vPvB – very Persistent and very Bioaccumulative h - hour mg/m^3 - milligram/cubic meter mm - millimeter mmHg - millimeter mercury w/w - weight/weight d - day

Key literature references and sources for data
www.ChemADVISOR.com/

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End of Safety Data Sheet

HALLIBURTON

SAFETY DATA SHEET

DCA-23003

Revision Date: 31-Jul-2018 **Revision Number:** 8

1. Product Identifier & Identity for the Chemical

Statement of Hazardous Nature Non-Hazardous according to the criteria of the 3rd Revised Edition of the Globally Harmonised System of Classification and Labelling of Chemicals (GHS), Non-Dangerous Goods according to the criteria of ADG.

1.1. Product Identifier

Product Name DCA-23003

Other means of Identification

Synonyms None

Hazardous Material Number: HM008080

Recommended use of the chemical and restrictions on use

Recommended Use Friction Reducer

Uses advised against No information available

Supplier's name, address and phone number

Manufacturer/Supplier Halliburton Australia Pty. Ltd.
15 Marriott Road, Jandakot, WA 6164
Australia
ACN Number: 009 000 775
Telephone Number: + 61 1 800 686 951
Fax Number: 61 (08) 9455 5300

E-mail Address fdunexchem@halliburton.com

Emergency phone number

+ 61 1 800 686 951
Global Incident Response Access Code: 334305
Contract Number: 14012

Australian Poisons Information Centre
24 Hour Service: - 13 11 26
Police or Fire Brigade: - 000 (exchange): - 1100

2. Hazard Identification

Statement of Hazardous Nature Non-Hazardous according to the criteria of the 3rd Revised Edition of the Globally Harmonised System of Classification and Labelling of Chemicals (GHS), Non-Dangerous Goods according to the criteria of ADG.

Classification of the hazardous chemical

Not classified

Label elements, including precautionary statements

Hazard Pictograms

Signal Word Not Hazardous

Hazard Statements: Not Classified

Precautionary Statements

Prevention	None
Response	None
Storage	None
Disposal	None

Contains

Substances	**CAS Number**
Hydrotreated light petroleum distillate	64742-47-8
Ethoxylated branched C13 alcohol	78330-21-9
Sodium diacetate	126-96-5

Other hazards which do not result in classification

This mixture contains no substance considered to be persistent, bioaccumulating nor toxic (PBT).
This mixture contains no substance considered to be very persistent nor very bioaccumulating (vPvB).

For the full text of the H-phrases mentioned in this Section, see Section 16

3. Composition/information on Ingredients

Substances	CAS Number	PERCENT (w/w)	GHS Classification - Australia
Hydrotreated light petroleum distillate	64742-47-8	10 - 30%	Asp. Tox. 1 (H304)
Ethoxylated branched C13 alcohol	78330-21-9	1 - 5%	Acute Tox. 4 (H302) Skin Irrit. 2 (H315) Eye Corr. 1 (H318) Aquatic Acute 2 (H401) Aquatic Chronic 3 (H412)
Sodium diacetate	126-96-5	1 - 5%	Eye Corr. 1 (H318)

4. First aid measures

Description of necessary first aid measures

Inhalation	If inhaled, move victim to fresh air and seek medical attention.
Eyes	In case of contact, immediately flush eyes with plenty of water for at least 15 minutes and get medical attention if irritation persists.
Skin	Wash with soap and water. Get medical attention if irritation persists. Remove contaminated clothing and launder before reuse.
Ingestion	Do NOT induce vomiting. Give nothing by mouth. Obtain immediate medical attention.

Symptoms caused by exposure

No significant hazards expected.

Medical Attention and Special Treatment

Notes to Physician Treat symptomatically

5. Fire Fighting Measures

Suitable extinguishing equipment

Suitable Extinguishing Media

Water fog, carbon dioxide, foam, dry chemical.

Extinguishing media which must not be used for safety reasons

None known.

Specific hazards arising from the chemical

Special exposure hazards in a fire
Product is not expected to burn unless all the water is boiled away. Decomposition in fire may produce harmful gases. Use water spray to cool fire exposed surfaces.

Special protective equipment and precautions for fire fighters
Special protective equipment for firefighters
Full protective clothing and approved self-contained breathing apparatus required for fire fighting personnel.

6. Accidental release measures

6.1. Personal precautions, protective equipment and emergency procedures
Use appropriate protective equipment. Spills of this product are very slippery. Avoid contact with skin, eyes and clothing. Avoid breathing vapors. Ensure adequate ventilation.

6.2. Environmental precautions
Prevent from entering sewers, waterways, or low areas.

6.3. Methods and material for containment and cleaning up
Isolate spill and stop leak where safe. Contain spill with sand or other inert materials. Scoop up and remove. Do NOT spread spilled product with water.

7. Handling and storage

7.1. Precautions for safe handling
Handling Precautions
Use appropriate protective equipment. Avoid contact with eyes, skin, or clothing. Avoid breathing vapors. Avoid breathing mist. Ensure adequate ventilation. Wash hands after use. Launder contaminated clothing before reuse.
Hygiene Measures
Handle in accordance with good industrial hygiene and safety practice.

7.2. Conditions for safe storage, including any incompatibilities
Storage Information
Store away from oxidizers. Store in a cool well ventilated area. Keep container closed when not in use. Store at temperatures between 40 and 90 F (5 and 35 C). Keep from freezing. Product has a shelf life of 6 months.
Other Guidelines
No information available

8. Exposure Controls/Personal Protection

Control parameters - exposure standards, biological monitoring
Exposure Limits

Substances	CAS Number	Australia NOHSC	ACGIH TLV-TWA
Hydrotreated light petroleum distillate	64742-47-8	Not applicable	Not applicable
Ethoxylated branched C13 alcohol	78330-21-9	Not applicable	Not applicable
Sodium diacetate	126-96-5	Not applicable	Not applicable

Appropriate engineering controls
Engineering Controls Use in a well ventilated area.

Personal protective equipment (PPE)
Personal Protective Equipment If engineering controls and work practices cannot prevent excessive exposures, the selection and proper use of personal protective equipment should be determined by an industrial hygienist or other qualified professional based on the specific application of this product.
Respiratory Protection Not normally needed. But if significant exposures are possible then the following respirator is recommended:
Organic vapor respirator with a dust/mist filter. (A2P2/P3)
Hand Protection Impervious rubber gloves. Polyvinylchloride gloves.
Skin Protection Normal work coveralls.
Eye Protection Chemical goggles; also wear a face shield if splashing hazard exists.

Other Precautions None known.
Environmental Exposure Controls No information available

9. Physical and Chemical Properties

9.1. Information on basic physical and chemical properties

Physical State: Liquid
Color Off white
Odor: Hydrocarbon
Odor Threshold: No information available

Property Remarks/ - Method	Values
pH:	5 - 8
Freezing Point / Range	No data available
Melting Point / Range	< 5 °C / < 41 °F
Boiling Point / Range	> 100 °C / 212 °F
Flash Point	No data available
Evaporation rate	No data available
Vapor Pressure	17.25 mmHg
Vapor Density	No data available
Specific Gravity	1.0 - 1.1
Water Solubility	Miscible with water
Solubility in other solvents	No data available
Partition coefficient: n-octanol/water	No data available
Autoignition Temperature	No data available
Decomposition Temperature	No data available
Viscosity	> 20.5 mm2/s
Explosive Properties	No information available
Oxidizing Properties	No information available

9.2. Other information

VOC Content (%) No data available

10. Stability and Reactivity

10.1. Reactivity
Not expected to be reactive.
10.2. Chemical stability
Stable
10.3. Possibility of hazardous reactions
Will Not Occur
10.4. Conditions to avoid
Freezing conditions.
10.5. Incompatible materials
Strong oxidizers.
10.6. Hazardous decomposition products
Carbon monoxide and carbon dioxide. Oxides of nitrogen. Hydrogen cyanide.

11. Toxicological Information

Information on routes of exposure
Principle Route of Exposure Eye or skin contact, inhalation.

Symptoms related to exposure
Most Important Symptoms/Effects
No significant hazards expected.

Toxicology data for the components

Substances	CAS Number	LD50 Oral	LD50 Dermal	LC50 Inhalation
Hydrotreated light	64742-47-8	>5000 mg/kg-bw (rat) (similar	>2000 mg/kg-bw (rabbit) (similar	>5.2 mg/L (rat, 4 h, vapor)

petroleum distillate		substance)	substance)	(similar substance)
Ethoxylated branched C13 alcohol	78330-21-9	1600 mg/kg-bw (rat) (similar substance)	>2000 mg/kg-bw (rabbit) (similar substance)	>0.22 mg/L (rat, 4h, aerosol, saturated) (similar substance)
Sodium diacetate	126-96-5	5600 mg/kg (rat)	> 2000 mg/kg (rat)	No data available

Immediate, delayed and chronic health effects from exposure

Inhalation If heated: May cause central nervous system depression including headache, dizziness, drowsiness, incoordination, slowed reaction time, slurred speech, giddiness and unconsciousness.

Eye Contact In vitro tests indicate that the product is not an eye irritant.

Skin Contact Prolonged or repeated contact may cause skin irritation.

Ingestion May act as obstruction if swallowed. Aspiration can be a hazard if this material is swallowed.

Chronic Effects/Carcinogenicity No data available to indicate product or components present at greater than 0.1% are chronic health hazards.

Exposure Levels

No data available

Interactive effects

Eye ailments. Skin disorders.

Data limitations

No data available

Substances	CAS Number	Skin corrosion/irritation
Hydrotreated light petroleum distillate	64742-47-8	Non-irritating to the skin (similar substances)
Ethoxylated branched C13 alcohol	78330-21-9	Skin, rabbit: Causes moderate skin irritation. (similar substances)

Substances	CAS Number	Serious eye damage/irritation
Hydrotreated light petroleum distillate	64742-47-8	Non-irritating to rabbit's eye (similar substances)
Ethoxylated branched C13 alcohol	78330-21-9	Eye, rabbit: Causes severe eye irritation which may damage tissue. (similar substances)

Substances	CAS Number	Skin Sensitization
Hydrotreated light petroleum distillate	64742-47-8	Did not cause sensitization on laboratory animals (guinea pig) (similar substances)
Ethoxylated branched C13 alcohol	78330-21-9	Did not cause sensitization on laboratory animals (guinea pig) (similar substances)
Sodium diacetate	126-96-5	Not regarded as a sensitizer.

Substances	CAS Number	Respiratory Sensitization
Hydrotreated light petroleum distillate	64742-47-8	Based on available data, the classification criteria are not met.
Ethoxylated branched C13 alcohol	78330-21-9	Based on available data, the classification criteria are not met.
Sodium diacetate	126-96-5	No information available

Substances	CAS Number	Mutagenic Effects
Hydrotreated light petroleum distillate	64742-47-8	In vitro tests did not show mutagenic effects. In vivo tests did not show mutagenic effects. (similar substances)
Ethoxylated branched C13 alcohol	78330-21-9	In vitro tests did not show mutagenic effects. In vivo tests did not show mutagenic effects. (similar substances)

Substances	CAS Number	Carcinogenic Effects
Hydrotreated light petroleum distillate	64742-47-8	Did not show carcinogenic effects in animal experiments (similar substances)
Ethoxylated branched C13 alcohol	78330-21-9	Did not show carcinogenic effects in animal experiments (similar substances)

Substances	CAS Number	Reproductive toxicity
Hydrotreated light petroleum distillate	64742-47-8	Animal testing did not show any effects on fertility. Did not show teratogenic effects in animal experiments. (similar substances)
Ethoxylated branched C13 alcohol	78330-21-9	Animal testing did not show any effects on fertility. Did not show teratogenic effects in animal experiments. (similar substances)
Sodium diacetate	126-96-5	(similar substances)

Substances	CAS Number	STOT - single exposure
Hydrotreated light petroleum distillate	64742-47-8	No significant toxicity observed in animal studies at concentration requiring classification.
Ethoxylated branched C13 alcohol	78330-21-9	No significant toxicity observed in animal studies at concentration requiring classification. (similar substances)
Sodium diacetate	126-96-5	No information available

Substances	CAS Number	STOT - repeated exposure
Hydrotreated light petroleum distillate	64742-47-8	No significant toxicity observed in animal studies at concentration requiring classification. (similar substances)
Ethoxylated branched C13 alcohol	78330-21-9	No significant toxicity observed in animal studies at concentration requiring classification. (similar substances)

Substances	CAS Number	Aspiration hazard
Hydrotreated light petroleum distillate	64742-47-8	Aspiration into the lungs may cause chemical pneumonitis including coughing, difficulty breathing, wheezing, coughing up blood and pneumonia, which can be fatal.
Ethoxylated branched C13 alcohol	78330-21-9	Based on available data, the classification criteria are not met.

12. Ecological Information

Ecotoxicity

Substance Ecotoxicity Data

Substances	CAS Number	Toxicity to Algae	Toxicity to Fish	Toxicity to Microorganisms	Toxicity to Invertebrates
Hydrotreated light petroleum distillate	64742-47-8	ErL50(72 h)>10000 mg/L (Skeletonema costatum)	LC50(96 h)>10000 mg/L (Scophthalmus maximus) NOELR(28 d)>1000 mg/L (fish)	No information available	LC50(48 h)>10000 mg/L (Acartia tonsa) NOELR(21 d)=1000 mg/L (Daphnia magna)
Ethoxylated branched C13 alcohol	78330-21-9	IC50(72 h)=1-10 mg/L (Desmodesmus subspicatus)	LC50(96 h)=1-10 mg/L (Cyprinus carpio)	No information available	EC50(48 h)=1-10 mg/L (Daphnia magna) NOAEC (21d) 0.77 mg/L (Daphnia magna)
Sodium diacetate	126-96-5	EC50 (72 h) >1000 mg/L (Skeletonema costatum)	LC0 (96 h) >100 mg/L (Danio rerio) LC50 (96 h) 273 mg/L (Oreochromis mossambicus)	No information available	EC50 (48 h) >1000 mg/L (Daphnia magna)

12.2. Persistence and degradability

Substances	CAS Number	Persistence and Degradability
Hydrotreated light petroleum distillate	64742-47-8	Readily biodegradable (68.1% @ 28d)
Ethoxylated branched C13 alcohol	78330-21-9	Readily biodegradable (> 60% @ 28d)
Sodium diacetate	126-96-5	No information available

12.3. Bioaccumulative potential

Bioaccumulation is unlikely

Substances	CAS Number	Log Pow
Hydrotreated light petroleum distillate	64742-47-8	No information available
Ethoxylated branched C13 alcohol	78330-21-9	Not Bioaccumulative; BCF = 12.7 - 237 L/Kg
Sodium diacetate	126-96-5	No information available

12.4. Mobility in soil

Substances	CAS Number	Mobility

Hydrotreated light petroleum distillate	64742-47-8	No information available
Ethoxylated branched C13 alcohol	78330-21-9	No information available
Sodium diacetate	126-96-5	No information available

12.6. Other adverse effects

Endocrine Disruptor Information

This product does not contain any known or suspected endocrine disruptors

13. Disposal Considerations

Safe handling and disposal methods

Disposal should be made in accordance with federal, state, and local regulations.

Disposal of any contaminated packaging

Follow all applicable national or local regulations.

Environmental regulations

Not applicable

14. Transport Information

Transportation Information

Australia ADG

UN Number	Not restricted
UN proper shipping name:	Not restricted
Transport Hazard Class(es):	Not applicable
Packing Group:	Not applicable
Environmental Hazards:	Not applicable

IMDG/IMO

UN Number	Not restricted
UN proper shipping name:	Not restricted
Transport Hazard Class(es):	Not applicable
Packing Group:	Not applicable
Environmental Hazards:	Not applicable

IATA/ICAO

UN Number	Not restricted
UN proper shipping name:	Not restricted
Transport Hazard Class(es):	Not applicable
Packing Group:	Not applicable
Environmental Hazards:	Not applicable

Special precautions during transport

None

HazChem Code

None Allocated

15. Regulatory Information

Safety, health and environmental regulations specific for the product

International Inventories

Australian AICS Inventory	All components are listed on the AICS or are subject to a relevant exemption, permit, or assessment certificate.
New Zealand Inventory of Chemicals	All components are listed on the NZIoC or are subject to a relevant exemption, permit, or assessment certificate.
EINECS (European Inventory of Existing Chemical Substances)	This product, and all its components, complies with EINECS

US TSCA Inventory	All components listed on inventory or are exempt.
Canadian Domestic Substances List (DSL)	All components listed on inventory or are exempt.

Poisons Schedule number
None Allocated

International Agreements

Montreal Protocol - Ozone Depleting Substances:	Does not apply.
Stockholm Convention - Persistent Organic Pollutants:	Does not apply
Rotterdam Convention - Prior Informed Consent:	Does not apply.
Basel Convention - Hazardous Waste:	Does not apply.

16. Other information

Date of preparation or review

Revision Date: 31-Jul-2018

Revision Note
SDS sections updated:
2

Full text of H-Statements referred to under sections 2 and 3
H302 - Harmful if swallowed
H304 - May be fatal if swallowed and enters airways
H315 - Causes skin irritation
H318 - Causes serious eye damage
H412 - Harmful to aquatic life with long lasting effects

Additional information

For additional information on the use of this product, contact your local Halliburton representative.

For questions about the Safety Data Sheet for this or other Halliburton products, contact Chemical Stewardship at 1-580-251-4335.

Key abreviations or acronyms used
bw – body weight
CAS – Chemical Abstracts Service
EC50 – Effective Concentration 50%
LC50 – Lethal Concentration 50%
LD50 – Lethal Dose 50%
LL50 – Lethal Loading 50%
mg/kg – milligram/kilogram
mg/L – milligram/liter
NOEC – No Observed Effect Concentration
OEL – Occupational Exposure Limit
PBT – Persistent Bioaccumulative and Toxic
ppm – parts per million
STEL – Short Term Exposure Limit
TWA – Time-Weighted Average
vPvB – very Persistent and very Bioaccumulative
h - hour
mg/m^3 - milligram/cubic meter
mm - millimeter
mmHg - millimeter mercury
w/w - weight/weight
d - day

Key literature references and sources for data
www.ChemADVISOR.com/
OSHA

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End of Safety Data Sheet

HALLIBURTON

SAFETY DATA SHEET

DCA-25005

Revision Date: 30-Sep-2015 **Revision Number:** 10

1. Product Identifier & Identity for the Chemical

Statement of Hazardous Nature Non-Hazardous according to the criteria of the 3rd Revised Edition of the Globally Harmonised System of Classification and Labelling of Chemicals (GHS), Non-Dangerous Goods according to the criteria of ADG.

1.1. Product Identifier

Product Name DCA-25005

Other means of Identification

Synonyms: None

Product Code: HM007672

Recommended use of the chemical and restrictions on use

Recommended Use Gelling Agent

Uses Advised Against No information available

Supplier's name, address and phone number

Manufacturer/Supplier

Halliburton Australia Pty. Ltd.
15 Marriott Road
Jandakot
WA 6164
Australia

ACN Number: 009 000 775
Telephone Number: + 61 1 800 686 951
Fax Number: 61 (08) 9455 5300

E-Mail address: fdunexchem@halliburton.com

Emergency phone number

+ 61 1 800 686 951

Australian Poisons Information Centre

24 Hour Service: - 13 11 26

Police or Fire Brigade: - 000 (exchange): - 1100

2. Hazard Identification

Statement of Hazardous Nature Non-Hazardous according to the criteria of the 3rd Revised Edition of the Globally Harmonised System of Classification and Labelling of Chemicals (GHS), Non-Dangerous Goods according to the criteria of ADG.

Classification of the hazardous chemical

Not classified

Label elements, including precautionary statements

Hazard Pictograms

Signal Word Not Hazardous

Hazard Statements Not Classified

Precautionary Statements

Prevention None

Response None

Storage None

Disposal None

Contains

Substances	**CAS Number**
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA

Other hazards which do not result in classification

This substance is not considered to be persistent, bioaccumulating nor toxic (PBT).
This substance is not considered to be very persistent nor very bioaccumulating (vPvB).

Australia Classification

For the full text of the H-phrases mentioned in this Section, see Section 16

Classification Not Classified
Risk Phrases None

3. Composition/information on Ingredients

Substances	CAS Number	PERCENT (w/w)	GHS Classification - Australia
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	60 - 100%	Not Applicable

4. First aid measures

Description of necessary first aid measures

Inhalation If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.

Eyes In case of contact, immediately flush eyes with plenty of water for at least 15 minutes and get medical attention if irritation persists.

Skin Wash with soap and water. Get medical attention if irritation persists.

Ingestion Under normal conditions, first aid procedures are not required.

Symptoms caused by exposure

No significant hazards expected.

Medical Attention and Special Treatment

Notes to Physician Treat symptomatically

5. Fire Fighting Measures

Suitable extinguishing equipment

Suitable Extinguishing Media

Water fog, carbon dioxide, foam, dry chemical.

Extinguishing media which must not be used for safety reasons

None known.

Specific hazards arising from the chemical

Special Exposure Hazards

Decomposition in fire may produce harmful gases. Organic dust in the presence of an ignition source can be explosive in high concentrations. Good housekeeping practices are required to minimize this potential.

Special protective equipment and precautions for fire fighters

Special Protective Equipment for Fire-Fighters

Full protective clothing and approved self-contained breathing apparatus required for fire fighting personnel.

6. Accidental release measures

6.1. Personal precautions, protective equipment and emergency procedures

Use appropriate protective equipment. Avoid creating and breathing dust. Avoid contact with skin, eyes and clothing. Ensure adequate ventilation.

6.2. Environmental precautions

Prevent from entering sewers, waterways, or low areas.

6.3. Methods and material for containment and cleaning up

Scoop up and remove.

7. Handling and storage

7.1. Precautions for Safe Handling

Handling Precautions

Avoid contact with eyes, skin, or clothing. Avoid creating or inhaling dust. Ensure adequate ventilation. Wash hands after use. Launder contaminated clothing before reuse. Use appropriate protective equipment.

Hygiene Measures

Handle in accordance with good industrial hygiene and safety practice.

7.2. Conditions for safe storage, including any incompatibilities

Storage Information

Store away from oxidizers. Store in a cool, dry location. Product has a shelf life of 24 months.

Other Guidelines

No information available

8. Exposure Controls/Personal Protection

Control parameters - exposure standards, biological monitoring

Exposure Limits

Substances	CAS Number	Australia NOHSC	ACGIH TLV-TWA
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	Not applicable	Not applicable

Appropriate engineering controls

Engineering Controls Use in a well ventilated area.

Personal protective equipment (PPE)

Respiratory Protection Not normally needed. But if significant exposures are possible then the following respirator is recommended:
Dust/mist respirator. (N95, P2/P3)

Hand Protection Normal work gloves.

Skin Protection Normal work coveralls.

Eye Protection Wear safety glasses or goggles to protect against exposure.

Other Precautions None known.

Environmental Exposure Controls Do not allow material to contaminate ground water system

9. Physical and Chemical Properties

9.1. Information on basic physical and chemical properties

Physical State: Solid
Color: Off white
Odor: Bean
Odor Threshold: No information available

Property Remarks/ - Method	Values
pH:	6.5-7.5
Freezing Point/Range	No data available
Melting Point/Range	No data available
Boiling Point/Range	No data available
Flash Point	> 93 °C / > 200 °F Cleveland Open Cup (COC)
Evaporation rate	No data available
Vapor Pressure	No data available
Vapor Density	No data available
Specific Gravity	1.42 - 1.47
Water Solubility	Soluble in water
Solubility in other solvents	No data available
Partition coefficient: n-octanol/water	No data available
Autoignition Temperature	No data available
Decomposition Temperature	No data available
Viscosity	No data available
Explosive Properties	No information available
Oxidizing Properties	No information available

9.2. Other information

VOC Content (%) No data available

10. Stability and Reactivity

10.1. Reactivity
Not expected to be reactive.
10.2. Chemical Stability
Stable
10.3. Possibility of Hazardous Reactions
Will Not Occur
10.4. Conditions to Avoid
None anticipated
10.5. Incompatible Materials
Strong oxidizers.
10.6. Hazardous Decomposition Products
Carbon monoxide and carbon dioxide.

11. Toxicological Information

Information on routes of exposure
Principle Route of Exposure Eye or skin contact, inhalation.

Sympotoms related to exposure
Most Important Symptoms/Effects
No significant hazards expected.

Numerical measures of toxicity

Toxicology data for the components

Substances	CAS Number	LD50 Oral	LD50 Dermal	LC50 Inhalation
Contains no hazardous substances in concentrations above	NA	No data available	No data available	No data available

cut-off values according to the competent authority				

Immediate, delayed and chronic health effects from exposure

Inhalation May cause mild respiratory irritation.
Eye Contact May cause mild eye irritation.
Skin Contact None known.
Ingestion None known.

Chronic Effects/Carcinogenicity No data available to indicate product or components present at greater than 0.1% are chronic health hazards.

Exposure Levels
No data available

Interactive effects
None known.

Data limitations
No data available

12. Ecological Information

Ecotoxicity
Product Ecotoxicity Data
No data available

Substance Ecotoxicity Data

Substances	CAS Number	Toxicity to Algae	Toxicity to Fish	Toxicity to Microorganisms	Toxicity to Invertebrates
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	No information available	No information available	No information available	No information available

12.2. Persistence and degradability

Substances	CAS Number	Persistence and Degradability
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	No information available

12.3. Bioaccumulative potential

Substances	CAS Number	Log Pow
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	No information available

12.4. Mobility in soil

Substances	CAS Number	Mobility
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	No information available

12.6. Other adverse effects

Endocrine Disruptor Information

This product does not contain any known or suspected endocrine disruptors

13. Disposal Considerations

Safe handling and disposal methods

Bury in a licensed landfill according to federal, state, and local regulations.

Disposal of any contaminated packaging

Follow all applicable national or local regulations.

Environmental regulations

Not applicable

14. Transport Information

Transportation Information

UN Number: Not restricted
UN Proper Shipping Name: Not restricted
Transport Hazard Class(es): Not applicable
Packing Group: Not applicable
Environmental Hazards: Not applicable

Special precautions during transport

None

HazChem Code

None Allocated

15. Regulatory Information

Safety, health and environmental regulations specific for the product

International Inventories

Australian AICS Inventory All components listed on inventory or are exempt.
New Zealand Inventory of Chemicals All components listed on inventory or are exempt.
EINECS Inventory This product, and all its components, complies with EINECS
US TSCA Inventory All components listed on inventory or are exempt.
Canadian DSL Inventory All components listed on inventory or are exempt.

Poisons Schedule number

None Allocated

16. Other information

Date of preparation or review

Revision Date: 30-Sep-2015

Revision Note

SDS sections updated: 2

Full text of R-phrases referred to under Sections 2 and 3
None

Full text of H-Statements referred to under sections 2 and 3
None

Additional information

For additional information on the use of this product, contact your local Halliburton representative.

For questions about the Safety Data Sheet for this or other Halliburton products, contact Chemical Stewardship at 1-580-251-4335.

Key abreviations or acronyms used

bw – body weight CAS – Chemical Abstracts Service EC50 – Effective Concentration 50% LC50 – Lethal Concentration 50% LD50 – Lethal Dose 50% LL50 – Lethal Loading 50% mg/kg – milligram/kilogram mg/L – milligram/liter NOEC – No Observed Effect Concentration OEL – Occupational Exposure Limit PBT – Persistent Bioaccumulative and Toxic ppm – parts per million STEL – Short Term Exposure Limit TWA – Time-Weighted Average vPvB – very Persistent and very Bioaccumulative h - hour mg/m^3 - milligram/cubic meter mm - millimeter mmHg - millimeter mercury w/w - weight/weight d - day

Key literature references and sources for data
www.ChemADVISOR.com/

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End of Safety Data Sheet

HALLIBURTON

SAFETY DATA SHEET

DCA-30001

Revision Date: 05-Jul-2016 **Revision Number:** 11

1. Product Identifier & Identity for the Chemical

Statement of Hazardous Nature Non-Hazardous according to the criteria of the 3rd Revised Edition of the Globally Harmonised System of Classification and Labelling of Chemicals (GHS), Non-Dangerous Goods according to the criteria of ADG.

1.1. Product Identifier

Product Name DCA-30001

Other means of Identification

Synonyms None

Hazardous Material Number: HM007676

Recommended use of the chemical and restrictions on use

Recommended Use Scale Inhibitor

Uses advised against No information available

Supplier's name, address and phone number

Manufacturer/Supplier

Halliburton/Baroid Australia Pty. Ltd.
15 Marriott Road
Jandakot
WA 6164
Australia

ACN Number: 009 000 775
Telephone Number: 61 (08) 9455 8300
Fax Number: 61 (08) 9455 5300

Product Emergency Telephone
Australia: + 61 1 800 686 951
Papua New Guinea: + 61 1 800 686 951
NewZealand: +64 800 451719

Fire, Police & Ambulance - Emergency Telephone
Australia: 000
Papua New Guinea: 000
New Zealand: 111

E-mail Address fdunexchem@halliburton.com

Emergency phone number

+ 61 1 800 686 951

Australian Poisons Information Centre
24 Hour Service: - 13 11 26
Police or Fire Brigade: - 000 (exchange): - 1100

2. Hazard Identification

Statement of Hazardous Nature Non-Hazardous according to the criteria of the 3rd Revised Edition of the Globally Harmonised System of Classification and Labelling of Chemicals (GHS), Non-Dangerous Goods according to the criteria of ADG.

Classification of the hazardous chemical

Not classified

Label elements, including precautionary statements

Hazard pictograms

Signal Word Not Hazardous

Hazard Statements: Not Classified

Precautionary Statements

Prevention None
Response None
Storage None
Disposal None

Contains

Substances	**CAS Number**
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA

Other hazards which do not result in classification

This mixture contains no substance considered to be persistent, bioaccumulating nor toxic (PBT).
This mixture contains no substance considered to be very persistent nor very bioaccumulating (vPvB).

For the full text of the H-phrases mentioned in this Section, see Section 16

3. Composition/information on Ingredients

Substances	CAS Number	PERCENT (w/w)	GHS Classification - Australia
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	60 - 100%	Not Applicable

4. First aid measures

Description of necessary first aid measures

Inhalation If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.

Eyes In case of contact, immediately flush eyes with plenty of water for at least 15 minutes and get medical attention if irritation persists.

Skin Wash with soap and water. Get medical attention if irritation persists.

Ingestion Do NOT induce vomiting. Give nothing by mouth. Obtain immediate medical attention.

Symptoms caused by exposure

No significant hazards expected.

Medical Attention and Special Treatment

Notes to Physician Treat symptomatically

5. Fire Fighting Measures

Suitable extinguishing equipment

Suitable Extinguishing Media

All standard fire fighting media

Extinguishing media which must not be used for safety reasons

None known.

Specific hazards arising from the chemical

Special exposure hazards in a fire

Not applicable

Special protective equipment and precautions for fire fighters

Special protective equipment for firefighters

Full protective clothing and approved self-contained breathing apparatus required for fire fighting personnel.

6. Accidental release measures

6.1. Personal precautions, protective equipment and emergency procedures

Use appropriate protective equipment. Avoid contact with skin, eyes and clothing. Avoid breathing vapors. Ensure adequate ventilation.

6.2. Environmental precautions

Prevent from entering sewers, waterways, or low areas.

6.3. Methods and material for containment and cleaning up

Isolate spill and stop leak where safe. Contain spill with sand or other inert materials. Scoop up and remove.

7. Handling and storage

7.1. Precautions for safe handling

Handling Precautions

Avoid contact with eyes, skin, or clothing. Avoid breathing mist. Avoid breathing vapors. Ensure adequate ventilation. Wash hands after use. Launder contaminated clothing before reuse. Use appropriate protective equipment.

Hygiene Measures

Handle in accordance with good industrial hygiene and safety practice.

7.2. Conditions for safe storage, including any incompatibilities

Storage Information

Store away from oxidizers. Product has a shelf life of 12 months.

Other Guidelines

No information available

8. Exposure Controls/Personal Protection

Control parameters - exposure standards, biological monitoring

Exposure Limits

Substances	CAS Number	Australia NOHSC	ACGIH TLV-TWA
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	Not applicable	Not applicable

Appropriate engineering controls

Engineering Controls Use in a well ventilated area.

Personal protective equipment (PPE)

Personal Protective Equipment If engineering controls and work practices cannot prevent excessive exposures, the selection and proper use of personal protective equipment should be determined by an industrial hygienist or other qualified professional based on the specific application of this product.

Respiratory Protection If engineering controls and work practices cannot keep exposure below occupational exposure limits or if exposure is unknown, wear a NIOSH certified, European Standard EN

149, AS/NZS 1715:2009, or equivalent respirator when using this product. Selection of and instruction on using all personal protective equipment, including respirators, should be performed by an Industrial Hygienist or other qualified professional.

Hand Protection	Butyl rubber gloves.
Skin Protection	Normal work coveralls.
Eye Protection	Chemical goggles; also wear a face shield if splashing hazard exists.
Other Precautions	None known.
Environmental Exposure Controls	Do not allow material to contaminate ground water system

9. Physical and Chemical Properties

9.1. Information on basic physical and chemical properties

Physical State:	Liquid	**Color**	Clear to slightly hazy amber
Odor:	Mild	**Odor Threshold:**	No information available

Property Remarks/ - Method	Values
pH:	6.49 - 7.49
Freezing Point / Range	-1.1 °C
Melting Point / Range	No data available
Boiling Point / Range	100 °C
Flash Point	> 95 °C / PMCC
Evaporation rate	< 1
Vapor Pressure	18 mmHg
Vapor Density	> 1
Specific Gravity	1.24
Water Solubility	Soluble in water
Solubility in other solvents	No data available
Partition coefficient: n-octanol/water	1.2
Autoignition Temperature	No data available
Decomposition Temperature	No data available
Viscosity	No data available
Explosive Properties	No information available
Oxidizing Properties	No information available

9.2. Other information

VOC Content (%)	No data available

10. Stability and Reactivity

10.1. Reactivity
Not expected to be reactive.
10.2. Chemical stability
Stable
10.3. Possibility of hazardous reactions
Will Not Occur
10.4. Conditions to avoid
None anticipated
10.5. Incompatible materials
Strong oxidizers.
10.6. Hazardous decomposition products
Carbon monoxide and carbon dioxide. Toxic monomer fumes.

11. Toxicological Information

Information on routes of exposure
Principle Route of Exposure Eye and skin contact.

Symptoms related to exposure
Most Important Symptoms/Effects

No significant hazards expected.

Numerical measures of toxicity

Toxicology data for the components

Substances	CAS Number	LD50 Oral	LD50 Dermal	LC50 Inhalation
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	No data available	No data available	No data available

Immediate, delayed and chronic health effects from exposure

Inhalation May cause mild respiratory irritation.
Eye Contact May cause mild eye irritation.
Skin Contact Prolonged or repeated contact may cause slight skin irritation.
Ingestion In large amounts: Irritation of the mouth, throat, and stomach.

Chronic Effects/Carcinogenicity No data available to indicate product or components present at greater than 0.1% are chronic health hazards.

Exposure Levels
No data available

Interactive effects
Skin disorders. Eye ailments. Respiratory disorders.

Data limitations
No data available

12. Ecological Information

Ecotoxicity
Product Ecotoxicity Data
No data available

Substance Ecotoxicity Data

Substances	CAS Number	Toxicity to Algae	Toxicity to Fish	Toxicity to Microorganisms	Toxicity to Invertebrates
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	No information available	No information available	No information available	No information available

12.2. Persistence and degradability
Biodegradable.

Substances	CAS Number	Persistence and Degradability

Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	No information available

12.3. Bioaccumulative potential

Does not bioaccumulate.

Substances	CAS Number	Log Pow
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	No information available

12.4. Mobility in soil

Substances	CAS Number	Mobility
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	No information available

12.6. Other adverse effects

Endocrine Disruptor Information

This product does not contain any known or suspected endocrine disruptors

13. Disposal Considerations

Safe handling and disposal methods

Disposal should be made in accordance with federal, state, and local regulations.

Disposal of any contaminated packaging

Follow all applicable national or local regulations.

Environmental regulations

Not applicable

14. Transport Information

Transportation Information

Australia ADG

UN Number	Not restricted
UN proper shipping name:	Not restricted
Transport Hazard Class(es):	Not applicable
Packing Group:	Not applicable
Environmental Hazards:	Not applicable

IMDG/IMO

UN Number	Not restricted
UN proper shipping name:	Not restricted
Transport Hazard Class(es):	Not applicable
Packing Group:	Not applicable
Environmental Hazards:	Not applicable

IATA/ICAO

UN Number	Not restricted
UN proper shipping name:	Not restricted
Transport Hazard Class(es):	Not applicable
Packing Group:	Not applicable
Environmental Hazards:	Not applicable

Special precautions during transport

None

HazChem Code

None Allocated

15. Regulatory Information

Safety, health and environmental regulations specific for the product

International Inventories

Australian AICS Inventory	All components are listed on the AICS or are subject to a relevant exemption, permit, or assessment certificate.
New Zealand Inventory of Chemicals	All components are listed on the NZIoC or are subject to a relevant exemption, permit, or assessment certificate.
EINECS (European Inventory of Existing Chemical Substances)	This product, and all its components, complies with EINECS
US TSCA Inventory	All components listed on inventory or are exempt.
Canadian Domestic Substances List (DSL)	All components listed on inventory or are exempt.

Poisons Schedule number
None Allocated

International Agreements

Montreal Protocol - Ozone Depleting Substances:	Does not apply
Stolkhom Convention - Persistent Organic Pollutants:	Does not apply
Rotterdam Convention - Prior Informed Consent:	Does not apply
Basel Convention - Hazardous Waste:	Does not apply

16. Other information

Date of preparation or review

Revision Date: 05-Jul-2016

Revision Note
SDS sections updated: 2

Full text of H-Statements referred to under sections 2 and 3
None

Additional information For additional information on the use of this product, contact your local Halliburton representative.

For questions about the Safety Data Sheet for this or other Halliburton products, contact Chemical Stewardship at 1-580-251-4335.

Key abreviations or acronyms used
bw – body weight
CAS – Chemical Abstracts Service
EC50 – Effective Concentration 50%
LC50 – Lethal Concentration 50%
LD50 – Lethal Dose 50%
LL50 – Lethal Loading 50%
mg/kg – milligram/kilogram
mg/L – milligram/liter
NOEC – No Observed Effect Concentration
OEL – Occupational Exposure Limit
PBT – Persistent Bioaccumulative and Toxic
ppm – parts per million
STEL – Short Term Exposure Limit
TWA – Time-Weighted Average
vPvB – very Persistent and very Bioaccumulative
h - hour

mg/m^3 - milligram/cubic meter
mm - millimeter
mmHg - millimeter mercury
w/w - weight/weight
d - day

Key literature references and sources for data
www.ChemADVISOR.com/

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End of Safety Data Sheet

HALLIBURTON

SAFETY DATA SHEET

DCA-32002

Revision Date: 07-Feb-2018 **Revision Number:** 19

1. Product Identifier & Identity for the Chemical

Statement of Hazardous Nature Hazardous according to the criteria of the 3rd Revised Edition of the Globally Harmonised System of Classification and Labelling of Chemicals (GHS), Non-Dangerous Goods according to the criteria of ADG.

1.1. Product Identifier

Product Name DCA-32002

Other means of Identification

Synonyms None

Hazardous Material Number: HM007683

Recommended use of the chemical and restrictions on use

Recommended Use Surfactant

Uses advised against No information available

Supplier's name, address and phone number

Manufacturer/Supplier Halliburton Australia Pty. Ltd.
15 Marriott Road, Jandakot, WA 6164
Australia
ACN Number: 009 000 775
Telephone Number: + 61 1 800 686 951
Fax Number: 61 (08) 9455 5300

E-mail Address fdunexchem@halliburton.com

Emergency phone number

+ 61 1 800 686 951
Global Incident Response Access Code: 334305
Contract Number: 14012

Australian Poisons Information Centre
24 Hour Service: - 13 11 26
Police or Fire Brigade: - 000 (exchange): - 1100

2. Hazard Identification

Statement of Hazardous Nature Hazardous according to the criteria of the 3rd Revised Edition of the Globally Harmonised System of Classification and Labelling of Chemicals (GHS), Non-Dangerous Goods according to the criteria of ADG.

Classification of the hazardous chemical

Acute Oral Toxicity	Category 4 - H302
Skin Corrosion/Irritation	Category 2 - H315
Serious Eye Damage/Irritation	Category 1 - H318
Acute Aquatic Toxicity	Category 2 - H401

Label elements, including precautionary statements

Hazard Pictograms



Signal Word DANGER

Hazard Statements:
H302 - Harmful if swallowed
H315 - Causes skin irritation
H318 - Causes serious eye damage
H401 - Toxic to aquatic life

Precautionary Statements

Prevention
P264 - Wash face, hands and any exposed skin thoroughly after handling
P270 - Do not eat, drink or smoke when using this product
P273 - Avoid release to the environment
P280 - Wear protective gloves/eye protection/face protection

Response
P301 + P312 - IF SWALLOWED: Call a POISON CENTER or doctor/physician if you feel unwell
P330 - Rinse mouth
P302 + P352 - IF ON SKIN: Wash with plenty of water.
P332 + P313 - If skin irritation occurs: Get medical advice/attention
P362 + P364 - Take off contaminated clothing and wash before reuse
P305 + P351 + P338 - IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing
P310 - Immediately call a POISON CENTER or doctor/physician

Storage None

Disposal P501 - Dispose of contents/container in accordance with local/regional/national/international regulations

Contains

Substances	**CAS Number**
Alcohols, C6-C12, ethoxylated propoxylated	68937-66-6
Alcohols, C10-C16, ethoxylated propoxylated	69227-22-1

Other hazards which do not result in classification
This mixture contains no substance considered to be persistent, bioaccumulating nor toxic (PBT).
This mixture contains no substance considered to be very persistent nor very bioaccumulating (vPvB).

For the full text of the H-phrases mentioned in this Section, see Section 16

3. Composition/information on Ingredients

Substances	CAS Number	PERCENT (w/w)	GHS Classification - Australia
Alcohols, C6-C12, ethoxylated propoxylated	68937-66-6	60 - 100%	Acute Tox. 4 (H302) Skin Irrit. 2 (H315) Eye Corr. 1 (H318) Aquatic Acute 2 (H401)
Alcohols, C10-C16, ethoxylated propoxylated	69227-22-1	10 - 30%	Acute Tox. 4 (H302) Skin Irrit. 2 (H315) Eye Corr. 1 (H318) Aquatic Acute 2 (H401)

4. First aid measures

Description of necessary first aid measures

Inhalation	Under normal conditions, first aid procedures are not required.
Eyes	Immediately flush eyes with large amounts of water for at least 15 minutes. Get immediate medical attention.
Skin	Wash with soap and water. Get medical attention if irritation persists.
Ingestion	Do NOT induce vomiting. Give nothing by mouth. Obtain immediate medical attention.

Symptoms caused by exposure

Causes severe eye irritation which may damage tissue. Causes skin irritation. Harmful if swallowed.

Medical Attention and Special Treatment

Notes to Physician Treat symptomatically

5. Fire Fighting Measures

Suitable extinguishing equipment

Suitable Extinguishing Media

Water fog, carbon dioxide, foam, dry chemical.

Extinguishing media which must not be used for safety reasons

None known.

Specific hazards arising from the chemical

Special exposure hazards in a fire

Decomposition in fire may produce harmful gases.

Special protective equipment and precautions for fire fighters

Special protective equipment for firefighters

Full protective clothing and approved self-contained breathing apparatus required for fire fighting personnel.

6. Accidental release measures

6.1. Personal precautions, protective equipment and emergency procedures

Use appropriate protective equipment. Avoid contact with skin, eyes and clothing. Avoid breathing vapors. Ensure adequate ventilation.

6.2. Environmental precautions

Prevent from entering sewers, waterways, or low areas.

6.3. Methods and material for containment and cleaning up

Isolate spill and stop leak where safe. Contain spill with sand or other inert materials. Scoop up and remove.

7. Handling and storage

7.1. Precautions for safe handling

Handling Precautions

Avoid contact with eyes, skin, or clothing. Wash hands after use. Avoid breathing vapors. Ensure adequate ventilation. Slippery when wet. Launder contaminated clothing before reuse. Use appropriate protective equipment.

Hygiene Measures

Handle in accordance with good industrial hygiene and safety practice.

7.2. Conditions for safe storage, including any incompatibilities

Storage Information

Store away from oxidizers. Keep container closed when not in use. Keep from heat, sparks, and open flames. Product has a shelf life of 24 months.

Other Guidelines

No information available

8. Exposure Controls/Personal Protection

Control parameters - exposure standards, biological monitoring

Exposure Limits

Substances	CAS Number	Australia NOHSC	ACGIH TLV-TWA
Alcohols, C6-C12, ethoxylated propoxylated	68937-66-6	Not applicable	Not applicable
Alcohols, C10-C16, ethoxylated propoxylated	69227-22-1	Not applicable	Not applicable

Appropriate engineering controls

Engineering Controls None known.

Personal protective equipment (PPE)

Personal Protective Equipment If engineering controls and work practices cannot prevent excessive exposures, the selection and proper use of personal protective equipment should be determined by an industrial hygienist or other qualified professional based on the specific application of this product.

Respiratory Protection If engineering controls and work practices cannot keep exposure below occupational exposure limits or if exposure is unknown, wear a NIOSH certified, European Standard EN 149, AS/NZS 1715:2009, or equivalent respirator when using this product. Selection of and instruction on using all personal protective equipment, including respirators, should be performed by an Industrial Hygienist or other qualified professional.

Hand Protection Impervious rubber gloves. Polyvinylchloride gloves.
Skin Protection Normal work coveralls.
Eye Protection Wear safety glasses or goggles to protect against exposure.
Other Precautions None known.
Environmental Exposure Controls Do not allow material to contaminate ground water system

9. Physical and Chemical Properties

9.1. Information on basic physical and chemical properties

Physical State: Liquid
Odor: Mild
Color Yellow
Odor Threshold: No information available

Property Remarks/ - Method	Values
pH:	6.5 (1%)
Freezing Point / Range	-3 °C
Melting Point / Range	No data available
Boiling Point / Range	No data available
Flash Point	240 °C / 464 °F PMCC
Evaporation rate	No data available
Vapor Pressure	No data available
Vapor Density	> 10
Specific Gravity	0.98
Water Solubility	Soluble in water
Solubility in other solvents	No data available
Partition coefficient: n-octanol/water	No data available
Autoignition Temperature	No data available
Decomposition Temperature	No data available
Viscosity	No data available
Explosive Properties	No information available
Oxidizing Properties	No information available

9.2. Other information

VOC Content (%) No data available

10. Stability and Reactivity

10.1. Reactivity

Not expected to be reactive.

10.2. Chemical stability

Stable

10.3. Possibility of hazardous reactions

Will Not Occur

10.4. Conditions to avoid

None anticipated

10.5. Incompatible materials

Strong oxidizers. Strong acids. Strong alkalis.

10.6. Hazardous decomposition products

Carbon monoxide and carbon dioxide.

11. Toxicological Information

Information on routes of exposure

Principle Route of Exposure Eye or skin contact, inhalation.

Symptoms related to exposure

Most Important Symptoms/Effects

Causes severe eye irritation which may damage tissue. Causes skin irritation. Harmful if swallowed.

Toxicology data for the components

Substances	CAS Number	LD50 Oral	LD50 Dermal	LC50 Inhalation
Alcohols, C6-C12, ethoxylated propoxylated	68937-66-6	600 mg/kg (Rat) (similar substance)	> 5200 mg/kg (Rabbit) (similar substance)	> 0.22 mg/L (saturated concentration) (Rat) (similar substance)
Alcohols, C10-C16, ethoxylated propoxylated	69227-22-1	600 mg/kg (Rat) (similar substance)	> 5200 mg/kg (Rabbit) (similar substance)	>0.22 mg/L (saturated concentration) (Rat) (similar substance)

Immediate, delayed and chronic health effects from exposure

Inhalation May cause mild respiratory irritation.

Eye Contact Causes severe eye irritation which may damage tissue.

Skin Contact Causes skin irritation.

Ingestion Harmful if swallowed. Irritation of the mouth, throat, and stomach.

Chronic Effects/Carcinogenicity No data available to indicate product or components present at greater than 0.1% are chronic health hazards.

Exposure Levels

No data available

Interactive effects

Skin disorders.

Data limitations

No data available

Substances	CAS Number	Skin corrosion/irritation
Alcohols, C6-C12, ethoxylated propoxylated	68937-66-6	Causes skin irritation. (Rabbit) (similar substances)
Alcohols, C10-C16, ethoxylated propoxylated	69227-22-1	Causes skin irritation. (Rabbit) (similar substances)

Substances	CAS Number	Serious eye damage/irritation
Alcohols, C6-C12, ethoxylated propoxylated	68937-66-6	Causes severe eye irritation (Rabbit) (similar substances)
Alcohols, C10-C16, ethoxylated propoxylated	69227-22-1	Causes severe eye irritation (Rabbit) (similar substances)

Substances	CAS Number	Skin Sensitization

Alcohols, C6-C12, ethoxylated propoxylated	68937-66-6	Did not cause sensitization on laboratory animals (guinea pig) (similar substances)
Alcohols, C10-C16, ethoxylated propoxylated	69227-22-1	Did not cause sensitization on laboratory animals (guinea pig) (similar substances)

Substances	CAS Number	Respiratory Sensitization
Alcohols, C6-C12, ethoxylated propoxylated	68937-66-6	No information available
Alcohols, C10-C16, ethoxylated propoxylated	69227-22-1	No information available

Substances	CAS Number	Mutagenic Effects
Alcohols, C6-C12, ethoxylated propoxylated	68937-66-6	In vitro tests did not show mutagenic effects. In vivo tests did not show mutagenic effects. (similar substances)
Alcohols, C10-C16, ethoxylated propoxylated	69227-22-1	In vitro tests did not show mutagenic effects. In vivo tests did not show mutagenic effects. (similar substances)

Substances	CAS Number	Carcinogenic Effects
Alcohols, C6-C12, ethoxylated propoxylated	68937-66-6	Did not show carcinogenic effects in animal experiments (similar substances)
Alcohols, C10-C16, ethoxylated propoxylated	69227-22-1	Did not show carcinogenic or teratogenic effects in animal experiments (similar substances)

Substances	CAS Number	Reproductive toxicity
Alcohols, C6-C12, ethoxylated propoxylated	68937-66-6	Animal testing did not show any effects on fertility.
Alcohols, C10-C16, ethoxylated propoxylated	69227-22-1	Animal testing did not show any effects on fertility.

Substances	CAS Number	STOT - single exposure
Alcohols, C6-C12, ethoxylated propoxylated	68937-66-6	No significant toxicity observed in animal studies at concentration requiring classification. (similar substances)
Alcohols, C10-C16, ethoxylated propoxylated	69227-22-1	No significant toxicity observed in animal studies at concentration requiring classification. (similar substances)

Substances	CAS Number	STOT - repeated exposure
Alcohols, C6-C12, ethoxylated propoxylated	68937-66-6	No significant toxicity observed in animal studies at concentration requiring classification. (similar substances)
Alcohols, C10-C16, ethoxylated propoxylated	69227-22-1	No significant toxicity observed in animal studies at concentration requiring classification. (similar substances)

Substances	CAS Number	Aspiration hazard
Alcohols, C6-C12, ethoxylated propoxylated	68937-66-6	No adverse health effects are expected from swallowing.
Alcohols, C10-C16, ethoxylated propoxylated	69227-22-1	No adverse health effects are expected from swallowing.

12. Ecological Information

Ecotoxicity

Algae Toxicity ErC50 (72h): 2.58 - 3.44 mg/L (Desmodesmus subspicatus)

Acute Crustaceans Toxicity: EC50(48h): 1.45 - 1.79 mg/L (Daphnia magna)

Substance Ecotoxicity Data

Substances	CAS Number	Toxicity to Algae	Toxicity to Fish	Toxicity to Microorganisms	Toxicity to Invertebrates
Alcohols, C6-C12, ethoxylated propoxylated	68937-66-6	EC50 (72h) 0.75 mg/L (Pseudokirchnerella subcapitata) (similar substance) EC50 (96h) 0.7 mg/L (Pseudokirchneriella subapitata) (similar substance) CD10 8 mg/L	LC50 (96h) 0.59 mg/L (Pleuronectes platessa) (similar substance) LC50 (96) 1.4 mg/L (Pimephales promelas) (similar substance) NOEC 4.4 mg/L (Pimephales promelas, juvenile)	ErC50 (16.9h) > 10 g/L (growth inhibition) (Pseudomonas putida) (similar substance)	EC50 (48h) 0.14 mg/L (Daphnia magna) (similar substance) EC50 (48h) 0.39 mg/L (Cerodaphnia dubia) (similar substance)

		(Pseudokirchneriella subapitata) EC10 2 mg/L (Brachionus calyciflorus)			
Alcohols, C10-C16, ethoxylated propoxylated	69227-22-1	EC50 (72h) 0.75 mg/L (Pseudokirchnerella subcapitata) (similar substance) ErC50 (48h) 0.7 mg/L (Skeletonema costatum) EC10 9.79 mg/L (Selenastrum capricornutum) (similar substance) ErC50 1.1 mg/L (Scenedesmus subspicatus) (similar substance)	LC50 (96h) 0.59 mg/L (Pleuronectes platessa) (similar substance) LC50 (96h) 1.6 mg/L (Pimephales promelas) (similar substace) LC50 (96h) 3 mg/L (Brachydanio rerio) (similar substance)	ErC50 (16.9h) > 10 g/L (Pseudomonas putida) (similar substance)	EC50 (48h) 0.14 mg/L (Daphnia magna) (similar substance) EC50 (48h) 02 mg/L (Daphnia magna) (similar substance)

12.2. Persistence and degradability

Readily biodegradable

Substances	CAS Number	Persistence and Degradability
Alcohols, C6-C12, ethoxylated propoxylated	68937-66-6	Readily biodegradable (60% @ 28d) (similar substances)
Alcohols, C10-C16, ethoxylated propoxylated	69227-22-1	Readily biodegradable (84% @ 28d) (similar substances)

12.3. Bioaccumulative potential

Substances	CAS Number	Log Pow
Alcohols, C6-C12, ethoxylated propoxylated	68937-66-6	Log Pow: 4.3 - 5.36 (estimated) BCF: 1.1 - 1.8 (fish, estimated)
Alcohols, C10-C16, ethoxylated propoxylated	69227-22-1	Log Pow: 4.3 - 5.36 (estimated) BCF: 1.1 - 1.8 (fish, estimated)

12.4. Mobility in soil

Substances	CAS Number	Mobility
Alcohols, C6-C12, ethoxylated propoxylated	68937-66-6	KOC = >4
Alcohols, C10-C16, ethoxylated propoxylated	69227-22-1	KOC = >4

12.6. Other adverse effects

Endocrine Disruptor Information

This product does not contain any known or suspected endocrine disruptors

13. Disposal Considerations

Safe handling and disposal methods

Disposal should be made in accordance with federal, state, and local regulations.

Disposal of any contaminated packaging

Follow all applicable national or local regulations. Contaminated packaging may be disposed of by: rendering packaging incapable of containing any substance, or treating packaging to remove residual contents, or treating packaging to make sure the residual contents are no longer hazardous, or by disposing of packaging into commercial waste collection.

Environmental regulations

Not applicable

14. Transport Information

Transportation Information

Australia ADG

UN Number Not restricted

UN proper shipping name:	Not restricted
Transport Hazard Class(es):	Not applicable
Packing Group:	Not applicable
Environmental Hazards:	Not applicable

IMDG/IMO

UN Number	Not restricted
UN proper shipping name:	Not restricted
Transport Hazard Class(es):	Not applicable
Packing Group:	Not applicable
Environmental Hazards:	Not applicable

IATA/ICAO

UN Number	Not restricted
UN proper shipping name:	Not restricted
Transport Hazard Class(es):	Not applicable
Packing Group:	Not applicable
Environmental Hazards:	Not applicable

Special precautions during transport
None

HazChem Code
•3Z

15. Regulatory Information

Safety, health and environmental regulations specific for the product

International Inventories

Australian AICS Inventory	All components are listed on the AICS or are subject to a relevant exemption, permit, or assessment certificate.
New Zealand Inventory of Chemicals	All components are listed on the NZIoC or are subject to a relevant exemption, permit, or assessment certificate.
EINECS (European Inventory of Existing Chemical Substances)	This product, and all its components, complies with EINECS
US TSCA Inventory	All components listed on inventory or are exempt.
Canadian Domestic Substances List (DSL)	All components listed on inventory or are exempt.

Poisons Schedule number
None Allocated

International Agreements

Montreal Protocol - Ozone Depleting Substances:	Does not apply
Stockholm Convention - Persistent Organic Pollutants:	Does not apply
Rotterdam Convention - Prior Informed Consent:	Does not apply
Basel Convention - Hazardous Waste:	Does not apply

16. Other information

Date of preparation or review

Revision Date: 07-Feb-2018

Revision Note
SDS sections updated:
2

Full text of H-Statements referred to under sections 2 and 3
H302 - Harmful if swallowed

H315 - Causes skin irritation
H318 - Causes serious eye damage

Additional information

For additional information on the use of this product, contact your local Halliburton representative.

For questions about the Safety Data Sheet for this or other Halliburton products, contact Chemical Stewardship at 1-580-251-4335.

Key abreviations or acronyms used

bw – body weight
CAS – Chemical Abstracts Service
EC50 – Effective Concentration 50%
LC50 – Lethal Concentration 50%
LD50 – Lethal Dose 50%
LL50 – Lethal Loading 50%
mg/kg – milligram/kilogram
mg/L – milligram/liter
NOEC – No Observed Effect Concentration
OEL – Occupational Exposure Limit
PBT – Persistent Bioaccumulative and Toxic
ppm – parts per million
STEL – Short Term Exposure Limit
TWA – Time-Weighted Average
vPvB – very Persistent and very Bioaccumulative
h - hour
mg/m^3 - milligram/cubic meter
mm - millimeter
mmHg - millimeter mercury
w/w - weight/weight
d - day

Key literature references and sources for data

www.ChemADVISOR.com/
NZ CCID

Disclaimer Statement

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End of Safety Data Sheet

HALLIBURTON

SAFETY DATA SHEET

DCA-32014

Revision Date: 31-Aug-2017 **Revision Number:** 3

1. Product Identifier & Identity for the Chemical

Statement of Hazardous Nature Hazardous according to the criteria of the 3rd Revised Edition of the Globally Harmonised System of Classification and Labelling of Chemicals (GHS), Dangerous Goods according to the criteria of ADG.

1.1. Product Identifier

Product Name DCA-32014

Other means of Identification

Synonyms None

Hazardous Material Number: HM008547

Recommended use of the chemical and restrictions on use

Recommended Use Surfactant

Uses advised against Consumer use

Supplier's name, address and phone number

Manufacturer/Supplier Halliburton Australia Pty. Ltd.
15 Marriott Road, Jandakot, WA 6164
Australia
ACN Number: 009 000 775
Telephone Number: + 61 1 800 686 951
Fax Number: 61 (08) 9455 5300

E-mail Address fdunexchem@halliburton.com

Emergency phone number

+ 61 1 800 686 951
Global Incident Response Access Code: 334305
Contract Number: 14012

Australian Poisons Information Centre
24 Hour Service: - 13 11 26
Police or Fire Brigade: - 000 (exchange): - 1100

2. Hazard Identification

Statement of Hazardous Nature Hazardous according to the criteria of the 3rd Revised Edition of the Globally Harmonised System of Classification and Labelling of Chemicals (GHS), Dangerous Goods according to the criteria of ADG.

Classification of the hazardous chemical

Aspiration Toxicity	Category 1 - H304
Skin Corrosion/Irritation	Category 2 - H315
Serious Eye Damage/Irritation	Category 1 - H318
Reproductive Toxicity	Category 1B - H360
Acute Aquatic Toxicity	Category 2 - H401
Flammable liquids.	Category 3 - H226

Label elements, including precautionary statements

Hazard Pictograms



Signal Word DANGER

Hazard Statements:
H226 - Flammable liquid and vapor
H304 - May be fatal if swallowed and enters airways
H315 - Causes skin irritation
H318 - Causes serious eye damage
H360 - May damage fertility or the unborn child
H401 - Toxic to aquatic life

Precautionary Statements

Prevention
P201 - Obtain special instructions before use
P202 - Do not handle until all safety precautions have been read and understood
P210 - Keep away from heat, hot surfaces, sparks, open flames and other ignition sources. No smoking.
P233 - Keep container tightly closed
P240 - Ground and bond container and receiving equipment.
P241 - Use explosion-proof electrical/ventilating/lighting/equipment
P242 - Use only non-sparking tools
P243 - Take action to prevent static discharges.
P264 - Wash face, hands and any exposed skin thoroughly after handling
P273 - Avoid release to the environment
P280 - Wear protective gloves/protective clothing/eye protection/face protection
P281 - Use personal protective equipment as required

Response
P301 + P310 - IF SWALLOWED: Immediately call a POISON CENTER or doctor/physician
P331 - Do NOT induce vomiting
P302 + P352 - IF ON SKIN: Wash with plenty of water.
P332 + P313 - If skin irritation occurs: Get medical advice/attention
P362 + P364 - Take off contaminated clothing and wash before reuse
P305 + P351 + P338 - IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing
P310 - Immediately call a POISON CENTER or doctor/physician
P308 + P313 - IF exposed or concerned: Get medical advice/attention
P370 + P378 - In case of fire: Use water spray for extinction

Storage
P403 + P235 - Store in a well-ventilated place. Keep cool
P405 - Store locked up

Disposal
P501 - Dispose of contents/container in accordance with local/regional/national/international regulations

Contains

Substances	**CAS Number**
Hydrotreated light petroleum distillate	64742-47-8
Ethanol	64-17-5
Fatty acids, tall-oil, ethoxylated	61791-00-2
C12-C15 Ethoxylated alcohols	68131-39-5
Amides, tall-oil fatty, N,N-bis(hydroxyethyl)	68155-20-4
Butyl alcohol	71-36-3

Methanol 67-56-1

Other hazards which do not result in classification
None known

For the full text of the H-phrases mentioned in this Section, see Section 16

3. Composition/information on Ingredients

Substances	CAS Number	PERCENT (w/w)	GHS Classification - Australia
Hydrotreated light petroleum distillate	64742-47-8	10 - 30%	Asp. Tox. 1 (H304)
Ethanol	64-17-5	10 - 30%	Eye Irrit. 2A (H319) Flam. Liq. 2 (H225)
Fatty acids, tall-oil, ethoxylated	61791-00-2	10 - 30%	Skin Irrit. 2 (H315) Eye Irrit. 2A (H319)
C12-C15 Ethoxylated alcohols	68131-39-5	10 - 30%	Acute Tox. 4 (H302) Skin Irrit. 2 (H315) Eye Corr. 1 (H318) Aquatic Acute 1 (H400) Aquatic Chronic 3 (H412)
Amides, tall-oil fatty, N,N-bis(hydroxyethyl)	68155-20-4	10 - 30%	Skin Irrit. 2 (H315) Eye Corr. 1 (H318) Aquatic Acute 2 (H401) Aquatic Chronic 3 (H412)
Butyl alcohol	71-36-3	5 - 10%	Acute Tox. 4 (H302) Skin Irrit. 2 (H315) Eye Corr. 1 (H318) STOT SE 3 (H335) Flam. Liq. 3 (H226)
Methanol	67-56-1	0.1 - 1%	Acute Tox. 3 (H301) Acute Tox. 3 (H311) Acute Tox. 3 (H331) Repr. 1B (H360) STOT SE 1 (H370) Flam. Liq. 2 (H225)

4. First aid measures

Description of necessary first aid measures

Inhalation If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.

Eyes In case of contact, immediately flush eyes with plenty of water for at least 30 minutes. Remove contact lenses after the first 5 minutes and continue washing. Seek immediate medical attention/advice. Suitable emergency eye wash facility should be immediately available

Skin In case of contact, immediately flush skin with plenty of soap and water for at least 15 minutes. Get medical attention.

Ingestion Get medical attention! If vomiting occurs, keep head lower than hips to prevent aspiration. Rinse mouth. Never give anything by mouth to an unconscious person. Following ingestion, onset of symptoms may be delayed by 12 to 24 hours. Admission to hospital should be the first priority even if symptoms are absent.

Symptoms caused by exposure

Causes severe eye irritation which may damage tissue. Causes skin irritation. Aspiration into the lungs may cause chemical pneumonitis including coughing, difficulty breathing, wheezing, coughing up blood and pneumonia, which can be fatal. Potential reproductive hazard. May cause birth defects.

Medical Attention and Special Treatment

Notes to Physician Treat symptomatically

5. Fire Fighting Measures

Suitable extinguishing equipment

Suitable Extinguishing Media

Water fog, carbon dioxide, foam, dry chemical.

Extinguishing media which must not be used for safety reasons

Do NOT spray pool fires directly with water. A solid stream of water directed into hot burning liquid can cause splattering.

Specific hazards arising from the chemical

Special exposure hazards in a fire

Decomposition in fire may produce harmful gases.

Special protective equipment and precautions for fire fighters

Special protective equipment for firefighters

Full protective clothing and approved self-contained breathing apparatus required for fire fighting personnel.

6. Accidental release measures

6.1. Personal precautions, protective equipment and emergency procedures

Ensure adequate ventilation. Use appropriate protective equipment. Remove sources of ignition. Take precautionary measures against static discharges All equipment used when handling the product must be grounded Avoid contact with skin, eyes and clothing.

6.2. Environmental precautions

Prevent from entering sewers, waterways, or low areas.

6.3. Methods and material for containment and cleaning up

Dike far ahead of liquid spill for later disposal. Soak up with inert absorbent material. Pick up and transfer to properly labeled containers. Remove ignition sources and work with non-sparking tools.

7. Handling and storage

7.1. Precautions for safe handling

Handling Precautions

Ensure adequate ventilation. Use appropriate protective equipment. Remove sources of ignition. Ground and bond containers when transferring from one container to another. Avoid contact with eyes, skin, or clothing.

Hygiene Measures

Handle in accordance with good industrial hygiene and safety practice.

7.2. Conditions for safe storage, including any incompatibilities

Storage Information

Store in a cool well ventilated area. Keep from heat, sparks, and open flames.

Other Guidelines

No information available

8. Exposure Controls/Personal Protection

Control parameters - exposure standards, biological monitoring

Exposure Limits

Substances	CAS Number	Australia NOHSC	ACGIH TLV-TWA
Hydrotreated light petroleum distillate	64742-47-8	Not applicable	Not applicable
Ethanol	64-17-5	TWA: 1000 ppm TWA: 1880 mg/m^3	STEL: 1000 ppm
Fatty acids, tall-oil, ethoxylated	61791-00-2	Not applicable	Not applicable
C12-C15 Ethoxylated alcohols	68131-39-5	Not applicable	Not applicable
Amides, tall-oil fatty, N,N-bis(hydroxyethyl)	68155-20-4	Not applicable	Not applicable
Butyl alcohol	71-36-3	50 ppm	TWA: 20 ppm

Methanol	67-56-1	TWA: 200 ppm TWA: 262 mg/m^3 STEL: 250 ppm STEL: 328 mg/m^3	TWA: 200 ppm STEL: 250 ppm

Appropriate engineering controls

Engineering Controls Ensure adequate ventilation, especially in confined areas

Personal protective equipment (PPE)

Personal Protective Equipment If engineering controls and work practices cannot prevent excessive exposures, the selection and proper use of personal protective equipment should be determined by an industrial hygienist or other qualified professional based on the specific application of this product.

Respiratory Protection If engineering controls and work practices cannot keep exposure below occupational exposure limits or if exposure is unknown, wear a NIOSH certified, European Standard EN 149, AS/NZS 1715:2009, or equivalent respirator when using this product. Selection of and instruction on using all personal protective equipment, including respirators, should be performed by an Industrial Hygienist or other qualified professional.
Organic vapor respirator.

Hand Protection Use gloves which are suitable for the chemicals present in this product as well as other environmental factors in the workplace.

Skin Protection Wear impervious protective clothing, including boots, gloves, lab coat, apron, rain jacket, pants or coverall, as appropriate, to prevent skin contact.

Eye Protection Chemical goggles; also wear a face shield if splashing hazard exists.

Other Precautions Eyewash fountains and safety showers must be easily accessible.

Environmental Exposure Controls No information available

9. Physical and Chemical Properties

9.1. Information on basic physical and chemical properties

Physical State: Liquid
Color Colorless to Light Amber
Odor: Mild hydrocarbon
Odor Threshold: No information available

Property Remarks/ - Method	Values
pH:	No data available
Freezing Point / Range	-44.2 °C
Melting Point / Range	No data available
Boiling Point / Range	No data available
Flash Point	34 °C / 93.2 °F
Evaporation rate	No data available
Vapor Pressure	No data available
Vapor Density	No data available
Specific Gravity	0.918
Water Solubility	No data available
Solubility in other solvents	No data available
Partition coefficient: n-octanol/water	No data available
Autoignition Temperature	No data available
Decomposition Temperature	No data available
Viscosity	No data available
Explosive Properties	No information available
Oxidizing Properties	No information available

9.2. Other information

VOC Content (%) No data available

10. Stability and Reactivity

10.1. Reactivity

Not expected to be reactive.

10.2. Chemical stability
Stable
10.3. Possibility of hazardous reactions
Will Not Occur
10.4. Conditions to avoid
Keep away from heat, sparks and flame.
10.5. Incompatible materials
Strong oxidizers. Strong acids. Strong alkalis.
10.6. Hazardous decomposition products
Carbon oxides. Oxides of nitrogen.

11. Toxicological Information

Information on routes of exposure
Principle Route of Exposure Skin contact. Eye contact. Inhalation.

Symptoms related to exposure
Most Important Symptoms/Effects
Causes severe eye irritation which may damage tissue. Causes skin irritation. Aspiration into the lungs may cause chemical pneumonitis including coughing, difficulty breathing, wheezing, coughing up blood and pneumonia, which can be fatal. Potential reproductive hazard. May cause birth defects.

Toxicology data for the components

Substances	CAS Number	LD50 Oral	LD50 Dermal	LC50 Inhalation
Hydrotreated light petroleum distillate	64742-47-8	>5000 mg/kg-bw (rat) (similar substance)	>2000 mg/kg-bw (rabbit) (similar substance)	>5.2 mg/L (rat, 4 h, vapor) (similar substance)
Ethanol	64-17-5	7060 mg/kg (Rat) 10,470 mg/kg (Rat)	> 15,800 mg/kg (Rabbit) 17,100 mg/kg (Rabbit)	124.7 mg/L (Rat) 4h
Fatty acids, tall-oil, ethoxylated	61791-00-2	> 6400 mg/kg (Rat)	No data available	No data available
C12-C15 Ethoxylated alcohols	68131-39-5	2 g/kg (Rat) 1600 mg/kg (Rat) > 5000 mg/kg (Rat)	> 2000 mg/kg (Rat) 2500 mg/kg (Rabbit)	No data available
Amides, tall-oil fatty, N,N-bis(hydroxyethyl)	68155-20-4	3500 mg/kg (Rat) > 5000 mg/kg (Rat)	> 2000 mg/kg (Rabbit)	> 0.219 mg/L (Mouse) 4h (similar substance)
Butyl alcohol	71-36-3	790 mg/kg (Rat)	3400 mg/kg (Rabbit)	> 17.6 mg/L (Rat) 4h
Methanol	67-56-1	300 mg/kg-bw (human) < 790 to 13,000 mg/kg (rat)	1000 mg/kg-bw (human) 17,100 mg/kg (rabbit)	10 mg/L (human, 4h, vapor)

Immediate, delayed and chronic health effects from exposure
Inhalation May cause central nervous system depression including headache, dizziness, drowsiness, incoordination, slowed reaction time, slurred speech, giddiness and unconsciousness.
Eye Contact Causes severe eye irritation which may damage tissue.
Skin Contact Causes skin irritation.
Ingestion Aspiration into the lungs may cause chemical pneumonitis including coughing, difficulty breathing, wheezing, coughing up blood and pneumonia, which can be fatal. Ingestion of this product may cause blindness due to the presence of methanol.

Chronic Effects/Carcinogenicity Prolonged or repeated exposure may cause reproductive system damage. May cause birth defects.

Exposure Levels
No data available

Interactive effects
No data available

Data limitations
No data available

Substances	CAS Number	Skin corrosion/irritation
Hydrotreated light petroleum distillate	64742-47-8	Non-irritating to the skin (similar substances)
Ethanol	64-17-5	Not irritating to skin in rabbits.
Fatty acids, tall-oil, ethoxylated	61791-00-2	Irritating to skin.
C12-C15 Ethoxylated alcohols	68131-39-5	May cause moderate skin irritation. (Rabbit)
Amides, tall-oil fatty, N,N-bis(hydroxyethyl)	68155-20-4	Skin, rabbit: Causes moderate skin irritation. (similar substances)
Butyl alcohol	71-36-3	Causes moderate skin irritation.
Methanol	67-56-1	Non-irritating to the skin (Rabbit)

Substances	CAS Number	Serious eye damage/irritation
Hydrotreated light petroleum distillate	64742-47-8	Non-irritating to rabbit's eye (similar substances)
Ethanol	64-17-5	Causes moderate eye irritation (Rabbit)
Fatty acids, tall-oil, ethoxylated	61791-00-2	Irritating to eyes
C12-C15 Ethoxylated alcohols	68131-39-5	Risk of serious damage to eyes (Rabbit) (similar substances)
Amides, tall-oil fatty, N,N-bis(hydroxyethyl)	68155-20-4	Causes severe eye irritation (similar substances)
Butyl alcohol	71-36-3	Causes severe eye irritation
Methanol	67-56-1	Non-irritating to the eye (Rabbit)

Substances	CAS Number	Skin Sensitization
Hydrotreated light petroleum distillate	64742-47-8	Did not cause sensitization on laboratory animals (guinea pig) (similar substances)
Ethanol	64-17-5	Did not cause sensitization on laboratory animals
Fatty acids, tall-oil, ethoxylated	61791-00-2	No information available
C12-C15 Ethoxylated alcohols	68131-39-5	Did not cause sensitization on laboratory animals (guinea pig)
Amides, tall-oil fatty, N,N-bis(hydroxyethyl)	68155-20-4	Did not cause sensitization on laboratory animals (similar substances)
Butyl alcohol	71-36-3	Not confirmed to cause skin or respiratory sensitization.
Methanol	67-56-1	Did not cause sensitization on laboratory animals (guinea pig)

Substances	CAS Number	Respiratory Sensitization
Hydrotreated light petroleum distillate	64742-47-8	No information available
Ethanol	64-17-5	Did not cause sensitization on laboratory animals
Fatty acids, tall-oil, ethoxylated	61791-00-2	No information available
C12-C15 Ethoxylated alcohols	68131-39-5	No information available
Amides, tall-oil fatty, N,N-bis(hydroxyethyl)	68155-20-4	No information available
Butyl alcohol	71-36-3	No information available
Methanol	67-56-1	No information available

Substances	CAS Number	Mutagenic Effects
Hydrotreated light petroleum distillate	64742-47-8	In vitro tests did not show mutagenic effects. In vivo tests did not show mutagenic effects. (similar substances)
Ethanol	64-17-5	Not regarded as mutagenic.
Fatty acids, tall-oil, ethoxylated	61791-00-2	No information available
C12-C15 Ethoxylated alcohols	68131-39-5	In vivo tests did not show mutagenic effects. In vitro tests did not show mutagenic effects.
Amides, tall-oil fatty, N,N-bis(hydroxyethyl)	68155-20-4	In vitro tests did not show mutagenic effects. In vivo tests did not show mutagenic effects. (similar substances)
Butyl alcohol	71-36-3	In vitro tests did not show mutagenic effects.
Methanol	67-56-1	The weight of evidence from available in vitro and in vivo studies indicates that this substance is not expected to be mutagenic.

Substances	CAS Number	Carcinogenic Effects

Hydrotreated light petroleum distillate	64742-47-8	Did not show carcinogenic effects in animal experiments (similar substances)
Ethanol	64-17-5	Did not show carcinogenic effects in animal experiments
Fatty acids, tall-oil, ethoxylated	61791-00-2	No information available
C12-C15 Ethoxylated alcohols	68131-39-5	Did not show carcinogenic effects in animal experiments
Amides, tall-oil fatty, N,N-bis(hydroxyethyl)	68155-20-4	Not regarded as carcinogenic.
Butyl alcohol	71-36-3	No information available
Methanol	67-56-1	No data of sufficient quality are available.

Substances	CAS Number	Reproductive toxicity
Hydrotreated light petroleum distillate	64742-47-8	Animal testing did not show any effects on fertility. Did not show teratogenic effects in animal experiments. (similar substances)
Ethanol	64-17-5	Animal testing did not show any effects on fertility.
Fatty acids, tall-oil, ethoxylated	61791-00-2	No information available
C12-C15 Ethoxylated alcohols	68131-39-5	No significant toxicity observed in animal studies at concentration requiring classification.
Amides, tall-oil fatty, N,N-bis(hydroxyethyl)	68155-20-4	Not a confirmed teratogen or embryotoxin.
Butyl alcohol	71-36-3	Animal testing did not show any effects on fertility. Did not show teratogenic effects in animal experiments.
Methanol	67-56-1	Experiments have shown reproductive toxicity effects on laboratory animals

Substances	CAS Number	STOT - single exposure
Hydrotreated light petroleum distillate	64742-47-8	No significant toxicity observed in animal studies at concentration requiring classification.
Ethanol	64-17-5	No significant toxicity observed in animal studies at concentration requiring classification.
Fatty acids, tall-oil, ethoxylated	61791-00-2	No information available
C12-C15 Ethoxylated alcohols	68131-39-5	No significant toxicity observed in animal studies at concentration requiring classification. (similar substances)
Amides, tall-oil fatty, N,N-bis(hydroxyethyl)	68155-20-4	No significant toxicity observed in animal studies at concentration requiring classification.
Butyl alcohol	71-36-3	May cause respiratory irritation.
Methanol	67-56-1	May cause disorder and damage to the Central Nervous System (CNS)

Substances	CAS Number	STOT - repeated exposure
Hydrotreated light petroleum distillate	64742-47-8	No significant toxicity observed in animal studies at concentration requiring classification. (similar substances)
Ethanol	64-17-5	No significant toxicity observed in animal studies at concentration requiring classification.
Fatty acids, tall-oil, ethoxylated	61791-00-2	No information available
C12-C15 Ethoxylated alcohols	68131-39-5	No significant toxicity observed in animal studies at concentration requiring classification. (similar substances)
Amides, tall-oil fatty, N,N-bis(hydroxyethyl)	68155-20-4	No significant toxicity observed in animal studies at concentration requiring classification.
Butyl alcohol	71-36-3	No significant toxicity observed in animal studies at concentration requiring classification.
Methanol	67-56-1	No data of sufficient quality are available.

Substances	CAS Number	Aspiration hazard
Hydrotreated light petroleum distillate	64742-47-8	Aspiration into the lungs may cause chemical pneumonitis including coughing, difficulty breathing, wheezing, coughing up blood and pneumonia, which can be fatal.
Ethanol	64-17-5	Not applicable
Fatty acids, tall-oil, ethoxylated	61791-00-2	Not applicable
C12-C15 Ethoxylated alcohols	68131-39-5	No adverse health effects are expected from swallowing.
Amides, tall-oil fatty, N,N-bis(hydroxyethyl)	68155-20-4	No information available
Butyl alcohol	71-36-3	Aspiration into the lungs may cause chemical pneumonitis including coughing, difficulty breathing, wheezing, coughing up blood and pneumonia, which can be fatal.
Methanol	67-56-1	Not applicable

12. Ecological Information

Ecotoxicity

Product Ecotoxicity Data

Product is not classified as hazardous to the environment.

Substance Ecotoxicity Data

Substances	CAS Number	Toxicity to Algae	Toxicity to Fish	Toxicity to Microorganisms	Toxicity to Invertebrates
Hydrotreated light petroleum distillate	64742-47-8	ErL50(72 h)>10000 mg/L (Skeletonema costatum)	LC50(96 h)>10000 mg/L (Scophthalmus maximus) NOELC(28 d)>1000 mg/L (fish)	No information available	LC50(48 h)>10000 mg/L (Acartia tonsa) NOEC(21 d)=1000 mg/L (Daphnia magna)
Ethanol	64-17-5	No information available	LC50 > 100 mg/L (Pimephales promelas)	No information available	LC50 9268 - 14,221 mg/L (Daphnia magna) LC50 5012 mg/L (Ceridaphnia dubia) NOEC 9.6 mg/L (Daphnia magna)
Fatty acids, tall-oil, ethoxylated	61791-00-2	EC50 (72h) > 44 mg/L EC50 (72h) 2.5 mg/L (Skeletonema costatum)	LC50 (95h) 7.8 mg/L (Brachydanio rerio) LC50 (96h) 45 mg/L (Cyprinodon variegatus)	EC20 (180m) >1000 mg/L	EC50 (48h) 16 mg/L (Daphnia magna) EC50 (48h) 26.8 mg/L (Acartia tonsa)
C12-C15 Ethoxylated alcohols	68131-39-5	No information available	EC50 (48h) 0.39 mg/L (Ceriodaphnia dubia) NOEC (30d) 0.28 mg/L (Pimephales promelas) NOEC (16d) 0.16 mg/L(Lepomis macrochirus)	No information available	No information available
Amides, tall-oil fatty, N,N-bis(hydroxyethyl)	68155-20-4	EC50 (72h) 2.2 mg/L (Scendesmus subspicatus) (similar substance)	LC50 (96h) 6.7 mg/L (Danio rerio) (similar substance)	No information available	LC50 (21d) = 0.1 mg/L (Daphnia magna) LC50 (48h) = 2.15 mg/L
Butyl alcohol	71-36-3	EC50 (96h) 225 mg/L (Pseudokirchnerella subcapitata)	LC50 (96h) 1376 mg/L (Pimephales promelas)	No information available	EC50 (48h) 1328 mg/L (Daphnia magna) NOEC (21d) 4.1 mg/L (Daphnia magna) EC50 (21d) 18 mg/L (Daphnia magna)
Methanol	67-56-1	EC50 (96 h) =22000 mg/L (Pseudokirchnerella subcapitata) NOEC (8 d) =8000 mg/L (Scenedesmus quadricauda)	LC50 (96 h) =15400 mg/L (Lepomis macrochirus) EC50 (200 h) =14536 mg/L (Oryzias latipes)	IC50 (3h) > 1000 mg/L (activated sludge)	EC50 (96 h) =18260 mg/L (Dapnia magna) NOEC (21 d) =208 mg/L (Dapnia magna)

12.2. Persistence and degradability

Substances	CAS Number	Persistence and Degradability
Hydrotreated light petroleum distillate	64742-47-8	Readily biodegradable (68.1% @ 28d)
Ethanol	64-17-5	No information available
Fatty acids, tall-oil, ethoxylated	61791-00-2	Readily biodegradable (74% @ 28d)
C12-C15 Ethoxylated alcohols	68131-39-5	Readily biodegradable
Amides, tall-oil fatty, N,N-bis(hydroxyethyl)	68155-20-4	Readily biodegradable (77% @ 28d)
Butyl alcohol	71-36-3	Biodegradable. (92% @ 20d)
Methanol	67-56-1	Readily biodegradable (95% @ 20d)

12.3. Bioaccumulative potential

Substances	CAS Number	Log Pow
Hydrotreated light petroleum distillate	64742-47-8	No information available
Ethanol	64-17-5	-0.32
Fatty acids, tall-oil, ethoxylated	61791-00-2	MW > 700
C12-C15 Ethoxylated alcohols	68131-39-5	3
Amides, tall-oil fatty, N,N-bis(hydroxyethyl)	68155-20-4	3.2 (estimated)

Butyl alcohol	71-36-3	1
Methanol	67-56-1	Not Bioaccumulative; BCF=1

12.4. Mobility in soil

Substances	CAS Number	Mobility
Hydrotreated light petroleum distillate	64742-47-8	No information available
Ethanol	64-17-5	No information available
Fatty acids, tall-oil, ethoxylated	61791-00-2	No information available
C12-C15 Ethoxylated alcohols	68131-39-5	No information available
Amides, tall-oil fatty, N,N-bis(hydroxyethyl)	68155-20-4	No information available
Butyl alcohol	71-36-3	KOC = 72
Methanol	67-56-1	No information available

12.6. Other adverse effects

Endocrine Disruptor Information

This product does not contain any known or suspected endocrine disruptors

13. Disposal Considerations

Safe handling and disposal methods

Disposal should be made in accordance with federal, state, and local regulations.

Disposal of any contaminated packaging

Follow all applicable national or local regulations.

Environmental regulations

Not applicable

14. Transport Information

Transportation Information

Australia ADG

UN Number UN1993
UN proper shipping name: Flammable Liquid, N.O.S. (Contains Ethanol, Butanol)
Transport Hazard Class(es): 3
Packing Group: III
Environmental Hazards: Not applicable

IMDG/IMO

UN Number UN1993
UN proper shipping name: Flammable Liquid, N.O.S. (Contains Ethanol, Butanol)
Transport Hazard Class(es): 3
Packing Group: III
Environmental Hazards: Not applicable

IATA/ICAO

UN Number UN1993
UN proper shipping name: Flammable Liquid, N.O.S. (Contains Ethanol, Butanol)
Transport Hazard Class(es): 3
Packing Group: III
Environmental Hazards: Not applicable

Special precautions during transport

None

HazChem Code

•3Y

15. Regulatory Information

Safety, health and environmental regulations specific for the product

International Inventories

Australian AICS Inventory	All components are listed on the AICS or are subject to a relevant exemption, permit, or assessment certificate.
New Zealand Inventory of Chemicals	All components are listed on the NZIoC or are subject to a relevant exemption, permit, or assessment certificate.
EINECS (European Inventory of Existing Chemical Substances)	This product does not comply with EINECS
US TSCA Inventory	All components listed on inventory or are exempt.
Canadian Domestic Substances List (DSL)	All components listed on inventory or are exempt.

Poisons Schedule number

None Allocated

International Agreements

Montreal Protocol - Ozone Depleting Substances:	Does not apply
Stockholm Convention - Persistent Organic Pollutants:	Does not apply
Rotterdam Convention - Prior Informed Consent:	Does not apply
Basel Convention - Hazardous Waste:	Does not apply

16. Other information

Date of preparation or review

Revision Date: 31-Aug-2017

Revision Note

SDS sections updated:
2

Full text of H-Statements referred to under sections 2 and 3

H225 - Highly flammable liquid and vapor
H226 - Flammable liquid and vapor
H301 - Toxic if swallowed
H302 - Harmful if swallowed
H304 - May be fatal if swallowed and enters airways
H311 - Toxic in contact with skin
H315 - Causes skin irritation
H318 - Causes serious eye damage
H319 - Causes serious eye irritation
H331 - Toxic if inhaled
H335 - May cause respiratory irritation
H360 - May damage fertility or the unborn child
H370 - Causes damage to organs
H400 - Very toxic to aquatic life
H401 - Toxic to aquatic life
H412 - Harmful to aquatic life with long lasting effects

Additional information For additional information on the use of this product, contact your local Halliburton representative.

For questions about the Safety Data Sheet for this or other Halliburton products, contact Chemical Stewardship at 1-580-251-4335.

Key abreviations or acronyms used

bw – body weight
CAS – Chemical Abstracts Service
EC50 – Effective Concentration 50%
LC50 – Lethal Concentration 50%

LD50 – Lethal Dose 50%
LL50 – Lethal Loading 50%
mg/kg – milligram/kilogram
mg/L – milligram/liter
NOEC – No Observed Effect Concentration
OEL – Occupational Exposure Limit
PBT – Persistent Bioaccumulative and Toxic
ppm – parts per million
STEL – Short Term Exposure Limit
TWA – Time-Weighted Average
vPvB – very Persistent and very Bioaccumulative
h - hour
mg/m^3 - milligram/cubic meter
mm - millimeter
mmHg - millimeter mercury
w/w - weight/weight
d - day

Key literature references and sources for data
www.ChemADVISOR.com/

Disclaimer Statement
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End of Safety Data Sheet

HALLIBURTON

MATERIAL SAFETY DATA SHEET

Product Trade Name: **FE-2**

Revision Date: 27-Aug-2013

1. IDENTIFICATION OF THE SUBSTANCE/PREPARATION AND OF THE COMPANY/UNDERTAKING

Statement of Hazardous Nature Hazardous according to the criteria of NOHSC, Non-Dangerous Goods according to the criteria of ADG.

Manufacturer/Supplier

Halliburton Australia Pty. Ltd.
15 Marriott Road
Jandakot
WA 6164
Australia

ACN Number: 009 000 775
Telephone Number: 61 (08) 9455 8300
Fax Number: 61 (08) 9455 5300

Product Emergency Telephone
Australia: 08-64244950
Papua New Guinea: 05 1 281 575 5000
NewZealand: 06-7559274

Fire, Police & Ambulance - Emergency Telephone
Australia: 000
Papua New Guinea: 000
New Zealand: 111

Identification of Substances or Preparation

Product Trade Name: FE-2
Synonyms: None
Chemical Family: Organic acid
UN Number: None
Dangerous Goods Class: None
Subsidiary Risk: None
Hazchem Code: None Allocated
Poisons Schedule: None Allocated
Application: Iron Control Agent

Prepared By

Chemical Compliance
Telephone: 1-580-251-4335
e-mail: fdunexchem@halliburton.com

2. COMPOSITION/INFORMATION ON INGREDIENTS

Substances	CAS Number	PERCENT (w/w)	Australia NOHSC	New Zealand WES	ACGIH TLV-TWA
Citric acid	77-92-9	60 - 100%	Not applicable	Not applicable	Not applicable

Non-Hazardous Substance to Total of 100%

3. HAZARDS IDENTIFICATION

Hazard Overview May cause eye, skin, and respiratory irritation. Airborne dust may be explosive.

Risk Phrases R36 Irritating to eyes.

HSNO Classification 6.1E (Inhalation) Acutely Toxic Substances
6.3B Mildly irritating to the skin
8.3A Corrosive to ocular tissue

4. FIRST AID MEASURES

Inhalation If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.

Skin Wash with soap and water. Get medical attention if irritation persists.

Eyes In case of contact, or suspected contact, immediately flush eyes with plenty of water for at least 15 minutes and get medical attention immediately after flushing.

Ingestion Do not induce vomiting. Slowly dilute with 1-2 glasses of water or milk and seek medical attention. Never give anything by mouth to an unconscious person.

Notes to Physician Not Applicable

5. FIRE FIGHTING MEASURES

Suitable Extinguishing Media
Water fog, carbon dioxide, foam, dry chemical.

Extinguishing media which must not be used for safety reasons
None known.

Special Exposure Hazards Decomposition in fire may produce toxic gases. Organic dust in the presence of an ignition source can be explosive in high concentrations. Good housekeeping practices are required to minimize this potential.

Special Protective Equipment for Fire-Fighters Full protective clothing and approved self-contained breathing apparatus required for fire fighting personnel.

6. ACCIDENTAL RELEASE MEASURES

Personal Precautionary Measures Use appropriate protective equipment. Avoid creating and breathing dust.

Environmental Precautionary Measures Prevent from entering sewers, waterways, or low areas.

Procedure for Cleaning / Absorption Scoop up and remove.

7. HANDLING AND STORAGE

Handling Precautions Avoid contact with eyes, skin, or clothing. Avoid creating or inhaling dust.

Storage Information Store away from alkalis. Store away from oxidizers. Store in a cool, dry location. Product has a shelf life of 60 months.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Engineering Controls Use in a well ventilated area.

Respiratory Protection Dust/mist respirator. (N95, P2/P3)

Hand Protection Impervious rubber gloves. Nitrile gloves. Neoprene gloves. Polyvinyl alcohol gloves. Polyvinylchloride gloves.

Skin Protection Normal work coveralls.

Eye Protection Chemical goggles; also wear a face shield if splashing hazard exists.

Other Precautions Eyewash fountains and safety showers must be easily accessible.

9. PHYSICAL AND CHEMICAL PROPERTIES

Physical State:	Solid
Color:	White
Odor:	Odorless
pH:	2 - 2.2
Specific Gravity @ 20 C (Water=1):	1.665
Density @ 20 C (kg/l):	Not Determined
Bulk Density @ 20 C (kg/M3):	Not Determined
Boiling Point/Range (C):	Not Determined
Freezing Point/Range (C):	Not Determined
Pour Point/Range (C):	Not Determined
Flash Point/Range (C):	Not Determined
Flash Point Method:	Not Determined
Autoignition Temperature (C):	1000
Flammability Limits in Air - Lower (g/m^3):	Not Determined
Flammability Limits in Air - Lower (%):	8
Flammability Limits in Air - Upper (g/m^3):	Not Determined
Flammability Limits in Air - Upper (%):	65
Vapor Pressure @ 20 C (mmHg):	Not Determined
Vapor Density (Air=1):	Not Determined
Percent Volatiles:	0
Evaporation Rate (Butyl Acetate=1):	Not Determined
Solubility in Water (g/100ml):	Soluble
Solubility in Solvents (g/100ml):	Not Determined
VOCs (g/l):	Not Determined
Viscosity, Dynamic @ 20 C (centipoise):	Not Determined
Viscosity, Kinematic @ 20 C (centistokes):	Not Determined
Partition Coefficient/n-Octanol/Water:	Not Determined
Molecular Weight (g/mole):	192.13
Decomposition Temperature (C):	Not Determined

10. STABILITY AND REACTIVITY

Stability Data: Stable

Hazardous Polymerization: Will Not Occur

Conditions to Avoid None anticipated

Incompatibility (Materials to Avoid) Strong alkalis. Strong oxidizers.

Hazardous Decomposition Products Carbon monoxide and carbon dioxide.

Additional Guidelines Not Applicable

11. TOXICOLOGICAL INFORMATION

Principle Route of Exposure Eye or skin contact, inhalation.

Sympotoms related to exposure

Acute Toxicity

Inhalation May cause respiratory irritation.

Eye Contact May cause severe eye irritation.

Skin Contact May cause skin irritation.

Ingestion Irritation of the mouth, throat, and stomach. May cause abdominal pain, vomiting, nausea, and diarrhea.

Chronic Effects/Carcinogenicity No data available to indicate product or components present at greater than 1% are chronic health hazards.

LD50 Oral: 11700 mg/kg; (rat)

Toxicology data for the components

Substances	CAS Number	LD50 Oral	LD50 Dermal	LC50 Inhalation
Citric acid	77-92-9	3000 mg/kg (Rat)	No data available	No data available

Test species: Rat

12. ECOLOGICAL INFORMATION

Ecotoxicological Information

Ecotoxicity Product

Acute Fish Toxicity: Not determined

Acute Crustaceans Toxicity: TLM96: 100-330 ppm (Crangon crangon)

Acute Algae Toxicity: Not determined

Ecotoxicity Substance

Substances	CAS Number	Toxicity to Algae	Toxicity to Fish	Toxicity to Microorganisms	Daphnia Magna (Water Flea)
Citric acid	77-92-9	No information available	LC50: 1516 mg/L (Lepomis macrochirus)	No information available	TLM96: 100-330 ppm (Crangon crangon)

Persistence and degradability
Biodegradable.

Bioaccumulative potential
Does not bioaccumulate

Mobility in soil
No information available

Results of PBT and vPvB assessment
No information available.

Other adverse effects

13. DISPOSAL CONSIDERATIONS

Disposal Method Bury in a licensed landfill according to federal, state, and local regulations.

Contaminated Packaging Follow all applicable national or local regulations. Contaminated packaging may be disposed of by: rendering packaging incapable of containing any substance, or treating packaging to remove residual contents, or treating packaging to make sure the residual contents are no longer hazardous, or by disposing of packaging into commercial waste collection.

14. TRANSPORT INFORMATION

Land Transportation

ADR
Not restricted

Air Transportation

ICAO/IATA
Not restricted

Sea Transportation

IMDG
Not restricted

Other Transportation Information

Labels: None

15. REGULATORY INFORMATION

Chemical Inventories

Australian AICS Inventory	All components listed on inventory or are exempt.
New Zealand Inventory of Chemicals	All components listed on inventory or are exempt.
US TSCA Inventory	All components listed on inventory or are exempt.
EINECS Inventory	This product, and all its components, complies with EINECS

Classification Xi - Irritant.

Risk Phrases R36 Irritating to eyes.

Safety Phrases

S24/25 Avoid contact with skin and eyes.

16. OTHER INFORMATION

The following sections have been revised since the last issue of this SDS
Not applicable

Contact

Australian Poisons Information Centre
24 Hour Service: - 13 11 26
Police or Fire Brigade: - 000 (exchange): - 1100

New Zealand National Poisons Centre
0800 764 766

Additional Information

For additional information on the use of this product, contact your local Halliburton representative.

For questions about the Safety Data Sheet for this or other Halliburton products, contact Chemical Compliance at 1-580-251-4335.

Disclaimer Statement

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*****END OF MSDS*****

HALLIBURTON

SAFETY DATA SHEET

BE-9

Revision Date: 13-Oct-2017 **Revision Number:** 20

1. Product Identifier & Identity for the Chemical

Statement of Hazardous Nature Hazardous according to the criteria of the 3rd Revised Edition of the Globally Harmonised System of Classification and Labelling of Chemicals (GHS), Dangerous Goods according to the criteria of ADG.

1.1. Product Identifier

Product Name BE-9

Other means of Identification

Synonyms None

Hazardous Material Number: HB006583

Recommended use of the chemical and restrictions on use

Recommended Use Biocide

Uses advised against No information available

Supplier's name, address and phone number

Manufacturer/Supplier Halliburton Australia Pty. Ltd.
15 Marriott Road, Jandakot, WA 6164
Australia
ACN Number: 009 000 775
Telephone Number: + 61 1 800 686 951
Fax Number: 61 (08) 9455 5300

E-mail Address fdunexchem@halliburton.com

Emergency phone number

+ 61 1 800 686 951
Global Incident Response Access Code: 334305
Contract Number: 14012

Australian Poisons Information Centre
24 Hour Service: - 13 11 26
Police or Fire Brigade: - 000 (exchange): - 1100

2. Hazard Identification

Statement of Hazardous Nature Hazardous according to the criteria of the 3rd Revised Edition of the Globally Harmonised System of Classification and Labelling of Chemicals (GHS), Dangerous Goods according to the criteria of ADG.

Classification of the hazardous chemical

Skin Corrosion/Irritation	Category 1 - H314
Serious Eye Damage/Irritation	Category 1 - H318
Acute Aquatic Toxicity	Category 1 - H400
Chronic Aquatic Toxicity	Category 2 - H411

Label elements, including precautionary statements

Hazard Pictograms



Signal Word DANGER

Hazard Statements:
H314 - Causes severe skin burns and eye damage
H318 - Causes serious eye damage
H400 - Very toxic to aquatic life
H411 - Toxic to aquatic life with long lasting effects

Precautionary Statements

Prevention
P260 - Do not breathe dust/fume/gas/mist/vapors/spray
P273 - Avoid release to the environment
P280 - Wear protective gloves/protective clothing/eye protection/face protection

Response
P301 + P330 + P331 - IF SWALLOWED: rinse mouth. Do NOT induce vomiting
P303 + P361 + P353 - IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water [or shower].
P363 - Wash contaminated clothing before reuse
P304 + P340 - IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing
P310 - Immediately call a POISON CENTER or doctor/physician
P305 + P351 + P338 - IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing
P391 - Collect spillage

Storage
P405 - Store locked up

Disposal
P501 - Dispose of contents/container in accordance with local/regional/national/international regulations

Contains

Substances	**CAS Number**
Tributyl tetradecyl phosphonium chloride	81741-28-8

Other hazards which do not result in classification
None known

For the full text of the H-phrases mentioned in this Section, see Section 16

3. Composition/information on Ingredients

Substances	CAS Number	PERCENT (w/w)	GHS Classification - Australia
Tributyl tetradecyl phosphonium chloride	81741-28-8	5 - 10%	Acute Tox. 4 (H302) Acute Tox. 2 (H330) Skin Corr. 1B (H314) Eye Corr. 1 (H318) Aquatic Acute 1 (H400) Aquatic Chronic 1 (H410)

4. First aid measures

Description of necessary first aid measures

Inhalation If inhaled, move victim to fresh air and seek medical attention.

Eyes Immediately flush eyes with large amounts of water for at least 30 minutes. Seek prompt medical attention.

Skin In case of contact, immediately flush skin with plenty of soap and water for at least 30 minutes and remove contaminated clothing, shoes and leather goods immediately. Get medical attention immediately.

Ingestion Do NOT induce vomiting. Give nothing by mouth. Obtain immediate medical attention.

Symptoms caused by exposure

Causes severe eye irritation which may damage tissue. Causes severe skin irritation with tissue destruction.

Medical Attention and Special Treatment

Notes to Physician Treat symptomatically

5. Fire Fighting Measures

Suitable extinguishing equipment

Suitable Extinguishing Media

Water fog, carbon dioxide, foam, dry chemical.

Extinguishing media which must not be used for safety reasons

None known.

Specific hazards arising from the chemical

Special exposure hazards in a fire

Decomposition in fire may produce harmful gases. Do not allow runoff to enter waterways. Use water spray to cool fire exposed surfaces.

Special protective equipment and precautions for fire fighters

Special protective equipment for firefighters

Full protective clothing and approved self-contained breathing apparatus required for fire fighting personnel.

6. Accidental release measures

6.1. Personal precautions, protective equipment and emergency procedures

Use appropriate protective equipment.

6.2. Environmental precautions

Prevent from entering sewers, waterways, or low areas.

6.3. Methods and material for containment and cleaning up

Isolate spill and stop leak where safe. Contain spill with sand or other inert materials. Scoop up and remove.

7. Handling and storage

7.1. Precautions for safe handling

Handling Precautions

Avoid contact with eyes, skin, or clothing. Wash hands after use. Launder contaminated clothing before reuse. Do NOT consume food, drink, or tobacco in contaminated areas.

Hygiene Measures

Handle in accordance with good industrial hygiene and safety practice.

7.2. Conditions for safe storage, including any incompatibilities

Storage Information

Store in a cool well ventilated area. Keep container closed when not in use. Store away from direct sunlight. Store in a dry location. Store in a manner to prevent commingling with incompatible materials. Store away from alkalis. Store away from reducing agents. Store locked up.

Other Guidelines

No information available

8. Exposure Controls/Personal Protection

Control parameters - exposure standards, biological monitoring

Exposure Limits

Substances	CAS Number	Australia NOHSC	ACGIH TLV-TWA
Tributyl tetradecyl phosphonium chloride	81741-28-8	Not applicable	Not applicable

Appropriate engineering controls

Engineering Controls Use in a well ventilated area. Local exhaust ventilation should be used in areas without good cross ventilation.

Personal protective equipment (PPE)

Personal Protective Equipment If engineering controls and work practices cannot prevent excessive exposures, the selection and proper use of personal protective equipment should be determined by an industrial hygienist or other qualified professional based on the specific application of this product.

Respiratory Protection If engineering controls and work practices cannot keep exposure below occupational exposure limits or if exposure is unknown, wear a NIOSH certified, European Standard EN 149, AS/NZS 1715:2009, or equivalent respirator when using this product. Selection of and instruction on using all personal protective equipment, including respirators, should be performed by an Industrial Hygienist or other qualified professional.
Dust/mist respirator. (N95, P2/P3)

Hand Protection Chemical-resistant protective gloves (EN 374) Suitable materials for longer, direct contact (recommended: protection index 6, corresponding to > 480 minutes permeation time as per EN 374): Neoprene gloves. (>= 0.75 mm thickness)
This information is based on literature references and on information provided by glove manufacturers, or is derived by analogy with similar substances. Please note that in practice the working life of chemical-resistant protective gloves may be considerably shorter than the permeation time determined in accordance with EN 374 as a result of the many influencing factors (e.g. temperature). If signs of wear and tear are noticed then the gloves should be replaced. Manufacturer's directions for use should be observed because of great diversity of types.

Skin Protection Wear impervious protective clothing, including boots, gloves, lab coat, apron, rain jacket, pants or coverall, as appropriate, to prevent skin contact.

Eye Protection Chemical goggles; also wear a face shield if splashing hazard exists.

Other Precautions Eyewash fountains and safety showers must be easily accessible.

Environmental Exposure Controls No information available

9. Physical and Chemical Properties

9.1. Information on basic physical and chemical properties

Physical State: Liquid
Color Clear colorless
Odor: Slight
Odor Threshold: No information available

Property Remarks/ - Method	Values
pH:	6-8
Freezing Point / Range	-8 - -10 °C
Melting Point / Range	No data available
Boiling Point / Range	100 °C / 212 °F
Flash Point	No data available
Evaporation rate	No data available
Vapor Pressure	No data available
Vapor Density	No data available
Specific Gravity	0.95 - 1.0
Water Solubility	Miscible with water
Solubility in other solvents	No data available
Partition coefficient: n-octanol/water	No data available
Autoignition Temperature	No data available
Decomposition Temperature	No data available
Viscosity	No data available
Explosive Properties	No information available
Oxidizing Properties	No information available

9.2. Other information

VOC Content (%) No data available

10. Stability and Reactivity

10.1. Reactivity

Not expected to be reactive.

10.2. Chemical stability

Stable

10.3. Possibility of hazardous reactions

Will Not Occur

10.4. Conditions to avoid

None anticipated

10.5. Incompatible materials

Reducing agents. Strong alkalis.

10.6. Hazardous decomposition products

Chlorine. Phosphorus acids. Carbon monoxide and carbon dioxide.

11. Toxicological Information

Information on routes of exposure

Principle Route of Exposure Eye or skin contact, inhalation.

Symptoms related to exposure

Most Important Symptoms/Effects

Causes severe eye irritation which may damage tissue. Causes severe skin irritation with tissue destruction.

Toxicology data for the components

Substances	CAS Number	LD50 Oral	LD50 Dermal	LC50 Inhalation
Tributyl tetradecyl phosphonium chloride	81741-28-8	= 611 mg/kg (rat)	No data of sufficient quality are available	> 0.908 mg/L (rat, 4hr, mist)

Immediate, delayed and chronic health effects from exposure

Inhalation May cause respiratory irritation.

Eye Contact Causes severe eye irritation which may damage tissue. May cause eye burns.

Skin Contact Causes severe skin irritation with tissue destruction.

Ingestion Irritation of the mouth, throat, and stomach. May cause abdominal pain, vomiting, nausea, and diarrhea.

Chronic Effects/Carcinogenicity No data available to indicate product or components present at greater than 0.1% are chronic health hazards.

Exposure Levels

No data available

Interactive effects

Lung disorders. Skin disorders.

Data limitations

No data available

Substances	CAS Number	Skin corrosion/irritation
Tributyl tetradecyl phosphonium chloride	81741-28-8	Causes burns (Rabbit)

Substances	CAS Number	Serious eye damage/irritation
Tributyl tetradecyl phosphonium chloride	81741-28-8	Causes severe eye irritation which may damage tissue. (Rabbit)

Substances	CAS Number	Skin Sensitization
Tributyl tetradecyl phosphonium chloride	81741-28-8	No information available

Substances	CAS Number	Respiratory Sensitization
Tributyl tetradecyl phosphonium chloride	81741-28-8	No information available

Substances	CAS Number	Mutagenic Effects
Tributyl tetradecyl phosphonium chloride	81741-28-8	No data of sufficient quality are available.

Substances	CAS Number	Carcinogenic Effects
Tributyl tetradecyl phosphonium chloride	81741-28-8	No information available

Substances	CAS Number	Reproductive toxicity
Tributyl tetradecyl phosphonium chloride	81741-28-8	No information available

Substances	CAS Number	STOT - single exposure
Tributyl tetradecyl phosphonium chloride	81741-28-8	No information available

Substances	CAS Number	STOT - repeated exposure
Tributyl tetradecyl phosphonium chloride	81741-28-8	No data of sufficient quality are available.

Substances	CAS Number	Aspiration hazard
Tributyl tetradecyl phosphonium chloride	81741-28-8	No information available

12. Ecological Information

Ecotoxicity

Substance Ecotoxicity Data

Substances	CAS Number	Toxicity to Algae	Toxicity to Fish	Toxicity to Microorganisms	Toxicity to Invertebrates
Tributyl tetradecyl phosphonium chloride	81741-28-8	No information available	LC50 (96 h) 0.46 mg/L (Oncorhynchus mykiss) LC50 (96 h) 0.06 mg/L (Lepomis macrochirus)	No information available	EC50 (48 h) 0.025 mg/L (Daphnia sp.)

12.2. Persistence and degradability

Substances	CAS Number	Persistence and Degradability
Tributyl tetradecyl phosphonium chloride	81741-28-8	(0% @ 28d)

12.3. Bioaccumulative potential

Substances	CAS Number	Log Pow
Tributyl tetradecyl phosphonium chloride	81741-28-8	< 3

12.4. Mobility in soil

Substances	CAS Number	Mobility
Tributyl tetradecyl phosphonium chloride	81741-28-8	No information available

12.6. Other adverse effects

Endocrine Disruptor Information

This product does not contain any known or suspected endocrine disruptors

13. Disposal Considerations

Safe handling and disposal methods
Disposal should be made in accordance with federal, state, and local regulations. Incineration recommended in approved incinerator according to federal, state, and local regulations. Substance should NOT be deposited into a sewage facility.

Disposal of any contaminated packaging
Follow all applicable national or local regulations.

Environmental regulations
Not applicable

14. Transport Information

Transportation Information

Australia ADG

UN Number	UN2922
UN proper shipping name:	Corrosive Liquid, Toxic, N.O.S. (contains Tributyl Tetradecyl Phosphonium Chloride)
Transport Hazard Class(es):	8, (6.1)
Packing Group:	II
Environmental Hazards:	Marine Pollutant

IMDG/IMO

UN Number	UN2922
UN proper shipping name:	Corrosive Liquid, Toxic, N.O.S. (contains Tributyl Tetradecyl Phosphonium Chloride)
Transport Hazard Class(es):	8, (6.1)
Packing Group:	II
Environmental Hazards:	Marine Pollutant
EMS:	EmS F-A, S-B

IATA/ICAO

UN Number	UN2922
UN proper shipping name:	Corrosive Liquid, Toxic, N.O.S. (contains Tributyl Tetradecyl Phosphonium Chloride)
Transport Hazard Class(es):	8, (6.1)
Packing Group:	II
Environmental Hazards:	Marine Pollutant

Special precautions during transport
None

HazChem Code
2X

15. Regulatory Information

Safety, health and environmental regulations specific for the product

International Inventories

Australian AICS Inventory	All components are listed on the AICS or are subject to a relevant exemption, permit, or assessment certificate.
New Zealand Inventory of Chemicals	All components are listed on the NZIoC or are subject to a relevant exemption, permit, or assessment certificate.
EINECS (European Inventory of Existing Chemical Substances)	This product, and all its components, complies with EINECS
US TSCA Inventory	All components listed on inventory or are exempt.
Canadian Domestic Substances List (DSL)	All components listed on inventory or are exempt.

Poisons Schedule number

None Allocated

International Agreements

Montreal Protocol - Ozone Depleting Substances:	Does not apply
Stockholm Convention - Persistent Organic Pollutants:	Does not apply
Rotterdam Convention - Prior Informed Consent:	Does not apply
Basel Convention - Hazardous Waste:	Does not apply

16. Other information

Date of preparation or review

Revision Date: 13-Oct-2017

Revision Note
SDS sections updated:
2

Full text of H-Statements referred to under sections 2 and 3
H302 - Harmful if swallowed
H314 - Causes severe skin burns and eye damage
H318 - Causes serious eye damage
H330 - Fatal if inhaled
H400 - Very toxic to aquatic life
H401 - Toxic to aquatic life
H410 - Very toxic to aquatic life with long lasting effects
H411 - Toxic to aquatic life with long lasting effects

Additional information

For additional information on the use of this product, contact your local Halliburton representative.

For questions about the Safety Data Sheet for this or other Halliburton products, contact Chemical Stewardship at 1-580-251-4335.

Key abreviations or acronyms used
bw – body weight
CAS – Chemical Abstracts Service
EC50 – Effective Concentration 50%
LC50 – Lethal Concentration 50%
LD50 – Lethal Dose 50%
LL50 – Lethal Loading 50%
mg/kg – milligram/kilogram
mg/L – milligram/liter
NOEC – No Observed Effect Concentration
OEL – Occupational Exposure Limit
PBT – Persistent Bioaccumulative and Toxic
ppm – parts per million
STEL – Short Term Exposure Limit
TWA – Time-Weighted Average
vPvB – very Persistent and very Bioaccumulative
h - hour
mg/m^3 - milligram/cubic meter
mm - millimeter
mmHg - millimeter mercury
w/w - weight/weight
d - day

Key literature references and sources for data
www.ChemADVISOR.com/
NZ CCID

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This information is furnished without warranty, expressed or implied, as to accuracy or completeness. The information is obtained from various sources including the manufacturer and other third party sources. The information may not be valid under all conditions nor if this material is used in combination with other materials or in any process. Final determination of suitability of any material is the sole responsibility of the user.

End of Safety Data Sheet

HALLIBURTON

SAFETY DATA SHEET

DCA-11001

Revision Date: 23-Jan-2017 **Revision Number:** 19

1. Product Identifier & Identity for the Chemical

Statement of Hazardous Nature Hazardous according to the criteria of the 3rd Revised Edition of the Globally Harmonised System of Classification and Labelling of Chemicals (GHS), Non-Dangerous Goods according to the criteria of ADG.

1.1. Product Identifier

Product Name DCA-11001

Other means of Identification

Synonyms None

Hazardous Material Number: HM007644

Recommended use of the chemical and restrictions on use

Recommended Use Additive

Uses advised against No information available

Supplier's name, address and phone number

Manufacturer/Supplier

Multi-Chem Mintech
1 Ward Road
East Rockingham
WA 6168
Australia

Telephone Number: 61 (08) 9419 5300
Fax Number: 61 (08) 9439 1055
Emergency Telephone Number: + 61 1 800 686 951

E-mail Address fdunexchem@halliburton.com

Emergency phone number

+ 61 1 800 686 951
Global Incident Response Access Code: 334305
Contract Number: 14012

Australian Poisons Information Centre
24 Hour Service: - 13 11 26
Police or Fire Brigade: - 000 (exchange): - 1100

2. Hazard Identification

Statement of Hazardous Nature Hazardous according to the criteria of the 3rd Revised Edition of the Globally Harmonised System of Classification and Labelling of Chemicals (GHS), Non-Dangerous Goods according to the criteria of ADG.

Classification of the hazardous chemical

Skin Corrosion/Irritation	Category 2 - H315
Serious Eye Damage/Irritation	Category 1 - H318
Specific Target Organ Toxicity - (Repeated Exposure)	Category 2 - H373
Acute Aquatic Toxicity	Category 3 - H402

Label elements, including precautionary statements

Hazard Pictograms



Signal Word DANGER

Hazard Statements:
H315 - Causes skin irritation
H318 - Causes serious eye damage
H373 - May cause damage to organs through prolonged or repeated exposure
H402 - Harmful to aquatic life

Precautionary Statements

Prevention
P260 - Do not breathe dust/fume/gas/mist/vapors/spray
P264 - Wash face, hands and any exposed skin thoroughly after handling
P273 - Avoid release to the environment
P280 - Wear protective gloves/eye protection/face protection

Response
P302 + P352 - IF ON SKIN: Wash with plenty of soap and water
P332 + P313 - If skin irritation occurs: Get medical advice/attention
P362 + P364 - Take off contaminated clothing and wash before reuse
P305 + P351 + P338 - IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing
P310 - Immediately call a POISON CENTER or doctor/physician
P314 - Get medical attention/advice if you feel unwell

Storage None

Disposal P501 - Dispose of contents/container in accordance with local/regional/national/international regulations

Contains Substances	**CAS Number**
Diethanolamine	111-42-2

Other hazards which do not result in classification
This mixture contains no substance considered to be persistent, bioaccumulating nor toxic (PBT).
This mixture contains no substance considered to be very persistent nor very bioaccumulating (vPvB).

For the full text of the H-phrases mentioned in this Section, see Section 16

3. Composition/information on Ingredients

Substances	CAS Number	PERCENT (w/w)	GHS Classification - Australia
Diethanolamine	111-42-2	10 - 30%	Acute Tox. 4 (H302) Skin Irrit. 2 (H315) Eye Corr. 1 (H318) STOT RE 2 (H373) Aquatic Acute 2 (H401) Aquatic Chronic 3 (H412)

4. First aid measures

Description of necessary first aid measures

Inhalation	If inhaled, move victim to fresh air and seek medical attention.
Eyes	In case of contact, immediately flush eyes with plenty of water for at least 30 minutes. Remove contact lenses after the first 5 minutes and continue washing. Seek immediate medical attention/advice. Suitable emergency eye wash facility should be immediately available
Skin	Remove contaminated clothing and launder before reuse. In case of contact, immediately flush skin with plenty of soap and water for at least 30 minutes and remove contaminated clothing, shoes and leather goods immediately. Get medical attention immediately.
Ingestion	Do NOT induce vomiting. Give nothing by mouth. Obtain immediate medical attention.

Symptoms caused by exposure

Causes severe eye irritation which may damage tissue. Causes skin irritation. Prolonged or repeated exposure may cause damage to organs.

Medical Attention and Special Treatment

Notes to Physician Treat symptomatically

5. Fire Fighting Measures

Suitable extinguishing equipment

Suitable Extinguishing Media

Carbon dioxide, dry chemical, foam.

Extinguishing media which must not be used for safety reasons

None known.

Specific hazards arising from the chemical

Special exposure hazards in a fire

Decomposition in fire may produce harmful gases.

Special protective equipment and precautions for fire fighters

Special protective equipment for firefighters

Full protective clothing and approved self-contained breathing apparatus required for fire fighting personnel.

6. Accidental release measures

6.1. Personal precautions, protective equipment and emergency procedures

Use appropriate protective equipment. Avoid contact with skin, eyes and clothing. Avoid breathing vapors. Ensure adequate ventilation. Evacuate all persons from the area.

6.2. Environmental precautions

Prevent from entering sewers, waterways, or low areas. Consult local authorities.

6.3. Methods and material for containment and cleaning up

Isolate spill and stop leak where safe. Contain spill with sand or other inert materials. Scoop up and remove.

7. Handling and storage

7.1. Precautions for safe handling

Handling Precautions

Avoid contact with eyes, skin, or clothing. Avoid breathing vapors. Wash hands after use. Launder contaminated clothing before reuse. Ensure adequate ventilation. Use appropriate protective equipment.

Hygiene Measures

Handle in accordance with good industrial hygiene and safety practice.

7.2. Conditions for safe storage, including any incompatibilities

Storage Information

Store away from oxidizers. Store in a cool well ventilated area. Keep container closed when not in use. Product has a shelf life of

12 months.

Other Guidelines

No information available

8. Exposure Controls/Personal Protection

Control parameters - exposure standards, biological monitoring

Exposure Limits

Substances	CAS Number	Australia NOHSC	ACGIH TLV-TWA
Diethanolamine	111-42-2	TWA: 3 ppm TWA: 13 mg/m^3	TWA: 1 mg/m^3

Appropriate engineering controls

Engineering Controls Use in a well ventilated area. Local exhaust ventilation should be used in areas without good cross ventilation.

Personal protective equipment (PPE)

Personal Protective Equipment If engineering controls and work practices cannot prevent excessive exposures, the selection and proper use of personal protective equipment should be determined by an industrial hygienist or other qualified professional based on the specific application of this product.

Respiratory Protection Wear a NIOSH certified, European Standard EN 149 (FFP2/FFP3), AS/NZS 1715, or equivalent respirator when using this product.

Hand Protection Chemical-resistant protective gloves (EN 374) Suitable materials for longer, direct contact (recommended: protection index 6, corresponding to > 480 minutes permeation time as per EN 374): Butyl rubber gloves. (>= 0.7 mm thickness)
This information is based on literature references and on information provided by glove manufacturers, or is derived by analogy with similar substances. Please note that in practice the working life of chemical-resistant protective gloves may be considerably shorter than the permeation time determined in accordance with EN 374 as a result of the many influencing factors (e.g. temperature). If signs of wear and tear are noticed then the gloves should be replaced. Manufacturer's directions for use should be observed because of great diversity of types.

Skin Protection Rubber apron.

Eye Protection Chemical goggles; also wear a face shield if splashing hazard exists.

Other Precautions Eyewash fountains and safety showers must be easily accessible.

Environmental Exposure Controls Do not allow material to contaminate ground water system

9. Physical and Chemical Properties

9.1. Information on basic physical and chemical properties

Physical State: Liquid
Color Water white
Odor: Characteristic
Odor Threshold: No information available

Property Remarks/ - Method	Values
pH:	10.5
Freezing Point / Range	16 °C
Melting Point / Range	No data available
Boiling Point / Range	250 °C / 482 °F
Flash Point	194 °C / 382 °F PMCC
Upper flammability limit	8.5
Lower flammability limit	1.3
Evaporation rate	No data available
Vapor Pressure	0.01 mmHg
Vapor Density	No data available
Specific Gravity	1.11
Water Solubility	Soluble in water
Solubility in other solvents	No data available
Partition coefficient: n-octanol/water	No data available

Autoignition Temperature	315 °C / 600 °F
Decomposition Temperature	No data available
Viscosity	No data available
Explosive Properties	No information available
Oxidizing Properties	No information available

9.2. Other information

VOC Content (%)	No data available

10. Stability and Reactivity

10.1. Reactivity
Not expected to be reactive.
10.2. Chemical stability
Stable
10.3. Possibility of hazardous reactions
Will Not Occur
10.4. Conditions to avoid
None anticipated
10.5. Incompatible materials
Strong oxidizers. Violent, explosive reaction with sulfur trioxide, decaborane, silver perchlorate, triethenyl aluminum, and hydrogen in presence of nickel catalyst at temperatures above 200 C.
10.6. Hazardous decomposition products
Oxides of nitrogen. Carbon monoxide and carbon dioxide.

11. Toxicological Information

Information on routes of exposure
Principle Route of Exposure Eye or skin contact, inhalation.

Symptoms related to exposure
Most Important Symptoms/Effects
Causes severe eye irritation which may damage tissue. Causes skin irritation. Prolonged or repeated exposure may cause damage to organs.

Numerical measures of toxicity

Toxicology data for the components

Substances	CAS Number	LD50 Oral	LD50 Dermal	LC50 Inhalation
Diethanolamine	111-42-2	620 µL/kg (Rat) 1600 mg/kg (Rat)	7640 µL/kg (Rabbit) 13,000 mg/kg (Rabbit)	3.35 mg/L (Rat)

Immediate, delayed and chronic health effects from exposure

Inhalation	May cause respiratory irritation.
Eye Contact	Causes severe eye irritation which may damage tissue.
Skin Contact	Causes skin irritation.
Ingestion	Irritation of the mouth, throat, and stomach.

Chronic Effects/Carcinogenicity Repeated overexposure may cause liver and kidney effects. Amines may form nitrosamines, a suspect carcinogen, if product is mixed with nitrates, nitrites, nitrogen oxides or other nitrosamines.

Exposure Levels
No data available

Interactive effects
Skin disorders.

Data limitations
No data available

Substances	CAS Number	Skin corrosion/irritation
Diethanolamine	111-42-2	Causes moderate skin irritation. (Rabbit)

Substances	CAS Number	Serious eye damage/irritation
Diethanolamine	111-42-2	Causes severe eye irritation (Rabbit)

Substances	CAS Number	Skin Sensitization
Diethanolamine	111-42-2	Did not cause sensitization on laboratory animals (guinea pig)

Substances	CAS Number	Respiratory Sensitization
Diethanolamine	111-42-2	No information available

Substances	CAS Number	Mutagenic Effects
Diethanolamine	111-42-2	In vivo tests did not show mutagenic effects.

Substances	CAS Number	Carcinogenic Effects
Diethanolamine	111-42-2	No data of sufficient quality are available.

Substances	CAS Number	Reproductive toxicity
Diethanolamine	111-42-2	Animal testing did not show any effects on fertility. (similar substances) Did not show teratogenic effects in animal experiments.

Substances	CAS Number	STOT - single exposure
Diethanolamine	111-42-2	No information available

Substances	CAS Number	STOT - repeated exposure
Diethanolamine	111-42-2	Causes damage to organs through prolonged or repeated exposure if swallowed: (Liver) (Blood) (Kidney)

Substances	CAS Number	Aspiration hazard
Diethanolamine	111-42-2	Not applicable

12. Ecological Information

Ecotoxicity

Substance Ecotoxicity Data

Substances	CAS Number	Toxicity to Algae	Toxicity to Fish	Toxicity to Microorganisms	Toxicity to Invertebrates
Diethanolamine	111-42-2	EC50 7.8 mg/L (Desmodesmus subspicatus) EC50 (96h) 2.2 mg/L (growth rate) (Selenastrum capricornutum)	LC50 4460-4980 mg/L (Pimephales promelas) LC50 (96h) 1460 mg/L (Pimephales promelas)	EC20 >1000 mg/L (respiration rate) (activated sludge) EC90 (30min) > 1000 mg/L (Activated sludge)	EC50 (48h) 30.1 mg/L (Ceriodaphnia dubia) EC50 (48h) 55 mg/L (Daphnia magna) NOEC (21d) 0.78 mg/L (Daphnia magna) (Reproduction)

12.2. Persistence and degradability

Substances	CAS Number	Persistence and Degradability
Diethanolamine	111-42-2	Readily biodegradable (88 - 97% @ 28d)

12.3. Bioaccumulative potential

Substances	CAS Number	Log Pow
Diethanolamine	111-42-2	-1.71

12.4. Mobility in soil

Substances	CAS Number	Mobility
Diethanolamine	111-42-2	No information available

12.6. Other adverse effects

Endocrine Disruptor Information

This product does not contain any known or suspected endocrine disruptors

13. Disposal Considerations

Safe handling and disposal methods

Disposal should be made in accordance with federal, state, and local regulations.

Disposal of any contaminated packaging

Follow all applicable national or local regulations.

Environmental regulations

Not applicable

14. Transport Information

Transportation Information

Australia ADG

UN Number	Not restricted
UN proper shipping name:	Not restricted
Transport Hazard Class(es):	Not applicable
Packing Group:	Not applicable
Environmental Hazards:	Not applicable

IMDG/IMO

UN Number	Not restricted
UN proper shipping name:	Not restricted
Transport Hazard Class(es):	Not applicable
Packing Group:	Not applicable
Environmental Hazards:	Not applicable

IATA/ICAO

UN Number	Not restricted
UN proper shipping name:	Not restricted
Transport Hazard Class(es):	Not applicable
Packing Group:	Not applicable
Environmental Hazards:	Not applicable

Special precautions during transport

None

HazChem Code

None Allocated

15. Regulatory Information

Safety, health and environmental regulations specific for the product

International Inventories

Australian AICS Inventory	All components are listed on the AICS or are subject to a relevant exemption, permit, or assessment certificate.
New Zealand Inventory of Chemicals	All components are listed on the NZIoC or are subject to a relevant exemption, permit, or assessment certificate.
EINECS (European Inventory of Existing Chemical Substances)	This product, and all its components, complies with EINECS
US TSCA Inventory	All components listed on inventory or are exempt.
Canadian Domestic Substances List (DSL)	All components listed on inventory or are exempt.

Poisons Schedule number
None Allocated

International Agreements

Montreal Protocol - Ozone Depleting Substances:	Does not apply
Stockholm Convention - Persistent Organic Pollutants:	Does not apply
Rotterdam Convention - Prior Informed Consent:	Does not apply
Basel Convention - Hazardous Waste:	Does not apply

16. Other information

Date of preparation or review

Revision Date: 23-Jan-2017

Revision Note

Full text of H-Statements referred to under sections 2 and 3
H302 - Harmful if swallowed
H315 - Causes skin irritation
H318 - Causes serious eye damage
H373 - May cause damage to organs through prolonged or repeated exposure if swallowed
H401 - Toxic to aquatic life
H402 - Harmful to aquatic life
H412 - Harmful to aquatic life with long lasting effects

Additional information

For additional information on the use of this product, contact your local Halliburton representative.

For questions about the Safety Data Sheet for this or other Halliburton products, contact Chemical Stewardship at 1-580-251-4335.

Key abreviations or acronyms used
bw – body weight
CAS – Chemical Abstracts Service
EC50 – Effective Concentration 50%
LC50 – Lethal Concentration 50%
LD50 – Lethal Dose 50%
LL50 – Lethal Loading 50%
mg/kg – milligram/kilogram
mg/L – milligram/liter
NOEC – No Observed Effect Concentration
OEL – Occupational Exposure Limit
PBT – Persistent Bioaccumulative and Toxic
ppm – parts per million
STEL – Short Term Exposure Limit
TWA – Time-Weighted Average
vPvB – very Persistent and very Bioaccumulative
h - hour
mg/m^3 - milligram/cubic meter
mm - millimeter
mmHg - millimeter mercury
w/w - weight/weight
d - day

Key literature references and sources for data
www.ChemADVISOR.com/

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conditions nor if this material is used in combination with other materials or in any process. Final determination of suitability of any material is the sole responsibility of the user.

End of Safety Data Sheet

HALLIBURTON

SAFETY DATA SHEET

DCA-13002

Revision Date: 21-Sep-2017 **Revision Number:** 22

1. Product Identifier & Identity for the Chemical

Statement of Hazardous Nature Hazardous according to the criteria of the 3rd Revised Edition of the Globally Harmonised System of Classification and Labelling of Chemicals (GHS), Dangerous Goods according to the criteria of ADG.

1.1. Product Identifier

Product Name DCA-13002

Other means of Identification

Synonyms None

Hazardous Material Number: HM007647

Recommended use of the chemical and restrictions on use

Recommended Use Breaker

Uses advised against No information available

Supplier's name, address and phone number

Manufacturer/Supplier Halliburton Australia Pty. Ltd.
15 Marriott Road, Jandakot, WA 6164
Australia
ACN Number: 009 000 775
Telephone Number: + 61 1 800 686 951
Fax Number: 61 (08) 9455 5300

E-mail Address fdunexchem@halliburton.com

Emergency phone number

+ 61 1 800 686 951
Global Incident Response Access Code: 334305
Contract Number: 14012

Australian Poisons Information Centre
24 Hour Service: - 13 11 26
Police or Fire Brigade: - 000 (exchange): - 1100

2. Hazard Identification

Statement of Hazardous Nature Hazardous according to the criteria of the 3rd Revised Edition of the Globally Harmonised System of Classification and Labelling of Chemicals (GHS), Dangerous Goods according to the criteria of ADG.

Classification of the hazardous chemical

Acute Oral Toxicity	Category 4 - H302
Skin Corrosion/Irritation	Category 2 - H315
Serious Eye Damage/Irritation	Category 2 - H319
Respiratory Sensitization	Category 1 - H334
Skin Sensitization	Category 1 - H317
Specific Target Organ Toxicity - (Single Exposure)	Category 3 - H335
Oxidizing solids.	Category 3 - H272

Label elements, including precautionary statements

Hazard Pictograms



Signal Word DANGER

Hazard Statements:
H272 - May intensify fire; oxidizer
H302 - Harmful if swallowed
H315 - Causes skin irritation
H317 - May cause an allergic skin reaction
H319 - Causes serious eye irritation
H334 - May cause allergy or asthma symptoms or breathing difficulties if inhaled
H335 - May cause respiratory irritation

Precautionary Statements

Prevention
P210 - Keep away from heat, hot surfaces, sparks, open flames and other ignition sources. No smoking.
P221 - Take any precaution to avoid mixing with combustibles
P261 - Avoid breathing dust/fume/gas/mist/vapors/spray
P264 - Wash face, hands and any exposed skin thoroughly after handling
P270 - Do not eat, drink or smoke when using this product
P271 - Use only outdoors or in a well-ventilated area
P272 - Contaminated work clothing should not be allowed out of the workplace
P280 - Wear protective gloves/protective clothing/eye protection/face protection
P285 - In case of inadequate ventilation wear respiratory protection

Response
P301 + P312 - IF SWALLOWED: Call a POISON CENTER or doctor/physician if you feel unwell
P330 - Rinse mouth
P302 + P352 - IF ON SKIN: Wash with plenty of water.
P332 + P313 - If skin irritation occurs: Get medical advice/attention
P333 + P313 - If skin irritation or rash occurs: Get medical advice/attention
P362 + P364 - Take off contaminated clothing and wash before reuse
P304 + P341 - IF INHALED: If breathing is difficult, remove to fresh air and keep at rest in a position comfortable for breathing
P342 + P311 - If experiencing respiratory symptoms: Call a POISON CENTER or doctor/physician
P305 + P351 + P338 - IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing
P337 + P313 - If eye irritation persists: Get medical advice/attention
P370 + P378 - In case of fire: Use water spray for extinction

Storage
P403 + P233 - Store in a well-ventilated place. Keep container tightly closed
P405 - Store locked up

Disposal
P501 - Dispose of contents/container in accordance with local/regional/national/international regulations

Contains Substances	**CAS Number**
Sodium persulfate	7775-27-1

Other hazards which do not result in classification

This substance is not considered to be persistent, bioaccumulating nor toxic (PBT).
This substance is not considered to be very persistent nor very bioaccumulating (vPvB).

For the full text of the H-phrases mentioned in this Section, see Section 16

3. Composition/information on Ingredients

Substances	CAS Number	PERCENT (w/w)	GHS Classification - Australia
Sodium persulfate	7775-27-1	60 - 100%	Acute Tox. 4 (H302) Skin Irrit. 2 (H315) Eye Irrit. 2 (H319) Resp. Sens. 1 (H334) Skin Sens. 1 (H317) STOT SE 3 (H335) Ox. Sol. 3 (H272)

4. First aid measures

Description of necessary first aid measures

Inhalation If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.

Eyes In case of contact, immediately flush eyes with plenty of water for at least 15 minutes and get medical attention if irritation persists.

Skin Wash off immediately with soap and plenty of water for at least 15 minutes while removing all contaminated clothing and shoes.

Ingestion Do NOT induce vomiting. Give nothing by mouth. Obtain immediate medical attention.

Symptoms caused by exposure

Causes eye irritation. Causes skin irritation. May cause allergic skin reaction. May cause allergic respiratory reaction. May cause respiratory irritation. Harmful if swallowed.

Medical Attention and Special Treatment

Notes to Physician Treat symptomatically

5. Fire Fighting Measures

Suitable extinguishing equipment

Suitable Extinguishing Media

Water fog, carbon dioxide, foam, dry chemical.

Extinguishing media which must not be used for safety reasons

None known.

Specific hazards arising from the chemical

Special exposure hazards in a fire

Oxidizer. May ignite combustibles. Decomposition in fire may produce harmful gases.

Special protective equipment and precautions for fire fighters

Special protective equipment for firefighters

Full protective clothing and approved self-contained breathing apparatus required for fire fighting personnel.

6. Accidental release measures

6.1. Personal precautions, protective equipment and emergency procedures

Remove sources of ignition. Use appropriate protective equipment. Avoid creating and breathing dust. Avoid contact with skin, eyes and clothing. Ensure adequate ventilation. Evacuate all persons from the area.

6.2. Environmental precautions

Prevent from entering sewers, waterways, or low areas. Consult local authorities.

6.3. Methods and material for containment and cleaning up

Scoop up and remove.

7. Handling and storage

7.1. Precautions for safe handling

Handling Precautions

Remove sources of ignition. Avoid contact with eyes, skin, or clothing. Avoid creating or inhaling dust. Avoid dust accumulations. Ensure adequate ventilation. Wash hands after use. Launder contaminated clothing before reuse. Use appropriate protective equipment.

Hygiene Measures

Handle in accordance with good industrial hygiene and safety practice.

7.2. Conditions for safe storage, including any incompatibilities

Storage Information

Store away from combustibles. Store in a cool well ventilated area. Keep container closed when not in use. Product has a shelf life of 12 months.

Other Guidelines

No information available

8. Exposure Controls/Personal Protection

Control parameters - exposure standards, biological monitoring

Exposure Limits

Substances	CAS Number	Australia NOHSC	ACGIH TLV-TWA
Sodium persulfate	7775-27-1	0.01 mg/m^3	TWA: 0.1 mg/m^3

Appropriate engineering controls

Engineering Controls Use in a well ventilated area. Localized ventilation should be used to control dust levels.

Personal protective equipment (PPE)

Personal Protective Equipment If engineering controls and work practices cannot prevent excessive exposures, the selection and proper use of personal protective equipment should be determined by an industrial hygienist or other qualified professional based on the specific application of this product.

Respiratory Protection If engineering controls and work practices cannot keep exposure below occupational exposure limits or if exposure is unknown, wear a NIOSH certified, European Standard EN 149, AS/NZS 1715:2009, or equivalent respirator when using this product. Selection of and instruction on using all personal protective equipment, including respirators, should be performed by an Industrial Hygienist or other qualified professional.
Dust/mist respirator. (N95, P2/P3)

Hand Protection Chemical-resistant protective gloves (EN 374) Suitable materials for longer, direct contact (recommended: protection index 6, corresponding to > 480 minutes permeation time as per EN 374): Butyl rubber gloves. (>= 0.7 mm thickness)
This information is based on literature references and on information provided by glove manufacturers, or is derived by analogy with similar substances. Please note that in practice the working life of chemical-resistant protective gloves may be considerably shorter than the permeation time determined in accordance with EN 374 as a result of the many influencing factors (e.g. temperature). If signs of wear and tear are noticed then the gloves should be replaced. Manufacturer's directions for use should be observed because of great diversity of types.

Skin Protection Rubber apron.

Eye Protection Dust proof goggles.

Other Precautions None known.

Environmental Exposure Controls Do not allow material to contaminate ground water system

9. Physical and Chemical Properties

9.1. Information on basic physical and chemical properties

Physical State: Solid
Color White
Odor: Odorless
Odor Threshold: No information available

Property Remarks/ - Method	Values
pH:	6
Freezing Point / Range	No data available
Melting Point / Range	No data available
Boiling Point / Range	No data available
Flash Point	No data available
Evaporation rate	No data available
Vapor Pressure	No data available
Vapor Density	No data available
Specific Gravity	2.47
Water Solubility	Soluble in water
Solubility in other solvents	No data available
Partition coefficient: n-octanol/water	No data available
Autoignition Temperature	No data available
Decomposition Temperature	No data available
Viscosity	No data available
Explosive Properties	No information available
Oxidizing Properties	No information available

9.2. Other information

Molecular Weight	238.1 g/mol
VOC Content (%)	No data available

10. Stability and Reactivity

10.1. Reactivity
Not expected to be reactive.
10.2. Chemical stability
Stable
10.3. Possibility of hazardous reactions
Will Not Occur
10.4. Conditions to avoid
Avoid contact with readily oxidizable materials.
10.5. Incompatible materials
Avoid halogens. Contact with acids. Strong alkalis. Combustible materials.
10.6. Hazardous decomposition products
Oxides of sulfur. Oxygen. Sulfuric acid.

11. Toxicological Information

Information on routes of exposure
Principle Route of Exposure Eye or skin contact, inhalation.

Symptoms related to exposure
Most Important Symptoms/Effects
Causes eye irritation. Causes skin irritation. May cause allergic skin reaction. May cause allergic respiratory reaction. May cause respiratory irritation. Harmful if swallowed.

Toxicology data for the components

Substances	CAS Number	LD50 Oral	LD50 Dermal	LC50 Inhalation

Sodium persulfate	7775-27-1	895 mg/kg (Rat) 1200 mg/kg 930 mg/kg 1000 mg/kg 920 mg/kg	> 10000 mg/kg (Rat)	19.0 mg/L (Rat) 4h > 5.1 mg/L (Rat) 4h

Immediate, delayed and chronic health effects from exposure

Inhalation May cause respiratory irritation. May cause allergy or asthma symptoms or breathing difficulties if inhaled

Eye Contact Causes eye irritation.

Skin Contact Causes skin irritation. May cause an allergic skin reaction.

Ingestion Harmful if swallowed. Irritation of the mouth, throat, and stomach.

Chronic Effects/Carcinogenicity No data available to indicate product or components present at greater than 0.1% are chronic health hazards.

Exposure Levels

No data available

Interactive effects

Lung disorders.

Data limitations

No data available

Substances	CAS Number	Skin corrosion/irritation
Sodium persulfate	7775-27-1	Causes skin irritation. (Rabbit)

Substances	CAS Number	Serious eye damage/irritation
Sodium persulfate	7775-27-1	Causes severe eye irritation (Rabbit)

Substances	CAS Number	Skin Sensitization
Sodium persulfate	7775-27-1	Skin sensitizer in guinea pig.

Substances	CAS Number	Respiratory Sensitization
Sodium persulfate	7775-27-1	May cause sensitization by inhalation

Substances	CAS Number	Mutagenic Effects
Sodium persulfate	7775-27-1	In vitro tests did not show mutagenic effects. In vivo tests did not show mutagenic effects.

Substances	CAS Number	Carcinogenic Effects
Sodium persulfate	7775-27-1	Did not show carcinogenic effects in animal experiments (similar substances)

Substances	CAS Number	Reproductive toxicity
Sodium persulfate	7775-27-1	Animal testing did not show any effects on fertility. Did not show teratogenic effects in animal experiments. (similar substances)

Substances	CAS Number	STOT - single exposure
Sodium persulfate	7775-27-1	May cause respiratory irritation.

Substances	CAS Number	STOT - repeated exposure
Sodium persulfate	7775-27-1	No significant toxicity observed in animal studies at concentration requiring classification.

Substances	CAS Number	Aspiration hazard
Sodium persulfate	7775-27-1	Not applicable

12. Ecological Information

Ecotoxicity

Substance Ecotoxicity Data

Substances	CAS Number	Toxicity to Algae	Toxicity to Fish	Toxicity to Microorganisms	Toxicity to Invertebrates
Sodium persulfate	7775-27-1	EC50 (72h) 116 mg/L (biomass) (Pseudokirchnerella subcapitata)	LC50 (96h) 163 mg/L (Oncorhynchus mykiss)	EC10 (18h) 36 mg/L (Pseudomonas putida)	EC50 (48h) 133 mg/L (Daphnia magna)

12.2. Persistence and degradability

Substances	CAS Number	Persistence and Degradability
Sodium persulfate	7775-27-1	The methods for determining biodegradability are not applicable to inorganic substances.

12.3. Bioaccumulative potential

Substances	CAS Number	Log Pow
Sodium persulfate	7775-27-1	No information available

12.4. Mobility in soil

Substances	CAS Number	Mobility
Sodium persulfate	7775-27-1	No information available

12.6. Other adverse effects

Endocrine Disruptor Information

This product does not contain any known or suspected endocrine disruptors

13. Disposal Considerations

Safe handling and disposal methods

Disposal should be made in accordance with federal, state, and local regulations.

Disposal of any contaminated packaging

This bag may contain residue of a hazardous material. Some authorities may regulate such containers as hazardous waste. Dispose of container according to national or local regulations.

Environmental regulations

Not applicable

14. Transport Information

Transportation Information

Australia ADG

UN Number UN1505
UN proper shipping name: Sodium Persulfate
Transport Hazard Class(es): 5.1
Packing Group: III
Environmental Hazards: Not applicable

IMDG/IMO

UN Number UN1505
UN proper shipping name: Sodium Persulfate
Transport Hazard Class(es): 5.1
Packing Group: III
Environmental Hazards: Not applicable
EMS: EmS F-A, S-Q

IATA/ICAO

UN Number UN1505
UN proper shipping name: Sodium Persulfate
Transport Hazard Class(es): 5.1

Packing Group: III
Environmental Hazards: Not applicable

Special precautions during transport
None

HazChem Code
1Z

15. Regulatory Information

Safety, health and environmental regulations specific for the product

International Inventories

Australian AICS Inventory	All components are listed on the AICS or are subject to a relevant exemption, permit, or assessment certificate.
New Zealand Inventory of Chemicals	All components are listed on the NZIoC or are subject to a relevant exemption, permit, or assessment certificate.
EINECS (European Inventory of Existing Chemical Substances)	This product, and all its components, complies with EINECS
US TSCA Inventory	All components listed on inventory or are exempt.
Canadian Domestic Substances List (DSL)	All components listed on inventory or are exempt.

Poisons Schedule number
None Allocated

International Agreements

Montreal Protocol - Ozone Depleting Substances:	Does not apply
Stockholm Convention - Persistent Organic Pollutants:	Does not apply
Rotterdam Convention - Prior Informed Consent:	Does not apply
Basel Convention - Hazardous Waste:	Does not apply

16. Other information

Date of preparation or review

Revision Date: 21-Sep-2017

Revision Note
SDS sections updated:
2

Full text of H-Statements referred to under sections 2 and 3
H272 - May intensify fire; oxidizer
H302 - Harmful if swallowed
H315 - Causes skin irritation
H317 - May cause an allergic skin reaction
H319 - Causes serious eye irritation
H334 - May cause allergy or asthma symptoms or breathing difficulties if inhaled
H335 - May cause respiratory irritation

Additional information For additional information on the use of this product, contact your local Halliburton representative.

For questions about the Safety Data Sheet for this or other Halliburton products, contact Chemical Stewardship at 1-580-251-4335.

Key abreviations or acronyms used
bw – body weight

CAS – Chemical Abstracts Service
EC50 – Effective Concentration 50%
LC50 – Lethal Concentration 50%
LD50 – Lethal Dose 50%
LL50 – Lethal Loading 50%
mg/kg – milligram/kilogram
mg/L – milligram/liter
NOEC – No Observed Effect Concentration
OEL – Occupational Exposure Limit
PBT – Persistent Bioaccumulative and Toxic
ppm – parts per million
STEL – Short Term Exposure Limit
TWA – Time-Weighted Average
vPvB – very Persistent and very Bioaccumulative
h - hour
mg/m^3 - milligram/cubic meter
mm - millimeter
mmHg - millimeter mercury
w/w - weight/weight
d - day

Key literature references and sources for data
www.ChemADVISOR.com/
OSHA
ECHA C&L

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End of Safety Data Sheet

HALLIBURTON

SAFETY DATA SHEET

DCA-13003

Revision Date: 05-Jul-2016 **Revision Number:** 13

1. Product Identifier & Identity for the Chemical

Statement of Hazardous Nature Hazardous according to the criteria of the 3rd Revised Edition of the Globally Harmonised System of Classification and Labelling of Chemicals (GHS), Dangerous Goods according to the criteria of ADG.

1.1. Product Identifier

Product Name DCA-13003

Other means of Identification

Synonyms None

Hazardous Material Number: HM007648

Recommended use of the chemical and restrictions on use

Recommended Use Breaker

Uses advised against No information available

Supplier's name, address and phone number

Manufacturer/Supplier Halliburton Australia Pty. Ltd.
15 Marriott Road
Jandakot
WA 6164
Australia

ACN Number: 009 000 775
Telephone Number: + 61 1 800 686 951
Fax Number: 61 (08) 9455 5300

E-mail Address fdunexchem@halliburton.com

Emergency phone number

+ 61 1 800 686 951

Australian Poisons Information Centre
24 Hour Service: - 13 11 26
Police or Fire Brigade: - 000 (exchange): - 1100

2. Hazard Identification

Statement of Hazardous Nature Hazardous according to the criteria of the 3rd Revised Edition of the Globally Harmonised System of Classification and Labelling of Chemicals (GHS), Dangerous Goods according to the criteria of ADG.

Classification of the hazardous chemical

Acute toxicity - Dermal	Category 4 - H312
Acute inhalation toxicity - vapor	Category 4 - H332
Skin Corrosion/Irritation	Category 1 - H314
Serious Eye Damage/Irritation	Category 1 - H318
Acute Aquatic Toxicity	Category 2 - H401

Label elements, including precautionary statements

Hazard pictograms



Signal Word Danger

Hazard Statements:
H312 - Harmful in contact with skin
H314 - Causes severe skin burns and eye damage
H318 - Causes serious eye damage
H332 - Harmful if inhaled
H401 - Toxic to aquatic life

Precautionary Statements

Prevention
P260 - Do not breathe dust/fume/gas/mist/vapors/spray
P271 - Use only outdoors or in a well-ventilated area
P273 - Avoid release to the environment
P280 - Wear protective gloves/protective clothing/eye protection/face protection

Response
P301 + P330 + P331 - IF SWALLOWED: rinse mouth. Do NOT induce vomiting
P303 + P361 + P353 - IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water/shower
P304 + P340 - IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing
P310 - Immediately call a POISON CENTER or doctor/physician
P305 + P351 + P338 - IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing

Storage
P405 - Store locked up

Disposal
P501 - Dispose of contents/container in accordance with local/regional/national/international regulations

Contains

Substances	**CAS Number**
Chlorous acid, sodium salt	7758-19-2
Sodium chloride	7647-14-5

Other hazards which do not result in classification
This mixture contains no substance considered to be persistent, bioaccumulating nor toxic (PBT).
This mixture contains no substance considered to be very persistent nor very bioaccumulating (vPvB).

For the full text of the H-phrases mentioned in this Section, see Section 16

3. Composition/information on Ingredients

Substances	CAS Number	PERCENT (w/w)	GHS Classification - Australia
Chlorous acid, sodium salt	7758-19-2	5 - 10%	Acute Tox. 3 (H301) Acute Tox. 2 (H310) Acute Tox. 2 (H330) Skin Corr. 1B (H314) Eye Corr. 1 (H318) STOT SE 3 (H335) STOT RE 2 (H373) Aquatic Acute 1 (H400) Aquatic Chronic 3 (H412) Ox. Sol. 2 (H272)

Sodium chloride	7647-14-5	10 - 30%	Not Classified

4. First aid measures

Description of necessary first aid measures

Inhalation If inhaled, move victim to fresh air and seek medical attention.

Eyes In case of contact, immediately flush eyes with plenty of water for at least 30 minutes. Remove contact lenses after the first 5 minutes and continue washing. Seek immediate medical attention/advice. Suitable emergency eye wash facility should be immediately available

Skin In case of contact, immediately flush skin with plenty of soap and water for at least 30 minutes and remove contaminated clothing, shoes and leather goods immediately. Get medical attention immediately.

Ingestion Do NOT induce vomiting. Give nothing by mouth. Obtain immediate medical attention.

Symptoms caused by exposure

Causes severe eye irritation which may damage tissue. Causes severe skin irritation with tissue destruction. Harmful in contact with skin. Harmful if inhaled.

Medical Attention and Special Treatment

Notes to Physician Treat symptomatically

5. Fire Fighting Measures

Suitable extinguishing equipment

Suitable Extinguishing Media

Water fog, carbon dioxide, foam, dry chemical.

Extinguishing media which must not be used for safety reasons

None known.

Specific hazards arising from the chemical

Special exposure hazards in a fire

Product is not expected to burn unless all the water is boiled away. Use water spray to cool fire exposed surfaces. Decomposition in fire may produce harmful gases. If allowed to dry, this product is an oxidizer.

Special protective equipment and precautions for fire fighters

Special protective equipment for firefighters

Full protective clothing and approved self-contained breathing apparatus required for fire fighting personnel.

6. Accidental release measures

6.1. Personal precautions, protective equipment and emergency procedures

Use appropriate protective equipment. Wear self-contained breathing apparatus in enclosed areas. Avoid contact with skin, eyes and clothing. Avoid breathing vapors. Ensure adequate ventilation. Evacuate all persons from the area.

6.2. Environmental precautions

Prevent from entering sewers, waterways, or low areas.

6.3. Methods and material for containment and cleaning up

Isolate spill and stop leak where safe. Contain spill with sand or other inert materials. Scoop up and remove.

7. Handling and storage

7.1. Precautions for safe handling

Handling Precautions

Avoid contact with eyes, skin, or clothing. Avoid breathing vapors. Ensure adequate ventilation. Wash hands after use. Launder

contaminated clothing before reuse. Use appropriate protective equipment.

Hygiene Measures

Handle in accordance with good industrial hygiene and safety practice.

7.2. Conditions for safe storage, including any incompatibilities

Storage Information

Store away from acids. Store away from reducing agents. Store away from direct sunlight. Keep from excessive heat. Product has a shelf life of 24 months.

Other Guidelines

No information available

8. Exposure Controls/Personal Protection

Control parameters - exposure standards, biological monitoring

Exposure Limits

Substances	CAS Number	Australia NOHSC	ACGIH TLV-TWA
Chlorous acid, sodium salt	7758-19-2	Not applicable	Not applicable
Sodium chloride	7647-14-5	Not applicable	Not applicable

Appropriate engineering controls

Engineering Controls Use in a well ventilated area.

Personal protective equipment (PPE)

Personal Protective Equipment If engineering controls and work practices cannot prevent excessive exposures, the selection and proper use of personal protective equipment should be determined by an industrial hygienist or other qualified professional based on the specific application of this product.

Respiratory Protection If engineering controls and work practices cannot keep exposure below occupational exposure limits or if exposure is unknown, wear a NIOSH certified, European Standard EN 149, AS/NZS 1715:2009, or equivalent respirator when using this product. Selection of and instruction on using all personal protective equipment, including respirators, should be performed by an Industrial Hygienist or other qualified professional.
Organic vapor/acid gas/chlorine respirator.

Hand Protection Chemical-resistant protective gloves (EN 374) Suitable materials for longer, direct contact (recommended: protection index 6, corresponding to > 480 minutes permeation time as per EN 374): Butyl rubber gloves. (>= 0.7 mm thickness)
This information is based on literature references and on information provided by glove manufacturers, or is derived by analogy with similar substances. Please note that in practice the working life of chemical-resistant protective gloves may be considerably shorter than the permeation time determined in accordance with EN 374 as a result of the many influencing factors (e.g. temperature). If signs of wear and tear are noticed then the gloves should be replaced. Manufacturer's directions for use should be observed because of great diversity of types.

Skin Protection Full protective chemical resistant clothing.

Eye Protection Chemical goggles; also wear a face shield if splashing hazard exists.

Other Precautions Eyewash fountains and safety showers must be easily accessible.

Environmental Exposure Controls Do not allow material to contaminate ground water system

9. Physical and Chemical Properties

9.1. Information on basic physical and chemical properties

Physical State: Liquid
Color Clear tan
Odor: Mild chlorine
Odor Threshold: No information available

Property Remarks/ - Method	Values
pH:	11.5-12.5
Freezing Point / Range	3-4 °C
Melting Point / Range	No data available
Boiling Point / Range	106 - 108 °C
Flash Point	No data available

Evaporation rate	No data available
Vapor Pressure	No data available
Vapor Density	No data available
Specific Gravity	1.17 - 1.23
Water Solubility	Soluble in water
Solubility in other solvents	No data available
Partition coefficient: n-octanol/water	No data available
Autoignition Temperature	No data available
Decomposition Temperature	No data available
Viscosity	No data available
Explosive Properties	No information available
Oxidizing Properties	No information available

9.2. Other information

VOC Content (%) No data available

10. Stability and Reactivity

10.1. Reactivity

Not expected to be reactive.

10.2. Chemical stability

Stable

10.3. Possibility of hazardous reactions

10.4. Conditions to avoid

Keep away from heat, sparks and flame. Avoid contact with organic materials. Avoid friction.

10.5. Incompatible materials

Prolonged contact with aluminum. Contact with metals. Organic matter. Contact with ammonia. All flammables, especially petroleum products, asphalt & other volatile flammables. Ammonium compounds. Strong acids.

10.6. Hazardous decomposition products

Chlorine.

11. Toxicological Information

Information on routes of exposure

Principle Route of Exposure Eye or skin contact, inhalation.

Symptoms related to exposure

Most Important Symptoms/Effects

Causes severe eye irritation which may damage tissue. Causes severe skin irritation with tissue destruction. Harmful in contact with skin. Harmful if inhaled.

Numerical measures of toxicity

Toxicology data for the components

Substances	CAS Number	LD50 Oral	LD50 Dermal	LC50 Inhalation
Chlorous acid, sodium salt	7758-19-2	165 mg/kg (Rat) 390 - 500 mg/kg (Rat) 212 – 284 mg/kg (Rat)	315 mg/kg (Rat) 134 mg/kg (Rabbit)	0.29 mg/L (Rat) 4h 230 mg/m³ (Rat) 4h
Sodium chloride	7647-14-5	3000 mg/kg-bw (rat)	No data available	No data available

Immediate, delayed and chronic health effects from exposure

Inhalation	Harmful if inhaled. Causes severe respiratory irritation.
Eye Contact	Causes severe eye irritation which may damage tissue.
Skin Contact	Harmful in contact with skin. Causes severe burns.
Ingestion	Causes burns of the mouth, throat and stomach. May cause abdominal pain, vomiting, nausea, and diarrhea.

Chronic Effects/Carcinogenicity Prolonged or repeated exposure may cause adverse effects on the blood.

Exposure Levels

No data available

Interactive effects
Blood disorders.

Data limitations
No data available

Substances	CAS Number	Skin corrosion/irritation
Chlorous acid, sodium salt	7758-19-2	Corrosive to skin (Rabbit)
Sodium chloride	7647-14-5	Non-irritating to the skin (Rabbit) Not a dermal irritant

Substances	CAS Number	Serious eye damage/irritation
Chlorous acid, sodium salt	7758-19-2	Corrosive to eyes (Rabbit)
Sodium chloride	7647-14-5	May cause mild eye irritation. (Rabbit)

Substances	CAS Number	Skin Sensitization
Chlorous acid, sodium salt	7758-19-2	Did not cause sensitization on laboratory animals (guinea pig)
Sodium chloride	7647-14-5	No information available Not confirmed to cause skin or respiratory sensitization.

Substances	CAS Number	Respiratory Sensitization
Chlorous acid, sodium salt	7758-19-2	No information available
Sodium chloride	7647-14-5	No information available

Substances	CAS Number	Mutagenic Effects
Chlorous acid, sodium salt	7758-19-2	Not regarded as mutagenic.
Sodium chloride	7647-14-5	No information available

Substances	CAS Number	Carcinogenic Effects
Chlorous acid, sodium salt	7758-19-2	Did not show carcinogenic effects in animal experiments
Sodium chloride	7647-14-5	Did not show carcinogenic effects in animal experiments

Substances	CAS Number	Reproductive toxicity
Chlorous acid, sodium salt	7758-19-2	Animal testing did not show any effects on fertility. (fetotoxic and teratogenic effects).
Sodium chloride	7647-14-5	Animal testing did not show any effects on fertility. Did not show teratogenic effects in animal experiments.

Substances	CAS Number	STOT - single exposure
Chlorous acid, sodium salt	7758-19-2	May cause respiratory irritation.
Sodium chloride	7647-14-5	No information available

Substances	CAS Number	STOT - repeated exposure
Chlorous acid, sodium salt	7758-19-2	Causes damage to organs through prolonged or repeated exposure if swallowed: (spleen) (Blood)
Sodium chloride	7647-14-5	No significant toxicity observed in animal studies at concentration requiring classification.

Substances	CAS Number	Aspiration hazard
Chlorous acid, sodium salt	7758-19-2	Not applicable
Sodium chloride	7647-14-5	Not applicable

12. Ecological Information

Ecotoxicity
Product Ecotoxicity Data
No data available

Substance Ecotoxicity Data

Substances	CAS Number	Toxicity to Algae	Toxicity to Fish	Toxicity to Microorganisms	Toxicity to Invertebrates
Chlorous acid, sodium salt	7758-19-2	EC50 (72h) 9.09 mg/L (Skeletonema costatum) EC50 (72h) 0.2 mg/L (Pseudokirchnerella	LC50 (96h) 210 mg/L (Scophthalmus maximus) TLM96 290 mg/L (Oncorhynchus mykiss)	EC50 (3h) > 75 mg/L (activated sludge)	LC50 (48h) 50.67 mg/L (Acartia tonsa) TLM96 0.29 mg/L (Daphnia magna)

		subcapitata)	TLM96 208 mg/L (Lepomis macrochirus)		NOEC (22d) 25 ug/L (Daphnia magna)
Sodium chloride	7647-14-5	EC50 (120h) 2430 mg/L (Nitzschia sp.)	TLM96 > 1000 mg/L (Oncorhynchus mykiss) LC50 (96h) 5840 mg/L (Lepomis macrochirus) NOEC (33d) 252 mg/L (Pimephales promelas)	NOEC 5000 – 8000 mg/L (activated sludge) NOEC 292-584 mg/L (Escherichia coli)	TLM96 > 1,000,000 ppm (Mysidopsis bahia) LC50 (48h) 874-4136 mg/L (Daphnia magna) NOEC (21d) 314 mg/L (Daphnia pulex)

12.2. Persistence and degradability

Substances	CAS Number	Persistence and Degradability
Chlorous acid, sodium salt	7758-19-2	The methods for determining biodegradability are not applicable to inorganic substances.
Sodium chloride	7647-14-5	No information available

12.3. Bioaccumulative potential

Substances	CAS Number	Log Pow
Chlorous acid, sodium salt	7758-19-2	No information available
Sodium chloride	7647-14-5	No information available

12.4. Mobility in soil

Substances	CAS Number	Mobility
Chlorous acid, sodium salt	7758-19-2	No information available
Sodium chloride	7647-14-5	No information available

12.6. Other adverse effects

Endocrine Disruptor Information

This product does not contain any known or suspected endocrine disruptors

13. Disposal Considerations

Safe handling and disposal methods

Disposal should be made in accordance with federal, state, and local regulations.

Disposal of any contaminated packaging

Follow all applicable national or local regulations.

Environmental regulations

Not applicable

14. Transport Information

Transportation Information

Australia ADG

UN Number UN1908
UN proper shipping name: Chlorite Solution (14% Available Chlorine)
Transport Hazard Class(es): 8
Packing Group: III
Environmental Hazards: Not applicable

IMDG/IMO

UN Number UN1908
UN proper shipping name: Chlorite Solution (14% Available Chlorine)
Transport Hazard Class(es): 8
Packing Group: III
Environmental Hazards: Not applicable
EMS: EmS F-A, S-B

IATA/ICAO

UN Number	UN1908
UN proper shipping name:	Chlorite Solution (14% Available Chlorine)
Transport Hazard Class(es):	8
Packing Group:	III
Environmental Hazards:	Not applicable

Special precautions during transport
None

HazChem Code
2X

15. Regulatory Information

Safety, health and environmental regulations specific for the product

International Inventories

Australian AICS Inventory	All components are listed on the AICS or are subject to a relevant exemption, permit, or assessment certificate.
New Zealand Inventory of Chemicals	All components are listed on the NZIoC or are subject to a relevant exemption, permit, or assessment certificate.
EINECS (European Inventory of Existing Chemical Substances)	This product, and all its components, complies with EINECS
US TSCA Inventory	All components listed on inventory or are exempt.
Canadian Domestic Substances List (DSL)	All components listed on inventory or are exempt.

Poisons Schedule number
None Allocated

International Agreements

Montreal Protocol - Ozone Depleting Substances:	Does not apply
Stolkhom Convention - Persistent Organic Pollutants:	Does not apply
Rotterdam Convention - Prior Informed Consent:	Does not apply
Basel Convention - Hazardous Waste:	Does not apply

16. Other information

Date of preparation or review

Revision Date: 05-Jul-2016

Revision Note
SDS sections updated: 2

Full text of H-Statements referred to under sections 2 and 3
H272 - May intensify fire; oxidizer
H301 - Toxic if swallowed
H310 - Fatal in contact with skin
H312 - Harmful in contact with skin
H314 - Causes severe skin burns and eye damage
H318 - Causes serious eye damage
H320 - Causes eye irritation
H330 - Fatal if inhaled
H332 - Harmful if inhaled
H335 - May cause respiratory irritation
H373 - May cause damage to organs through prolonged or repeated exposure if inhaled
H400 - Very toxic to aquatic life
H412 - Harmful to aquatic life with long lasting effects

Additional information

For additional information on the use of this product, contact your local Halliburton representative.

For questions about the Safety Data Sheet for this or other Halliburton products, contact Chemical Stewardship at 1-580-251-4335.

Key abreviations or acronyms used

bw – body weight
CAS – Chemical Abstracts Service
EC50 – Effective Concentration 50%
LC50 – Lethal Concentration 50%
LD50 – Lethal Dose 50%
LL50 – Lethal Loading 50%
mg/kg – milligram/kilogram
mg/L – milligram/liter
NOEC – No Observed Effect Concentration
OEL – Occupational Exposure Limit
PBT – Persistent Bioaccumulative and Toxic
ppm – parts per million
STEL – Short Term Exposure Limit
TWA – Time-Weighted Average
vPvB – very Persistent and very Bioaccumulative
h - hour
mg/m^3 - milligram/cubic meter
mm - millimeter
mmHg - millimeter mercury
w/w - weight/weight
d - day

Key literature references and sources for data

www.ChemADVISOR.com/
OSHA
ECHA C&L

Disclaimer Statement

This information is furnished without warranty, expressed or implied, as to accuracy or completeness. The information is obtained from various sources including the manufacturer and other third party sources. The information may not be valid under all conditions nor if this material is used in combination with other materials or in any process. Final determination of suitability of any material is the sole responsibility of the user.

End of Safety Data Sheet

Appendix K

Chemical Risk Assessment – Packer Fluid and Lubricants

Packer Fluid Recipe - NaBR

Chemical Name	CAS Number	Volume or Mass of Chemical (L or kg)	Concentration in Injected Fluid (mg/L)	Parent Compound Purpose	Ecotoxicity[1]	Toxicity[2]	Biodegradation[1,3]	Bioaccummulative[1]	Tier 1 Screening Assessment	Discussion	Tier 2 Assessment Worker Ingestion Risk	Tier 2 Assessment Worker Dermal Risk	Tier 2 Assessment Worker Aerosol Inhalation Risk	Hazard Quotient	Outcome of Tier 2 Worker Risk Assessment[1]
Sodium Bromide	7647-15-6	8,160 kg	0.072	Fluid density	Acute Toxicity: 96hr LC50 fish >440 mg/L LC50value invertebrates >1000 mg/L EC50value algae: 440 mg/L Chronic toxicity: NOEC fish: 10 mg/L 16 day NOEC invertebrates: 2.8 mg/L	Based on chronic: Low	N.A.(Inorganic)	N.A. (Inorganic)	Tier 1 (NICNAS IMAP)	Poses no unreasonable risk to human health or the environment based on Tier I assessment under the NICNAS IMAP assessment framework	NA	NA	NA	NA	NA
Glutaraldehyde	111-30-8	40 kg	0.00015	Biocide	96 h acute Bluegill sunfish LC50 = 11.2 mg/L 48 h acute Oyster larvae LC550 = 2.1 mg/L 96 h acute Green crabs LC50 = 465 mg/L 96 h acute Grass shrimp LC50 = 41 mg/L 48 acute Daphnia magna LC50 = 0.35 mg/L 48 acute Daphnia magna LC50 = 16.3 mg/L 21 d reproducti'n Daphnia magna LOEC = 4.3 mg/L, NOEC = 2.1 mg/L 96 h algal growth inhibition Selenastrum capricornutum ILm = 3.9 mg/L (median inhibitory limit) 96 h algal growth inhibition Scenedesmus subspicatus EC50 = 1.0 mg/L Bacterial inhibition Sewage microbes IC50 = 25-34 mg/L	Based on Chronic: Moderate	Readily biodegradable	No based on the Log Pow of -0.01	Tier 1	The risk was classified as moderate based on chronic data, however the substance is readily biodegradable and not bioaccumulative. The exposure concentration is below the respective ecotoxicity values. A Tier 2 assessment is not required.	NA	NA	NA	NA	NA
Methanol	67-56-1	40 kg	0.00001	Biocide	LC50s ranged from 15,400 to 29,400 mg/L (fish) 24-hour and 48-hour EC50s were > 10,000 mg/L (Daphnia) 28 days NOEC was 446.7 mg/L (fish) 21 days NOEC was 208 mg/L (invertebrates)	Based on Chronic: Low	Readily biodegradable	Not bioaccumulative based on the Log Kow of -0.74	Tier 1	The risk was classified as low based on chronic data and it is expected to be readily biodegradable and not bioaccummulative. The exposure concentration is below the respective ecotoxicity values. A Tier 2 assessment is not required.	NA	NA	NA	NA	NA
BARACOR W-991*	Unknown	416 ltr	0.002	Corrosion inhibitor	--	Based on information provided in the SDS, this substance is classified as not hazardous .	--	--	Tier 1	NA	NA	NA	NA	NA	NA
Triazine based biocide C572,2',2"-(hexahydro-1,3, 5-triazine-1,3,5-triyl) triethanol	4719-04-4	208 ltr	0.0015	H2S scavenger	LC50 for fish 240.04 mg/L LC50 for invertebrates 60.67 mg/L EC50 for freshwater algae: 6.6 mg/L	Based on acute: High	Expected to be readily biodegradable.	Not bioaccumulative	Tier 1	The risk was classified as high based on acute data, however the substance is readily biodegradable and not bioaccummulative. The exposure concentration is below the respective ecotoxicity values. A Tier 2 assessment is not required.	NA	NA	NA	NA	NA
OXYGON*	Unknown	25 kg	0.0005	Oxygen scavenger	--	Based on information provided in the SDS, this substance is classified as not hazardous .	--	--	Tier 1	NA	NA	NA	NA	NA	NA
Sodium Hypochlorite	7681-52-9	0.03 ML	0.2	Sanitising agent	Acute fish (measured) = 0.023 mg/L Acute E(L)C50 for fish = 0.2 mg a.i./L, Acute E(L)C50 for Daphnia =0.04 mg active chlorine/L) Acute E(L)C50 for algae =0.095 mg/L.	Based on acute: Very High	Not applicable (inorganic salt, ionic species ubiquitous in environment)	Not applicable (inorganic salt, ionic species ubiquitous in environment)	Tier 2	The risk was classified as very high based on acute data. A Tier 2 assessment is required.	5.2E-06	7.6E-09	2.9E-05	3.4E-05	Based on the calculated HQ the chemical is of low concern for workers (refer to individual toxicity profile and risk calculations for further detail).
													Total Risk	**3.4E-05**	The chronic health risks associated with potential exposure to COPC identified in flowback water, where the NaBR Packer Fluid recipe is used and assuming 100% mass recovery are considered to be low and acceptable.

Notes
* Chemical composition and information not provided to AECOM due to proprietary controls by the chemical manufacturer
Tier 1 (NICNAS) - Chemical identified as of low concern for human health, as published in the National Assessment of Chemicals Associated with Coal Seam Gas Extraction in Australia (NICNAS 2017).
1 - Please refer to the individual toxicity profiles for further detail.
2 - Toxicity assessed using NT (2021)
3 - Biodegradation assessed as per NT (2021) and DoEE (2017)
BCF - Bioconcentration Factor
NA - Not Applicable
NICNAS 2017 - National Assessment of Chemicals Associated with Coal Seam Gas Extraction in Australia
DoEE 2017 - Draft Risk Assessment Guidance Manual: For Chemicals Associated with Coal Seam Gas Extraction, Australian Government, Department of Energy
NT 2021 - Northern Territory Government, Department of Environment, Parks and Water Security, Environment Management Plan Content Guideline, 2021

Toxicity and Dermal Absorption Parameters

C = calculated from chronic value, Ch = chronic value adopted

CAS#	Chemical	Oral/Dermal Exposures				Inhalation Exposures								
		Threshold Chronic TDI or RfD (mg/kg/day)		Dermal Permeability (cm/hr)	Reference	Inhalation Unit Risk $(ug/m^3)^{-1}$	Non-Threshold Slope Factor $(mg/kg/day)^{-1}$		Threshold Chronic TC or RfC (mg/m^3)		NOAEC or LOAEC (mg/m^3)	NOAEL or LOAEL (mg/kg bw/d)	Reference	UF	Reference
	COPC in Hydraulic Fracturing Fluid Injected into Well														
7681-52-9	Sodium hypochlorite	0.136	D	3.21E-06	EPI				0.476	converted from RFD		13.6	NICNAS (2017)	100	NICNAS (2017)

References:

D - Derived (refer to individual Toxicity Profiles)

EPI - USEPA Estimation Programs Interface (EPI) Suite

NICNAS (2017) - Department of the Environment and Energy 2017 , National assessment of chemicals associatedwith coal seam gas extraction in Australia, prepared by the National Industrial ChemicalsNotification and Assessment Scheme

Exposure to Chemicals via Incidental Ingestion of Flowback fluid - HVFR/SW Recipe

Chronic Exposures

General Data/ Equations	Units	Exposure Calculations (RME) Ingestion of Flowback Water by Workers	
Exposure Parameters			
Exposure Frequency (EF)	days/year	20	Assume work 5 days per week for 1 month during the fraccing period
Exposure Duration (ED)	years	0.083	Maximum duration of the frac. Works will be complete in one month.
Body Weight (BW)	kg	78	Average male and female adults as per enHealth 2012
Averaging Time - NonThreshold (ATc)	days	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (ATn)	days	30.42	USEPA 1989 and CSMS 1996
Ingestion Rate (IRw)	L/day or L/hr	0.005	Assume Incidental ingestion of 5 ml (1 tsp) of water per day during fraccing.
Bioavailability (B)	-	100%	Assume 100% bioavailability via ingestion of chemicals in water.
Intake Factor = IRw*ET*B*EF*ED / BW*AT	L/kg/day	**4.2E-09** **3.5E-06**	**NonThreshold** **Threshold**

Daily Intake from Water = Concentration in Water x Intake Factor (ref: USEPA 1989)
NonThreshold Risk = Daily Intake from Water for NonThreshold Effects x Slope Factor
Hazard Quotients = (Daily Intake from Water for Threshold Effects/ADI)

Chemical		Toxicity Data				Concentration	Daily Intake		Calculated Risk	
		Non-Threshold Slope Factor	Chronic Threshold TDI	Background Intake (% Chronic TDI)	Chronic TDI Allowable for Assessment (TDI-Background)	in Water	NonThreshold	Threshold	NonThreshold Risk	Chronic Hazard Quotient
		$(mg/kg\text{-}day)^{-1}$	(mg/kg/day)		(mg/kg/day)	(mg/L)	(mg/kg/day)	(mg/kg/day)	(unitless)	(unitless)
7681-52-9	Sodium hypochlorite		1.4E-01		1.4E-01	0.20	8.4E-10	7.0E-07	--	5.2E-06
								Total Risk (mixture)		**5.17E-06**

Note:
This scenario is deemed protective of the following scenarios due to the less frequent and short duration of exposures:
- Worker exposure during a spill (i.e.a couple breaks on a tank and releases product onto the worker) or leak scenarios

Dermal Exposure to Chemicals via Contact with Flow Back Water - HVFR/SW Recipe

Chronic Exposures

General Data/ Equations	Units	Exposure Calculations (RME) Dermal Contact with Flow Back Water by Workers	
Exposure Parameters			
Exposure Frequency (EF)	days/year	20	Assume work 5 days per week for 1 month during the fraccing period
Exposure Duration (ED)	years	0.083	Maximum duration of the frac. Works will be complete in one month.
Body Weight (BW)	kg	78	Average male and female adults as per enHealth 2012
Averaging Time - NonThreshold (ATc)	days	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (ATn)	days	30.42	USEPA 1989 and CSMS 1996
Surface Area (SAw)	cm^2	2300	Hands and forearms exposed (enHealth 2012) Occupational HSE would require long pants and closed shoes on Australian work sites; forearms conservatively included
Exposure Time (ET)	hr/day	1	Assume contact with flow back water for 1 hours per day
Conversion Factor (CF)	L/cm^3	1.E-03	Conversion of units
Intake Factor = $\frac{SAw*ET*CF*EF*ED}{BW*AT}$	L-hr/(cm-kg-day)	**1.9E-06** **1.6E-03**	**NonThreshold** **Threshold**

Daily Intake from Water = Concentration in Water x Dermal Permeability x Intake Factor (ref: USEPA 1989, 2004)
NonThreshold Risk = Daily Intake from Water for NonThreshold Effects x Slope Factor
Hazard Quotients = (Daily Intake from Water for Threshold Effects/ADI)

	Chemical	Toxicity Data					Concentration	Daily Intake		Calculated Risk	
		Non-Threshold Slope Factor	Chronic Threshold TDI	Background Intake (% chronic TDI)	Chronic TDI Allowable for Assessment (TDI-Background)	Dermal Permeability	in Water	NonThreshold	Threshold	NonThreshold Risk	Chronic Hazard Quotient
		$(mg/kg\text{-}day)^{-1}$	(mg/kg/day)		(mg/kg/day)	(cm/hr)	(mg/L)	(mg/kg/day)	(mg/kg/day)	(unitless)	(unitless)
7681-52-9	Sodium hypochlorite		1.4E-01		1.4E-01	3.2E-6	0.20	1.2E-12	1.0E-09	--	7.6E-09
									Total Risk (mixture)		**7.6E-09**

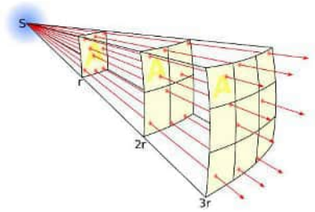
Note:
This scenario is deemed protective of the following scenarios due to the less frequent and short duration of exposures:
- Worker exposure during a spill (i.e.a couple breaks on a tank and releases product onto the worker) or leak scenarios

Aerosol Exposure - HVFR/SW Recipe

The concentration of COPC in aerosol spray was estimated by calculating the concentration for driftable droplets using a mixed box model in which steady state
An emission factor for driftable aerosol was estimated using the algorithm presented below.

Emission Factor for Driftable Aerosol Algorithm

$$Emission\ Factor_{driftable\ aerosol}\left(\frac{L}{m^3}\right) = \frac{Box\ Centre^2(m) \times \left(\frac{Spray\ Vol\ \left(\frac{L}{hr}\right) \times Aerosol_{driftable}(\%)}{BoxVR\ \left(\frac{m^2}{hr}\right)}\right)}{BoxDistance^2\ (m)}$$



Aerosol Exposure Modelling Notes:

1) The inhalation of chemicals in mist/aerosol resultant from irrigation activities is dependent upon the concentration in water, the amount of water used per unit time, how close a person stands to the spray generation, how long they are in a position of exposure and the extent of spray drift (determined by the size of the water droplets and speed/direction of the wind). These equations are applicable for non-volatile contaminants that are inhaled.

2) These equations calculate the concentration for driftable droplets using a simple well mixed box model in which steady state air concentrations are calculated. The 'Inverse square law' is then applied to approximate the air concentration at a distance from the virtual air box. This law assumes the further away a receptor is from the spray source, the density of the droplets will decrease. The density of the spray droplets is inversely proportional to the square of the distance from the source.

Parameter	Units	Value	Description
Spray box length	m	3	Assume a 'spray box' of 3 m long.
Spray box width	m	3	Assume a 'spray box' of 3 m wide.
Box Centre	m	1.5	Distance to centre of box is 1.5 m.
$Box_{Distance}$	m	2	Distance the irrigation worker is from the 'spray box'. Assumed a distance of 2 m.
$Aerosol_{driftable}$	unitless	0.2	Proportion of aerosol spray that drifts outside the 'spray box' and available for exposure. Assumed 0.2, based on a droplet size of 400 – 500 µm that falls approximately 0.3 m in less than 10 seconds, with a lateral drift of approximately 3.5 m in a 5 km/hr wind (i.e. a light breeze) (Grisso et al. 2013).
Spray Volume	L/hr	1800.0	1800 L/min, irrigation value adopted from NZ MtE (2011) Appendix 5A.
Wind speed	m/hr	9000	Based on windspeed of 2.5 m/sec
BoxVR	m^3/hr	81000.0	Ventilation rate of spray in the 'spray box'. Assumed to be 81,000 m3/hr based on a wind speed of 9000 m/hr, and a 'spray box' dimension of 3 x 3 m.

CAS	Chemical	Concentration in Water	Generation rate of chemical in volume	Driftable Aerosol Emission Factor
		mg/L	mg/hr	L/m^3
7681-52-9	Sodium hypochlorite	0.20	72	2.500000E-03

Exposure to Chemicals via Inhalation of Mist from the Evaporation Units - HVFR/SW Recipe

Chronic Exposures

General Data/ Equations	Units	Exposure Calculations (RME) Inhalation of Mist by Workers	
Exposure Parameters			
Exposure Frequency (EF)	days/year	240	Exposure for 5 days per week minus 4 weeks holidays
Exposure Duration (ED)	years	1	Maximum duration that the flowback tank will be on-site
Exposure Time (ET)	hr/day	1	Professional judgement for irrigation exposure. Assume worker to be near tank for 1 hours every working day.
Driftable aerosol emission factor (EMF)	L/m3	2.50E-03	Calculated
Aerosol Inhalation Bioavailability (AAF)	unitless	1.0	Assume 100% bioavailability
Averaging Time - Threshold (AT)	years	1.0	USEPA 1989 and CSMS 1996
$ITF_{inh,w,shwr} = \frac{EmF \times AAF \times ET_{iw} \times EF \times ED}{365\ \frac{days}{year} \times 24\ \frac{hours}{day} \times AT}$			

Daily Intake = Concentration in Water x Intake Factor (ref: USEPA 1989)
Hazard Quotients = (Daily Intake from Water for Threshold Effects/ADI)

CAS	Chemical	Groundwater Concentration	Aerosol Inhalation Bioavailability	Driftable Aerosol Emission Factor	RfC (Background Corrected)	Threshold Intake and Risk Calculations: Adult Exposure Factor (threshold)	Adult Exposure Adjusted Air Concentration (threshold)	Hazard Index (Adult)
		mg/L	(unitless)	(L/m^3)	(mg/m^3)	(L/m^3)	(mg/m^3)	(unitless)
7681-52-9	Sodium hypochlorite	0.20	1.00	2.50E-03	4.76E-01	6.85E-05	1.37E-05	2.9E-05
							Total Threshold Risk (mixture)	**2.88E-05**

Summary of Risk to Workers - HVFR/SW Recipe
Exposure fo Target Chemicals - Theoretical Data

Receptor/Exposure Pathway	Calculated HI 100% Mass Return
Use of Stimulation Fluid in Hydraulic Fracturing	
HYBRID Recipe	
Workers	
Ingestion of Chemicals via Incidental Contact with Flowback Water	5.2E-06
Dermal Exposure to Chemicals via Incidental Contact with Flowback Water	7.6E-09
Inhalation of mist from the evaporation units	2.9E-05
Total Risk	**3.4E-05**

Chemical Name	CAS Number	Volume or Mass of Chemical (L or kg)	Concentration in Injected Fluid (mg/L)	Parent Compound Purpose	Ecotoxicity[1]	Toxicity[2]	Biodegradation[1,3]	Bioaccummulative[1]	Tier 1 Screening Assessment	Discussion	Tier 2 Assessment Worker Ingestion Risk	Tier 2 Assessment Worker Dermal Risk	Tier 2 Assessment Worker Aerosol Inhalation Risk	Hazard Quotient	Outcome of Tier 2 Worker Risk Assessment[1]
Calcium Chloride	10043-52-4	8,304 kg	0.15	Fluid density	Acute Toxicity 96-hr LC50 value was 4,630 mg/L in fathead minnow (Pimephales promelas) 48-hr EC50 was 1,062 mg/L for Daphnia magna 72-hr EC50 = >4,000 for fresh water algae 72-hr EC50 = 2,900 mg/L for fresh water algae (biomass) Chronic Toxicity 21-day NOEC = 160 mg/L for Daphnia magna	Based on acute and chronic: Low	Not applicable (inorganic salt, ionic species ubiquitous in environment)	Not applicable (inorganic salt, ionic species ubiquitous in environment)	Tier 1	The risk was classified as low based on chronic data and acute data. The substance is inorganic and ubiquitous in the environment. The exposure concentration is below the respective ecotoxicity values A Tier 2 assessment is not required.	NA	NA	NA	NA	NA
Glutaraldehyde	111-30-8	40 kg	0.00015	Biocide	96 h acute Bluegill sunfish LC50 = 11.2 mg/L 48 h acute Oyster larvae LC550 = 2.1 mg/L 96 h acute Green crabs LC50 = 465 mg/L 96 h acute Grass shrimp LC50 = 41 mg/L 48 acute Daphnia magna LC50 = 0.35 mg/L 48 acute Daphnia magna LC50 = 16.3 mg/L 21 d reproductn Daphnia magna LOEC = 4.3 mg/L, NOEC = 2.1 mg/L 96 h algal growth inhibition Selenastrum capricornutum ILm = 3.9 mg/L (median inhibitory limit) 96 h algal growth inhibition Scenedesmus subspicatus EC50 = 1.0 mg/L Bacterial inhibition Sewage microbes IC50 = 25-34 mg/L	Based on Chronic: Moderate	Readily biodegradable	No based on the Log Pow of -0.01	Tier 1	The risk was classified as moderate based on chronic data . The exposure concentration is below the respective ecotoxicity values. A Tier 2 assessment is not required.	NA	NA	NA	NA	NA
Methanol	67-56-1	40 kg	0.000005	Biocide	LC50s ranged from 15,400 to 29,400 mg/L (fish) 24-hour and 48-hour EC50s were > 10,000 mg/L (Daphnia) 28 days NOEC was 446.7 mg/L (fish) 21 days NOEC was 208 mg/L (invertebrates)	Based on Chronic: Low	Readily biodegradable	Not bioaccumulative based on the Log Kow of -0.74	Tier 1	The risk was classified as low based on chronic data and it is expected to be readily biodegradable and not bioaccummulative. The exposure concentration is below the respective ecotoxicity values. A Tier 2 assessment is not required.	NA	NA	NA	NA	NA
Ethanolamine	141-43-5	1000 ltr	0.003	Corrosion inhibitor	Acute toxicity: 96 h LC50 (fish): 105 mg/L 48 h EC50 (invertebrates): 27.04 mg/L 72 h ErC50 (algae): 2.8 mg/L Chronic toxicity: 41 d NOEC (fish): 1.24 mg/L 21 d NOEC (invertebrates): 0.85 mg/L 72 h ErC10 (algae): 0.7 mg/L	Based on chronic: Low	Expected to be readily biodegradable	Not bioaccumulative	Tier 1	The risk was classified as low based on chronic data and it is expected to be readily biodegradable and not bioaccummulative. The exposure concentration is below the respective ecotoxicity values. A Tier 2 assessment is not required.	NA	NA	NA	NA	NA
Triazine based biocide C572,2',2''-(hexahydro-1,3, 5-triazine-1,3,5-triyl) triethanol	4719-04-4	208 ltr	0.0015	H2S scavenger	LC50 for fish 240.04 mg/L LC50 for invertebrates 60.67 mg/L EC50 for freshwater algae: 6.6 mg/L	Based on acute: High	Expected to be readily biodegradable.	Not bioaccumulative	Tier 1	The risk was classified as high based on actue data. However it is expected to be readily biodegradable and not bioaccummulative. The exposure concentration is below the respective ecotoxicity values. A Tier 2 assessment is not required.	NA	NA	NA	NA	NA
OXYGON*	Unknown	25 kg	0.0005	Oxygen scavenger	--	Based on information provided in the SDS, this substance is classified as not hazardous .	--	--	Tier 1	NA	NA	NA	NA	NA	NA
													Total Risk	**NA**	The chronic health risks associated with potential exposure to COPC identified in flowback water, where the CaCL2 Packer Fluid recipe is used and assuming 100% mass recovery are considered to be low and acceptable.

Notes
* Chemical composition and information not provided to AECOM due to proprietary controls by the chemical manufacturer
Tier 1 (NICNAS) - Chemical identified as of low concern for human health, as published in the National Assessment of Chemicals Associated with Coal Seam Gas Extraction in Australia (NICNAS 2017).
1 - Please refer to the individual toxicity profiles for further detail.
2 - Toxicity assessed using NT (2021)
3 - Biodegradation assessed as per NT (2021) and DoEE (2017)
BCF - Bioconcentration Factor
NA - Not Applicable
NICNAS 2017 - National Assessment of Chemicals Associated with Coal Seam Gas Extraction in Australia
DoEE 2017 - Draft Risk Assessment Guidance Manual: For Chemicals Associated with Coal Seam Gas Extraction, Australian Government, Department of Energy
NT 2021 - Northern Territory Government, Department of Environment, Parks and Water Security, Environment Management Plan Content Guideline, 2021

AECOM

Lubricant Recipe

Client Name: Tamboran B2 Pty Ltd
Project Name: Chemical Risk Assessment

Chemical Name	CAS Number	Volume or Mass of Chemical (L or kg)	Concentration in Injected Fluid (mg/L)	Parent Compound Purpose	Ecotoxicity[1]	Toxicity[2]	Biodegradation[1,3]	Bioaccummulative[1]	Tier 1 Screening Assessment	Discussion	Tier 2 Assessment Worker Ingestion Risk	Tier 2 Assessment Worker Dermal Risk	Tier 2 Assessment Worker Aerosol Inhalation Risk	Hazard Quotient	Outcome of Tier 2 Worker Risk Assessment[1]
Triethylene glycol, monobutyl ether,	143-22-6	14,500 L	0.00273	Lubricant	Acute Toxicity: 96hr LC50 fish:2400 mg/L 48 hr LC50 invertebrates:2210 mg/L EC50 algae: 500 mg/L Chronic toxicity: 30 day NOEC fish: 805 mg/L 30 day NOEC invertebrates: 314 mg/L	Based on acute and chronic: Low	Readily biodegradable	Based on a log Kow value <4.5 the substance is not bioaccumulative.	Tier 1 (NICNAS IMAP)	Poses no unreasonable risk to the environment based on Tier I assessment under the NICNAS IMAP assessment framework	NA	NA	NA	NA	NA
2-Butoxyethanol	111-76-2	14,500 L	0.00147	Lubricant	Acute Aquatic - Fish -96-hr LC50 Oncorhynchus mykiss - 1,464 mg/L -96-hr LC50 Pimephales promelas - range from 1,580 mg/L - 2,137 mg/L -96 hr LC50 - Lepomis machrochirus - 1,490 mg/L Acute Aquatic - Invertebrate -48-hr EC50 Daphnia magna - range from - 881 mg/L - 2,650 mg/L Acute Aquatic - Algae and other aquatic plants -72-hr EC50 Pseudokirchneriella subcapitata - 911 mg/L -72-hr EC50 Selenastrum capricornutum - 720 mg/L Chronic Aquatic - Fish -21-day NOEC Brachydanio rerio - > 100 mg/L Chronic Aquatic - Invertebrate - 21-day NOEC Daphnia magna - 100 mg/L	Based on acute and chronic: Low	Readily biodegradable	Based on a log Kow value greater than 3, and a maximum BCF value of under 800 the substance is not bioaccumulative.	Tier 1	The risk was classified as low based on chronic and acute data. The substance is expected to be readily biodegradable and not bioaccumulative. The exposure concentration is below the respective ecotoxicity values. A Tier 2 assessment is not required.	NA	NA	NA	NA	NA
Diethanolamine	111-42-2	14,500 L	0.00105	Lubricant	Fish 96-h LC50 = 1370 mg/l Invertebrates 48-h EC50 = 55 mg/l Pseudokirchneriella subcapitata 96-h ErC50 = 2.2 mg/l Microorganisms 16-h TTC = 16 mg/l Daphnia magna, the NOEC (21 days) was 0.78 mg/l	Based on Chronic: High	Readily biodegradable	No. Based on a measured log Kow of -2.18 and a calculated BCF of 3.16	Tier 1	The risk was classified as high based on chronic data. However the substance is expected to be readily biodegradable and not bioaccumulative and the exposure concentration is below the respective ecotoxicity values. A Tier 2 assessment is not required.	NA	NA	NA	NA	NA
Fatty Esters (Radiagreen EME)*	Unknown	4,800L	Unknown	Lubricant	--	Based on information provided in the SDS, this substance is classified as not hazardous .	--	--	Tier 1	NA	NA	NA	NA	NA	NA
Fatty Esters (Radiagreen EBL)*	Unknown	4,800L	Unknown	Lubricant	--	Based on information provided in the SDS, this substance is classified as not hazardous .	--	--	Tier 1	NA	NA	NA	NA	NA	NA
Styrene**	100-42-5	Unknown	Unknown	Lubricant	Acute Toxicity: 96hr LC50 fish:10 mg/L 96 hr LC50 invertebrates:9.5 mg/L 96 hr EC50 algae: 6.3 mg/L Chronic toxicity: 21 day NOEC invertebrates: 1.0 mg/L	Based on acute and chronic: High	Readily biodegradable	Based on a log Kow value 3 the substance is not bioaccumulative.	Not assessed as concentration is unknown	NA	NA	NA	NA	NA	NA
Sulphonated organic polymer (Polydrill)*	Unknown	Unknown	Unknown	Drilling Fluid Additive	--	Based on information provided in the SDS, this substance is classified as not hazardous .	--	--	Tier 1	NA	NA	NA	NA	NA	NA
													Total Risk	**NA**	The chronic health risks associated with potential exposure to COPC identified in flowback water, where the lubricant recipe is used and assuming 100% mass recovery are considered to be low and acceptable.

Notes
* Chemical composition and information not provided to AECOM due to proprietary controls by the chemical manufacturer
** Chemical concentration not provided to AECOM due to proprietary controls by the chemical manufacturer
Tier 1 (NICNAS) - Chemical identified as of low concern for human health, as published in the National Assessment of Chemicals Associated with Coal Seam Gas Extraction in Australia (NICNAS 2017).
1 - Please refer to the individual toxicity profiles for further detail.
2 - Toxicity assessed using NT (2021)
3 - Biodegradation assessed as per NT (2021) and DoEE (2017)
BCF - Bioconcentration Factor
NA - Not Applicable
NICNAS 2017 - National Assessment of Chemicals Associated with Coal Seam Gas Extraction in Australia
DoEE 2017 - Draft Risk Assessment Guidance Manual: For Chemicals Associated with Coal Seam Gas Extraction, Australian Government, Department of Energy
NT 2021 - Northern Territory Government, Department of Environment, Parks and Water Security, Environment Management Plan Content Guideline, 2021

Appendix L

CRA Recycled Flowback Water

AECOM

Recycled Flowback Data

Project Name: Beetaloo

Chemical Name	CAS Number	Maximum Concentration in Flowback Fluid (mg/L)	Tier 1 Screening Assessment	Discussion	Tier 2 Assessment Worker Ingestion Risk	Tier 2 Assessment Worker Dermal Risk	Tier 2 Assessment Worker Aerosol Inhalation Risk	Hazard Quotient	Outcome of Tier 2 Worker Risk Assessment
Benzene	71-43-2	0.007	Tier 2	Maximum concentration above NHMRC 2011 Health Guideline	Threshold Risk = 6.15E-06 Non Threshold Risk = 1.0E-12	Threshold Risk = 1.4E-06 Non Threshold Risk = 2.4E-13	Threshold Risk = 1.6E-05 Non Threshold Risk = 4.1E-14	Threshold Risk =2.4E-05 Non Threshold Risk = 1.3E-12	Based on the calculated risks the chemical is of low concern for workers (refer to risk calculations for further detail).
Ethylbenzene	100-41-4	0.01	Tier 1	Maximum concentration below NHMRC 2011 Health Guideline	NA	NA	NA	NA	NA
Toluene	108-88-3	0.048	Tier 1	Maximum concentration below NHMRC 2011 Health Guideline	NA	NA	NA	NA	NA
Xylene Total	1330-20-7	0.23	Tier 1	Maximum concentration below NHMRC 2011 Health Guideline	NA	NA	NA	NA	NA
Alkalinity (Bicarbonate) as CaCO3	471-34-1	716	Tier 1	NA. No human health guideline available*	NA	NA	NA	NA	NA
Alkalinity (Total) as CaCO3	471-34-1	716	Tier 1	NA. No human health guideline available*	NA	NA	NA	NA	NA
Ammonia (filtered)	007664-41-7	34	Tier 1	Maximim concentration below the WHO Drinking Water Guideline	NA	NA	NA	NA	NA
Anions Total	-	724	Tier 1	NA. No human health guideline available	NA	NA	NA	NA	NA
Bicarbonate	-	873.52	Tier 1	NA. No human health guideline available	NA	NA	NA	NA	NA
Bromide (filtered)	7726-95-6	260	Tier 1	NA. No human health guideline available*	NA	NA	NA	NA	NA
Calcium (filtered)	7440-70-2	1740	Tier 1	NA. No human health guideline available	NA	NA	NA	NA	NA
Carbonate	-	0.6	Tier 1	NA. No human health guideline available	NA	NA	NA	NA	NA
Cations Total	-	718	Tier 1	NA. No human health guideline available	NA	NA	NA	NA	NA
Chloride	16887-00-6	25400	Tier 1	NA. No human health guideline available*	NA	NA	NA	NA	NA
Electrical Conductivity (Lab)	-	59600	Tier 1	NA. No human health guideline available	NA	NA	NA	NA	NA
Fluoride	16984-48-8	1.2	Tier 1	Maximum concentration below NHMRC 2011 Health Guideline	NA	NA	NA	NA	NA
Kjeldahl Nitrogen Total	-	65.6	Tier 1	NA. No human health guideline available	NA	NA	NA	NA	NA
Magnesium (filtered)	7439-95-4	370	Tier 1	NA. No human health guideline available	NA	NA	NA	NA	NA
Methane	74-82-8	8.37	Tier 1	NA. No human health guideline available	NA	NA	NA	NA	NA
Nitrite + Nitrate (as N)	014797-55-8	0.26	Tier 1	Maximim concentration below the WHO Drinking Water Guideline	NA	NA	NA	NA	NA
Nitrogen (Total)	7727-37-9	65.6	Tier 1	NA. No human health guideline available	NA	NA	NA	NA	NA
pH (Lab)	-	6.74	Tier 1	NA. No human health guideline available	NA	NA	NA	NA	NA
Phosphorus	7723-14-0	1.07	Tier 1	NA. No human health guideline available	NA	NA	NA	NA	NA
Potassium (filtered)	7440-09-7	83	Tier 1	NA. No human health guideline available*	NA	NA	NA	NA	NA
Silicon as Si	7440-21-3	16	Tier 1	NA. No human health guideline available	NA	NA	NA	NA	NA
Silicon as SiO2	7631-86-9	33	Tier 1	NA. No human health guideline available	NA	NA	NA	NA	NA
Sodium (filtered)	7440-23-5	13900	Tier 1	NA. No human health guideline available*	NA	NA	NA	NA	NA
Sulphate as SO4 (filtered)	14808-79-8	42	Tier 1	NA. No human health guideline available*	NA	NA	NA	NA	NA
Total Dissolved Solids (filtered)	-	49200	Tier 1	NA. No human health guideline available*	NA	NA	NA	NA	NA
Total Dissolved Solids (Calculated)	-	37900	Tier 1	NA. No human health guideline available*	NA	NA	NA	NA	NA
Total Hardness as CaCO3 (filtered)	-	5560	Tier 1	NA. No human health guideline available*	NA	NA	NA	NA	NA
Aluminium	7429-90-5	0.3	Tier 1	Maximum concentration below the USEPA RSL 2022 Guideline	NA	NA	NA	NA	NA
Arsenic	007440-38-2	0.084	Tier 2	Maximum concentration above NHMRC 2011 Health Guideline	1.48E-04	6.79E-05	5.75E-03	5.97E-03	Based on the calculated HQ the chemical is of low concern for workers (refer to risk calculations for further detail).
Barium	7440-39-3	110	Tier 2	Maximum concentration above NHMRC 2011 Health Guideline	1.93E-03	8.89E-04	1.08E-02	1.36E-02	Based on the calculated HQ the chemical is of low concern for workers (refer to risk calculations for further detail).
Boron	7440-42-8	54.5	Tier 2	Maximum concentration above NHMRC 2011 Health Guideline	9.57E-04	8.19E-04	5.33E-03	7.11E-03	Based on the calculated HQ the chemical is of low concern for workers (refer to risk calculations for further detail).
Chromium (III+VI) (filtered)		0.048	Tier 1	Maximum concentration below the USEPA RSL 2022 Guideline	NA	NA	NA	NA	NA
Cobalt	7440-48-4	0.024	Tier 2	Maximum concentration above USEPA RSL 2022 Guidelline	6.02E-05	1.11E-05	1.64E-02	1.65E-02	Based on the calculated HQ the chemical is of low concern for workers (refer to risk calculations for further detail).
Iron	7439-89-6	97	Tier 2	Maximum concentration above USEPA RSL 2022 Guidelline	4.87E-04	2.24E-04	2.71E-03	3.42E-03	Based on the calculated HQ the chemical is of low concern for workers (refer to risk calculations for further detail).
Manganese	7439-96-5	3.09	Tier 2	Maximum concentration above NHMRC 2011 Health Guideline	6.78E-05	3.12E-05	3.78E-04	4.77E-04	Based on the calculated HQ the chemical is of low concern for workers (refer to risk calculations for further detail).
Mercury	007439-97-6	0.026	Tier 2	Maximum concentration above NHMRC 2011 Health Guideline	1.52E-04	2.12E-05	8.90E-03	9.08E-03	Based on the calculated HQ the chemical is of low concern for workers (refer to risk calculations for further detail).
Nickel	7440-02-0	0.04	Tier 2	Maximum concentration above NHMRC 2011 Health Guideline	1.17E-05	1.08E-06	1.37E-01	1.37E-01	Based on the calculated HQ the chemical is of low concern for workers (refer to risk calculations for further detail).
Strontium	7440-24-6	170	Tier 2	Maximum concentration above USEPA RSL 2022 Guidelline	9.95E-04	3.28E-04	5.54E-03	6.87E-03	Based on the calculated HQ the chemical is of low concern for workers (refer to risk calculations for further detail).
Zinc		0.13	Tier 1	Maximum concentration below the USEPA RSL 2022 Guideline	NA	NA	NA	NA	NA
2-methylnaphthalene	91-57-6	0.046	Tier 2	Maximum concentration above USEPA RSL 2022 Guidelline	4.04E-06	1.70E-04	2.25E-05	1.97E-04	Based on the calculated HQ the chemical is of low concern for workers (refer to risk calculations for further detail).
3-&4-methylphenol		0.0113	Tier 1	Maximum concentration below the USEPA RSL 2022 Guideline	NA	NA	NA	NA	NA
Naphthalene	91-20-3	0.043	Tier 2	Maximum concentration above USEPA RSL 2022 Guidelline	7.55E-06	1.62E-04	2.95E-04	4.64E-04	Based on the calculated HQ the chemical is of low concern for workers (refer to risk calculations for further detail).
Phenol		0.004	Tier 1	Maximum concentration below the USEPA RSL 2022 Guideline	NA	NA	NA	NA	NA
TPH C6 - C9 Fraction[A]	-	0.31	Tier 1	Maximim concentration below the WHO Drinking Water Guideline	NA	NA	NA	NA	NA
TPH C10 - C14 Fraction[A]	-	0.93	Tier 2	Maximum concentration above WHO Drinking Water Guidelline	7.08E-05	2.26E-03	1.91E-04	2.52E-03	Based on the calculated HQ the chemical is of low concern for workers (refer to risk calculations for further detail).
TPH C15 - C28 Fraction[A]	-	3.07	Tier 2	Maximum concentration above WHO Drinking Water Guidelline	3.23E-04	4.82E-02	1.80E-03	5.03E-02	Based on the calculated HQ the chemical is of low concern for workers (refer to risk calculations for further detail).
TPH C29 - C36 Fraction[A]	-	1.72	Tier 2	Maximum concentration above WHO Drinking Water Guidelline					Based on the calculated HQ the chemical is of low concern for workers (refer to risk calculations for further detail).
TPH C34 - C40 Fraction[A]	-	0.65	Tier 2	Maximum concentration above WHO Drinking Water Guidelline					Based on the calculated HQ the chemical is of low concern for workers (refer to risk calculations for further detail).
					Total Risk		**Non-Threshold**	**1.3E-12**	The calculated risks associated with potential exposure to COPC measured in recycled flowback water is below the Non-Threshold target of 1E-05 and Threshold target of 1, respectively. Hence, chronic health risks are considered to be low and acceptable.
							Threshold	**2.5E-01**	

Notes
NA - Not Applicable
* - Listed as naturally occuring chemical for which drinking water guideline values have not been established (WHO 2017)
A - No fractionation into aromatic and aliphatic components was undertaken for the identified TPH impacts. The approach adopted for the fractionation of TPH into aromatic and aliphatic components is summarised below:
• For TPH C6-C9 it is assumed that the total BTEX concentration reported is representative of the aromatic portion of TPH, and that the remaining TPH (i.e., total TPH C6-C9 minus total BTEX) is representative of the aliphatic portion of the TPH fraction. If the total BTEX concentration is less than the total TPH C6-C9 concentration, the TPH C6-C9 aliphatic portion has been calculated as the remaining concentration of TPH C6-C9;
•The higher TPH fractions are split conservatively, assuming a 50/50 ratio for aromatic and aliphatic components;
•TPH 15+ is the sum of the C15 - C40 concentrations

NHMRC 2011 Australian Drinking Water Guidelines 6. Volume 1. National Water Quality Management Strategy. National Health and Medical Research Council. Updated September 2022.
WHO Drinking Water Guidelines 2017 - World Health Organisation Drinking Water Guidelines and rolling revisions
USEPA RSLs 2022 - USEPA Regional Screening Levels

Toxicity and Dermal Absorption Parameters

C = calculated from chronic value, Ch = chronic value adopted

CAS#	Chemical	Oral/Dermal Exposures						Inhalation Exposures			
		Non-Threshold Slope Factor $(mg/kg/day)^{-1}$		Threshold Chronic TDI or RfD (mg/kg/day)		Dermal Permeability (cm/hr)	Reference	Inhalation Unit Risk $(ug/m^3)^{-1}$		Threshold Chronic TC or RfC (mg/m^3)	
	Chemicals of Potential Concern										
71-43-2	Benzene	3.50E-02	NHMRC (2011)	0.0040	USEPA IRIS	5.00E-04	USEPA (1995) as per NEPC (2013)	6.00E-06	WHO (2010)	3.00E-02	USEPA IRIS
007440-38-2	Arsenic			0.0020	NEPC (2013)	1.00E-03	RAIS			1.00E-03	RIVM (2001)
7440-39-3	Barium			0.2000	ATSDR (2007)	1.00E-03	RAIS			0.7	converted from RFD
7440-42-8	Boron			0.2000	USEPA RSL (2022)	1.86E-03	EPI			0.7	converted from RFD
7440-48-4	Cobalt			0.0014	RIVM (2001)	4.00E-04	RAIS			1.00E-04	WHO (2006)
7439-89-6	Iron			0.7000	PPRTV (USEPA RSL (2022)	1.00E-03	RAIS			2.45	converted from RFD
7439-96-5	Manganese			0.1600	ATSDR (2008)	1.00E-03	RAIS			0.56	converted from RFD
007439-97-6	Mercury			0.0006	WHO (2017)	3.03E-04	RAIS			2.00E-04	WHO (2003)
7440-02-0	Nickel			0.0120	WHO (2017)	2.00E-04	RAIS			2.00E-05	EA (2009)
7440-24-6	Strontium			0.6000	USEPA RSL (2022)	7.17E-04	EPI			2.1	converted from RFD
91-57-6	2-methylnaphthalene			0.0400	ATSDR (2005)	9.17E-02	RAIS			0.14	converted from RFD
91-20-3	Naphthalene			0.0200	IRIS	4.66E-02	RAIS			1.00E-02	WHO (2010)
-	TPH C10 - C14 Fraction Aromatic[E]			0.0300	TPHCWG	6.94E-02	TPHCWG			0.2	TPHCWG
-	TPH C10 - C14 Fraction Aliphatic[E]			0.1000	TPHCWG	6.94E-02	TPHCWG			1	TPHCWG
-	TPH C15+ Fraction Aromatic[E]			0.0300	TPHCWG	3.24E-01	TPHCWG			0.105	converted from RFD
-	TPH C15+ Fraction Aliphatic[E]			2.0000	TPHCWG	3.24E-01	TPHCWG			7	converted from RFD

Notes:

E - No fractionation into aromatic and aliphatic components was undertaken for the identified TPH impacts. The approach adopted for the fractionation of TPH into aromatic and aliphatic components is summarised below:

- For TPH C6-C9 it is assumed that the total BTEX concentration reported is representative of the aromatic portion of TPH, and that the remaining TPH (i.e., total TPH C6-C9 minus total BTEX) is representative of the aliphatic portion of the TPH fraction. If the total BTEX concentration is less than the total TPH C6-C9 concentration, the TPH C6-C9 aliphatic portion has been calculated as the remaining concentration of TPH C6-C9;
- The higher TPH fractions are split conservatively, assuming a 50/50 ratio for aromatic and aliphatic components;
- TPH 15+ is the sum of the C15 - C40 concentrations

References:

IRIS - Integrated Risk Information System (USEPA)

RAIS - US Department of Energy Office of Environmental Management, Risk Assessment Information System

ATSDR - Agency for Toxic Substance and Disease Registry toxicity profiles for individual compounds.

PPRTV - Provisional Peer Reviewed Toxicity Values (USEPA, Office of Superfund Remediation and Technology Innovation (OSRTI))

NHMRC (2011) Australian Drinking Water Guidelines 6. Volume 1. National Water Quality Management Strategy. National Health and Medical Research Council. Updated September 2022.

USEPA (2022) Regional Screening Levels. Updated May 2022. https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables

NEPC (2013) National Environmental Protection (Assessment of Site Contamination) Measure 1999 as ammended May 2013. National Environmental Protection Council, May 2013.

TPHCWG - TPH Criteria Working Group. Development of fraction specific reference doses (RfDs) and reference concentrations (RfCs) for total petroleum hydrocarbons (TPH), 1997

WHO (2010) Guidelines for Indoor Air Quality

WHO (2017) - World Health Organisation Drinking Water Guidelines and rolling revisions

Exposure to Chemicals via Incidental Ingestion of Flowback fluid - Recycled

Chronic Exposures

General Data/ Equations	Units	Exposure Calculations (RME) Ingestion of Flowback Water by Workers	
Exposure Parameters			
Exposure Frequency (EF)	days/year	20	Assume work 5 days per week for 1 month during the fraccing period
Exposure Duration (ED)	years	0.083	Maximum duration of the frac. Works will be complete in one month.
Body Weight (BW)	kg	78	Average male and female adults as per enHealth 2012
Averaging Time - NonThreshold (ATc)	days	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (ATn)	days	30.42	USEPA 1989 and CSMS 1996
Ingestion Rate (IRw)	L/day or L/hr	0.005	Assume Incidental ingestion of 5 ml (1 tsp) of water per day during fraccing.
Bioavailability (B)	-	100%	Assume 100% bioavailability via ingestion of chemicals in water.
Intake Factor = IRw*ET*B*EF*ED / BW*AT	L/kg/day	**4.2E-09** **3.5E-06**	**NonThreshold** **Threshold**

Daily Intake from Water = Concentration in Water x Intake Factor (ref: USEPA 1989)
NonThreshold Risk = Daily Intake from Water for NonThreshold Effects x Slope Factor
Hazard Quotients = (Daily Intake from Water for Threshold Effects/ADI)

CAS	Chemical	Toxicity Data				Concentration	Daily Intake		Calculated Risk	
		Non-Threshold Slope Factor	Chronic Threshold TDI	Background Intake (% Chronic TDI)	Chronic TDI Allowable for Assessment (TDI-Background)	in Water	NonThreshold	Threshold	NonThreshold Risk	Chronic Hazard Quotient
		$(mg/kg\text{-}day)^{-1}$	(mg/kg/day)		(mg/kg/day)	(mg/L)	(mg/kg/day)	(mg/kg/day)	(unitless)	(unitless)
71-43-2	Benzene	3.5E-02	4.0E-03		4.0E-03	0.01	2.9E-11	2.5E-08	1.0E-12	6.1E-06
007440-38-2	Arsenic		2.0E-03		2.0E-03	0.08	3.5E-10	3.0E-07	--	1.5E-04
7440-39-3	Barium		2.0E-01		2.0E-01	110.00	4.6E-07	3.9E-04	--	1.9E-03
7440-42-8	Boron		2.0E-01		2.0E-01	54.50	2.3E-07	1.9E-04	--	9.6E-04
7440-48-4	Cobalt		1.4E-03		1.4E-03	0.02	1.0E-10	8.4E-08	--	6.0E-05
7439-89-6	Iron		7.0E-01		7.0E-01	97.00	4.1E-07	3.4E-04	--	4.9E-04
7439-96-5	Manganese		1.6E-01		1.6E-01	3.09	1.3E-08	1.1E-05	--	6.8E-05
007439-97-6	Mercury		6.0E-04		6.0E-04	0.03	1.1E-10	9.1E-08	--	1.5E-04
7440-02-0	Nickel		1.2E-02		1.2E-02	0.04	1.7E-10	1.4E-07	--	1.2E-05
7440-24-6	Strontium		6.0E-01		6.0E-01	170.00	7.1E-07	6.0E-04	--	1.0E-03
91-57-6	2-methylnaphthalene		4.0E-02		4.0E-02	0.05	1.9E-10	1.6E-07	--	4.0E-06
91-20-3	Naphthalene		2.0E-02		2.0E-02	0.04	1.8E-10	1.5E-07	--	7.6E-06
-	TPH C10 - C14 Fraction Aromatic[A]		0.0300		3.0E-02	0.47	1.9E-09	1.6E-06	--	5.4E-05
-	TPH C10 - C14 Fraction Aliphatic[A]		0.1000		1.0E-01	0.47	1.9E-09	1.6E-06	--	1.6E-05
-	TPH C15+ Fraction Aromatic[A]		0.0300		3.0E-02	2.72	1.1E-08	9.6E-06	--	3.2E-04
-	TPH C15+ Fraction Aliphatic[A]		2.0000		2.0E+00	2.72	1.1E-08	9.6E-06	--	4.8E-06
								Total Risk (mixture)	**1.0E-12**	**5.22E-03**

Note:
This scenario is deemed protective of the following scenarios due to the less frequent and short duration of exposures:
- Worker exposure during a spill (i.e.a couple breaks on a tank and releases product onto the worker) or leak scenarios

A - No fractionation into aromatic and aliphatic components was undertaken for the identified TPH impacts. The approach adopted for the fractionation of TPH into aromatic and aliphatic components is summarised below:
- For TPH C6-C9 it is typically assumed that the total BTEX concentration reported is representative of the aromatic portion of TPH, and that the remaining TPH (i.e., total TPH C6-C9 minus total BTEX) is representative of the aliphatic portion of the TPH fraction. If the total BTEX concentration is less than the total TPH C6-C9 concentration, the TPH C6-C9 aliphatic portion has been calculated as the remaining concentration of TPH C6-C9;
- The higher TPH fractions are split conservatively, assuming a 50/50 ratio for aromatic and aliphatic components;
- TPH 15+ is the sum of the C15 - C40 concentrations

Dermal Exposure to Chemicals via Contact with Flow Back Water - Recycled

Chronic Exposures

General Data/ Equations	Units	Exposure Calculations (RME) Dermal Contact with Flow Back Water by Workers	
Exposure Parameters			
Exposure Frequency (EF)	days/year	20	Assume work 5 days per week for 1 month during the fraccing period
Exposure Duration (ED)	years	0.083	Maximum duration of the frac. Works will be complete in one month.
Body Weight (BW)	kg	78	Average male and female adults as per enHealth 2012
Averaging Time - NonThreshold (ATc)	days	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (ATn)	days	30.42	USEPA 1989 and CSMS 1996
Surface Area (SAw)	cm^2	2300	Hands and forearms exposed (enHealth 2012) Occupational HSE would require long pants and closed shoes on Australian work sites; forearms conservatively included
Exposure Time (ET)	hr/day	1	Assume contact with flow back water for 1 hours per day
Conversion Factor (CF)	L/cm^3	1.E-03	Conversion of units
Intake Factor = SAw*ET*CF*EF*ED / BW*AT	L-hr/(cm-kg-day)	**1.9E-06** **1.6E-03**	**NonThreshold** **Threshold**

Daily Intake from Water = Concentration in Water x Dermal Permeability x Intake Factor (ref: USEPA 1989, 2004)
NonThreshold Risk = Daily Intake from Water for NonThreshold Effects x Slope Factor
Hazard Quotients = (Daily Intake from Water for Threshold Effects/ADI)

CAS	Chemical	Toxicity Data				Dermal Permeability	Concentration in Water	Daily Intake		Calculated Risk	
		Non-Threshold Slope Factor	Chronic Threshold TDI	Background Intake (% chronic TDI)	Chronic TDI Allowable for Assessment (TDI-Background)			NonThreshold	Threshold	NonThreshold Risk	Chronic Hazard Quotient
		$(mg/kg\text{-}day)^{-1}$	(mg/kg/day)		(mg/kg/day)	(cm/hr)	(mg/L)	(mg/kg/day)	(mg/kg/day)	(unitless)	(unitless)
71-43-2	Benzene	3.5E-02	4.0E-03		4.0E-03	5.0E-4	0.01	6.7E-12	5.7E-09	2.4E-13	1.4E-06
007440-38-2	Arsenic		2.0E-03		2.0E-03	1.0E-3	0.08	1.6E-10	1.4E-07	--	6.8E-05
7440-39-3	Barium		2.0E-01		2.0E-01	1.0E-3	110.00	2.1E-07	1.8E-04	--	8.9E-04
7440-42-8	Boron		2.0E-01		2.0E-01	1.9E-3	54.50	1.9E-07	1.6E-04	--	8.2E-04
7440-48-4	Cobalt		1.4E-03		1.4E-03	4.0E-4	0.02	1.8E-11	1.6E-08	--	1.1E-05
7439-89-6	Iron		7.0E-01		7.0E-01	1.0E-3	97.00	1.9E-07	1.6E-04	--	2.2E-04
7439-96-5	Manganese		1.6E-01		1.6E-01	1.0E-3	3.09	5.9E-09	5.0E-06	--	3.1E-05
007439-97-6	Mercury		6.0E-04		6.0E-04	3.0E-4	0.03	1.5E-11	1.3E-08	--	2.1E-05
7440-02-0	Nickel		1.2E-02		1.2E-02	2.0E-4	0.04	1.5E-11	1.3E-08	--	1.1E-06
7440-24-6	Strontium		6.0E-01		6.0E-01	7.2E-4	170.00	2.3E-07	2.0E-04	--	3.3E-04
91-57-6	2-methylnaphthalene		4.0E-02		4.0E-02	9.2E-2	0.05	8.1E-09	6.8E-06	--	1.7E-04
91-20-3	Naphthalene		2.0E-02		2.0E-02	4.7E-2	0.04	3.9E-09	3.2E-06	--	1.6E-04
-	TPH C10 - C14 Fraction Aromatic[A]		3.0E-02		3.0E-02	6.9E-2	0.47	6.2E-08	5.2E-05	--	1.7E-03
-	TPH C10 - C14 Fraction Aliphatic[A]		1.0E-01		1.0E-01	6.9E-2	0.47	6.2E-08	5.2E-05	--	5.2E-04
-	TPH C15+ Fraction Aromatic[A]		3.0E-02		3.0E-02	3.2E-1	2.72	1.7E-06	1.4E-03	--	4.7E-02
-	TPH C15+ Fraction Aliphatic[A]		2.0E+00		2.0E+00	3.2E-1	2.72	1.7E-06	1.4E-03	--	7.1E-04
									Total Risk (mixture)	**2.36E-13**	**5.32E-02**

Note:
This scenario is deemed protective of the following scenarios due to the less frequent and short duration of exposures:
- Worker exposure during a spill (i.e.a couple breaks on a tank and releases product onto the worker) or leak scenarios

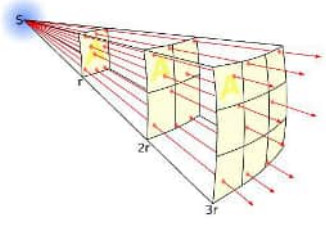
A - No fractionation into aromatic and aliphatic components was undertaken for the identified TPH impacts. The approach adopted for the fractionation of TPH into aromatic and aliphatic components is summarised below:
• For TPH C6-C9 it is typically assumed that the total BTEX concentration reported is representative of the aromatic portion of TPH, and that the remaining TPH (i.e., total TPH C6-C9 minus total BTEX) is representative of the aliphatic portion of the TPH fraction. If the total BTEX concentration is less than the total TPH C6-C9 concentration, the TPH C6-C9 aliphatic portion has been calculated as the remaining concentration of TPH C6-C9;
•The higher TPH fractions are split conservatively, assuming a 50/50 ratio for aromatic and aliphatic components;
•TPH 15+ is the sum of the C15 - C40 concentrations

Aerosol Exposure - Recycled Flowback

The concentration of COPC in aerosol spray was estimated by calculating the concentration for driftable droplets using a mixed box model in which steady state concentrations
An emission factor for driftable aerosol was estimated using the algorithm presented below.

Emission Factor for Driftable Aerosol Algorithm

$$Emission\ Factor_{driftable\ aerosol}\left(\frac{L}{m^3}\right) = \frac{Box\ Centre^2(m) \times \left(\frac{Spray\ Vol\ \left(\frac{L}{hr}\right) \times Aerosol_{driftable}(\%)}{BoxVR\ \left(\frac{m^3}{hr}\right)}\right)}{BoxDistance^2\ (m)}$$



Aerosol Exposure Modelling Notes:

1) The inhalation of chemicals in mist/aerosol resultant from irrigation activities is dependent upon the concentration in water, the amount of water used per unit time, how close a person stands to the spray generation, how long they are in a position of exposure and the extent of spray drift (determined by the size of the water droplets and speed/direction of the wind). These equations are applicable for non-volatile contaminants that are inhaled.

2) These equations calculate the concentration for driftable droplets using a simple well mixed box model in which steady state air concentrations are calculated. The 'Inverse square law' is then applied to approximate the air concentration at a distance from the virtual air box. This law assumes the further away a receptor is from the spray source, the density of the droplets will decrease. The density of the spray droplets is inversely proportional to the square of the distance from the source.

Parameter	Units	Value	Description
Spray box length	m	3	Assume a 'spray box' of 3 m long.
Spray box width	m	3	Assume a 'spray box' of 3 m wide.
Box Centre	m	1.5	Distance to centre of box is 1.5 m.
$Box_{Distance}$	m	2	Distance the irrigation worker is from the 'spray box'. Assumed a distance of 2 m.
$Aerosol_{driftable}$	unitless	0.2	Proportion of aerosol spray that drifts outside the 'spray box' and available for exposure. Assumed 0.2, based on a droplet size of 400 – 500 µm that falls approximately 0.3 m in less than 10 seconds, with a lateral drift of approximately 3.5 m in a 5 km/hr wind (i.e. a light breeze) (Grisso et al. 2013).
Spray Volume	L/hr	1800.0	1800 L/min, irrigation value adopted from NZ MtE (2011) Appendix 5A.
Wind speed	m/hr	9000	Based on windspeed of 2.5 m/sec
BoxVR	m^3/hr	81000.0	Ventilation rate of spray in the 'spray box'. Assumed to be 81,000 m3/hr based on a wind speed of 9000 m/hr, and a 'spray box' dimension of 3 x 3 m.

CAS	Chemical	Concentration in Water mg/L	Generation rate of chemical in volume mg/hr	Driftable Aerosol Emission Factor L/m^3
71-43-2	Benzene	0.01	2.52	2.500000E-03
007440-38-2	Arsenic	0.08	30.24	2.500000E-03
7440-39-3	Barium	110.00	39600	2.500000E-03
7440-42-8	Boron	54.50	19620	2.500000E-03
7440-48-4	Cobalt	0.02	8.64	2.500000E-03
7439-89-6	Iron	97.00	34920	2.500000E-03
7439-96-5	Manganese	3.09	1112.4	2.500000E-03
007439-97-6	Mercury	0.03	9.36	2.500000E-03
7440-02-0	Nickel	0.04	14.4	2.500000E-03
7440-24-6	Strontium	170.00	61200	2.500000E-03
91-57-6	2-methylnaphthalene	0.05	16.56	2.500000E-03
91-20-3	Naphthalene	0.04	15.48	2.500000E-03
-	TPH C10 - C14 Fraction Aromatic[A]	0.47	167.4	2.500000E-03
-	TPH C10 - C14 Fraction Aliphatic[A]	0.47	167.4	2.500000E-03
-	TPH C15+ Fraction Aromatic[A]	2.72	979.2	2.500000E-03
-	TPH C15+ Fraction Aliphatic[A]	2.72	979.2	2.500000E-03

A - No fractionation into aromatic and aliphatic components was undertaken for the identified TPH impacts. The approach adopted for the fractionation of TPH into aromatic and aliphatic components is summarised below:

- For TPH C6-C9 it is typically assumed that the total BTEX concentration reported is representative of the aromatic portion of TPH, and that the remaining TPH (i.e., total TPH C6-C9 minus total BTEX) is representative of the aliphatic portion of the TPH fraction. If the total BTEX concentration is less than the total TPH C6-C9 concentration, the TPH C6-C9 aliphatic portion has been calculated as the remaining concentration of TPH C6-C9;
- The higher TPH fractions are split conservatively, assuming a 50/50 ratio for aromatic and aliphatic components;
- TPH 15+ is the sum of the C15 - C40 concentrations

Exposure to Chemicals via Inhalation of Mist from the Evaporation Units - Recycled Flowback

Chronic Exposures

General Data/ Equations	Units	Exposure Calculations (RME) Inhalation of Mist by Workers	
Exposure Parameters			
Exposure Frequency (EF)	days/year	240	Exposure for 5 days per week minus 4 weeks holidays
Exposure Duration (ED)	years	1	Maximum duration that the flowback tank will be on-site
Exposure Time (ET)	hr/day	1	Professional judgement for irrigation exposure. Assume worker to be near tank for 1 hours every working day.
Driftable aerosol emission factor (EMF)	L/m3	2.50E-03	Calculated
Aerosol Inhalation Bioavailability (AAF)	unitless	1.0	Assume 100% bioavailability
Averaging Time - Threshold (AT)	years	1.000	USEPA 1989 and CSMS 1996
$ITF_{inh,w,shwr} = \frac{EmF \times AAF \times ET_{iw} \times EF \times ED}{365\ \frac{days}{year} \times 24\ \frac{hours}{day} \times AT}$			

Daily Intake = Concentration in Water x Intake Factor (ref: USEPA 1989)
Hazard Quotients = (Daily Intake from Water for Threshold Effects/ADI)

CAS	Chemical	Groundwater Concentration	Aerosol Inhalation Bioavailability	Driftable Aerosol Emission Factor	RfC (Background Corrected)	Threshold Intake and Risk Calculations: Adult Exposure Factor (threshold)	Adult Exposure Adjusted Air Concentration (threshold)	Hazard Index (Adult)	Non-Threshold Intake and Risk Calculations: Inhalation Unit Risk	Adult Exposure Factor (non-threshold)	Lifetime Exposure Factor (non-threshold)	Lifetime Exposure Adjusted Air Concentration (non-threshold)	Lifetime Excess Cancer Risk
		mg/L	(unitless)	(L/m^3)	(mg/m^3)	(L/m^3)	(mg/m^3)	(unitless)	$(mg/m^3)^{-1}$	(L/m^3)	(L/m^3)	(mg/m^3)	(unitless)
71-43-2	Benzene	0.01	1.00	2.50E-03	3.00E-02	6.85E-05	4.79E-07	1.60E-05	6.00E-06	9.78E-07	9.78E-07	6.85E-09	4.11E-14
007440-38-2	Arsenic	0.08	1.00	2.50E-03	1.00E-03	6.85E-05	5.75E-06	5.75E-03	-	-	-	-	-
7440-39-3	Barium	110.00	1.00	2.50E-03	7.00E-01	6.85E-05	7.53E-03	1.08E-02	-	-	-	-	-
7440-42-8	Boron	54.50	1.00	2.50E-03	7.00E-01	6.85E-05	3.73E-03	5.33E-03	-	-	-	-	-
7440-48-4	Cobalt	0.02	1.00	2.50E-03	1.00E-04	6.85E-05	1.64E-06	1.64E-02	-	-	-	-	-
7439-89-6	Iron	97.00	1.00	2.50E-03	2.45E+00	6.85E-05	6.64E-03	2.71E-03	-	-	-	-	-
7439-96-5	Manganese	3.09	1.00	2.50E-03	5.60E-01	6.85E-05	2.12E-04	3.78E-04	-	-	-	-	-
007439-97-6	Mercury	0.03	1.00	2.50E-03	2.00E-04	6.85E-05	1.78E-06	8.90E-03	-	-	-	-	-
7440-02-0	Nickel	0.04	1.00	2.50E-03	2.00E-05	6.85E-05	2.74E-06	1.37E-01	-	-	-	-	-
7440-24-6	Strontium	170.00	1.00	2.50E-03	2.10E+00	6.85E-05	1.16E-02	5.54E-03	-	-	-	-	-
91-57-6	2-methylnaphthalene	0.05	1.00	2.50E-03	1.40E-01	6.85E-05	3.15E-06	2.25E-05	-	-	-	-	-
91-20-3	Naphthalene	0.04	1.00	2.50E-03	1.00E-02	6.85E-05	2.95E-06	2.95E-04	-	-	-	-	-
-	TPH C10 - C14 Fraction Aromatic[A]	0.47	1.00	2.50E-03	2.00E-01	6.85E-05	3.18E-05	1.59E-04	-	-	-	-	-
-	TPH C10 - C14 Fraction Aliphatic[A]	0.47	1.00	2.50E-03	1.00E+00	6.85E-05	3.18E-05	3.18E-05	-	-	-	-	-
-	TPH C15+ Fraction Aromatic[A]	2.72	1.00	2.50E-03	1.05E-01	6.85E-05	1.86E-04	1.77E-03	-	-	-	-	-
-	TPH C15+ Fraction Aliphatic[A]	2.72	1.00	2.50E-03	7.00E+00	6.85E-05	1.86E-04	2.66E-05	-	-	-	-	-
							Total Risk (mixture)	**0.195**					**4.11E-14**

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- For TPH C6-C9 it is typically assumed that the total BTEX concentration reported is representative of the aromatic portion of TPH, and that the remaining TPH (i.e., total TPH C6-C9 minus total BTEX) is representative of the aliphatic portion of the TPH fraction. If the total BTEX concentration is less than the total TPH C6-C9 concentration, the TPH C6-C9 aliphatic portion has been calculated as the remaining concentration of TPH C6-C9;
- The higher TPH fractions are split conservatively, assuming a 50/50 ratio for aromatic and aliphatic components;
- TPH 15+ is the sum of the C15 - C40 concentrations

Summary of Risk to Workers - Recycled Flowback Exposure fo Target Chemicals

Receptor/Exposure Pathway	Calculated Non-Threshold Risk 100% Mass Return	Calculated HI 100% Mass Return
Use of Stimulation Fluid in Hydraulic Fracturing		
HVFR Recipe		
Workers		
Ingestion of Chemicals via Incidental Contact with Flowback Water	1.02E-12	0.0052
Dermal Exposure to Chemicals via Incidental Contact with Flowback Water	2.36E-13	0.05
Inhalation of mist from the evaporation units	4.11E-14	0.195
Total Risk	**1.30E-12**	**0.25**

RECYCLED FLOWBACK DATA

Project Name: Beetaloo

			BTEX							Inorganics																		
		Anionic Surfactants as MBAS	Benzene	Ethylbenzene	Toluene	Xylene (m & p)	Xylene (o)	Xylene Total	Sum of BTEX	Alkalinity (Bicarbonate) as CaCO3	Alkalinity (Total) as CaCO3	Ammonia (filtered)	Anions Total	Bicarbonate	Bromide (filtered)	Calcium (filtered)	Carbonate	Cations Total	Chloride	Electrical Conductivity (Lab)	Fluoride	Kjeldahl Nitrogen Total	Magnesium (filtered)	Methane	Nitrite + Nitrate (as N)	Nitrogen (Total)	pH (Lab)	Phosphorus
		mg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	mg/L	mg/L	mg/L	meq/L	mg/L	mg/L	mg/L	mg/L	meq/L	mg/L	µS/cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	pH_Units	mg/L
EQL		0.1	1	1	1	1	1	1	1	1	1	0.01	0.01		0.05	0.2		0.01	1	1	0.1	0.05	0.1	0.001	0.01	0.1	0.01	0.01
NHMRC (2011) Australian Drinking Water Guidelines			**1**	**300**	**800**			**600**													**1.5**							
WHO (2017) Drinking Water Guidelines (mg/L)												**35** (taste only)													**50**			
USEPA (2022) Regional Screening Levels																												
Field ID	**Date**																											
AMUNGEE NW-1H	**15/11/2016**																											
BET_PW001_Fe_15.3%	**11/11/2016**	0.2	3	<2	2	<2	<2	<2	5	364	364		639	444.08		1,320	0.6	599	22,400	54,400	1.1	55.1	271	4.76	<0.01	55.1	6.5	<0.05
BET_PW001_Fe_15.8%	**17/11/2016**	0.1	3	<2	2	<2	<2	<2	5	364	364		684	444.08		1,400	0.6	612	24,000	54,800	1.1	50.1	282	5.22	0.04	50.1	6.4	<0.05
BET_PW001_Fe_16.0%	**20/11/2016**	0.2	3	<2	2	<2	<2	<2	5	390	390		685	475.8		1,410	0.6	617	24,000	54,900	1.1	54.8	275	6.48	<0.01	54.8	6.44	0.3
BET-PW001	**8/09/2021**		3	3	14	60	14	75	95	140	140	34		170.8	260	1,500			21,000	59,600		37	370		<0.1		6	<0.02
BET-PW001_Fe14.1%	**30/10/2016**	0.2	3	<2	2	<2	<2	<2	5	498	498		622	607.56		1,270	0.6	640	21,700	57,300	1.2	57.3	277	3.99	0.02	57.3	6.47	0.16
BET-PW001_Fe14.5%	**2/11/2016**	<0.1	4	<2	3	<2	<2	<2	7	465	465		633	567.3		1,330	0.6	666	22,100	57,000	1.2	55.5	284	4.29	0.01	55.5	6.43	0.12
BET-PW001_Fe14.8%	**5/11/2016**	0.2	3	<2	2	<2	<2	<2	5	441	441		638	538.02		1,380	0.6	688	22,300	57,300	1.2	56.3	306	5.41	0.02	56.3	6.43	0.1
BET-PW001_Fe15.1%	**8/11/2016**	0.2	3	<2	2	<2	<2	<2	5	342	342		644	417.24		1,380	0.6	688	22,600	58,300	1.2	55.2	305	5.27	0.01	55.2	6.39	0.06
BET-PW001_Fe_9	**29/09/2016**	<0.1	4	<2	3	2	<2	2	9	474	474		408	578.28		853	0.6	464	14,100	40,600	1.2	52.2	147	1.2	0.04	52.2	6.54	0.41
BET-PW001_Fe_9.4	**5/10/2016**	<0.1	7	<2	6	2	<2	2	15	716	716		398	873.52		774	0.6	446	13,600	39,000	1.2	51.6	133	6.29	0.26	51.9	6.74	1.07
BET-PW001_Fe_10.6	**7/10/2016**	<0.1	3	<2	3	<2	<2	<2	6	540	540		443	658.8		980	0.6	503	15,300	44,100	1.1	50.6	165	5.39	0.17	50.8	6.63	0.47
BET-PW001_Fe_11.5%	**15/10/2016**	<0.1	3	<2	2	2	<2	2	7	506	506		524	617.32		1,220	0.6	610	18,200	49,000	1.1	45.1	253	5.46	0.03	45.1	6.47	0.22
BET-PW001_Fe_12.5%	**19/10/2016**	<0.1	4	<2	3	<2	<2	<2	7	472	472		540	575.84		1,360	0.6	627	18,800	51,100	1.1	48	269	5.5	0.12	48.1	6.45	0.12
BET-PW001_Fe_12.15%	**17/10/2016**	0.1	4	<2	3	<2	<2	<2	7	474	474		526	578.28		1,230	0.6	593	18,300	50,500	1.1	65.6	252	7.09	0.02	65.6	6.5	0.16
BET-PW001_Fe_13%	**22/10/2016**	<0.1	4	<2	3	<2	<2	<2	7	566	566		556	690.52		1,200	0.6	555	19,300	52,600	1.1	61.3	233	6.5	<0.01	61.3	6.51	<0.1
BET-PW001_Fe_13.5%	**25/10/2016**	<0.1	3	<2	2	<2	<2	<2	5	556	556		575	678.32		1,210	0.6	551	20,000	53,500	1.1	59.4	235	6.49	<0.01	59.4	6.55	0.15
BET-PW001_Fe_16.2	**23/12/2016**	0.1	3	<2	2	<2	<2	<2	5	377	377		628	459.94		1,600	0.6	674	22,000	51,700	1	58	272	7.35	<0.01	58	6.56	<0.05
BET-PW001_Fe_16.5%	**28/12/2016**	<0.1	2	<2	<2	<2	<2	<2	2	367	367		611	447.74		1,740	0.6	718	21,400	52,800	1.1	61.5	295	7.75	<0.01	61.5	6.5	0.1
BET-PW001_FE_16.4	**26/12/2016**	0.2	2	<2	<2	<2	<2	<2	2	371	371		684	452.62		1,650	0.6	686	24,000	52,300	1.1	60	283	8.37	<0.01	60	6.5	<0.05
BET-PW001_FE_16.6%	**30/12/2016**	0.2	2	<2	<2	<2	<2	<2	2	384	384		724	468.48		1,740	0.6	713	25,400	52,300	1.1	62.1	295	7.72	<0.01	62.1	6.5	<0.05
BET-PW001 2209 Sep	**22/09/2021**		5	10	48	180	42	230	290	460	460	27		561.2	190	1,100			15,000	37,400		32	270		<0.1		6.3	<0.02
	Maximum Concentration	0.2	7	10	48	180	42	230	290	716	716	34	724	873.52	260	1740	0.6	718	25400	59600	1.2	65.6	370	8.37	0.26	65.6	6.74	1.07

Notes:

NHMRC (2011) Australian Drinking Water Guidelines 6. Volume 1. National Water Quality Management Strategy. National Health and Medical Research Council, updated September 2022.

WHO (2017) World Health Organisation Drinking Water Guidelines and rolling revisions

USEPA (2022) Regional Screening Levels. Updated May 2022. https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables

No fractionation into aromatic and aliphatic components was undertaken for the identified TPH impacts. The approach adopted for the fractionation of TPH into aromatic and aliphatic components is summarised below:

- For TPH C6-C9 it is assumed that the total BTEX concentration reported is representative of the aromatic portion of TPH, and that the remaining TPH (i.e., total TPH C6-C9 minus total BTEX) is representative of the aliphatic portion of the TPH fraction. If the total BTEX concentration is less than the total TPH C6-C9 concentration, the TPH C6-C9 aliphatic portion has been calculated as the remaining concentration of TPH C6-C9;
- The higher TPH fractions are split conservatively, assuming a 50/50 ratio for aromatic and aliphatic components;
- TPH 15+ is the sum of the C15 - C40 concentrations

RECYCLED FLOWBACK DATA

Project Name: Beetaloo

										Metals													PAH's and Phenolics			
		Potassium (filtered)	Silicon as Si	Silicon as SiO2	Sodium (filtered)	Sulphate as SO4 (filtered)	Total Dissolved Solids (filtered)	Total Dissolved Solids (Calculated)	Total Hardness as CaCO3 (filtered)	Aluminium	Arsenic (filtered)	Barium (filtered)	Boron (filtered)	Chromium (III+VI) (filtered)	Cobalt	Iron	Manganese	Manganese (filtered)	Mercury	Nickel (filtered)	Strontium	Zinc	Zinc (filtered)	2-methylnaphthalene	3-&4-methylphenol	Naphthalene	Phenol
		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	µg/L	µg/L	µg/L	µg/L
EQL		0.01	0.02	0.05	0.5	1	10	1	1	0.001	0.0005	0.001	0.001	0.0005	0.0002	0.001	0.0005	0.0005	0.0001	0.0005	0.001	0.001	0.001	1	1	1	1
NHMRC (2011) Australian Drinking Water Guidelines											**0.01**	**2**	**4**				**0.5**	**0.5**	**0.001**	**0.02**							
WHO (2017) Drinking Water Guidelines (mg/L)																											
USEPA (2022) Regional Screening Levels										**20**				**22**	**0.006**	**14**					**12**	**6**	**6**	**1.1**	**370** (as 4 methylphenol)	**0.12**	**5800**
Field ID	**Date**																										
AMUNGEE NW-1H	**15/11/2016**																										
BET_PW001_Fe_15.3%	**11/11/2016**	70			11,700	<10	44,200	35,400	4,410		<0.01	60.7	34.6	0.01				2.26		0.018			<0.05		5.2	<1	2.8
BET_PW001_Fe_15.8%	**17/11/2016**	70			11,900	<10	46,600	35,600	4,660		<0.01	65.7	33.1	0.015				2.42		<0.01			<0.05		5.6	<1	2.1
BET_PW001_Fe_16.0%	**20/11/2016**	69			12,000	<10	49,200	35,700	4,650		<0.01	66.5	34.8	0.013				2.53		0.028			<0.05		10.3	<1	3.5
BET-PW001	**8/09/2021**	53	16	33	8,800	2	35,000			0.3	<0.025	110	12	<0.025	0.024	79	1.9	1.7	0.026	0.03	170	0.13	0.11	46	<1	43	2
BET-PW001_Fe14.1%	**30/10/2016**	76			12,700	<10	45,500	37,200	4,310		<0.01	68.8	45.4	0.031				2.74		0.018			<0.05		6.8	<1	2.8
BET-PW001_Fe14.5%	**2/11/2016**	80			13,200	<10	45,300	37,000	4,490		0.011	74.8	44	0.032				2.9		0.014			<0.05		4.4	<1	2
BET-PW001_Fe14.8%	**5/11/2016**	83			13,600	<10	45,600	37,200	4,700		<0.01	77.8	43.9	0.033				3.09		<0.01			<0.05		4.3	<1	2.1
BET-PW001_Fe15.1%	**8/11/2016**	83			13,600	<10	44,300	37,900	4,700		<0.01	68.5	45.4	0.031				2.4		0.012			<0.05		4.7	<1	2.6
BET-PW001_Fe_9	**29/09/2016**	55			9,370	20	33,600	26,400	2,740		0.084	35.6	50.9	0.035				1.82		0.04			<0.05		<2	<1	1.5
BET-PW001_Fe_9.4	**5/10/2016**	58			9,080	17	30,400	25,400	2,480		0.011	30.5	54.5	0.048				1.95		0.012			<0.05		<2	<1	<1
BET-PW001_Fe_10.6	**7/10/2016**	60			10,100	42	32,300	28,700	3,130		<0.01	42	49.4	0.034				1.8		0.01			<0.05		<2	<1	<1
BET-PW001_Fe_11.5%	**15/10/2016**	72			12,100	<10	38,800	31,800	4,090		<0.010	51.9	45.9	0.042				2.38		<0.010			<0.050		2.6	<1.0	2.3
BET-PW001_Fe_12.5%	**19/10/2016**	74			12,300	38	39,000	33,200	4,500		<0.010	59.1	43.5	0.033				2.43		<0.010			<0.050		2.9	<1.0	2.2
BET-PW001_Fe_12.15%	**17/10/2016**	70			11,700	26	37,400	32,800	4,110		<0.010	53.9	44.5	0.03				2.24		<0.010			<0.050		2.1	<1.0	2.2
BET-PW001_Fe_13%	**22/10/2016**	64			10,900	<1	37,700	34,200	3,960		<0.01	63.5	40	0.032				2.34		0.014			<0.05		2.7	<1	1.6
BET-PW001_Fe_13.5%	**25/10/2016**	65			10,800	<1	31,800	34,800	3,990		<0.01	68.4	41.1	0.03				2.44		0.018			<0.05		7	<1	1.7
BET-PW001_Fe_16.2	**23/12/2016**	68			13,100	<10	42,000	33,600	5,120		<0.010	66.2	35.1	0.025				2.31		0.021			<0.050		2.5	<1.0	2.8
BET-PW001_Fe_16.5%	**28/12/2016**	70			13,900	<10	44,800	34,300	5,560		<0.010	77.8	31	0.031				2.64		<0.010			<0.050		5.8	<1.0	3.1
BET-PW001_FE_16.4	**26/12/2016**	67			13,300	<10	44,200	34,000	5,280		<0.010	71.6	34.2	0.028				2.56		0.017			<0.050		3.3	<1.0	2.5
BET-PW001_FE_16.6%	**30/12/2016**	70			13,800	<10	44,500	34,000	5,560		<0.010	80.1	34	0.029				2.75		<0.010			<0.050		11.3	<1.0	4
BET-PW001 2209 Sep	**22/09/2021**	39	7.3	16	6,200	1	29,000			<0.05	<0.005	90	8.2	<0.005	0.0032	97	1.9	1.8	0.0025	<0.005	150	0.097	0.07	42	<1	38	2
	Maximum Concentration	83	16	33	13900	42	49200	37900	5560	0.3	0.084	110	54.5	0.048	0.024	97	1.9	3.09	0.026	0.04	170	0.13	0.11	46	11.3	43	4

Notes:

NHMRC (2011) Australian Drinking Water Guidelines 6. Volume 1. National Water Quality Management Strategy. National Health and Medical Research Council, updated September 2022.

WHO (2017) World Health Organisation Drinking Water Guidelines and rolling revisions

USEPA (2022) Regional Screening Levels. Updated May 2022. https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables

No fractionation into aromatic and aliphatic components was undertaken for the identified TPH impacts. The approach adopted for the fractionation of TPH into aromatic and aliphatic components is summarised below:

- For TPH C6-C9 it is assumed that the total BTEX concentration reported is representative of the aromatic portion of TPH, and that the remaining TPH (i.e., total TPH C6-C9 minus total BTEX) is representative of the aliphatic portion of the TPH fraction. If the total BTEX concentration is less than the total TPH C6-C9 concentration, the TPH C6-C9 aliphatic portion has been calculated as the remaining concentration of TPH C6-C9;
- The higher TPH fractions are split conservatively, assuming a 50/50 ratio for aromatic and aliphatic components;
- TPH 15+ is the sum of the C15 - C40 concentrations

RECYCLED FLOWBACK DATA

Project Name: Beetaloo

		Radionuclides		TPH											
		Gross alpha activity_	Gross beta activity (excluding activity of K-40)	C6 - C9 Fraction	C6 - C10 Fraction	C6 - C10 Fraction minus BTEX (F1)	C10 - C14 Fraction	C10 - C16 Fraction	C10 - C16 Fraction minus Naphthalene (F2)	C15 - C28 Fraction	C16 - C34 Fraction	C29 - C36 Fraction	C34 - C40 Fraction	C10 - C36 Fraction (Sum)	C10 - C40 Fraction (Sum)
		Bq/L	Bq/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
EQL		0	0	10	10	10	10	10	10	50	50	50	50	50	50
NHMRC (2011) Australian Drinking Water Guidelines		**0.5**	**0.5**												
WHO (2017) Drinking Water Guidelines (mg/L)				**15000 aliphatic**			**100 aromatic 300 aliphatic**			**90 aromatic 300 alipatic**		**90 aromatic 300 alipatic**	**90 aromatic 300 alipatic**		
USEPA (2022) Regional Screening Levels															
Field ID	**Date**														
AMUNGEE NW-1H	**15/11/2016**	9.22	5.22												
BET_PW001_Fe_15.3%	**11/11/2016**	11	5.32	50	40	40	<50	<100	<100	1,080	1,020	<50	<100	1,080	1,020
BET_PW001_Fe_15.8%	**17/11/2016**	10.2	5.08	100	90	80	60	<100	<100	410	410	<50	<100	470	410
BET_PW001_Fe_16.0%	**20/11/2016**	9.3	4.8	110	90	80	80	<100	<100	200	220	<50	<100	280	220
BET-PW001	**8/09/2021**	12	8.8	220	260	170	380	420	400	320	160	<50	<50	700	580
BET-PW001_Fe14.1%	**30/10/2016**	3.06	17.2	80	80	80	70	<100	<100	610	620	<50	<100	680	620
BET-PW001_Fe14.5%	**2/11/2016**	2.86	17.8	130	130	120	120	100	100	130	<100	<50	<100	250	100
BET-PW001_Fe14.8%	**5/11/2016**	5.13	18.3	60	50	40	<50	<100	<100	530	490	<50	<100	530	490
BET-PW001_Fe15.1%	**8/11/2016**	5.08	15.9	60	60	60	130	160	160	1,180	1,160	<50	<100	1,310	1,320
BET-PW001_Fe_9	**29/09/2016**	<0.62	<1.25	50	60	50	110	120	120	430	490	120	<100	660	610
BET-PW001_Fe_9.4	**5/10/2016**			100	100	80	90	130	130	3,070	4,160	1,720	650	4,880	4,940
BET-PW001_Fe_10.6	**7/10/2016**	2.43	5.99	50	50	40	180	190	190	240	260	60	<100	480	450
BET-PW001_Fe_11.5%	**15/10/2016**	8.82	15.4	60	60	50	110	<100	<100	470	600	200	<100	780	600
BET-PW001_Fe_12.5%	**19/10/2016**	8.38	8.31	80	80	70	240	120	120	100	110	<50	<100	340	230
BET-PW001_Fe_12.15%	**17/10/2016**	6.31	7.55	80	80	70	160	<100	<100	<100	110	<50	<100	160	110
BET-PW001_Fe_13%	**22/10/2016**	8.57	9.76	90	90	80	270	240	240	170	210	<50	<100	440	450
BET-PW001_Fe_13.5%	**25/10/2016**	12.4	12.7	80	80	80	190	140	140	180	280	150	130	520	550
BET-PW001_Fe_16.2	**23/12/2016**			110	110	100	<50	<100	<100	490	570	120	<100	610	570
BET-PW001_Fe_16.5%	**28/12/2016**			200	200	200	<50	<100	<100	450	470	70	<100	520	470
BET-PW001_FE_16.4	**26/12/2016**			130	130	130	<50	<100	<100	470	440	<50	<100	470	440
BET-PW001_FE_16.6%	**30/12/2016**			70	70	70	<50	<100	<100	610	640	90	<100	700	640
BET-PW001 2209 Sep	**22/09/2021**	7	5.2	310	390	100	930	630	550	<50	<50	<50	<50	930	630
	Maximum Concentration	12.4	18.3	310	390	200	930	630	550	3070	4160	1720	650	4880	4940

Notes:

NHMRC (2011) Australian Drinking Water Guidelines 6. Volume 1. National Water Quality Management Strategy. National Health and Medical Research Council, updated September 2022.

WHO (2017) World Health Organisation Drinking Water Guidelines and rolling revisions

USEPA (2022) Regional Screening Levels. Updated May 2022. https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables

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- The higher TPH fractions are split conservatively, assuming a 50/50 ratio for aromatic and aliphatic components;
- TPH 15+ is the sum of the C15 - C40 concentrations

APPENDIX E.1 Chemical Risk Assessment – Condor

Hydraulic Stimulation Chemical Risk Assessment

Tamboran Resources Northern Territory Tenements

Prepared for:

Prepared by:

January 2023

Document Control

PROJECT DETAILS

Project No.	AUS_C04159
Report Revision No.	B
Date of Issue	12 January 2023
Project Manager	Joe Hayes
Project Director	Nigel Goulding

REPORT DETAILS

Title	Hydraulic Stimulation Chemical Risk Assessment
Main Author(s)	Joe Hayes, Chrissy Peterson, Ben Petrides
Client	Condor Energy
Client Contact	Andrew McKenzie

DISTRIBUTION LIST

Date	No. of Copies	Company/Organisation	Name	Issue Type
22/12/2022	1	Condor Energy	Andrew McKenzie, Scott Ross	e
12/01/2023	1	Condor Energy	Andrew McKenzie, Scott Ross	e

Note:
(e) electronic file
(h) hardcopy

REVISION HISTORY

Date	Revision #	Key Changes
22/12/2022	A	Draft issued for review
12/01/2023	B	Final issued

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Acronyms

AICIS	Australian Industrial Chemicals Introduction Scheme, 2022
CAS	Chemical Abstracts Service
COPC	constituent of potential concern
CRA	Chemical Risk Assessment
DoEE	Department of the Environment and Energy
EMP	Environment Management Plan
EP	Exploration Permit
LC50/EC50	lethal concentration 50 / effect concentration 50
NEPC	National Environment Protection Council
NEPM	National Environment Protection (Assessment of Site Contamination) Measure
NICNAS	National Industrial Chemicals Notification and Assessment Scheme
NOAEL	no observed adverse effect level
NOEC	no observed effect concentration
NT	Northern Territory
PBT	persistent (P), bioaccumulative (B) and toxic (T)
SDS	safety data sheet

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Units of Measure

Area	
ha	hectare
m^2	square metres
Density	
kg/m^3	kilograms per cubic metre
Electrical Conductance	
µS/cm	microsiemen per centimetre
dS/m	decisiemen per metre
mS/cm	millisiemen per centimetre
mV	millivolt
Length	
µm	micrometres
cm	centimetres
km	kilometres
m	metres
mm	millimetres
Mass	
µg	micrograms
g	grams
kg	kilograms
mg	milligrams
t	metric tonnes
Concentration by Mass	
µg/kg	microgram per kilogram
mg/kg	milligram per kilogram

Pressure	
kPa	Kilopascals
Pa	Pascals
Temperature	
°C	degrees Celsius
°F	degrees Fahrenheit
K	Kelvin
Velocity	
m/s	metres per second
Volume	
µL	microlitres
cL	centilitres
cm^3	cubic centimetre
GL	gigalitre
L	litres
m^3	cubic metre
mL	millilitres
ML	megalitre
Concentration by Volume	
µg/L	microgram per litre
mg/L	milligram per litre
ppmv	parts per million by volume
ppbv	parts per billion by volume

1 Introduction

Condor Energy ("Condor") has been retained by Tamboran B2 Pty Ltd ("Tamboran") to provide hydraulic stimulation services for pilot wells located within Tamboran's tenements within the Beetaloo Sub-basin of the Northern Territory (NT). Tamboran recently acquired NT exploration permits (EPs) 98, EP117 and EP76 (**Figure 1-1**) within the Beetaloo Sub-basin from Origin Energy B2 Pty Ltd ("Origin"). There are no homesteads within 10 km of the proposed worksites.

Prior to the transfer of assets to Tamboran, Origin prepared Environment Management Plans (EMP) for EP98, EP117 and EP76 to progress exploration activities across their respective tenements. The EMPs cover various exploration activities, which include undertaking seismic surveys, drilling targeted exploration wells and subsequent hydraulic fracturing of these wells (Origin, 2021a; Origin, 2021b). Tamboran is also developing an updated EMP for EP98, EP117 and EP76; however, at this time the Origin EMP was used as the basis for this evaluation. For the purposes of this assessment, it is assumed that the environmental controls relevant to hydraulic stimulation under the updated Tamboran EMP will be effectively the same as that within the current EMP.

Under the Code of Practice: Petroleum Activities in the Northern Territory 2021 ("the Code"), an EMP is required for oil and gas activities. Hydraulic stimulation (or fracturing) activities were reviewed in the *Independent Scientific Inquiry into Hydraulic Fracturing of Onshore Unconventional Reservoirs in the Northern Territory* report issued on 27 March 2018 (NT, 2018). The Inquiry concluded that the risks associated with unconventional onshore shale gas extraction in the NT could be appropriately managed provided all the recommendations of its report were adopted and implemented. The NT Government accepted all 135 recommendations and announced the lifting of a previous moratorium on exploration on 17 April 2018. Of the 135 recommendations, 35 were required to be implemented prior to the commencement of exploration, with the remaining recommendations required to be implemented prior to the commencement of production. The development of an EMP is a key component of meeting these requirements. The EMP documents the relevant natural environment, proposed activities and methods to manage the environmental impacts and risks associated with proposed activities, including how to address regulatory obligations and relevant report recommendations that have underpinned the Code of Practice: Onshore Petroleum Activities in Northern Territory 2021.

Condor is undertaking planning for the hydraulic stimulation program and has retained EHS Support Pty Ltd ("EHS Support") to prepare a Chemical Risk Assessment (CRA) to reflect the proposed stimulation fluids for potential use in EP98, EP117 or EP76. Tamboran is currently planning to undertake hydraulic stimulation of existing wells at the at the Amungee NW-2H site, and also plan to undertake further exploration activities, including drilling wells and undertaking hydraulic stimulation within other areas of EP98, EP117 and EP76 in the future. This CRA documents the relevant EMP requirements utilising the chemicals present in the proposed hydraulic stimulation formulations for future stimulation activities. This formulation is presented in **Appendix A**. Chemicals listed in this table with a volume of 0 were not assessed in this CRA. Additional updates to this CRA may be required in the future, with the evaluation of any additional proposed chemicals/revised chemical concentrations, and this will be undertaken where applicable.

This CRA evaluates potential hazards associated with chemicals and the potential for human and environmental receptor exposure, and where potentially hazardous chemicals have complete exposure pathways, quantification of the potential risks. This CRA is supported by a broader

evaluation of environmental conditions and risks and recommended avoidance, mitigation and management strategies.

This CRA for the hydraulic stimulation activities developed as part of the EMP meets the requirements of the NT Code of Practice as well as being in general accordance with the following:

- Petroleum Operations, Department of Environment, Parks and Water Security (DEPWS), Environment Management Plan Content Guideline (NT, 2021);
- Department of the Environment and Energy, Exposure Draft - Chemical Risk Assessment Guidance Manual: for chemicals associated with coal seam gas extraction (DoEE, 2017);
- Australian Industrial Chemicals Introduction Scheme, 2022 (AICIS) (which has progressively replaced NICNAS below, since 31 August 2020);
- National Industrial Chemicals Notification and Assessment Scheme (NICNAS), National Assessment of Chemicals Associated with Coal Seam Gas Extraction in Australia (NICNAS, 2017a);
- enHealth Environmental Health Risk Assessment, Guidelines for Assessing Human Health Risks from Environmental Hazards (enHealth, 2012); and
- National Environment Protection (Assessment of Site Contamination) Measure 1999 (ASC NEPM); Schedule B4, Site-specific health risk assessment methodology (NEPC, 2013).

Reference has also been made to the relevant information available within the Petroleum Onshore Information Northern Territory (POINT) online mapping and data catalogue.

The chemicals assessed in this CRA have been compiled from several formulations that have been used (or are planned for use) in the Beetaloo Sub-Basin and potentially in other tenements and basins. The lists of chemicals assessed are presented in **Appendix A** and were provided by Condor. **Appendix A** also includes maximum concentrations that potentially would be used in a hydraulic stimulation. It should be noted that the compiled lists of chemicals have been assessed as “one formulation” (noting that they contain a number of separately used components that are applied at various stages during the stimulation process) with maximum concentrations provided by Condor. This is a conservative assessment for the hydraulic stimulation program because the actual concentration of individual chemicals will potentially be less, and there may be fewer chemicals represented in a selected formulation.

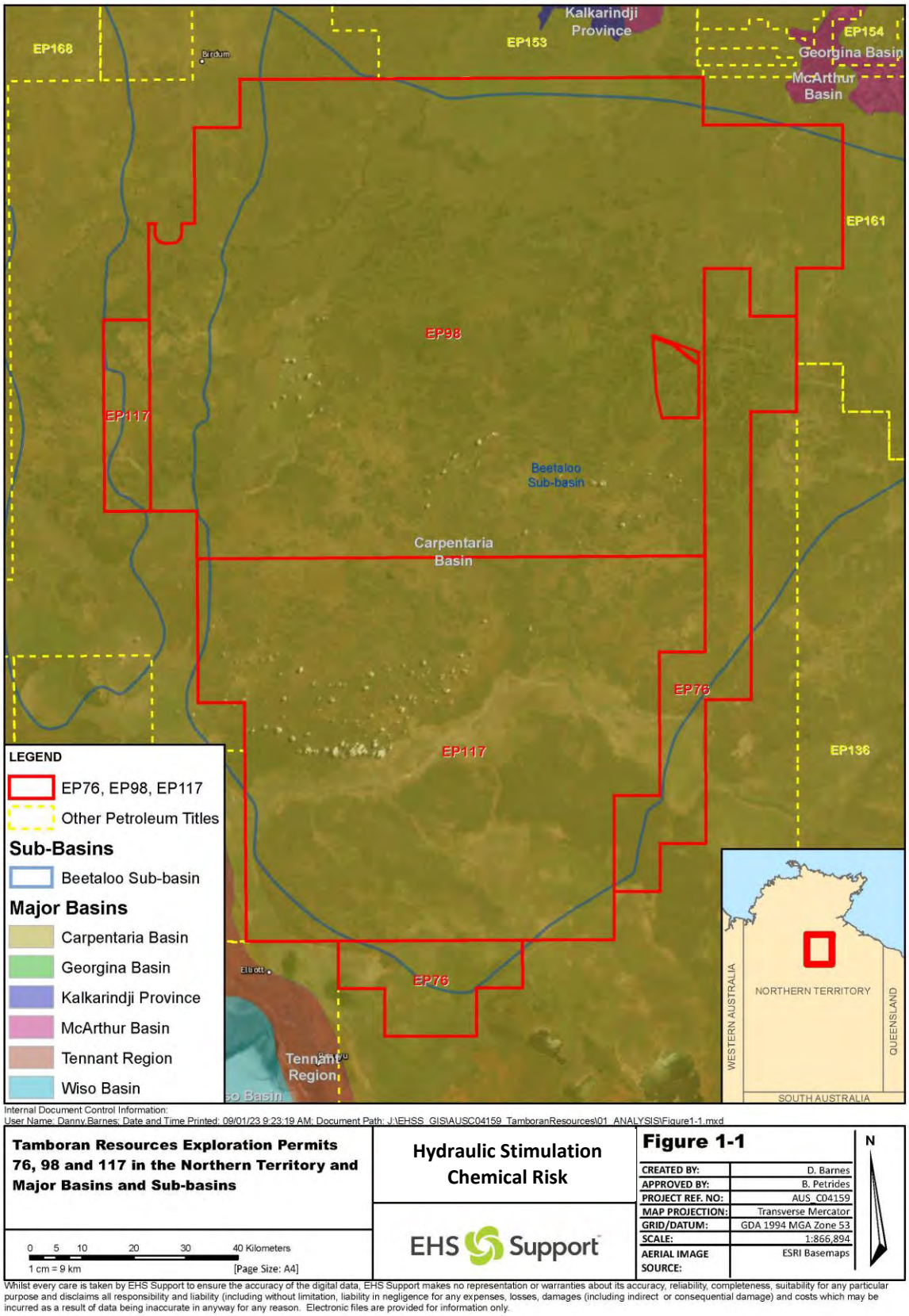


Figure 1-1 Location of Tamboran Tenements

2 Tier Assessment

A tiered assessment was conducted on the compiled hydraulic fracturing fluid systems using screening of the potential human health and ecological hazards that should be considered for potential exposure to the hydraulic fracturing fluids during transportation, hydraulic fracturing activities (including storage) and subsequent treatment and disposal of flowback. The tiered assessment includes the following steps:

- Tier 1 – Identify chemicals of low human health and ecological concern that do not require additional evaluation in the tier assessment process.
- Tier 2 – Chemicals that are not identified as a low human health and ecological concern and therefore require an additional risk assessment to characterise potential risks. This is done using a quantitative evaluation of the risks based on the potential complete exposure pathways and Tier 1 assessment.

2.1 Conceptual Exposure Model

The EMP developed for EP98, EP117 and EP76 will provide an overview of the proposed hydraulic stimulation program, which is similar to that which will be utilised by Condor's other NT tenements. The stimulation process involves pumping slurry, primarily consisting of water and sand (proppant) plus a minor volume of a specific blend of chemicals down the well to a specific geological target at sufficient pressure to create fractures in the target geological formation. Proppant keeps the fractures open after the fluid pressure is released, thereby improving the wells productive potential. Chemicals used in hydraulic stimulation fluid systems are designed to optimise stimulation outcomes and are commonly found in food and other household domestic products.

Casing bullhead fracture stimulations are typically implemented in shale development with a pump down plug and perforation technique for fluid diversion. This is achieved by pumping down a bridge plug and perforating guns on wireline to the desired depth in the horizontal wellbore. The plug is set, and the zone is perforated. The tools are then removed from the well, and the fracture stimulation treatment is pumped in. This process is repeated until all target zones in the well are complete.

The life cycle of chemicals used during the hydraulic fracturing of wells includes the following general categories:

- Transportation of chemicals – from the supplier warehouse to the well lease and between well leases.
- Hydraulic fracturing activities – storage of chemicals, usage (e.g., blending, injecting) and subsequent recovery of fluids (including storage in produced water and flowback fluid treatment tanks) at the well lease and associated vendor chemical additives.
- Disposal and management – recovered vendor chemical additives in wastes and hydraulic fracturing flowback.

Throughout the life cycle of chemical additive products, without adequate management controls in place, there is the potential for human and environmental receptors to be exposed to the chemical additives. Based on an evaluation of the life cycle of products and chemicals, environmental conditions in the areas of development, anticipated populations and location selection, the following potentially complete exposure pathways were identified:

- Transportation of chemicals:
  - Human and environmental receptor exposure to chemicals as a result of accidental release during transport from supplier warehouse to well lease or between well leases (i.e., truck rollover).
  - Human and environmental receptors exposed to surface water bodies that received runoff from an accidental release during transportation.
- Hydraulic fracturing activities:
  - Human and environmental receptor exposure to chemicals as a result of accidental release during the storage and preparation of products on the well lease for hydraulic fracturing activities.
  - Human and environmental receptor exposure to residual chemicals (vendor chemicals) in recovered materials as a result of an accidental release from storages (treatment tanks) on the well lease.
  - Human and environmental receptors exposed to surface water bodies that received runoff from an accidental release during hydraulic fracturing activities.
- Treatment, Storage and disposal:
  - Human and environmental receptor exposure to chemicals as a result of accidental release during transport of surplus chemicals and wastes (i.e., flowback) from the well lease to a disposal/management facility.
  - Human and environmental receptor exposure to chemicals as a result of accidental release of stored wastes and/or flowback.
  - Human and environmental receptors exposed to surface water bodies that received runoff from an accidental release of stored wastes and/or flowback.

To assess the unmitigated risks from the improbable scenario where some fluids were to overflow the bunded area, a range of release scenarios are considered comprising:

- Smaller release volumes of 1,000 L and 100,000 L, which would reflect small scale releases; and
- An improbable release out of the bunded area (1,000,000 L).

Appendix B provides an assessment of the potential for effects on groundwater associated with a release of hydraulic fracturing fluid, waste or flowback to the land surface scenarios. The results of this assessment showed that the travel times for surface releases to reach groundwater are very long, thereby providing ample opportunity for containment and remedial action. Therefore, the potential for impacts to groundwater is considered low.

Both mitigated and unmitigated risks from an overland flow scenario from a release have been assessed as part of the assessment. Typical pads for shale development in the Beetaloo range from 5.5 -10 ha with typically 1 m high berm walls surrounding any inground treatment tanks and/or double-lined aboveground tanks to contain and manage the risk from potential releases. In the absence of this structure, a major release could have the potential to migrate a distance off the well pad. However, with these measures, any releases would be limited to the potential for incidental/minor spillage outside the fluid storage and containment area. In the context of a potential release scenario of 1,000 L outside of the containment and storage area, the maximum affected area of spreading will be less than 0.4 ha and limited to the proximity of the release area.

Therefore, given the planned management control of the construction of a bunded area surrounding treatment tanks, the potential for a complete exposure pathway to surface water bodies associated with runoff from an accidental release is considered unlikely and not assessed further.

The risks associated with the transport of chemicals and wastes is considered to be managed to a level as low as reasonably practicable. This is because the potential for a release is controlled through the implementation of a traffic/transport management plan, including use of designated trucking routes, vehicle signage, vehicle management systems (to manage speed and driving behaviour/habits). In the unlikely event of a vehicular accident, incident and spill response procedures will be implemented. In this context, this scenario is not assessed further.

The management of chemicals and wastes will be conducted at the well lease using drums, intermediate bulk containers and engineered tanks designed to contain the fluids. No permanent storage of chemicals, flowback or wastes will be conducted in ponds or sumps, and therefore the potential for releases is considered limited. Wastewater will be managed through the use of engineered treatment tanks that will contain liquids and may have the potential for exposures to avian receptors; however, this exposure route is unlikely given that tanks would not harbour fish or other vertebrates that would be attractive to avian species, or that would give rise to incidental ingestion of water during feeding. In the unlikely event of a release to the ground, the potential for exposures (other than workers) is limited. The well pad sites are fenced to limit access to the public and prevent entry by livestock and large native fauna. If materials are spilled to the ground, then investigation, remediation and rehabilitation activities will be immediately implemented to address soil impacts. In this context, exposure during and post-activity are unlikely.

Lastly, chemical exposures to workers are controlled through engineering, management controls and personal protective equipment, which are focused on elimination and mitigation of the potential for dermal contact and potential for incidental ingestion (therefore, the exposures are considered unlikely). In addition, Safe Work Australia and Condor Occupational Safety Guidance are used to minimise human health exposure.

2.2 Tier 1 Assessment

The Tier 1 assessment includes an evaluation of the human health and environmental hazards of the chemicals in the two hydraulic fracturing fluid systems. The objective of the Tier 1 assessment is to identify chemicals of low human health and ecological concern that do not require additional chemical risk assessment in the Tier 2 assessment. A persistent, bioaccumulative and toxic (PBT) assessment was conducted because of specific concerns for substances that can be shown to persist for long periods in the environment, bioaccumulate in food chains and that can give rise to toxic effects after a longer time and over a greater spatial scale than chemicals without these properties.

Furthermore, a regulatory review was conducted to determine if the chemicals were identified as potential chemicals of concern in AICIS or NICNAS. Additional information is provided in the risk assessment dossiers (**Appendix C**) and safety data sheets (SDSs) (**Appendix D**) for the compiled hydraulic fracturing fluid systems. This information can be used for emergency responders, health and safety managers and environmental hazard clean-up teams.

As per the DEPWS Environment Management Plan Content Guideline (DEPWS, 2021), the Tier 1 assessment included the following:

- Name of chemical;
- Chemical purpose;
- Chemical Abstract Service (CAS) number;
- Total mass in kg;
- Approximate downhole concentration for that chemical expressed in mg/L;

- Appropriate ecotoxicity (aquatic and oral values) data including for acute lethal concentration 50 / effect concentration 50 (LC50/EC50) and chronic no observed effect concentration (NOEC) data where available; and
- Information on the biodegradation and bioaccumulation potential of organic chemicals.

The results of the Tier 1 assessment for the hydraulic fracturing fluid system formulations noting which chemical additives were assessed, the information used for the assessment and the chemicals categorised as Tier 1 or Tier 2, is presented in **Table 1** (attached). **Table 1** also includes discussion on Tier 1 assessment findings and whether a chemical was retained for further evaluation in the Tier 2 assessment. Observed recovery of drilling, well development and hydraulic fracturing fluids chemicals in flowback from other regional operators of oil and gas petroleum tenements is approximately 20 percent or less of the injected fluid chemical concentration. The concentration declines have been attributed to dilution by pore water within the shales, sorption, complexation and decay (bio-decay, hydrolysis). For the purposes of the Tier 1 and Tier 2 assessments, the higher injected fluid concentrations have been considered.

The following general approach was used to screen the constituents of potential concern (COPCs):

- A chemical was identified by AICIS (2022) or NICNAS (NICNAS, 2017a; NICNAS, 2017b) as a chemical of low concern, the PBT assessment did not identify a PBT substance and no human health hazard was identified; therefore, a Tier 2 assessment was deemed not to be warranted.
- If the chemical was not categorised by NICNAS as a chemical of low concern (either because it needed further evaluation or was not included in the 2017 NICNAS assessment) but was not a PBT substance and no human health hazard was identified, then a Tier 2 assessment was deemed not to be warranted.
- If the chemical satisfied the toxicity criteria for the PBT assessment because of aquatic toxicity values or a human health hazard was identified, the potential for complete exposure pathways was then assessed to determine the potential for risk (an incomplete pathway precludes an exposure occurring and an associated potential risk). In this context, site setting and management protocols associated with the action were evaluated, and if the pathway was incomplete, a Tier 2 assessment was not deemed to be warranted. Key controls limiting the potential for exposure included:
    - Implementation of the management controls within the EMP, which ensures the well site is located away from surface water (the current location is greater than 10 km away from the mapped watercourse, precluding a surface release from impacting surface water).
    - Maintenance of access control restrictions during hydraulic fracturing activities that will prevent access by the public, livestock and large native fauna.
    - Australia SafeWork Place and Condor Occupational Safety Guidance will be used to minimise human health exposure.

The outcome of the Tier 1 assessment identified the chemicals of low human health and environmental concern. Based on this outcome, no further management or mitigation is considered necessary for the majority of the chemicals. The following section presents the chemical(s) that could potentially pose significant hazards or risks evaluated in the Tier 2 Assessment.

2.3 Tier 2 Assessment

Of the chemicals evaluated for the hydraulic fracturing system formulation, glutaraldehyde (CAS number 111-30-8) was carried through to Tier 2 assessment. Chemicals identified in the Tier 1 assessment with a high ecotoxicity hazard assessment and therefore having a potential avian wildlife

exposure to fluids stored in treatment tanks were carried through to a Tier 2 assessment. Glutaraldehyde (CAS number 111-30-8) satisfied this criterion and had the requisite toxicity data for a Tier 2 assessment. No chemicals were identified in the Tier 1 assessment for a human health Tier 2 assessment.

2.3.1 Avian Wildlife

Potential exposure to selected chemical additives and/or flowback in treatment tanks by avian wildlife was assessed for representative avian species. **Appendix E** presents the outcomes of the Tier 2 assessment for this chemical (glutaraldehyde [CAS number 111-30-8]).

The potential exposure pathway for avian wildlife was assessed based on the potential ingestion of waters containing the selected chemicals (including flowback) from treatment tanks that were used for storage during the hydraulic fracturing activities of approximately three weeks. If a chemical was included in multiple fluid systems (e.g., glutaraldehyde), the maximum injected concentration (present in any of the fluid systems) was used in the Tier 2 assessment. Potential dietary intake of water containing these chemicals was compared to toxicity reference values developed specifically for avian wildlife to estimate a hazard quotient; a potential hazard quotient threshold level less than 1 indicates there are no unacceptable exposures to the avian species.

The hazard quotient for all the assessed avian species was orders of magnitude less than the threshold hazard quotient level of 1 (**Appendix E**). Therefore, there were no unacceptable exposures to the avian species. In addition, as a further conservative consideration, even if the potential exposure period is expanded to one year, the hazard quotient for the assessed avian species still will be orders of magnitude less than the threshold hazard quotient level of 1.

3 Summary and Risk Management

The goal of the CRA was to demonstrate that potential risks associated with hydraulic stimulation chemicals proposed for use by Condor across Tamboran's EP98, EP117 and EP76 tenements have been eliminated or reduced as much as is reasonably practicable to potentially exposed human and ecological receptors.

The life cycle of the hydraulic stimulation fluid system chemicals was assessed specifically for hydraulic stimulation operations and included:

- Activities associated with hydraulic stimulation chemical mixing and use at the well pad; and
- Management of flowback water (i.e., stored on-site) during or after the completion of hydraulic stimulation activities at the well pad.

The hydraulic stimulation chemicals within the life cycle (i.e., mixing, usage and storage) may result in potential exposure to human receptors and the environment through accidental releases. These potential releases, whilst unexpected, are considered to have a very low probability of occurrence and are constrained by the EMP requirements to managing risk, existing legislative requirements and the ongoing mitigating of potential impacts.

Condor and Tamboran have developed and implemented a range of systems and plans to control the transportation and storage of chemicals during field development and operational activities. This includes personnel induction and training, effective traffic management and routing to minimise the potential for accidents and spill management planning and response equipment. These systems and processes are considered effective in lowering the probability of occurrence of consequence associated with transportation incidents.

The human health and ecological hazard mitigation information provided in the chemical risk assessment dossiers and SDSs primarily focuses on safe handling, transportation and worker protection.

Based on the outcomes of this assessment, no further management controls are considered necessary.

4 Limitations

EHS Support has prepared this report in accordance with the usual care and thoroughness of the consulting profession for the use of Condor and only those third parties who have been authorised in writing by EHS to rely on the report. It is based on generally accepted practices and standards at the time it was prepared. No other warranty, expressed or implied, is made as to the professional advice included in this report. It is prepared in accordance with the scope of work and for the purpose outlined in the Proposal email dated 2 August 2022 and subsequent emails.

The methodology adopted and sources of information used by EHS Support are outlined in this report. EHS Support has made no independent verification of this information beyond the agreed scope of works, and EHS Support assumes no responsibility for any inaccuracies or omissions. No indications were found during our investigations that the information contained in this report as provided to EHS Support was false.

This report was prepared through January 2023 and is based on the information reviewed at the time of preparation. EHS Support disclaims responsibility for any changes that may have occurred after this time.

This report should be read in full. No responsibility is accepted for the use of any part of this report in any other context or for any other purpose, or by third parties. This report does not purport to give legal advice. Legal advice can only be given by qualified legal practitioners.

5 References

Australian Governments: Geological and Bioregional Assessment for the Beetaloo GBA (https://www.bioregionalassessments.gov.au/assessments/geological-and-bioregional-assessment-program/beetaloo-sub-basin/beetaloo-gba-region-stage-two-report)

Australian Industrial Chemicals Introduction Scheme. 2022. Chemical Information Database. Available online at: https://www.industrialchemicals.gov.au/chemical-information/search-assessments

Department of the Environment and Energy (DoEE). 2017. Exposure Draft - Chemical Risk Assessment Guidance Manual: for chemicals associated with coal seam gas extraction, Guidance manual prepared by Hydrobiology and ToxConsult Pty Ltd for the Department of the Environment and Energy, Commonwealth of Australia, Canberra.

DEPWS. 2021. Environment Management Plan Content Guideline. 11 August 2021.

enHealth. 2012. Environmental Health Risk Assessment, Guidelines for Assessing Human Health Risks from Environmental Hazards.

Origin. 2021a. Beetaloo Sub-Basin Beetaloo W-1. Environment Management Plan (ORI8-2), Exploration Permit 117. 7 February 2021.

Origin. 2021b. Beetaloo Sub-Basin Multi-Well Drilling, Stimulation and Well Testing Program. Environment Management Plan (ORI10-3), EP98, EP76. 9 December 2021.

National Environment Protection Council (NEPC). 2013. National Environment Protection (Assessment of Site Contamination) Measure 1999 (ASC NEPM); Schedule B4, Site-specific health risk assessment methodology. Amended 2013.

National Industrial Chemicals Notification and Assessment Scheme (NICNAS). 2017a. National Assessment of Chemicals Associated with Coal Seam Gas Extraction in Australia, Overview. Department of the Environment and Energy. Department of Health. National Industrial Chemicals Notification and Assessment Scheme.

NICNAS. 2017b. Chemicals of low concern for human health based on an initial assessment of hazards, Project report prepared by the National Industrial Chemicals Notification and Assessment Scheme (NICNAS) as part of the National Assessment of Chemicals Associated with Coal Seam Gas Extraction in Australia, Commonwealth of Australia, Canberra.

NT. 2018. Scientific Inquiry into Hydraulic Fracturing of Onshore Unconventional Reservoirs in the Northern Territory. Final Report. April. Darwin Northern Territory.

Northern Territory Governments POINT online mapping and data catalogue (https://point.nt.gov.au/weave/point.html)

Tables

Table 1
Evaluation of Compiled List of Chemicals
Condor Energy Northern Territory Tenement - Chemical Risk Assessment

Chemical Name	CAS Number	Density (kg/m^3)	Chemical Mass in Fluid (kg)	Concentration in Injected Fluid (mg/L)	Ecotoxicity	Toxicity	Biodegradation	Bioaccummulative	Screening	Discussion	Outcome of Tier 2 Assessment
Ethoxylated branched C13 alcohol	78330-21-9	926	4894	166.43	**Aquatic Toxicity** Freshwater fish: 2 species, 720 to 1,500 µg/L. Freshwater crustaceans: 2 species, 590 to 860 µg/L. Freshwater rotifers: 1 species, *Brachionus calyciflorus* , 1,300 µg/L Freshwater algae, diatoms and blue-green algae: 6 species, 200 to 8,700 µg/L. Freshwater mesocosms: 4 NOEC data for multiple species tests were 80, 80, 320, and 330 µg/L, although replication was insufficient to meet OECD (1992) requirements. Normalised data were 380, 380, 320, and 1,520 µg/L. **Chronic Toxicity** -No studies available Freshwater fish: 2 species, 720 to 1,500 micrograms per litre (µg/L). Freshwater crustaceans: 2 species, 590 to 860 µg/L. Freshwater rotifers: 1 species, Bra*chionus calyciflorus, 1* ,300 µg/L Freshwater algae, diatoms and blue-green algae: 6 species, 200 to 8,700 µg/L. Freshwater mesocosms: 4 NOEC data for multiple species tests were 80, 80, 320, and 330 µg/L, although replication was insufficient to meet OECD (1992) requirements. Normalised data were 380, 380, 320, and 1,520 µg/L. **Terrestrial Toxicity** -No studies are available **$PNEC_{water}$** . 0.14 mg/L **$PNEC_{sediment}$** . 11.95 mg/kg sediment wet weight **$PNEC_{soil}$** . 10.54 mg/kg soil dry weight	Qualitative Assessment: Human Health Hazard -Low concern Ecological Hazard - moderate toxicity PBT Assessment: Substance exhibits lower toxicity than that established by regulatory guidance.	Environmental Fate Property: Readily biodegradable PBT Assessment: Does not meet the screening criteria for persistence.	Environmental Fate Property: BCF for AEs have a reported range of <5-387.5 PBT Assessment: Does not meet the screening criteria for bioaccumulation.	Tier 1 (PBT/Exposure Assessment)	PBT Assessment: The overall conclusion is that Ethoxylated branched C13 alcohol is not a PBT substance. Qualitative Assessment indicated low concern to human health. The estimated injected concentration did exceed the ecotoxicity values or PNECs for this chemical. However, this chemical is readily biodegradable and does not bioaccumulate. Additionally, the potential exposure to aquatic receptors is considered incomplete (refer to text). Therefore, a Tier 2 assessment was not warranted. Management: Implementation of Constraints Protocol in EMP will be required to prevent accidental discharge/release. Therefore, a Tier 2 assessment was not warranted.	NA
Sodium thiosulphate	7772-98-7	1690	8050	150.00	**Aquatic Toxicity** **Acute Aquatic** -96-hr LC_{50} *Lepomis macrochirus* - 510 mg/L -96-hr LC_{50} *Salmo gairdneri* - 770 mg/L -72-hr EC_{50} *Pseudokirchneriella subcapitata* - >100 mg/L -48-hr EC_{50} *Daphnia magna* - 230 mg/L **Chronic Studies** - No data are available. **Terrestrial Toxicity** - No studies are available **$PNEC_{water}$** - 1.0 mg/L **$PNEC_{soil}$** - No data available	Qualitative Assessment: Human Health Hazard - Low concern Ecological Hazard - Low concern PBT Assessment: Substance exhibits lower toxicity than that established by regulatory guidance.	Environmental Fate Properties: Dissociates completely in aqueous media PBT Assessment: Does not meet the criteria for biodegradation.	Environmental Fate Properties: Dissociates to ions that are ubiquitous in environment PBT Assessment: Does not meet the screening criteria for bioaccumulation.	Tier 1 (Qualitative/PBT/Exposure Assessment)	PBT Assessment: The overall conclusion is that Sodium thiosulphate not a PBT substance. Qualitative assessment indicated low concern to human health. The estimated injected concentration did exceed the ecotoxicity values or PNECs for this chemical. However, this chemical dissociates completely in aqueous media to ions that are ubiquitous in the environment. Additionally, the potential exposure to aquatic receptors is considered incomplete (refer to text). Therefore, a Tier 2 assessment was not warranted. Management: Implementation of Constraints Protocol in EMP will be required to prevent accidental discharge/release. Therefore, a Tier 2 assessment was not warranted.	NA
Sodium sulphate	7757-82-6	2700	2466	28.76	**Aquatic Toxicity** **Acute Aquatic - Fish** -96-hr LC_{50} *Pimephales promelas* 7,960 mg/L **Acute Aquatic - Invertebrate** -48-hr EC_{50} - *Daphnia magna* - 4,736 mg/L **Chronic Aquatic - Invertebrate** -7-day - $LOEC_{50}$ - *Ceriodapnia dubia* 1,109 mg/L **Terrestrial Toxicity** No data available **$PNEC_{water}$** - 11 mg/L **$PNEC_{soil}$** - not derived	Qualitative Assessment: Human Health Hazard - Low concern Ecological Hazard - Low concern PBT Assessment: Substance exhibits lower toxicity than that established by regulatory guidance.	Environmental Fate Properties: Dissociates completely in aqueous media PBT Assessment: Biodegradation is not applicable to these inorganic ions.	Environmental Fate Properties: Will dissociate to sodium and sulfate ions which are not expected to bioaccumulate. PBT Assessment: Does not meet the screening criteria for bioaccumulation.	Tier 1 (Qualitative/PBT/Exposure Assessment)	PBT Assessment: The overall conclusion is that sodium sulphate is not a PBT substance. Qualitative assessment indicated low concern to human health. The estimated injected concentration did exceed the ecotoxicity values or PNECs for this chemical. However, this chemical dissociates completely in aqueous media to ions that are ubiquitous in the environment. It does not bioaccumulate. Human health hazards and ecological hazards are of low concern. Therefore, a Tier 2 assessment was not warranted. Management: Implementation of Constraints Protocol in EMP will be required to prevent accidental discharge/release. Therefore, a Tier 2 assessment was not warranted.	NA

Table 1
Evaluation of Compiled List of Chemicals
Condor Energy Northern Territory Tenement - Chemical Risk Assessment

Chemical Name	CAS Number	Density (kg/m^3)	Chemical Mass in Fluid (kg)	Concentration in Injected Fluid (mg/L)	Ecotoxicity	Toxicity	Biodegradation	Bioaccummulative	Screening	Discussion	Outcome of Tier 2 Assessment
Sodium Sulphite	7757-83-7	2630	2088	25.00	**Aquatic Toxicity** **Acute Aquatic - Fish** -96-hr LC_{50} Golden Orfe - 316 mg/L **Acute Aquatic - Invertebrate** -48-hr EC_{50} *Daphnia magna* - 89* (59) mg/L -72-hr EC_{50} *Desmodesmus subspicatus* - 43.8* (29)mg/L * test substance sodium disulphite; adjusted concentration for sodium sulphite in parentheses **Chronic Toxicity** -34-day NOEC Zebrafish >316 mg/L. -21-day NOEC *Daphnia magna* >10* (6.6) mg/L -EC_{10} *Desmodesmus subspicatus* 33.3* (22) mg/L * test substance sodium disulphite; adjusted concentration for sodium sulphite in parentheses **Terrestrial Toxicity** No adequate studies were located. **$PNEC_{water}$** - 0.7 mg/L (NOEC for invertebrates) **$PNEC_{soil}$** - not derived	Qualitative Assessment: Human Health Hazard - Low concern Ecological Hazard - low concern. PBT Assessment: Substance exhibits lower toxicity than that established by regulatory guidance.	Environmental Fate Properties: Dissociates completely in aqueous media PBT Assessment: Does not meet the criteria for biodegradation.	Environmental Fate Properties: Dissociates to ions that are ubiquitous in environment PBT Assessment: Does not meet the screening criteria for bioaccumulation.	Tier 1 (Qualitative/PBT/Exposure Assessment)	PBT Assessment: The overall conclusion is that Sodium Sulphite is not a PBT substance. Qualitative assessment indicated low concern to human health and to aquatic life. The estimated injected concentration did exceed the ecotoxicity values or PNECs for this chemical. However, this chemical dissociates completely in aqueous media to ions that are ubiquitous in the environment. It does not bioaccumulate. Additionally, the potential exposure to aquatic receptors is considered incomplete (refer to text). Therefore, a Tier 2 assessment was not warranted. Management: Implementation of Constraints Protocol in EMP will be required to prevent accidental discharge/release. Therefore, a Tier 2 assessment was not warranted.	NA
Ethylene glycol	107-21-1	1110	5509	156.29	**Aquatic Toxicity** **Acute Aquatic - Fish** -96-hr LC_{50} *Pimephales promelas* - >72,860 mg/L -96-hr LC_{50} *Oncorhynchus mykiss* - 22,810 mg/L and 24,591 mg/L **Acute Aquatic - Invertebrate** -48-hr EC_{50} *Daphnia magna* - >100 mg/L, 46,300 mg/L (20°C), 51,000 mg/L (24°C) -48-hr EC50 *Ceriodaphnia dubia-affinis* - 25,800 mg/L (20°C), 10,000 mg/L (24°C) **Acute Aquatic - Algae and other aquatic plants** -96-hr IC_{50} *Selenastrum capricornutum* - 10,940 mg/L -96-hr NOEC *Selenastrum capricornutum* - 10,000 mg/L **Chronic Aquatic - Fish** -7-day NOEC *Pimephales promelas* - 15,380 mg/L **Chronic Aquatic - Invertebrate** -7-day NOEC *Ceriodaphnia dubia* - 8,590 mg/L **Chronic Aquatic - Algae** -72-hr NOEC *Pseudokirchneriella subcapitata* - >100 mg/L **Terrestrial Toxicity** No data available. **$PNEC_{water}$** - 10 mg/L **$PNEC_{soil}$** - 0.13 mg/kg soil dry weight (equilibrium partitioning method)	Qualitative Assessment: Human Health Hazard - Repeated exposures may cause kidney toxicity Ecological Hazard - Low concern PBT Assessment: Substance exhibits lower toxicity than that established by regulatory guidance.	Environmental Fate Property: Readily biodegradable. PBT Assessment: Does not meet the screening criteria for persistence.	Environmental Fate Properties: -Calculated log Kow is -1.36 -BCF in golden ide (*Leuciscus idus melanotus*) after 3 days exposure was 10 PBT Assessment: Does not meet the criteria for bioaccumulation.	Tier 1 (Qualitative/PBT/Exposure Assessment)	PBT Assessment: The overall conclusion is that ethylene glycol is not a PBT substance. Qualitative Assessment indicated potential hazard to human health (e.g., kidney toxicity). The estimated injected concentration did exceed the ecotoxicity values or PNECs for this chemical. However, this chemical is readily biodegradable and does not bioaccumulate. Additionally, the potential exposure to aquatic receptors is considered incomplete (refer to text). Therefore, a Tier 2 assessment was not warranted. Management: Australia WorkSafe and Condor Occupational Health & Safety procedures will be used to minimise human health exposure. Implementation of Constraints Protocol in EMP will be required to prevent accidental discharge/release. Therefore, a Tier 2 assessment was not warranted.	NA

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Condor Energy Northern Territory Tenement - Chemical Risk Assessment

Chemical Name	CAS Number	Density (kg/m^3)	Chemical Mass in Fluid (kg)	Concentration in Injected Fluid (mg/L)	Ecotoxicity	Toxicity	Biodegradation	Bioaccummulative	Screening	Discussion	Outcome of Tier 2 Assessment
Glutaraldehyde	111-30-8	1130	16871	470.14	**Aquatic Toxicity** **Acute Aquatic - Fish** -96-hr LC_{50} Bluegill Sunfish - 13 mg/L -96-hr LC_{50} *Oncorhynchus mykiss* - 10 mg/L **Acute Aquatic - Invertebrate** -48-hr LC_{50} *Daphnia magna* - 14.87 mg/L and 14 mg/L **Acute Aquatic - Algae and other aquatic plants** -72-hr EC_{50} *Scenedesmus subspicatus* - 0.375 mg/L (biomass), 0.6 (growth rate), 0.025 (NOEC) -72-hr EC_{50} *Scenedesmus subspicatus* - 0.92 mg/L (biomass), 0.61 (growth rate), 0.33 (NOEC) -72-hr EC_{50} *Scenedesmus subspicatus* - 0.61 mg/L (growth rate) **Chronic Aquatic - Fish** -97-day LOEC *Oncorhynchus mykiss* - 5 mg/L -97-day NOEC *Oncorhynchus mykiss* - 1.6 mg/L **Chronic Aquatic - Invertebrate** -21-day NOEC *Daphnia magna* - 5 mg/L **Terrestrial Toxicity** **Earthworms** -14-day LC50 - >500 mg/kg soil dry weight **Soil microoganisms** -28-day EC50 - 360 mg/kg soil dry weight - > 593 mg/kg soil dry weight -28-day EC10 - 1.5 mg/kg soil dry weight - 11.5 mg/kg soil dry weight **Avian** -single dose (oral gavage) LC50 Mallard duck - 206 mg/kg -5-day dietary NOEC - Mallard duck - >2,500 ppm **Terrestrial Plants:** -19-day EC_{50} - *Avena sativa* (oats) - >1,000 mg/kg soil dry weight; NOEC - ≥1000 (emergence rate, dry matter, shoot length) -19-day EC_{50} - *Brassica napus* (rapeseed) - >1,000 mg/kg soil dry weight; NOEC - ≥1000 (emergence rate), 500 (dry matter), 250 (shoot length) -19-day EC_{50} - *Vicia sativa* (vetch) - >1,000 mg/kg soil dry weight (emergence rate and shoot length); 901 mg/kg soil dry weight based on dry weight; NOEC - ≥1000 (emergence rate), 125 (dry matter), 125 (shoot length) **$PNEC_{water}$** - 0.0025 mg/L (Chronic algae) **$PNEC_{soil}$** -1.5 mg/kg soil dry weight (Chronic soil organisms)	Qualitative Assessment: Human Health Hazard - Corrosive; skin/respiratory sensitizer Ecological Hazard - Very toxic to aquatic life with long lasting effects. Moderatly toxic to birds on acute basis. PBT Assessment: Substance exhibits higher toxicity than that established by regulatory guidance.	Environmental Fate Properties: Readily biodegradable. PBT Assessment: Does not meet the screening criteria for persistence.	Environmental Fate Property: The log Kow at different pH values range from -0.36-0.80. PBT Assessment: Does not meet the screening criteria for bioaccumulation.	Tier 2	NICNAS Assessment (2018) Human Health - potentially harmful to public health in event of transport spill. - potentially harmful to workers health in event of industrial incident Environment -Potentially harmful to the environment in the event of transport spill PBT Assessment: The overall conclusion is that glutaraldehyde is not a PBT substance. Qualitative Assessment indicated potential hazard to human health (e.g., skin irritant). The estimated injected concentration did exceed the ecotoxicity values or PNECs for this chemical and does meet the screening criteria for toxicity. This chemical is readily biodegradable and does not bioaccumulate. Additionally, the potential exposure to aquatic receptors is considered incomplete (refer to text). Therefore, a Tier 2 assessment was not warranted for aquatic receptors. Management: Implementation of Constraints Protocol in EMP will be required to prevent accidental discharge/release. Australia SafeWork Place and Condor Occupational Safety Guidance will be used to minimise human health exposure. Therefore, a Tier 2 assessment was not warranted for human receptors. Chemicals with a high ecotoxicity hazard assessment have a potential avian wildlife exposure to chemicals stored in treatment tanks. Therefore a Tier 2 assessment was conducted for avian receptors.	A quantitative risk characterisation was used to assess the risk to avian receptors from potential exposure to gluteraldehyde (**Appendix E**). There were no unacceptable potential risks to avian receptors as a result of ingestion of waters stored in treatment tanks.
Diammonium peroxidisulphate	7727-54-0	1260	9388	234.63	**Aquatic Toxicity** **Acute Aquatic - Fish** -96-hr LC_{50} *Oncorhynchus mykiss* - 76.3 mg/L **Acute Aquatic - Invertebrate** -48-hr EC_{50} *Daphnia magna* - 120 mg/L **Acute Aquatic - Algae** -72-hr EC_{50} *Phaedactylum tricornutum* - 320 mg/L **Chronic Aquatic - Invertebrate** -21-day NOEC *Daphnia magna* 20.8 mg/L **Terrestrial Toxicity** No terrestrial toxicity studies identified. **$PNEC_{water}$** - 0.4 mg/L **$PNEC_{soil}$** - not derived	Qualitative Assessment: Human Health Hazard - Moderate concern (irigating to eyes, skin, and respiratory tract.) Ecological Hazard - Low concern PBT Assessment: Substance exhibits lower toxicity than that established by regulatory guidance.	Environmental Fate Properties: Dissociates completely in aqueous media PBT Assessment: Not applicable	Environmental Fate Properties: Inorganic salt that dissolves to respective cations and anions. PBT Assessment: Does not meet the screening criteria for bioaccumulation. Diammonium peroxidisulphate is not a PBT substance	Tier 1 (NICNAS/ Qualitative/PBT/Exposure Assessment)	NICNAS has assessed diammonium peroxidisulphate in an IMAP Tier 1 assessment and concluded that it poses no unreasonable risk to the environment. PBT Assessment: The overall conclusion is that sodium diammonium peroxodisulphate is not a PBT substance. Qualitative assessment indicated moderate potential human hazard Moderate concern (iritating to eyes, skin, and respiratory tract). The estimated injected concentration did exceed the ecotoxicity values or PNECs for this chemical. However, this chemical dissociates completely in aqueous media to its respective cations and anions. It does not bioaccumulate Therefore, a Tier 2 assessment was conducted for potential exposures to humans. Management: Australia SafeWork Place and Condor Occupational Safety Guidance will be used to minimise human health exposure. Implementation of Constraints Protocol in EMP will be required to prevent accidental discharge/release. Therefore, a Tier 2 assessment was not warranted.	NA

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Condor Energy Northern Territory Tenement - Chemical Risk Assessment

Chemical Name	CAS Number	Density (kg/m^3)	Chemical Mass in Fluid (kg)	Concentration in Injected Fluid (mg/L)	Ecotoxicity	Toxicity	Biodegradation	Bioaccummulative	Screening	Discussion	Outcome of Tier 2 Assessment
Hydrotreated light petroleum distillate	64742-47-8	850	46096	1707.75	**Aquatic Toxicity** **Acute Aquatic - Fish** -96-hr LL_{50} *Oncorhynchus mykiss* - 2-5 mg/L -96-hr NOEL *Oncorhynchus mykiss* - 2.0 mg/L **Acute Aquatic - Invertebrate** -48-hr EL_{50} *Daphnia magna* - 1.4 mg/L -48-hr NOEL *Daphnia magna* - 0.3 mg/L **Acute Aquatic - Algae** -72-hr EC_{50} *Raphidocelis subcapitata* - <1-3 (average value of 2) mg/L -72-hr EC_{50} *Selenastrum capricornutum* - 3.7 mg/L **Chronic Aquatic - Invertebrate** -21-day NOEL *Daphnia magna* 0.48 mg/L -21-day EL_{50} (reproduction)- 0.89 mg/L **Terrestrial Toxicity** No terrestrial toxicity studies identified. **$PNEC_{water}$** - 0.005 mg/L **$PNEC_{soil}$** - 0.32 mg/kg dry weight	Qualitative Assessment: Human Health Hazard - Low concern Ecological Hazard - Low toxicity PBT Assessment: Substance exhibits lower toxicity than that established by regulatory guidance.	Environmental Fate Properties: Inherently biodegradable PBT Assessment: Does not meet the screening criteria for persistence	Environmental Fate Property: EPISUITE estimated BCF = 3.162 L/kg wet-weight PBT Assessment: Does not meet the screening criteria for bioaccumulation.	Tier 1 (Qualitative/PBT/Exposure Assessment)	PBT Assessment: The overall conclusion is that hydrotreated light petroleum distillate is not a PBT substance. Qualitative assessment indicated low concern for human and ecological hazards. The estimated injected concentration did exceed the ecotoxicity values or PNECs for this chemical. This chemical is inherently biodegradable and does not meet the PBT assessment criteria for toxicity or bioaccumulation. Additionally, the potential exposure to aquatic receptors is considered incomplete (refer to text). Therefore, a Tier 2 assessment was not warranted. Management: Australia SafeWork Place and Condor Occupational Safety Guidance will be used to minimise human health exposure. Implementation of Constraints Protocol in EMP will be required to prevent accidental discharge/release. Therefore, a Tier 2 assessment was not warranted.	NA
Guar Gum	9000-30-0	NA	NA	476.80	**Aquatic Toxicity** **Acute Aquatic - Fish** -96-hr LC_{50} *Oncorhynchus mykiss* - 218 mg/L **Acute Aquatic - Invertebrate** -48-hr LC_{50} *Daphnia magna* - 42 mg/L -96-hr LC_{50} *Daphnia magna* - <6.2 mg/L **Chronic Aquatic** -No chronic studies available **Terrestrial Toxicity** No data available. **$PNEC_{water}$** - 0.006 mg/L (Acute *Daphnia*) **$PNEC_{soil}$** - not derived	Qualitative Assessment: Human Health Hazard - Low concern Ecological Hazard - Low concern to fish, moderate acute toxicity to invertebrates PBT Assessment: Substance exhibits lower toxicity than that established by regulatory guidance.	Environmental Fate Properties: Readily biodegradable. PBT Assessment: Does not meet the screening criteria for persistence.	Environmental Fate Properties: Not expected to bioaccumulate. PBT Assessment: Does not meet the screening criteria for bioaccumulation.	Tier 1 (NICNAS/ PBT/ Exposure Assessment)	NICNAS Assessment (2018) Human Health - unlikely to cause harm to public - unlikely to cause harm to workers Environment -Potentially harmful to the environment in the event of transport spill NICNAS: Identified as chemical of low concern for human health in National assessment of chemicals associated with coal seam gas extraction in Australia, Tech Report Number 11 (NICNAS, 2017) PBT Assessment - The overall conclusion is that guar gum is not a PBT substance. Qualitative assessment indicated low concern to human health. The estimated injected concentration did exceed the ecotoxicity values or PNECs for this chemical. However, this chemical is readily biodegradable, is not expected to bioaccumulate, and does not meet the PBT criteria for toxicty. Additionally, the potential exposure to aquatic receptors is considered incomplete (refer to text). Therefore, a Tier 2 assessment was not warranted. Management: Implementation of Constraints Protocol in EMP will be required to prevent accidental discharge/release. Therefore, a Tier 2 assessment was not warranted.	NA

Table 1
Evaluation of Compiled List of Chemicals
Condor Energy Northern Territory Tenement - Chemical Risk Assessment

Chemical Name	CAS Number	Density (kg/m^3)	Chemical Mass in Fluid (kg)	Concentration in Injected Fluid (mg/L)	Ecotoxicity	Toxicity	Biodegradation	Bioaccummulative	Screening	Discussion	Outcome of Tier 2 Assessment
Quartz or Organophillic phyllosilicate	14808-60-7	NA	NA	34.13	**Aquatic and Terrestrial Toxicity** -No studies are available. -Expected to be low concern for toxicity to aquatic organisms. **$PNEC_{water}$** - not derived **$PNEC_{soil}$** - not derived	Qualitative Assessment: Human Hazard: Inhalation: silicosis and lung cancer in humans. Oral/dermal: low concern. Ecological Hazard: Low concern PBT Assessment: Substance exhibits higher toxicity than that established by regulatory guidance.	Environmental Fate Properties: Not relevant PBT Assessment: Does not meet the screening criteria for persistence.	Environmental Fate Properties: inorganic complex not expected to bioaccumulate PBT Assessment: Does not meet the screening criteria for bioaccumulation.	Tier 1 (Qualitative Assessment/ PBT)	PBT Assessment: The overall conclusion is that Crystalline silica, quartz is not a PBT substance. Qualitative Assessment indicated hazardous to human health by the inhalation pathway; not hazardous by the oral/dermal route. Management: Australia WorkSafe and Condor Occupational Health & Safety procedures will be used to minimise human health exposure. Therefore a Tier 2 Assessment is not warranted.	NA
Hydrochloric acid	7647-01-0	1190	53211	1408.10	**Aquatic Toxicity** **Acute Aquatic - Fish** -96-hr LC_{50} *Lepomis macrochirus* - pH 3.25-3.5 (20 mg/L) **Acute Aquatic - Invertebrate** -48-hr EC_{50} *Daphnia magna* - pH 4.92 (0.45 mg/L) **Acute Aquatic - Algae and other aquatic plants** -72-hr EC_{50} *Chlorella vulgaris* - pH 4.7 (growth rate) (0.73 m/L) 72-hr EC_{10} *Chlorella vulgaris* - pH 4.7 (0.364 mg/L) **Chronic Aquatic** -No chronic studies available **Terrestrial Toxicity** No data available. **$PNEC_{water}$** - not derived **$PNEC_{soil}$** - not derived	Qualitative Assessment: Human Health Hazard - Corrosive; respiratory irritant Ecological Hazard - Low concern PBT Assessment: Substance exhibits lower toxicity than that established by regulatory guidance.	Environmental Fate Properties: Dissociates completely PBT Assessment: Not applicable.	Environmental Fate Property: Not expected to bioaccumulate. PBT Assessment: Does not meet the screening criteria for bioaccumulation.	Tier 1 (NICNAS/ Qualitative Assessment/ PBT)	NICNAS Assessment (2018) Human Health - unlikely to cause harm to public - potentially harmful to workers health in event of industrial incident Environment -Potentially harmful to the environment in the event of transport spill PBT Assessment - The overall conclusion is that hydrochloric acid is not a PBT substance. Qualitative Assessment indicated potential hazard to human health (e.g., corrosive). Management: Implementation of Constraints Protocol in EMP will be required to prevent accidental discharge/release. Australia SafeWork Place and Condor Occupational Safety Guidance will be used to minimise human health exposure. Therefore, a Tier 2 assessment was not warranted.	NA
Citric acid	77-92-9	1670	26516	500.0	**Aquatic Toxicity** **Acute Aquatic - Fish** -48-hr LC_{50} *Leuciscus idus melanotus* (golden orfe) - 440 mg/L and 760 mg/L -96-hr LC_{50} *Lepomis macrochirus* (fathead minnow)- >100 mg/L **Acute Aquatic - Invertebrate** -24-hr EC_{50} *Daphnia magna* - 85 mg/L (un-neutralised test solution) 1,535 mg/L in neutralised solution **Acute Aquatic - Algae and other aquatic plants** -8-day EC_0 *Scenedesmus quadricauda* - 640 mg/L **Chronic Aquatic** -No chronic studies available **Terrestrial Toxicity** No data available. **$PNEC_{water}$** - 0.44 mg/L (Acute Daphnia) **$PNEC_{soil}$** - 0.002 mg/kg soil dry weight (equilibrium partitioning method)	Qualitative Assessment: Human Health Hazard -Eye irritant Ecological Hazard - Low concern PBT Assessment: Substance exhibits lower toxicity than that established by regulatory guidance.	Environmental Fate Properties: Readily biodegradable PBT Assessment: Does not meet the screening criteria for persistence.	Environmental Fate Properties: log K_{ow} is -1.61 to -1.80 PBT Assessment: Does not meet the screening criteria for bioaccumulation.	Tier 1 (NICNAS/ PBT/ Exposure Assessment)	NICNAS: Identified as chemical of low concern for human health in National assessment of chemicals associated with coal seam gas extraction in Australia, Tech Report Number 11 (NICNAS, 2017) Qualitative Assessment indicated potential hazard to human health (e.g., eye irritant). PBT Assessment: The overall conclusion is that citric acid is not a PBT substance. The estimated injected concentration did exceed the PNECs for this chemical. This chemical is readily biodegradable, does not bioaccumulate, and does not meet the PBT assessment criteria for toxicity. Additionally, the potential exposure to aquatic receptors is considered incomplete (refer to text). Therefore, a Tier 2 assessment was not warranted. Management: Implementation of Constraints Protocol in EMP will be required to prevent accidental discharge/release. Australia WorkSafe and Condor Occupational Health & Safety procedures will be used to minimise human health exposure.	NA

Table 1
Evaluation of Compiled List of Chemicals
Condor Energy Northern Territory Tenement - Chemical Risk Assessment

Chemical Name	CAS Number	Density (kg/m^3)	Chemical Mass in Fluid (kg)	Concentration in Injected Fluid (mg/L)	Ecotoxicity	Toxicity	Biodegradation	Bioaccummulative	Screening	Discussion	Outcome of Tier 2 Assessment
Acetic acid	64-19-7	1040	16513	500.0	**Aquatic Toxicity** **Acute Aquatic - Fish** -96-hr LC_{50} *Oncorhynchus mykiss* - (test substance potassium acetate) >300.82 mg/L (as acetate ion) -96-hr LC_{50} *Danio rerio* - (test substance potassium acetate) >300.82 mg/L (as acetate ion) -96-hr LC_{50} *Oncorhynchus mykiss* - (test substance acetic acid) 64.8 mg/L (measured) -96-hr LC_{50} *Oncorhynchus mykiss* - (test substance acetic acid) 31.3 mg/L - 67.6 mg/L **Acute Aquatic - Invertebrate** -48-hr EC_{50} *Daphnia magna* - (test substance potassium acetate) >300.82 mg/L (as acetate ion) -48-hr EC_{50} *Daphnia magna* - (test substance acetic acid) 79.5 mg/L (measured) -48-hr EC_{50} *Daphnia magna* - (test substance acetic acid) 18.9 mg/L (measured) **Acute Aquatic - Algae and other aquatic plants** -72-hr EC_{50} *Desmodesmus subspicatus* - 486.5 mg/L **Chronic Aquatic - Fish** -21-day *Oncorhynchus mykiss* study - measured NOEC 57.2 mg/L (60% acetic acid) and 34.3 mg/L (100% acetic acid) **Chronic Aquatic - Invertebrate** -21-day *Daphnia magna* reproduction study measured NOEC 80 mg/L (60% acetic acid) and 31.4 mg/L (100% acetic acid) -21-day *Daphnia magna* reproduction study measured NOEC 22.7 mg/L (100% acetic acid) **Terrestrial Toxicity** No data available. **$PNEC_{water}$** - 3.0 mg/L (E(L)C50 test fish or *Dapnhia magna*) **$PNEC_{soil}$** - 0.04 mg/kg soil dry weight (equilibrium partitioning method)	Qualitative Assessment: Human Health Hazard - Corrosive, respiratory irritant Ecological Hazard - moderate actute toxicity to aquatic organisms. PBT Assessment: Substance exhibits lower toxicity than that established by regulatory guidance.	Environmental Hazard Assessment: Readily biodegradable PBT Assessment: Does not meet the screening criteria for persistence.	Environmental Fate Property: Low K_{ow} is -0.17 PBT Assessment: Does not meet the screening criteria for bioaccumulation.	Tier 1 (NICNAS/ PBT/ Exposure Assessment)	NICNAS Assessment (2018) Human Health - potentially harmful to public health in event of transport spill. - potentially harmful to workers health in event of industrial incident Environment -unlikely to cause harm to environment PBT Assessment: The overall conclusion is that acetic acid is not a PBT substance. The estimated injected concentration did exceed the ecotoxicity values or PNECs for this chemical. However, this chemical is readily biodegradable, does not bioaccumulate, and does not meet the PBT criteria for toxicity to aquatic organisms. Additionally, the potential exposure to aquatic receptors is considered incomplete (refer to text). Therefore, a Tier 2 assessment was not warranted. Management: Implementation of Constraints Protocol in EMP will be required to prevent accidental discharge/release. Australia WorkSafe and Condor Occupational Health & Safety procedures will be used to minimise human health exposure. Therefore, a Tier 2 assessment was not warranted.	NA
Isopropanol	67-63-0	800	67	2.6	**Aquatic Toxicity** **Acute Aquatic - Fish** -96-hr LC_{50} *Pimpephales promelas* - 9,640 mg/L **Acute Aquatic - Invertebrate** -24-hr EC_{50} *Daphnia magna* >10,000 mg/L **Chronic Aquatic - Invertebrate** -16 day NOEC *Daphnia magna* 141 mg/L -21 day NOEC *Daphnia magna* 30 mg/L -7-day NOEC *Scenedesmus quadricauda* is 1,800 mg/L **Terrestrial Toxicity** -EC_{50} lettuce seed germination test - 2,100 mg/L **$PNEC_{water}$** - 0.3 mg/L **$PNEC_{soil}$** - 0.014 mg/kg soil dry weight (equilibrium partitioning method)	Qualitative Assessment: Human Health Hazard -Low concern Ecological Hazard - Low concern PBT Assessment: Substance exhibits lower toxicity than that established by regulatory guidance.	Environmental Fate Properties: Readily biodegradable PBT Assessment: Does not meet the screening criteria for persistence.	Environmental Fate Properties: Bioaccumulation of isopropanol is not expected to occur based on its log K_{ow} value of 0.05 and its calculated BCF value of 1. PBT Assessment: Does not meet the screening criteria for bioaccumulation.	Tier 1 (Qualitative Assessment/PBT)	PBT Assessment: The overall conclusion is that isopropanol is not a PBT substance. Qualitative assessment indicated low concern to human health. The estimated injected concentration did exceed the ecotoxicity values or PNECs for this chemical. However, this chemical is readily biodegradable and does not bioaccumulate. Therefore, a Tier 2 assessment was not warranted. Management: mplementation of Constraints Protocol in EMP will be required to prevent accidental discharge/release. Therefore, a Tier 2 assessment was not warranted.	NA
Alcohols, C12-16, ethoxylated	68551-12-2	930	53	1.79	**Aquatic Toxicity** Toxicity values (NOECs) utilised in development of ANZECC water quality guideline for alcohol ethoxylates: -Freshwater fish: 2 species, 720 to 1,500 µg/L -Freshwater crustaceans: 2 species, 590 to 860 µg/L. -Freshwater rotifers: 1 species, *Brachionus calyciflorus* , 1,300 µg/L -Freshwater algae, diatoms and blue-green algae: 6 species, 200 to 8,700 µg/L. - Freshwater mesocosms: 4 NOEC data for multiple species tests were 80, 80, 320, and 330µg/L, although replication was insufficient to meet OECD (1992) requirements. Normalised data were 380, 380, 320, and 1,520 µg/L **Terrestrial Toxicity** No data available. **$PNEC_{water}$** - 0.140 mg/L (ANZECC Water Quality Guideline for alcohol ethoxyates) **$PNEC_{soil}$** - 0.0 to 10.7 mg/kg dry weight soil (equilibrium partitioning method)	Qualitative Assessment: Human Health Hazard - Low concern Ecological Hazard - Harmful to aquatic life with long lasting effects PBT Assessment: Substance exhibits lower toxicity than that established by regulatory guidance.	Environmental Fate Property: Readily biodegradable PBT Assessment: Does not meet the screening criteria for persistence.	Environmental Fate Property: Log K_{ow} range from <5 to 387.5 PBT Assessment: Does not meet the screening criteria for bioaccumulation.	Tier 1 (Qualitative/ PBT/ Exposure Assessment)	PBT Assessment: The overall conclusion is that Alcohols, C12-16, ethoxylated is not a PBT substance. Qualitative Assessment indicated low concern to human health; however harmful effects to aquatic life. The estimated injected concentration did exceed the ecotoxicity values or PNECs for this chemical. However, this chemical is readily biodegradable and does not bioaccumulate. Additionally, the potential exposure to aquatic receptors is considered incomplete (refer to text). Therefore, a Tier 2 assessment was not warranted. Management: Implementation of Constraints Protocol in EMP will be required to prevent accidental discharge/release. Therefore, a Tier 2 assessment was not warranted.	NA

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Chemical Name	CAS Number	Density (kg/m^3)	Chemical Mass in Fluid (kg)	Concentration in Injected Fluid (mg/L)	Ecotoxicity	Toxicity	Biodegradation	Bioaccummulative	Screening	Discussion	Outcome of Tier 2 Assessment
Cinnamaldehyde	104-55-2	1041	59	1.79	**Aquatic Toxicity** **Acute Aquatic - Fish** -96-hr LC_{50} *Brachydanio rerio* - >3.9 mg/L to < 5.5 mg/L -96-hr LC_{50} *Poecilia reticulata* - >3.5 mg/L to < 6.5 mg/L - 96 hr LC_{50} - *Lepomis machrochirus* - > 20 mg/L **Acute Aquatic - Invertebrate** -48-hr EC_{50} *Daphnia magna* - 3.21 mg/L to 11.5 mg/L **Acute Aquatic - Algae and other aquatic plants** -72-hr EC_{50} *Desmodesmus subspicatus* - 31.6 mg/L -72-hr EC_{50} *Chlorella vulgaris* - 16.09 mg/L **Chronic Toxicity** -21-day EC_{50} - *Daphnia magna* - 0.402 mg/L -28-day NOEC - estimated for fish - 15.159 mg/L **Terrestrial Toxicity** -5-day LOEL - *Colinus virginianus* - 1% w/w **$PNEC_{water}$** - 0.152 mg/L (chronic fish) **$PNEC_{soil}$** - 0.075 mg/kg dry weight soil (equilibrium partitioning method)	Qualitative Assessment: Human Health Hazard -Skin/eye irritant; skin sensitizer Ecological Hazard - Toxic to aquatic life PBT Assessment: Substance exhibits lower toxicity than that established by regulatory guidance.	Environmental Fate Properties: Readily biodegradable. PBT Assessment: Does not meet the screening criteria for persistence.	Environmental Fate Property: log K_{ow} is 2.107 PBT Assessment: Does not meet the screening criteria for bioaccumulation.	Tier 1 (Qualitative Assessment/ PBT/ Exposure Assessment)	PBT Assessment: The overall conclusion is that cinnamaldehyde is not a PBT substance. Qualitative Assessment indicated potential hazard to human health (e.g., skin irritant). The estimated injected concentration did exceed the ecotoxicity values or PNECs for this chemical. This chemical is readily biodegradable, does not bioaccumulate, and does not meet the PBT assessment criteria for toxicity. Additionally, the potential exposure to aquatic receptors is considered incomplete (refer to text). Therefore, a Tier 2 assessment was not warranted. Management: Implementation of Constraints Protocol in EMP will be required to prevent accidental discharge/release. Australia WorkSafe and Condor Occupational Health & Safety procedures will be used to minimise human health exposure.	NA
Methanol	67-56-1	790	1	0.06	**Aquatic Toxicity** **Acute Aquatic - Fish** -96-hr LC_{50} Bluegill - 15,400 mg/L -96-hr LC_{50} *Salmo gairdneri* - 20,100 mg/L -96-hr LC_{50} *Pimphales promelas* - 28,100 mg/L **Acute Aquatic - Invertebrate** -96-hr EC_{50} *Daphnia magna* - 18,620 mg/L -48-hr EC_{50} *Daphnia magna* - >10,000 mg/L **Acute Aquatic - Algae and other aquatic plants** -96-hr EC_{50} *Selenastrum capricornutum* -~22,000 mg/L -10-14 d EC_{50} *Chlorella pyrenoidosa* - 28,400 mg/L **Chronic Aquatic** -No chronic studies available **Terrestrial Toxicity** 35-d EC_{50} Earthworm *Eisenia fetida* - 17,199 mg/kg soil dry weight 63-d EC_{50} Earthworm *Eisenia fetida* - 26,646 mg/kg soil dry weight 28-d EC_{25} *Folsomia candida* - 2,842 mg/kg soil dry weight (test results) 28-d NOEC (reproduction) *Folsomia candida* - 1,000 mg/kg soil dry weight (derived graphically) 14-d EC_{50} *Hordeum vulgare* - 15,492 mg/kg soil dry weight 14-d NOEC (seedline emergence) *Hordeum vulgare* - 12,000 mg/kg soil dry weight (derived graphically) 14-d EC_{25} *Hordeum vulgare* - 2,538 mg/kg soil dry weight (test results) 14-d NOEC (shoot dry mass) *Hordeum vulgare* - 1,555 mg/kg soil dry weight (derived graphically) 14-d EC_{25} *Hordeum vulgare* - 2,823 mg/kg soil dw (test results) 14-d NOEC (root dry mass) *Hordeum vulgare* - 2,592 mg/kg soil dw (derived graphically) 14-d EC_{25} *Hordeum vulgare* - 4,885 mg/kg soil dw (test results) 14-d NOEC (shoot length) *Hordeum vulgare* - 2,592 mg/kg soil dw (derived graphically) 14-d EC_{25} *Hordeum vulgare* - 5,752 mg/kg soil dw (test results) 14-d NOEC (rott length length) *Hordeum vulgare* - 4,320 mg/kg soil dw (derived graphically) **$PNEC_{water}$** - 10 mg/L (Acute *Daphnia)* **$PNEC_{soil}$** - 100 mg/kg soil dry weight (equilibrium partitioning method)	Qualitative Assessment: Human Health Hazard - Low concern if used at <3% Ecological Hazard - Low concern PBT Assessment: Substance exhibits lower toxicity than that established by regulatory guidance.	Environmental Fate Properties: Readily biodegradable PBT Assessment: Does not meet the screening criteria for persistence.	Environmental Fate Properties: -Calculated log K_{ow} - 1.36 -BCF in *Cyprinus carpio* 1.0, BCF *Leuciscus idus* <10 PBT Assessment: Does not meet the criteria for bioaccumulation.	Tier 1 (NICNAS/ Qualitative Assessment/ PBT)	NICNAS Assessment (2018) Human Health - potentially harmful to public in event of transport spill or pond leak - potentially harmful to workers when mixing and/or cleaning or in event of industrial accident Environment -unlikely to cause harm to environment PBT Assessment: The overall conclusion is that methanol is not a PBT substance. Qualitative assessment indicated low concern to human health The estimated injected concentration did not exceed the ecotoxicity values or PNECs for this chemical. This chemical is readily biodegradable, does not bioaccumulate, and does not meet the PBT assessment criteria for toxicity. Therefore, a Tier 2 assessment was not warranted. Management: Australia SafeWork Place and Condor Occupational Safety Guidance will be used to minimise human health exposure. Therefore, a Tier 2 assessment was not warranted.	NA

Table 1
Evaluation of Compiled List of Chemicals
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Chemical Name	CAS Number	Density (kg/m^3)	Chemical Mass in Fluid (kg)	Concentration in Injected Fluid (mg/L)	Ecotoxicity	Toxicity	Biodegradation	Bioaccummulative	Screening	Discussion	Outcome of Tier 2 Assessment
Sodium (C14-16) olefin sulfonate	68439-57-6	1054	4910	146.68	**Aquatic Toxicity** **Acute Aquatic - Fish** -96-hr LC_{50} *Danio rerio* (Zebra Fish) - 4.2 mg/L **Acute Aquatic - Invertebrate** -48-hr EC_{50} *Ceriodaphnia dubia* - 4.53 mg/L **Acute Aquatic - Algae** -72-hr EC_{50} *Skeletonema costatum* - 5.2 mg/L **Chronic Aquatic - Invertebrate** -21-day NOEC *Daphnia magna* -6.3 mg/L -21-day NOEC *Daphnia magna* -2.42 mg/L **$PNEC_{water}$** - 0.08 mg/L (Acute Fish) **$PNEC_{soil}$** - 0.002 mg/kg dry weight soil (equilibrium partitioning method)	Qualitative Assessment: Human Health Hazard - Low concern Ecological Hazard - Low concern PBT Assessment: Substance exhibits lower toxicity than that established by regulatory guidance.	Environmental Fate Properties: Readily biodegradable PBT Assessment: Does not meet the screening criteria for persistence.	Environmental Fate Properties: -Measured log K_{ow} -1.3 PBT Assessment: Does not meet the criteria for bioaccumulation.	Tier 1 (Qualitative/PBT/Exposure Assessment)	PBT Assessment: The overall conclusion is that Sodium (C14-16) olefin sulfonate is not a PBT substance. Qualitative Assessment indicated low concern to human health. The estimated injected concentration did exceed the ecotoxicity values or PNECs for this chemical. However, this chemical is readily biodegradable and does not bioaccumulate. Additionally, the potential exposure to aquatic receptors is considered incomplete (refer to text). Therefore, a Tier 2 assessment was not warranted. Management: Implementation of Constraints Protocol in EMP will be required to prevent accidental discharge/release. Therefore, a Tier 2 assessment was not warranted.	NA
Diisobutyl glutarate	71195-64-7	966	606	19.75	**Aquatic Toxicity** **Acute Aquatic - Fish** -96-hr LC_{50} *Oryzias latipes* - 3.7 mg/L **Acute Aquatic - Invertebrate** -24-hr LC_{50} *Daphnia magna* - 17 mg/L **Acute Aquatic - Algae** -72-hr EC_{50} *Selenastrum sp* . - 2.8 mg/L **Chronic Aquatic - Invertebrate** -21-day NOEC *Daphnia magna* 5.6 mg/L **Chronic- Algae** -72-hr NOEC *Selenastrum capricornutum* - 2mg/L **Terrestrial Toxicity** No data available. **$PNEC_{water}$** - 0.04 mg/L (Acute Fish) **$PNEC_{soil}$** - 0.13 mg/kg dry weight soil (equilibrium partitioning method)	Qualitative Assessment: Human Health Hazard - Low concern Ecological Hazard - Low concern PBT Assessment: Substance exhibits lower toxicity than that established by regulatory guidance.	Environmental Fate Properties: Readily biodegradable PBT Assessment: Does not meet the screening criteria for persistence.	Environmental Fate Properties: -Measured log K_{ow} -4.3 PBT Assessment: Does not meet the criteria for bioaccumulation.	Tier 1 (Qualitative/PBT/Exposure Assessment)	PBT Assessment: The overall conclusion is that Diisobutyl glutarate is not a PBT substance. Qualitative Assessment indicated low concern to human health. The estimated injected concentration did exceed the ecotoxicity values or PNECs for this chemical. However, this chemical is readily biodegradable and does not bioaccumulate. Additionally, the potential exposure to aquatic receptors is considered incomplete (refer to text). Therefore, a Tier 2 assessment was not warranted. Management: Implementation of Constraints Protocol in EMP will be required to prevent accidental discharge/release. Therefore, a Tier 2 assessment was not warranted.	NA
Diisobutyl succinate	925-06-4	978	204	6.58	**Aquatic Toxicity** **Acute Aquatic - Fish** -96-hr LC_{50} *Oryzias latipes* - 3.7 mg/L **Acute Aquatic - Invertebrate** -24-hr LC_{50} *Daphnia magna* - 17 mg/L **Acute Aquatic - Algae** -72-hr EC_{50} *Selenastrum sp* . - 2.8 mg/L **Chronic Aquatic - Invertebrate** -21-day NOEC *Daphnia magna* 5.6 mg/L **Chronic- Algae** -72hr NOEC *Selenastrum capricornutum* - 2 mg/L **Terrestrial Toxicity** No data available. **$PNEC_{water}$** - 0.04 mg/L (Acute Fish) **$PNEC_{soil}$** - 0.13 mg/kg dry weight soil (equilibrium partitioning method)	Qualitative Assessment: Human Health Hazard - Low concern Ecological Hazard - Low concern PBT Assessment: Substance exhibits lower toxicity than that established by regulatory guidance.	Environmental Fate Properties: Readily biodegradable PBT Assessment: Does not meet the screening criteria for persistence.	Environmental Fate Properties: -Measured log K_{ow} -4.3 PBT Assessment: Does not meet the criteria for bioaccumulation.	Tier 1 (Qualitative/PBT/Exposure Assessment)	PBT Assessment: The overall conclusion is that Diisobutyl succinate is not a PBT substance. Qualitative Assessment indicated low concern to human health. The estimated injected concentration did exceed the ecotoxicity values or PNECs for this chemical. However, this chemical is readily biodegradable and does not bioaccumulate. Additionally, the potential exposure to aquatic receptors is considered incomplete (refer to text). Therefore, a Tier 2 assessment was not warranted. Management: Implementation of Constraints Protocol in EMP will be required to prevent accidental discharge/release. Therefore, a Tier 2 assessment was not warranted.	NA

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Condor Energy Northern Territory Tenement - Chemical Risk Assessment

Chemical Name	CAS Number	Density (kg/m^3)	Chemical Mass in Fluid (kg)	Concentration in Injected Fluid (mg/L)	Ecotoxicity	Toxicity	Biodegradation	Bioaccummulative	Screening	Discussion	Outcome of Tier 2 Assessment
Diisobutyl adipate	141-04-8	951	170	5.64	**Aquatic Toxicity** **Acute Aquatic - Fish** -96-hr LC_{50} *Oryzias latipes* - 3.7 mg/L **Acute Aquatic - Invertebrate** -24-hr LC_{50} *Daphnia magna* - 17 mg/L **Acute Aquatic - Algae** -72-hr EC_{50} *Selenastrum sp* . - 2.8 mg/L **Chronic Aquatic - Invertebrate** -21-day NOEC *Daphnia magna* 5.6 mg/L **Chronic- Algae** -72hr NOEC *Selenastrum capricornutum* - 2 mg/L **Terrestrial Toxicity** No data available. **$PNEC_{water}$** - 0.04 mg/L (Acute Fish) **$PNEC_{soil}$** - 0.13 mg/kg dry weight soil (equilibrium partitioning method)	Qualitative Assessment: Human Health Hazard - Low concern Ecological Hazard - Low concern PBT Assessment: Substance exhibits lower toxicity than that established by regulatory guidance.	Environmental Fate Properties: Readily biodegradable PBT Assessment: Does not meet the screening criteria for persistence.	Environmental Fate Properties: -Measured log K_{ow} -4.3 PBT Assessment: Does not meet the criteria for bioaccumulation.	Tier 1 (Qualitative/PBT/Exposure Assessment)	PBT Assessment: The overall conclusion is that Diisobutyl adipate is not a PBT substance. Qualitative Assessment indicated low concern to human health. The estimated injected concentration did exceed the ecotoxicity values or PNECs for this chemical. However, this chemical is readily biodegradable and does not bioaccumulate. Management: Implementation of Constraints Protocol in EMP will be required to prevent accidental discharge/release. Therefore, a Tier 2 assessment was not warranted.	NA
Sodium Gluconate	527-07-1	1790	15351	270.07	**Aquatic Toxicity** **Acute Aquatic - Fish** -96-hr LC_{50} *Oryzias latipes* - >100 mg/L **Acute Aquatic - Invertebrate** -48-hr EC_{50} *Daphnia magna* - >1000 mg/L **Acute Aquatic - Algae** -72-hr E_rC_{50} *Selenastrum capricornutum* - > 1000 mg/L **Chronic Aquatic - Algae** -72-hr NOEC *Selenastrum capricornutum* - 560 mg/L **Terrestrial Toxicity** No data available. **$PNEC_{water}$** - 5.6 mg/L (Acute Fish) **$PNEC_{soil}$** - not derived	Qualitative Assessment: Human Health Hazard - Low concern Ecological Hazard - Low concern PBT Assessment: Substance exhibits lower toxicity than that established by regulatory guidance.	Environmental Fate Properties: Readily biodegradable PBT Assessment: Does not meet the screening criteria for persistence.	Environmental Fate Properties: -Measured log K_{ow} -5.99 PBT Assessment: Does not meet the criteria for bioaccumulation.	Tier 1 (Qualitative/PBT/Exposure Assessment)	PBT Assessment: The overall conclusion is that Sodium Gluconate is not a PBT substance. Qualitative Assessment indicated low concern to human health. The estimated injected concentration did exceed the ecotoxicity values or PNECs for this chemical. However, this chemical is of lo ecoloical concern, readily biodegradable, and does not bioaccumulate. Additionally, the potential exposure to aquatic receptors is considered incomplete (refer to text). Therefore, a Tier 2 assessment was not warranted. Management: Implementation of Constraints Protocol in EMP will be required to prevent accidental discharge/release. Therefore, a Tier 2 assessment was not warranted.	NA
Boric Acid	10043-35-3	1489	6385	135.03	**Aquatic Toxicity** **Acute Aquatic - Fish** -96-hr LC_{50} Fathead minnow - 79.7 mg/L **Acute Aquatic - Invertebrate** -96-hr LC_{50} *Legumia recta* (Black sandshell mussel) - 147 mg/L -96-hr LC_{50} *Hyalella azteca* -64 mg/L **Acute Aquatic - Algae** -72-hr EC_{50} *Pseudokirchneriella subcapitata* - 52.4 mg/L **Chronic Aquatic - Fish** -72-hr LC_{10} *P. promelas* - 3.5-47 mg B/L -72-hr LC_{10} freshwater fish- 21.6 mg B/L -34-day NOEC (Biomass) *Danio rerio* - 1.8 mg B/L -32-day NOEC (Mortality) *Pimephales promelas* - 11 mg B/L **Chronic Aquatic- Invertebrate** -14-day NOEC (Reproduction) *Daphnia magna* - 2.4 mg B/L **Chronic Aquatic - Algae** -72-hr NOEC *Pseudokirchneriella subcapitata* - 17.5 mg B/L -4-day NOEC (Growth) *Pseudokirchneriella subcapitata* -2.8 mg B/L **Terrestrial Toxicity** No data available. **$PNEC_{water}$** - 940 µg/L (ANZG water quality guideline) **$PNEC_{soil}$** - 5.7 mg/kg soil dry weight	Qualitative Assessment: Human Health Hazard - Low concern Ecological Hazard - Low concern PBT Assessment: Substance exhibits lower toxicity than that established by regulatory guidance.	Environmental Fate Properties: Dissociates completely PBT Assessment: Not applicable for this inorganic compound	Environmental Fate Properties: -BCF <0.1-10.5 L/kg (reported for borates in fish and oysters). PBT Assessment: Does not meet the criteria for bioaccumulation.	Tier 1 (Qualitative/PBT/Exposure Assessment)	PBT Assessment: The overall conclusion is that Boric Acid is not a PBT substance. Qualitative Assessment indicated low concern to human health. The estimated injected concentration did exceed the ecotoxicity values or PNECs for this chemical. However, this chemical dissociates completely and it does not bioaccumulate. Additionally, the potential exposure to aquatic receptors is considered incomplete (refer to text). Therefore, a Tier 2 assessment was not warranted. Management: Implementation of Constraints Protocol in EMP will be required to prevent accidental discharge/release. Therefore, a Tier 2 assessment was not warranted.	NA

Table 1
Evaluation of Compiled List of Chemicals
Condor Energy Northern Territory Tenement - Chemical Risk Assessment

Chemical Name	CAS Number	Density (kg/m^3)	Chemical Mass in Fluid (kg)	Concentration in Injected Fluid (mg/L)	Ecotoxicity	Toxicity	Biodegradation	Bioaccummulative	Screening	Discussion	Outcome of Tier 2 Assessment
Potassium Hydroxide	1310-58-3	2044	21963	338.37	**Aquatic Toxicity** **Acute Aquatic - Fish** -96-hr LC_{50} *Gambusia affinis* (mosquito fish) - 80 mg/L -96-hr LC_{50} *Gambusia affinis* (mosquito fish)- 125 mg/L -24-hr LC_{50} *Carassius auratus* (goldfish)-160 mg/L -48-hr LC_{50} *Leuciscus idus melanotus* - 189 mg/L **Acute Aquatic - Invertebrate** -48-hr LC_{50} *Ceriodaphnia cf. dubia* - 40 mg/L **Chronic Toxicity** No studies available **Terrestrial Toxicity** No data available. **$PNEC_{water}$** - not derived **$PNEC_{soil}$** - not derived	Qualitative Assessment: Human Health Hazard - Limited toxicity Ecological Hazard - Low concern PBT Assessment: Substance exhibits lower toxicity than that established by regulatory guidance.	Environmental Fate Properties: Readily biodegradable-dissociates completely PBT Assessment: Criteria is not applicable for the inorganic ions.	Environmental Fate Properties: Essential to all living organisms. PBT Assessment: Does not meet the criteria for bioaccumulation.	Tier 1 (Qualitative Assessment/PBT)	PBT Assessment: The overall conclusion is that Potassium Hydroxide is not a PBT substance. Qualitative Assessment indicated low concern to human health. The estimated injected concentration did exceed the ecotoxicity values or PNECs for this chemical. However, this chemical dissociates completely and does not bioaccumulate. Management: No additional management required, Tier 1 screening satisfied.	NA
Mannanase	37288-54-3	1420	3	0.07	**Aquatic Toxicity** **Acute Aquatic - Fish** -96-hour LC50 *Oncorhynchus mykiss* (rainbow trout) - >105.8 mg/L **Acute Aquatic - Invertebrate** -48-hour EC50 *Daphnia Magna* - >105.8 mg/L **Acute Aquatic-Algae** -72-hour EC50 *Raphidocelis subcapitata* (green algae) - >105.8 mg/L **Chronic Toxicity** -72 hr NOEC - *Raphidocelis subcapitata* - 26.5 mg/L **Terrestrial Toxicity** No studies available **$PNEC_{water}$** - 0.139 mg/L **$PNEC_{soil}$** - 0.002 mg/kg soil dry weight (equilibrium partitioning method)	Qualitative Assessment: Human Health Hazard - low concern Ecological Hazard - low acute and chronic toxicity PBT Assessment: Substance exhibits lower toxicity than that established by regulatory guidance.	Environmental Fate Properties: Readily biodegradable PBT Assessment: Does not meet the screening criteria for persistence	Environmental Fate Properties: Log K_{ow} = -1.3 PBT Assessment: Does not meet the criteria for bioaccumulation	Tier 1 (Qualitative Assessment/PBT)	PBT Assessment: The overall conclusion is that Mannanase is not a PBT substance. Qualitative Assessment indicated low concern to human health. The estimated injected concentration did not exceed the ecotoxicity values or PNECs for this chemical. In addition, this chemical is readily biodegradable and does not bioaccumulate. Management: No additional management required, Tier 1 screening satisfied.	NA
Sodium Bromate	7789-38-0	3339	168421	1588.39	**Aquatic Toxicity** **Acute Aquatic - Fish** -96-hour LC_{50} *Morone saxatillis* (striped bass) - 30.8 mg/L -48-hour LC_{50} *Morone saxatillis* (striped bass) - 605.0 mg/L -24-hour LC_{50} *Leiostomus xanthurus* -698.0 mg/L **Chronic Toxicity** -10-day LC_{50} *Morone saxatillis* (striped bass) - 92.6 mg/L -10-day LC_{50} *Leiostomus xanthurus* - 278.6 mg/L **Terrestrial Toxicity** No studies available **$PNEC_{water}$** - 0.308 mg/L **$PNEC_{soil}$** - NA	Qualitative Assessment: Human Health Hazard - moderate concern Ecological Hazard - low acute and chronic toxicity concern to aquatic organisms PBT Assessment: Substance exhibits lower toxicity than that established by regulatory guidance.	Environmental Fate Properties: Dissociates completely PBT Assessment: Does not meet screening criteria for persistence	Environmental Fate Properties: Low K_{ow} value PBT Assessment: Does not meet the criteria for bioaccumulation	Tier 1 (Qualitative/PBT/Exposure Assessment)	PBT Assessment: The overall conclusion is that Sodium bromate is not a PBT substance. Qualitative Assessment indicated moderate concern to human health. The estimated injected concentration did exceed the ecotoxicity values or PNECs for this chemical. However, this chemical dissociates completely and does not bioaccumulate. Additionally, the potential exposure to aquatic receptors is considered incomplete (refer to text). Therefore, a Tier 2 assessment was not warranted. Management: Implementation of Constraints Protocol in EMP will be required to prevent accidental discharge/release. Therefore, a Tier 2 assessment was not warranted.	NA

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Condor Energy Northern Territory Tenement - Chemical Risk Assessment

Chemical Name	CAS Number	Density (kg/m^3)	Chemical Mass in Fluid (kg)	Concentration in Injected Fluid (mg/L)	Ecotoxicity	Toxicity	Biodegradation	Bioaccummulative	Screening	Discussion	Outcome of Tier 2 Assessment
Hepta sodium phosphonate	22042-96-2	1400	4446	100.00	**Aquatic Toxicity** **Acute Aquatic - Fish** -96-hr LC_{50} *Gambusia affinis* (mosquito fish) - 180-252 (mean:216) mg active/L **Acute Aquatic - Invertebrate** -48-hr EC_{50} *Chironomus tentans* - 7,589 mg active/L **Chronic Toxicity** -60-day NOEC *Oncorhynchus mykiss* - 25.6 mg active acid/L **Terrestrial Toxicity** -14-day LC_{50} Mallard duck (*Anas platyrhynchos*)- >454 mg/kg -14-day LC_{50} Bobwhite quail (*Colunus virginianus*)- >454 mg/kg **$PNEC_{water}$** - 0.31 mg DTPMP sodium salt/L **$PNEC_{soil}$** - 40 mg DTPMP sodium salt/kg soil dry	Qualitative Assessment: Human Health Hazard - Low toxicity Ecological Hazard - Low concern PBT Assessment: Substance exhibits lower toxicity than that established by regulatory guidance.	Environmental Fate Properties: Not readily biodegradable PBT Assessment: Does not meet the screening criteria for persistence.	Environmental Fate Properties: BCF values in fish studies are <10 and <94 for concentrations 18.8 and 2.03 mg/L respectively PBT Assessment: Does not meet the criteria for bioaccumulation.	Tier 1 (Qualitative Assessment/PBT/Exposure Assessment)	PBT Assessment: The overall conclusion is that hepta sodium phosphonate is not a PBT substance. Qualitative Assessment indicated low concern to human health. The estimated injected concentration did exceed the ecotoxicity values or PNECs for this chemical and is not readily biodegradable. However, this chemical is of low ecological concern and does not bioaccumulate. Additionally, the potential exposure to aquatic receptors is considered incomplete (refer to text). Management: Implementation of Constraints Protocol in EMP will be required to prevent accidental discharge/release. No additional management required, Tier 1 screening satisfied.	NA
Polyoxyethylene nonylphenol ether	9016-45-9	1050	4690	140.65	**Aquatic Toxicity** **Acute Aquatic - Fish** -96-hr LC_{50} *Pimephales promelas* - 0.218 mg/L -96-hr LC_{50} *Lepomis macrochirus* - 1.3 mg/L **Acute Aquatic - Invertebrate** -48-hr EC_{50} *Ceriodaphnia dubia* - 0.328 mg/L -48-hr LC_{50} *Daphnia* - 1.8 mg/L **Acute Aquatic- Algae** -48-hr EC_{50} *Pseudokirchneriella subcapitata* - 20-50 mg/L **Chronic Toxicity-Fish** -21-day NOEC *Oncorhynchus mykiss* - 0.048 mg/L -7-day NOEC *Ceriodaphnia dubia* - 0.285 mg/L **Chronic Toxicity- Invertebrates** -6-day NOEC *Daphnia Magna* - 1.0 mg/L **Chronic Toxicity-Algae** -96-hr NOEC *Pseudokirchneriella subcapitata* - 8 mg/L -120-hr (5 day) EC_{50} *Scenedesmus Opoliensis* - 37.4 mg/L **Terrestrial Toxicity** No data available. **$PNEC_{water}$**- 0.00096 mg/L **$PNEC_{soil}$** - not derived	Qualitative Assessment: Human Health Hazard - Low to moderate toxicity Ecological Hazard - moderate concern PBT Assessment: Substance exhibits lower toxicity than that established by regulatory guidance.	Environmental Fate Properties: Readily biodegradable PBT Assessment: Does not meet the screening criteria for persistence.	Environmental Fate Properties: BCF values in fish studies are <1.4 L/Kg PBT Assessment: Does not meet the criteria for bioaccumulation.	Tier 1 (Qualitative Assessment/PBT Exposure Assessment)	PBT Assessment: The overall conclusion is that Polyoxyethylene nonylphenol ether is not a PBT substance. Qualitative Assessment indicated low concern to human health. The estimated injected concentration did exceed the ecotoxicity values or PNECs for this chemical. However, this chemical is readily biodegradable and does not bioaccumulate. Additionally, the potential exposure to aquatic receptors is considered incomplete (refer to text). Therefore, a Tier 2 assessment was not warranted. Management: Implementation of Constraints Protocol in EMP will be required to prevent accidental discharge/release. Therefore, a Tier 2 assessment was not warranted.	NA

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Chemical Name	CAS Number	Density (kg/m^3)	Chemical Mass in Fluid (kg)	Concentration in Injected Fluid (mg/L)	Ecotoxicity	Toxicity	Biodegradation	Bioaccummulative	Screening	Discussion	Outcome of Tier 2 Assessment
Quaternary ammonium compounds, bis(hydrogenated tallow alkyl)dimethyl, salts with bentonite	68953-58-2	NA	NA	140.65	**Aquatic Toxicity** **Acute Aquatic - Fish** -96-hr LC_{50} Freshwater rainbow trout- > ca. 500 mg/L **Acute Aquatic - Invertebrate** -48-hr EC_{50} *Daphnia magna* - > 100 mg/L -96-hr EC_{50} *Daphnia magna* - 300 mg/L -48-hr EC_{50} *Daphnia magna* - <500 mg/L -72-hr EC_{50} *Skeletonema costatum* - 23.8 mg/L -72-hr EC_{50} *Skeletonema costatum* - 82.3 mg/L -72-hr EC_{50} *Skeletonema coastatum* - >1,000 mg/L **Acute Aquatic- Algae** -72-hr EC_{50} *Scenedesmus subspicatus* - >100 mg/L **Chronic Toxicity** -21-day NOEC *Daphnia magna* - 3.2 mg/L -72-hour NOEC *Scenedesmus subspicatus* - 100 mg/L **Terrestrial Toxicity** -14-day NOEC earthworms- 1000 mg/kg -14-day LC_{50} earthworms- >1000 mg/kg -EC_{50} *Tritium gestivum* - >100 mg/kg -EC_{50} *Raphanus sativus* ->100 mg/kg -NOEC *Tritium gestivum* - 100 mg/kg -NOEC *Raphanus sativus* - 100 mg/kg -LC_{50} *Lepidum sativum* - 9 mg/kg -LOEC *Lepidum sativum* - 1 mg/kg **$PNEC_{water}$** - 0.064 mg/L **$PNEC_{soil}$** - not derived	Qualitative Assessment: Human Health Hazard - Low toxicity Ecological Hazard - low concern PBT Assessment: Substance exhibits lower toxicity than that established by regulatory guidance.	Environmental Fate Properties: Not readily biodegradation PBT Assessment: Does not meet the screening criteria for persistence.	Environmental Fate Properties: Insoluble in water and is not bioavailable PBT Assessment: Does not meet the criteria for bioaccumulation.	Tier 1 (Qualitative/PBT/Exposure Assessment)	PBT Assessment: The overall conclusion is that Quaternary ammonium compounds, bis(hydrogenated tallow alkyl)dimethyl, salts with bentonite is not a PBT substance. Qualitative Assessment indicated low concern to human health. The estimated injected concentration did exceed the ecotoxicity values or PNECs for this chemical and is not readily biodegradable. However, this chemical of low ecological conern, is insoluble in water and does not bioaccumulate. Additionally, the potential exposure to aquatic receptors is considered incomplete (refer to text). Therefore, a Tier 2 assessment was not warranted. Management: Implementation of Constraints Protocol in EMP will be required to prevent accidental discharge/release. Therefore, a Tier 2 assessment was not warranted.	NA
1,6-Hexanediol	629-11-8	960	429	14.06	**Aquatic Toxicity** **Acute Aquatic - Fish** -96-hr LC_{50} *Leuciscus idus* - 4,460-10,000 mg/L **Acute Aquatic - Invertebrate** -48-hr EC_{50} *Daphnia magna* - >500 mg/L **Acute Aquatic-Algae** -72-hr EC_{50} *Desmodesmus subspicatus* - 5,940 mg/L **Chronic Toxicity** -72h EC_{10} *Desmodesmus subspicatus* - 1,180 mg/L -96h NOEC *Leuciscus idus* - 2,200 mg/L **Terrestrial Toxicity** -EC_{50} *Psudomonas putida* - >10,000 mg/L **$PNEC_{water}$** - 50 mg/L **$PNEC_{soil}$** - 0.67 mg/L	Qualitative Assessment: Human Health Hazard - Low toxicity Ecological Hazard - low concern PBT Assessment: Substance exhibits lower toxicity than that established by regulatory guidance.	Environmental Fate Properties: Readily biodegradable PBT Assessment: Does not meet the screening criteria for persistence.	Environmental Fate Properties: Log K_{ow} is low. PBT Assessment: Does not meet the criteria for bioaccumulation.	Tier 1 (NICNAS/ Qualitative Assessment/PBT/Exposure Assessment)	NICNAS has assessed sodium benzoate in an IMAP Tier 1 assessment and concluded that it poses no unreasonable risk to the environment (NICNAS, 2019). PBT Assessment: The overall conclusion is that 1,6 Hexanediol is not a PBT substance. Qualitative Assessment indicated low concern to human health. The estimated injected concentration did not exceed the ecotoxicity values or PNECs for this chemical. In addition, this chemical is readily biodegradable and does not bioaccumulate. Additionally, the potential exposure to aquatic receptors is considered incomplete (refer to text). Therefore, a Tier 2 assessment was not warranted. Management: Implementation of Constraints Protocol in EMP will be required to prevent accidental discharge/release. Therefore, a Tier 2 assessment was not warranted.	NA
Sodium erythorbate	6381-77-7	1702	568	10.51	**Aquatic Toxicity** **Acute Aquatic - Fish** -96-hr LC_{50} *Oncorhynchus mykiss* - >100 mg/L **Acute Aquatic - Invertebrate** -48-hr EC_{50} *Daphnia magna* - >100 mg/L **Acute Aquatic-Algae** -72-hr EC_{50} *Raphidocelis subcapitata* - >160 mg/L **Chronic Toxicity** - 72-hr NOEC - *Raphidocelis subcapitata* - 20 mg/L **Terrestrial Toxicity** No data available. **$PNEC_{water}$** - 0.2 mg/L **$PNEC_{soil}$** - 0.027 mg/kg soil dry weight (equilibrium partitioning method)	Qualitative Assessment: Human Health Hazard - low concern Ecological Hazard - low concern PBT Assessment: Substance exhibits lower toxicity than that established by regulatory guidance.	Environmental Fate Properties: Inherently Biodegradable PBT Assessment: Does not meet the screening criteria for persistence.	Environmental Fate Properties: -log K_{ow} - -3.29 and estunated BCF (0.8933). PBT Assessment: Does not meet the criteria for bioaccumulation.	Tier 1 (Qualitative Assessment/PBT)	PBT Assessment: The overall conclusion is that Sodium erythorbate is not a PBT substance. Qualitative Assessment indicated low concern to human health. The estimated injected concentration did exceed the ecotoxicity values or PNECs for this chemical. However, this chemical is inherently biodegradable and does not bioaccumulate. Additionally, the potential exposure to aquatic receptors is considered incomplete (refer to text). Therefore, a Tier 2 assessment was not warranted. Management: Implementation of Constraints Protocol in EMP will be required to prevent accidental discharge/release. Therefore, a Tier 2 assessment was not warranted.	NA

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Chemical Name	CAS Number	Density (kg/m^3)	Chemical Mass in Fluid (kg)	Concentration in Injected Fluid (mg/L)	Ecotoxicity	Toxicity	Biodegradation	Bioaccummulative	Screening	Discussion	Outcome of Tier 2 Assessment
Ethoxylated Decanol	26183-52-8	880	17	0.6	**Aquatic Toxicity** **Acute Aquatic - Fish** -96-hr LC_{50} *Cyprinus carpio and Danio rerio* - 1.2 mg/L **Acute Aquatic - Invertebrate** -48-hr EC_{50} *Daphnia magna* - 0.39 mg/L to 0.91 mg/L **Acute Aquatic-Algae** -72-hr EC_{50} *Desmodesmus subspicatus* - 0.18 mg/L to 1.8 mg/L (growth rate) **Chronic Toxicity** - 10-day NOEC *Lepomis macrochirus* - 0.16 mg/L -30-day NOEC *Lepomis macrochirus* - > 0.33 mg/L -21-day NOEC - *Daphnia magna* - 0.77 mg/L -72-hr NOEC *Desmodesmus subspicatus* - 0.4 mg/L **Terrestrial Toxicity** -NOEL *Eisenia fetida* - >1,000 mg/kg soil dry weight (acute toxicity) **$PNEC_{water}$** - 0.016 mg/L **$PNEC_{soil}$** - 1 mg/kg soil dry weight (acute toxicity study)	Qualitative Assessment: Human Health Hazard - Low acute toxicity Ecological Hazard - moderately toxic to aquatic organisms PBT Assessment: Substance exhibits lower toxicity than that established by regulatory guidance.	Environmental Fate Properties: Readily Biodegradable PBT Assessment: Does not meet the screening criteria for persistence.	Environmental Fate Properties: Measured log K_{ow} 3.51 PBT Assessment: Does not meet the screening criteria for bioaccumulation	Tier 1 (Qualitative Assessment/PBT/Exposure Assessment)	PBT Assessment: The overall conclusion is that Ethoxylated Decanol is not a PBT substance. Qualitative Assessment indicated low concern to human health. The estimated injected concentration did exceed the ecotoxicity values or PNECs for this chemical. However, this chemical is readily biodegradable and does not bioaccumulate. Additionally, the potential exposure to aquatic receptors is considered incomplete (refer to text). Therefore, a Tier 2 assessment was not warranted. Management: Implementation of Constraints Protocol in EMP will be required to prevent accidental discharge/release. Therefore, a Tier 2 assessment was not warranted.	NA
Ethoxylated Tallow Alkyl Amine	61791-26-2	958	9	0.3	**Aquatic Toxicity** **Acute Aquatic - Fish** -96-hr LL_{50} *Danio rerio* - >100 mg/L **Acute Aquatic - Invertebrate** -48-hr LL_{50} *Daphnia magna* - 12.41 mg/L **Acute Aquatic-Algae** -72-hr LL_{50} *Pseudokirchnerella subcapitata* - 39.7 mg/L **Chronic Toxicity** Algae - 72-hr EC_{10} - 7.08 mg/L **Terrestrial Toxicity** No studies available **$PNEC_{water}$** - 0.071 mg/L **$PNEC_{soil}$** - 3.14 mg/kg soil dry weight (Equilibrium partitioning method)	Qualitative Assessment: Human Health Hazard - low toxicity Ecological Hazard - low acute aquatic toxicity PBT Assessment: Substance exhibits lower toxicity than that established by regulatory guidance	Environmental Fate Properties: Readily biodegradable PBT Assessment: Does not meet the screening criteria for persistence.	Environmental Fate Properties Structure indicates no potential for bioaccumulation PBT Assessment: Does not meet the screening criteria for bioaccumulation.	Tier 1 (Qualitative Assessment/PBT/Exposure Assessment)	PBT Assessment: The overall conclusion is that Ethoxylated Tallow Alkyl Amine is not a PBT substance. Qualitative Assessment indicated low concern to human health. The estimated injected concentration did exceed the ecotoxicity values or PNECs for this chemical. However, this chemical is readily biodegradable and does not bioaccumulate. Additionally, the potential exposure to aquatic receptors is considered incomplete (refer to text). Therefore, a Tier 2 assessment was not warranted. Management: Implementation of Constraints Protocol in EMP will be required to prevent accidental discharge/release. Therefore, a Tier 2 assessment was not warranted.	NA
Polyoxyethylene glycol trimethylnonyl ether	127087-87-0	1050	91	2.73	**Aquatic Toxicity** **Acute Aquatic - Fish** -96-hr LC_{50} *Pimephales promelas* - 0.218 mg/L -96-hr LC_{50} *Lepomis macrochirus* - 1.3 mg/L **Acute Aquatic - Invertebrate** -48-hr EC_{50} *Ceriodaphnia dubia* - 0.328 mg/L -48-hr LC_{50} *Daphnia* - 1.8 mg/L **Acute Aquatic- Algae** -48-hr EC_{50} *Pseudokirchneriella subcapitata* - 20-50 mg/L **Chronic Toxicity-Fish** -21-day NOEC *Oncorhynchus mykiss* - 0.048 mg/L -7-day NOEC *Ceriodaphnia dubia* - 0.285 mg/L **Chronic Toxicity- Invertebrates** -6-day NOEC *Daphnia Magna* - 1.0 mg/L **Chronic Toxicity-Algae** -96-hr NOEC *Pseudokirchneriella subcapitata* - 8 mg/L -120-hr (5 day) EC_{50} *Scenedesmus Opoliensis* - 37.4 mg/L **Terrestrial Toxicity** No data available. **$PNEC_{water}$-** 0.00096 mg/L **$PNEC_{soil}$** - not derived	Qualitative Assessment: Human Health Hazard - Low to moderate toxicity Ecological Hazard - moderate concern PBT Assessment: Substance exhibits lower toxicity than that established by regulatory guidance.	Environmental Fate Properties: Readily biodegradable PBT Assessment: Does not meet the screening criteria for persistence.	Environmental Fate Properties: BCF values in fish studies are <1.4 L/Kg PBT Assessment: Does not meet the criteria for bioaccumulation.	Tier 1 (Qualitative/PBT/Exposure Assessment)	PBT Assessment: The overall conclusion is that Polyoxyethylene nonylphenol ether is not a PBT substance. Qualitative Assessment indicated low concern to human health. The estimated injected concentration did exceed the ecotoxicity values or PNECs for this chemical. However, this chemical is readily biodegradable and does not bioaccumulate. Additionally, the potential exposure to aquatic receptors is considered incomplete (refer to text). Therefore, a Tier 2 assessment was not warranted. Management: Implementation of Constraints Protocol in EMP will be required to prevent accidental discharge/release. Therefore, a Tier 2 assessment was not warranted.	NA

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Condor Energy Northern Territory Tenement - Chemical Risk Assessment

Chemical Name	CAS Number	Density (kg/m^3)	Chemical Mass in Fluid (kg)	Concentration in Injected Fluid (mg/L)	Ecotoxicity	Toxicity	Biodegradation	Bioaccummulative	Screening	Discussion	Outcome of Tier 2 Assessment
Potassium Sorbate Food Grade	24634-61-5	1360	20	0.45	**Aquatic Toxicity** **Acute Aquatic - Fish** -96-hr LC_{50} *Danio rerio* - >500 mg/L (mortality) to > 1250 mg/L (mortality) -96-hr LC_{50} *Oncorhynchus mykiss* - >1000 mg/L **Acute Aquatic - Invertebrate** -48-hr EC_{50} *Daphnia magna* - 750 mg/L to 982 mg/L (mobility) **Acute Aquatic-Algae** -72-hr EC_{50} *Desmodesmus subspicatus* - 480 mg/L (growth rate) **Chronic Toxicity** -72-hr NOEC *Desmodesmus subspicatus* - 8.46 mg/L -21-d NOEC *Daphnia magna* - 50 mg/L **Terrestrial Toxicity** -14-day LC_{50} *Eisenia fetida* - 864 mg/kg soil dry weight -14-day NOEC *Eisenia fetida* - 582 mg/kg soil dry weight -31-day NOEC *Brassica rapa* - >100 mg/kg soil dry weight -39-day NOEC *Avena sativa* - >100 mg/kg soil dry weight **$PNEC_{water}$** - 0.169 mg/L **$PNEC_{soil}$** - 1 mg/kg soil dry weight	Qualitative Assessment: Human Health Hazard - low acute toxicity Ecological Hazard - low toxicity to aquatic organisms PBT Assessment: Substance exhibits lower toxicity than that established by regulatory guidance.	Environmental Fate Properties: Readily biodegradable PBT Assessment: Does not meet the screening criteria for persistence	Environmental Fate Properties: Measured BCF in fish is 0.007 at ph 6.5 PBT Assessment: Does not meet the criteria for bioaccumulation	Tier 1 (Qualitative Assessment/PBT/Exposure Assessment)	PBT Assessment: The overall conclusion is that Potassium Sorbate Food Grade is not a PBT substance. Qualitative Assessment indicated low concern to human health. The estimated injected concentration did not exceed the ecotoxicity values or PNECs for this chemical. However, this chemical is readily biodegradable and not expected to bioaccumulate. Additionally, the potential exposure to aquatic receptors is considered incomplete (refer to text). Therefore, a Tier 2 assessment was not warranted for aquatic receptors. Management: Implementation of Constraints Protocol in EMP will be required to prevent accidental discharge/release. Therefore, a Tier 2 assessment was not warranted.	NA
Sodium Benzoate	532-32-1	1500	0	0.01	**Aquatic Toxicity** **Acute Aquatic - Fish** -96-hour LC_{50} *Pimephales promelas* - 484 mg/L (mortality) -96-hour LC_{50} *Pimephales promelas* - >100 (mortality) **Acute Aquatic - Invertebrate** -96-hour LC_{50} *Daphnia magna* - >100 mg/L (mortality) **Acute Aquatic-Algae** -72-hour EC_{50} *Raphidocelis subcapitata* - >30.5 mg/L (growth rate) **Chronic Toxicity** -72-hour EC_{10} *Raphidocelis subcapitata* - 6.5 mg/L (growth rate) -144-hour NOEC - *Danio rerio* - 10 mg/L **Terrestrial Toxicity** No studies available **$PNEC_{water}$** - 0.65 mg/L **$PNEC_{soil}$** - 0.06 mg/kg	Qualitative Assessment: Human Health Hazard - low concern Ecological Hazard - low concern PBT Assessment: Substance exhibits lower toxicity than that established by regulatory guidance.	Environmental Fate Properties: Readily biodegradable PBT Assessment: Does not meet the screening criteria for persistence.	Environmental Fate Properties: log K_{ow} - 1.88 PBT Assessment: Does not meet the criteria for bioaccumulation	Tier 1 (NICNAS/ Qualitative Assessment/ PBT)	NICNAS has assessed sodium benzoate in an IMAP Tier 1 assessment and concluded that it poses no unreasonable risk to the environment (NICNAS, 2019). PBT Assessment: The overall conclusion is that methanol is not a PBT substance. Qualitative assessment indicated low concern to human health The estimated injected concentration did not exceed the ecotoxicity values or PNECs for this chemical. This chemical is readily biodegradable, does not bioaccumulate, and does not meet the PBT assessment criteria for toxicity. Therefore, a Tier 2 assessment was not warranted. Management: No additional management required, Tier 1 screening satisfied.	NA
Formic Acid	64-18-6	1220	0.0000015	1.19	**Aquatic Toxicity** **Acute Aquatic - Fish** -96-hr LC_{50} *Brachydanio rerio* (Zebrafish) - 130 mg/L -96-hr LC_{50} *Oncorhynchus mykiss* (Rainbow trout) - 3,500 mg/L **Acute Aquatic - Invertebrate** -48-hr EC_{50} *Daphnia magna* - 365 mg/L to 540 mg/L **Acute Aquatic-Algae** -72-hr EC_{50} *Pseudokirchneriella subcapitata* - 1,240 mg/L **Chronic Toxicity** -21-d NOEC *Daphnia* - 100 mg/L **Terrestrial Toxicity** No data available **$PNEC_{water}$** -10 mg/L **$PNEC_{soil}$** - 4.13 mg/kg soil dry weight (equilibrium partitioning method)	Qualitative Assessment: Human Health Hazard - low acute toxicity Ecological Hazard - low concern PBT Assessment: Substance exhibits lower toxicity than that established by regulatory guidance.	Environmental Fate Properties: Readily biodegradable PBT Assessment: Does not meet the screening criteria for persistence	Environmental Fate Properties: Not excpected to bioaccumulate. log K_{ow}= -2.1 PBT Assessment: Does not meet the criteria for bioaccumulation	Tier 1 (NICNAS/ Qualitative Assessment/ PBT)	NICNAS has assessed formic acid in an IMAP Tier 1 assessment and concluded that it poses no unreasonable risk to the environment (NICNAS, 2019). PBT Assessment: The overall conclusion is that Formic Acid is not a PBT substance. Qualitative Assessment indicated low concern to human health. The estimated injected concentration did not exceed the ecotoxicity values or PNECs for this chemical. This chemical is readily biodegradable and does not bioaccumulate. Management: No additional management required, Tier 1 screening satisfied.	NA

Table 1
Evaluation of Compiled List of Chemicals
Condor Energy Northern Territory Tenement - Chemical Risk Assessment

Chemical Name	CAS Number	Density (kg/m^3)	Chemical Mass in Fluid (kg)	Concentration in Injected Fluid (mg/L)	Ecotoxicity	Toxicity	Biodegradation	Bioaccummulative	Screening	Discussion	Outcome of Tier 2 Assessment
Alkylpyridine Quat	68909-18-2	1104	31	0.89	**Aquatic Toxicity** **Acute Aquatic - Fish** -96-hr LC50 *Cyprinodon variegatus* - 14.1 mg/L **Acute Aquatic - Invertebrate** -48-hr EC50 *Daphnia magna* - 3.1 mg/L **Acute Aquatic-Algae** - 72-hr EC50 *Pseudokirchneriella subcapitata* - 0.47 mg/L **Chronic Toxicity** No studies available. **Terrestrial Toxicity** No studies available. **$PNEC_{water}$** - 0.00047 mg/L **$PNEC_{soil}$** - 0.0063 mg/kg soil dry weight (Equilibrium partitioning method)	Qualitative Assessment: Human Health Hazard - Skin corrosion causing skin burns and eye damage. Ecological Hazard - Exhibits significant acute and chronic aquatic toxicity PBT Assessment: Substance exhibits higher toxicity than that established by regulatory guidance.	Environmental Fate Properties: Inherently biodegradable. PBT Assessment: Does not meet the screening criteria for persistence.	Environmental Fate Properties: Not excpected to bioaccumulate. log K_{ow}= -2.1 PBT Assessment: Does not meet the criteria for bioaccumulation	Tier 1 (Qualitative Assessment/ PBT/Exposure Assessment)	PBT Assessment: The overall conclusion is that alkylpyridine quat is not a PBT substance. Qualitative Assessment indicated potential hazard to human health (e.g., skin irritant). The estimated injected concentration did exceed the ecotoxicity values or PNECs for this chemical and does meet the screening criteria for toxicity. This chemical is inherently biodegradable and does not bioaccumulate. Additionally, the potential exposure to aquatic receptors is considered incomplete (refer to text). Therefore, a Tier 2 assessment was not warranted for aquatic receptors. Management: Implementation of Constraints Protocol in EMP will be required to prevent accidental discharge/release. Australia SafeWork Place and Condor Occupational Safety Guidance will be used to minimise human health exposure. Therefore, a Tier 2 assessment was not warranted.	NA
2-Ethylhexanol PO/EO polymer	64366-70-7	NA	NA	0.3	**Aquatic Toxicity** -LC_{50}/EC_{50} > 100 mg/L for test most sensitive test species **Chronic Toxicity** No studies available. **Terrestrial Toxicity** No studies available. **$PNEC_{water}$** - 0.1 mg/L **$PNEC_{soil}$** - not derived	Qualitative Assessment: Human Health Hazard - low acute toxicity Ecological Hazard - low concern PBT Assessment: Substance exhibits lower toxicity than that established by regulatory guidance.	Environmental Fate Properties: Readily biodegradable PBT Assessment: Does not meet the screening criteria for persistence	Environmental Fate Properties: Not excpected to bioaccumulate. PBT Assessment: Does not meet the criteria for bioaccumulation	Tier 1 (ACIS/Qualitative Assessment/ PBT)	AICIS Assessment (2022): Chemical unlikely to require further regulation to manage risks to environment. PBT Assessment: The overall conclusion is that 2-Ethylhexanol PO/EO polymer is not a PBT substance. Qualitative assessment indicated low concern for human and ecological health. The estimated injected concentration did exceed the ecotoxicity values or PNECs for this chemical. However, this chemical is readily biodegradable and not expected to bioaccumulate. Therefore, given this information and the AICIS Assessment findings, a Tier 2 assessment was not warranted Management: No additional management required Tier 1 screening satisfied.	NA
Ammonium sulphate	7783-20-2	1770	7928	141.04	**Aquatic Toxicity** **Acute Aquatic - Fish** -96-hour LC_{50} *Onchorhyncus mykiss* , *Salmo gairdneri* - 53 mg/L -96-hour -LC_{50}*Prosopium williamsoni* - 57.2 mg/L **Acute Aquatic - Invertebrate** -48-hr EC_{50} *Daphnia magna* - 169 mg/L -48-hr EC_{50} *Ceriodaphnia acanthina* - 121.7 mg/L **Chronic Toxicity** -30-day EC_{10} *Lepomis macrochirus* 5.29 mg/L -10-week EC_{10} *Hyallella azteca* - 3.12 mg/L -18-day EC_{50} - *Chlorella vulgaris* - 2,700 mg/L -5-day EC_{50} - *Chlorella vulgaris* - 1,605 mg/L **Terrestrial Toxicity** No data were available **$PNEC_{water}$** - 0.312 mg/L **$PNEC_{soil}$** - not derived	Qualitative Assessment: Human Health Hazard - low concern Ecological Hazard - low concern PBT Assessment: Substance exhibits lower toxicity than that established by regulatory guidance.	Environmental Fate Properties: Dissociates completely in aqueous media PBT Assessment: Does not meet the screening criteria for persistence.	Environmental Fate Property: Log Kow is -5.1 PBT Assessment: Does not meet the screening criteria for bioaccumulation.	Tier 1 (Qualitative/PBT/Exposure Assessment)	PBT Assessment: The overall conclusion is that ammonium sulphate is not a PBT substance. Qualitative assessment indicated low concern to human health. The estimated injected concentration did exceed the ecotoxicity values or PNECs for this chemical. However, this chemical dissociates completely and does not bioaccumulate. Therefore, a Tier 2 assessment was not warranted. Management: Implementation of Constraints Protocol in EMP will be required to prevent accidental discharge/release. Therefore, a Tier 2 assessment was not warranted.	NA

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Chemical Name	CAS Number	Density (kg/m^3)	Chemical Mass in Fluid (kg)	Concentration in Injected Fluid (mg/L)	Ecotoxicity	Toxicity	Biodegradation	Bioaccummulative	Screening	Discussion	Outcome of Tier 2 Assessment
Sodium polyacrylate	9003-04-7	NA	NA	23.51	**Aquatic Toxicity** **Acute Aquatic - Fish** -96-hr LC_{50} for *Brachydanio rerio, Salmo giardneri, Leucisucus idus, and Lepomis macrhochirus* are dependent on molecular weight and range from >200 to > 10000 mg/L **Acute Aquatic - Invertebrate** -46-hr EC_{50} for *Daphnia magna* are dependent on molecular weight and range from >200 mg/L to >276 mg/L **Acute Aquatic-Algae** -72-hr EC_{50} (molecular weight of 8,000) *Selenastrum capricornutum* - 40 mg/L -96-hr EC50 (molecular weight of 78,000) *Selenastrum capricornutum* - 44 mg/L **Chronic Toxicity** Fish -32-day NOEC (molecular weight of 4,500) *Pimephales promelaas* - 56 mg/L -28-day NOEC (molecular weight of 4,500) *Brachydanio rerio* - >450 mg/L -14-day NOEC (molecular weight of 78,000) *Brachydanio rerio* - >400 mg/L Invertebrate -21-day NOEC for *Daphnia magna* dependent on molecular weight and range from > 12 to > 450 mg/L Algae -96-hr NOEC for *Scenedesmus subspicatus* are dependent on molecular weight and range from 32.8 to 180 mg/L **Terrestrial Toxicity** -14-day EC0 to *Eisenia foetida foetida* - 1,000 mg/L -14-day EC0 - *Eisenia foetida andrei* - 1,000 mg/L -21-day NOEC - *Brassica rapa* - 1,000 mg/L **PNECwater** - 1.2 mg/L **PNECsoil -** 25 mg/kg	Qualitative Assessment: Human Health Hazard - low concern Ecological Hazard - low toxicity concern for aquatic organisms, terrestrial invertebrates, and plants. PBT Assessment: Does not meet the screening criteria for toxicity.	Environmental Fate Properties: Not readily biodegradable. PBT Assessment: Does not meet the screening criteria for persistence.	Environmental Fate Property: Not expected to bioaccumulate due to their high molecular weights PBT Assessment: Does not meet the screening criteria for bioaccumulation.	Tier 1 (Qualitative/PBT/Exposure Assessment)	PBT Assessment: The overall conclusion is that Sodium polyacrylate is not a PBT substance. Qualitative assessment indicated low concern for human health. The estimated injected concentration did exceed the ecotoxicity values or PNECs for this chemical and is not readily biodegradable. However, this chemical does not bioaccumulate. Additionally, the potential exposure to aquatic receptors is considered incomplete (refer to text). Therefore, a Tier 2 assessment was not warranted. Management: Implementation of Constraints Protocol in EMP will be required to prevent accidental discharge/release. Therefore, a Tier 2 assessment was not warranted.	NA
Sodium bisulfite	7631-90-5	1348	201	4.7	**Aquatic Toxicity** **Acute Aquatic - Fish** -96-hr LC_{50} *Leuciscus idus* - 316 mg/L -96-hr LC_{50} *Salmo gairdneri* - 147-215 mg/L -96-hour LC_{50} *Brachydanio rerio* - 464-1,000 mg/L **Acute Aquatic - Invertebrate** -48-hour EC_{50} *Daphnia magna* - 88.8 mg/L **Acute Aquatic-Algae** -96-hour EC_{50} *S. subspicatus* - 43.9 mg/L -72-hour EC_{10} *S. subspicatus* - 33.3 mg/L **Chronic Toxicity** -Chronic toxicity studies on sodium sulfite -34-day NOEC *Danio rerio* - >316 mg/L -21-day NOEC *Daphnia magna* - >10 mg/L No chronic studies are available on sodium bisulfite **Terrestrial Toxicity** No studies available **$PNEC_{water}$** - 0.8 mg/L **$PNEC_{soil}$** - not derived	Qualitative Assessment: Human Health Hazard - low concern Ecological Hazard - low to moderate toxicity concern to aquatic organisms PBT Assessment: Substance exhibits lower toxicity than that established by regulatory guidance.	Environmental Fate Properties: An inorganic compound that dissociates completely to ionic species and sulfur dioxide gas. PBT Assessment: Does not meet the screening criteria for persistence.	Environmental Fate Property: Not expected to bioaccumulate because its dissociates species are inorganic ions and a gas PBT Assessment: Does not meet the screening criteria for bioaccumulation.	Tier 1 (Qualitative/PBT)	PBT Assessment: The overall conclusion is that Sodium bisulfite is not a PBT substance. Qualitative assessment indicated low concern for human receptors and low to moderate concern for aquatic receptors. The estimated injected concentration did exceed the ecotoxicity values or PNECs for this chemical. Additionally, the potential exposure to aquatic receptors is considered incomplete (refer to text). Therefore, a Tier 2 assessment was not warranted. Management: Implementation of Constraints Protocol in EMP will be required to prevent accidental discharge/release. Therefore, a Tier 2 assessment was not warranted.	NA

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Chemical Name	CAS Number	Density (kg/m^3)	Chemical Mass in Fluid (kg)	Concentration in Injected Fluid (mg/L)	Ecotoxicity	Toxicity	Biodegradation	Bioaccummulative	Screening	Discussion	Outcome of Tier 2 Assessment
Alkyl Alcohol	56-81-5	1261	188	4.7	**Aquatic Toxicity** **Acute Aquatic - Fish** -96-hr LC_{50} *Oncorhynchus mykiss* - 54,000 mg/L -96-hr LC_{50} *Pimephales promelas* - 885 mg/L -96 hrLC_{50} - *Carassius auratus* - >5000 mg/L **Acute Aquatic - Invertebrate** - 24-hr EC_{50} *Daphnia magna* - >10,000 -48 hr - LC_{50} *Daphnia magna* - 1995 mg/L **Chronic Toxicity** -NOEC - fish - > 100 mg/L - NOEC - *Daphnia magna* - 897 mg/L **Terrestrial Toxicity** -No studies available **$PNEC_{water}$** - 18 mg/L **$PNEC_{soil}$** - 0.24 mg/kg soil dry weight (Equilibrium partitioning method)	Qualitative Assessment: Human Health Hazard-low concern Ecological Hazard-low toxicity concern to aquatic organisms PBT Assessment: Does not meet the screening criteria for toxicity.	Environmental Fate Properties: Readily biodegradable. PBT Assessment: Does not meet the screening criteria for persistence	Environmental Fate Property: Measured log K_{ow} is -1.75 PBT Assessment: Does not meet the screening criteria for bioaccumulation.	Tier 1 (Qualitative/PBT)	PBT Assessment: The overall conclusion is that Alkyl Alcohol is not a PBT substance. Qualitative assessment indicated low concern for human and ecological health. The estimated injected concentration did not exceed the ecotoxicity values or PNECs for this chemical. Therefore, a Tier 2 assessment was not warranted Management: No additional management required Tier 1 screening satisfied.	NA
2-Propenoic acid, homopolymer, ammonium salt	9003-03-6	NA	NA	4.7	**Aquatic Toxicity** **Acute Aquatic - Fish** -96-hr LC_{50} for *Brachydanio rerio, Salmo giardneri, Leucisucus idus, and Lepomis macrhochirus* are dependent on molecular weight and range from >200 to > 10000 mg/L **Acute Aquatic - Invertebrate** -46-hr EC_{50} for *Daphnia magna* are dependent on molecular weight and range from >200 mg/L to >276 mg/L **Acute Aquatic-Algae** -72-hr EC_{50} (molecular weight of 8,000) *Selenastrum capricornutum* - 40 mg/L -96-hr EC50 (molecular weight of 78,000) *Selenastrum capricornutum* - 44 mg/L **Chronic Toxicity** Fish -32-day NOEC (molecular weight of 4,500) *Pimephales promelaas* - 56 mg/L -28-day NOEC (molecular weight of 4,500) *Brachydanio rerio* - >450 mg/L -14-day NOEC (molecular weight of 78,000) *Brachydanio rerio* - >400 mg/L Invertebrate -21-day NOEC for *Daphnia magna* dependent on molecular weight and range from > 12 to > 450 mg/L Algae -96-hr NOEC for *Scenedesmus subspicatus* are dependent on molecular weight and range from 32.8 to 180 mg/L **Terrestrial Toxicity** -14-day EC0 to *Eisenia foetida foetida* - 1,000 mg/L -14-day EC0 - *Eisenia foetida andrei* - 1,000 mg/L -21-day NOEC - *Brassica rapa* - 1,000 mg/L **PNECwater** - 1.2 mg/L **PNECsoil** - 25 mg/kg	Qualitative Assessment: Human Health Hazard - low concern Ecological Hazard - low toxicity concern for aquatic organisms, terrestrial invertebrates, and plants. PBT Assessment: Does not meet the screening criteria for toxicity.	Environmental Fate Properties: Not readily biodegradable. PBT Assessment: Does not meet the screening criteria for persistence.	Environmental Fate Property: Not expected to bioaccumulate due to their high molecular weights PBT Assessment: Does not meet the screening criteria for bioaccumulation.	Tier 1 (Qualitative/PBT/Exposure Assessment)	PBT Assessment: The overall conclusion is that 2-Propenoic acid, homopolymer, ammonium salt is not a PBT substance. Qualitative assessment indicated low concern for human health. The estimated injected concentration did exceed the ecotoxicity values or PNECs for this chemical. It is not readily biodegradable; however, it is not expected to bioaccumulate. Additionally, the potential exposure to aquatic receptors is considered incomplete (refer to text). Therefore, a Tier 2 assessment was not warranted. Management: Implementation of Constraints Protocol in EMP will be required to prevent accidental discharge/release. Therefore, a Tier 2 assessment was not warranted.	NA

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Chemical Name	CAS Number	Density (kg/m^3)	Chemical Mass in Fluid (kg)	Concentration in Injected Fluid (mg/L)	Ecotoxicity	Toxicity	Biodegradation	Bioaccummulative	Screening	Discussion	Outcome of Tier 2 Assessment
Potassium persulfate	7727-21-1	1390	208	4.7	**Aquatic Toxicity** **Acute Aquatic - Fish** -96-h LC_{50} *Oncorhynchus mykiss* (Rainbow trout) - 76.3 mg/L (mortality) -96-h LC_{50} *Oncorhynchus mykiss* (Rainbow trout) - 163 mg/L (mortality) -96-hr LC_{50} *Oncorhynchus mykiss* - 76.3 mg/L **Acute Aquatic - Invertebrate** -48-h EC_{50} *Daphnia magna* - 120 mg/L **Acute Aquatic-Algae** -72-h EC_{50} *Raphidocelis subcapitata* - 83.7 mg/L -72-h EC_{50} *Raphidocelis subcapitata* - 116 mg/L **Chronic Toxicity** -21-d NOEC *Daphnia magna* - 20.8 mg/L -120-h NOEC *Raphidocelis subcapitata* - 154 mg/L (biomass) -120-h NOEC *Raphidocelis subcapitata* - 23.5 mg/L (biomass) -120-h NOEC *Raphidocelis subcapitata* - 6.92 mg/L (biomass) **Terrestrial Toxicity** Persulphates are not expected to be distributed to the terrestrial compartment and consequently not to cause toxicity to terrestrial organisms and plants. **$PNEC_{water}$** - 0.416 mg/L **$PNEC_{soil}$** - no derived	Qualitative Assessment: Human Health Hazard- low concern Ecological Hazard- low toxicity concern to aquatic receptors PBT Assessment: Does not meet the screening criteria for toxicity.	Environmental Fate Properties: Expected to biodegrade PBT Assessment: Does not meet the screening criteria for persistence.	Environmental Fate Property: Not expected to bioaccumulate PBT Assessment: Does not meet the screening criteria for bioaccumulation.	Tier 1 (Qualitative/PBT/Exposure Assessment)	PBT Assessment: The overall conclusion is that Potassium persulfate is not a PBT substance. Qualitative assessment indicated low concern for human health. The estimated injected concentration did exceed the ecotoxicity values or PNECs for this chemical. However, this chemical is expected to biodegrade and does not bioaccumulate. Additionally, the potential exposure to aquatic receptors is considered incomplete (refer to text). Therefore, a Tier 2 assessment was not warranted. Management: Implementation of Constraints Protocol in EMP will be required to prevent accidental discharge/release. Therefore, a Tier 2 assessment was not warranted.	NA
2-Ethoxy-naphthalene	93-18-5	1241.3	185	4.7	**Aquatic Toxicity** **Acute Aquatic - Invertebrate** -72-h EC_{50} *Daphnia magna* - 3.9 mg/L (mobility) **Chronic Toxicity** -No studies available **Terrestrial Toxicity** -No studies available **$PNEC_{water}$** - 0.039 mg/L **$PNEC_{soil}$** - 1.61 mg/kg soil dry weight (Equilibrium paritioning method)	Qualitative Assessment: Human Health Hazard- low acute oral and dermal toxicity. Ecological Hazard- aquatic toxicity is unlikely to occur due to insoluble nature. PBT Assessment: Does not meeting criteria for toxicity.	Environmental Fate Properties: Readily biodegradable. PBT Assessment: Does not meet the screening criteria for persistence.	Environmental Fate Property: Not expected to bioaccumulate. PBT Assessment: Does not meet the screening criteria for bioaccumulation.	Tier 1 (Qualitative/PBT/Exposure Assessment)	PBT Assessment: The overall conclusion is that 2-Ethoxy-naphthalene is not a PBT substance. Qualitative assessment indicated low concern for human health. The estimated injected concentration did exceed the ecotoxicity values or PNECs for this chemical.] However, this chemical is readily biodegradable and does not bioaccumulate. Additionally, the potential exposure to aquatic receptors is considered incomplete (refer to text). Therefore, a Tier 2 assessment was not warranted. Management: Implementation of Constraints Protocol in EMP will be required to prevent accidental discharge/release. Therefore, a Tier 2 assessment was not warranted.	NA
Nonoxynol-9	26571-11-9	1050	10	0.3	**Aquatic Toxicity** **Acute Aquatic - Fish** - 95-hr LC_{50} *Pimephales promelas* (Fathead minnow) - .128 mg/L - 96-hr LC_{50} *Lepomis macrochirus* (Bluegill) - 1.3 mg/L **Acute Aquatic - Invertebrate** -48-hr EC_{50} *Ceriodaphnia dubia* (Water flea) - .328 mg/L -48-hr LC_{50} *Daphnia magna* - 1.8 mg/L **Acute Aquatic-Algae** -48-hr EC_{50} *Pseudokirchneriella subcapitata* - 20-50 mg/L **Chronic Toxicity** -21-day NOEC *Oncorhynchus mykiss* (Rainbow trout) - .048 mg/L -7-day NOEC *Ceriodaphnia dubia* - .285 mg/L -6-day NOEC *Daphnia Magna* - 1.0 mg/L -96-hr NOEC *Pseudokirchneriella subcapitata* - 8 mg/L -120-hr (5-d) EC_{50} *Pseudokirchneriella subcapitata* -37.4 mg/L **Terrestrial Toxicity** -No data were available. **$PNEC_{water}$** - 10 mg/L **$PNEC_{soil}$** - unavailable	Qualitative Assessment: Human Health Hazard-low to moderate oral acute toxicity and low dermal toxicity Ecological Hazard- moderate toxicity concern to aquatic receptors PBT Assessment: Does not meet the criteria for toxicity	Environmental Fate Properties: Readily biodegradable PBT Assessment: Does not meet the screening criteria for persistence.	Environmental Fate Property: It is not expected to bioaccumulate. Low potential to adsorb to soil or sediment. PBT Assessment: Does not meet the screening criteria for bioaccumulation.	Tier 1 (Qualitative/PBT)	PBT Assessment: The overall conclusion is that Nonoxynol-9 is not a PBT substance. Qualitative assessment indicated low to moderate concern for human health. The estimated injected concentration did not exceed the PNECs for this chemical. Therefore, a Tier 2 assessment was not warranted. Management: No additional management required, Tier 1 screening satisfied.	NA

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Talc	14807-96-6	2700	1038	12.1	**Aquatic Toxicity** Acute Aquatic -96-h LC_{50} Unnamed fish species - 89,581 mg/L (QSAR) -48-h LC_{50} Daphnid species - 36,812 mg/L (QSAR) -96 h LC50 Freshwater algae - 7,203 mg/L Chronic Aquatic - Fish No data available **Terrestrial Toxicity** No data available. **$PNEC_{water}$** - 72 mg/L **$PNEC_{soil}$** - not derived	Qualitative Assessment: Human Health Hazard - Low concern Ecological Hazard - Low concern PBT Assessment: Substance exhibits lower toxicity than that established by regulatory guidance.	Environmental Fate Properties: Biodegradability is not relevant because inorganic substance. PBT Assessment: Does not meet the screening criteria for persistence.	Environmental Fate Properties: Bioaccumulation not expected to occur based on its log K_{ow} value of -9.4. PBT Assessment: Does not meet the screening criteria for bioaccumulation.	Tier 1 (NICNAS/Qualitative Assessment/PBT)	NICNAS has assessed talc in an IMAP Tier 1 assessment and concluded that it poses no unreasonable risk to the environment (NICNAS, 2019). PBT Assessment: The overall conclusion is that talc is not a PBT substance. Qualitative assessment indicated low concern to human health The estimated injected concentration did not exceed the ecotoxicity values or PNECs for this chemical. Therefore, a Tier 2 assessment was not warranted. Management: No additional management required, Tier 1 screening satisfied.	NA
Polyacrylamide	250852-02-3	NA	NA	141.04	**Aquatic Toxicity** No data available **Chronic Toxicity** No data available **Terrestrial Toxicity** No data available **$PNEC_{water}$** -not derived **$PNEC_{soil}$** - not derived	Qualitative Assessment: Human Health Hazard - low acute toxicity Ecological Hazard - low concern PBT Assessment: Substance exhibits lower toxicity than that established by regulatory guidance.	Environmental Fate Properties: Not readily biodegradable PBT Assessment: Does meet the screening criteria for persistence	Environmental Fate Properties: Not excpected to bioaccumulate because of expected very high molecurlar weight and poor water solubility PBT Assessment: Does not meet the criteria for bioaccumulation	Tier 1 (NICNAS/ Qualitative Assessment/ PBT)	NICNAS: Identified polyacrylamide (25085-02-3) as a polymer of low concern for human health in in IMAP Tier 1 assessment PBT Assessment: The overall conclusion is that polyacrylamide (25085-02-3) is not a PBT substance. Qualitative Assessment indicated low concern to human health. This chemical is not readily biodegradable; however, it is not expected to bioaccumulate. Aquatic toxicity studies were not available; however, this chemical is expected to have low concern for aquatic toxicity becuase of its very high molecular weight and poor water solubility. Therefore, a Tier 2 Assessment is not warranted. Management: No additional management required, Tier 1 screening satisfied.	
Polyacrylamide	9005-05-8	NA	NA	1545.96	**Aquatic Toxicity** **Acute Aquatic - Fish** -LC_{50} for Fathead minnow, rainbow trout, and blue gill sunfish are dependent on ioinic charge and range from >100 to 840 mg/L **Acute Aquatic - Invertebrate** -EC_{50} for *Daphnia magna* (ionic charge -39) - 470 mg/L **Chronic Toxicity** No Studies Available **Terrestrial Toxicity** No data available **$PNEC_{water}$** -0.1 mg/L **$PNEC_{soil}$** - not derived	Qualitative Assessment: Human Health Hazard - low acute toxicity Ecological Hazard - low concern PBT Assessment: Substance exhibits lower toxicity than that established by regulatory guidance.	Environmental Fate Properties: Not expected to biodegrade due to high molecular weight PBT Assessment: Does meet the screening criteria for persistence	Environmental Fate Properties: Not excpected to bioaccumulate because of expected very high molecurlar weight and water solubility PBT Assessment: Does not meet the criteria for bioaccumulation	Tier 1 (NICNAS/ Qualitative Assessment/ PBT)	NICNAS: Identified polyacrylamide (9003-05-8) as a polymer that poses no unreasonable risk to the environment. PBT Assessment: The overall conclusion is that polyacrylamide (25085-02-3) is not a PBT substance. Qualitative Assessment indicated low concern to human health. The estimated injected concentration did exceed the PNEC or aquatic toxicity value. This chemical is not readily biodegradable; however, it is not expected to bioaccumulate. Additionally, the potential exposure to aquatic receptors is considered incomplete (refer to text). Therefore, a Tier 2 assessment was not warranted. Management: Implementation of Constraints Protocol in EMP will be required to prevent accidental discharge/release. Therefore, a Tier 2 assessment was not warranted.	

Table 1
Evaluation of Compiled List of Chemicals
Condor Energy Northern Territory Tenement - Chemical Risk Assessment

Table Notes:
°C = degrees Celsius
µg/L = microgram per litre
AICIS = Australian Industrial Chemicals Introduction Scheme
ANZECC = Australian and New Zealand Environment Conservation Council
Ca:Mg = calcium:magnesium
CaCO3 = calcium carbonate
CAS = Chemical Abstract Service
CFT = Chemical Fracture Tracer
dw = dry weight
EC_0 = The concentration of a substance that is estimated to be lethal to 0% of the test organisms
EC_{50} = effects concentration of half the maximal response
ECHA = European Chemicals Agency
EG = ethylene glycol
EMP = Environmental Management Plan
GFT = Gas Fracture Tracer
HCO3- = bicarbonate
IMAP = Inventory Multi-tiered Assessment and Prioritisation
kg/L = kilogram per litre
Kow = n-octanol-water partition coefficient
L = litre
LC_{50} = lethal concentration of 50 percent of population
LOEC = lowest observed effects concentration
mg/kg = milligram per kilogram
mg/L = milligrams per litre
Na+ = Sodium ion
NA = not applicable
NICNAS = National Industrial Chemicals Notification and Assessment Scheme
NOEC = no observed effect concentration
NOELR = no observed effect loading rate
PBT = persistence, bioaccumulative, toxic
PEG - polyethylene glycol
PNEC = predicted no effect concentration
TGK = toxicity threshold (growth inhibition)
WAF = Water Accommodated Fraction Analysis
Additional NICNAS cher
Silica dioxide
Sodium Chloride
Tributyl tetradecyl phosphonium chloride
UVCB = unknown or variable composition, complex reaction products or biological materials

AICIS. 2022. Chemicals unlikely to require further regulation to manage risk to environment; Evaluation statement. 30 May.
Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand (ANZECC & ARMCANZ). (2000). Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Canberra, ACT: Author.
NICNAS 2017, Chemicals of low concern for human health based on an initial assessment of hazards, Project report prepared by the National Industrial Chemicals Notification and Assessment Scheme (NICNAS) as part of the National Assessment of Chemicals Associated with Coal Seam Gas Extraction in Australia, Commonwealth of Australia, Canberra.
NICNAS 2018, Human health Tier II assessment, Project report prepared by the National Industrial Chemicals Notification and Assessment Scheme (NICNAS) as part of the National Assessment of Chemicals Associated with Coal Seam Gas Extraction in Australia, Commonwealth of Australia, Canberra.
Organisation for Economic Co-operation and Development (OECD). (1992). Test No. 301: Ready Biodegradability. (Biodégradabilité Facile.) Paris: OECD Publishing.
Soucek, D.J. (2007). Comparison of hardness and chloride regulated acute effects of sodium sulfate on two freshwater crustaceans. Environ. Toxicol. Chem. 26: 773-779.
Australian Industrial Chemicals Introduction Scheme. 2021. Chemical Information Database. Available online at:

Appendix A Compiled List of Chemicals

CONFIDENTIAL INFORMATION - ONLY TO BE USED FOR REGULATOR NOTIFICATION (QLD FORMAT)

08-January-2023

Pre Frac NOC for Tamboran (Hybrid system with Borate Crosslinked and High Viscosity Friction Reducer fluid systems with 15% HCL Acid Spearhead, 100 Mesh & 40/70 Sand)

Total injected fluid volume (kilolitres):		**31755.702**		
Comprising of:				
Base fluid type (e.g. water)		**Litres**		**% of total volume**
Makeup Water		29749793.160		93.683%
Proppant type (e.g. sand)	**Proppant size**	**Kilograms**	**Litres**	**% of total volume**
Sand	20/40 Sand	0.000	0.000	0.00000%
Sand	100 Mesh	347222.222	130998.845	0.41252%
Sand	40/70	3905895.692	1473603.332	4.64044%

Any wet chemical constitutes:	**Litres**	**CAS Number**	**% of total volume**
Alcohols, C11-14-iso-, C13-rich,ethoxylated	5285.099	78330-21-9	0.016643%
Sodium (C14-16) olefin sulfonate	4658.053	68439-57-6	0.014668%
Diisobutyl glutarate	627.046	71195-64-7	0.001975%
Diisobutyl succinate	209.015	925-06-4	0.000658%
Diisobutyl adipate 141-04-8	179.156	141-04-8	0.000564%
sodium thiosulphate	4763.355	7772-98-7	0.015000%
sodium sulphate	913.330	7757-82-6	0.002876%
sodium sulphite	793.893	7757-83-7	0.002500%
Ethylene Glycol	4963.172	107-21-1	0.015629%
Glutaraldehyde	14929.657	111-30-8	0.047014%
Ammonium Sulphate	4478.897	7783-20-2	0.014104%
Polyacrylamide	4478.897	25085-02-3	0.014104%
Sodium polyacrylate	746.483	9003-04-7	0.002351%
Sodium bisulfite	149.297	7631-90-5	0.000470%
Alkyl Alcohol	149.297	56-81-5	0.000470%
2-Propenoic acid, homopolymer, ammonium salt	149.297	9003-03-6	0.000470%
Potassium persulfate	149.297	7727-21-1	0.000470%
2-Ethoxy-naphthalene	149.297	93-18-5	0.000470%
Sodium Gluconate	8576.225	527-07-1	0.027007%
Boric Acid	4288.112	10043-35-3	0.013503%
Potassium Hydroxide	10745.265	1310-58-3	0.033837%
Ammonium Persulphate	7450.906	7727-54-0	0.023463%
Talc	384.295	14807-96-6	0.001210%
Sodium Bromate	50440.588	7789-38-0	0.158839%
Hepta sodium phosphonate	3175.570	22042-96-2	0.010000%
DISTILLATES, HYDROTREATED LIGHT	54230.768	64742-47-8	0.170775%
Guar Gum	15141.114	9000-30-0	0.047680%
Polyoxyethylene nonylphenol ether	4466.405	9016-45-9	0.014065%
Quaternary ammonium compounds, bis(hydrogenated tallow alkyl)dimethyl, salts with bentonite	4466.405	68953-58-2	0.014065%
1,6-Hexanediol	446.641	629-11-8	0.001406%
Quartz or Organophilic phyllosilicate	1083.668	14808-60-7	0.003413%
HydroChloric Acid	44715.156	7647-01-0	0.140810%
N-Benzyl-Alkylpyridinium Chloride	28.391	68909-18-2	0.000089%
Formic Acid	37.854	64-18-6	0.000119%
Sodium erythorbate	333.810	6381-77-7	0.001051%
Citric Acid	15877.851	77-92-9	0.050000%
Acetic Acid	15877.851	64-19-7	0.050000%
EGMBE	0.000	111-76-2	0.000000%
Isopropanol	83.279	67-63-0	0.000262%
Ethoxylated C12-C16 Alcohol	56.781	68551-12-2	0.000179%
Ethoxylated Decanol	18.927	26183-52-8	0.000060%
Cinnamaldehyde	56.781	104-55-2	0.000179%
Ethoxylated Tallow Alkyl Amine	9.464	61791-26-2	0.000030%
Methanol	1.893	67-56-1	0.000006%
Potassium Chloride	0.000	7447-40-7	0.000000%
Polyacrylamide	49092.948	9003-05-08	0.154596%
Polyethylene glycol trimethylnonyl ether	86.584	127087-87-0	0.000273%
Water in Additive	62324.751	7732-18-5	0.196263%
Potassium Sorbate Food Grade	14.385	24634-61-5	0.000045%
Sodium Benzoate	0.288	532-32-1	0.000001%
Mannanase (Mannan endo-1,4-beta-mannosidase)	2.158	37288-54-3	0.000007%
Nonoxynol-9	9.464	26571-11-9	0.000030%
2-Ethylhexanol PO/EO polymer	9.464	64366-70-7	0.000030%

*Note: display all values to 3 significant figures.

Total	**100.0000%**

Appendix B Assessment of Potential Release to Surface

Potential Risk to Groundwater from Hypothetical Water Releases

Exploration Permits EP76, EP98 & EP117

Prepared for:



Prepared by:

EHS Support

January 2023

Document Control

PROJECT DETAILS

Project No.:	AUS_C04159
Report Revision No.:	B
Date of Issue:	9 January 2022
Project Manager:	Joe Hayes
Project Director:	Nigel Goulding

REPORT DETAILS

Title:	Potential Risk to Groundwater from Hypothetical Water Releases
Main Author(s):	Chris Smitt/Ben Petrides
Approved By:	Joe Hayes
Client:	Condor Energy
Client Contact:	Andrew McKenzie

DISTRIBUTION LIST

Date	No. of Copies	Company/Organisation	Name	Issue type
22 December 2022	1	Condor Energy	Andrew McKenzie, Scott Ross	e
9 January 2023	1	Condor Energy	Andrew McKenzie, Scott Ross	e

Note:
(e) electronic file
(h) hardcopy

REVISION HISTORY

Date	Revision #	Key Changes
22/10/2022	A	Draft issued for review

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Acronyms

CLA	Cambrian Limestone Aquifer
E&A	exploration and appraisal
EP	exploration permit
Ma	million years ago
mbgl	metres below ground level
NT	Northern Territory
POINT	Petroleum Onshore Information Northern Territory

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Units of Measure

Area	
ha	hectare
m^2	square metres
Density	
kg/m^3	kilograms per cubic metre
Electrical Conductance	
µS/cm	micro Siemen per centimetre
mV	millivolt
Length	
µm	micrometres
cm	centimetres
km	kilometres
m	metres
Mass	
µg	micrograms
kg	kilograms
mg	milligrams
t	metric tonnes
Concentration by Mass	
µg/kg	microgram per kilogram
mg/kg	milligram per kilogram
Pressure	
kPa	kilopascals
Pa	Pascals
Temperature	
°C	degrees Celsius
°F	degrees Fahrenheit
K	kelvin
Velocity	
m/d	metres per day
m/s	metres per second
L/s	Litres per second
Volume	
µL	microlitres
cm^3	cubic centimetre
GL	gigalitre
L	litres
m^3	cubic metre
mL	millilitres
ML	megalitre
Concentration by Volume	
µg/L	microgram per litre
mg/L	milligram per litre
ppmv	parts per million by volume
ppbv	parts per billion by volume

1 Introduction

This report provides an assessment of the potential for impacts on groundwater associated with Tamboran B2 Pty Ltd shale gas activities within exploration permits (EP) EP76, EP98 and EP117 in the Northern Territory (NT). In particular this assessment focusses on the area of the four proposed exploration and appraisal (E&A) wells; two at Amungee NW located in the centre of EP98 and two at the Valkerri 76 S2 site located in the central region of EP76. Both of these locations are located within the Amungee Mungee pastoral station. This assessment also focusses on the exploration well Beetaloo W-1, drilled in September 2016 in the centre of EP117.

For the purpose of this assessment, the primary mode of potential impact was identified as an accidental release to the land surface and the resulting radial land flow and sub-surface infiltration. The technical assessment and modelling is provided in the following sections.

1.1 Objective

The objective of this assessment is to define the potential extent of the area impacted by a release or "spill" of fluids and the likelihood of migration to groundwater. Specifically, the following objectives were addressed:

1. Using three spill scenarios (1,000 L, 100,000 L and 1 ML), determine the maximum pooled area in which a spill would inundate.
2. Over the size of the pooled area, determine infiltration rates to gain an understanding of vertical groundwater movement and associated travel time.
3. Evaluate the potential impacts on groundwater and other receptors of interest.

1.2 Scope of Work

To meet the objectives described above, the following work tasks were undertaken:

1. Establish applicable soil/aquifer characteristics within the areas of interest based on a literature review, available stratigraphic information from the Petroleum Onshore Information Northern Territory (POINT)1 web-based data catalogue and other literature (as appropriate).
2. Assess the water pooling area on a flat surface using the formulae proposed by Grimaz et al. (2007).
3. Assess the infiltration capacity of surface soils and ponding time using the analytical Green-Ampt infiltration equation (Green and Ampt, 1911).
4. Assess the infiltration velocity and depth once surface soils become saturated using Darcy's Law (Darcy, 1856).
5. Qualitatively evaluate the potential impacts on groundwater and other receptors of interest.

[1] NT. 2022. Petroleum Onshore Information, NT. Available online at: https://point.nt.gov.au/weave/point.html?deviceType=Desktop . Accessed December 2022.

1.3 Area of Interest

This assessment of the potential for impacts on groundwater associated with shale gas activities in the Northern Territory is applicable to EP76, EP98 and EP117 only. The EPs are shown on **Figure 1-1**, along with the major Basins and Sub-basins.

1.3.1 Receptors of Interest

The sites were chosen based on the geological, environmental, cultural, and social suitability of the site. The approximate buffer distances to the nearest environmental and community receptors are provided in **Table 1-1**.

Table 1-1 Buffer distances to sensitive receptors

Receptor	EP76 – Valkerri 76 S2	EP98 – Amungee NW	EP117 – Beetaloo W-1
Closest pastoral bore	4 km	11.4 km	7.5 km
Nearest homestead	27 km	50 km	12 km
Nearest community	65 km (Daly Waters)	100 km (Jingaloo)	16 km (Jingaloo)
Bullwaddy Conservation Reserve	40 km	30 km	-
Lake Woods	161 km	125 km	-
Frew Ponds	-	-	45 km
Lake Woods	-	-	60 km
Nearest mapped watercourse (Newcastle Creek)	20 km	13 km	8.5 km
Aboriginal protected areas	8 km	7 km	-

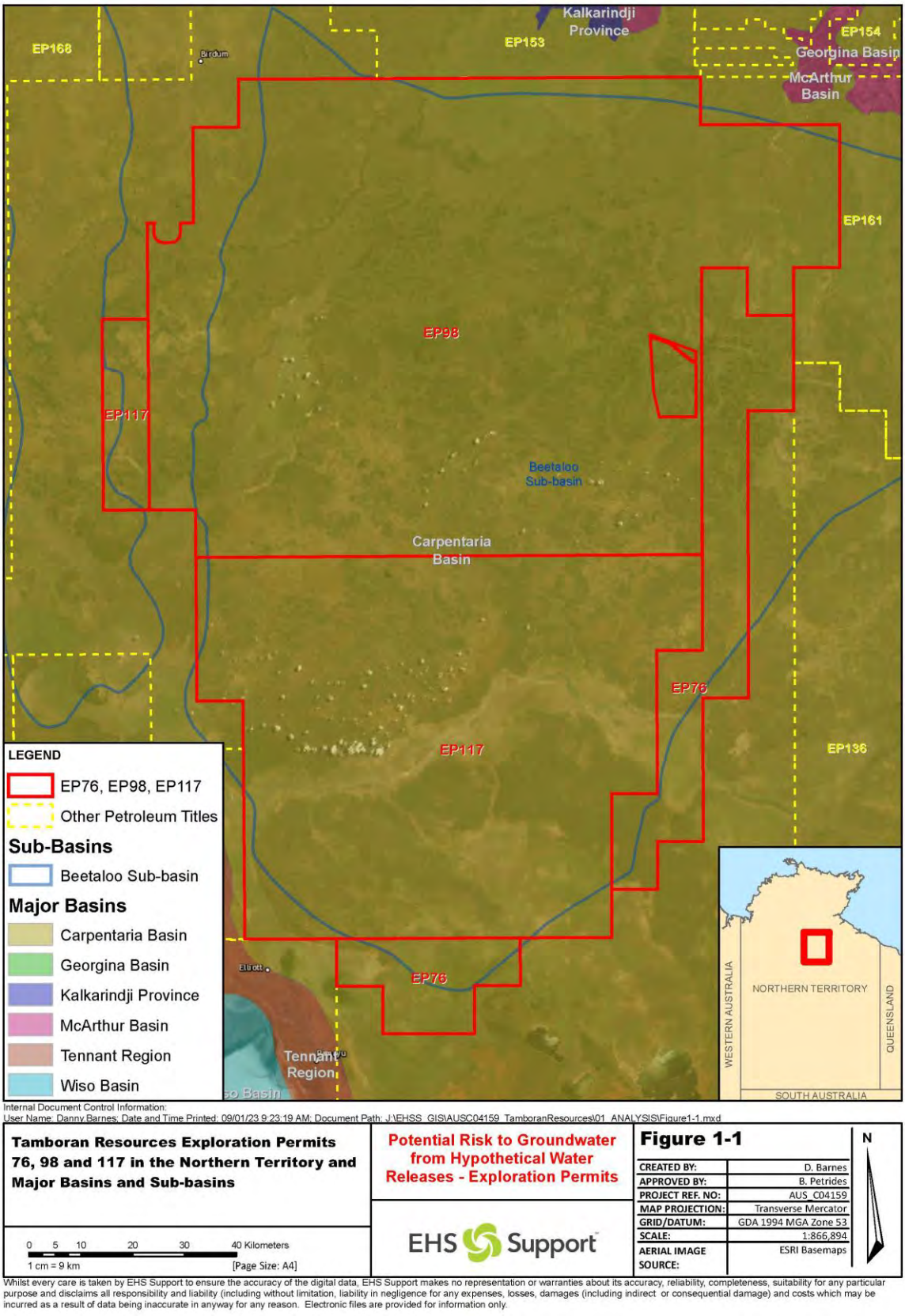


Figure 1-1 Tamboran B2 Pty Ltd Exploration Permits 76, 98 and 117 in the Northern Territory and Major Basins and Sub-basins

2 Overview of Hydrogeology/Geology

2.1 Geology

The Beetaloo Sub-basin comprises a thick sequence of mudstone and sandstone formations (Roper Group) that were deposited approximately 1,500-1,300 million years ago (Ma). The Roper Group is estimated to reach in excess of 5,000 m in thickness in the centre of the Sub-basin and estimated to be thinner outside the formally defined Beetaloo Sub-basin. The Roper Group is overlain unconformably by the yet to be formally defined Neoproterozoic Group. Unconformably overlying the Neoproterozoic group is the Georgina Basin (Cambrian) sedimentary package, which includes widespread extrusive flood basalts and a thick limestone sequence that forms the Cambrian Limestone Aquifer (CLA), a significant water supply aquifer. The Georgina Basin is capped unconformably by a thin section of Cretaceous mudstone and sandstone (Albian aged approx. 100–113 Ma) and recent alluvial and laterite deposits.

The proposed E&A wells will be completed in the Velkerri formation. Organic richness within the Velkerri formation is generally confined to three to four main shale intervals, the A, A-B, B and C shales. The existing Amungee NW-1H and Velkerri 76 S2-1 wells have been completed in the Velkerri B shale.

The Velkerri Formation Amungee Member is overlain with thick series of low permeability units (mudstone, siltstones, tight sandstone and Volcanic units), which include the Velkerri Formation Wyworrie Member, Kyalla Formation, Hayfield Formation, and Antrim Plateau Volcanics. These formations provide thick and multilayered effective geological barriers, with the Gum Ridge Formation separated from the target formations by >1,500 m.

2.2 Basins and Sub-basins

Table 2-1 presents Tamboran B2 Pty Ltd tenements and the associated geological basins (sub-basins where relevant). **Table 2-2** provides a summary of the basins and the inter-relationships. **Figure 2-1** presents EP76 and relevant basins, **Figure 2-2** presents EP98 and relevant basins and **Figure 2-3** presents EP117 and relevant basins.

Table 2-1 Basins and Sub-basins Relevant to the Areas of Interest

Exploration Permit	Owner	Basin(s)	Sub-Basin
EP76	Tamboran B2 Pty Ltd (77.5%) and Falcon Oil & Gas Australia (22.5%)	Carpentaria	Beetaloo
EP98	Tamboran B2 Pty Ltd (77.5%) and Falcon Oil & Gas Australia (22.5%)	Carpentaria	Beetaloo
EP117	Tamboran B2 Pty Ltd (77.5%) and Falcon Oil & Gas Australia (22.5%)	Carpentaria	Beetaloo

Table 2-2 Basin Summary and Relationships

Basin	Age (Ma)	Thickness (km)	Lithology	Relationship
Carpentaria	65 – 205	5	Sedimentary: sandstone, mudstone, limestone	Unconformably overlies the sedimentary rocks of Palaeoproterozoic Murphy Inlier, Paleo-Mesoproterozoic McArthur and South Nicholson basins, Neoproterozoic to Palaeozoic Georgina Basin and Palaeozoic Daly Basin.
Wiso	360 – 540	<0.3 to 3	Sedimentary: dolostone, limestone, shale, sandstone, siltstone.	Faulted against Palaeo-Neoproterozoic metamorphic rocks of the Aileron Province to the south. Unconformably overlies Palaeoproterozoic rocks of the Tanami Region to the west, Tennant Region to the east, and the Palaeo-Mesoproterozoic Birrindudu Basin to the northwest. Cretaceous rocks of the Carpentaria Basin cover its northern margin.
Georgina	355 – 850	3.7	Sedimentary: dolostone, limestone, shale, sandstone, siltstone.	Unconformably overlies Palaeoproterozoic Murphy, Warramunga and Davenport provinces, Palaeo-Mesoproterozoic McArthur and South Nicholson basins and Lawn Hill Platform, and in fault contact with Palaeo-Neoproterozoic Aileron Province. Interpreted to be contiguous with Neoproterozoic to Palaeozoic Wiso and Daly basins that developed as distinct depocentres isolated by basement highs formed from the Cambrian Kalkarindji Province. Unconformably overlain by Mesozoic Carpentaria and Eromanga basins.
Daly	470 – 520	1	Sedimentary: limestone, dolostone, sandstone, siltstone, conglomerate	Unconformably overlies the Palaeoproterozoic Pine Creek Orogen and Palaeo-Mesoproterozoic Birrindudu Basin to the north and east and Neoproterozoic Victoria Basin to the west. Overlain by Mesozoic Carpentaria Basin on its southern margin
Victoria	700 – 850	0.950	Sedimentary: dolostone, sandstone, limestone, shale.	Unconformably overlies Palaeoproterozoic Pine Creek Orogen and Palaeo-Mesoproterozoic Birrindudu Basin. Unconformably overlain by Neoproterozoic Wolfe Basin, Neoproterozoic to Palaeozoic Wiso Basin, Palaeozoic Daly Basin and Cambrian Kalkarindji Province.

Basin	Age (Ma)	Thickness (km)	Lithology	Relationship
Beetaloo Sub-basin	1,320 – 1,650	10	Sedimentary and minor volcanic: dolostone, sandstone, shale, felsic and mafic volcanic rocks.	The Beetaloo Sub-basin is a structural component of the Proterozoic greater McArthur Basin. It consists of two discrete subsurface volumes of sedimentary rock, typically bounded by faults, containing the thickest preserved formations that host significant hydrocarbon resources. Significant thicknesses of Mesoproterozoic sediment accumulated in the Beetaloo Sub-basin relative to adjacent areas (Munson, 2016). The sub-basin lies entirely under the cover of younger basin sediments of the Neoproterozoic Centralian A Superbasin, the Paleozoic Centralian B Superbasin (including the Georgina, Wiso and Daly basins) and the Mesozoic Carpentaria Basin.
McArthur	1,430 – 1,800	12	Sedimentary and minor volcanic: dolostone, sandstone, shale, felsic and mafic volcanic rocks.	Unconformably overlies Palaeoproterozoic Pine Creek Orogen, Murphy Province and Arnhem Province to the northwest, southeast and northeast respectively. Unconformably overlain by the Palaeozoic Arafura, Georgina and Mesozoic Carpentaria basins. Interpreted to be contiguous under cover with the Palaeo-Mesoproterozoic Birrindudu Basin and Tomkinson Province.
Birrindudu	1,550 – 1,780	10	Sedimentary: sublithic arenite, quartz arenite, siltstone, shale, conglomerate, stromatolitic chert, limestone, glauconitic sandstone.	Unconformably overlies Palaeoproterozoic Pine Creek Orogen to the north. Unconformably overlain by Palaeozoic Wiso and Daly basins to the east; by Cambrian Ord Basin to southwest; by Neoproterozoic Wolfe Creek Basin to west and Neoproterozoic Victoria Basin to the north; and in places, by Cambrian Kalkarindji Province and patchy sedimentary rocks of basin-margin Mesozoic sandstone. Towards the south is underlain by Palaeoproterozoic metasediments and granites of Tanami Region. In northwest, in faulted contact with Palaeozoic–Mesozoic Bonaparte Basin and Palaeoproterozoic rocks of Halls Creek Orogen.

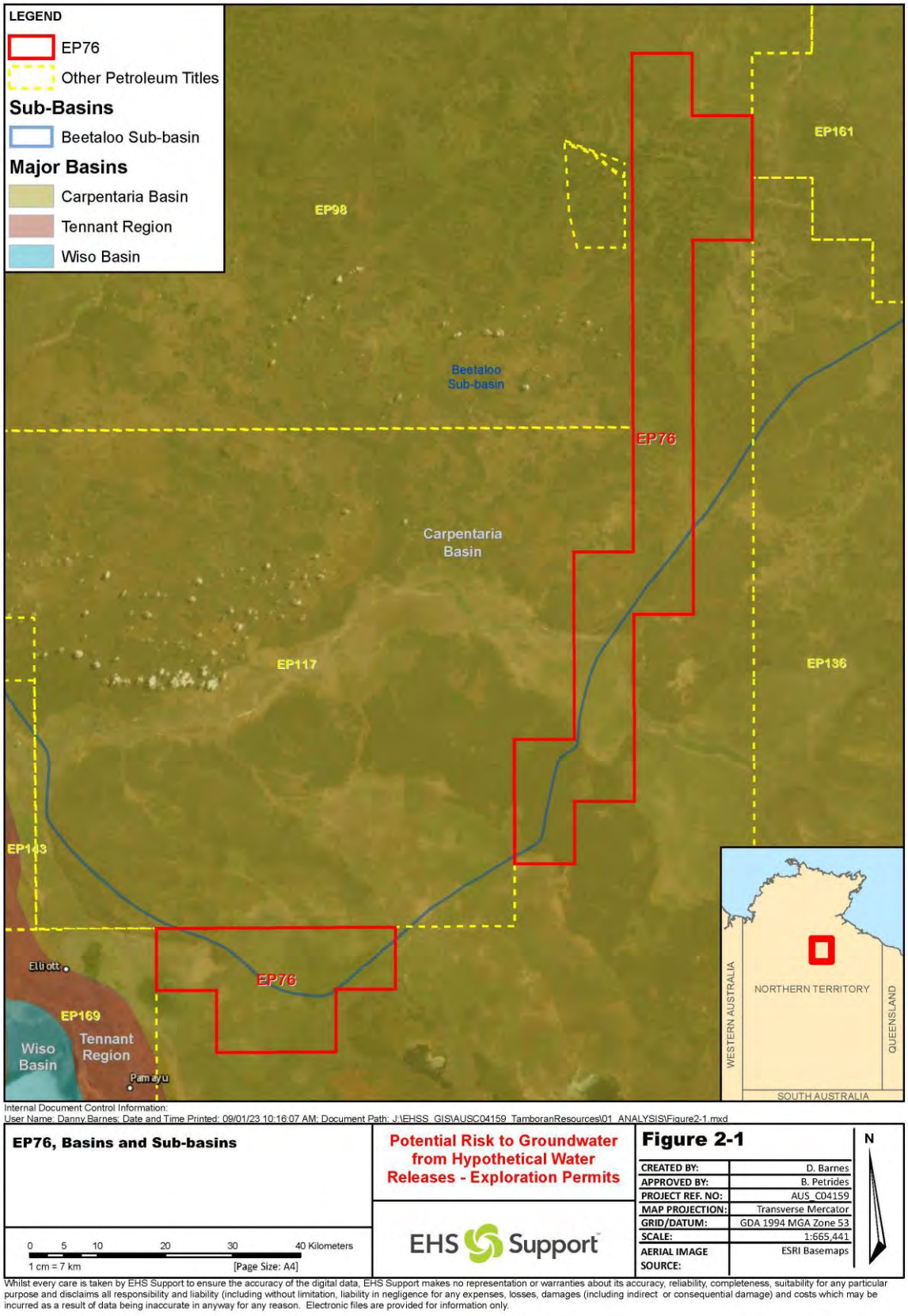


Figure 2-1 EP76, Basins and Sub-Basins

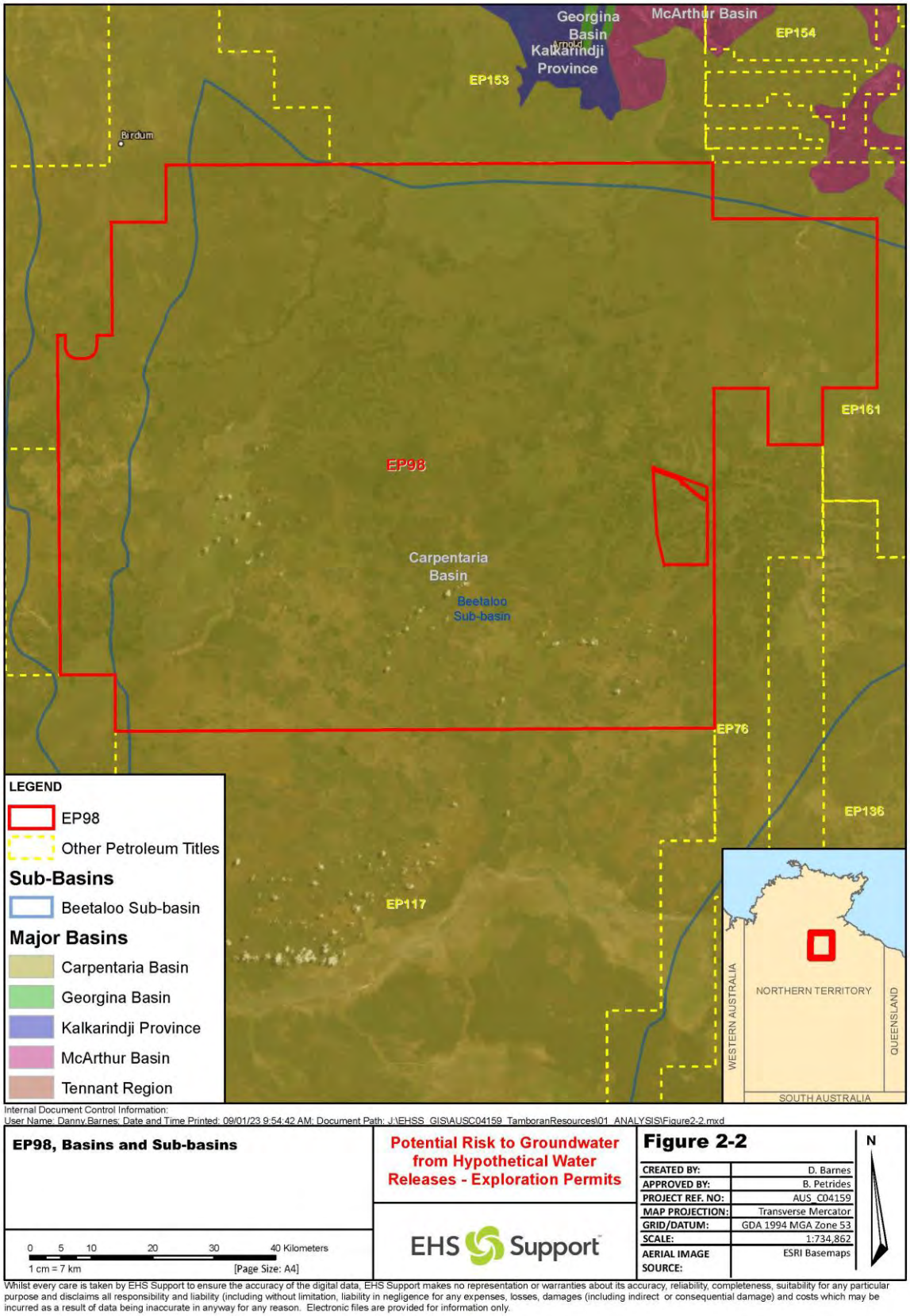


Figure 2-2 EP98, Basins and Sub-Basins

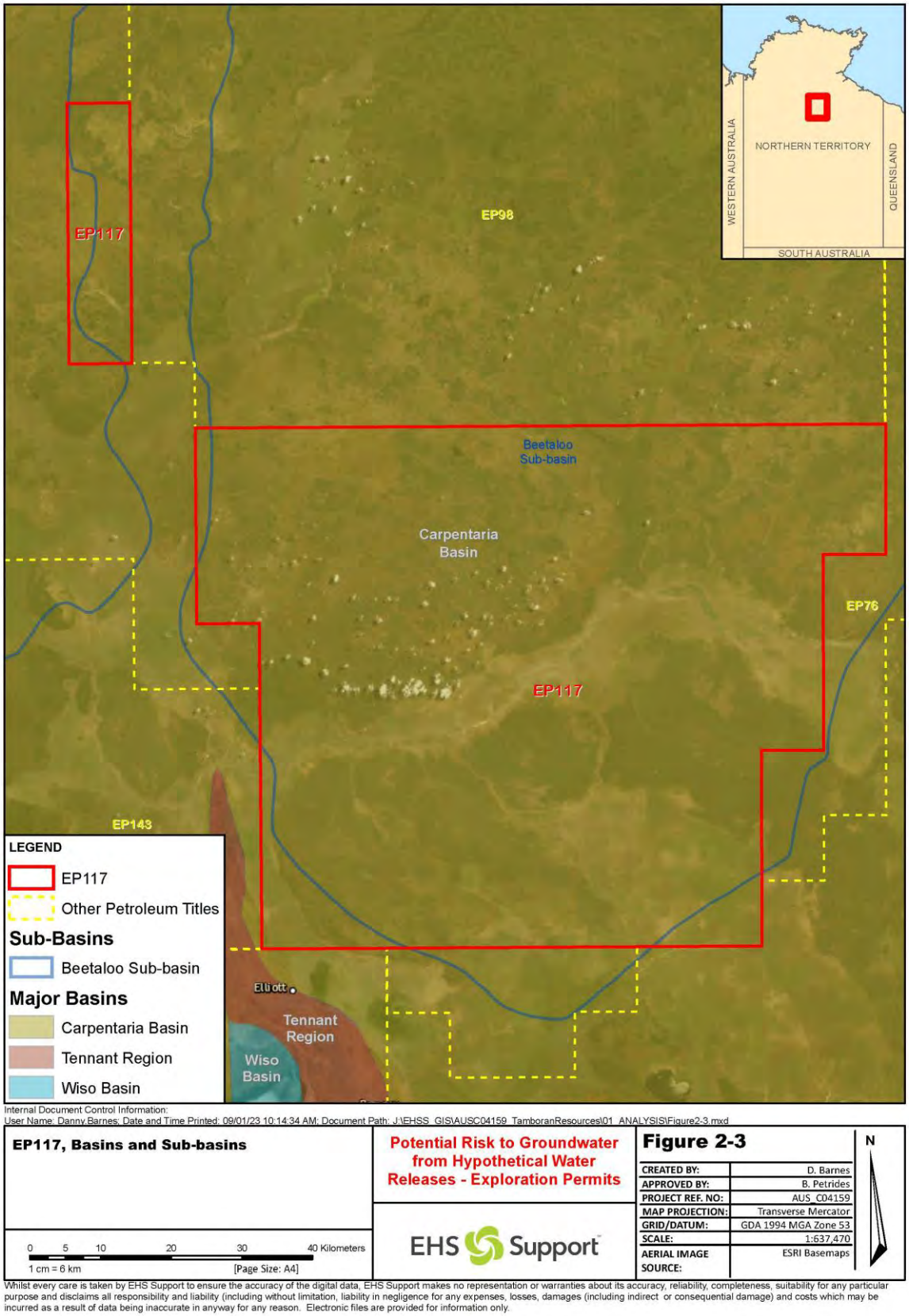


Figure 2-3 EP117, Basins and Sub-Basins

2.3 Stratigraphic Overview in Each Exploration Permit

The shallow (<100 m) hydrostratigraphic sequence within each EP was evaluated by reviewing petroleum drillholes, where present, groundwater extraction licence well construction logs, and other stock and domestic supply well construction logs. These shallow sequences are most susceptible to impacts associated by a release or "spill" of fluids. The breakdown of available information is presented in **Table 2-3**.

Table 2-3 Available Stratigraphic Information from Existing Drillholes and Wells

Exploration Permit	# of Petroleum Drillholes	# of Groundwater Extraction Licenced Wells	# of Other Registered Use Wells
EP76	1	1	23
EP98	9	3	149
EP117	3	1	83

Figure 2-4 shows the petroleum drillholes, groundwater extraction licenced wells and stock and domestic supply wells in each of the exploration permits.

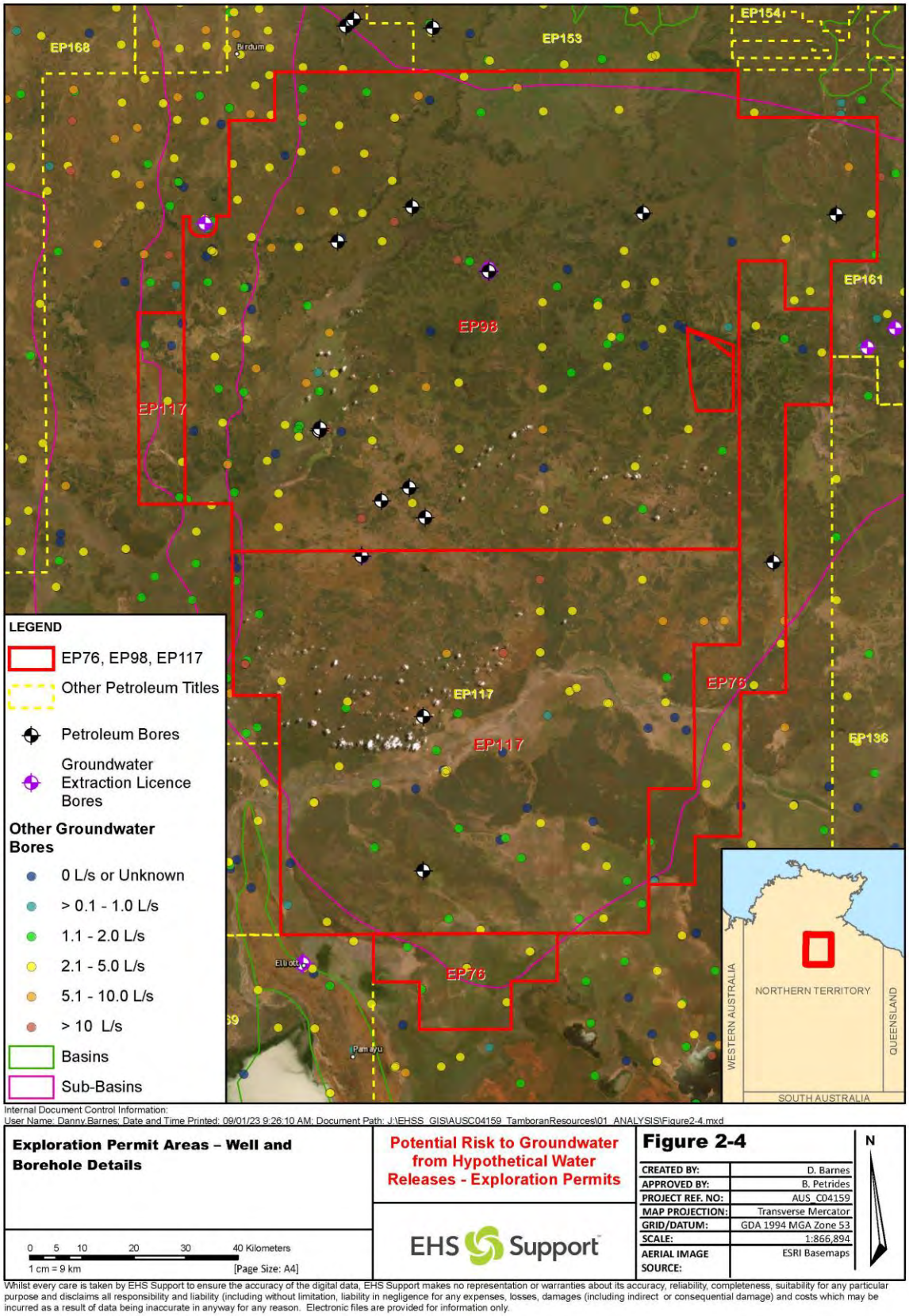


Figure 2-4 Exploration Permit Areas – Well and Borehole Details

2.3.1 Exploration Permit 76

EP76 covers an area of approximately 1,880 km^2. One petroleum well has been drilled in this EP; Velkerri 76 S2-1 and based on the basic well completion report (**Figure 2-5**) the generalised lithology is described in **Table 2-4**.

In this EP, the Anthony Lagoon Formation, comprising sandstone and dolomitic/siltstone/limestone and the Gum Ridge Formation comprising fossiliferous siltstone and chert and limestone form the major aquifer in the region. Groundwater yields in these fractured and karstic rocks have been recorded between 5.0 and 15.0 L/sec.

Table 2-4 EP76 – Generalised Stratigraphy

Depth From (mbgl)	Depth to (mbgl)	Lithology	Hydrogeological Unit
0	60	Undifferentiated sediments (Clay)	-
60	350	Limestone	Anthony Lagoon Formation/Gum Ridge Formation

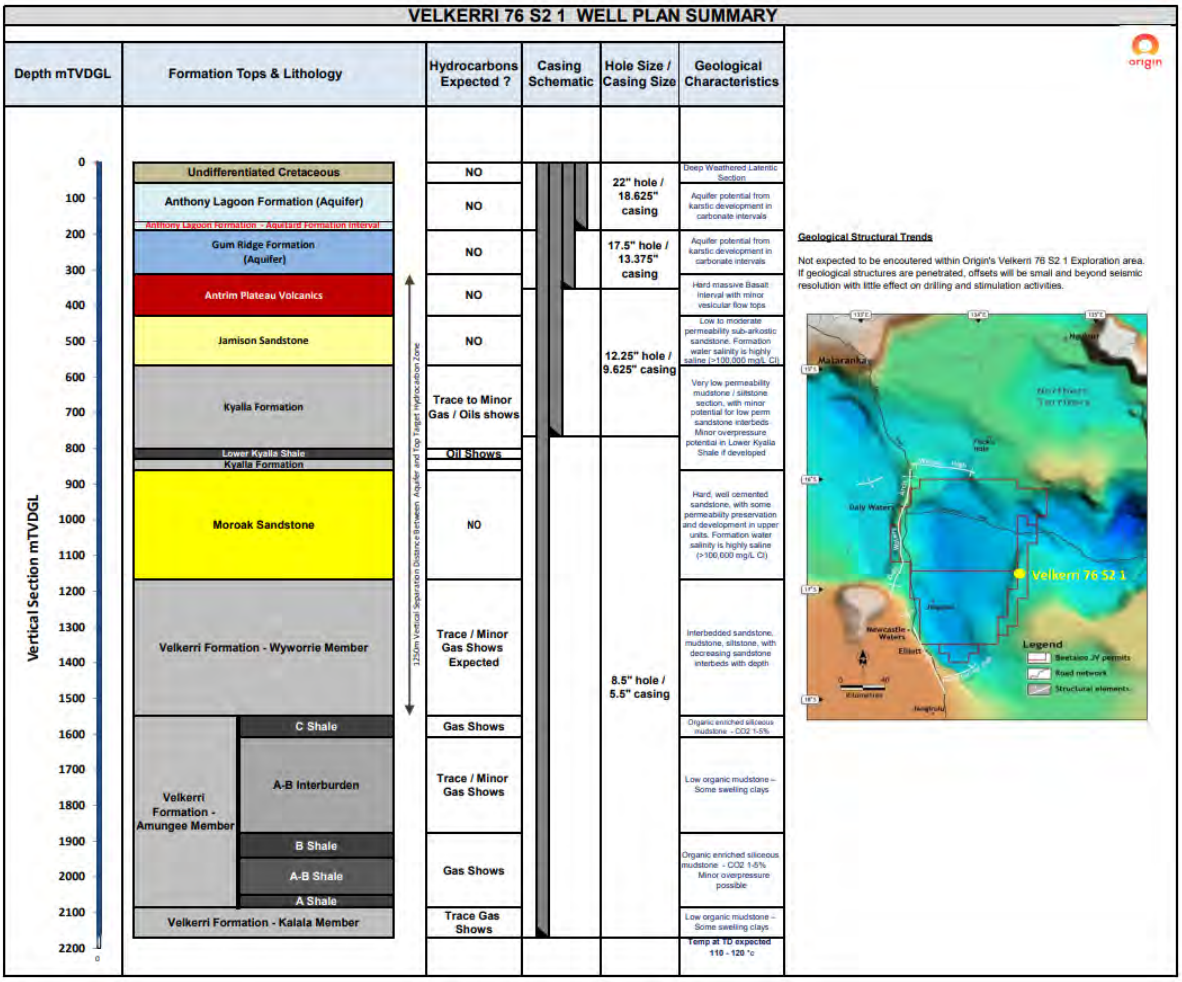


Figure 2-5 Well Plan Summary – Velkerri 76 S2-1

2.3.2 Exploration Permit 98

EP98 covers an area of approximately 10,124 km^2. Fifteen petroleum wells have been drilled in this EP: Chanin 1, Kalala South 1, Amungee (Amungee NW1, Amungee NW 1H, Amungee NW 1H Re-entry, Amungee NW-2H), Ronald 1, Burdo 1, Balmain 1, Mason 1, Shortland 1, Jamison 1, and Shenandoah (Shenandoah 1, Shenandoah 1A, Shenandoah 1A Re-entry). Based on the basic well completion reports, the generalised lithology is described in **Table 2-5** and shown on **Figure 2-6**.

Table 2-5 EP98 – Generalised Stratigraphy

Depth From (mbgl)	Depth to (mbgl)	Lithology	Hydrogeological Unit
0	80	Undifferentiated sediments (Clay)	-
80	220	Limestone	Gum Ridge Formation*

*Historically this unit has been mapped as the Tindall Limestone

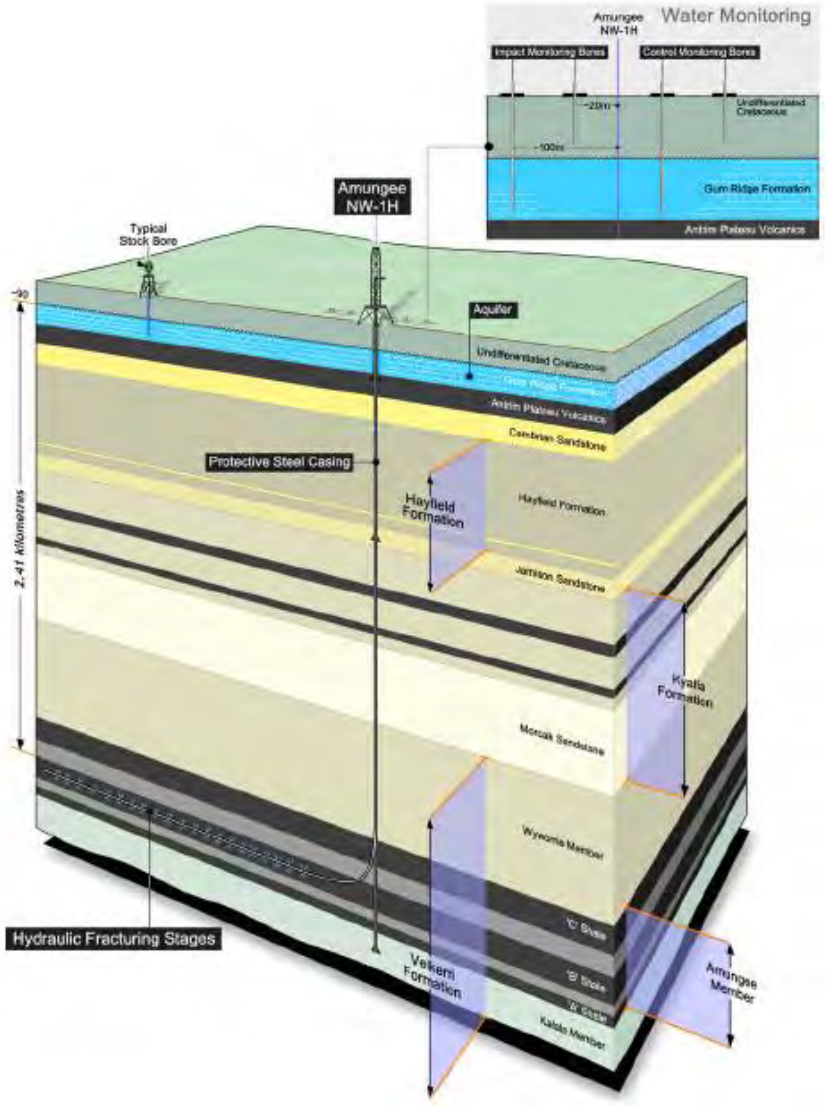


Figure 2-6 Schematic of the Existing Amungee NW-1H Well

2.3.3 Exploration Permit 117

EP117 covers an area of approximately 6,375 km^2. One petroleum well has been drilled in this EP; Beetaloo W-1 and based on the basic well completion report (**Figure 2-7**) the generalised lithology is described in **Table 2-6.**

Table 2-6 EP117 – Generalised Stratigraphy

Depth From (mbgl)	Depth to (mbgl)	Lithology	Hydrogeological Unit
0	116	Undifferentiated sediments (Clay)	-
116	436	Limestone	Anthony Lagoon Formation/Gum Ridge Formation

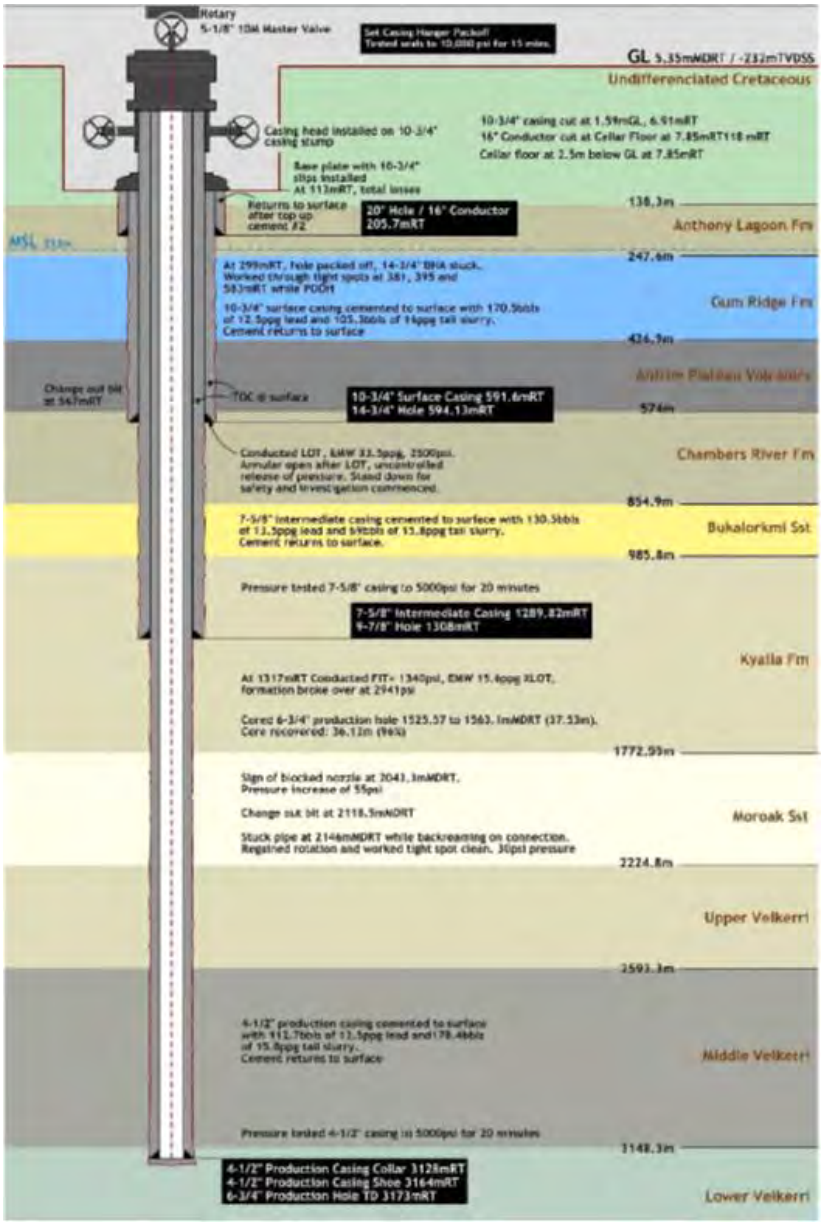


Figure 2-7 As Drilled Schematic of Beetaloo W-1

2.4 Hydrogeology

Within the Beetaloo exploration area, groundwater use is primarily from the CLA with minor, localised use from formations where shallower groundwater is intersected, where the CLA is too deep, or where the CLA is absent from erosion. This includes:

- Overlying Cretaceous sediments where it is saturated in the central-south of the Beetaloo Sub-basin;
- Antrim Plateau Volcanics in the north-west; and
- Bukalara Sandstone in the north-east.

The CLA, comprising the Gum Ridge Formation and the Anthony Lagoon Formation, is an extensive regional aquifer system that forms the principal water resource in the Beetaloo Sub-Basin.

In the vicinity of the Amungee NW site, the Anthony Lagoon Formation is interpreted as being eroded by the Base Cretaceous unconformity. At Amungee NW the Gum Ridge Formation is the upper water bearing aquifer unit with a standing water depth of approximately 106 m below ground level (mbgl).

At Velkerri 76 S2 and Beetaloo W-1, the Anthony Lagoon Formation forms the upper water bearing aquifer with the groundwater level at approximately 89 mbgl and 73 mbgl respectively.

The limestone in the Gum Ridge Formation is commonly fractured and cavernous with recorded bore yields up to 100 L/s from this aquifer. At both Amungee NW and Velkerri 76 S2, yields in excess of 20 L/sec were achieved with minimal (<1 m) aquifer losses.

Approximately 80% of groundwater bores drilled in the basin screen the CLA, and the aquifer supplies water for the pastoral industry and local communities, including Elliot, Daly Waters, Larrimah, and Newcastle Waters. The CLA contains a significant but largely undeveloped groundwater resource with the sustainable yield from the Georgina Basin estimated at 100,000 ML/year (NALWTF, 2009). Existing groundwater use in the Beetaloo Sub-Basin is estimated at 6,000 ML/year, primarily used for agricultural production (Foulton and Knapton, 2015).

The Antrim Plateau Volcanics conformably underlies the CLA in the north and central part of the Beetaloo Sub-Basin. Much of the Sub-Basin consists of sequences of massive basalt flows with negligible primary porosity. The north-west portion of the Sub-Basin forms a marginal aquifer where the formation is shallow and fractured; however, reported use is primarily from a sandstone sequence at the contact with the Gum Ridge Formation. There is no reported use within the three petroleum EPs held by Origin.

The Bukalara Sandstone forms a fractured and weathered aquifer where it outcrops beyond the north-east margin of the Beetaloo Sub-Basin. The formation consists of quartz sandstone with shale interbeds and probable enhanced permeability in these areas due to jointing within the sandstone. No use is reported from the formation away from the north-east margin of the Beetaloo Sub-Basin where it is at considerable depth. This unit, if present, will be protected through intermediate casing and cement.

The regional groundwater flow direction in the CLA is north-west toward Mataranka, where the aquifer discharges into the Roper River and supports significant groundwater dependent ecosystems (aquatic, riparian and floodplain), including the Roper River at Elsey National Park and Red Lily/57 Mile Waterhole. These discharge features occur around 100 km north-west of the Beetaloo Sub-Basin. Dry season flow in the Roper River has been gauged at 95,000-126,000 ML/yr and provides an

estimate of the magnitude groundwater discharge from the CLA. Large decadal changes in the discharge to the Roper River suggest that most recharge input occurs close to the discharge zone (i.e., beyond the Beetaloo Sub-Basin region). Groundwater recharge mechanisms to the CLA are poorly characterised but are likely to be dominated by infiltration through sinkholes and preferential recharge through soil cavities.

3 Analytical Assessment (Methodology)

Liquid releases on a permeable soil surface undergo three main processes that control the extent of the release and the subsequent environmental impacts. These processes are:

- Overland flow (runoff);
- Evaporation; and
- Infiltration.

In this assessment, overland flow (also referred to as runoff) is assessed along with infiltration.

3.1 Lateral Spreading of Fluid/Runoff

Runoff of water as a fluid dynamical process has concurrently been an important research topic with surface water hydrology and is typically described with the use of the Saint Venant equations (Woolhiser and Liggett, 1967). However, only recently has runoff been coupled with surface infiltration at a spatial scale that can be applicable to point source flows, such as release from a pipeline. Esteves et al. (2000) provides a list of theoretical models that include the basic elements of a liquid release on land.

The approach adopted for this assessment is a progression of the Green and Ampt (1911) model (**Section 3.2.1**). In essence, the Green and Ampt model approximates the curved soil moisture profiles allowing the calculation of the soils' infiltration capacity. The remaining water balance component is therefore runoff. This is visually presented in **Figure 3-1**.

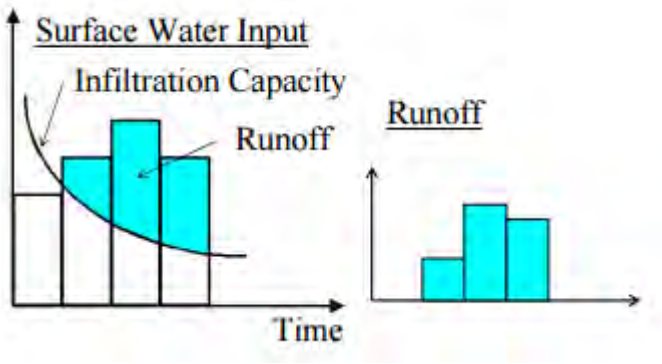


Figure 3-1 Conceptualisation of the Green and Ampt Model and the Remaining Runoff

Due to the regional approach and the complexity of this assessment, slight modifications to mathematical theory behind this and similar models were undertaken to predict the regional scale flow characteristics from a point source.

Whilst the Green and Ampt (1911) equation was used to assess the initial infiltration depths, modifications to the algorithm developed by Grimaz et al. (2007) and the Manning Kinematic Equation were adopted to model the remaining water assumed to be runoff. These analytical steps are provided in **Section 3.1.1**.

3.1.1 Water Pooling on Flat Surfaces

For instantaneous releases on flat surfaces (and assuming this water bypasses any bunded walls), the formulae (Equation 1) proposed by Grimaz et al. (2007) was used to estimate the area of the

pool of liquid on flat ground. This method is used for oil spills but can allow for water by varying the liquid properties (primarily viscosity and permeability).

$$A_{pool} \cong 2.3782 \frac{Q^{4/5}}{(k_i k_r)^{1/5}} \quad (1)$$

Where:

A_{pool} = the area of the pool of liquid on the surface [m^2]
Q = the total amount of liquid released [m^3]
k_i = the intrinsic permeability of soil [m^2]
k_r, = the relative permeability of the liquid [-].

The values of k_r, which vary with different grades of water saturation of soil, are shown in **Table 3-1**. For the conservative nature of this assessment, a k_r value of 0.3 will be assumed.

Table 3-2 provides the intrinsic permeability values used for sand and clay soil profiles. Sand and clay were chosen as these represent the extremes of potential infiltration and therefore bound the conditions observed in soils within the Area of Interest.

Table 3-1 Relative Permeability k_r, for Different Scenarios of Accidental Release

Soil Situation	k_r
Dry: long time without rainfall in warm regions and in hot seasons	1
Slightly wet: long time without rainfall in other regions or seasons	0.9
Very wet: from 2 hours to 2 days after strong rainfall	0.3
Completely saturated: during strong rainfall with ponds on surface	0

Table 3-2 Values of Intrinsic Permeability and Kinematic Viscosity for Sand and Clay

Soil situation	k_i
k_i = intrinsic permeability of soil (m^2)	
Sand	1.00E-08
Clay	1.00E-13

3.2 Infiltration into Unsaturated Zone

The spilt fluid will not only tend to spread out over the surface of the soil and evaporate but will also penetrate into the ground (unless it is impermeable). Infiltration to the unsaturated zone, and in particular infiltration capacity and time for ponding to occur, can be determined using the Green and Ampt (1911) infiltration equation.

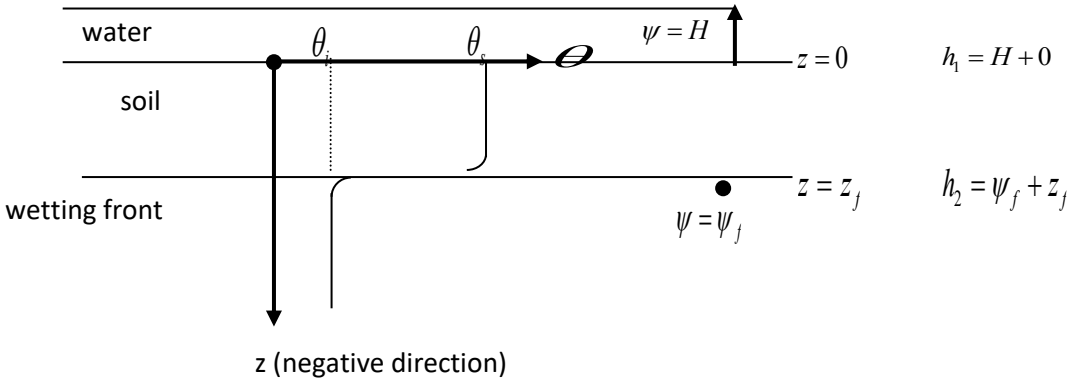
The infiltration rate actually experienced in a given soil depends on the amount and distribution of soil moisture and on the availability of water at the surface with a maximum rate at which the soil in a given condition can absorb water. This upper limit is called the infiltration capacity, f_c, and is a limitation on the rate at which water can move into the ground. If surface water input is less than infiltration capacity, the infiltration rate will be equal to the surface water input rate (w). If irrigation (analogous to a release) intensity exceeds the ability of the soil to absorb moisture, infiltration occurs at the infiltration capacity rate until the soil is saturated and ponding and associated runoff occurs. Infiltration capacity declines over time until a steady state is reached.

Several processes combine to reduce the infiltration capacity. The filling of fine pores with water reduces capillary forces drawing water into pores reducing the storage potential of the soil. Clay swells as it becomes wetter, and the size of pores is reduced. Coarse-textured soils such as sands have large pores which water can easily drain, while the fine pores in clays retard drainage. If the soil particles are held together in aggregates by organic matter or a small amount of clay, the soil will have a loose, friable structure that will allow rapid infiltration and drainage.

The calculation of infiltration at a point combines the physical conservation of mass (water) principle expressed through the continuity equation with quantification of unsaturated flow through soils, expressed by Darcy's equation. The downward hydraulic gradient inducing infiltration is from a combination of the effect of gravity, quantified by the elevation head, and capillary surface tension forces, quantified by the pressure head (negative due to suction) being lower at depth due to lower moisture content. If the water input rate is greater than the saturated hydraulic conductivity (i.e., w is greater than K_{sat}), at some point in time the water content at the surface will reach saturation. At this time, the infiltration capacity drops below the surface water input rate and runoff is generated. This time is referred to as the ponding time. After ponding occurs, water continues to infiltrate, and a zone of saturation begins to propagate downward into the soil as the wetting front. After ponding, the infiltration rate is less than the water input rate and the excess water accumulates at the surface and becomes infiltration excess runoff. As time progresses and the depth of the zone of saturation increases, the contribution of the suction head to the gradient inducing infiltration is reduced, so infiltration capacity is reduced. Once the soil profile is completely saturated no further water can infiltrate.

3.2.1 Green and Ampt Infiltration Model

The Green and Ampt (1911) model (Equation 2) is an approximation of the infiltration process described above and was utilised to assess infiltration capacity and time for ponding for various soils.



$$q = -K_s \frac{dh}{dz} = -K_s \frac{h_2 - h_1}{z_2 - z_1} = -K_s \frac{(\psi_f + z_f) - (H + 0)}{z_f - 0} = -K_s \frac{\psi_f + z_f - H}{z_f} \qquad (2)$$

Where

H = the depth of ponding, cm
Ks = saturated hydraulic conductivity (cm/s)
q = flux at the surface (cm/h) and is negative
f = suction at wetting front (negative pressure head)

θ_i = initial moisture content (dimensionless)

θ_s = saturated moisture content (dimensionless)

The following assumptions are implicit in the Green and Ampt equation:

- As water infiltrates, the wetting front advances at the same rate with depth, which produces a well-defined wetting front.
- The volumetric water content remains constant above and below the wetting front as it advances.
- The soil-water suction immediately below the wetting front remains constant with both time and location as the wetting front advances.

3.2.2 Darcy Infiltration Model

Once the soil has become permanently saturated (i.e., established) from a constant head driving behind the wetting front or when the Green and Ampt *flux (q) becomes constant*, Darcy's Law can be applied to determine the rate at which water can infiltrate vertically. This is shown in Equation 3.

$$qD = \frac{-K_{h,v}\frac{\Delta h}{\Delta l}}{n} \quad (3)$$

Where

qD = specific discharge of groundwater or Darcy Flux (m/day)
Kh,v = average hydraulic conductivity (vertical [Kv] or horizontal [Kh]) of the saturated sediment (m/day)
$\Delta h / \Delta l$ = hydraulic gradient driving the fluid (-)
η = effective porosity (-)

4 Analytical Assessment (Results)

This section presents the results of the assessment outlined in **Section 1.2** and the methodology (described in **Section 3.1** and **Section 3.2**) for determining:

- Lateral spreading/overland flow (**Section 4.1**);
- Infiltration into unsaturated zone (**Section 0**); and
- Infiltration rates under saturated flow conditions (**Section 4.3**).

4.1 Overland Flow

4.1.1 Overland Flow on Flat Surfaces

To assess the unmitigated risks from the improbable scenario where some fluids were to overflow the bunded area, a range of release scenarios are considered comprising:

1. Smaller release volumes of 1,000 L and 100,000 L, which would reflect small scale releases, and
2. An improbable release out of the bunded area (1,000,000 L).

Section 2 presents a summary of the recorded shallow lithology in each EP based on petroleum drillholes, licenced groundwater extraction wells, and stock and domestic supply wells. For modelling purposes, the shallow stratigraphy in each EP has been simplified. It is noted that this simplification allows for a more conservative evaluation of infiltration, as most surficial sediments in the Areas of Interest are composed of either natural clays or clays derived from weathering of the host rock.

Table 4-1 presents the simplified stratigraphy in each EP adopted for modelling, and model input parameters are provided in **Table 4-2**. It is noted that the shallow stratigraphy across the Areas of Interest are considered to be laterally equivalent and/or comprise similar hydraulic properties; these can be grouped into two main categories:

1. Low permeability formations including the Anthony Lagoon Beds.
2. Higher permeability formations including the Gum Ridge Limestone and Tindall Limestone.

For the purposes of assessing surface water pooling, soil properties reflective of a clay and more permeable sandier soils have been applied to Equation 1. These parameters are presented in **Table 3-1** and **Table 3-2.**

Table 4-1 Simplified Shallow Stratigraphy

Exploration Permit	Lithology	Hydrogeological Unit
EP76 & EP117	Clay overlying Limestone	Anthony Lagoon Beds/Gum Ridge Formation
EP98	Clay overlying Limestone	Gum Ridge Formation/ Tindall Limestone

Table 4-2 Modelling Input Parameters

Parameter	Anthony Lagoon Beds	Gum Ridge Limestone / Tindall Limestone /	Literature Source
Exploration Permit	EP76	EP76, EP98	
Porosity	0.482*	0.4**	* Dingman, 1994 **Knapton, 2006
Hydraulic Conductivity (K_{sat}) (m/d)	$8.6x10^{-4}$	0.864	Freeze, R. A., & Cherry, J. A. (1979).
Air-Entry Tension (cm)	40.5	12.1	Dingman, 1994
Saturated Tension (cm)	30.78	9.2	Dingman, 1994
Intrinsic permeability (m^2)	$1x10^{-13}$	$1x10^{-16}$	Dingman, 1994

Sources:
Dingman, S.L. 1994. Physical Hydrology Edition 5, Macmillan Publishing Company, 1994 ISBN 002329745X, 9780023297458 575 pages
Freeze, R.A. and Cherry, J.A. 1979. Groundwater. Prentice-Hall, Inc., Englewood Cliffs.
Knapton. 2006. Regional Groundwater Modelling of the Cambrian Limestone Aquifer System of the Wiso Basin, Georgina Basin and Daly Basin. Technical Report No. 29/2006A Department of Natural Resources, Environment & The Arts, Alice Springs.

Without the inclusion of bunding, a catastrophic release (1 ML) could impact an area of up to 94.7 ha if the surface geology remained consistent of a tight clay/sit representative of the Anthony Lagoon Beds. In the event of a smaller scale release of 1,000 L and prior to any bunds being established, these impacts would be highly localised being 0.4 ha (about half the size of a soccer field). It should be again stated, the above is a very conservative assessment.

Table 4-3 Model Results - Pooled Water Area

Stratigraphic Unit	Volume Released (L)	Volume Released (m^3)	Area (m^2)	Radius (m)	Comment
Anthony Lagoon Beds	1,000	1	3769.2	34.6	Releases of 1 to $100m^3$ improbable to over topping bunding walls.
	100,000	100	150054.3	218.5	
	1,000,000	1,000	946778.5	549.0	
Gum Ridge Limestone / Tindall Limestone	1,000	1	946.8	17.4	Releases of 1 to $100m^3$ improbable to over topping bunding walls.
	100,000	100	37691.9	109.5	
	1,000,000	1,000	237820.0	275.1	

4.2 Green and Ampt Infiltration Model

In addition to potential overland flow, infiltration into the sub-surface would occur. In the case of releases that are not contained within the bunded area, the infiltration rate would be slow due to the limited head of fluids within the release area, while in the bunded area, the retention of release fluids would provide a higher head as liquids could be present up to the height of the surrounding walls.

The results of the Green and Ampt Infiltration equation are discussed below and shown in **Figure 4-1**.

Recalling from **Section 2** and **Section 4.1.1** above, there are two distinct hydrogeological units (siltstone/clay and limestone) that extend across the Areas of Interest. The assessment therefore is based upon the time to infiltrate through both these formations.

Assuming the sub-surface is similar to the lower permeable units as defined in **Table 4-1** and **Table 4-2**, the results indicate that the ground would become quickly saturated (the infiltration capacity of the soils are exceeded). As a result, and spill would unlikely move to any significant depth as the majority of the water would run off, however for the water that remains and not inclusive of evaporation, any spill will take approximately between 40 days (Limestone) and >1000 days (Siltstone) to move through the top 1m. After 40 days it would be assumed the water on the surface would have evaporated. This is based on a saturated hydraulic conductivity of a siltstone/clay (K = 0.000001 cm/s [0.00086 m/d]) and for a limestone (K = 0.001 cm/s [0.864 m/d]).

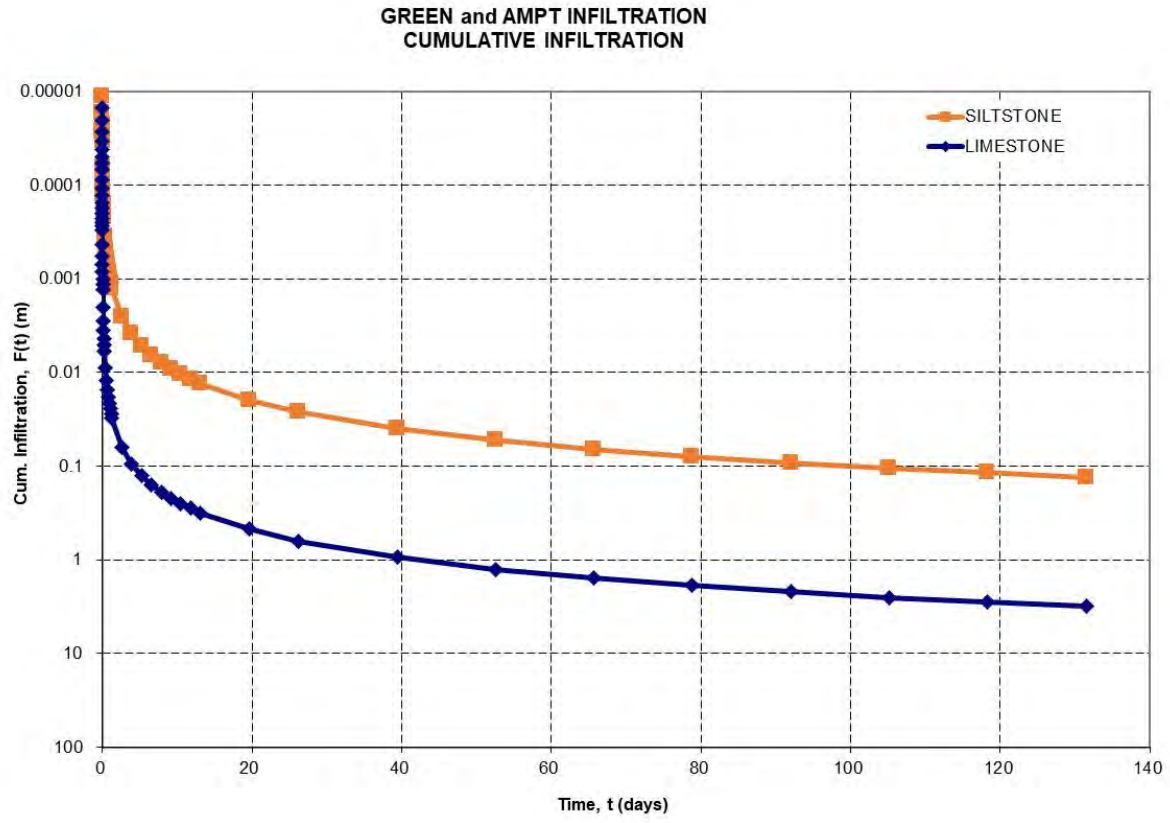


Figure 4-1 Results of the Green and Ampt Analytical Model for Limestone and Siltstone

Note: Siltstone equivalent to the Anthony Lagoon Beds. Permeable sandstone equivalent to the Gum Ridge Limestone / Tindall Limestone.

4.3 Darcy Infiltration Model

The results of the Darcy infiltration modelling are discussed as follows and shown in **Figure 4-2**. Adopting the same assumptions as presented in **Section 3.2.1**, (i.e., the sub-surface is similar to the units described in **Table 4-1** and hydraulic properties defined in **Table 4-2**) and that the water is available in the surface to act as a driving head (i.e., a consistent leak), the results indicate water will take approximately 400 days to move through the first 10 m and then approximately another 2,000 days to move through another 50 m (siltstone/clay). If the subsurface was equivalent to a limestone which is more permeable, water would take 200 days to reach 50 m depth, or the approximate depth of the water table.

It should be noted that this evaluation is highly conservative as it assumes the sub-surface is completely saturated and has a constant driving head. However, in reality the driving head will be removed, either by evaporation or remediation, well before the predicted travel time is reached.

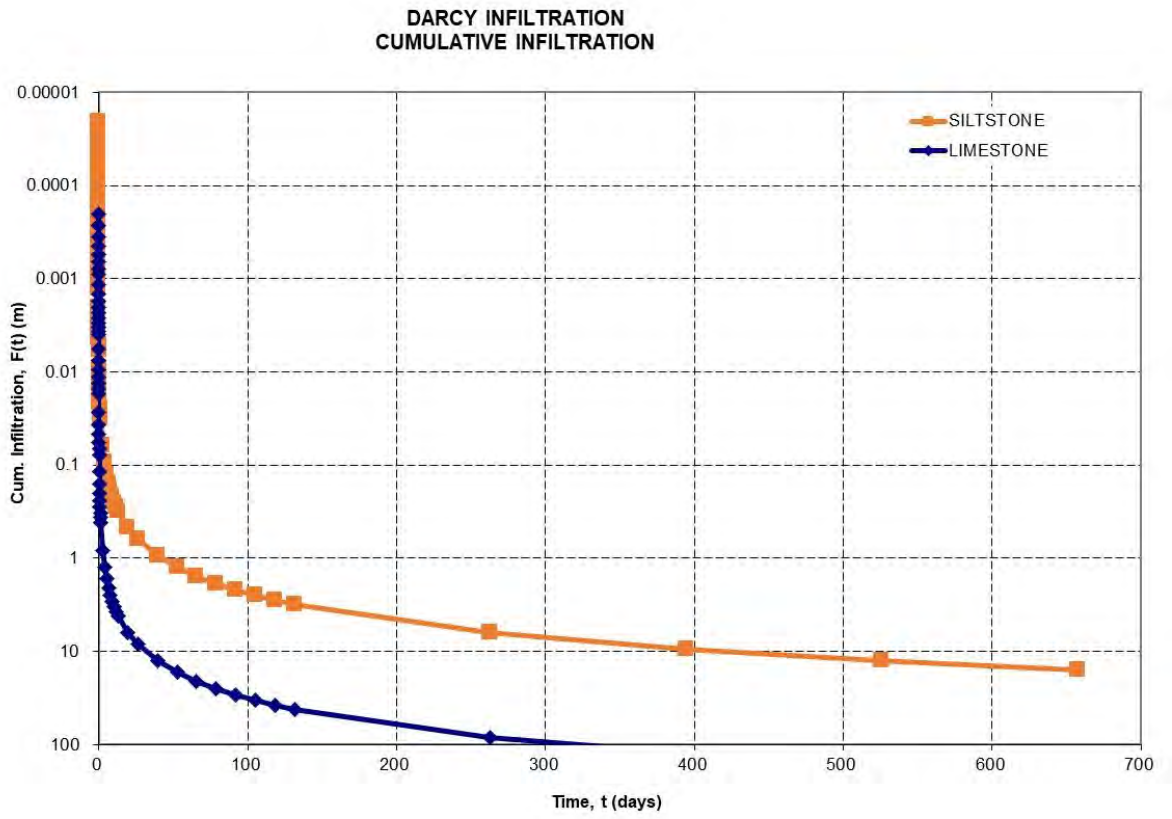


Figure 4-2 Results of the Darcy Analytical Model for Limestone and Siltstone

Note: Siltstone equivalent to the Anthony Lagoon Beds. Permeable sandstone equivalent to the Gum Ridge Limestone / Tindall Limestone.

5 Discussion

The results of this assessment present a very conservative estimate of the potential impacts to surface environmental receptors and groundwater. Its conservatism is inherent in the assumption that some of the scenarios considered that no risk mitigation measures were adopted and that the water releases were catastrophic.

In the context of smaller scale releases outside of the bunded area, this assessment indicates that spills of up to 1,000 L would only migrate a radial distance of 35 m. A catastrophic spill of 1,000,000 L on a relatively impermeable surface could migrate radially 549 m; however, this level of spill is considered highly unlikely with the assessment being highly conservative.

In the context of potential impact to groundwater via infiltration, modelling using both Green and Ampt (1911) and Darcy's equations (1856) (to assess unsaturated and saturated soils) has been conducted based on highly conservative assumptions. It has been determined that water would take 2,000 days to move through 50 m of siltstone/clay and 200 days for a lithology consistent with limestone. However, the modelling does not consider the capacity of the formation to retain water. In this context and based on the finite volume of water in the compound, it is not anticipated that a single release would infiltrate to groundwater.

With reference to potential sensitive receptors listed in **Table 1-1**, for the highly conservative and catastrophic release of 1,000,000 L of fluid, no sensitive receptors would be impacted.

6 Limitations

EHS Support Pty Ltd (EHS Support) has prepared this report in accordance with the usual care and thoroughness of the consulting profession for the use of Condor and only those third parties who have been authorised in writing by EHS Support to rely on the report. It is based on generally accepted practices and standards at the time it was prepared. No other warranty, expressed or implied, is made as to the professional advice included in this report. It is prepared in accordance with the scope of work and for the purpose outlined in the Proposal email dated 2 August 2022.

The methodology adopted and sources of information used by EHS Support are outlined in this report. EHS Support has made no independent verification of this information beyond the agreed scope of works and EHS Support assumes no responsibility for any inaccuracies or omissions. No indications were found during our investigations that information contained in this report as provided to EHS Support was false.

This report was prepared in December 2022 and January 2023 and is based on the information reviewed at the time of preparation. EHS Support disclaims responsibility for any changes that may have occurred after this time.

This report should be read in full. No responsibility is accepted for use of any part of this report in any other context or for any other purpose or by third parties. This report does not purport to give legal advice. Legal advice can only be given by qualified legal practitioners.

This report contains information obtained by inspection, sampling, testing or other means of investigation. This information is directly relevant only to the points in the ground where they were obtained at the time of the assessment. The borehole logs indicate the inferred ground conditions only at the specific locations tested. The precision with which conditions are indicated depends largely on the frequency and method of sampling, and the uniformity of conditions as constrained by the project budget limitations. The behaviour of groundwater and some aspects of contaminants in soil and groundwater are complex. Our conclusions are based upon the analytical data presented in this report and our experience. Future advances in regard to the understanding of chemicals and their behaviour, and changes in regulations affecting their management, could impact on our conclusions and recommendations regarding their potential presence on this site.

Where conditions encountered at the site are subsequently found to differ significantly from those anticipated in this report, EHS Support must be notified of any such findings and be provided with an opportunity to review the recommendations of this report.

Whilst to the best of our knowledge information contained in this report is accurate at the date of issue, sub-surface conditions, including groundwater levels can change in a limited time. Therefore, this document and the information contained herein should only be regarded as valid at the time of the investigation unless otherwise explicitly stated in this report.

7 References

Darcy, H. (1856). Les fontaines publiques de la ville de Dijon. Paris: Dalmont.

Dingman, S.L. 1994. Physical Hydrology Edition 5, Macmillan Publishing Company, 1994 ISBN 002329745X, 9780023297458 575 pages

Esteves, M., X. Faucher, S. Galle, and M. Vauclin. 2000. "Overland flow and infiltration modeling for small plots during steady rain: Numerical results versus observed values." Journal of Hydrology 228:265-282.

Freeze, R.A. and Cherry, J.A. 1979. Groundwater. Prentice-Hall, Inc., Englewood Cliffs.

Fulton S. and Knapton A. 2015. Beetaloo Basin Hydrogeological Assessment.

Grimaz, S., Allen, S., Steward, J. and Dolcetti, G. 2007. "Predictive evaluation of the extent of the surface spreading for the case of accidental spillage of oil on ground". Selected Paper IcheaP8, AIDIC Conference series, Vol. 8, pp. 151-160.

Green, W.H. and G. Ampt. 1911. Studies of Soil Physics, Part I – The Flow of Air and Water Through Soils. J. Ag. Sci. 4:1-24.

Knapton. 2006. Regional Groundwater Modelling of the Cambrian Limestone Aquifer System of the Wiso Basin, Georgina Basin and Daly Basin. Technical Report No. 29/2006A Department of Natural Resources, Environment & The Arts, Alice Springs.

Munson. 2016. Sedimentary characterisation of the Wilton package, greater McArthur Basin, Northern Territory. NTGS Record 2016-003. Northern Territory Geological Survey.

NALWTF. 2009. Sustainable Development in Northern Australia, A report to Gpvenment from the Northern Australia Land and Water Taskforce. Commonwealth of Australia, 2009. ISBN – 978-1-921095-94-8

Woolhiser, A. and J. A. Liggett. 1967. Unsteady, one-dimensional flow over a plane— The rising hydrograph. Water Resources Research, 3(3):753–771, 1967. ISSN 0043-1397. doi: 10.1029/WR003i003p00753.

Appendix C Risk Dossiers

1,6 HEXANEDIOL

This dossier on 1,6 hexanediol presents the most critical studies pertinent to the risk assessment of 1,6 hexanediol in its use in coal seam or shale gas extraction activities. This dossier does not represent an exhaustive or critical review of all available data. The majority of information presented in this dossier was obtained from the ECHA database that provides information on chemicals that have been registered under the EU REACH (ECHA). Where possible, study quality was evaluated using the Klimisch scoring system (Klimisch et al., 1997).

NICNAS has assessed 1,6-hexanediol in an IMAP Tier 1 assessment and concluded that it poses no unreasonable risk to the environment.

I. SUBSTANCE IDENTIFICATION

Chemical Name (IUPAC): Hexane-1,6-diol

CAS RN: 629-11-8

Molecular formula: $C_6H_{14}O_2$

Molecular weight: 118.17 g/mol

Synonyms: alpha,omega-Hexanediol, HDO, Hexamethylene glycol, Hexamethylenediol, Hexane-1,6-diol, Adipol

SMILES: C(CCCO)CCO

II. PHYSICO-CHEMICAL PROPERTIES

Table 1: Overview of the Physico-Chemical Properties of 1,6 hexanediol

Property	Value	Klimisch Score	Reference
Physical state at 20oC and 101.3 kPa	Solid colourless crystalline	2	ECHA
Melting Point	39.5-42.1^{o}C	3	ECHA
Boiling Point	250^{o}C @ 101.3 kPa	3	ECHA
Density	960 kg/m3@ 20^{o}C	2	ECHA
Vapour Pressure	0.1Pa @ 25^{o}C	2	ECHA
Partition Coefficient (log K_{ow})	0@25^{o}C	2	ECHA
Water Solubility	1000 g/L @ 20^{o}C	2	ECHA
Flash Point	136^{o}C @ 101.3 hPa	2	ECHA
Auto flammability	320^{o}C @ 101.3 hPa	2	ECHA
Viscosity	Not applicable	-	ECHA
Henry's Law Constant	Not applicable	-	ECHA

III. ENVIRONMENTAL FATE PROPERTIES

A. Summary

1,6-Hexanediol is expected to degrade in the environment, has a low potential for adsorption, and is unlikely to bioaccumulate. Specific data are discussed below.

B. Biodegradation

Degradation studies were conducted according to OECD guideline 301C using municipal activated sludge without preconditioning. After 28 days a DOC removal of 98% and a biological oxygen demand of 95% (BOD/ThOD) was measured. This result is supported by a literature study, which showed a DOC removal > 90% after 7 days in a test according to OECD 301A also using municipal activated sludge. [Kl Score = 3] (ECHA). Therefore, the substance is expected to biodegrade rapidly.

If a chemical is found to be readily biodegradable, it is categorised as Not Persistent since its half-life is substantially less than 60 days (DoEE, 2017).

C. Environmental Distribution

1,6-Hexanediol is not expected to adsorb to suspended solids and sediment based upon the K_{oc} of 1.01 and the log K_{oc} of 0.004 as calculated by use from EPISUITE™ using the MCI method.

If 1,6 hexanediol is released to water, it is not expected to absorb to suspended soils and sediments based on its high water solubility and low K_{oc} value.

D. Bioaccumulation

No bioaccumulation studies were conducted. Due to the low log K_{ow}, of 0, bioaccumulation in organisms is not expected [Kl. score = 2].

IV. HUMAN HEALTH HAZARD ASSESSMENT

A. Summary

1,6 hexanediol has low acute toxicity and it is rapidly excreted via urine. It is not irritating to the skin or the eye. 1,6 hexanediol is not a skin sensitizer nor is genotoxic.

B. Metabolism

An oral gavage study in Chinchilla rabbits were administered 2 mmol per kilogram body weight (mmol/kg bw) of 1,6 hexanediol via oral gavage. Roughly 4-9 % of the administered dose was excreted as glucuronide in the urine. Another urinary metabolite was adipic acid, which is the product that results from oxidation of both the hydroxyl groups of the parent compound (ECHA) [KI score =1].

C. Acute Toxicity

The oral LD_{50} in rats is approximately 3,000 milligrams per kilogram (mg/kg) (ECHA) [Kl. score = 2]. The 8-hour LC_{50} in rats is >3.3 mg/L air (ECHA) [Kl. score = 2]. The dermal LD_{50} in rabbits is >2,500 mg/kg (ECHA) [Kl. score = 2].

D. Irritation

Application of 1 millilitre (mL) to the skin of rabbits for 20 hours under occlusive conditions was not irritating. The mean of the 24, 48, and 72-hour scores were 0.00 for both erythema and oedema (ECHA) [Kl. score = 2].

Instillation of 0.1 mL into the eyes of rabbits was not irritating. The mean of the 24, 48, and 72-hour scores were: 0.00 for corneal opacity; 0.00 for iridial lesions; 1.70 for conjunctival redness; and 1.00 for chemosis (ECHA) [Kl. score = 1].

E. Sensitisation

1,6-Hexanediol was not considered a skin sensitizer when tested in a guinea pig maximization test (ECHA) [Kl. score = 1].

F. Repeated Dose Toxicity

Oral

Male and female Wistar rats were dosed with 0, 100, 400, or 1,000 mg/kg 1,6-hexanediol by oral gavage for 28 days. There were no substantial treatment-related effects regarding feed consumption, body weight, body weight gain, clinical chemistry parameters, clinical signs, gross pathology, or histopathology. The no observed adverse effects level (NOAEL) for this study is 1,000 mg/kg-day, the highest dose tested (ECHA) [Kl. score = 1].

Male and female Wistar rats were dosed with 0, 100, 400, or 1,000 mg/kg 1,6-hexanediol by oral gavage for 91-92 days (male and female respectively). There were no treatment effects observed in the female group, so the NOAEL was determined to be 1,000 mg/kg/day. The NOAEL for this study is 400 mg/kg-day based on reduced body weight in male rats(ECHA) [Kl. score = 1].

Inhalation

There are no studies available.

Dermal

There are no studies available

G. Genotoxicity

In Vitro Studies

The *in vitro* genotoxicity studies on 1,6 hexanediol are presented in Table 2.

Table 2: *In vitro* Genotoxicity Studies on 1,6 hexanediol

Test System	Results*		Klimisch Score	Reference
	-S9	+S9		
Bacterial reverse mutation (S. typhimurium strains	-	-	2	ECHA

Test System	Results*		Klimisch Score	Reference
	-S9	+S9		
Bacterial reverse mutation (S. typhimurium strains	-	-	2	ECHA
Mammalian cell gene mutation (HGPRT, Chinese hamster V79 cells)	-	-	1	ECHA
Chromosomal aberrations (Chinese hamster V79 cells)	-	-	1	ECHA

*+, positive; -, negative

In Vivo Studies

No studies available

H. Carcinogenicity

No studies available.

I. Reproductive Toxicity/Developmental Toxicity

A reproductive/developmental toxicity screening (OECD TG 421) study has been conducted on 1,6-hexanediol. Male and female Wistar rats were dosed with 0, 100, 400, or 1,000 mg/kg-day by oral gavage for four weeks. There was no indication of reproductive or developmental toxicity. The 1,000 mg/kg males had reduced body weights and body weight gain. The NOAEL for reproductive and developmental toxicity is 1,000 mg/kg-day, the highest dose tested. The NOAEL for parental toxicity is 1,000 mg/kg-day for females and 400 mg/kg-day for males (ECHA) [Kl. score = 1].

Male and female Wistar rats were dosed with 0, 100, 400, or 1,000 mg/kg 1,6-hexanediol by oral gavage for 56 days. There were no treatment-related effects on oestrous cycle length and the number of cycles that were obtained. Sperm motility, the incidence of abnormal sperm in the cauda epididymis, and the sperm head counts in the testis and cauda epididymis were similar between treated and control males. The NOAEL for reproductive and developmental toxicity endpoints is 1,000 mg/kg-day, the highest dose tested (ECHA) [Kl. score = 1].

V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES

The toxicological reference values developed for 1,6 hexanediol follow the methodology discussed in enHealth (2012). The approach used to develop drinking water guidance values is described in the Australian Drinking Water Guidelines (ADWG, 2011).

A. Non-Cancer

Oral

The lowest NOAEL from these studies is 400 mg/kg-day based on the absence of treatment-related effects in a reproductive and developmental toxicity study.

The NOAEL of 400 mg/kg-day from the four-week reproductive and developmental toxicity study will be used to determine the oral reference dose (RfD) and the drinking water guidance value.

Oral Reference Dose (oral RfD)

Oral RfD = NOAEL / (UF_A x UF_H x UF_L x UF_{Sub} x UF_D)

Where:

UF_A (interspecies variability) = 10
UF_H (intraspecies variability) = 10
UF_L (LOAEL to NOAEL) = 1
UF_{Sub} (subchronic to chronic) = 10
UF_D (database uncertainty) = 1
Oral RfD =400/(10 x 10 x 1 x 10 x 1) = 400/1000 = 0.4 mg/kg/day

Drinking water guidance value

Drinking water guidance value = (animal dose) x (human weight) x (proportion of intake from water) / (volume of water consumed) x (safety factor)

Using the oral RfD,

Drinking water guidance value = (oral RfD) x (human weight) x (proportion of water consumed) / (volume of water consumed)

Where:

Human weight = 70 kg (ADWG, 2011)
Proportion of water consumed = 10% (ADWG, 2011)
Volume of water consumed = 2L (ADWG, 2011)
Drinking water guidance value = (0.4 x 70 x 0.1)/2 = 1.4 mg/L

B. Cancer

There is no evidence that 1,6 hexanediol is a carcinogen.

VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES

1,6 hexanediol does not exhibit the following physico-chemical properties:

- Explosivity
- Flammability
- Oxidising potential

VII. ENVIRONMENTAL HAZARD ASSESSMENT

A. Summary

1,6 hexanediol has low acute and chronic aquatic toxicity to algae, fish, and invertebrates.

B. Aquatic Toxicity

Acute Studies

Table 3 lists the results of acute aquatic toxicity studies conducted on 1,6 hexanediol .

Table 3: Acute Aquatic Toxicity Studies on 1,6 hexanediol

Test Species	Endpoint	Results (mg/L)	Klimisch Score	Reference
Leuciscus idus	96- hour LC_{50}	4,460-10,000	2	ECHA
Daphnia magna	48-hour EC_{50}	>500	2	ECHA
Desmodesmus subspicatus	72-hour EC_{50}	5,940	2	ECHA

Chronic Studies

The 72h EC_{10} for Desmodesmus subspicatus, also known as Scenedesmus subspicatus, is 1,180 mg/L(ECHA) [KI Score =2].

The 96h no observed effect concentration (NOEC) for Leuciscus idus is 2,200 mg/L based on mortality (ECHA) [KI Score =2].

C. Terrestrial Toxicity

The EC_{50} for Pseudomonas putida is >10,000 mg/L based on growth inhibition.

D. Calculation of PNEC

The PNEC calculations for 1,6 hexanediol follow the methodology discussed in DEWHA (2009).

PNEC Water

Experimental results are available for three trophic levels. Acute E(L)C_{50} values are available for fish (4,460 mg/L) , *Daphnia* (>500 mg/L), and algae (5,490 mg/L).NOEC/72h EC_{10} values from long-term studies are available for algae (1,180 mg/L) and fish (2,200 mg/L). On the basis that the data consists of short-term results from three trophic levels and long-term results from two trophic levels, an assessment factor of 10 has been applied to the lowest reported E(L)C_{50} value of 500 mg/L for Daphnia. The E(L)C_{50} value is used because the value for Daphnia is lower than the NOEC values for all other trophic levels, including fish and algae. The $PNEC_{aquatic}$ is 50 mg/L.

PNEC Sediment

There are no toxicity data for sediment-dwelling organisms. Therefore, the $PNEC_{sed}$ was calculated using the equilibrium partitioning method. The $PNEC_{sed}$ is 32.03 mg/kg sediment wet weight.

The calculations are as follows:

$PNEC_{sed} = (K_{sed\text{-}water}/BD_{sed}) \times 1000 \times PNEC_{water}$
$= (0.82/1280) \times 1000 \times 50$
$= 32.031 mg/kg$

Where:
$K_{sed\text{-}water}$ = suspended matter-water partition coefficient (m^3/m^3)
BD_{sed} = bulk density of sediment (kg/m^3) = 1,280 [default]
$K_{sed\text{-}water} = 0.8 + [(0.2 \times Kp_{sed})/1000 \times BD_{solid}]$

= 0.8 + [(0.2 x 0.0404/1000 x 2400]
= 0.82 m^3/m^3

Where:

Kp_{sed} = solid-water partition coefficient (L/kg)
BD_{solid} = bulk density of the solid phase (kg/m^3) = 2,400 [default]
$Kp_{sed} = K_{oc} \times f_{oc}$
=1.01 x 0.04
= 0.0404 L/kg

Where:

K_{oc} = organic carbon normalised distribution coefficient (L/kg). The K_{oc} for1,6 hexanediol calculated from EPISUITE™ using the MCI is 1.01 L/kg.
F_{oc} = fraction of organic carbon in sediment = 0.04 [default].

PNEC Soil

There are no toxicity data for terrestrial or soil organisms. Therefore, the $PNEC_{soil}$ was calculated using the equilibrium partitioning method. The $PNEC_{soil}$ is 0.67 mg/kg soil dry weight.

The calculations are as follows:

$PNEC_{soil} = (Kp_{soil}/BD_{soil}) \times 1000 \times PNEC_{water}$
= (0.02/1500) x 1000 x 50
= 0.67 mg/kg

Where:

Kp_{soil} = soil-water partition coefficient (m^3/m^3)
BD_{soil} = bulk density of soil (kg/m^3) = 1,500 [default]
$Kp_{soil} = K_{oc} \times f_{oc}$
= 1.01 x 0.02
= 0.02 m^3/m^3

Where:

K_{oc} = organic carbon normalised distribution coefficient (L/kg). The K_{oc} for 1,6 hexandiol calculated from EPISUITE™ using the MCI is 1.01 L/kg.
F_{oc} = fraction of organic carbon in soil = 0.02 [default].

VIII. PERSISTENCE, BIOACCUMULATION AND TOXICITY (PBT) ASSESSMENT

The methodology for the Persistent, Bioaccumulative and Toxic (PBT) substances assessment is based on the Australian and EU REACH Criteria methodology (DEWHA, 2009; ECHA, 2017).

1,6 hexanediol is readily biodegradable and thus does not meet the screening criteria for persistence.

1,6 hexanediol has a low K_{ow}. Thus, 1,6 hexanediol does not meet the criteria for bioaccumulation.

The NOECs from the chronic aquatic toxicity studies on 1,6 hexanediol are > 0.1 mg/L. The acute $E(L)C_{50}$ values from the acute aquatic toxicity studies on 1,6 hexanediol are > 1 mg/L. Thus, 1,6 hexanediol does not meet the criteria for toxicity.

The overall conclusion is that 1,6 hexanediol is not a PBT substance.

IX. CLASSIFICATION AND LABELLING

A. Classification

Not Classified

B. Labelling

None

A. Pictogram

None

X. HANDLING AND SAFETY INFORMATION (OCCUPATIONAL LIMITS AND TRANSPORTATION REQUIREMENTS)

A. First Aid

Eye Contact

In case of contact, immediately flush eyes with plenty of water for at least 15 minutes.

Skin Contact

Wash thoroughly with soap and water.

Inhalation

If inhaled, remove from area to fresh air. Get medical attention.

Ingestion

Rinse mouth with water and then drink a glass of water. Get medical attention. Never give anything by mouth to an unconscious person.

Fire Fighting Information

Extinguishing Media

Water spray, carbon dioxide, foam, dry chemical.

Specific Exposure Hazards

Keep product and empty container away from heat and sources of ignition. May emit toxic fumes under fire conditions. Depending on conditions, decomposition products may include the following: carbon monoxide, carbon dioxide.

Special Protective Equipment for Firefighters

Wear self-contained breathing apparatus.

B. Accidental Release Measures

Personal Precautions

Use appropriate protective equipment. Handle in accordance with good industrial hygiene and safety practice.

Environmental Precautions

Prevent from entering sewers, waterways or low areas.

Steps to be Taken if Material is Released or Spilled

For large amounts: dike spillage and pump off product. For residues: pick up with suitable absorbent material. Dispose of contaminated material as prescribed.

C. Storage And Handling

General Handling

Keep product and empty container away from heat and sources of ignition. Ensure adequate ventilation, especially in confined areas.

Storage

Keep container tightly closed and in a dry and well-ventilated place. Keep in a cool place.

D. Exposure Controls / Personal Protection

Occupational Exposure Standards

Workplace Australia has not established a value for this substance.

Engineering Controls

Good general ventilation should be used.

Personal Protection Equipment

Respiratory Protection: Respiratory protection is not required.

Hand Protection: Chemical resistant protective gloves.

Skin Protection: Body protection must be chosen depending on activity and possible exposure.

Eye protection: Safety glasses with side-shields.

Other Precautions: Handle in accordance with good industrial hygiene and safety practice. Wearing of closed work clothing is recommended. Ensure that eyewash stations and safety showers are close to the workstation location.

E. Transport Information

1,6 Hexanediol is not considered hazardous for purposes of transportation by road or rail. An Australian Dangerous Goods code is not required.

XI. DISPOSAL MANAGEMENT

Disposal should be in accordance with all local, state and federal regulations.

XII. REGULATORY STATUS

Australian AICS Inventory: Listed.

XIII. REFERENCES

ADWG. (2011). National Water Quality Management Strategy. Australian Drinking Water Guidelines, Section 6, Australian Government, National Health and Medical Research Council, Natural Resource Management Ministerial Council. Updated January 2022. Available: https://www.nhmrc.gov.au/about-us/publications/australian-drinking-water-guidelines

Department of the Environment, Water, Heritage and the Arts (DEWHA). (2009). Environmental risk assessment guidance manual for industrial chemicals, Department of the Environment, Water, Heritage and the Arts, Commonwealth of Australia. Available: http://www.nepc.gov.au/resource/chemical-risk-assessment-guidance-manuals

Department of the Environment and Energy (DoEE). (2017). Chemical Risk Assessment Guidance Manual: for chemicals associated with coal seam gas extraction, Guidance manual prepared by Hydrobiology and ToxConsult Pty Ltd for the Department of the Environment and Energy, Commonwealth of Australia, Canberra.

ECHA. ECHA REACH database: http://echa.europa.eu/information-on-chemicals/registered-substances

enHealth Human Risk Assessment (HHRA). (2012). Environmental Health Risk Assessment, Guidelines for Assessing Human Health Risks from Environmental Hazards. Office of Health Protection of the Australian Government Department of Health. Available: https://www1.health.gov.au/internet/main/publishing.nsf/Content/health-pubhlth-publicat-environ.htm

European Chemicals Agency (ECHA). (2017). Guidance on Information Requirements and Chemical Safety Assessment, Chapter R11: PBT Assessment, European Chemicals Agency, Helsinki, Finland. Available: https://echa.europa.eu/guidance-documents/guidance-on-information-requirements-and-chemical-safety-assessment

Klimisch, H.J., Andreae, M., and Tillmann, U. (1997). A systematic approach for evaluating the quality of experimental and toxicological and ecotoxicological data. Regul. Toxicol. Pharmacol. 25:1-5.

PubChem. National Institutes of Health. National Library of Medicine National Center for Biotechnology Information. https://pubchem.ncbi.nlm.nih.gov/

U.S. Environmental Protection Agency (USEPA). (2017). EPISuite™ v. 4.11, United States Environmental Protection Agency, Office of Pollution Prevention and Toxics and Syracuse Research Corporation. Available: https://www.epa.gov/tsca-screening-tools/epi-suitetm-estimation-program-interface.

2-ETHOXY-NAPHTHALENE

This dossier on 2-ethoxy-naphthalene presents the most critical studies pertinent to the risk assessment of 2-ethoxy-naphthalene in its use in coal seam or shale gas extraction activities. This dossier does not represent an exhaustive or critical review of all available data. The majority of information presented in this dossier was obtained from the ECHA database that provides information on chemicals that have been registered under the EU REACH (ECHA). Where possible, study quality was evaluated using the Klimisch scoring system (Klimisch et al., 1997).

I. SUBSTANCE IDENTIFICATION

Chemical Name (IUPAC): 2-ethoxynaphthalene

CAS RN: 93-18-5

Molecular formula: $C_{12}H_{12}O$

Molecular weight: 172.2 g/mol

Synonyms: 2-ethoxy-naphthalene; 2-ethoxynaphthalene; Naphthalene, 2-ethoxy-; Bromelia; Ethyl β-naphtholate; Ethyl β-naphthyl ether

SMILES: O(C=1C=CC=2C=CC=CC2C1) CC

II. PHYSICO-CHEMICAL PROPERTIES

Table 1: Overview of the Physico-chemical Properties of 2-ethoxy-naphthalene

Property	Value	Klimisch Score	Reference
Physical state at 20°C and 101.3 kPa	White powder	1	ECHA
Melting Point	35-37.1°C @ 96.93 kPa	1	ECHA
Boiling Point	300°C @96.88 kPa	1	ECHA
Density	1241.3 kg/m^3@ 20°C	1	ECHA
Vapour Pressure	0.518 Pa @ 25°C	2	ECHA
Partition Coefficient (log K_{ow})	3.75 @ 25°C	1	ECHA
Water Solubility	0.00001 g/L @ 30°C	1	ECHA
Flash Point	140.6 °C	1	ECHA
Auto flammability	Not applicable because the substance is a solid	-	ECHA
Viscosity	Not applicable because the substance is a solid	-	ECHA
Henry's Law Constant	Not applicable because the substance does not have an ionic structure	-	ECHA

III. ENVIRONMENTAL FATE PROPERTIES

A. Summary

2-ethoxy-naphthalene is readily biodegradable in the environment. The substance will strongly adsorb to soil or suspended sediments and is insoluble in water. However, 2-ethoxy-naphthalene is not expected to bioaccumulate.

B. Biodegradation

An OECD Guideline 301 D (Ready Biodegradability: Closed Bottle) test was conducted to determine the biodegradability of 2-ethoxynaphthalene. The results of this study demonstrated that 2-ethoxy-naphthalene undergoes 33.45% biodegradation after 42 days of incubation at 20 ± 1 °C (ECHA)[KI. score =1].

These results indicate the 2-ethoxy-naphthalene is inherently biodegradable. If a chemical is found to be readily or inherently biodegradable, it is categorised as Not Persistent since its half-life is substantially less than 60 days (DoEE, 2017).

C. Environmental Distribution

An OECD Guideline 121 (Estimation of the Adsorption Coefficient K_{oc} on soil and on sewage sludge using high performance liquid chromatography HPLC) study was performed to determine the log K_{oc} for 2-ethoxy-naphthalene. The log K_{oc} value of 2-ethoxy-naphthalene was determined to be 3.490 ± 0.003 (K_{oc} = 3090) at 25°C. This log K_{oc} value indicates that 2-ethoxy-naphthalene has a strong sorption to soil and sediment and therefore has negligible to slow migration potential to ground water (ECHA)[KI. score =1).

The half-life period of 2-ethoxy-naphthalene in soil is estimated to be 30 days (720 hrs). Based on this half-life value of 2-ethoxy-naphthalene, it is concluded that the chemical is not persistent in the soil environment and the exposure risk to soil dwelling animals is moderate to low (ECHA).

D. Bioaccumulation

The bioconcentration factor (BCF) of 2-ethoxy-naphthalene was estimated using the EPISuite program (BCFBAF (v3.01) model) developed by the US EPA. The bioconcentration factor (BCF) of 2-ethoxy-naphthalene was estimated to be 136.6 L/kg whole body wet weight at 25°C. This result indicates that 2-ethoxy-naphthalene is not expected to bioaccumulate (ECHA) [KI. score =2].

IV. HUMAN HEALTH HAZARD ASSESSMENT

A. Summary

2-ethoxy-naphthalene has low acute oral and dermal toxicity. This substance is not irritating to the skin, but it is slightly irritating to the eye. 2-ethoxy-naphthalene is not a skin sensitiser. 2-ethoxy-naphthalene is not mutagenic or genotoxic. There are no studies available to evaluate the carcinogenic potential of this substance. 2-ethoxy-naphthalene is not a reproductive or developmental toxicant.

B. Acute Toxicity

Oral

An OECD Guideline 423 (Acute Oral Toxicity-Acute Toxic Class Method) study was conducted female Sprague-Dawley rats exposed to 300 or 2000 mg/kg of 2-ethoxy-naphthalene via oral gavage. Gross pathological examination did not reveal any abnormalities in animals from 300 mg/kg and 2000 mg/kg dose groups. Therefore, the acute oral LD_{50} value of 2-ethoxy-naphthalene was considered to be >2000 mg/kg body weight (ECHA) [KI. score =1].

Inhalation

There are no studies available.

Dermal

An OECD Guideline 402 (Acute dermal toxicity) study was conducted using male and female Sprague-Dawley rats exposed to 2000 mg of 2-ethoxy-naphthalene via semi occlusive dressing for 24 hours. It was concluded that the acute dermal median lethal dose (LD_{50}) of 2-ethoxy-naphthalene was considered to be >2000 mg/kg body weight (ECHA) [KI. score =1].

An acute dermal toxicity study was conducted using rabbits exposed to 5,000 mg/kg bw/day of 2-ethoxy-naphthalene. The acute dermal LD_{50} value was considered to be >5,000 mg/kg bw (ECHA)[KI. score =2].

C. Irritation

Skin

An OECD Guideline 402 (Acute dermal toxicity) study was conducted using male and female Sprague-Dawley rats exposed to 2000 mg/kg of 2-ethoxy-naphthalene via occlusive dressing for 24 hours. Administration of the test item did not result in any signs of toxicity and mortality during the study period of 14 days. Animals exhibited normal body weight gain through the study period of 14 days. Gross pathological examination did not reveal any abnormalities attributable to the treatment. The overall irritation score of the substance was determined to be 0 and no erythema and oedema (skin irritation) were observed at the end of 14 days after patch removal. Hence, it was concluded that 2-ethoxy-naphthalene (CAS No. 93-18-5) was not-irritating to the skin of rats under the experimental conditions tested (ECHA) [KI. score =1].

Eye

An *in vivo* eye irritation study was conducted using New Zealand white rabbits exposed to a single exposure of 0.1 grams or undiluted 2-ethoxy-naphthalene. The individual mean score for animal nos. 1, 2 and 3 at 24, 48, 72 hours for corneal opacity, iris, conjunctiva and chemosis were found 1.00, 0.00, 2.00, 1.00; 1.00, 0.00, 2.00, 1.33, and 1.00, 0.00, 2.00, 1.33, respectively. The effects observed in all the animals were fully reversible within an observation period of 21 days. 2-Ethoxy-naphthalene was estimated to be slightly irritating to eyes. (ECHA) [KI. score =2].

D. Sensitisation

An Open Epicutaneous Test (OET) was performed on guinea pigs to assess the skin sensitisation potential of 3,10,30, or 100 % of 2-ethoxy-naphthalene. It was observed that none of the guinea pigs

induced contact sensitisation at challenge concentration of 2%. Thus, 2-ethoxy-naphthalene was considered to be not sensitising on skin of guinea pigs when tested via an Open Epicutaneous Test (OET) (ECHA) [KI. score =2].

E. Repeated Dose Toxicity

Oral

A sub chronic repeat dose oral toxicity study was performed using male and female FDRL rats exposed to 5.1 mg/kg (males) or 5.7 mg/kg (females) 2-ethoxy-naphthalene via their feed diluted in cotton seed oil for 90 days. Administration of 2-ethoxy-naphthalene for 90 days at a level in excess of at least 100 times the maximum estimated daily dietary intake in man evoked no adverse effect on growth, food consumption, haematology, blood chemistry, liver and kidney weights or on gross and microscopic appearance of major organs at autopsy. Hence, the No Observed Adverse Effect Level (NOAEL) for 2-ethoxy-naphthalene is considered to be 5.1 mg/kg bw/day in males and 5.7 mg/kg bw/day in females (ECHA) [KI. score =2].

A sub chronic repeat dose oral toxicity study was performed using rats exposed to 5 mg/kg bw/day of 2-ethoxy-naphthalene via oral gavage. There were no significant alterations were noted at the tested dose level. The NOAEL for 2-ethoxy-naphthalene was reported to be is 5.0 mg/kg bw/day (ECHA) [KI. score =2].

A sub chronic repeat dose oral toxicity study was conducted using rats exposed to 1,000 mg/kg bw/day (2%) of 2-ethoxy-naphthalene via their feed for 60 days. During the 2 months study period, the treated rats developed cataracts and 2-ethoxy-naphthalene was considered to be cataractogenic. Based on these observations, the NOAEL for 2-ethoxy-naphthalene was reported to be < 1000 mg/Kg/day (ECHA)[KI. score =2].

Inhalation

There are no studies available.

Dermal

There are no studies available.

F. Genotoxicity

In vitro Studies

The *in vitro* genotoxicity studies on 2-ethoxy-naphthalene are presented in Table 2.

Table 2: *In vitro* Genotoxicity Studies on 2-ethoxy-naphthalene

Test System	Results*		Klimisch Score	Reference
	-S9	+S9		
OECD Guideline 471 Bacterial Reverse Mutation Assay (Salmonella typhimurium strains TA 100, TA 102, TA 98, TA 1535, and TA 1537	-	-	1	ECHA
Salmonella typhimurium TA 98, TA 100, TA 1535, TA 1537	-	-	2	ECHA

Test System	Results*		Klimisch Score	Reference
	-S9	+S9		
Salmonella typhimurium TA 98, TA 100, T1535, TA 1537 and E. coli WP2 uvr A pKM 101	-	-	2	ECHA
Bacterial reverse mutation assay (S. typhimurium TA 98 TA 100 TA 1535, TA 1537, TA 15838	-	-	2	ECHA
In vitro cytogeneticity chromosome aberration study in mammalian cells (human peripheral blood lymphocytes and Chinese hamster fibroblast cell line, CHL)	-	-	2	ECHA
OECD Guideline 473 *In vitro* mammalian chromosome aberration test (human peripheral blood lymphocytes) **	-	-	1	ECHA
OECD Guideline 473 *In vitro* mammalian chromosome aberration test (Chinese hamster fibroblast cell line, CHL) ***	-	-	2	ECHA

*+, positive; -, negative
**Methyl 2-naphthyl ether (CAS RN 93-04-9)
***4-methoxybenzaldehyde (CAS RN 123-11-5)

In vivo Studies

A drosophila sex linked recessive lethal mutation (SLRL) assay was conducted to determine the mutagenic potential of 25 mM of 2-ethoxy-naphthalene in male drosophila melanogaster exposed to 2-ethoxy-naphthalene via their oral feed. Sex linked recessive lethal mutation were noted in the chromosomes. 2-ethoxy-naphthalene gave negative gene mutation results in the Drosophila SLRL test performed using male Drosophila melanogaster species (ECHA) [KI. score =2].

An *in vivo* micronucleus assay was performed to determine the mutagenic nature of 2-ethoxy-naphthalene in male and female NMRI mice exposed to 0,344, 603, 861 mg/kg of 2-ethoxy-naphthalene via intraperitoneal route of exposure for 24 hours. The micronucleus assay was performed using bone marrow smears of male and female NMRI mice. 2-ethoxy-naphthalene failed to produce genetic effects in this micronucleus assay (ECHA)[KI. score =2].

G. Carcinogenicity

Oral

There are no studies available.

Inhalation

There are no studies available.

Dermal

There are no studies available.

H. Reproductive Toxicity

A sub chronic oral feeding study was conducted using male and female FDRL rats exposed to 0, 5.1, 5.7 mg/kg bw/day of 2-ethoxy-naphthalene daily for 90 days. There were no adverse effects on body weight and food consumption or food efficiency throughout the administration period. Similarly, no effect on haematological parameters and organ weight of treated male and female rats were observed as compared to control. In addition, there were no gross pathological or histopathological changes observed in the treated male and female rats in liver, kidneys, stomach, small and large intestines, spleen, pancreas, heart, lungs, bone marrow, muscle, brain, spinal cord, bladder, adrenals, thyroid, pituitary, gonads, salivary glands, and lymph nodes as compared to control. Therefore, the NOAEL was considered to be 5.1 mg/kg bw/day for males and 5.7 mg/kg bw/day for females (ECHA) [KI. score =2].

A 28 day repeat oral toxicity study was conducted using male and female Sprague-Dawley rats exposed 0, 125, 250, and 500 mg/kg bw/day of 2-methoxynaphthalene via oral gavage. The results showed that methyl 2-naphthyl ether significantly increased the level of testosterone in the 500 mg/kg body weight/day group as well as it significantly increased the level of estrogen in the 250 mg/kg body weight/day group. The relative and absolute organ weight of ovaries decreased when treated with 125, 250 or 500 mg/kg body weight/day. In similarity, the relative and absolute organ weight of uterus decreased in the 125 or 500 mg/kg body weight/day groups. No significant changes in were detected in hematology, clinical biochemistry, mortality organ weight, and no effects were observed in water consumption, ophthalmoscopic examination or locomotor activity. In male rats, the relative organ weights of the testes and epididymides increased when rats were treated with 500 mg/kg body weight/day. Histopathology performed on reproductive organs after treatment with 500 mg/kg body weight/day did not reveal any toxic lesions as compared to control. Hence, NOAEL was considered to be 250 mg/kg bw/day when Sprague Dawley rats were exposed daily to test material by oral route for 28 days. (ECHA)[KI. score =1].

I. Developmental Toxicity

<u>Oral</u>

An OECD Guideline 414 (Prenatal developmental toxicity) study was conducted using New Zealand White rabbits exposed to 2-ethoxy-naphthalene via oral gavage for 15-30 days. The test material dissolved in 0.5% Carboxymethyl cellulose in dose concentration 0, 3, 10 and 50 mg/kg/day and administered by daily gavage through gestation day 6 to 28 to mated females (25/dose group).The preliminary range-finding study (0, 10, 60 and 300 mg/kg/day) was performed, Based on preliminary range-finding study findings, 0, 3, 10 and 50 mg/kg/day were selected for the main study. There were no maternal death or necropsy findings at any dose levels. There was a significant reduction in the body weight gain during the treatment period in the high dose group (50 mg/kg). The food consumption was comparable to the vehicle control group. The reduction in body weight during the treatment period was considered treatment related. One rabbit aborted in the high dose group, there were 2 non pregnant rabbits in control, 4 in low dose group, 3 in mid dose group and 4 in the high dose group. There was one complete resorption in mid dose group. At the end, at least 20 litters were observed in each of the dose groups. The maternal data parameters comprising of implantations, early and late resorptions, pre- and post-implantation loss in all the treatment groups were comparable to the vehicle control group. The mean number of corpora lutea, implantation and live foetus were significantly lower in high dose group (50 mg/kg bw/day) when compared with the control group. Observed decrease in corpora lutea at 50 mg/kg bw/day is considered as biological variation because the treatment was initiated after the implantation (gestation day 6). Therefore, the decrease observed in the absolute uterine weight, implantation and live foetus reported at this dose level are also considering as biological variation as these observations are directly correlated

with the decrease in the number of the corpora lutea. Hence, the NOAEL for developmental toxicity was considered to be 50 mg/kg/day (ECHA)[KI. score =2].

An OECD Guideline 414 (Prenatal developmental toxicity) study was conducted using Crl:CD BR VAF/Plus rats exposed to , 150, 300, 600, or 1000 mg/kg/day of 2-ethoxy-naphthalene via oral gavage for 15-30 days. Mortality was observed in the 1000 mg/kg/day dose group. Clinical signs such as tremors, uncoordinated movements, recumbent posture, languidness, cold body and decreased body weight gain were observed. Foetal body weights were decreased at 600 and 1000 mg/kg/day. Skeletal variations were seen at the 300 mg/kg/day and at higher doses. The skeletal variations manifested as increased unossified sternebrae, seventh cervical ribs, and misaligned sternebrae. Hence, the NOELs for maternal and developmental toxicity were considered to be 150 mg/kg/day (ECHA) [KI. score =2].

Inhalation

There are no studies available.

Dermal

There are no studies available.

V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES

The toxicological reference values developed for 2-ethoxy-naphthalene follow the methodology discussed in enHealth (2012). The approach used to develop drinking water guidance values is described in the Australian Drinking Water Guidelines (ADWG, 2011).

A. Non-Cancer

Oral

A 90-day sub chronic repeat dose oral toxicity study was performed using male and female FDRL rats exposed to 5.1 mg/kg (males) or 5.7 mg/kg (females) 2-ethoxy-naphthalene via their feed diluted in cotton seed oil for 90 days. . No adverse effect on growth, food consumption, haematology, blood chemistry, liver and kidney weights or on gross and microscopic appearance of major organs at autopsy was observed. The NOAEL for 2-ethoxy-naphthalene was reported to be is 5.1 mg/kg bw/day for males and 5.7 mg/kg bw/day for females (ECHA) [KI. score =2]. These NOAELs were supported by a 28-day sub chronic repeat dose oral toxicity study which reported no significant alterations at the dose level of 5.0 mg/kg bw/day in rats. The NOAEL of 5.1 mg/kg bw/day will be used for determining the oral reference dose (RfD) and the drinking water guidance value.

Oral Reference Dose (oral RfD)

Oral RfD = NOAEL / (UF_A x UF_H x UF_L x UF_{Sub} x UF_D)

Where:

UF_A (interspecies variability) = 10
UF_H (intraspecies variability) = 10
UF_L (LOAEL to NOAEL) = 1
UF_{Sub} (subchronic to chronic) = 10
UF_D (database uncertainty) = 1
Oral RfD = 5.1/(1 x 10 x 1 x 1 x 1) = 5.1/1000 = 0.005 mg/kg/day

Drinking water guidance value

Drinking water guidance value = (animal dose) x (human weight) x (proportion of intake from water) / (volume of water consumed) x (safety factor)

Using the oral RfD,

Drinking water guidance value = (oral RfD) x (human weight) x (proportion of water consumed) / (volume of water consumed)

Where:

Human weight = 70 kg (ADWG, 2011)
Proportion of water consumed = 10% (ADWG, 2011)
Volume of water consumed = 2L (ADWG, 2011)
Drinking water guidance value = (0.005 x 70 x 0.1)/2 = 0.017 mg/L

B. Cancer

There are no studies available to evaluate the carcinogenic potential of 2-ethoxy-naphthalene.

VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES

2-ethoxy-naphthalene does not exhibit the following physico-chemical properties:

- Explosivity
- Flammability
- Oxidising potential

VII. ENVIRONMENTAL HAZARD ASSESSMENT

A. Summary

2-ethoxy-naphthalene is of low aquatic and terrestrial toxicity concern.

B. Aquatic Toxicity

Acute Studies

Table 3 lists the results of acute aquatic toxicity studies conducted on 2-ethoxy-napthalene. Limited studies have been conducted since the substance is highly insoluble in water and aquatic toxicity is unlikely to occur (ECHA).

Table 3: Acute Aquatic Toxicity Studies on 2-ethoxy-napthalene

Test Species	Endpoint	Results (mg/L)	Klimisch score	Reference
Daphnia magna	72-h EC_{50}	3.9 (mobility)	1	ECHA

Chronic Studies

There are no studies available.

C. Terrestrial Toxicity

The test material 2-ethoxy-naphthalene is considered to have negligible direct or indirect exposure to soil. The half-life period of 2-ethoxy-naphthalene in soil is estimated to be 30 days (720 hrs). Based on this half-life value, it is concluded that the chemical is not persistent in the soil environment and the exposure risk to soil dwelling animals is moderate to low (ECHA).

D. Calculation of PNEC

The PNEC calculations for 2-ethoxy-napthalene follow the methodology discussed in DEWHA (2009).

PNEC Water

Because of the insolubility of the substance, experimental results are available for one trophic level (invertebrates). An acute EC_{50} value is available for Daphnia magna (3.9 mg/L). On the basis that the data consists of one short-term study for one trophic level and that the substance is not persistent in the environment, an assessment factor of 100 has been applied to the lowest reported EC_{50} value of 3.9 mg/L for invertebrates. The EC_{50} value is used because the value for invertebrates is the only value available for this substance. The $PNEC_{aquatic}$ is 0.039 mg/L.

PNEC Sediment

There are no toxicity data for sediment-dwelling organisms. Therefore, the $PNEC_{sed}$ was calculated using the equilibrium partitioning method. The $PNEC_{sed}$ is 1.832 mg/kg sediment wet weight.

The calculations are as follows:

$PNEC_{sed} = (K_{sed\text{-}water}/BD_{sed}) \times 1000 \times PNEC_{water}$
$= (60.1/1280) \times 1000 \times 0.039$
$= 1.832$ mg/kg

Where:

$K_{sed\text{-}water}$ = suspended matter-water partition coefficient (m^3/m^3)
BD_{sed} = bulk density of sediment (kg/m^3) = 1,280 [default]
$K_{sed\text{-}water} = 0.8 + [(0.2 \times Kp_{sed})/1000 \times BD_{solid}]$
$= 0.8 + [(0.2 \times 60.1/1000 \times 2400]$
$= 60.1\ m^3/m^3$

Where:

Kp_{sed} = solid-water partition coefficient (L/kg)
BD_{solid} = bulk density of the solid phase (kg/m^3) = 2,400 [default]
$Kp_{sed} = K_{oc} \times f_{oc}$
$= 3090 \times 0.04$
$= 123.6$ L/kg

Where:

K_{oc} = organic carbon normalised distribution coefficient (L/kg). The K_{oc} for 2-ethoxy-naphthalene was determined from an OECD Guideline 121 study. The K_{oc} value was reported to be 3090 L/kg.
F_{oc} = fraction of organic carbon in sediment = 0.04 [default].

PNEC Soil

There are no toxicity data for terrestrial or soil organisms. Therefore, the $PNEC_{soil}$ was calculated using the equilibrium partitioning method. The $PNEC_{soil}$ is 1.61 mg/kg soil dry weight.

The calculations are as follows:

$PNEC_{soil} = (Kp_{soil}/BD_{soil}) \times 1000 \times PNEC_{water}$
$= (61.8/1500) \times 1000 \times 0.039$
$= 1.61$ mg/kg

Where:
Kp_{soil} = soil-water partition coefficient (m^3/m^3)
BD_{soil} = bulk density of soil (kg/m^3) = 1,500 [default]
$Kp_{soil} = K_{oc} \times f_{oc}$
$= 3090 \times 0.02$
$= 61.8\ m^3/m^3$

Where:
K_{oc} = organic carbon normalised distribution coefficient (L/kg). The K_{oc} for 2-ethoxy-naphthalene was determined from an OECD Guideline 121 study. The K_{oc} value was reported to be 3090 L/kg.
F_{oc} = fraction of organic carbon in soil = 0.02 [default].

VIII. PERSISTENCE, BIOACCUMULATION AND TOXICITY (PBT) ASSESSMENT

The methodology for the Persistent, Bioaccumulative and Toxic (PBT) substances assessment is based on the Australian and EU REACH Criteria methodology (DEWHA, 2009; ECHA, 2017).

2-ethoxy-napthalene is readily biodegradable and thus does not meet the screening criteria for persistence.

The estimated BCF for 2-ethoxy-naphthalene is 136.6 L/kg. Thus, 2-ethoxy-napthalene does not meet the criteria for bioaccumulation.

Because of the insoluble nature of the substance and the low potential for aquatic toxicity, there are no data from chronic aquatic toxicity studies for 2-ethoxy-naphthalene. The acute EC_{50} values from a single acute aquatic toxicity study on 2-ethoxy-naphthalene is > 1 mg/L. Thus, 2-ethoxy-naphthalene does not meet the criteria for toxicity.

The overall conclusion is that 2-ethoxy-naphthalene is not a PBT substance.

IX. CLASSIFICATION AND LABELLING

A. Classification

H411: Aquatic Chronic 2

H315: Skin irritation 2

H319: Eye irritation 2/2A

B. Labelling

Warning

A. Pictogram



X. HANDLING AND SAFETY INFORMATION (OCCUPATIONAL LIMITS AND TRANSPORTATION REQUIREMENTS)

A. First Aid

Please refer to the product SDS for additional information and confirmation of the information provided herein.

Eye Contact

In case of contact, immediately flush eyes with plenty of water for at least 15 minutes.

Skin Contact

Wash thoroughly with soap and water.

Inhalation

If inhaled, remove from area to fresh air. Get medical attention.

Ingestion

Rinse mouth with water and then drink a glass of water. Get medical attention. Never give anything by mouth to an unconscious person.

B. Fire Fighting Information

Extinguishing Media

Water spray, carbon dioxide, foam, dry chemical.

Specific Exposure Hazards

Keep product and empty container away from heat and sources of ignition. May emit toxic fumes under fire conditions. Depending on conditions, decomposition products may include the following: carbon monoxide, carbon dioxide.

Special Protective Equipment for Firefighters

Wear self-contained breathing apparatus.

C. Accidental Release Measures

Personal Precautions

Use appropriate protective equipment. Handle in accordance with good industrial hygiene and safety practice.

Environmental Precautions

Prevent from entering sewers, waterways or low areas.

Steps to be Taken if Material is Released or Spilled

For large amounts: dike spillage and pump off product. For residues: pick up with suitable absorbent material. Dispose of contaminated material as prescribed.

D. Storage And Handling

General Handling

Keep product and empty container away from heat and sources of ignition. Ensure adequate ventilation, especially in confined areas.

Storage

Keep container tightly closed and in a dry and well-ventilated place. Keep in a cool place.

E. Exposure Controls / Personal Protection

Occupational Exposure Standards

There are no workplace exposure standards for 2-ethoxy-naphthalene in Australia.

Engineering Controls

Good general ventilation should be used.

Personal Protection Equipment

Respiratory Protection: Respiratory protection is not required.

Hand Protection: Chemical resistant protective gloves.

Skin Protection: Body protection must be chosen depending on activity and possible exposure.

Eye protection: Safety glasses with side-shields.

Other Precautions: Handle in accordance with good industrial hygiene and safety practice. Wearing of closed work clothing is recommended. Ensure that eyewash stations and safety showers are close to the workstation location.

F. Transport Information

2-ethoxy-naphthalene is not considered hazardous for purposes of transportation by road or rail. An Australian Dangerous Goods code is not required.

XI. DISPOSAL MANAGMENT

Disposal should be in accordance with all local, state and federal regulations.

XII. REGULATORY STATUS

Australian AICS Inventory: Listed.

XIII. REFERENCES

ADWG. (2011). National Water Quality Management Strategy. Australian Drinking Water Guidelines, Section 6, Australian Government, National Health and Medical Research Council, Natural Resource Management Ministerial Council. Updated January 2022. Available: https://www.nhmrc.gov.au/about-us/publications/australian-drinking-water-guidelines

Department of the Environment, Water, Heritage and the Arts [DEWHA]. (2009). Environmental risk assessment guidance manual for industrial chemicals, Department of the Environment, Water, Heritage and the Arts, Commonwealth of Australia. Available: http://www.nepc.gov.au/resource/chemical-risk-assessment-guidance-manuals

Department of the Environment and Energy [DoEE]. (2017). Chemical Risk Assessment Guidance Manual: for chemicals associated with coal seam gas extraction, Guidance manual prepared by Hydrobiology and ToxConsult Pty Ltd for the Department of the Environment and Energy, Commonwealth of Australia, Canberra.

ECHA. ECHA REACH database: http://echa.europa.eu/information-on-chemicals/registered-substances

enHealth Human Risk Assessment [HHRA]. (2012). Environmental Health Risk Assessment, Guidelines for Assessing Human Health Risks from Environmental Hazards. Office of Health Protection of the Australian Government Department of Health. Available: https://www1.health.gov.au/internet/main/publishing.nsf/Content/health-pubhlth-publicat-environ.htm

European Chemicals Agency [ECHA]. (2017). Guidance on Information Requirements and Chemical Safety Assessment, Chapter R11: PBT Assessment, European Chemicals Agency, Helsinki, Finland. Available: https://echa.europa.eu/guidance-documents/guidance-on-information-requirements-and-chemical-safety-assessment

Klimisch, H.J., Andreae, M., and Tillmann, U. (1997). A systematic approach for evaluating the quality of experimental and toxicological and ecotoxicological data. Regul. Toxicol. Pharmacol. 25:1-5.

U.S. Environmental Protection Agency [EPA]. (2017). EPISuite™ v. 4.11, United States Environmental Protection Agency, Office of Pollution Prevention and Toxics and Syracuse Research Corporation. Available: https://www.epa.gov/tsca-screening-tools/epi-suitetm-estimation-program-interface.

ACETIC ACID

This dossier on acetic acid presents the most critical studies pertinent to the risk assessment of acetic acid in its use in coal seam or shale gas extraction activities. It does not represent an exhaustive or critical review of all available data. The majority of information presented in this dossier was obtained from the ECHA database that provides information on chemicals that have been registered under the EU REACH (ECHA). Where possible, study quality was evaluated using the Klimisch scoring system (Klimisch et al., 1997).

NICNAS has assessed acetic acid in an IMAP Tier 1 assessment and concluded that it poses no unreasonable risk to the environment.

I. SUBSTANCE IDENTIFICATION

Chemical Name (IUPAC): Acetic acid

CAS RN: 64-19-7

Molecular formula: $C_2H_4O_2$

Molecular weight: 60.1 g/mol

Synonyms: Acetic acid, ethanoic acid, ethylic acid, methane carboxylic acid, vinegar acid

SMILES: CC(=O)O

II. PHYSICO-CHEMICAL PROPERTIES

Key physical and chemical properties for the substance are shown in Table 1.

Table 1: Overview of the Physico-Chemical Properties of Acetic Acid

Property	Value	Klimisch Score	Reference
Physical state at 20°C and 101.3 kPa	Colourless liquid with a pungent odour.	2	ECHA
Melting Point	16.64°C @ 101.3 kPa	2	ECHA
Boiling Point	117.9°C @ 101.3 kPa	2	ECHA
Density	1040 kg/m^3 @ 25°C	2	ECHA
Vapour Pressure	2079 Pa @ 25°C	2	ECHA
Partition Coefficient (log K_{ow})	-0.17 @ 20°C	2	ECHA
Water Solubility	602.9 g/L @ 25°C	2	ECHA
Viscosity	1.056 mPa s @ 25°C	2	ECHA
Dissociation constant (pKa)	4.756 @ 25°C	2	ECHA

Acetic acid readily dissociates in aqueous media to the acetate ($H_3C2O_2^-$) and hydrogen (H^+) ions.

III. ENVIRONMENTAL FATE PROPERTIES

A. Summary

The acetate ion of acetic acid is readily biodegradable, is not expected to bioaccumulate, and has a low potential to adsorb to soil.

B. Partitioning

The pKa of acetic acid is 4.76, indicating that this substance will exist partially in anion form in the environment and anions generally do not adsorb more strongly to soils containing organic carbon and clay than their neutral counterparts (PubChem).

Volatilization of acetic acid from water and moist soil surfaces is not expected to be an important fate process given a Henry's Law constant of 0.21 pascal cubic metre per mole (Pa-m^3/mol) (ECHA). Acetic acid is expected to volatilise from dry soil surfaces based upon its vapour pressure.

Hydrolysis is not expected to be an important environmental fate process since this substance lacks functional groups that hydrolyse under environmental conditions(PubChem).

C. Biodegradation

Acetic acid was readily biodegradable in a non-acclimated freshwater study. Degradation was 96% after 20 days (Price et al., 1974; ECHA) [Kl. score = 2]. Acetic acid is also readily biodegradable under anaerobic conditions (Kameya et al., 1995) [Kl. score = 2].

If a chemical is found to be readily biodegradable, it is categorised as Not Persistent since its half-life is substantially less than 60 days (DoEE, 2017a).

D. Environmental Distribution

No experimental data are available for acetic acid. Using KOCWIN in EPISuite™ (USEPA, 2017), the estimated K_{oc} values from log K_{ow} and the molecular connectivity index (MCI) are 1.153 and 1.0 L/kg, respectively. Based on these values, acetic acid has a low potential for adsorption to soil and sediment and is expected to have very high mobility in soil.

Acetic acid is highly soluble in water and dissociates completely in aqueous solution to acetate and its hydrogen ion. However, the chemistry of the receiving water compartment, such as its pH and the presence of metal ions, may affect the speciation and partitioning of this substance and its buffering capacity (DoEE, 2017b).

E. Bioaccumulation

There are no bioaccumulation studies on acetic acid. Bioaccumulation of acetic acid is not expected to occur because acetic acid dissociates completely in aqueous solution to acetate and its hydrogen ion.

Both ions are ubiquitous in the environment. Acetate is naturally found in eukaryotic and prokaryotic cells and is involved in their biochemical pathways.

IV. HUMAN HEALTH HAZARD ASSESSMENT

A. Summary

Acetic acid is a corrosive liquid. Depending on the concentration, aqueous solutions of acetic acid are either corrosive, irritating, or non-irritating to the skin, eyes, and gastrointestinal tract. Vapours from aqueous solutions of acetic acid can cause respiratory irritation. There are no adequate repeated dose toxicity studies on acetic acid. Acetic acid is not genotoxic. Positive findings have been reported in some in vitro genotoxicity studies and are considered to be the result of the pH change in the test system. There are no carcinogenicity studies by the oral or inhalation route. It is not carcinogenic by the dermal route. Animal studies have shown no developmental toxicity from ingestion of acetic acid.

B. Acute Toxicity

Oral

The oral LD_{50} of the sodium salt of acetic acid in rats is 3,310 milligrams per kilogram (mg/kg) (Woodard et al., 1941; ECHA) [Kl. score =2]. The oral LD_{50} of the acetic acid in unfasted rats is 3,530 mg/kg (ECHA) [Kl. score =4]. The oral LD_{50} of the sodium salt of acetic acid in mice is 4,960 mg/kg (Smyth et al., 1951; ECHA) [Kl. score =2].

Inhalation

The 4-hour inhalation LC_{50} in rats for acetic acid vapor is 11.4 milligrams per litre (mg/L). There were clinical signs that were indicative of corrosion (ECHA) [Kl. score = 2].

C. Irritation

Application of a 3.3% or a 10% aqueous solution of acetic acid to the skin of rabbits for 4 hours was slightly irritating. The Primary Dermal Irritation Index scores were 0.5 and 1.1, respectively (Nixon et al., 1990; ECHA) [Kl. score = 2]. Application of a 10% solution of acetic acid to the skin of rabbits for 4 hours under semi-occlusive conditions was slightly irritating (ECHA) [Kl. score = 2].

Instillation of 0.1 mL of a 10% solution of acetic acid to the eyes of rabbits was considered irritating. The mean of the 24-, 48-, and 72-hours scores were: 2.67 for erythema; 1.67 for chemosis; 1.72 for corneal opacity; and a mean of 87% corneal swelling (Jacobs and Martens, 1989; ECHA) [Kl. score = 2]

D. Sensitisation

No studies are available.

E. Repeated Dose Toxicity

Oral

No adequate studies for human health risk assessment are available.

Inhalation

No studies are available.

Dermal

No adequate studies are available.

F. Genotoxicity

In Vitro Studies

The *In Vitro* genotoxicity studies on acetic acid are presented below in Table 2.

Table 2: *In Vitro* Genotoxicity Studies on Acetic Acid

Test System	Results*		Klimisch Score	Reference
	-S9	+S9		
Bacterial reverse mutation (*S. typhimurium* strains)	NC	-	2	Ishidate et al. (1984); ECHA
Bacterial reverse mutation (*S. typhimurium* strains)	-	-	2	Zeiger et al. (1992); ECHA
Chromosomal aberrations (CHO cells)	-**	-**	2	Morita et al. (1990); ECHA
Mammalian cell gene mutation (mouse lymphoma L5178Y cells)	-***	-***	2	Seifried et al. (2006); ECHA

*+, positive; -, negative; NC, not conducted.
**A dose-dependent increase in chromosomal aberrations was observed with 10 mM acetic acid (-S9) and 8 mM acetic acid (+S9). These concentrations were close to the cytotoxic limit at which the cells could no longer be evaluated. These effects were abolished by neutralizing the test medium or increasing the buffer capacity. These results suggest that the positive findings are due to the acidic pH of the incubation medium rather than a consequence of an intrinsic clastogenic potential of acetic acid.
***Acetic anhydride (hydrolyses to acetic acid in aqueous media).

In Vivo Studies

No studies are available on acetic acid.

A bone marrow micronucleus study has been conducted on acetic anhydride, which hydrolyses to acetic acid. Male and female SD rats were exposed by inhalation to 0, 1, 5, or 20 parts per million (ppm) acetic anhydride, 6 hours/day, 5 days/week for 13 weeks. The incidence of micronucleated immature erythrocytes was not increased at any exposure concentration (ECHA). [Kl. score = 1]

G. Carcinogenicity

No oral or inhalation studies are available.

No deaths nor skin tumours were seen when acetic acid was applied dermally once a week to CD-1 mice for 32 weeks (Slaga et al., 1975; ECHA) [Kl. score = 4].

H. Reproductive Toxicity

No studies are available.

I. Developmental Toxicity

Pregnant female Wistar rats were dosed with 0 or various concentrations up to 1,600 mg/kg apple cider vinegar (5% acetic acid) by oral gavage on gestational days 6 to 15. There were no maternal or developmental toxicity effects noted at any dose level. The no observed adverse effect level (NOAEL) for maternal and developmental toxicity is 1,600 mg/kg-day (ECHA). [Kl. score = 2]

Pregnant female CD-1 mice were dosed with 0, 16, 74.3, 345, or 1,600 mg/kg apple cider vinegar (5% acetic acid) by oral gavage on gestational days 6 to 15. There were no treatment-related effects on maternal or foetal survival, or on soft or skeletal tissues. There was no effect on the foetal development in the presence of slight maternal toxicity (reduced body weight gain) at 345 mg/kg. At 1,600 mg/kg, there was an increase in the number of litters containing a dead foetus and some reductions in ossification. The NOAELs for maternal and developmental toxicity are 74.3 and 345 mg/kg-day, respectively (ECHA). [Kl. score = 2]

Pregnant female Dutch-belted rabbits were dosed with 0, 16, 74.3, 345, or 1,600 mg/kg apple cider vinegar (5% acetic acid) by oral gavage on gestational days 6 to 18. There were no treatment-related effects on maternal or foetal survival, or on soft or skeletal tissues. There was a reduction in the pregnancy rate in the high-dose group; and a dose-dependent decrease in maternal body weights at >74.3 mg/kg. Some deaths or abortions occurred in all treated groups and some litter losses were reported at >345 mg/kg. Maternal effects were much more noticeable than the effects on foetal development. These findings have been considered a consequence of the bactericidal properties of orally administered acetic acid within the gastrointestinal tract of female rabbits, and not a direct effect on embryonic implantation and development of acetic acid (EU, 2008). It is likely that this accounts for the apparent increased sensitivity of this species to oral administration of acetic acid. The NOAEL for developmental toxicity is 1,600 mg/kg-day; a NOAEL for maternal toxicity was not identified (ECHA). [Kl. score = 2]

V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES

The toxicological reference values developed for acetic acid follow the methodology discussed in enHealth (2012). The approach used to develop drinking water guidance values is described in the Australian Drinking Water Guidelines (ADWG, 2011).

A. Non-Cancer

Oral

There are no repeated dose toxicity studies that were considered adequate for human health risk assessment.

The Joint FAO/WHO Expert Committee on Food Additives (JECFA) has maintained a group acceptable daily intake (ADI) of "not limited" for acetic acid and its potassium and sodium salts (JECFA).

While concentration of acetic acid will affect pH, and extreme pH values (<4 and >11) may adversely affect health, there are insufficient data to set a health guideline value (ADWG, 2011)

B. Cancer

There are no carcinogenicity studies by the oral or inhalation route. A dermal carcinogenicity study in mice showed no carcinogenic activity when acetic acid was applied to the skin for 32 weeks. Thus, a cancer reference value was not derived.

VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES

Acetic acid is a flammable liquid.

Acetic acid does not exhibit the following physico-chemical properties:

- Explosivity
- Oxidising potential

VII. ENVIRONMENTAL HAZARD ASSESSMENT

A. Summary

Acetic acid is of moderate acute toxicity concern to aquatic organisms, in part because of the effect of pH changes from the dissociated hydrogen ion. The acetate ion is of low acute toxicity concern to aquatic organisms.

B. Aquatic Toxicity

Acute Studies

Table 3 presents the results of acute aquatic toxicity studies on acetic acid and potassium acetate.

Table 3: Acute Aquatic Toxicity Studies on Acetic Acid and Potassium Acetate

Test Substance	Test Species	Endpoint	Results (mg/L)	Klimisch Score	Reference
Potassium acetate	*Oncorhynchus mykiss*	96-hour LC_{50}	>300.82*	2	ECHA
Potassium acetate	*Danio rerio*	96-hour LC_{50}	>300.82*	2	ECHA

Test Substance	Test Species	Endpoint	Results (mg/L)	Klimisch Score	Reference
Acetic acid	*Oncorhynchus mykiss*	96-hour LC_{50}	64.8 (measured)	4	ECHA
Acetic acid	*Oncorhynchus mykiss*	96-hour LC_{50}	31.3 – 67.6	4	ECHA
Potassium acetate	*Daphnia magna*	48-hour EC_{50}	>300.82*	2	ECHA
Acetic acid	*Daphnia magna*	48-hour EC_{50}	79.5 (measured)	4	ECHA
Acetic acid	*Daphnia magna*	48-hour EC_{50}	18.9 (measured)	4	ECHA
Acetic acid	*Desmodesmus subspicatus*	72-hour EC_{50}	486.5	4	ECHA

*As the acetate ion.

Chronic Studies

In a 21-day fish (*Oncorhynchus mykiss*) chronic study, the measured no observed effect concentration (NOEC) values for 60% and 100% acetic acid were 57.2 and 34.3 mg/L, respectively (ECHA). [Kl. score = 4]

In a 21-day *Daphnia* reproduction study, the measured NOEC for 60% and 100% acetic acid were 80 and 31.4 mg/L, respectively (ECHA). [Kl. score = 4]

In a 21-day *Daphnia* reproduction study, the measured NOEC for 100% acetic acid was 22.7 mg/L (ECHA). [Kl. score = 4]

C. Terrestrial Toxicity

No data are available.

D. Calculation of PNEC

Despite the low Klimisch scores for aquatic toxicity testing (K=4), the PNEC calculations for acetic acid follow the methodology discussed in DEWHA (2009).

PNEC Water

Experimental results are available for three trophic levels. For the acute toxicity studies, data are available on both acetic acid and potassium acetate; both substances dissociate completely in aqueous media to the acetate anion and the corresponding cations (H+ and K+). The toxicity of these substances is expected to be driven by the acetate ion, with the cations having a minor role. The toxicity data on potassium acetate are preferred because of the absence of a potential pH change from the dissociated H+ ion of acetic acid. For the chronic toxicity studies, only acetic acid has been tested for two trophic levels: fish and invertebrates. These studies will not be used to derive the PNEC value; however, an assessment factor of 100 will be applied to the lowest acute $E(L)C_{50}$ values for the acetate ion.

From the potassium acetate studies, acute $E(L)C_{50}$ values (adjusted for acetic acid) are available for fish (300.82 mg/L) and Daphnia (300.82 mg/L). By applying an assessment factor of 100 to the $E(L)C_{50}$ value of 300.82 mg/L from either fish or Daphnia, the $PNEC_{water}$ for acetic acid is 3.0 mg/L.

PNEC Sediment

There are no toxicity data for sediment-dwelling organisms. Therefore, the $PNEC_{sed}$ was calculated using the equilibrium partitioning method. The $PNEC_{sed}$ is 1.9 mg/kg sediment wet weight.

The calculations are as follows:

$PNEC_{sed} = (K_{sed\text{-}water}/BD_{sed}) \times 1{,}000 \times PNEC_{water}$

$= (0.82/1{,}280) \times 1{,}000 \times 3.0$

$= 1.9$ mg/kg

Where:

$K_{sed\text{-}water}$ = suspended matter-water partition coefficient (cubic metre per cubic metre [m^3/m^3])

BD_{sed} = bulk density of sediment (kg/m^3) = 1,280 [default]

$K_{sed\text{-}water} = 0.8 + [(0.2 \times Kp_{sed})/1{,}000 \times BD_{solid}]$

$= 0.8 + [(0.2 \times 0.04/1{,}000 \times 2{,}400]$

$= 0.82$ kg/m^3

Where:

Kp_{sed} = solid-water partition coefficient (L/kg).

BD_{solid} = bulk density of the solid phase (kg/m^3) = 2,400 [default]

$Kp_{sed} = K_{oc} \times f_{oc}$

$= 1.0 \times 0.04$

$= 0.04$ L/kg

Where:

K_{oc} = organic carbon normalized distribution coefficient (L/kg). The K_{oc} for acetic acid calculated from EPISUITE™ using the MCI is 1.0 L/kg .

F_{oc} = fraction of organic carbon in sediment = 0.04 [default].

PNEC Soil

There is no toxicity data for terrestrial or soil organisms. Therefore, the $PNEC_{soil}$ was calculated using the equilibrium partitioning method. The $PNEC_{soil}$ is 0.04 mg/kg soil dry weight.

The calculations are as follows:

$PNEC_{soil} = (Kp_{soil}/BD_{soil}) \times 1000 \times PNEC_{water}$

$= (0.02/1500) \times 1000 \times 3.0$

$= 0.04$ mg/kg

Where:

Kp_{soil} = soil-water partition coefficient (m^3/m^3)

BD_{soil} = bulk density of soil (kg/m^3) = 1,500 [default]

$Kp_{soil} = K_{oc} \times f_{oc}$

$= 1.0 \times 0.02$

= 0.02 m^3/m^3

Where:
K_{oc} = organic carbon normalised distribution coefficient (L/kg). The K_{oc} for acetic acid calculated from EPISUITE™ using the MCI is 1.0 L/kg .
F_{oc} = fraction of organic carbon in soil = 0.02 [default].

VIII. PERSISTENCE, BIOACCUMULATION AND TOXICITY ASSESSMENT

The methodology for the Persistent, Bioaccumulative and Toxic (PBT) substances assessment is based on the Australian and EU REACH Criteria methodology (DEWHA, 2009; ECHA, 2017).

Acetic acid is readily biodegradable; thus, it does not meet the screening criteria for persistence.

Bioaccumulation of acetic acid is not expected to occur because acetic acid dissociates completely in aqueous media to acetate and its hydrogen ion. Both ions are ubiquitous in the environment. Acetate is naturally found in eukaryotic and prokaryotic cells and is involved in their biochemical pathways. The log K_{ow} for acetic acid is -0.17. Thus, acetic acid does not meet the screening criteria for bioaccumulation.

The NOECs from the chronic aquatic toxicity studies on acetic acid are >0.1 mg/L. The EC_{50} values for potassium acetate are > 1 mg/L. Thus, acetic acid does not meet the criteria for toxicity.

The overall conclusion is that acetic acid is not a PBT substance.

IX. CLASSIFICATION AND LABELLING

A. Classification

Flammable Liquid Category 3

Skin Corrosion Category 1A

EU:

≥90%: Skin Corrosion 1A

≥25% to <90%: Skin Corrosion 1B

≥10% to <25%: Skin irritant Category 2; Eye irritant Category 2

In addition to the hazard statements corresponding the GHS classifications (if Skin Corrosion 1A or 1B is included), the following non-GHS hazard statement is to be added to the SDS: AUH071: Corrosive to the Respiratory Tract.

B. Labelling

Danger

C. Pictogram



X. HANDLING AND SAFETY INFORMATION (OCCUPATIONAL LIMITS AND TRANSPORTATION REQUIREMENTS)

A. First Aid

Eye Contact

Immediately flush open eyes with plenty of water for at least 15 minutes. Remove contacts, if present and easy to do. Get medical attention immediately, preferably a physician for an ophthalmologic examination.

Skin Contact

For minor skin contact, avoid spreading material on unaffected skin. Remove and isolate contaminated clothing. Wash the contaminated area of body with soap and fresh water. Get medical attention immediately.

Inhalation

Move person to fresh air. Administer oxygen if breathing is difficult. Do not use mouth-to-mouth method if victim inhaled the substance; give artificial respiration with the air of a pocket mask equipped with a one-way valve or other proper respiratory medical device. Give artificial respiration if victim is not breathing. Get medical attention immediately.

Ingestion

Rinse mouth and lips with plenty of water if person is conscious. Do not induce vomiting. Do not use mouth-to-mouth method if victim had ingested the substance. Obtain medical attention immediately if ingested.

Notes to Physician

Treat as a corrosive due to pH of the material. All treatments should be based on observed signs and symptoms of distress in the patient.

B. Fire Fighting Information

Extinguishing Media

Use water spray or fog, foam, dry chemical or carbon dioxide. Do not use straight streams of water.

Specific Exposure Hazards

Flammable liquid and vapor. Vapours are flammable and heavier than air. Vapours may travel across the ground and reach remote ignition sources causing a flashback fire danger. Emits toxic fumes under fire conditions. Depending on conditions, decomposition products may include the following: carbon dioxide, carbon monoxide.

Special Protective Equipment for Firefighters

Structural firefighter's protective clothing provides limited protection in fire situations only; it is not effective in spill situations where direct contact with the substance is possible. Wear chemical protective clothing that is specifically recommended by the manufacturer. It may provide little or no thermal protection. Wear positive pressure self-contained breathing apparatus (SCBA). Move containers from fire area if you can do it without risk.

C. Accidental Release Measures

Personal Precautions

Isolate area. Keep unnecessary and unprotected personnel from entering the area. Use personal protective clothing. Ensure adequate ventilation. Wear respiratory protection if ventilation is inadequate. Do not breath mist, vapours, or spray. Avoid contact with skin, eye, and clothing. Eliminate all sources of ignition.

Environmental Precautions

Prevent from entering sewers, waterways, or low areas.

Steps to be Taken if Material is Released or Spilled

Eliminate all sources of ignition. All equipment used when handling the material must be grounded. A vapor suppressing foam may be used to reduce vapours. Use clean non-sparking tools to collect absorbed material. Pick up with suitable absorbent material and transfer to a container for chemical waste. For large amounts, dike spillage and pump off product into container for chemical waste. Dispose of contaminated material as prescribed.

D. Storage And Handling

General Handling

Prevent exposure to ignition sources (i.e., use non-sparking tools and explosion-proof equipment). Avoid contact with eyes, skin, and clothing. Avoid breathing vapor. Wash thoroughly after handling. Keep

container closed. Use with adequate ventilation. Use proper bonding and/or ground procedures. However, bonding and grounds may not eliminate the hazard from static accumulation. Peroxides may form upon prolonged storage. Exposure to light, heat or air significantly increases peroxide formation. If evaporated to a residue, the mixture of peroxides residue and material vapor may explode when exposed to heat or shock.

Storage

Keep container tightly closed. Store in a cool, well-ventilated area away from heat and light. Storage containers should be grounded and bonded. Fixed storage containers, transfer containers and associated equipment should be grounded and bonded to prevent accumulation of static charge.

E. Exposure Controls / Personal Protection

Occupational Exposure Standards

The workplace exposure standard for acetic acid in Australia is 10 ppm (25 mg/m^3) as a 8-hr time-weighted average (TWA) and 15 ppm (37 mg/m^3) as a 15-min short-term exposure limit (STEL).

Engineering Controls

Good general ventilation should be used. Ventilation rates should be matched to conditions. If applicable, use process enclosures, local exhaust ventilation, or other engineering controls to maintain airborne levels below recommended exposure limits. If exposure limits have not been established, maintain airborne levels to an acceptable level.

Personal Protection Equipment

Respiratory Protection:

If workers are exposed to concentrations above the exposure limit, they must use appropriate, certified respirators. If there are no applicable exposure limit requirements or guidelines, use an approved respirator. Selection of air-purifying or positive pressure supplied-air will depend on the specific operation and the potential airborne concentration of the product. For emergency conditions, use an approved positive-pressure self-contained breathing apparatus.

Hand Protection:

Use gloves chemically resistant to this material. Consult the safety data sheet (SDS) for appropriate glove barrier materials.

Skin Protection:

Use protective clothing chemically resistant to this material. Selection of specific items such as face shield, boots, apron, or full body suit will depend on the task.

Eye protection:

Use chemical goggles.

Other Precautions:

Wash hands, forearms, and face thoroughly after handling chemical products, before eating, smoking, and using the lavatory and at the end of the working period. Appropriate techniques should be used to remove potentially contaminated clothing. Wash contaminated clothing before reusing. Ensure that eyewash stations and safety showers are close to the workstation location.

F. Transport Information

For glacial acetic acid or >80% acetic acid solutions:
UN 2789 (ACETIC ACID, GLACIAL or ACETIC ACID SOLUTION)
Class: 8
Packing Group: II

For ≥50% to 80% acetic acid solutions:
UN 2790 (ACETIC ACID SOLUTION)
Class: 8
Packing Group: II

For >10% to <50% acetic acid solutions:
UN 2790 (ACETIC ACID SOLUTION)
Class: 8
Packing Group: III

XI. DISPOSAL MANAGEMENT

Disposal should be in accordance with all local, state, and federal regulations.

XII. REGULATORY STATUS

Australian AICS Inventory: Listed.

XIII. REFERENCES

ADWG. (2011). National Water Quality Management Strategy. Australian Drinking Water Guidelines, Section 6, Australian Government, National Health and Medical Research Council, Natural Resource Management Ministerial Council. Updated January 2022. Available: https://www.nhmrc.gov.au/about-us/publications/australian-drinking-water-guidelines

Department of the Environment, Water, Heritage and the Arts (DEWHA). (2009). Environmental risk assessment guidance manual for industrial chemicals, Department of the Environment, Water, Heritage and the Arts, Commonwealth of Australia. Available: http://www.nepc.gov.au/resource/chemical-risk-assessment-guidance-manuals

Department of the Environment and Energy (DoEE). (2017a). Chemical Risk Assessment Guidance Manual: for chemicals associated with coal seam gas extraction, Guidance manual prepared by Hydrobiology and ToxConsult Pty Ltd for the Department of the Environment and Energy, Commonwealth of Australia, Canberra.

DoEE. (2017b). Environmental risks associated with surface handling of chemicals used in coal seam gas extraction in Australia, Project report Appendices A, B, C, D, F, and G prepared by the Chemicals and Biotechnology Assessments Section (CBAS) in the Department of the Environment and Energy as part of the National Assessment of Chemicals Associated with Coal Seam Gas Extraction in Australia, Commonwealth of Australia, Canberra.

ECHA. ECHA REACH database: http://echa.europa.eu/information-on-chemicals/registered-substances

enHealth Human Risk Assessment (HHRA). (2012). Environmental Health Risk Assessment, Guidelines for Assessing Human Health Risks from Environmental Hazards. Office of Health Protection of the Australian Government Department of Health. Available: https://www1.health.gov.au/internet/main/publishing.nsf/Content/health-pubhlth-publicat-environ.htm

European Chemicals Agency (ECHA). (2017). Guidance on Information Requirements and Chemical Safety Assessment, Chapter R11: PBT Assessment, European Chemicals Agency, Helsinki, Finland. Available: https://echa.europa.eu/guidance-documents/guidance-on-information-requirements-and-chemical-safety-assessment

Ishidate, M., Jr., Sofuni, T., Yoshikawa, K., Hayashi, M., Nohmi, T., Sawada, M., and Matsuoka, A. (1984). Primary mutagenicity screening of food additives currently used in Japan. Fd. Chem. Toxicol. 22: 623-636.

Jacobs, G.A., and Martens, M.A. (1989). An objective method for the evaluation of eye irritation in vivo. Fd. Chem. Toxicol. 27: 255-258.

Kameya, T., Murayama, T., Urano, K., and Kitano, M. (1995). Biodegradation ranks of priority organic compounds under anaerobic conditions. Sci. Total Environ. 170: 43-51.

Klimisch, H.J., Andreae, M., and Tillmann, U. (1997). A systematic approach for evaluating the quality of experimental and toxicological and ecotoxicological data. Regul. Toxicol. Pharmacol. 25:1-5.

Morita, T., Takeda, K., and Okumura, K. (1990). Evaluation of clastogenicity of formic acid, acetic acid and lactic acid. Mutat. Res. 240: 195-202.

Nixon, G.A., Bannon, E.A., Gaynor, T.W., Johnston, D.H., and Griffith, J.F. (1990). Evaluation of modified methods for determining skin irritation. Regul. Toxicol. Pharmacol. 12: 127-136.

Price, K.S., Waggy, G.T., and Conway, R.A. (1974). Brine shrimp bioassay and seawater BOD of petrochemicals. J. Water Pollut Control Fed. 46: 63- 77.

PubChem. National Institutes of Health. National Library of Medicine National Center for Biotechnology Information. https://pubchem.ncbi.nlm.nih.gov/

Seifried, H.E., Seifried, R.M., Clarke, J.J., Junghans, T.B., and San, R.H.C. (2006) A compilation of two decades of mutagenicity test results with the Ames Salmonella typhimurium and L5178Y mouse lymphoma cell mutation assays. Chem. Res. Toxicol. 19: 627-644.

Slaga, T., Bowden, G., and Boutwell, R. (1975). Acetic acid, a potent stimulator of mouse epidermal macromolecular synthesis and hyperplasia but with weak tumor-promoting ability. Natl. Cancer Inst. 55: 983-987.

Smyth, H.F., Carpenter, C.P., and Weil, C. (1951). Range-finding toxicity data: list IV. Arch. Ind. Hyg. 4: 119-122.

PubChem. PubChem open chemistry database: https://pubchem.ncbi.nlm.nih.gov

United States Environmental Protection Agency (USEPA). (2017). EPISuite™ v. 4.11, United States Environmental Protection Agency, Office of Pollution Prevention and Toxics and Syracuse Research Corporation. Available at: https://www.epa.gov/tsca-screening-tools/epi-suitetm-estimation-program-interface.

Woodard, G., Lange, S.W., Nelson, K.W., and Calvery, H.O. (1941). The acute oral toxicity of acetic, chloroacetic, dichloroacetic, and trichloroacetic acids. J. Ind. Hyg. Toxicol. 23: 78-82.

Zeiger, E., Anderson, B., Haworth, S., Lawlor, R., and Mortelmans, K. (1992). Salmonella mutagenicity tests: V. Results from the testing of 311 chemicals. Environ. Mol. Mutagen. 19(Suppl. 21): 2-141.

ALCOHOLS, C12-16, ETHOXYLATED

This dossier on alcohols, C12-16, ethoxylated presents the most critical studies pertinent to the risk assessment of alcohols, C12-16, ethoxylated in its use in coal seam or shale gas extraction activities. This dossier does not represent an exhaustive or critical review of all available data. The information presented in this dossier was obtained primarily from the Human & Environmental Risk Assessment on Ingredients of European Household Cleaning Products: Alcohol Ethoxylates (HERA, 2009), and from the ECHA database that provides information on chemicals that have been registered under the EU REACH (ECHA). Where possible, study quality was evaluated using the Klimisch scoring system (Klimisch *et al.*, 1997).

For the purpose of this dossier, alcohols, C12-15, ethoxylated (CAS RN 68131-39-5) has been reviewed as a surrogate chemical for ethoxylated C12-C16 alcohol (CAS No. 68551-12-2), where appropriate.

I. SUBSTANCE IDENTIFICATION

Chemical Name: Alcohols, C12-16, ethoxylated

CAS RN: 68551-12-2

Molecular formula: $H–(CH_2)_{12–16}–(OCH_2CH_2)_n–OH$ (where n is the average number of EO units)

Molecular weight: Not available (UVCB substance)

Synonyms: Alcohols, C12-16, ethoxylated, Ethoxylated C12-16 alcohols; polyethylene glycol, dodecyl, tetradecyl, hexadecyl ether

SMILES: Not available (UVCB substance)

Alcohol ethoxylates (AE) are a class of non-ionic surfactant polymers that have the basic structure $C_{x-y}AE_n$. The subscript (x-y) following the 'C' indicates the range of carbon chain units. The hydrocarbon chain can be either linear or branched. AEs also contain an ethylene oxide (E) chain attached to the alcohol. The degree of ethylene oxide (EO) polymerization is indicated by the subscript (n) which indicates the average number of ethylene oxide units. Ethoxylated C12-C16 alcohol (CAS No. 68551-12-2) has an average number of 1 to 6 moles of ethylene oxide units.

II. PHYSICO-CHEMICAL PROPERTIES

No information is available on alcohols, C12-16, ethoxylated. Therefore, data were read across from a similar substance, alcohols, C12-15, ethoxylated (CAS RN 68131-39-5), as shown below.

Table 1: Overview of the Physico-chemical Properties of Alcohols, C12-15, Ethoxylated (1 to 2.5 moles ethoxylated)

Property	Value	Klimisch score	Reference
Physical state at 20°C and 101.3 kPa	Clear liquid with a rancid odor*	2	ECHA
Melting Point	7.22°C (pressure not provided)	2	ECHA

Property	Value	Klimisch score	Reference
Boiling Point	271.11-516.11°C (pressure not provided)	2	ECHA
Density	ca. 930 kg/m^3 @ 20°C	2	ECHA
Vapor Pressure	<1 Pa@ 25°C	2	ECHA
Partition coefficient (log K_{ow})	5.06** @ 25°C	2	ECHA
Water Solubility	0.021 g/L @ 25°C	2	ECHA
Flash Point	165.56°C	2	ECHA
Auto flammability	235°C	2	ECHA
Viscosity	28.1 mPa s (dynamic) @ 20°C	2	ECHA

*Based on alcohols, C12-15, ethoxylated (1 to 2.5 EO) [CAS No. 68131-39-5]
**Weight-averaged log K_{oc} of whole substance based on normalized composition

III. ENVIRONMENTAL FATE PROPERTIES

A. Summary

Alcohols, C12-16, ethoxylated is readily biodegradable. It has a low potential for bioaccumulation and a moderate potential for absorption to soil and sediment.

B. Biodegradation

There are no studies available for alcohol, C12-16, ethoxylated.

AE homologues with linear hydrocarbon chain lengths from C8 to C15 and mean values ranging from 3-20 EO units are readily biodegradable (HERA, 2009). If a chemical is found to be readily biodegradable, it is categorized as Not Persistent since its half-life is substantially less than 60 days (DoEE, 2017).

Alcohols, C12-C14, ethoxylated (7-8) degraded to 100% in 28 days in a die away screening test (HERA, 2009) [Kl. Score = 2].

Alcohols, C12-15, ethoxylated is readily biodegradable. In an OECD 301B test, degradation of 10 mg/L of alcohols, C12-15. ethoxylated was 72% after 28 days but it failed the 10-day window (ECHA) [Kl. score = 1].

In an OECD 301B test, degradation of 20 mg/L of alcohols, C12-15. ethoxylated was 61% after 28 days but it failed the 10-day window (ECHA) [Kl. score = 1].

A 240 mg/L concentration of alcohol, C12-15, ethoxylated (7 EO) degraded 80- 88% in 28 days when tested using a shake-flask CO_2-evolution test method (ECHA) [Kl. score = 2].

C. Environmental Distribution

There are no experimental data are available for alcohols, C12-16, ethoxylated. Using KOCWIN in EPISuite™ (EPA, 2018), the estimated K_{oc} values for surrogates of alcohols, C12-16, ethoxylated are:

K_{oc} for C12-C16 linear alcohol, ethoxylated (2 EO): 3,920 L/kg (molecular connectivity index, MCI) and 13,530 L/kg (K_{ow}).

The adsorption potential of the alcohols, C12-15 was determined using QSAR-calculations (EPI Suite v4.11) using the KOCWIN v2.00 model based on the Molecular Connectivity Index (MCI) and the log Kow method. Smiles-codes of the unethoxylated alcohols as well as smiles-codes of the alcohol ethoxylates with an ethoxylation of 1 EO, 2 EO and 3 EO of the homologues with chain lengths of C12 and C15 were chosen as representatives of the mixture. The representative structures fall within the applicability domain of both models and thus the calculations are considered valid. The results are given as a range which represents the variation of carbon chain length and the degree of ethoxylation according to substance specifications. The calculated log Koc values range from 2.301 to 3.352 (MCI method) and 2.382 to 3.926 (log Kow method) (ECHA) [KI. score =2].

Based on these K_{oc} values, if released to soil, the alcohols, C12-C16 ethoxylated is expected to adsorb strongly to soil and it is expected to have a low potential for mobility.

D. Bioaccumulation

The potential for bioaccumulation of AEs is considered low due to the biotransformation and excretion of the substance. The various studies present considerable evidence that AEs are rapidly eliminated and metabolised (ECHA).

The BCF values for alcohol ethoxylates in fathead minnows have been reported to range from <5 to 387.5 L/kg (Toll et al., 2000; as cited in ECHA) [KI.score=2]. The uptake rates varied from 330 to 1660 (L x kg/d) and elimination rates varied from 3.3 to 59 per day (Toll et al., 2000; as cited in ECHA) [KI. score=2]. The high concentration in fish is thought to be prevented by an efficient biotransformation of the alcohol ethoxylates, leading to a high elimination rate.

IV. HUMAN HEALTH HAZARD ASSESSMENT

A. Summary

The acute toxicity of alcohols, C12-16, ethoxylated is low by the oral and dermal routes. Skin irritation studies in rabbits on alcohols, C12-16, ethoxylated have shown mixed results, but human patch studies on these alcohol ethoxylates do not support a skin irritant classification. Alcohols, C12-16, ethoxylated is expected to be irritating to the eyes of rabbits. Alcohols, C12-16, ethoxylated is not a skin sensitizer. Repeated dose toxicity studies on alcohol ethoxylates similar to alcohols, C12-16, ethoxylated in rats do not indicate any target organ effects. These alcohol ethoxylates are not genotoxic, carcinogenic, and they have a low potential for reproductive and developmental toxicity.

B. Acute Toxicity

There are no acute toxicity studies are available on alcohols, C12-16, ethoxylated.

<u>Oral</u>

The oral LD_{50} in rats for $C_{12\text{-}15}AE_3$ is >5,000 mg/kg (ECHA) [Kl. score = 2]. The oral LD_{50} in rats for $C_{12\text{-}15}AE_7$ is 1,700 mg/kg (HERA, 2009) [Kl. score = 2]. The oral LD_{50} value in rats for $C_{12\text{-}13}AE_{6.5}$ is 2,100 mg/kg (HERA, 2009) [Kl. score = 2]. The oral LD_{50} value in rats for $C_{12\text{-}15}AE_{11}$ is >2,000 mg/kg in males and between 1,000 and 2,000 mg/kg in females (HERA, 2009) [Kl. score = 2]. The oral LD_{50} values in rats for $C_{14\text{-}15}AE_{13}$ in two separate studies are 1,100 and 1,000 mg/kg (HERA, 2009) [Kl. score = 2]. The

relative number of EO units, but not the carbon chain length, appears to influence acute oral toxicity (HERA, 2009).

The acute oral LD_{50} for alcohols, C12-C15, ethoxylated in male and female Wistar rats is >5000-<10,000 mg/kg bw (ECHA) [KI. score = 2].

Inhalation

The 4-hour LC_{50} for alcohols, C12-C15, ethoxylated in male and female Sprague-Dawley rats is > 1,600 mg/m^3 (>1.6 mg/L) (ECHA) [KI. score =2].

Dermal

Acute dermal LD_{50} values of >2,000 mg/kg were determined for $C_{12\text{-}14}AE_3$ and $C_{12\text{-}14}AE_6$ in two separate studies (HERA, 2009) [Kl. score = 2]. The acute dermal LD_{50} of $C_{12\text{-}15}AE_7$ is >2,000 mg/kg (HERA, 2009) [Kl. score = 2].

The acute dermal LD_{50} for alcohols, C12-C15, ethoxylated in male and female Wistar rats >2000 mg/kg bw (ECHA) [KI. score =2].

C. Irritation

Skin

Application of 0.5 mL isotridecanol, ethoxylated (3 EO) to the skin of rabbits for 4 hours under occlusive conditions was considered irritating (ECHA) [Kl. score = 2].

Application of 0.5 mL isotridecanol, ethoxylated (3 EO) to the skin of rabbits for 4 hours under semi-occlusive conditions was not considered irritating (ECHA) [Kl. score = 2].

In a 24-hour human patch test, there was some short-lived redness in some individuals from the application of $C_{12\text{-}14}AE_3$, but there was no scaling or edema in any subjects (HERA, 2009) [Kl. score = 2].

In a standard 4-hour human patch test, the irritation potential of $C_{12\text{-}15}AE_5$ and $C_{12\text{-}15}AE_5$ were compared to 20% sodium dodecyl sulfate (which is classified a skin irritant under GHS). The results showed that neither alcohol ethoxylate should be classified as a skin irritant (Basketter et al., 2004) [Kl. score = 2]. Nonetheless, the substance is classified by ECHA as an irritant (see Section IX).

Eye

Most alcohol ethoxylates tested as the undiluted neat test material are moderately to severely irritating to the eyes of rabbits, with an eye irritation index (EII) ranging from >25 to 50 (HERA, 2009). The alcohol ethoxylates $C_{12\text{-}14}AE_3$, $C_{12\text{-}14}AE_6$, $C_{13}AE_6$, and $C_{12\text{-}14}AE_{10}$ were found to be moderately to severely irritating to the eyes of rabbits (HERA, 2009). In another study, $C_{12\text{-}15}AE_{11}$ was considered moderately to severely irritating to the eyes of rabbits (HERA, 2009).

Some alcohol ethoxylates were reported to be practically or minimally irritating to the eyes of rabbits with EII scores of 0.5 to 15. These alcohol ethoxylates include: $C_{12\text{-}15}AE_3$, $C_{14\text{-}15}AE_7$, $C_{12\text{-}14}AE_{15}$, $C_{14\text{-}15}AE_{18}$, and $C_{13}AE_{20}$ (HERA, 2009).

D. Sensitisation

There are no sensitisation studies are available on alcohols, C12-16, ethoxylated.

In a guinea pig maximization test, $C_{12\text{-}13}AE_{<2.5}$ (CAS No. 66455-14-9) was not considered a skin sensitizer (ECHA) [Kl. score = 2].

In guinea pig maximization tests, $C_{12\text{-}15}AE_3$, $C_{12\text{-}15}AE_7$, and $C_{14\text{-}15}AE_7$ were not considered skin sensitizers (HERA, 2009) [Kl. scores = 2].

E. Repeated Dose Toxicity

Oral

There are no repeated dose toxicity studies are available on alcohols, C12-16, ethoxylated. Data for similar ethoxylates are presented below.

Rats were given in their diet 0%, 0.0313%, 0.0625%, 0.125, 0.25, 0.5 or 1.0% $C_{12\text{-}15}AE_7$ for 90 days. The animals in the ≥0.25% groups showed significantly reduced body weight gain, which was associated with marked decreases in food and water consumption. Relative liver weights were significantly increased in the ≥0.5% male rats and ≥0.25% females. Histopathologic examination showed hepatocytic enlargement in the ≥0.125% groups, suggesting increased liver metabolism based on increased alkaline phosphatase activity at the higher dose levels. The NOAEL was established at 0.0625% in the diet or 102 mg/kg-day (HERA, 2009) [Kl. score = 2].

Rats were fed $C_{12\text{-}14}AE_7$ in the diet at concentrations of 0%, 0.0313%, 0.0625%, 0.125%, 0.25%, 0.5% and 1.0% for 90 days. The animals in the ≥0.25% groups showed significantly reduced body weight gain, which was associated with marked decreases in food and water consumption. Relative liver weights were significantly increased in the ≥0.5% male rats and ≥0.25% females. Histopathologic examination showed hepatocytic enlargement in the ≥0.125% groups, suggesting increased liver metabolism based on increased alkaline phosphatase activity at the higher dose levels. The NOAEL was established at 0.0625% in the diet or 110 mg/kg-day (HERA, 2009) [Kl. score = 2].

Male and female Wistar rats given in their diet 0, 300, 1,000, 3,000, and 10,000 ppm $C_{14\text{-}15}AE_7$ for 90 days. There were no deaths during the study. Mean body weights and feed were lower in 10,000 ppm males and the 3,000 ppm females. Feed consumption was lower in the 10,000 ppm animals and the 3,000 ppm females. Relative liver weights were increased in the ≥3,000 ppm animals, and relative spleen weights were increased in the 10,000 ppm males. Clinical chemistry changes were noted in the 10,000-ppm group and consisted of significantly higher urea, chloride and potassium levels in males, significantly higher urea, chloride and cholesterol in females. Increased total leucocytes and lymphocytes were seen in the 10,000 ppm animals and in the 3,000 ppm males. The 10,000 ppm females showed lower numbers of neutrophils; mean cell volume and mean cell hemoglobin were identified in one or both sexes fed in the ≥3,000 ppm dose groups. In the 1,000 ppm females, there were minor, but statistically significant changes in the liver and kidney weights and plasma urea concentration; these effects were considered to be of no toxicological significance. Histopathologic examination showed no treatment-related effects at any dose level. The NOAEL for this study is 1,000 ppm in the diet, which corresponded to 50 mg/kg-day (HERA, 2009) [Kl. score = 2].

Rats were given in their diet 0, 0.1, 0.5, or 1% $C_{14\text{-}15}AE_7$ for 90 days. Body weights, food intake, organ weights, and hematology and clinical chemistry parameters were similar across groups. The NOAEL

for this study is 1% in the diet, which corresponded to 700 and 785 mg/kg-day for males and females, respectively (HERA, 2009) [Kl. score = 2].

Rats were given in their diet 0, 0.1, 0.5 or 1% $C_{12\text{-}13}AE_{6.5}$ or $C_{14\text{-}15}AE_{7}$ for two years. Body weight gain was reduced in the 1% males and ≥0.5% females, which was likely due to the reduced food consumption in these animals. At study termination, organ to body weight ratios were increased in the ≥0.5% females (liver, kidney, and brain), 1% females (heart), and 1% males (liver). A dose-related focal myocarditis was observed in males. While focal myocarditis is commonly observed in non-treated aging rats, the incidence in the treated animals were higher than in the controls. The NOAEL was established at 0.1% or 50 mg/kg-day (HERA, 2009) [Kl. score = 2].

Male and female CR rats were given in their diet $C_{14\text{-}15}AE_{7}$ at 0.1, 0.5 and 1% for two years. A treatment-related body weight depression was observed in females at the two highest treatment levels and in males at the 1% dose level, probably due to the poor palatability of the diet. Relative liver, kidney, heart, and thyroid/parathyroid gland weights were increased in the 1% dietary group at study termination. Histopathological examination showed a dose-related increase in the incidence of focal myocarditis at the 12-month time point, but not at the end of the study at two years. The NOAEL for this study was considered to be 0.5% in the diet, which corresponded to 162 and 190 mg/kg-day for males and females, respectively (HERA, 2009) [Kl. score = 2].

An OECD guideline 422 (Combined repeated dose toxicity study with the reproduction/developmental toxicity screening test) was conducted in male and female Wistar rats exposed to a daily (7 days a week) dose of 100, 300, and 1,000 mg/kg bw/day of alcohols, C12-C15, ethoxylated by oral gavage for 29 (males) -64 days (females). Slightly increased plasma albumin concentrations were observed in males at the 300 and 1000 mg/kg bw/day dose levels, increased plasma urea concentrations were observed in males at the 1000 mg/kg bw/day dose level, decreased plasma cholesterol concentrations in males at the 300 and 1000 mg/kg bw/day levels and increased bile acid concentrations in females at the 1000 mg/kg bw/day dose level were considered as non-adverse since these changes were not associated with any adverse pathological alterations. Non-adverse test item-related morphologic alterations were present in males and females at the 1000 mg/kg bw/day dose level in the liver (macroscopically enlarged liver, centrilobular hypertrophy, increased weights starting at 100 mg/kg bw/day in males and 300 mg/kg bw/day in females), forestomach (squamous cell hyperplasia) and jejunum (vacuolation in the lamina propria), in males starting at 100 mg/kg bw/day in the thyroid gland (follicular cell hypertrophy and increased weights at 1000 mg/kg bw/day) and in females at 1000 mg/kg/day in the adrenal gland (macroscopically enlarged adrenal gland, diffuse cortical hypertrophy, and increased weights at 1000 mg/kg bw/day). There were no toxicologically significant changes were noted in any of the remaining parameters investigated in this study, i.e., mortality, clinical appearance, functional observations (motor activity, grip strength, hearing ability, pupillary reflex and static righting reflex), body weight, food consumption, hematology and clotting parameters, male T4 thyroid hormone. A systemic NOAEL of ≥1000 mg/kg bw/day and a reproductive toxicity NOAEL of ≥1000 mg/kg bw/day was established for this study (ECHA) [KI. score = 1].

Inhalation

There are no studies are available.

Dermal

There are no adequate studies are available.

F. Genotoxicity

In vitro Studies

The genotoxicity studies conducted on alcohol ethoxylates are reviewed in HERA (2009). The results of few of the *in vitro* studies on similar alcohol ethoxylates to alcohols, C12-16, ethoxylated are presented below in Table 2.

Table 2: *In Vitro* Genotoxicity Studies on Selected Alcohol Ethoxylates

Test Substance	Test System	Results*		Klimisch Score	References
		-S9	+S9		
$C_{14\text{-}15}AE_7$	Bacterial reverse mutation (*S. typhimurium* strains)	-	-	2	HERA, 2009
$C_{14\text{-}15}AE_7$	Bacterial reverse mutation (*S. typhimurium* strains)	-	-	2	HERA, 2009
$C_{14}AE_{12}$	Chromosomal aberrations (CHO cells)	-	-	2	HERA, 2009

*+, positive; -, negative

In Vivo Studies

In two separate studies, CD-1 mice were given an intraperitoneal dose of 0, 50, or 100 mg/kg $C_{12\text{-}15}AE_3$ or $C_{12\text{-}14}AE_9$. There were no increases in the frequency of micronuclei in the bone marrow cells (Talmage, 1994) [Kl. score = 2].

Male and female Tunstall rats were given a single oral gavage dose of 0, 250, 500, or 1,000 mg/kg $C_{14\text{-}15}AE_7$. There were no increases in chromosomal aberrations in the bone marrow cells (HERA, 2009 [Kl. score = 2].

G. Carcinogenicity

There are no studies are available on alcohols, C12-16, ethoxylated. Therefore, data from similar substances are presented below.

Male and female Sprague-Dawley rats were given in their diet $C_{12\text{-}13}AE_{6.5}$ in the diet at doses up to 1% (500 mg/kg-day). Reduced food consumption was noted at the higher dose levels (*i.e.*, 0.5 and 1% for females and 1% for males), resulting in a lower body weight gain compared to the control group. No treatment-related histopathology was found and no increase in tumour incidence was observed (HERA, 2009) [Kl. score = 2].

Male and female Charles River rats were given in their diet 0, 0.1, 0.5 or 1% $C_{14\text{-}15}AE_7$ for two years. There were no treatment-related changes in general behaviour and appearance. The survival rate of the test animals was comparable if not better than the controls. Body weights of the 0.5% females and the 1% males and females had significantly lower weight gains than the control. There were no treatment-related effects on organ weights and tumour incidence (HERA, 2009) [Kl. score = 2].

Male and female Sprague-Dawley rats were given in their diet $C_{14\text{-}15}AE_7$ at 0.1, 0.5 and 1% for two years. A treatment-related body weight depression was observed in females at the two highest treatment levels and in males at the 1% dose level, probably due to the poor palatability of the diet. There was no evidence for any carcinogenic activity (HERA, 2009) [Kl. score = 2].

H. Reproductive Toxicity

There are studies are available on alcohols, C12-16, ethoxylated.

CD rats were given in their diet 0, 0.05, 0.1 or 0.5% (approximately 0, 25, 50 or 250 mg/kg-day) $C_{12}AE_6$ in a two-generation reproductive toxicity study. There were no treatment related effects in the parents or pups on general behaviour, appearance, or survival. At 0.5%, there was reduced weight gain in both the parental animals and the pups compared to the controls. Fertility was unaffected by treatment. The NOAEL for reproductive toxicity is 0.5% in the diet, which corresponds to 250 mg/kg-day (HERA, 2009) [Kl. score = 2].

In a two-generation developmental and teratogenicity study, CD rats were given in their diet 0, 0.05, 0.1 or 0.5% $C_{14\text{-}15}AE_7$ (approximately 0, 25, 50 or 250 mg/kg-day). Three of the treated groups were given the test substance continuously throughout the study; in the other three groups the females received the test substance on GD 6-15 and the males were untreated. None of the deaths of parental rats during the study was considered to be compound related. There were no treatment-related changes in behaviour or appearance in the parental rats or pups. Slightly lower body weight gain was noted in the 0.5% continuously treated females. Food consumption was similar for control and treated rats. Fertility, gestation, and viability indices were similar across groups. The average 21-day body weights for the 0.5% continuous treated pups were significantly lower than that of the control. Relative liver weights of the 0.5% continuously treated F_1 parental animals were increased at the 91-day sacrifice; relative liver weights of the 0.5% continuously treated males were also increased at the 60-day and caesarean section sacrifices. There were no treatment-related histopathological lesions in any of the tissues from the F_0 and F_1 generations. The NOAEL for reproductive toxicity is 0.5% in the diet or 250 mg/kg-day (HERA, 2009) [Kl. score = 2].

A sub-acute reproductive and developmental toxicity screening study was completed using male and female Wistar rats exposed to 100, 300, and 1,000 mg/kg bw/day of alcohols, C12-15, ethoxylated via oral gavage for 29 (males)-64 (females) days. All the females had regular cycles of 4 to 5 days. Extended di-oestrous occurred during the mating period in three females of the control group and two females of the mid-dose group (300 mg/kg bw/day) with a regular cycle during premating. One female at 300 mg/kg bw/day had an inconclusive cycle determination during the premating phase. Given their absence of a dose-related incidence, this finding did not indicate a relation with treatment. Length and regularity of the oestrous cycle were considered not to have been affected by treatment with the test item up to 1000 mg/kg bw/day. Mating index was not affected by treatment. The mating indices were 90, 100, 100 and 100% for the control, 100, 300 and 1000 mg/kg bw/day groups, respectively. One female of the control group did not mate. All of the paired females showed evidence of mating within 4 days, except one female at 300 mg/kg bw/day for which mating took 13 days. Hence, precoital time was not affected by treatment with the test item. Number of implantation sites was considered not to be affected by treatment. The mean number of implantation sites were 11.0, 8.9, 12.9 and 12.1 for the control, 100, 300 and 1000 mg/kg bw/day. The relatively low mean number of implantation sites at 100 mg/kg bw/day was attributed to the low number of implantation sites in three females (4, 1 and 2 implantation sites, respectively). In the absence of a dose-related incidence, the relatively low mean number of implantation sites at 100 mg/kg bw/day was considered not to be related to treatment with the test item. One female at 100 mg/kg bw/day and one female at 1000 mg/kg bw/day were not pregnant. In the absence of a dose-related incidence of non-pregnancy, this was considered not to be related to treatment with the test item. The fertility indices were 100, 90, 100 and 90% for the control, 100, 300 and 1000 mg/kg bw/day groups, respectively. It was considered not to be affected by treatment of the animals. Gestation index and duration of gestation were not affected by treatment with the test item up to 1000 mg/kg bw/day. The gestation indices were 100% for all groups. All pregnant females had 21-22

days gestation, except for one female at 100 mg/kg bw/day which only had 19 days of gestation (her litter consisted of 1 pup only). Given the incidental occurrence and lack of a dose-related trend, no toxicological relevance was attributed to this early delivery. No signs of difficult or prolonged parturition and no deficiencies in maternal care were noted among the pregnant females. A NOAEL for systemic toxicity was reported to be ≥1000 mg/kg bw/day ECHA) [KI. score =1].

A two-generation reproductive toxicity study was completed using male and female Fischer 344 rats exposed to 10, 100, and 250 mg/kg bw/day alcohols, C12-15, ethoxylated via dermal exposure. No mortalities were observed in the parental generation, and the five deaths in the F1 adult males and females in the control and treatment groups were not considered to be compound related. In the highest dose group, body weights of both males and females in both treated generations were sporadically decreased compared to controls. There was no effect on maternal body weight during gestational and lactational periods in both generations. At necropsy organ weight differences in liver, lung, kidney, and heart were observed in the F1 generation. However, there were no pathological findings that were associated with these affected organs. There were no compound-related effects on mating and fertility indices and mean gestational length in both generations. No effects on testicular weights, sperm counts and LDH-X activities in F0 and F1 male adults were observed. Macroscopic and microscopic examination of the reproductive organs did not reveal significant differences in the treated groups compared to the controls. A NOAEL for systemic toxicity was reported to be ≥ 250 mg/kg bw/day based on changes in body and organ weights that were not associated with histopathological findings. A reproductive toxicity NOAEL was reported to be ≥ 250 mg/kg bw/day (ECHA)[KI. score = 2].

I. Developmental Toxicity

There are no studies are available on alcohols, C12-16, ethoxylated.

In a two-generation reproductive toxicity study, Charles River rats were given in their diet 0, 0.05, 0.1 or 0.5% (about 0, 25, 50 or 250 mg/kg-day) $C_{12}AE_6$. General behaviour, appearance and survival were unaffected by treatment. At the 0.5% dose level, adults and pups gained less weight than the control rats. In the 0.5% dose group, there was a statistical increase in embryo lethality and soft tissue anomalies and at the 0.1% there was a statistical decrease in mean foetal liver weight. Neither of these effects was considered to be treatment-related by the authors as they showed no dose response characteristics. The NOAEL for maternal toxicity is 50 mg/kg-day. The NOAEL for developmental and teratogenicity is 0.1% in the diet or 50 mg/kg-day (HERA, 2009) [Kl. score = 2].

Pregnant rabbits were given by oral gavage 0, 50, 100 or 200 mg/kg $C_{12}AE$ from gestational days 2 to 16. Nine control rabbits and 31 treated rabbits died during the study. Surviving rabbits at the 200 mg/kg dose group generally showed slight losses of body weight. At 100 and 200 mg/kg, ataxia and a slight decrease in body weight was observed in the pregnant animals. In seven treated and two control rabbits, early deliveries were recorded. There were no treatment-related effects on corpora lutea, implantations, number of live foetuses and spontaneous abortions. The NOAEL for maternal toxicity is 50 mg/kg-day; the NOAEL for developmental toxicity is 200 mg/kg-day (HERA, 2009) [Kl. score = 2].

A developmental toxicity study was conducted using Fischer 344 rats exposed to 10,100,250 mg/kg bw/day alcohols, C12-15 ethoxylated via dermal exposure three days a week from gestation day 0 until weaning. In the highest dose, body weights of both males and females in both treated generations were sporadically and not always statistically significant decreased compared to controls. At necropsy organ weight differences in liver, lung, kidney, and heart were observed in the F1 generation, but no pathological findings were associated with the affected organs. There were no

treated related effects reported for the foetuses. The NOAEL for developmental toxicity was reported to be ≥ 250 mg/kg bw/day and the NOAEL for maternal toxicity was reported to be ≥ 250 mg/kg bw/day. The NOAEL for fetotoxicity was reported to be ≥250 mg/kg bw/day (ECHA) [KI.score =2].

V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES

The toxicological reference values developed for alcohols, C12-16, ethoxylated follow the methodology discussed in enHealth (2012). The approach used to develop drinking water guidance values is described in the Australian Drinking Water Guidelines (ADWG, 2011).

A. Non-Cancer

Oral

Two-year dietary studies in rats have been conducted on alcohol ethoxylates $C_{12\text{-}13}AE_{6.5}$ and $C_{14\text{-}15}AE_{7}$ (HERA, 2009). The lowest NOAEL from these studies is 50 mg/kg-day based on increased organ weights. The NOAEL of 50 mg/kg-day will be used to derive an oral reference dose and drinking water guidance value for alcohols, C12-16, ethoxylated.

Oral Reference Dose (oral RfD)

Oral RfD = NOAEL / (UF_A x UF_H x UF_L x UF_{Sub} x UF_D)

Where:
UF_A (interspecies variability) = 10
UF_H (intraspecies variability) = 10
UF_L (LOAEL to NOAEL) = 1
UF_{Sub} (subchronic to chronic) = 1
UF_D (database uncertainty) = 1

Oral RfD = 50/(10 x 10 x 1 x 1 x 1) = 50/100 = 0.5 mg/kg-day

Drinking water guidance value

Drinking water guidance value = (animal dose) x (human weight) x (proportion of intake from water) / (volume of water consumed) x (safety factor)

Using the oral RfD,
Drinking water guidance value = (oral RfD) x (human weight) x (proportion of water consumed) / (volume of water consumed)

where:
Human weight = 70 kg (ADWG, 2011)
Proportion of water consumed = 10% (ADWG, 2011)
Volume of water consumed = 2L (ADWG, 2011)

Drinking water guidance value = (0.5 x 70 x 0.1)/2 = 1.8 mg/L

B. Cancer

Several alcohol ethoxylates similar to alcohols, C12-16, ethoxylated were not carcinogenic to rats in a two-year dietary study. Thus, a cancer reference value was not derived.

VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES

Alcohols, C12-16, ethoxylated does not exhibit the following physico-chemical properties:

- Explosivity
- Flammability
- Oxidizing potential

VII. ENVIRONMENTAL HAZARD ASSESSMENT

A. Summary

There are no aquatic toxicity studies for ethoxylated C12-C16 alcohol. The aquatic toxicity of other AEs has been extensively evaluated in numerous studies on fish, daphnids and algae as well as microorganisms. A review of the acute studies indicates that invertebrates are somewhat more sensitive to AEs than fish and algae. AEs have moderate chronic toxicity to aquatic life.

B. Aquatic Toxicity

There are no acute aquatic toxicity studies for ethoxylated C12-C16 alcohol. The aquatic toxicity of other AEs has been extensively evaluated in numerous studies on fish, daphnids and algae as well as microorganisms. Table 3 lists the results of acute aquatic toxicity studies on read across substance alcohols, C12-C15, ethoxylated (1 to 2.5 EO) [CAS No. 68131-39-5], alcohols, C12-C14, ethoxylated (2 EO) [CAS No. 68439-50-9] and alcohols, C12-C15, branched and linear, ethoxylated [CAS No. 106232-83-1].

Table 3: Acute Aquatic Toxicity Studies on Ethoxylated C12-C16 Alcohol[a,b,c]

Test Species	Endpoint	Results (mg/L)	Klimisch score	Reference
Oncorhynchus mykiss (Rainbow Trout)	96-hr LC_{50}	1.3 – 1.7[a]	2	ECHA
Danio Rio	96-hr LC_{50}	1.2[b]	2	ECHA
Danio Rio	96-hr LC_{50}	2[b]	2	ECHA
Zebrafish	96-hr LC_{50}	>2[c]	2	ECHA
Daphnia magna	48-hr EC_{50}	0.14[a]	2	ECHA
Daphnia magna	48-hr EC_{50}	0.23[a]	2	ECHA
Daphnia magna	48-hr EC_{50}	0.53[b]	2	ECHA
Daphnia magna	48-hr EC_{50}	2.84[b,d]	2	ECHA
Daphnia magna	48-hr EC_{50}	1.2[e]	1	ECHA
Daphnia magna	48-hr EC_{50}	>2[b]	2	ECHA
Daphnia magna	48-hr EC_{50}	>2[c]	2	ECHA
Daphnia magna	48-hr EC_{50}	0.23	2	ECHA
Pseudokirchneriella subcapitata	72-hr EC_{50}	0.75[a]	2	ECHA

Test Species	Endpoint	Results (mg/L)	Klimisch score	Reference
Pseudokirchneriella subcapitata	72-hr EC_{50}	>2[c]	2	ECHA
Pseudokirchneriella subcapitata	72-hr EC_{50}	0.41[b]	2	ECHA
Desmodesmus subspicatus (green algae)	72-hr EC_{50}	0.778[b]	2	ECHA
Desmodesmus subspicatus (green algae)	72-hr EC_{50}	0.87[e]	1	ECHA
Desmodesmus subspicatus (green algae)	72-hr EC_{50}	1.3[e]	1	ECHA

a: Read across to alcohols, C12-C15, ethoxylated (1 to 2.5 EO) CAS No. 68131-39-5
b: Read across to alcohols, C12-C14, ethoxylated (EO 2) CAS No. 68439-50-9
c: Read across to alcohols, C12-C15, branched and linear, ethoxylated (CAS No. 106232-83-1)
d: alcohols, C12-C14, ethoxylated (EO 1) CAS No. 68439-50-9 as WAF (water accommodated fraction)
e: alcohols, C12-C14, ethoxylated (EO 4 or EO 6) CAS No. 68439-50-9

A review of the acute studies indicates that invertebrates are somewhat more sensitive to AEs than fish and algae. As concluded in HERA (2009), the Danish EPA (2001) found that the acute toxicity of AE to invertebrates varies, with EC50 values from 0.1 mg/l to more than 100 mg/l for linear AE and from 0.5 mg/l to 50 mg/l for branched AE. The toxicity is species specific and may vary between 0.29 mg/l and 270 mg/l for the same linear AE (Lewis and Suprenant 1983, quoted in Danish EPA 2001). The most commonly used invertebrates for testing are Daphnia magna and Daphnia pulex, and they are also among the most sensitive invertebrates to AE. The Danish EPA (2001) found that some AE are very toxic to invertebrates, i.e., linear AE of C12-15 EO1-8 and branched AE with a low degree of branching, i.e. < 10-25%. They concluded that branching of the alkyl chain reduces the toxicity of AE to invertebrates, as also observed for algae (Danish EPA, 2001). However, the data used to reach this conclusion is from specially synthesized AE which have been shown to have a significantly higher toxicity than the AE made from a technical alcohol which are used commercially (Kaluza and Taeger, 1996).

Chronic studies

In developing a water quality guideline for AEs (ANZG, 2018), the toxicity data was normalized for a specific alkyl chain length or a specific number of EO groups. The NOECs listed below were normalized to an alkyl chain length of C13.3 and EO of 8.2. There were chronic data for 13 species that belonged to 7 taxonomic groups (fish, crustacea, blue alga, diatoms, green alga, protozoa, and worms).

Freshwater fish: 2 species, 720 to 1,500 µg/L.

Freshwater crustaceans: 2 species, 590 to 860 µg/L.

Freshwater rotifers: 1 species, Brachionus calyciflorus, 1,300 µg/L.

Freshwater algae, diatoms and blue-green algae: 6 species, 200 to 8,700 µg/L.

Freshwater mesocosms: 4 NOEC data for multiple species tests were 80, 80, 320 and 330 µg/L, although replication was insufficient to meet OECD (1992) requirements. Normalized data were 380, 380, 320 and 1,520 µg/L.

C. Terrestrial Toxicity

There are no studies are available. The substance is readily biodegradable. Therefore, soil is not expected to be a compartment of concern. Thus, the risk to terrestrial macroorganisms is regarded to be negligible (ECHA).

D. Calculation of PNEC

The PNEC calculations for ethoxylated C12-C16 alcohol follow the methodology discussed in DEWHA (2009).

PNEC water

The ANZECC water quality guideline (2018) for freshwater is: "A high reliability trigger value of 140 mg/L was derived for AE (normalized data) using the statistical distribution method with 95% protection."

For the purposes of calculating the PNEC values for sediment and soil, the $PNEC_{water}$ will be 0.14 mg/L.

PNEC sediment

There are no toxicity data for sediment-dwelling organisms. Nonetheless, a $PNEC_{sed}$ was calculated using the equilibrium partitioning method. The $PNEC_{sed}$ is 0.0875 mg/kg sediment wet weight.

The calculations are as follows:
$PNEC_{sed} = (K_{sed\text{-}water}/BD_{sed}) \times 1000 \times PNEC_{water}$
$= 0.800/1280 \times 1000 \times 0.140$
$= 0.0875$ mg/kg

Where:
$K_{sed\text{-}water}$ = suspended matter-water partition coefficient (m^3/m^3)
BD_{sed} = bulk density of sediment (kg/m^3) = 1,280 kg/m^3[default]
$PNEC_{water}$ = 0.002 mg/L

$K_{sed\text{-}water} = 0.8 + [(0.2 \times Kp_{sed})/1000 \times BD_{solid}]$
$= 0.8 + [(0.2 \times 156.8)/1000 \times 2400]$
$= 0.800\ m^3/m^3$

And:
Kp_{sed} = solid-water partition coefficient (L/kg)
BD_{solid} = bulk density of the solid phase (kg/m^3) = 2,400 kg/m^3[default]
$Kp_{sed} = K_{oc} \times f_{oc}$
$= 3920 \times 0.04$
$= 156.8$ L/kg

Where:
K_{oc} = organic carbon normalised distribution coefficient (L/kg). The K_{oc} for alcohols, C12-16, ethoxylated based on the molecular connectivity index (MCI) is 3,920 L/kg (USEPA, 2018).
f_{oc} = fraction of organic carbon in sediment = 0.04 [default].

PNEC soil

There are no toxicity data for terrestrial or soil organisms. Therefore, the $PNEC_{soil}$ was calculated using the equilibrium partitioning method. The $PNEC_{soil}$ is 7.32 mg/kg soil dry weight.

The calculations are as follows:

$PNEC_{soil} = (Kp_{soil}/BD_{soil}) \times 1000 \times PNEC_{water}$
$= (78.4/1500) \times 1000 \times 0.14$
$= 7.32 mg/kg$

Where:
Kp_{soil} = soil-water partition coefficient (m^3/m^3)
BD_{soil} = bulk density of soil (kg/m^3) = 1,500 kg/m^3 [default]

$Kp_{soil} = K_{oc} \times f_{oc}$
$= 3920 \times 0.02$
$= 78.4\ m^3/m^3$

Where:
K_{oc} = organic carbon normalised distribution coefficient (L/kg). The K_{oc} for alcohols, C12-16, ethoxylated based on the molecular connectivity index (MCI) is 3,920 L/kg (USEPA, 2018).
f_{oc} = fraction of organic carbon in soil = 0.02 [default].

VIII. PERSISTENCE, BIOACCUMULATION AND TOXICITY (PBT) ASSESSMENT

The methodology for the Persistent, Bioaccumulative and Toxic (PBT) substances assessment is based on the Australian and EU Reach Criteria methodology (DEWHA, 2009; ECHA, 2017).

Alcohols, C12-16, ethoxylated is readily biodegradable and thus does not meet the screening criteria for persistence.

The bioconcentration factors (BCF) in fish for ethoxylated alcohols (which includes alcohols, C12-16, ethoxylated) have been reported to range from <5 to 387.5. Thus, alcohols, C12-16, ethoxylated does not meet the screening criteria for bioaccumulation.

The chronic NOEC values for alcohols ethoxylates are >0.1 mg/L. Thus, alcohols, C12-16, ethoxylated do not meet the criteria for toxicity.

The overall conclusion is that alcohols, C12-16, ethoxylated is not a PBT substance.

IX. CLASSIFICATION AND LABELLING

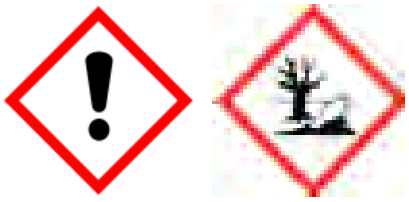
A. Classification

H400: Very toxic to aquatic life
H412: Harmful to aquatic life with long lasting effects

B. Labelling

Warning

C. Pictogram



X. HANDLING AND SAFETY INFORMATION (OCCUPATIONAL LIMITS AND TRANSPORTATION REQUIREMENTS)

A. First Aid

Eye Contact

Rinse immediately with plenty of running water. If easy to do, remove contact lenses. Get medical attention.

Skin Contact

Wash with soap and water. Get medical attention if symptoms occur.

Inhalation

Treat symptomatically. Move to fresh air. Get medical attention.

Ingestion

Rinse mouth with water and then drink plenty of water. Never give anything by mouth to an unconscious person. Seek medical attention.

B. Fire Fighting Information

Extinguishing Media

Water spray, dry chemical, foam. Do not use water jet.

Specific Exposure Hazards

May emit toxic fumes under fire conditions. Depending on conditions, decomposition products may include the following: carbon monoxide, carbon oxides.

Special Protective Equipment for Firefighters

Self-contained breathing apparatus and full protective clothing must be worn in case of fire.

C. Accidental Release Measures

Personal Precautions

Wear appropriate personal protective equipment. Do not breath mist or aerosol.

Environmental Precautions

Prevent from entering sewers, waterways, or low area

Steps to be Taken if Material is Released or Spilled

Absorb spill with inert absorbent material, then place in a container for chemical waste.

D. Storage And Handling

General Handling

Protect against moisture. Shut containers immediately after taking product because product takes up the humidity of air. No special precautions are necessary beyond normal good hygiene practices.

Other Handling Precautions

Wash hands thoroughly after handling. Avoid breathing mists or aerosols.

Storage

Keep container closed.

E. Exposure Controls / Personal Protection

Occupational Exposure Standards

Workplace Australia has not established an occupational exposure standard for alcohols, C12-16, ethoxylated.

Engineering Controls

Good general ventilation should be used.

Personal Protection Equipment

Respiratory Protection:
Wear respiratory protection if ventilation is inadequate.

Hand Protection:
Chemical resistant protective gloves.

Skin Protection:
Body protection must be chosen depending on activity and possible exposure.

Eye protection:
Chemical safety goggles.

Other Precautions:
Handle in accordance with good industrial hygiene and safety practice. Eyewash fountains and safety showers must be easily accessible.

F. Transport Information

UN: UN 1993

Class:3

Packaging Group: II

XI. DISPOSAL MANAGEMENT

Disposal should be in accordance with all local, state, and federal regulations.

XII. REGULATORY STATUS

Australian AICS Inventory: Listed.

XIII. REFERENCES

ADWG. (2011). National Water Quality Management Strategy. Australian Drinking Water Guidelines, Section 6, Australian Government, National Health and Medical Research Council, Natural Resource Management Ministerial Council. Updated January 2022. Available: https://www.nhmrc.gov.au/about-us/publications/australian-drinking-water-guidelines

ANZECC & ARMCANZ. (2000). Australian and New Zealand guidelines for fresh and marine water quality. National Water Quality Management Strategy Paper No 4, Australian and New Zealand Environment and Conservation Council & Agriculture and Resource Management Council of Australia and New Zealand, Canberra, Australia. Available: https://www.waterquality.gov.au/anz-guidelines/resources/previous-guidelines/anzecc-armcanz-2000

Basketter, D.A., York, M., McFadden, J.P., and Robinson, M.K. (2004). Determination of skin irritation potential in the human 4-h patch test. Contact Dermatitis 51: 1-4.

Department of the Environment, Water, Heritage and the Arts [DEWHA]. (2009). Environmental risk assessment guidance manual for industrial chemicals, Department of the Environment, Water, Heritage and the Arts, Commonwealth of Australia. Available: http://www.nepc.gov.au/resource/chemical-risk-assessment-guidance-manuals

ECHA. ECHA REACH database: http://echa.europa.eu/information-on-chemicals/registered-substances

enHealth Human Risk Assessment [HHRA] (2012). Environmental Health Risk Assessment, Guidelines for Assessing Human Health Risks from Environmental Hazards. Office of Health Protection of the Australian Government Department of Health.

European Chemicals Agency [ECHA]. (2017). Guidance on Information Requirements and Chemical Safety Assessment, Chapter R11: PBT Assessment, European Chemicals Agency, Helsinki, Finland. Available: https://echa.europa.eu/guidance-documents/guidance-on-information-requirements-and-chemical-safety-assessment

Klimisch, H.J., Andreae, M., and Tillmann, U. (1997). A systematic approach for evaluating the quality of experimental and toxicological and ecotoxicological data. Regul. Toxicol. Pharmacol. 25:1-5.

Human and Environmental Risk Assessment (HERA) on Ingredients of Household Cleaning Products: Alcohol Ethoxylates (2009), http://www.heraproject.com.

OECD (1992). Report of the OECD workshop on extrapolation of laboratory aquatic toxicity data to the real environment. OECD Environment Monographs No. 59, Organisation for Economic Co-operation and Development, Paris.

Talmage, S.S. (1994). Environmental and Human Safety of Major Surfactants – Alcohol Ethoxylates and Alkylphenol Ethoxylates, pp. 35, The Soap and Detergent Association, Lewis Publishers, Boca Raton, Florida.

Toll, J., Haller, M., Labee, E., Verweij, M., and Sijm, D.T.H.M. (2000). Toxicology and Chemistry, 19 646–653.

U.S. Environmental Protection Agency [EPA] (2018). EPISuite™ v. 4.11, United States Environmental Protection Agency, Office of Pollution Prevention and Toxics and Syracuse Research Corporation. Available at: https://www.epa.gov/tsca-screening-tools/epi-suitetm-estimation-program-interface.

ALCOHOLS, C11-14-ISO-, C13-RICH, ETHOXYLATED

This dossier on alcohols, C11-14-iso-, C13-rich, ethoxylated presents the most critical studies pertinent to the risk assessment of alcohols, C11-14-iso-, C13-rich, ethoxylated in their use in coal seam or shale gas extraction activities. This dossier does not represent an exhaustive or critical review of all available data. The information presented in this dossier was obtained primarily from the Human & Environmental Risk Assessment on Ingredients of European Household Cleaning Products: Alcohol Ethoxylates (HERA, 2009). Where possible, study quality was evaluated using the Klimisch scoring system (Klimisch et al., 1997).

I. SUBSTANCE IDENTIFICATION

Chemical Name (IUPAC): Alcohols, C11-14-iso-, C13-rich, ethoxylated

CAS RN: 78330-21-9

Molecular formula: Not available (UVCB substance)

Molecular weight: 233.46 g/mol

Synonyms: Ethoxylated branched C11-14, C13-rich alcohols; alpha-Alkyl-omega-hydroxypoly(oxypropylene) and/or poly(oxyethylene) polymers where the alkyl chain contains a minimum of six carbons, minimum number average molecular weight (in amu) 1,100

SMILES: C.C.[*]C.CCCCCCCCCCOCC

II. PHYSICO-CHEMICAL PROPERTIES

Alcohol ethoxylates (AEs) are a class of non-ionic surfactants that have the basic structure $C_{x-y}AE_n$. The subscript (x-y) following the 'C' indicates the range of carbon chain units. The hydrocarbon chain can be either linear or branched. AEs also contain an ethylene oxide (E) chain attached to the alcohol. The degree of ethylene oxide polymerization is indicated by the subscript (n) which indicates the average number of ethylene oxide units. Alcohols, C11-14-iso-, C13-rich, ethoxylated has an average number of 7 moles of ethylene oxide units.

No information is available on alcohols, C11-14-iso-, C13-rich, ethoxylated. Thus, data were read across from a similar substance, alcohols, C12-15, ethoxylated, as shown below.

Table 1: Overview of the Physico-Chemical Properties of Alcohols, C11-14-iso-, C13-rich, ethoxylated[1]

Property	Value	Klimisch score	Reference
Physical state at 20°C and 101.3 kPa	Clear liquid with a rancid odour*	2	ECHA
Melting Point	7.22°C @ 101.3 kPa	2	ECHA
Boiling Point	287°C @ 101.3 kPa	1	ECHA
Density	926 kg/m^3 @ 15.56°C	1	ECHA
Vapour Pressure	Negligible	-	ECHA

Property	Value	Klimisch score	Reference
Partition coefficient (log K_{ow})	5.06* @25 ^{O}C	2	ECHA
Water Solubility	0.007 – 0.063 g/L @ 25 ^{o}C	1	ECHA
Flash Point	165.56 ^{o}C	2	ECHA
Auto Flammability	235 ^{o}C	2	ECHA
Viscosity	28.1 mPa s (dynamic) @ 20^{o}C	1	ECHA

1 – Based on alcohols, C12-C15, ethoxylated (1 to 2.5 EO) [CAS RN 68131-39-5]

*Based on alcohols, C12-14, ethoxylated (1 to 2.5 EO) [CAS RN 68439-50-9]

III. ENVIRONMENTAL FATE PROPERTIES

A. Summary

Alcohols, C11-14-iso-, C13-rich, ethoxylated is readily biodegradable. They are slightly soluble and have high adsorption potential to soil and sediment. However, they have a low potential to bioaccumulate.

B. Biodegradation

No studies are available on alcohols, C11-14-iso-, C13-rich, ethoxylated.

AEs with a typical alkyl chain (e.g., C12 to C15) will normally reach more than 60% ultimate degradation in standardized tests for ready biodegradability (HERA, 2009). For example, alcohols, C12-15, ethoxylated is readily biodegradable. In an OECD 301B test, degradation was 72% in 28 days, but failed the 10-day window (ECHA) [Kl. score = 1].

An alcohol, C12-15, ethoxylated (7 EO) degraded 80 to 88% in 28 days when tested using a shake-flask CO_2-evolution test method (ECHA) [Kl. score = 2].

If a chemical is found to be inherently biodegradable or readily biodegradable, it is categorised as Not Persistent since its half-life is substantially less than 60 days (DoEE, 2017).

C. Environmental Distribution

No experimental data are available for alcohols, C11-14-iso-, C13-rich, ethoxylated.

Using KOCWIN in EPISUITE™ (USEPA, 2019), the estimated K_{oc} values for alcohols, C1.1-14-iso-, C13-rich, ethoxylated were 5649 L/kg (MCI) and 20,085 L/kg (K_{ow}). However, as described in ECHA, one should keep in mind that surfactancy (the fact that surfactants tend to stay in the boundary layer between the phases) and dissociation is not considered in the EPISUITE™ estimations. Therefore, calculated K_{oc} values should be used with caution.

If released to soil, these K_{oc} values indicate a high potential for both adsorption and low potential for mobility. If released to water, based on these K_{oc} values and slight solubility, this substance is expected to strongly adsorb to suspended solids or sediment.

D. Bioaccumulation

There are no bioaccumulation studies on this substance. The BCF values for AEs in fathead minnows have been reported to range from <5 to 387.5 (Toll et al., 2000). The uptake rates varied from 330 to 1,660 (L x kg/d) and elimination rates varied from 3.3 to 59 per day (Toll et al., 2000). The high concentrations in fish are thought to be prevented by an efficient biotransformation of the alcohol ethoxylates, leading to a high elimination rate. Thus, it can be stated that bioaccumulation of AEs is regarded to be negligible as the surfactants will be rapidly metabolised (ECHA).

IV. HUMAN HEALTH HAZARD ASSESSMENT

A. Summary

Overall, AEs are not expected to be systemically toxic. The available datasets for AEs ranging from C6–C18 and EO3–EO12 are considered representative of the AE category and were used to assess alcohols, C11-14-iso-, C13-rich, ethoxylated.

The acute toxicity of similar AEs is low by the oral and dermal routes. The skin irritation rabbit studies show that the degree of irritation depends on the testing conditions and length of the exposure period. Human patch studies on AEs do not support a skin irritant classification and alcohol ethoxylates in this group are not considered skin sensitisers. Alcohols, C11-14-iso-, C13-rich, ethoxylated is expected to be irritating to the eyes of rabbits. Repeated dose toxicity studies on AEs similar to alcohols, C11-14-iso-, C13-rich, ethoxylated in rats do not indicate any target organ effects. These AEs are not genotoxic, carcinogenic, and have a low potential for reproductive and developmental toxicity.

B. Metabolism

In rats, AEs are readily absorbed in the gastrointestinal tract (i.e., oral absorption has been estimated to be >75%) and rapidly excreted via the urine and faeces after oral application. The alkyl chain length appears to have an impact on the metabolism. AEs with longer alkyl chains are excreted at a higher proportion into expired air and less in urine. Also, ethoxy chain length impacts the proportions excreted via the urine, the faeces, and the expired air with more being excreted via the faeces and expired in the air with longer ethoxy chain length (HERA, 2009).

The same trends were observed when AEs were administered dermally, with the only difference being that adsorption was slower and less of the total administered compound was absorbed (HERA, 2009).

C. Acute Toxicity

No acute toxicity studies are available on alcohols, C11-14-iso-, C13-rich, ethoxylated.

The oral LD_{50} in rats for $C_{12\text{-}15}AE_3$ is >5,000 milligrams per kilogram (mg/kg) (ECHA) [Kl. score = 2]. The oral LD_{50} in rats for $C_{12\text{-}15}AE_7$ is 1,700 mg/kg (HERA, 2009) [Kl. score = 2]. The oral LD_{50} value in rats for $C_{12\text{-}13}AE_{6.5}$ is 2,100 mg/kg (HERA, 2009) [Kl. score = 2]. The oral LD_{50} value in rats for $C_{12\text{-}15}AE_{11}$ is >2,000 mg/kg in males and between 1,000 and 2,000 mg/kg in females (HERA, 2009) [Kl. score = 2]. The oral LD_{50} values in rats for $C_{14\text{-}15}AE_{13}$ in two separate studies are 1,100 and 1,000 mg/kg (HERA, 2009) [Kl. score = 2]. The relative number of ethoxylate (EO) units, but not the carbon chain length, appears to influence acute oral toxicity (HERA, 2009).

An acute dermal LD_{50} values of >2,000 mg/kg were determined for $C_{12\text{-}14}AE_3$ and $C_{12\text{-}14}AE_6$ in two separate studies (HERA, 2009) [Kl. score = 2]. The acute dermal LD_{50} of $C_{12\text{-}15}AE_7$ is >2,000 mg/kg (HERA, 2009) [Kl. score = 2].

D. Irritation

Skin

Application of 0.5 millilitres (mL) $C_{12\text{-}13}AE_{<2.5}$ (CAS RN 66455-14-9) to the skin of rabbits for 24 hours under occlusive conditions was considered irritating (ECHA) [Kl. score = 2].

Application of 0.5 mL alcohols $C_{12\text{-}13}$, branched and linear, <2.5 EO to the skin of rabbits for 4 hours under occlusive conditions was not considered irritating (ECHA) [Kl. score = 2].

In a 24-hour human patch test, there was some short-lived redness in some individuals from the application of $C_{12\text{-}14}AE_3$, but there was no scaling or oedema in any subjects (HERA, 2009) [Kl. score = 2].

In a standard 4-hour human patch test, the irritation potential of $C_{12\text{-}15}AE_5$ and $C_{12\text{-}15}AE_5$ were compared to 20% sodium dodecyl sulfate, which is classified a skin irritant under GHS. The results showed that neither AE should be classified as a skin irritant (Basketter et al., 2004) [Kl. score = 2].

Eye

Most AEs tested as the undiluted neat test material are moderately to severely irritating to the eyes of rabbits, with an eye irritation index (EII) ranging from >25 to 50 (HERA, 2009). The AEs $C_{12\text{-}14}AE_3$, $C_{12\text{-}14}AE_6$, $C_{13}AE_6$, and $C_{12\text{-}14}AE_{10}$ were found to be moderately to severely irritating to the eyes of rabbits (HERA, 2009). In another study, $C_{12\text{-}15}AE_{11}$ was considered moderately to severely irritating to the eyes of rabbits (HERA, 2009).

Some AEs were reported to be practically or minimally irritating to the eyes of rabbits with EII scores of 0.5 to 15. These AEs include: $C_{12\text{-}15}AE_3$, $C_{14\text{-}15}AE_7$, $C_{12\text{-}14}AE_{15}$, $C_{14\text{-}15}AE_{18}$, and $C_{13}AE_{20}$ (HERA, 2009).

E. Sensitisation

No sensitisation studies are available on alcohols, C11-14-iso-, C13-rich, ethoxylated.

In a guinea pig maximisation test, $C_{12\text{-}13}AE_{<2.5}$ (CAS RN 66455-14-9) was not considered a skin sensitiser (ECHA) [Kl. score = 2].

F. Repeated Dose Toxicity

Oral

No repeated dose toxicity studies are available on alcohols, C11-14-iso-, C13-rich, ethoxylated.

Rats were given 0%, 0.0313%, 0.0625%, 0.125%, 0.25%, 0.5% or 1.0% $C_{12\text{-}15}AE_7$ in their diet for 90 days. The animals in the $\geq$0.25% groups showed significantly reduced body weight gain, which was associated with marked decreases in food and water consumption. Relative liver weights were significantly increased in the $\geq$0.5% male rats and $\geq$0.25% females. Histopathologic examination showed hepatocytic enlargement in the $\geq$0.125% groups, suggesting increased liver metabolism on the basis of increased alkaline phosphatase activity at the higher dose levels. The no observed

adverse effect level (NOAEL) was established at 0.0625% in the diet or 102 mg/kg/day (HERA, 2009) [Kl. score = 2].

Rats were fed $C_{12-14}AE_7$ in the diet at concentrations of 0%, 0.0313%, 0.0625%, 0.125%, 0.25%, 0.5% and 1.0% for 90 days. The animals in the ≥0.25% groups showed significantly reduced body weight gain, which was associated with marked decreases in food and water consumption. Relative liver weights were significantly increased in the ≥0.5% male rats and ≥0.25% females. Histopathologic examination showed hepatocytic enlargement in the ≥0.125% groups, suggesting increased liver metabolism on the basis of increased alkaline phosphatase activity at the higher dose levels. The NOAEL was established at 0.0625% in the diet or 110 mg/kg/day (HERA, 2009) [Kl. score = 2].

Rats were given 0%, 0.1%, 0.5% or 1% $C_{12-13}AE_{6.5}$ in their diet for two years. Body weight gain was reduced in the 1% males and ≥0.5% females, which was likely due to the reduced food consumption in these animals. At study termination, organ to body weight ratios were increased in the ≥0.5% females (liver, kidney and brain), 1% females (heart), and 1% males (liver). A dose-related focal myocarditis was observed in males. While focal myocarditis is commonly observed in non-treated aging rats, the incidence in the treated animals were higher than in the controls. The NOAEL was established at 0.1% or 50 mg/kg/day (HERA, 2009) [Kl. score = 2].

Inhalation

No studies are available.

Dermal

No adequate studies are available.

G. Genotoxicity

In Vitro Studies

The genotoxicity studies conducted on alcohol ethoxylates are reviewed in HERA (2009). The results of few of the *in vitro* studies on similar alcohol ethoxylates to alcohols, C11-14-iso-, C13-rich, ethoxylated are presented in Table 2.

Table 2: *In Vitro* Genotoxicity Studies on Selected Alcohol Ethoxylates

Test Substance	Test System	Results*		Klimisch Score	Reference
		-S9	+S9		
$C_{14-15}AE_7$	Bacterial reverse mutation (*S. typhimurium* strains)	-	-	2	HERA, 2009
$C_{14-15}AE_7$	Bacterial reverse mutation (*S. typhimurium* strains)	-	-	2	HERA, 2009
$C_{14}AE_{12}$	Chromosomal aberrations (CHO cells)	-	-	2	HERA, 2009

*+, positive; -, negative

In Vivo Studies

In two separate studies, CD-1 mice were given an intraperitoneal dose of 0, 50, or 100 mg/kg $C_{12-15}AE_3$ or $C_{12-14}AE_9$. There were no increases in the frequency of micronuclei in the bone marrow cells (Talmage, 1994) [Kl. score = 2].

Male and female Tunstall rats were given a single oral gavage dose of 0, 250, 500, or 1,000 mg/kg $C_{14-15}AE_7$. There were no increases in chromosomal aberrations in the bone marrow cells (HERA, 2009) [Kl. score = 2].

H. Carcinogenicity

No studies are available on alcohols, C11-14-iso-, C13-rich, ethoxylated. Based on the available data, chemicals in this group are not considered carcinogenic.

Male and female Sprague-Dawley rats were given $C_{12-13}AE_{6.5}$ in their diet at doses up to 1% (500 mg/kg/day). Reduced food consumption was noted at the higher dose levels (i.e., 0.5% and 1% for females and 1% for males), resulting in a lower body weight gain compared to the control group. No treatment-related histopathology was found and no increase in tumour incidence was observed (HERA, 2009) [Kl. score = 2].

Male and female Charles River rats were given 0, 0.1, 0.5 or 1% $C_{14-15}AE_7$ in their diet for two years. There were no treatment-related changes in general behaviour and appearance. The survival rate of the test animals was comparable if not better than the controls. Body weights of the 0.5% females and the 1% males and females had significantly lower weight gains than the control. There were no treatment-related effects on organ weights and tumour incidence (HERA, 2009) [Kl. score = 2]

Male and female Sprague-Dawley rats were given $C_{14-15}AE_7$ in their diet at 0.1%, 0.5% and 1% for two years. A treatment-related body weight depression was observed in females at the two highest treatment levels and in males at the 1% dose level, probably due to the poor palatability of the diet. There was no evidence for any carcinogenic activity (HERA, 2009) [Kl. score = 2].

I. Reproductive Toxicity

No studies are available on alcohols, C11-14-iso-, C13-rich, ethoxylated. Based on the data available, the chemicals of this group are not considered to cause reproductive toxicity.

CD rats were given 0%, 0.05%, 0.1% or 0.5% (approximately 0, 25, 50, or 250 mg/kg/day) $C_{12}AE_6$ in their diet in a two-generation reproductive toxicity study. There were no treatment related effects in the parents or pups on general behaviour, appearance or survival. At 0.5%, there was reduced weight gain in both the parental animals and the pups compared to the controls. Fertility was unaffected by treatment. The NOAEL for reproductive toxicity is 0.5% in the diet, which corresponds to 250 mg/kg/day (HERA, 2009) [Kl. score = 2].

In a two-generation developmental and teratogenicity study, CD rats were given 0%, 0.05%, 0.1% or 0.5% $C_{14-15}AE_7$ in their diet (approximately 0, 25, 50 or 250 mg/kg/day). Three of the treated groups were given the test substance continuously throughout the study; in the other three groups the females received the test substance on GD 6-15 and the males were untreated. None of the deaths of parental rats during the study was considered to be compound-related. There were no treatment-related changes in behaviour or appearance in the parental rats or pups. Slightly lower body weight gain was noted in the 0.5% continuously treated females. Food consumption was similar for control

and treated rats. Fertility, gestation and viability indices were similar across groups. The average 21-day body weights for the 0.5% continuous treated pups were significantly lower than that of the control. Relative liver weights of the 0.5% continuously treated F_1 parental animals were increased at the 91-day sacrifice; relative liver weights of the 0.5% continuously treated males were also increased at the 60-day and caesarean section sacrifices. There were no treatment-related histopathological lesions in any of the tissues from the F_0 and F_1 generations. The NOAEL for reproductive toxicity is 0.5% in the diet or 250 mg/kg/day (HERA, 2009) [Kl. score = 2].

J. Developmental Toxicity

No studies are available on alcohols, C11-14-iso-, C13-rich, ethoxylated. Based on the data available, the chemicals of this group are not considered to cause developmental toxicity.

In a two-generation reproductive toxicity study, Charles River rats were given 0, 0.05, 0.1 or 0.5% (about 0, 25, 50 or 250 mg/kg/day) $C_{12}AE_6$ in their diet. General behaviour, appearance and survival were unaffected by treatment. At the 0.5% dose level, adults and pups gained less weight than the control rats. In the 0.5% dose group, there was a statistical increase in embryo lethality and soft tissue anomalies, and at the 0.1% there was a statistical decrease in mean foetal liver weight. Neither of these effects was considered to be treatment-related by the authors as they showed no dose response characteristics. The NOAEL for maternal toxicity is 50 mg/kg/day. The NOAEL for developmental and teratogenicity is 0.1% in the diet or 50 mg/kg/day (HERA, 2009) [Kl. score = 2].

Pregnant rabbits were given 0, 50, 100 or 200 mg/kg $C_{12}AE_6$ by oral gavage from gestational days 2 to 16. Nine control rabbits and 31 treated rabbits died during the study. Surviving rabbits at the 200 mg/kg dose group generally showed slight losses of body weight. At 100 and 200 mg/kg, ataxia and a slight decrease in body weight was observed in the pregnant animals. In seven treated and two control rabbits, early deliveries were recorded. There were no treatment-related effects on corpora lutea, implantations, number of live foetuses and spontaneous abortions. The NOAEL for maternal toxicity is 50 mg/kg/day; the NOAEL for developmental toxicity is 200 mg/kg/day (HERA, 2009) [Kl. score = 2].

V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES

The toxicological reference values developed for alcohols, C11-14-iso-, C13-rich, ethoxylated follow the methodology discussed in enHealth (2012). The approach used to develop drinking water guidance values is described in the Australian Drinking Water Guidelines (ADWG, 2011).

A. Non-Cancer

<u>Oral</u>

A two-year dietary study in rats has been conducted on $C_{12\text{-}13}AE_{6.5}$ (HERA, 2009). The NOAEL from this study is 50 mg/kg/day based on increased organ weights. The NOAEL of 50 mg/kg/day will be used for determining the oral reference dose (RfD) and the drinking water guidance value.

Oral Reference Dose (oral RfD)

Oral RfD = NOAEL / (UF_A x UF_H x UF_L x UF_{Sub} x UF_D)

Where:

UF_A (interspecies variability) = 10
UF_H (intraspecies variability) = 10

UF_L (LOAEL to NOAEL) = 1
UF_{Sub} (subchronic to chronic) = 1
UF_D (database uncertainty) = 1
Oral RfD = 50/(10 x 10 x 1 x 1 x 1) = 50/100 = 0.5 mg/kg/day

Drinking water guidance value

Drinking water guidance value = (animal dose) x (human weight) x (proportion of intake from water) / (volume of water consumed) x (safety factor)

Using the oral RfD,

Drinking water guidance value = (oral RfD) x (human weight) x (proportion of water consumed) / (volume of water consumed)

Where:
Human weight = 70 kg (ADWG, 2011)
Proportion of water consumed = 10% (ADWG, 2011)
Volume of water consumed = 2L (ADWG, 2011)
Drinking water guidance value = (0.5 x 70 x 0.1)/2 = 1.8 mg/L

B. Cancer

The AEs $C_{12-13}AE_{6.5}$ and $C_{14-15}AE_7$ were not carcinogenic to rats in a two-year dietary study. Thus, a cancer reference value was not derived.

VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES

Alcohols, C11-14-iso-, C13-rich, ethoxylated does not exhibit the following physico-chemical properties:

- Explosivity
- Flammability
- Oxidising potential

VII. ENVIRONMENTAL HAZARD ASSESSMENT

A. Summary

Alcohols, C11-14-iso-, C13-rich, ethoxylated has moderate chronic toxicity concern to aquatic life.

B. Aquatic Toxicity

Acute Studies

There are no acute aquatic toxicity studies for ethoxylated C12-C16 alcohol. The aquatic toxicity of other AEs has been extensively evaluated in numerous studies on fish, daphnids and algae as well as microorganisms. Table 3 lists the results of acute aquatic toxicity studies on read across substance alcohols, C12-C15, ethoxylated (1 to 2.5 EO) [CAS RN 68131-39-5], alcohols, C12-C14, ethoxylated (2 EO) [CAS RN 68439-50-9] and alcohols, C12-C15, branched and linear, ethoxylated [CAS RN 106232-83-1].

Table 3: Acute Aquatic Toxicity Studies on Ethoxylated C12-C16 Alcohol[a,b,c]

Test Species	Endpoint	Results (mg/L)	Klimisch Score	Reference
Oncorhynchus mykiss (Rainbow Trout)	96-hr LC_{50}	1.3 – 1.7[a]	2	ECHA
Danio Rio	96-hr LC_{50}	1.2[b]	2	ECHA
Danio Rio	96-hr LC_{50}	2[b]	2	ECHA
Zebrafish	96-hr LC_{50}	>2[c]	2	ECHA
Daphnia magna	48-hr EC_{50}	0.14[a]	2	ECHA
Daphnia magna	48-hr EC_{50}	0.23[a]	2	ECHA
Daphnia magna	48-hr EC_{50}	0.53[b]	2	ECHA
Daphnia magna	48-hr EC_{50}	2.84[b,d]	2	ECHA
Daphnia magna	48-hr EC_{50}	1.2[e]	1	ECHA
Daphnia magna	48-hr EC_{50}	>2[b]	2	ECHA
Daphnia magna	48-hr EC_{50}	>2[c]	2	ECHA
Daphnia magna	48-hr EC_{50}	0.23	2	ECHA
Pseudokirchneriella subcapitata	72-hr EC_{50}	0.75[a]	2	ECHA
Pseudokirchneriella subcapitata	72-hr EC_{50}	>2[c]	2	ECHA
Pseudokirchneriella subcapitata	72-hr EC_{50}	0.41[b]	2	ECHA
Desmodesmus subspicatus (green algae)	72-hr EC_{50}	0.778[b]	2	ECHA
Desmodesmus subspicatus (green algae)	72-hr EC_{50}	0.87[e]	1	ECHA
Desmodesmus subspicatus (green algae)	72-hr EC_{50}	1.3[e]	1	ECHA

a: Read across to alcohols, C12-C15, ethoxylated (1 to 2.5 EO) CAS No. 68131-39-5
b: Read across to alcohols, C12-C14, ethoxylated (EO 2) CAS No. 68439-50-9
c: Read across to alcohols, C12-C15, branched and linear, ethoxylated (CAS No. 106232-83-1)
d: alcohols, C12-C14, ethoxylated (EO 1) CAS No. 68439-50-9 as WAF (water accommodated fraction)
e: alcohols, C12-C14, ethoxylated (EO 4 or EO 6) CAS No. 68439-50-9

A review of the acute studies indicates that invertebrates are somewhat more sensitive to AEs than fish and algae. As concluded in HERA (2009), the Danish EPA (2001) found that the acute toxicity of AE to invertebrates varies, with EC50 values from 0.1 mg/L to more than 100 mg/L for linear AE and from 0.5 mg/L to 50 mg/L for branched AE. The toxicity is species specific and may vary between 0.29 mg/L and 270 mg/L for the same linear AE (Lewis and Suprenant 1983, quoted in Danish EPA 2001). The most commonly used invertebrates for testing are Daphnia magna and Daphnia pulex, and they are also among the most sensitive invertebrates to AE. The Danish EPA (2001) found that some AEs are very toxic to invertebrates (i.e., linear AE of C12-15 EO1-8 and branched AE with a low degree of branching, < 10-25%). They concluded that branching of the alkyl chain reduces the toxicity of AE to invertebrates, as also observed for algae (Danish EPA, 2001). However, the data used to reach this conclusion is from specially synthesised AEs, which have been shown to have a significantly higher toxicity than the AE made from a technical alcohol which are used commercially (Kaluza and Taeger, 1996).

Chronic Studies

In developing a water quality guideline for AEs (ANZG, 2018), the toxicity data was normalised for a specific alkyl chain length or a specific number of EO groups. The no observed effect concentrations (NOECs) listed below were normalised to an alkyl chain length of C13.3 and EO of 8.2.

Freshwater fish: 2 species, 720 to 1,500 micrograms per litre (μg/L).

Freshwater crustaceans: 2 species, 590 to 860 μg/L.

Freshwater rotifers: 1 species, *Brachionus calyciflorus*, 1,300 μg/L

Freshwater algae, diatoms and blue-green algae: 6 species, 200 to 8,700 μg/L.

Freshwater mesocosms: 4 NOEC data for multiple species tests were 80, 80, 320, and 330 μg/L, although replication was insufficient to meet OECD (1992) requirements. Normalised data were 380, 380, 320, and 1,520 μg/L.

C. Terrestrial Toxicity

No studies are available.

D. Calculation of PNEC

The PNEC calculations for alcohols, C11-14-iso-, C13-rich, ethoxylated follow the methodology discussed by DEWHA (2009).

PNEC Water

The ANZG water quality guideline (2018) for freshwater is: "*A high reliability trigger value of 140 μg/L was derived for AE (normalised data) using the statistical distribution method with 95% protection.*"

For the purposes of calculating the PNEC values for sediment and soil, the $PNEC_{water}$ will be 0.14 mg/L.

PNEC Sediment

There are no toxicity data for sediment-dwelling organisms. Therefore, the $PNEC_{sed}$ was calculated using the equilibrium partitioning method. The $PNEC_{sed}$ is 11.95 mg/kg sediment wet weight.

The calculations are as follows:

$PNEC_{sed} = (K_{sed\text{-}water}/BD_{sed}) \times 1000 \times PNEC_{water}$
$= (109/1280) \times 1000 \times 0.14$
$= 11.95$ mg/kg

Where:
$K_{sed\text{-}water}$ = suspended matter-water partition coefficient (cubic metre per cubic metre [m^3/m^3])
BD_{sed} = bulk density of sediment (kilograms per cubic metre [kg/m^3]) = 1,280 [default]

$K_{sed\text{-}water}$ = 0.8 + [(0.2 x Kp_{sed})/1,000 x BD_{solid}]
= 0.8 + [(0.2 x 226/1,000 x 2,400]
= 109 m^3/m^3

Where:
Kp_{sed} = solid-water partition coefficient (litres per kilogram [L/kg])
BD_{solid} = bulk density of the solid phase (kg/m^3) = 2,400 [default]

Kp_{sed} = K_{oc} x f_{oc}
= 5,649 x 0.04
= 226 L/kg

Where:
K_{oc} = organic carbon normalised distribution coefficient (L/kg). The K_{oc} for alcohols, C11-14-iso-, C13-rich, ethoxylated calculated from EPISUITE™ using the MCI is 5,649 L/kg. The MCI method is preferred to the K_{ow} method due to the surfactant properties of the substance.
F_{oc} = fraction of organic carbon in sediment = 0.04 [default].

PNEC Soil

There are no toxicity data for terrestrial or soil organisms. Therefore, the $PNEC_{soil}$ was calculated using the equilibrium partitioning method. The $PNEC_{soil}$ is 10.54 mg/kg soil dry weight.

The calculations are as follows:

$PNEC_{soil}$ = (Kp_{soil}/BD_{soil}) x 1,000 x $PNEC_{water}$
= (113/1,500) x 1,000 x 0.14
= 10.54 mg/kg

Where:
Kp_{soil} = soil-water partition coefficient (m^3/m^3)
BD_{soil} = bulk density of soil (kg/m^3) = 1,500 [default]

Kp_{soil} = K_{oc} x f_{oc}
= 5,649 x 0.02
= 113 m^3/m^3

Where:
K_{oc} = organic carbon normalised distribution coefficient (L/kg). The K_{oc} for alcohols, C11-14-iso-, C13-rich, ethoxylated calculated from EPISUITE™ using the MCI is 5,649 L/kg.
F_{oc} = fraction of organic carbon in soil = 0.02 [default].

VIII. PERSISTENCE, BIOACCUMULATION AND TOXICITY (PBT) ASSESSMENT

The methodology for the Persistent, Bioaccumulative and Toxic (PBT) substances assessment is based on the Australian and EU REACH Criteria methodology (DEWHA, 2009; ECHA, 2017).

Alcohols, C11-14-iso-, C13-rich, ethoxylated is readily biodegradable and thus does not meet the screening criteria for persistence.

The measured BCF in fish for AEs, which includes alcohols, C11-14-iso-, C13-rich, ethoxylated, have been reported to range from <5 to 387.5. Thus, alcohols, C11-14-iso-, C13-rich, ethoxylated does not meet the screening criteria for bioaccumulation.

The chronic NOEC values for AEs are >0.1 mg/L. Thus, alcohols, C11-14-iso-, C13-rich, ethoxylated does not meet the criteria for toxicity.

The overall conclusion is that alcohols, C11-14-iso-, C13-rich, ethoxylated is not a PBT substance.

IX. CLASSIFICATION AND LABELLING

A. Classification

Eye Irritant Category 2

Aquatic Chronic Toxicity Category 3

B. Labelling

Danger! According to the classification provided by companies to ECHA in Classification, Labelling and Packaging (CLP) notifications, this substance is very toxic to aquatic life, causes serious eye damage, is harmful if swallowed, is harmful to aquatic life with long lasting effects and causes skin irritation.

A. Pictogram



X. HANDLING AND SAFETY INFORMATION (OCCUPATIONAL LIMITS AND TRANSPORTATION REQUIREMENTS)

A. First Aid

Eye Contact

In case of contact, immediately flush eyes with plenty of water for at least 15 minutes.

Skin Contact

Wash thoroughly with soap and water.

Inhalation

If inhaled, remove from area to fresh air. Get medical attention.

Ingestion

Rinse mouth with water and then drink a glass of water. Get medical attention. Never give anything by mouth to an unconscious person.

B. Fire Fighting Information

Extinguishing Media

Water spray, carbon dioxide, foam, dry chemical.

Specific Exposure Hazards

May emit toxic fumes under fire conditions. Depending on conditions, decomposition products may include the following: carbon monoxide, carbon dioxide.

Special Protective Equipment for Firefighters

Self-contained breathing apparatus and full protective clothing must be worn in case of fire.

C. Accidental Release Measures

Personal Precautions

Use appropriate protective equipment. Handle in accordance with good industrial hygiene and safety practice.

Environmental Precautions

Prevent from entering sewers, waterways or low areas.

Steps to be Taken if Material is Released or Spilled

For large amounts: dike spillage and pump off product. For residues: pick up with suitable absorbent material. Dispose of contaminated material as prescribed.

D. Storage And Handling

General Handling

Protect against moisture. Shut containers immediately after taking product because product takes up the humidity of air. No special precautions are necessary beyond normal good hygiene practices.

Wash hands thoroughly after handling. Avoid breathing mists or aerosols.

Storage

Keep container tightly closed.

E. Exposure Controls / Personal Protection

Occupational Exposure Standards

Workplace Australia has not established an occupational exposure standard for alcohols, C11-14-iso-, C13-rich, ethoxylated.

Engineering Controls

Good general ventilation should be used.

Personal Protection Equipment

Respiratory Protection: Respiratory protection is not required if ventilation is adequate.

Hand Protection: Chemical resistant protective gloves.

Skin Protection: Body protection must be chosen depending on activity and possible exposure.

Eye protection: Safety glasses with side-shields.

Other Precautions: Handle in accordance with good industrial hygiene and safety practice. Wearing of closed work clothing is recommended. Ensure that eyewash stations and safety showers are close to the workstation location.

F. Transport Information

Alcohols, C11-14-iso-, C13-rich, ethoxylated is not considered hazardous for purposes of transportation by road or rail. An Australian Dangerous Goods code is not required.

XI. DISPOSAL MANAGEMENT

Disposal should be in accordance with all local, state and federal regulations.

XII. REGULATORY STATUS

Australian AICS Inventory: Listed.

XIII. REFERENCES

ADWG. (2011). National Water Quality Management Strategy. Australian Drinking Water Guidelines, Section 6, Australian Government, National Health and Medical Research Council, Natural Resource Management Ministerial Council. Updated January 2022. Available: https://www.nhmrc.gov.au/about-us/publications/australian-drinking-water-guidelines

Basketter, D.A., York, M., McFadden, J.P., and Robinson, M.K. (2004). Determination of skin irritation potential in the human 4-h patch test. Contact Dermatitis 51: 1-4.

Department of the Environment, Water, Heritage and the Arts (DEWHA). (2009). Environmental risk assessment guidance manual for industrial chemicals, Department of the Environment, Water, Heritage and the Arts, Commonwealth of Australia. Available: http://www.nepc.gov.au/resource/chemical-risk-assessment-guidance-manuals

Department of the Environment and Energy (DoEE). (2017). Chemical Risk Assessment Guidance Manual: for chemicals associated with coal seam gas extraction, Guidance manual prepared by Hydrobiology and ToxConsult Pty Ltd for the Department of the Environment and Energy, Commonwealth of Australia, Canberra.

ECHA. ECHA REACH database: http://echa.europa.eu/information-on-chemicals/registered-substances

enHealth Human Risk Assessment (HHRA). (2012). Environmental Health Risk Assessment, Guidelines for Assessing Human Health Risks from Environmental Hazards. Office of Health Protection of the Australian Government Department of Health. Available: https://www1.health.gov.au/internet/main/publishing.nsf/Content/health-pubhlth-publicat-environ.htm

European Chemicals Agency (ECHA). (2017). Guidance on Information Requirements and Chemical Safety Assessment, Chapter R11: PBT Assessment, European Chemicals Agency, Helsinki, Finland. Available: https://echa.europa.eu/guidance-documents/guidance-on-information-requirements-and-chemical-safety-assessment

Human and Environmental Risk Assessment (HERA). (2009). Ingredients of Household Cleaning Products: Alcohol Ethoxylates. http://www.heraproject.com.

Klimisch, H.J., Andreae, M., and Tillmann, U. (1997). A systematic approach for evaluating the quality of experimental and toxicological and ecotoxicological data. Regul. Toxicol. Pharmacol. 25:1-5.

OECD. (1992). Report of the OECD workshop on extrapolation of laboratory aquatic toxicity data to the real environment. OECD Environment Monographs No. 59, Organisation for Economic Co-operation and Development, Paris.

Talmage, S.S. (1994). Environmental and Human Safety of Major Surfactants – Alcohol Ethoxylates and Alkylphenol Ethoxylates, pp. 35, The Soap and Detergent Association, Lewis Publishers, Boca Raton, Florida.

Toll, J., Haller, M., Labee, E., Verweij, M., and Sijm, D.T.H.M. (2000). Toxicology and Chemistry, 19 646–653.

U.S. Environmental Protection Agency (USEPA). (2017). EPISuite™ v. 4.11, United States Environmental Protection Agency, Office of Pollution Prevention and Toxics and Syracuse Research Corporation. Available: https://www.epa.gov/tsca-screening-tools/epi-suitetm-estimation-program-interface.

ALKYLPYRIDINE

This dossier on alkylpyridine presents the most critical studies pertinent to the risk assessment of alkylpyridine in its use in coal seam or shale gas extraction activities. This dossier does not represent an exhaustive or critical review of all available data. The majority of information presented in this dossier was obtained from the ECHA database that provides information on chemicals that have been registered under the EU REACH (ECHA). Where possible, study quality was evaluated using the Klimisch scoring system (Klimisch et al., 1997).

I. SUBSTANCE IDENTIFICATION

Chemical Name (IUPAC): 1-benzyl-1-methyl-2H-pyridin-1-ium; chloride

CAS RN: 68909-18-2

Molecular formula: $C_{12}H_7ClNR1R2R3R4R5$, where R1-5 are alkyl groups

Molecular weight: 221.72 g/mol

Synonyms: Alkylpyridine; Et Me derivs., chlorides, Pyridinium, methyl-1-(phenylmethyl)-, chloride, N-Benzylpicolinonium chloride, Pyridinium, methyl-1-(phenylmethyl)-, chloride (1:1)

SMILES: C[N+]1(CC=CC=C1) CC2=CC=CC=C2.[Cl-]

II. PHYSICO-CHEMICAL PROPERTIES

Table 1: Overview of the Physico-chemical Properties of Alkylpyridine

Property	Value	Klimisch Score	Reference
Physical state at 20oC and 101.3 kPa	Liquid	1	ECHA
Melting Point	-57.27°C @ 101.3 kPa	1	ECHA
Boiling Point	116.34°C @ 101.3 kPa	1	ECHA
Density	1,104 kg/m^3	2	ECHA
Vapour Pressure	200 Pa @ 20°C	2	ECHA
Partition Coefficient (log K_{ow})	3 @ 25°C	2	ECHA
Water Solubility	100 g/L @ 30°C	2	ECHA
Flash Point	55°C	1	ECHA
Auto flammability	There is no evidence of self-ignition at temperatures up to 400°C@ 101.49 kPa	1	ECHA
Viscosity	47.9 mm^2/s (static) @ 38°C	1	ECHA
Henry's Law Constant	This endpoint is not technically feasible due to the UVCB nature of the substance	-	ECHA

III. ENVIRONMENTAL FATE PROPERTIES

A. Summary

N-benzyl-alkylpyridium chloride is inherently biodegradable. Components show variable sorption to soils and sediments. It is not expected to bioaccumulate based on the experimental log K_{ow}.

B. Biodegradation

The ready biodegradation of N-benzyl-alkylpyridium chloride in seawater was determined according to OCED guideline 306 (Biodegradability in Seawater). The rate of degradation was estimated at 13% in seawater assay. The substance was considered likely to be inherently biodegradable (ECHA) [Kl Score=3].

If a chemical is found to be readily biodegradable, it is categorised as Not Persistent since its half-life is substantially less than 60 days (DoEE, 2017).

C. Environmental Distribution

A screening test conducted in accordance with OECD 121 indicated that due to its multi component nature, N-benzyl-alkylpyridium chloride displayed a range of Log K_{oc} values from <1.25 to 5.40. The substance is considered to be a UVCB substance comprising multiple components, of similar chemical functionality, in varying proportions. A quantitative assessment of these components would therefore present considerable technical difficulty as there is not considered to be an analytical method that is sufficiently sensitive, and so a more detailed assessment in accordance with OECD 106 for example would not be technically possible. For the purposes of this dossier, a log K_{oc} is estimated to be a midpoint of the range stated above (i.e., approximately 3).

D. Bioaccumulation

No bioconcentration studies have been conducted on N-benzyl alkylpyridium chloride. N-benzyl alkylpyridium chloride is not expected to bioaccumulate based on the experimental log K_{ow} of 3 (ECHA) [Kl. score = 1].

IV. HUMAN HEALTH HAZARD ASSESSMENT

A. Summary

Very little information exists regarding the specific hazards associated with N-benzyl alkylpyridium chloride. Thus, the information provided in this section is taken from data collected for quaternary ammonium compounds in general.

Significant absorption of quaternary ammonium compounds is unlikely due to their highly ionic nature. As the substance is corrosive (i.e., pH=1.2), very little toxicity data are available except for acute toxicity data showing a LD_{50} in rats that is approximately 50 mg/kg-day.

B. Metabolism

No toxicokinetic data are available for these substances, however the data on related quaternary ammonium compounds are summarised below.

Absorption

Significant absorption of quaternary ammonium compounds is unlikely due to their highly ionic nature. WHO (1998) reports the oral absorption of quaternary ammonium compounds in general to be poor. A published Canadian review of the toxicity of the quaternary ammonium compound didecyldimethylammonium chloride (DDAC) notes experiments in rats in which up to 99% of orally administered radioactivity was recovered in the faeces and less than 2.5% in the urine (ECHA 2020).

The dermal absorption of quaternary ammonium compounds is likely to be low based on the chemical structure, ionic nature, molecular weight, and lack of lipophilicity of the substance. Absorption of this group of substances through skin is also indicated to be very low based on an absence of reports of systemic effects following dermal exposure (WHO, 1998). However, it is noted that the substance is corrosive, therefore it is possible that systemic absorption may occur following significant accidental dermal exposures resulting in skin burns, where the normal barrier integrity of the skin is compromised. Buist et al. (2007) reported very low dermal penetration (0.5%) for the quaternary ammonium compound DDAC in human skin in vitro over a 48-hour period.

No data are available for absorption following inhalation exposure; however, it is considered unlikely that absorption by his route of exposure would be significant. Although not relevant to the human risk assessment, the WHO document notes that the systemic absorption of quaternary ammonium compounds following parenteral administration is 'possible'.

Distribution

No data on distribution are available. However, given the water solubility of the substance, it is likely to be widely distributed via the circulation if absorbed.

Metabolism

No data are available for the substance; however significant metabolism is not predicted given the likely poor systemic absorption. A published Canadian review of the toxicity of the quaternary ammonium compound DDAC reports some oxidative metabolism of the decyl sidechain, but no molecular cleavage by N-dealkylation (Henderson, 1992).

Excretion

Data indicate that quaternary ammonium compounds are largely excreted in the faeces (WHO, 1998; Henderson, 1992). The poor absorption and chemical nature of the substance (specifically the lack of lipophilicity) indicate that substance quaternary ammonium compounds have no or little potential for bioaccumulation.

C. Acute Toxicity

The oral LD_{50} in rats is 50.1 milligrams per kilogram (mg/kg, HPVIS) [Kl. score = 2]. There are no acute inhalation or dermal toxicity studies on N-benzyl-alkylpyridium chloride.

D. Irritation

There are no studies available. However, N-benzyl-alkylpyridium chloride is considered corrosive based on its pH of 1.2 (ECHA).

E. Sensitisation

There are no studies available.

F. Repeated Dose Toxicity

Oral

There are no studies available.

Inhalation

There are no studies available.

Dermal

There are no studies available.

G. Genotoxicity

In vitro Studies

The *in vitro* genotoxicity studies on alkylpyridine are presented in Table 2.

Table 2: *In vitro* Genotoxicity Studies on alkylpyridine

Test System	Results*		Klimisch Score	Reference
	-S9	+S9		
Bacterial reverse mutation (S. typhimurium strains)	-	-	1	ECHA
Mammalian cell gene mutation (mouse lymphoma L5178Y cells)	-	-	1	ECHA
Chromosomal aberrations (human lymphocytes)	-	-	1	ECHA

*+, positive; -, negative

In Vivo Studies

There are no studies available.

H. Carcinogenicity

Oral

There are no studies available.

Inhalation

There are no studies available.

Dermal

There are no studies available.

I. Reproductive Toxicity

There are no studies available.

J. Developmental Toxicity

Oral

There are no studies available.

Inhalation

There are no studies available.

Dermal

There are no studies available.

V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES

No data are available on N-benzyl-alkylpyridium chloride to derive oral toxicological reference and drinking water guidance values.

VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES

Alkylpyridine does not exhibit the following physico-chemical properties:

- Flammability
- Oxidising potential

The substance is classified as flammable (Flam. Liquid 3).

VII. ENVIRONMENTAL HAZARD ASSESSMENT

A. Summary

N-benzyl-alkylpyridium chloride exhibits significant acute and chronic aquatic toxicity. Sediment dwelling organisms are far less sensitive to the substance perhaps based on combined effects of biodegradation and binding to the sediment matrix.

B. Aquatic Toxicity

Acute Studies

Table 3 lists the results of acute aquatic toxicity studies conducted on alkylpyridine.

Table 3: Acute Aquatic Toxicity Studies on Alkylpyridine

Test Species	Endpoint	Results (mg/L)	Klimisch score	Reference
Cyprinodon variegatus	96-hr LC_{50}	14.1	1	ECHA
Daphnia magna	48-hr EC_{50}	3.1	1	ECHA
Pseudokirchneriella subcapitata	72-hr EC_{50}	0.47	1	ECHA

Chronic Studies

There are no studies available.

C. Terrestrial Toxicity

There are no studies available.

D. Calculation of PNEC

The PNEC calculations for alkylpyridine follow the methodology discussed in DEWHA (2009).

PNEC Water

Experimental results are available for three two trophic levels. Acute EC_{50} values are available for Cyprinodon variegatus (14.1 mg/L), Daphnia (3.1 milligrams per litre [mg/L]), and algae (0.47 mg/L). On the basis that the data consists of short-term results from three trophic levels, an assessment factor of 1,000 has been applied to the lowest reported E(L)C50 value of 0.47 mg/L for algae. The $PNEC_{water}$ is 0.00047 mg/L.

PNEC Sediment

There are no toxicity data for sediment-dwelling organisms. Therefore, the $PNEC_{sed}$ was calculated using the equilibrium partitioning method. The $PNEC_{sed}$ is 0.0073 mg/kg sediment wet weight.

The calculations are as follows:

$PNEC_{sed} = (K_{sed\text{-}water}/BD_{sed}) \times 1000 \times PNEC_{water}$
$= (20/1280) \times 1000 \times 0.00047$
$= 0.0073$ mg/kg

Where:
$K_{sed\text{-}water}$ = suspended matter-water partition coefficient (m^3/m^3)
BD_{sed} = bulk density of sediment (kg/m^3) = 1,280 [default]
$K_{sed\text{-}water} = 0.8 + [(0.2 \times Kp_{sed})/1000 \times BD_{solid}]$
$= 0.8 + [(0.2 \times 40/1000 \times 2400]$
$= 20\ m^3/m^3$

Where:
Kp_{sed} = solid-water partition coefficient (L/kg)
BD_{solid} = bulk density of the solid phase (kg/m^3) = 2,400 [default]
$Kp_{sed} = K_{oc} \times f_{oc}$

= 1000 x 0.04
= 40 L/kg

Where:

K_{oc} = organic carbon normalised distribution coefficient (L/kg). The K_{oc} for alkylpyridine is estimated to be 1000 L/kg.

F_{oc} = fraction of organic carbon in sediment = 0.04 [default].

PNEC Soil

There are no toxicity data for terrestrial or soil organisms. Therefore, the $PNEC_{soil}$ was calculated using the equilibrium partitioning method. The $PNEC_{soil}$ is 0.0063 mg/kg soil dry weight.

The calculations are as follows:

$PNEC_{soil} = (Kp_{soil}/BD_{soil}) \times 1000 \times PNEC_{water}$
= (20/1500) x 1000 x 0.00047
= 0.0063 mg/kg

Where:

Kp_{soil} = soil-water partition coefficient (m^3/m^3)

BD_{soil} = bulk density of soil (kg/m^3) = 1,500 [default]

$Kp_{soil} = K_{oc} \times f_{oc}$
= 1000 x 0.02
= 20 m^3/m^3

Where:

K_{oc} = organic carbon normalised distribution coefficient (L/kg). The K_{oc} for alkylpyridine was estimated to be 1000 L/kg.

F_{oc} = fraction of organic carbon in soil = 0.02 [default].

VIII. PERSISTENCE, BIOACCUMULATION AND TOXICITY (PBT) ASSESSMENT

The methodology for the Persistent, Bioaccumulative and Toxic (PBT) substances assessment is based on the Australian and EU REACH Criteria methodology (ADWG, 2011; DEWHA, 2009; ECHA, 2017).

N-benzyl alkylpyridium chloride is estimated to be ultimately biodegradable and thus does not meet the screening criteria for persistence.

No bioconcentration studies are available for N-benzyl alkylpyridium chloride. However. the measured log K_{ow} for N-benzyl alkylpyridium chloride is 3; thus, N-benzyl alkylpyridium chloride does not meet the screening criteria for bioaccumulation.

The acute EC_{50} values for alkylpyridine in algae is <1 mg/L. Thus, alkylpyridium meets the screening criteria for toxicity.

The overall conclusion is that alkylpyridium is not a PBT substance.

IX. CLASSIFICATION AND LABELLING

A. Classification

H226-Flammable Liquid 3

H314-Skin Corrosion 1B: Causes severe skin burns and eye damage

H318-Eye damage 1

H400-Aquatic Acute 1: Very toxic to aquatic life

H410- Aquatic Chronic 1

B. Labelling

Warning

A. Pictogram



X. HANDLING AND SAFETY INFORMATION (OCCUPATIONAL LIMITS AND TRANSPORTATION REQUIREMENTS)

A. First Aid

Please refer to the product SDS for additional information and confirmation of the information provided herein.

Eye Contact

In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Consult physician.

Skin Contact

Wash thoroughly with soap and water. Consult physician.

Inhalation

If inhaled, remove from area to fresh air. Get medical attention.

Ingestion

Rinse mouth with water and then drink a glass of water. Get medical attention. Never give anything by mouth to an unconscious person.

B. Fire Fighting Information

Extinguishing Media

Water spray, carbon dioxide, alcohol resistant foam, dry chemical.

Specific Exposure Hazards

Keep product and empty container away from heat and sources of ignition. May emit toxic fumes under fire conditions. Depending on conditions, decomposition products may include the following: carbon monoxide, carbon dioxide.

Special Protective Equipment for Firefighters

Wear self-contained breathing apparatus.

C. Accidental Release Measures

Personal Precautions

Use appropriate protective equipment. Handle in accordance with good industrial hygiene and safety practice.

Environmental Precautions

Prevent from entering sewers, waterways or low areas.

Steps to be Taken if Material is Released or Spilled

For large amounts: dike spillage and pump off product. For residues: pick up with suitable absorbent material. Dispose of contaminated material as prescribed.

D. Storage And Handling

General Handling

Keep product and empty container away from heat and sources of ignition. Ensure adequate ventilation, especially in confined areas.

Storage

Keep container tightly closed and in a dry and well-ventilated place. Keep in a cool place.

E. Exposure Controls / Personal Protection

Occupational Exposure Standards

The are no workplace exposure standards for alkylpyridine in Australia.

Engineering Controls

Good general ventilation should be used.

Personal Protection Equipment

Respiratory Protection: Respiratory protection is not required.

Hand Protection: Chemical resistant protective gloves.

Skin Protection: Body protection must be chosen depending on activity and possible exposure.

Eye protection: Safety glasses with side-shields.

Other Precautions: Handle in accordance with good industrial hygiene and safety practice. Wearing of closed work clothing is recommended. Ensure that eyewash stations and safety showers are close to the workstation location.

F. Transport Information

Alkylpyridine is not considered hazardous for purposes of transportation by road or rail. An Australian Dangerous Goods code is not required.

XI. DISPOSAL MANAGMENT

Disposal should be in accordance with all local, state and federal regulations.

XII. REGULATORY STATUS

Australian AICS Inventory: Listed.

XIII. REFERENCES

ADWG. (2011). National Water Quality Management Strategy. Australian Drinking Water Guidelines, Section 6, Australian Government, National Health and Medical Research Council, Natural Resource Management Ministerial Council. Updated January 2022. Available: https://www.nhmrc.gov.au/about-us/publications/australian-drinking-water-guidelines

Buist, Harrie E, Cees de Heer, Johan A van Burgsteden, Johannes J M van de Sandt. (2007). Dermatokinetics of didecyldimethylammonium chloride and the influence of some commercial biocidal formulations on its dermal absorption in vitro. Regul Toxicol Pharmacol. 2007 Jun; 48(1):87-92.

Department of the Environment, Water, Heritage and the Arts [DEWHA]. (2009). Environmental risk assessment guidance manual for industrial chemicals, Department of the Environment, Water, Heritage and the Arts, Commonwealth of Australia. Available: http://www.nepc.gov.au/resource/chemical-risk-assessment-guidance-manuals

Department of the Environment and Energy [DoEE]. (2017). Chemical Risk Assessment Guidance Manual: for chemicals associated with coal seam gas extraction, Guidance manual prepared by Hydrobiology and ToxConsult Pty Ltd for the Department of the Environment and Energy, Commonwealth of Australia, Canberra.

ECHA. ECHA REACH database: http://echa.europa.eu/information-on-chemicals/registered-substances

enHealth Human Risk Assessment [HHRA]. (2012). Environmental Health Risk Assessment, Guidelines for Assessing Human Health Risks from Environmental Hazards. Office of Health Protection of the Australian Government Department of Health. Available: https://www1.health.gov.au/internet/main/publishing.nsf/Content/health-pubhlth-publicat-environ.htm

European Chemicals Agency [ECHA]. (2017). Guidance on Information Requirements and Chemical Safety Assessment, Chapter R11: PBT Assessment, European Chemicals Agency, Helsinki, Finland. Available: https://echa.europa.eu/guidance-documents/guidance-on-information-requirements-and-chemical-safety-assessment

ECHA 2020. Registration dossier for Quaternary ammonium compounds, di-C12-18-alkyldimethyl, chlorides. https://echa.europa.eu/bg/registration-dossier/-/registered-dossier/11882/7/2/2.

Henderson, N.D. (1992). A Review of the Environmental Impact and Toxic Effects of DDAC. BC Ministry of Environment Lands and Parks. https://a100.gov.bc.ca/pub/eirs/viewDocumentDetail.do;jsessionid=F65A8B7F8727D1AE503713758D79DCEC?fromStatic=true&repository=EPD&documentId=3961

HPVIS. The U.S. EPA High Production Volume Information System: https://iaspub.epa.gov/oppthpv/public_search.html_page

Klimisch, H.J., Andreae, M., and Tillmann, U. (1997). A systematic approach for evaluating the quality of experimental and toxicological and ecotoxicological data. Regul. Toxicol. Pharmacol. 25:1-5.

WHO. (1998). International Programme on Chemical Safety (IPCS). Quaternary ammonium (PIM 022). http://www.inchem.org/documents/pims/chemical/pimg022.htm

AMMONIUM SULFATE

This dossier on ammonium sulfate (CAS RN 7783-20-2) presents the most critical studies pertinent to the risk assessment of the substance in its use in coal seam or shale gas extraction activities. This dossier does not represent an exhaustive or critical review of all available data. The majority of information presented in this dossier was obtained from the ECHA database that provides information on chemicals that have been registered under the EU REACH (ECHA). Where possible, study quality was evaluated using the Klimisch scoring system (Klimisch et al., 1997).

NICNAS has assessed ammonium sulfate in an IMAP Tier 1 assessment and concluded that it poses no unreasonable risk to the environment.

I. SUBSTANCE IDENTIFICATION

Chemical Name (IUPAC): diazanium sulfate

CAS RN: 7783-20-2

Molecular formula: $H_8N_2O_4S$

Molecular weight: 132.14 g/mol

Synonyms: ammonium sulfate, diammonium sulfate, sulfuric acid diammonium salt, mascagnite

SMILES: [NH4+].[NH4+].[O-]S(=O)(=O)[O-]

II. PHYSICAL AND CHEMICAL PROPERTIES

Table 1: Physico-chemical Properties of Ammonium Sulfate

Property	Value	Klimisch Score	Reference
Physical state at 20°C and 101.3 kPa	solid	2	ECHA
Melting Point	> 280°C (pressure not provided)	2	ECHA
Boiling Point	Not applicable as substance is solid	1	ECHA
Density	1770 kg/m^3 @ 25°C	2	ECHA
Vapour Pressure	0 Pa @ 25°C	2	ECHA
Partition Coefficient (log K_{ow})	-5.1 @ 25°C	2	ECHA
Water Solubility	767 g/L @ 25°C	2	ECHA
Flash Point	Not applicable as substance is solid	1	ECHA
Auto flammability	Not applicable as substance is solid	1	ECHA
Viscosity	Not applicable as substance is solid	1	ECHA

Property	Value	Klimisch Score	Reference
Dissociation constant (pKa)	9.25 @ 25°C	2	ECHA

III. ENVIRONMENTAL FATE PROPERTIES

A. Summary

Ammonium sulfate dissociates in aqueous media to the ammonium ion (NH_4^+) and sulfate anion (SO_4^{2-}). Ammonium sulfate is an inorganic ionic substance that is not expected to adsorb or bioaccumulate. Ammonium sulfate is hydrophilic, and it has high mobility in the soil.

B. Biodegradation

Given the fact the ammonium sulfate is an inorganic substance, biodegradation testing is not applicable.

C. Environmental Distribution

Ammonium sulfate is water soluble so it is mainly expected to partition to aqueous phase. Based on its log K_{ow}, it is not expected to adsorb substantially to the soil phase.

D. Bioaccumulation

No experimental data were available for bioaccumulation or bioconcentration of ammonium sulfate. Based on the high water solubility and the ionic nature, ammonium sulfate is not expected to adsorb or bioaccumulate to a significant extent. In addition, due to the log K_{ow} of –5.1 bioaccumulation is not expected (ECHA).

IV. HUMAN HEALTH HAZARD ASSESSMENT

A. Summary

Ammonium sulfate exhibits low acute toxicity by the oral, inhalation and dermal routes. It is not irritating to the skin and eyes; and it is not a skin sensitiser. In repeated dose toxicity studies, dose-related changes were not observed in rats given ammonium sulfate in feed for 52-weeks. Ammonium sulfate is not genotoxic and is not carcinogenic. No reproductive or developmental effects were observed in read-across studies.

B. Acute Toxicity

<u>Oral</u>

In an OECD Guideline (401) study, Gassner rats were exposed to ammonium sulfate via oral gavage. The LD_{50} was determined to be 4,250 mg/kg bw/day in male and female rats (ECHA) [KI score = 2].

In an OECD Guideline (423 Acute Oral Toxicity) study Wistar rats were exposed to ammonium sulfate via oral gavage. The LD_{50} in rats was determined to be > 2000 mg/kg bw/day (ECHA) [KI score = 2].

Inhalation

In an OECD Guideline 433 (Acute Inhalation Toxicity: Fixed Concentration Procedure) study Sprague-Dawley rats were exposed to ammonium sulfate via nose only aerosol inhalation. The resulting LC_0 was determined to be 3.5 mg/m^3 after 4 hours of exposure (ECHA) [KI score = 2].

Dermal

In an OECD Guideline 434 (Acute Dermal Toxicity) study Wistar rats were exposed to ammonium sulfate via open coverage. The LD50 for this study was determined to be > 2000 mg/kg bw/day (ECHA) [KI score = 2].

C. Irritation

Skin

Vienna White rabbits were exposed to ammonium sulfate for up to 20 hours and they were observed for 8 days. There were no signs of clinical toxicity, so ammonium sulfate is not considered irritating to the skin (ECHA) [KI score = 2].

Eye

Ammonium sulfate was placed on the eyes of Vienna White rabbits without rinsing for 8 days. All of the observed effects were considered reversible, so this substance is not considered an eye irritant (ECHA) [KI score 2].

D. Sensitisation

A guinea pig maximisation test was used to determine if ammonium sulfate is a skin sensitiser. The animals did not show any signs of toxicity throughout the study period. [KI. score = 1]. Ammonium sulfate is not sensitising to the skin of guinea pigs (ECHA) [KI score = 1].

E. Repeated Dose Toxicity

Oral

In an OECD 453 (Combined Chronic Toxicity/Carcinogenicity) study Fischer 344 rats were continuously exposed to ammonium sulfate via their feed for 52weeks.

In the chronic study, groups of 10 rats/sex were fed a diet containing the test substance (purity not given) at concentrations of 0, 0.1, 0.6, or 3% for 1 year. These concentrations corresponded to average daily intakes of 0, 42, 256, and 1527 mg/kg bw/day for males and 0, 48, 284, and 1490 mg/kg bw/day for females, respectively.

No mortality was found in any groups throughout the treatment period. No test substance-related change in the body weights was found. Absolute and relative kidney weights were increased at the high dose level for both sexes. Absolute spleen weights were decreased and relative liver weights were increased in high dose males. No dose-related changes were found in the other organs.

The NOAEL for females was determined to be 284 mg/kg bw/day and the NOAEL for males was determined to be 256 mg/kg bw/day (ECHA) [KI score = 1].

Inhalation

Rats were exposed via whole body inhalation of ammonium sulfate for 8 hours a day over a 14-day treatment period. The NOEC was determined to be 300 mg/m^3 (ECHA) [KI score = 2].

Dermal

No data were available**.**

F. Genotoxicity

In vitro Studies

The results of the *in vitro* genotoxicity studies on ammonium sulfate based are presented in Table 2.

Table 2: *In Vitro* Genotoxicity Studies on Ammonium Sulfate

Test System	Results*		Klimisch Score	Reference
	-S9	+S9		
OECD Guideline 471 (Bacterial Reverse Mutation Assay) S. typhimurium TA 1535, TA 1537, TA 98 and TA 100	-	-	2	ECHA
OECD Guidline 476 (In vitro Mammalian Cell Gene Mutation Test) Chinese hamster lung fibroblasts (V79)	-	-	1	ECHA
OECD Guidline 473 (In vitro Mammalian Chromosome Aberration Test) human lymphocytes	-	-	2	ECHA

*+, positive; -, negative.

In vivo Studies

An *in vivo* mammalian somatic cell study also known as the cytogenicity/erythrocyte micronucleus cell test was conducted using ddY mice exposed to ammonium sulfate. The results showed that ammonium sulfate is not genotoxic to mice as there were no adverse effects observed (ECHA) [KI score = 2].

G. Carcinogenicity

Oral

A chronic oral toxicity and carcinogenicity study was conducted in rats, similar to the requirements of OECD TG 453. For investigation of the carcinogenic potential, groups of 50 rats/sex were fed a diet containing the test substance (purity not given) at concentrations of 0, 1.5, or 3% for 2 years. These concentrations corresponded to average daily intakes of 0,

564.1, and 1288.2 mg/kg bw/day for males and 0, 4649.9, and 1371.4 mg/kg bw/day for females respectively.

No macroscopic changes were recorded by gross pathology, except for massive nodular or focal lesions suggesting neoplastic changes. At histopathological examination, non-neoplastic and neoplastic lesions were noted in the control and treatment groups, with no significant inter-group difference in their incidences or severity.

The authors concluded that the no observed adverse effect level of ammonium sulfate was the 0.6% diet, which is equivalent to 256 and 284 mg/kg bw/d in males and females, respectively, and the compound is noncarcinogenic under the conditions of the study. There was no evidence of a long-term carcinogenic activity of the test substance.

Data on purity of the test substance are lacking; however, since no adverse effects were observed, this is not considered to affect the evaluation of the carcinogenic potential of ammonium sulfate in an adverse manner (ECHA) [Kl. Score = 1].

Inhalation

No studies are available.

Dermal

No studies are available.

H. Reproductive Toxicity

Oral

Read across of data for ammonium phosphate (7783-28-0) was conducted to screen for the reproductive and developmental toxicity effects of ammonium sulfate. A one generation reproductive toxicity study was conducted using Sprague Dawley rats exposed via oral gavage. The NOAEL for reproductive toxicity was determined to be 1500 mg/kg bw/day (ECHA) [KI score = 1].

I. Developmental Toxicity

An OECD Guideline 422 (Combined Repeated Dose Toxicity) study was conducted using Sprague Dawley rats exposed via oral gavage to a read across substance, ammonium phosphate (7783-28-0), for two weeks. A NOAEL could not be established for maternal toxicity based on inflammatory/degenerative stomach changes recorded during histopathological examination. The foetal NOAEL was determined to be 1,500 mg/kg bw/day (ECHA) [Kl. Score = 1].

V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES

The toxicological reference values developed for ammonium sulfate follow the methodology discussed in enHealth (2012). The approach used to develop drinking water guidance values is described in the Australian Drinking Water Guidelines (ADWG, 2011).

A. Non-Cancer

Oral

The NOAEL from a rat 52-week oral feeding study was reported to be 256 mg/kg bw/day for males based on the actual dose received. This NOAEL will be used for determining the oral reference dose (RfD) and the drinking water guidance value.

Oral Reference Dose (oral RfD)

Oral RfD = NOAEL / (UF_A x UF_H x UF_L x UF_{Sub} x UF_D)

Where:

UF_A (interspecies variability) = 10
UF_H (intraspecies variability) = 10
UF_L (LOAEL to NOAEL) = 1
UF_{Sub} (subchronic to chronic) = 1
UF_D (database uncertainty) = 1
Oral RfD = 256/(10 x 10 x 1 x 1 x 1) = 256/100 = 2.56 mg/kg/day.

Drinking water guidance value

Drinking water guidance value = (animal dose) x (human weight) x (proportion of intake from water) / (volume of water consumed) x (safety factor)

Using the oral RfD,

Drinking water guidance value = (oral RfD) x (human weight) x (proportion of water consumed) / (volume of water consumed)

Where:

Human weight = 70 kg (ADWG, 2021)
Proportion of water consumed = 10% (ADWG, 2021)
Volume of water consumed = 2L (ADWG, 2021)
Drinking water guidance value = (2.56 x 70 x 0.1)/2 = 8.96 mg/L

B. Cancer

Ammonium sulfate is not considered a carcinogen. Thus, a cancer reference value will not be calculated for this substance.

VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES

Ammonium does not exhibit the following physico-chemical properties:

- Explosivity
- Flammability
- Oxidising potential

VII. ENVIRONMENTAL HAZARD ASSESSMENT

A. Summary

Ammonium sulfate is of low acute concern to aquatic life. Algae is more tolerant than fish or invertebrates.

B. Aquatic Toxicity

In aqueous solution, ammonium salts are completely dissociated into NH_4^+ and a corresponding anion. This equilibrium depends on temperature, pH and ionic strength of the water in the environment. Un-ionized NH_3 species exists in the aquatic environments and the fraction (NH_3/(NH_3 +NH_4^+)) steeply increases with elevated pH value or temperature. It is well known that toxicity to aquatic organisms has been attributed to un-ionized ammonia (NH_3) species, and NH_4^+ species is considered to be non- or significantly less-toxic (Emerson et al., 1975 in ECHA). However, recent developments in assessing ammonia toxicity clearly show that in contrast to earlier assumptions where un-ionized ammonia was considered to be the toxic component, both the uncharged and charged molecule are toxic. Therefore, a joint toxicity model has been proposed, with ammonia causing most toxicity at high pH values and ammonium ion also contributing to toxicity at lower pH values (U.S. EPA 1999, OECD 2007 in ECHA).

It is generally accepted, that the principal toxic component of ammonium salts such as ammonium chloride or -sulphate is ammonia, rather than the corresponding anion (see also: OECD 2004, SIDS ammonium chloride or OECD 2007 ammonium sulphate). Therefore, toxicity values for ammonium salts (such as: ammonium -sulphates, phosphates, carbonates, chlorides or nitrates), where the major toxic component is ammonia, can be considered as equivalent, therefore read-across to those substances is possible. Consequently, the aquatic toxicity data compiled for ammonium sulfate comprises the total topic of ammonia toxicity. Species mean chronic values (SMCV) as described in ECHA were considered as relevant endpoints.

Acute Studies

Table 3 lists the results of acute aquatic toxicity studies conducted on ammonium sulfate.

Table 3: Acute Aquatic Toxicity Studies on Ammonium Sulfate[1]

Test Species	Endpoint	Results (mg/L)	Klimisch Score	Reference
Onchorhyncus mykiss, Salmo gairdneri	96-hour LC_{50} mortality	53	1	ECHA
Prosopium williamsoni	96-hour LC_{50}	57.2	1	ECHA
Ceriodaphnia acanthina	48-hour EC_{50} mobility	121.7	1	ECHA
Daphnia magna	48-hour EC_{50} mobility	169	1	ECHA

1 - Acute toxicity results were normalized to pH 8 and ammonium sulfate.

Chronic Studies

Chronic values were normalized to 25°C. As indicated, plants (algae) are more tolerant than fish or invertebrates to ammonia.

Fish: A 30-day study was conducted to determine the toxicity of ammonium sulfate to *Lepomis macrochirus.* The EC_{10} for ammonium sulfate was determined to be 5.29 mg/L (ECHA) [KI score 1].

Invertebrates: A 10-week study was conducted to determine the toxicity ammonium sulfate to *Hyallella azteca*. The EC_{10} for ammonium sulfate was determined to be 3.12 mg/L based on reproduction (ECHA) [KI score = 1].

Algae: An 18-day study was conducted to determine the toxicity of ammonium sulfate to *Chlorella vulgaris*. The EC_{50} value for ammonium sulfate was determined to be 2,700 mg/L (ECHA) [KI score = 2].

A 5-day study was conducted to determine the toxicity of ammonium sulfate to *Chlorella vulgaris*. The EC_{50} value for ammonium sulfate was determined to be 1,605 mg/L based on the growth rate (ECHA) [Kl. Score = 2].

C. Terrestrial Toxicity

No reliable studies available.

D. Calculation of PNEC

The PNEC calculations for ammonium sulfate follow the methodology discussed in DEWHA (2009).

PNEC Water

Experimental results are available for three trophic levels. Acute $E(L)C_{50}$ values are available for fish (53 mg/L) and invertebrates (121.7 mg/L). NOEC values from long-term studies are available for fish (5.29 mg/L), invertebrates (3.12 mg/L) and algae (1,605 mg/L). On the basis that the data consists of short-term results from two trophic levels and long-term results from three trophic levels, an assessment factor of 10 has been applied to the lowest reported EC_{10} value of 3.12 mg/L for invertebrates. Therefore, the $PNEC_{water}$ is 0.312 mg/L.

PNEC Sediment

No reliable experimental toxicity data on sediment organisms are available. Ammonium sulfate dissociates completely in water with its environmental distribution is dominated by its high water solubility. K_{ow} and K_{oc} parameters do not readily apply to inorganics, such as ammonium sulfate. Thus, the equilibrium partitioning method cannot be used to calculate the $PNEC_{sediment}$. Based on its properties, no adsorption of ammonium sulfate to sediment is to be expected, and the assessment of this compartment will be covered by the aquatic assessment.

PNEC Soil

No reliable experimental toxicity data on terrestrial organisms are available. The environmental distribution of ammonium sulfate is dominated by its water solubility. K_{ow} and K_{oc} parameters do not readily apply to inorganics, such as ammonium sulfate. Thus, the equilibrium partitioning method cannot be used to calculate the $PNEC_{soil}$. Based on its properties, ammonium sulfate is not expected to significantly adsorb to soil, and the assessment of this compartment will be covered by the aquatic assessment.

VIII. PERSISTENCE, BIOACCUMULATION AND TOXICITY (PBT) ASSESSMENT

The methodology for the Persistent, Bioaccumulative and Toxic (PBT) substances assessment is based on the Australian and EU REACH Criteria methodology (DEWHA, 2009; ECHA, 2008).

Ammonium sulfate is an inorganic salt that dissociates completely to ammonium and sulfate ions in aqueous solutions. Biodegradation is not applicable to these inorganic ions. For the purposes of this PBT assessment, the persistent criteria are not considered applicable to ammonium sulfate or its dissociated ions.

The estimated log K_{ow} is for ammonium sulfate is equal to -5.1. This value suggests that ammonium sulfate is not expected to bioaccumulate (ECETOC, 2000). Therefore, ammonium sulfate does not meet the screening criterion for bioaccumulation.

The NOEC or EC10 values from chronic aquatic toxicity studies are > 0.1 mg/L. The acute $E(L)C_{50}$ values for fish and invertebrates are > 1 mg/L. Thus, ammonium sulfate does not meet the criteria for toxicity.

The overall conclusion is that ammonium sulfate is not a PBT substance.

IX. CLASSIFICATION AND LABELLING

A. Classification

Acute Toxicity: H302: Harmful if swallowed

Irritation: H315: Causes skin irritation

Eye: H318: Cause serious eye damage

STOT: H335: May cause respiratory irritation

B. Signal word

Danger

C. Pictogram



X. HANDLING AND SAFETY INFORMATION (OCCUPATIONAL LIMITS AND TRANSPORTATION REQUIREMENTS)

A. First Aid

Eye Contact

Immediately flush open eyes with plenty of water for at least 15 minutes. Remove contacts, if present and easy to do. Get medical attention immediately, preferably a physician for an ophthalmologic examination.

Skin Contact

For minor skin contact, avoid spreading material on unaffected skin. Remove and isolate contaminated clothing. Wash the contaminated area of body with soap and fresh water. Get medical attention. Launder contaminated clothing before reuse.

Inhalation

Move person to fresh air. Administer oxygen if breathing is difficult. Do not use mouth-to-mouth method if victim inhaled the substance; give artificial respiration with the air of a pocket mask equipped with a one-way valve or other proper respiratory medical device. Give artificial respiration if victim is not breathing. Get medical attention immediately.

Ingestion

Do not induce vomiting. Get medical attention immediately.

Notes to Physician

All treatments should be based on observed signs and symptoms of distress in the patient.

B. Fire Fighting Information

Extinguishing Media

Use water spray or fog, foam, dry chemical or carbon dioxide.

Specific Exposure Hazards

Emits toxic fumes under fire conditions. Depending on conditions, decomposition products may include the following: carbon dioxide, carbon monoxide.

Special Protective Equipment for Firefighters

Wear self-contained breathing apparatus and chemical-protective clothing.

C. Accidental Release Measures

Personal Precautions

Isolate area. Keep unnecessary and unprotected personnel from entering the area. Use personal protective clothing. Ensure adequate ventilation. Wear respiratory protection if ventilation is inadequate. Do not breath mist, vapours or spray. Avoid contact with skin, eyes and clothing. Eliminate all sources of ignition.

Environmental Precautions

Prevent from entering sewers, waterways or low areas.

Steps to be Taken if Material is Released or Spilled

Eliminate all sources of ignition. Pick up with suitable absorbent material and transfer to a container for chemical waste. For large amounts: dike spillage and pump off product into container for chemical waste. Dispose of contaminated material as prescribed.

D. Storage And Handling

General Handling

Keep away from heat, sparks and flame. Avoid contact with eyes, skin and clothing. Avoid breathing vapour. Wash thoroughly after handling. Keep container closed. Use with adequate ventilation.

Storage

Keep container tightly closed. Store away from heat and light.

E. Exposure Controls / Personal Protection

Occupational Exposure Standards

Workplace Australia has not established an occupational exposure standard for ammonium sulfate.

Engineering Controls

Good general ventilation should be used. Ventilation rates should be matched to conditions. If applicable, use process enclosures, local exhaust ventilation or other engineering controls to maintain airborne levels below recommended exposure limits. If exposure limits have not been established, maintain airborne levels to an acceptable level.

Personal Protection Equipment

Respiratory Protection: If workers are exposed to concentrations above the exposure limit, they must use appropriate, certified respirators. If there are no applicable exposure limit requirements or guidelines, use an approved respirator. Selection of air-purifying or positive pressure supplied-air will depend on the specific operation and the potential airborne concentration of the product. For emergency conditions, use an approved positive-pressure self-contained breathing apparatus. The following should be effective types of air-purifying respirators: organic vapour cartridge with a particulate pre-filter.

Hand Protection: Use gloves chemically resistant to this material. Consult the SDS for appropriate glove barrier materials.

Skin Protection: Use protective clothing chemically resistant to the material. Selection of specific items such as face shield, boots, apron or full body suit will depend on the task.

Eye Protection: Use chemical goggles.

Other Precautions: Wash hands, forearms and face thoroughly after handling chemical products; before eating, smoking and using the lavatory; and at the end of the working period. Appropriate techniques should be used to remove potentially contaminated clothing. Wash contaminated clothing before reusing. Ensure that eyewash stations and safety showers are close to the workstation location.

F. Transport Information

UN number: 20506 (Solid). This UN number is for ammonium hydrogen sulfate.

XI. DISPOSAL MANAGEMENT

Disposal should be in accordance with all local, state and federal regulations.

XII. REGULATORY STATUS

Australian AICS Inventory: Listed.

XIII. REFERENCES

ADWG. (2021). National Water Quality Management Strategy. Australian Drinking Water Guidelines, Section 6, Australian Government, National Health and Medical Research Council, Natural Resource Management Ministerial Council.

Department of the Environment, Water, Heritage and the Arts [DEWHA]. (2009). Environmental risk assessment guidance manual for industrial chemicals, Department of the Environment, Water, Heritage and the Arts, Commonwealth of Australia.

ECETOC. (2000). European Centre for Ecotoxicology and Toxicology of Chemicals The Role of Bioaccumulation in Environmental Risk Assessment: The Aquatic Environment and the Related Food Web. European Centre for Ecotoxicology and Toxicology of Chemicals (ECETOC), Technical Report No. 68, Brussels.

ECHA. ECHA REACH database: https://echa.europa.eu/information-on-chemicals/registered-substances

enHealth Human Risk Assessment [HHRA]. (2012). Environmental Health Risk Assessment, Guidelines for Assessing Human Health Risks from Environmental Hazards. Office of Health Protection of the Australian Government Department of Health.

European Chemicals Agency [ECHA]. (2008). Guidance on Information Requirements and Chemical Safety Assessment, Chapter R11: PBT Assessment, European Chemicals Agency, Helsinki, Finland.

Klimisch, H.J., Andreae, M., and Tillmann, U. (1997). A systematic approach for evaluating the quality of experimental and toxicological and ecotoxicological data. Regul. Toxicol. Pharmacol. 25:1-5.

PubChem. National Institutes of Health. National Library of Medicine National Center for Biotechnology Information. https://pubchem.ncbi.nlm.nih.gov/

BORIC ACID (CAS No. 10043-35-3)
SODIUM TETRABORATE DECAHYDRATE (BORAX) (CAS No. 1303-96-4)

This dossier presents the most critical studies pertinent to the risk assessment of two boron compounds (boric acid and borax) in their use in coal seam or shale gas extraction activities. This dossier does not represent an exhaustive or critical review of all available data. The majority of information presented in this dossier was obtained from the ECHA database that provides information on chemicals that have been registered under the EU REACH (ECHA). Where possible, study quality was evaluated using the Klimisch scoring system (Klimisch et al., 1997).

I. SUBSTANCE IDENTIFICATION

Chemical Name (IUPAC): boric acid

CAS RN: 10043-35-3

Molecular formula: BH_3O_3

Molecular weight: 61.84 g/mol

Synonyms: orthoboric acid; boracic acid; borofax; boron hydroxide; boron trihydroxide

Chemical Name (IUPAC): disodium bicyclo[3.3.1]tetraboroxane-3,7-bis(olate)

CAS RN: 1303-96-4

Molecular formula: $B_4Na_2O_7$

Molecular weight: 381.4 g/mol

Synonyms: sodium tetraborate decahydrate; borax; monosodium metaborate; sodium borate; sodium borate (NaBO2); sodium diborate; sodium meta borate; sodium metaborate; sodium tetraborate

SMILES: B(O)(O)O

II. Physical AND Chemical Properties

Limited measured data are available for borax. In the environment, borax is expected to dissociate and/or hydrolyse to release boric acid at neutral pH. Therefore, measured data available for boric acid have been presented as analogue data for this substance.

Key physical and chemical properties for boric acid are shown in Table 1.

Table 1: Overview of the Physico-Chemical Properties of Boric Acid

Property	Value	Klimisch Score	Reference
Physical state at 20°C and 101.3 kPa	White, odorless, crystalline solid	2	ECHA
Melting Point	>100°C (decomposes)	1	ECHA
Boiling Point	Not Applicable	-	ECHA
Density	1489 kg/m^3 @ 20°C	1	ECHA
Vapor Pressure	0 Pa @ 25°C	1	ECHA
Partition Coefficient (log K_{ow})	Not Applicable, substance is inorganic	-	ECHA
Water Solubility	48.8 g/L @ 20°C	1	ECHA
Dissociation Constant (pKa)	8.94 @ 20°C	1	ECHA

Boron is almost exclusively found in the environment in the form of boron-oxygen compounds, which are often referred to as borates. The high strength of the B-O bond relative to those between boron and other elements makes boron oxide compounds stable compared to nearly all non-oxide boron materials. Indeed, the B-O bond is among the strongest found in the chemistry of naturally occurring inorganic substances (ECHA).

In the environment, borates and compounds of boric acid will dissociate and/or hydrolyse to form the same boron species. For example, when borax dissolves in dilute solutions, it dissociates into Na^+ ions and the tetraborate anion ($B_4O_5(OH)_4^{2-}$). Boric acid ($B(OH)_3$) is formed following acid catalysed hydrolysis of the tetraborate anion. Under alkaline conditions, dilute solutions of the tetraborate anion depolymerise rapidly to the mononuclear borate anion ($B(OH)_4^-$) (NICNAS, 2019).

Boric acid is a Lewis acid that acts as a weak monoprotic acid by accepting OH^- and not as a proton donor (pKa 9.14). Therefore, at the near neutral pH of most environmental systems and at low concentrations (<0.025 mol B/L), the neutral mononuclear species ($B(OH)_3$) will dominate and only a small proportion of boron will exist as the borate monoanion, $B(OH)_4^-$. Therefore, boric acid is in equilibrium with borate anions in the environment. Both species are very stable as they do not undergo biotransformation or redox reactions under normal environmental conditions (NICNAS, 2019).

Exposure to borates are often expressed in terms of boron (B) equivalents based on the fraction of boron in the source substance on a molecular weight basis. The B equivalents used are a generic designation rather than a designation of the element boron. The factor for converting boric acid to B-equivalents is 0.1748. The factor for converting borax to B-equivalents is 0.2149.

III. ENVIRONMENTAL FATE PROPERTIES

A. Summary

Borax will transform into boric acid in the aquatic environment. Boric acid is in equilibrium with borate anions in the environment. Degradation is not applicable to inorganic borates. Boric acid is

highly soluble in water. Some partitioning to soil and sediment does occur, however, this adsorption is pH dependent and has a low potential for bioaccumulation.

B. Partitioning

Borax will transform into boric acid in the aquatic environment. Boric acid is in equilibrium with borate anions in the environment. Both species are very stable as they do not undergo biotransformation or redox reactions under normal environmental conditions. Boric acid is highly water soluble, and it tends to remain in surface waters. Although some partitioning from water to soil and sediment does occur, the adsorption is pH dependent with the greatest adsorption occurring under alkaline conditions (pH 7.5 to 9.0) (NICNAS, 2019).

C. Biodegradation

Degradation is not applicable to inorganic borates. Inorganic borates are not subject to hydrolysis, photodegradation, or biodegradation (ECHA). They are subject to chemical transformation processes (adsorption, complexation, precipitation, fixation) once released into the environment (ECHA).

D. Environmental Distribution

The Kp value for boron compounds was calculated as the median of all measured Kp values from the Geochemical Mapping of Agricultural and Grazing Land Soil project ("GEMAS project): 2.19 L/kg dry weight (ECHA) [Kl. Score = 2]. The chemistry of boron in soils and aquatic systems is simplified by the absence of oxidation- reduction reactions or volatilisation. Redox processes can mobilise Fe oxides and Mn oxides, which may lead to a release of boron in aquatic systems. Generally, sediments are characterised with higher pH values than the soil matrix, which increases the boron sorption capacity (ECHA).

If released to soil, based on this low Kp value, low vapour pressure and high water solubility, boric acid and borax are considered relatively mobile in the environment, under certain conditions (ECHA).

E. Bioaccumulation

The WHO review of boron (1998) noted, "highly water soluble materials are unlikely to bioaccumulate to any significant degree and that borate species are all present essentially as un-dissociated and highly soluble boric acid at neutral pH". Bioconcentration factors (BCFs) of <0.1 to 10.5 L/kg have been reported from laboratory tests of fish and oysters (Hamilton and Wiedmeyer, 1990; Thompson et al., 1976).

IV. HUMAN HEALTH HAZARD ASSESSMENT

A. Summary

Borax exhibits low acute toxicity by oral and dermal routes. Boric acid exhibits low acute toxicity by oral, dermal, and inhalation routes. Neither substance is a skin or eye irritant, nor a skin sensitiser. Borax will predominantly exist as un-dissociated boric acid in aqueous media at physiological pH. The developing foetus and the testes are the two most sensitive targets of boron toxicity in multiple species. The testicular effects include reduced organ weight and organ-to-body weight ratio, atrophy, degeneration of the spermatogenic epithelium, impaired spermatogenesis, reduced fertility, and sterility. The developmental effects from boron exposure include high prenatal mortality; reduced foetal body weight; and malformations and variations. Repeated inhalation exposure to read-across substance boron oxide resulted in slight irritation to the respiratory tract,

but no systemic toxicity. Boric acid was not genotoxic, and boric acid and borax were not carcinogenic to rodents.

A. Toxicokinetics

Boric acid is not metabolised in either animals or humans, owing to the high energy level required (523 kJ/mol) to break the B - O bond. Other inorganic borates convert to boric acid at physiological pH in the aqueous layer overlying the mucosal surfaces prior to absorption. Most of the simple inorganic borates exist predominantly as undissociated boric acid in dilute aqueous solution at physiological and environmental pH, leading to the conclusion that the main species in the plasma of mammals is un-dissociated boric acid. Since other borates dissociate to form boric acid in aqueous solutions, they too can be considered to exist as un-dissociated boric acid under the same conditions. Additional support for this derives from studies in which more than 90% of administered doses of inorganic borates are excreted in the urine as boric acid. Absorption of borates via the oral route is nearly 100%. For the inhalation route also 100 % absorption is assumed as worst-case scenario. Dermal absorption through intact skin is very low with a percent dose absorbed of 0.226 ± 0.125 in humans. Using the % dose absorbed plus standard deviation (SD) for boric acid, a dermal absorption for borates of 0.5% (rounded from 0.45%) can be assumed as a worse case estimate (ECHA).

In the blood boric acid is the main species present and is not further metabolised. Boric acid is distributed rapidly and evenly through the body, with concentrations in bone 2 to 3 times higher than in other tissues. Boric acid is excreted rapidly, with elimination half-lives of 1 hour in the mouse, 3 hours in the rat and <27.8 hours in humans and has low potential for accumulation. Boric acid is mainly excreted in the urine (ECHA).

B. Acute Toxicity

The oral LD_{50} of borax in rats is > 2,500 mg/kg (ECHA) [Kl. score = 1]. The oral LD_{50} of boric acid in rats is 3,450 mg/kg (ECHA) [Kl. score = 1].

There are no acute inhalation studies on borax. In a read-across study for borax, the 4-hour inhalation LC_{50} value for disodium tetraborate pentahydrate in rats is >2.04 mg/L (ECHA) [Kl. score = 1]. The 4-hour inhalation LC_{50} value for boric acid in rats is >2.01 mg/L. The mass median aerodynamic diameter (MMAD) was 2.8 µm (ECHA) [Kl. score = 1]. In another study, the 4-hour inhalation LC_{50} value for boric acid in rats was >2.03 mg/L (ECHA) [Kl. score = 1].

The dermal LD_{50} of borax in rabbits is >2,000 mg/kg (ECHA) [Kl. score = 2]. The dermal LD_{50} of boric acid in rabbits is >2,000 mg/kg (ECHA) [Kl. score = 1].

C. Irritation

Application of 0.5 g. of borax to the skin of rabbits for 4 hours under occlusive conditions was not irritating. The mean erythema and oedema scores were 0.00 (ECHA) [Kl. scores = 2]. Application of 0.5 g. of boric acid to the skin of rabbits for 24 hours under occlusive conditions was not irritating. The mean of the 24- and 72-hour scores were 0.13 for erythema and 0.00 for oedema (ECHA) [Kl. scores = 1].

Disodium tetraborates are eye irritants. Instillation of 0.08 mL of read-across substance disodium tetraborate pentahydrate into the eyes of rabbits was slightly irritating. The mean of 24-, 48-, and

72-hour scores were 0.22 for corneal opacity; 0.22 for iridial lesions; 2.8 for conjunctival redness; and 1.89 for chemosis. The effects were fully reversible (ECHA) [Kl. score = 1].

Boric acid induced mild conjunctivae redness and chemosis and minor effects on the iris. The effects were reversible within 7 days (ECHA). Instillation of 100 mg of boric acid into the eyes of rabbits was slightly irritating. The mean of 24-, 48-, and 72-hour scores were 0.00 for corneal opacity; 0.11 for iridial lesions; 0.94 for conjunctival redness; and 0.56 for chemosis (ECHA) [Kl. score = 1].

D. Sensitisation

There are no skin sensitisation studies on borax. Read-across substance disodium tetraborate pentahydrate was not a skin sensitiser to guinea pigs in a Buehler test (ECHA) [Kl. score = 1].

Boric acid was not a skin sensitiser to guinea pigs in a Buehler test (ECHA) [Kl. score = 1]. Sodium tetraborate pentahydrate was not a skin sensitiser to guinea pigs in a Buehler test (ECHA) [Kl. score = 1]. Sodium tetraborate decahydrate was not a skin sensitiser to guinea pigs in a Buehler test (ECHA) [Kl. score = 1].

E. Repeated Dose Toxicity

<u>Oral</u>

Male and female Sprague-Dawley (SD) rats were given boric acid in their feed at doses of 0, 52.5, 175, 525, 1,750 or 5,250 ppm B equivalents for 90 days. The average intake has been estimated to be approximately 0, 2.6, 8.8, 26, 87.5 or 262.5 mg B/kg-day, respectively (EPA, 2004). By week six, all of the animals in the highest dose died. Clinical signs in the top two dose levels were rapid respiration, inflamed eyes, swollen paws, and desquamated skin on the paws and tails. There was also reduced food consumption and body weight gain. The 1,750 ppm females showed reduced liver, spleen ovary, and adrenal weights; the 1,750 ppm males showed reduced liver, spleen, kidney, testes, and adrenal weights. The adrenals of 4 of the 1,750 ppm males showed minor increases in lipid content and size of the cells in the zona reticularis. Atrophied testis (complete atrophy of the spermatogenic epithelium and decreased in the size of the seminiferous tubules) was seen in all of the 1,750 ppm males. One 525 ppm male had partial testicular atrophy. The no observable adverse effects level (NOAEL) for this study is 175 ppm boron or 8.8 mg B/kg-day (Weir and Fisher, 1972). [Kl. score = 2]

Male and female SD rats were given in their diet borax at doses of 0, 52.5, 175, 525, 1,750 or 5,250 ppm B equivalents for 90 days. The average intake has been estimated to be approximately 0, 2.6, 8.8, 26, 87.5 or 262.5 mg B/kg-day, respectively (EPA, 2004). By week 6, all of the animals in the highest dose died. Clinical signs in the top two dose levels were rapid respiration, inflamed eyes, swollen paws, and desquamated skin on the paws and tails. There was also reduced food consumption and body weight gain. The 1,750 ppm females showed reduced liver, spleen and ovary weights; the 1,750 ppm males showed reduced liver, spleen, kidney, testes, and brain weights. The adrenals of the majority of the 1,750 ppm males and females showed slight to moderate increases in lipid content and size of the cells in the zona reticularis. Atrophied testis (complete atrophy of the spermatogenic epithelium and decreased in the size of the seminiferous tubules) was seen in all of the 1,750 ppm males. Four 525 ppm males had partial testicular atrophy. Spermatogenic arrest was found in one 525 ppm male. The NOAEL for this study is 175 ppm boron or 8.8 mg B/kg-day (Weir and Fisher, 1972). [Kl. score = 2]

Male and female B6CF1$_1$ mice were given in the diet 0, 1,200, 2,500, 5,000, 10,000 or 20,000 ppm boric acid for 13 weeks (control and highest dose group) or 16 weeks (remaining dose groups). These dietary levels correspond to approximately 0, 34, 70, 141, 281 and 563 mg B/kg-day for males, respectively; and 0, 47, 97, 194, 388 and 776 mg B/kg-day for females, respectively (EPA, 2004). There was mortality (8/10 males; 6/10, females) in the 20,000 ppm, as well as hyperkeratosis and acanthosis. One male also died in 10,000 ppm group. Degeneration or atrophy of the seminiferous tubules occurred in the ≥5,000 ppm males. Minimal to mild extramedullary haematopoiesis of the spleen was observed in all dose groups. The LOAEL for this study is 1,200 ppm, corresponding to 34 and 47 mg B/kg-day for males and females, respectively (NTP 1987). [Kl. score = 2]

Male and female SD rats were given in their diet 0, 117, 350 or 1,170 ppm boric acid for two years. The average intake has been estimated to be approximately 0, 5.9, 17.5 or 58.5 mg B/kg-day, respectively (EPA, 2004). The 1,170 ppm rats had decreased food consumption during the first 13 weeks of the study and suppressed growth throughout the study. Signs of toxicity in the 1,170 ppm animals included swelling and desquamation of the paws, scaly tails, inflammation of the eyelids, and bloody discharge from the eyes. All of the 1,170 ppm males had testicular atrophy at the 6-, 12- and 24-month time points. The seminiferous epithelium was atrophied, and the tubular size in the testes was decreased. There were significant decreases in the absolute and relative testes weights. Brain and relative thyroid weights were increased. The NOAEL for this study is 350 ppm B equivalents or 17.5 mg B/kg-day (Weir and Fisher, 1972). [Kl. score = 2]

Male and female B6C3F$_1$ mice were given up to 20,000 ppm boric acid in their feed for 13 weeks (NTP, 1987). Eight out of the ten males and six out of the ten females from the 20,000-ppm group died and one of the ten males from the 10,000-ppm group died before end of study. Symptoms included nervousness, hunched appearance, dehydration, foot lesions and scaly tails. Incidences of extra medullary haematopoiesis of the spleen observed of varying severity in all dose groups for both males and females and hyperkeratosis and/or acanthosis of the stomach observed at the highest dose only in both males and females. At doses > 5,000 ppm (142 mg B/kg bw for the male), degeneration or atrophy of the seminiferous tubules was observed. The NOAEL for this study is 34 mg B/kg-day (NTP, 1987). [Kl. score = 2]

Inhalation

Male and female rats were exposed by inhalation to 0, 77, 175, or 470 mg/m^3 boron oxide. The exposures were 6 hours/day, 5 days/week for 24, 12, and 10 weeks for the 77, 175, and 470 mg/m^3 concentrations groups, respectively. The mass median aerodynamic diameter (MMAD) were 2.5, 1.9, and 2.4 µm for the 77, 175, and 479 mg/m^3 concentrations groups, respectively. There was no evidence of systemic toxicity. Some of the 470 mg/m^3 had reddish exudate from the nose. As these animals were covered with dust, this effect may have been local irritation of the nose and from the animals scratching the nose. The NOAEL for systemic toxicity is 470 mg/m^3, the highest exposure concentration tested. The NOAEL for localised effects (irritation) is 175 mg/m^3 (ECHA). [Kl. score = 2]

Dermal

No studies are available.

F. Genotoxicity

In vitro Studies

There are no *in vitro* genotoxicity studies on borax. Table 2 presents the results of the *in vitro* genotoxicity studies on boric acid.

Table 2: *In vitro* Genotoxicity Studies on Boric Acid

Test System	Results*		Klimisch Score	Reference
	-S9	+S9		
Bacterial reverse mutation (*S. typhimurium* strains)	-	-	1	ECHA
Bacterial reverse mutation (*S. typhimurium* strains)	-	-	2	ECHA
Mammalian cell gene mutation (mouse lymphoma L5178Y cells)	-	-	1	ECHA
Chromosomal aberrations (Chinese hamster ovary cells)	-	-	1	ECHA
Chromosomal aberrations (Chinese hamster ovary cells)	-	-	1	ECHA
Chromosomal aberrations (human peripheral lymphocytes)	NS	+	2	ECHA
Unscheduled DNA synthesis (rat liver cells)	NA	-	1	ECHA

*+, positive; -, negative; NA, not applicable; NS, not specified.

In vivo Studies

No studies are available on borax.

Male and female Swiss Webster mice were given two daily doses of 0, 225, 450, 900, 1,800, or 3,500 mg/kg boric acid. The frequency of micronucleated polychromatic erythrocytes were not increased at any dose level (ECHA) [Kl. score = 1].

G. Carcinogenicity

Oral

Male and female SD rats were given disodium tetraborate decahydrate (borax) or boric acid in their diet at doses of 0, 117, 350, or 1,170 ppm as B equivalents (approximately 0, 5.9, 17.5, or 58.5 mg B/kg-day) for two years. There was no mention of tumours in the report. Nevertheless, NTP (1987) concluded that this study provided adequate data on the lack of carcinogenic effects of boric acid in rats (Weir and Fisher, 1972; EPA, 2004).

Male and female $B6C3F_1$ mice were given 0, 2,500, or 5,000 ppm boric acid in their diet for 103 weeks. The dietary levels are equivalent to 0, 446, or 1,150 mg/kg-day boric acid or 0, 78.1, or 201.3 mg B/kg-day. There was no evidence of carcinogenicity (NTP, 1987). [Kl. score = 2]

H. Reproductive Toxicity

A three-generation reproductive toxicity study was conducted in SD rats with boric acid. Male and female rats were fed a diet containing 0, 117, 350 or 1,170 ppm boron (approximately 0, 5.9, 17.5 or 58.5 mg B/kg-day, respectively). In the lower two dose groups, there were no treatment-related effects on reproduction. Litter size, progeny weights, fertility, live birth indices, lactation, appearance were similar to the controls. No gross abnormalities were noted in these two dose groups. The 1,170-ppm dose group were found to be sterile, and there were no litters from mating the treated females with control males. Lack of viable sperm was found in the atrophied testes of all 1,170 ppm males. Decreased ovulation was also seen in the majority of the ovaries of the 1,170 ppm females. The NOAEL for this study is 350 ppm boron or approximately 17.5 mg B/kg-day (Weir and Fisher, 1972). [Kl. score = 2]

A three-generation reproductive toxicity study was conducted in Sprague-Dawley rats with borax. Male and female rats were fed a diet containing 0, 117, 350 or 1,170 ppm boron (approximately 0, 5.9, 17.5 or 58.5 mg B/kg-day, respectively). In the lower two dose groups, there were no treatment-related effects on reproduction. Litter size, progeny weights, fertility, live birth indices, lactation, appearance were similar to the controls. No gross abnormalities were noted in these two dose groups. The 1,170-ppm dose group were found to be sterile, and there were no litters from mating the treated females with control males. Lack of viable sperm was found in the atrophied testes of all 1,170 ppm males. Decreased ovulation was also seen in the majority of the ovaries of the 1,170 ppm females. The NOAEL for this study is 350 ppm boron or approximately 17.5 mg B/kg-day (Weir and Fisher, 1972). [Kl. score = 2]

In a continuous breeding protocol, male and female CD-1 mice were given in their diet 0, 1,000, 4,500 or 9,000 ppm boric acid in their feed. The authors estimated that the average daily intakes were: 0, 26.6, 111, and 220 mg B/kg-day to males; and 0, 31.8, 152, 257 mg B/kg-day to females. Boric acid consumption did not differ among the groups. There were no litters in the 9,000 ppm breeding pairs. At 4,500 ppm, there was a successful first litter, after which there was a progressive decrease in fertility; only one pair produced a fourth and fifth litter. All fertility indices were affected in the 4,500-ppm group. A complete crossover mating trial was conducted using control mice and the 4,500-ppm mice. The results showed that the probable cause of the reduced fertility was a decrement in male fertility. A dose-related decrease in body, testicular and epididymal weights was observed in the 4,500 and 9,000 ppm F_0 males. Sperm count was significantly decreased in these two dose groups, and percent motile sperm was decreased in all dose groups. Testicular histopathology showed seminiferous tubular atrophy in the 9,000 ppm males and partial atrophy of the seminiferous tubules in the 4,500 ppm males. There were no histopathologic changes in the 4,500 ppm females. No statistically significant decreases in mating index, fertility index, or live pups/litter in the 4,500 ppm females, but the number of days to litter in this dose group was increased. Oestrous cyclicity was unaffected. Reproductive organ weights were unaffected, but relative maternal liver and kidney/adrenal weights were reduced. An F_1 fertility trial was performed using offspring from the 1,000-ppm groups. There was no decreases in mating, fertility or reproductive performance. The F_2 adjusted live pup weight was slightly, but significantly, reduced from controls. A clear NOAEL for reproductive toxicity in males was not seen in this study. The 1,000 ppm males had decreased sperm motility in the F_0 generation and decreased sperm concentration in the F_1 generation. Decreased F_2 pup relative body weight was statistically significant from controls. The NOAEL in this study for females is 1,000 ppm boric acid or 32 mg B/kg-day). The LOAEL in this study for males is 1,000 ppm or 27 mg B/kg-day; a NOAEL was not established (Fail et al. 1991). [Kl. score = 2]

I. Developmental Toxicity

No studies are available on borax.

Pregnant female SD rats were given 0, 0.1, 0.2 or 0.4% boric acid in their feed on gestational days (GD) 0 to 20 or 0.8% boric acid on GD 6 to 15. The average amounts of boric acid ingested were estimated to be 0, 78, 163, 330 or 539 mg/kg-day (0, 13.6, 28.5 or 57.7 mg B/kg-day), respectively. Effects on the pregnant rats were altered food and/or water intake at ≥0.2% boric acid, increased liver and kidney weights relative to body weights at ≥0.2%, reduced weight gain at ≥0.4%, and increased corrected weight gain at 0.4% boric acid. There was a reduction in foetal body weights in all treated groups (94, 87, 63, and 47% of control weight, respectively). Increased malformations occurred at ≥0.2%, and prenatal mortality was increased at 0.8%. There was a dose-response for altered skeletal morphology in rats (≥0.1%), and specific findings were significantly elevated above controls at ≥0.2%. Specifically, there was an increased incidence of short rib XIII (a malformation) and a decreased incidence or rudimentary or full rib(s) at lumbar I (an anatomical variation) (Heindel et al. 1992). [Kl. score = 2]

Pregnant female SD rats (dams) were given 0, 0.025, 0.005, 0.075, 0.1 or 0.2% boric acid in their feed on GD 0 to 20. Approximately half of the dams were terminated on GD 20, and the remaining dams delivered their litters. Pup growth and viability were monitored until postnatal day (PND) 21. The average amounts of boron ingested on GD 20 were 0, 3.3, 6.3, 9.6, 13.3, and 25 mg B/kg-day], respectively. The average amounts of boron ingested on PND 21 were : 0, 3.2, 6.5, 9.7, 12.9, and 25.3 mg B/kg-day, respectively. There were no maternal deaths and no treatment-related clinical signs. Maternal body weights were similar across all groups during gestation. However, decreased maternal body weights (GD 19 and 20 at sacrifice) and decreased maternal body weight gain (GD 15-18 and GD 0-20) were statistically significant in trend tests. There was a 10% reduction in gravid uterine weight (statistically significant) in the 0.2% group. Corrected maternal weight (maternal gestational weight minus reduced gravid uterine weight) was unaffected by treatment. Feed intake in the 1,000 ppm dams was minimally affected and only during the first three days of dosing. Water consumption was higher in the treated groups after GD 15. The number of corpora lutea and uterine implantation sites, and the percentage of preimplantation loss were similar across all groups. Increased relative kidney weights were increased in the 0.2% group. There were no differences in the viability of the offspring between treated and controls. On GD 20, foetal body weight was 94% and 88% of controls in the 0.1% and 0.2% groups, respectively; recovery was complete at birth (~GD 22). The incidence of short rib XIII was increased on GD 20 in the ≥0.1% groups, but only in the 0.2% group at PND 21. The incidence of wavy rib was increased on GD 20 in the ≥0.1% group; the reversibility of this effect was confirmed on PND 21. There was a slight decrease in extra lumbar ribs in the 0.2% group on GD 20, and extra lumbar ribs were seen in the 0.2% group on PND 21. The developmental NOAEL was considered to be 0.075% boric acid or 9.6 mg B/kg-day on GD 20; and 0.1% boric acid or 12.9 mg B/kg-day on PND 21 (Price et al. 1996a). [Kl. score = 1]

Pregnant Swiss mice were given in their diet 0, 0.1, 0.2 or 0.4% boric acid on GD 0 to 17. The average amounts of boric acid ingested were estimated to be 248, 452 or 1,003 mg/kg-day (0, 43.4, 79.0 or 175.3 mg/B/kg-day), respectively. Maternal toxicity consisted of mild kidney lesions (≥0.1%), increased water intake and relative kidney weights (0.4%), and decreased water intake during treatment. Foetal body weights were reduced in the ≥0.2% groups, and there were increased incidences of resorptions and malformed foetuses per litter in the 0.4% group. The LOAEL for maternal toxicity is 248 mg/kg-day boric acid or 43.4 mg B/kg-day; a NOAEL was not established. The NOAEL for developmental toxicity is 248 mg/kg-day boric acid or 43.4 mg B/kg-day (Heindel et al., 1992). [Kl. score = 2]

Pregnant female New Zealand rabbits were dosed by oral gavage with 0, 62.5, 125 or 250 mg/kg boric acid (0, 10.9, 21.9 or 43.7 mg B/kg) during GD 6-19. Feed intake was in the 250 mg/kg maternal animals during the exposure period, but it was increased in the ≥125 mg/kg dose groups. In the 250 mg/kg group, maternal body weights during GD 9-30, weight gain during GD 6-19, gravid uterine weight, and number of corpora lutea per dam were significantly reduced. In the ≥125 mg/kg groups, maternal corrected gestational weight gain was increased compared to controls. Maternal liver weights were unaffected by treatment. In the 250 mg/kg group, relative, but not absolute, kidney weights were increased, although no effects in the kidney were noted in the histopathological examination. Prenatal mortality was increased in the 250 mg/kg group (90% resorptions/litter versus 6% for controls); the proportion of pregnant females with no live foetuses was increased (73% versus 0%), and live litter size was reduced (2.3 foetuses versus 8.8). Thus, there were only 14 live foetuses (6 live litters) available for evaluation in the 250 mg/kg group. The percentage malformed foetuses/litter was increased in the 250 mg/kg group, primarily due to cardiovascular defects (72% versus 3% of controls). There was no definitive maternal or developmental toxicity in the 62.5 or 125 mg/kg dose groups. The NOAEL for maternal and developmental toxicity is 125 mg/kg-day boric acid or 21.9 mg B/kg-day (Price et al. 1996b). [Kl. score = 1]

V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES

The toxicological reference values developed for boric acid follow the methodology discussed in enHealth (2012). The approach used to develop drinking water guidance values is described in the Australian Drinking Water Guidelines (ADWG, 2011).

Non-Cancer

An oral reference dose was not derived for boric acid or borax.

The Australian drinking water guideline value for boron (4 mg/L) may be applicable (ADWG, 2011). The health-based ADWG value was based on a tolerable daily intake (TDI) of 0.16 mg/kg bw. This TDI is based on the NOAEL of 9.6 mg/kg bw/day for foetal bodyweight effects in a rat developmental study (Price et al. 1996a) with an uncertainty factor of 60 (10 for interspecies and 6 for human intraspecies).

Cancer

There was no evidence of carcinogenicity in rat and mouse chronic studies conducted on borax and/or boric acid. Thus, a cancer reference value was not derived.

VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES

Borax and boric acid do not exhibit the following physico-chemical properties:

- Explosivity
- Flammability
- Oxidising potential

VII. ENVIRONMENTAL HAZARD ASSESSMENT

A. Summary

Borax and boric acid have low acute and chronic toxicity to aquatic organisms.

A. Aquatic Toxicity

In ecotoxicological tests for boron, the exposure concentrations are expressed as boron equivalents (i.e., mg B/L). This is because boric acid and borate salts will have the same boron speciation when dissolved in environmental matrices. Therefore, in the following sections toxicological values are given as mg B/L regardless of the form of boron that was tested

Acute Studies

Borax will transform into boric acid in the aquatic environment. Table 3 lists the results of acute aquatic toxicity studies conducted on boric acid.

Table 3: Acute Aquatic Toxicity Studies on Boric Acid

Test Species	Endpoint	Results (mg B/L)	Klimisch score	Reference
Fathead minnow	96-hr LC_{50}	79.7	2	ECHA
Legumia recta (Black sandshell mussel)	96-hr LC_{50}	147	2	ECHA
Hyalella azteca	96-hr LC_{50}	64	2	ECHA
Pseudokirchneriella subcapitata	72-hr EC_{50}	52.4	1	ECHA

Chronic Studies

Long-term effects (LC_{10}) on freshwater fish ranged from 3.5 to 47 mg B/L. Adequate long-term LC_{10} of 21.6 mg B/L was found for the freshwater fish *P. promelas* in a study according to EPA OPPTS 850.1400 (ECHA) [Kl. Score = 2].

Long-term effects (LC10/no observed effect concentration [NOEC]) on reproduction on freshwater vertebrates ranged from 6.6 to 32 mg B/L based on several well-accepted guideline studies (ECHA) [Kl. Scores =1 or 2].

Boric acid has been evaluated for its toxicity towards the freshwater alga *Pseudokirchneriella subcapitata* (formerly *Selenastrum capricornutum*) in an Alga growth inhibition test according to Organisation for Economic Cooperation and Development (OECD) 201 under GLP requirements. The exposure duration was 72 hours under static conditions. The NOEC growth rate determined from the study was 17.5 mg B/L (ECHA) [Kl. Score = 1].

The ANZG water quality guideline (2021) derived a very high reliability default guideline value (DGVs) for (dissolved) boron in freshwater from 22 chronic (long-term) toxicity data, comprising eight fish, two amphibians, three crustaceans, one bivalve, three macrophytes, one green microalga, three diatoms, and one blue–green alga. The summary of representative data used by ANZG to develop a water quality guideline for boron is presented in Table 4. These values are noted to be consistent with those reported in ECHA. Additional chronic aquatic toxicity data is found in the ANZG Technical Brief (2021).

Table 4: Chronic Aquatic Toxicity Studies on Boron[1]

Test Species	Endpoint	Results (mg B/L)
Danio rerio	34-day NOEC (Biomass)	1.8
Pimephales promelas	32-day NOEC (Mortality)	11
Daphnia magna	14-day NOEC (Reproduction)	2.4
Pseudokirchneriella subcapitata	4-day NOEC (Growth)	2.8

1 - The DGVs are based on toxicity data for boron as either boric acid, H_3BO_3 (CAS 10043-35-3), or borax, $Na_2B_4O_710H_2O$ (CAS 1303-96-4), in freshwater.

In the chronic toxicity dataset, fish sensitivity to boron ranged from the least sensitive species in the dataset (*Melanotaenia splendida*, LC10 102 mg/L) to the third most sensitive species in the dataset (*Danio rerio*, NOEC 1.8 mg/L). Of the crustaceans, *D. magna* was best represented in the literature, with 18 published NOEC values (ranging from 2.4 mg/L to 29 mg/L) for six different endpoints from six different publications. The final NOEC of 2.4 mg/L used in the DGV derivation was lower than that for *C. dubia* (NOEC 5.6 mg/L) and for the amphipod *H. azteca* (NOEC 6.6 mg/L).For *P. subcapitata*, there were three separate studies available with toxicity data for boron. The toxicity values from these studies ranged from a NOEC of 2.8 mg/L to a NEC of 27 mg/L, varying with endpoint, duration and test medium used. Boron was least toxic to *P. subcapitata* when tested in algal growth medium with added $NaHCO_3$, suggesting that carbonate addition may have influenced boron toxicity. Therefore, although NECs are preferred to NOECs or EC10s (Warne et al., 2018), in this instance, a reliable NOEC of 2.8 mg/L was the most sensitive toxicity value for *P. subcapitata* (ANZG, 2021).

B. Sediment Toxicity

Limited sediment toxicity data are available for boric acid and boron containing compounds in general (NICNAS, 2019).

Chronic toxicity values for the effects of boric acid on sediment-dwelling invertebrates have been obtained for a freshwater midge (*Chironomus riparius*, harlequin fly), a freshwater bivalve (*Lampsilis siliquoidea*, fatmucket clam), and the aquatic worm (*Lumbriculus variegatus,* California blackworm). The respective toxicity values for these species are as follows: 28 d NOEC = 37.8 mg B/kg; 21 d LC25 (survival) = 363.1 mg B/kg; and 28 d NOEC = 100.8 mg B/kg (NICNAS, 2019).

Due to the high water solubility of boron and its low partitioning to sediment, sediment toxicity testing for boron is particularly challenging as it is difficult to ensure that exposure is through the solid phase (i.e., sediment) and not from the aqueous boric acid in the overlying water (NICNAS, 2019).

C. Terrestrial Toxicity

Ecotoxicological tests with plants and soil invertebrates have recorded modest chronic toxicity values (NOECs/ECs) in the range of 15.3 to 84.0 and 5.2 to 315 mg total B/kg, respectively (ECHA, 2008). However, to predict the potential toxicity of boron to plants and soil organisms, measuring the total boron concentration may be unsuitable. Instead, potential toxicity is better predicted using boron concentrations in the soil solution (extractable boron) (Mertens, et al., 2011). In Australia, it is generally accepted that boron toxicity will pose a risk to terrestrial plants when soil concentrations exceed 15 mg/kg of extractable boron (NICNAS, 2019).

D. Calculation of PNEC

PNEC Water

The ANZG water quality guideline (2021) derived a very high reliability DGV for (dissolved) boron in freshwater. The DGVs for 99, 95, 90 and 80% species protection are 340 µg/L, 940 µg/L, 1,500 µg/L and 2,500 µg/L, respectively. The 95% species protection level for boron in freshwater (940 µg/L) is recommended for adoption in the assessment of slightly-to-moderately disturbed ecosystems. (ANZG, 2021).

PNEC Sediment

Limited sediment toxicity data are available for boric acid and boron containing compounds in general (NICNAS, 2019). Due to the high water solubility of boron and its low partitioning to sediment, sediment toxicity testing for boron is particularly challenging as it is difficult to ensure that exposure is through the solid phase (i.e., sediment) and not from the aqueous boric acid in the overlying water (NICNAS, 2019). K_{ow} and K_{oc} parameters do not readily apply to inorganics, such as boric acid and borax. Therefore, the equilibrium partitioning method cannot be used to calculate the $PNEC_{sed}$. As a result, the assessment of this compartment will be covered by the aquatic assessment.

PNEC Soil

In the ECHA REACH database (ECHA), a $PNEC_{soil}$ was derived for boron using the species sensitivity distribution method and an assessment factor of 2. The $PNEC_{soil}$ was determined to be 5.7 mg/kg soil dry weight.

VIII. PERSISTENCE, BIOACCUMULATION AND TOXICITY (PBT) ASSESSMENT

The methodology for the Persistent, Bioaccumulative and Toxic (PBT) substances assessment is based on the Australian and EU Reach Criteria methodology (DEWHA, 2009; ECHA, 2017).

Borax is an inorganic compound that dissociates completely to boric acid and the borate anion in aqueous media. Biodegradation is not applicable to these inorganic compounds; both boric acid and borate are also ubiquitous and are present in most water, soil and sediment. For the purposes of this PBT assessment, the persistent criteria are not considered applicable.

A BCF of <0.1-10.5 L/kg has been reported for borates in fish and oysters. This data suggests that boric acid does not bioaccumulate in the aquatic environment. Thus, boric acid and borax do not meet the criteria for bioaccumulation.

The chronic toxicity data on boric acid has a NOEC > 0.1 mg/L. Acute $E(L)C_{50}$ values are > 1 mg/L. Thus, borax and boric acid do not meet the criteria for toxicity.

The overall conclusion is that borax and boric acid are not PBT substances.

IX. CLASSIFICATION AND LABELLING

A. Classification

Reproductive toxicity (Category 1B), H360

B. Labelling

Danger

C. Pictogram



X. HANDLING AND SAFETY INFORMATION (OCCUPATIONAL LIMITS AND TRANSPORTATION REQUIREMENTS)

A. First Aid

Eye Contact

In case of contact, immediately flush eyes with plenty of water for at least 15 minutes.

Skin Contact

Wash thoroughly with soap and water.

Ingestion

Rinse mouth with water and then drink plenty of water. Never give anything by mouth to an unconscious person.

B. Fire Fighting Information

Extinguishing Media

Water spray, carbon dioxide, foam, dry chemical.

Specific Exposure Hazards

Not combustible. May emit hazardous vapours under fire conditions. Depending on conditions, decomposition products may include the following: borane/boron oxides.

Special Protective Equipment for Firefighters

Wear self-contained breathing apparatus and chemical-protective clothing to prevent skin contact.

C. Accidental Release Measures

Personal Precautions

Use appropriate protective equipment. Avoid inhalation of dusts. Avoid substance contact. Ensure adequate ventilation.

Environmental Precautions

Prevent from entering sewers, waterways, or low areas.

Steps to be Taken if Material is Released or Spilled

Soak up with inert absorbent material.

D. Storage And Handling

General Handling

Keep product and empty container away from heat and sources of ignition. Ensure adequate ventilation, especially in confined areas.

Storage

Keep container tightly closed and in a dry and well-ventilated place. Keep in a cool place.

E. Exposure Controls / Personal Protection

Occupational Exposure Standards

Workplace Australia has not established an occupational exposure standard for boric acid.

Boron oxide (CAS No. 1303-86-2) has an exposure standard of 10 mg/m^3 time weighted average (TWA)

Engineering Controls

Good general ventilation should be used.

Personal Protection Equipment

Respiratory Protection: Respiratory protection is required when dusts are generated.

Hand Protection: Chemical resistant protective gloves.

Skin Protection: Body protection must be chosen depending on activity and possible exposure.

Eye protection: Safety glasses with side-shields.

Other Precautions: Handle in accordance with good industrial hygiene and safety practice. Wearing of closed work clothing is recommended. Ensure that eyewash stations and safety showers are close to the workstation location.

F. Transport Information

Boric acid is not considered hazardous for purposes of transportation by road or rail. An Australian Dangerous Goods code is not required.

XI. DISPOSAL MANAGEMENT

Disposal should be in accordance with all local, state and federal regulations.

XII. REGULATORY STATUS

Australian AICS Inventory: Listed.

XIII. REFERENCES

ADWG. (2011). National Water Quality Management Strategy. Australian Drinking Water Guidelines, Section 6, Australian Government, National Health and Medical Research Council, Natural Resource Management Ministerial Council. Updated January 2022. Available: https://www.nhmrc.gov.au/about-us/publications/australian-drinking-water-guidelines

Allen, B.C., Strong, P.L., Price, C.J., Hubbard, S.A., and Daston, G.P. (1996). Benchmark dose analysis of developmental toxicity in rats exposed to boric acid. Fundam. Appl. Toxicol. 32: 194-204.

ANZG (2021). Toxicant default guideline values for aquatic ecosystem protection: Boron in freshwater. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. CC BY 4.0. Australian and New Zealand Governments and Australian state and territory governments, Canberra, ACT, Australia.

Commonwealth of Australia (2014). Hydraulic fracturing ('fraccing') techniques, including reporting requirements and governance arrangements, Background review, . Accessed 1 March 2017 at http://www.environment.gov.au

Department of the Environment, Water, Heritage and the Arts (DEWHA). (2009). Environmental risk assessment guidance manual for industrial chemicals, Department of the Environment, Water, Heritage and the Arts, Commonwealth of Australia. Available: http://www.nepc.gov.au/resource/chemical-risk-assessment-guidance-manuals

Department of the Environment and Energy (DoEE). (2017). Chemical Risk Assessment Guidance Manual: for chemicals associated with coal seam gas extraction, Guidance manual prepared by Hydrobiology and ToxConsult Pty Ltd for the Department of the Environment and Energy, Commonwealth of Australia, Canberra.

ECHA. ECHA REACH database: http://echa.europa.eu/information-on-chemicals/registered-substances

enHealth Human Risk Assessment (HHRA). (2012). Environmental Health Risk Assessment, Guidelines for Assessing Human Health Risks from Environmental Hazards. Office of Health Protection of the Australian Government Department of Health. Available: https://www1.health.gov.au/internet/main/publishing.nsf/Content/health-pubhlth-publicat-environ.htm

European Chemicals Agency (ECHA). (2017). Guidance on Information Requirements and Chemical Safety Assessment, Chapter R11: PBT Assessment, European Chemicals Agency, Helsinki, Finland. Available: https://echa.europa.eu/guidance-documents/guidance-on-information-requirements-and-chemical-safety-assessment

Fail, P.A., George, J.D., Seely, J.C., Grizzle, T.B., and Heindel, J.J. (1991). Reproductive toxicity of boric acid in Swiss (CD-1) mice: assessment using the continuous breeding protocol. Fundam. Appl. Toxicol. 17: 225-239.

Hamilton, S.J., and Wiedmeyer, R.H. (1990). Concentrations of boron, molybdenum and selenium in chinook salmon. Trans. Amer. Fisheries Soc. 119: 500-510.

Heindel, J.J., Price, C.J., Field, E.A., Marr, M.C., Myers, C.B., Morrissey, R.E., and Schwetz, B.A. (1992). Developmental toxicity of boric acid in mice and rats. Fundam. Appl. Toxicol. 18: 266-272.

Klimisch, H.J., Andreae, M., and Tillmann, U. (1997). A systematic approach for evaluating the quality of experimental and toxicological and ecotoxicological data. Regul. Toxicol. Pharmacol. 25:1-5.

NICNAS. (2019). Boric acid and precursors to boric acid: Environment tier II assessment. Available on-line: https://www.industrialchemicals.gov.au/sites/default/files/Boric%20acid%20and%20precursors%20to%20boric%20acid_%20Environment%20tier%20II%20assessment.pdf

NSW Agriculture (2003). Boron deficiency in pastures and field crops. Accessed 7 March 2017 at http://www.dpi.nsw.gov.au

National Toxicology Program [NTP] (1987). Toxicology and Carcinogenesis Studies of Boric Acid (CAS No. 10043-35-3) in B6C3F_1 Mice. NTP TR 324, NIH Publication No. 88-2580. National Toxicology Program, U.S. Department of Health and Human Services, National Institute of Health.

Price, C.J., Strong, P.L., Marr, M.C., Myers, C.B., and Murray, F.J. (1996a). Developmental toxicity NOAEL and postnatal recovery in rats fed boric acid during gestation. Fundam. Appl. Toxicol. 32: 179-193.

Price, C.J., Marr, M.C., Myers, C.B., Seely, J.C., Heindel, J.J., and Schwetz, B.A. (1996b). The developmental toxicity of boric acid in rabbits. Fundam. Appl. Toxicol. 34: 176-187.

U.S. EPA (1993). Registration Elibility Decision (RED): Boric Acid and its Sodium Salts, EPA 738-R-93-017. Office of Prevention, Pesticides and Toxic Substances, United States Environmental Protection Agency, September 1993.

U.S. EPA (2004). U.S. EPA (United States Environmental Protection Agency). Integrated Risk Information System (IRIS) – Boron and Compounds; CASRN 7440-42-8. Available at: http://www.epa.gov/iris.

Weir, R.J., Jr., and Fisher, R.S. (1972). Toxicologic studies on borax and boric acid. Toxicol. Appl. Pharmacol. 23: 351-364.

WHO (1998). Environmental Health Criteria 204, Boron, International Programme on Chemical Safety, World Health Organization, Geneva, Switzerland.

CINNAMALDEHYDE

This dossier on cinnamaldehyde presents the most critical studies pertinent to the risk assessment of cinnamaldehyde in its use in coal seam or shale gas extraction activities. This dossier does not represent an exhaustive or critical review of all available data. The information presented in this dossier was obtained from the ECHA database that provides information on chemicals that have been registered under the EU REACH (ECHA). Where possible, study quality was evaluated using the Klimisch scoring system (Klimisch *et al.*, 1997).

I. SUBSTANCE IDENTIFICATION

Chemical Name (IUPAC): 3-phenylacryladehyde

CAS RN: 104-55-2

Molecular formula: C_9H_8O

Molecular weight: 132.16 g/mol

Synonyms: Cinnamaldehyde; (2E)-3-phenylprop-2-enal; 3-phenylacrylaldehyde; cinnamal; (E)-cinnamaldehyde; 3-phenylpropenal; cinnamic aldehyde; phenylacrolein; cinnamylaldehyde; 3-phenyl-2-propenal; trans-cinnamaldehyde; (E)-3-phenylpropenal; (E)-3-phenyl-2-propenal; 3-phenylacrolein; 3-phenyl-2-propenaldehyde; 3-phenyl-2-propen-1-al; acrolein, 3-phenyl-; 2-propenal, 3-phenyl-; 2-propenal, 3-phenyl-, (2E)-

SMILES: C1=CC=C(C=C1)C=CC=O

II. PHYSICO-CHEMICAL PROPERTIES

Table 1: Overview of the Physico-chemical Properties of Cinnamaldehyde

Property	Value	Klimisch Score	Reference
Physical state at 20°C and 101.3 kPa	Light colorless clear liquid	1	ECHA
Melting point	-18°C @ 96.990 kPa	1	ECHA
Boiling point	>250°C @ 96.990 kPa	1	ECHA
Density	1,041 kg/m^3 @ 20°C and 96.75 kPa	1	ECHA
Vapor pressure	3.853 Pa @ 25°C	2	ECHA
Partition coefficient (log K_{ow})	2.107±0.0017 @ 25°C	1	ECHA
Water solubility	2.865 g/L @ 25°C	1	ECHA
Flash point	105°C @ 96.83 kPa	1	ECHA
Auto flammability	Not auto-flammable	1	ECHA
Viscosity	22.12 mPa s @ 20°C 18 mPa s @ 40°C	1	ECHA

III. ENVIRONMENTAL FATE PROPERTIES

A. Summary

Cinnamaldehyde is expected to biodegrade and not expected to bioaccumulate to any significant extent. It has a low potential to adsorb to soil or sediment.

B. Biodegradation

Cinnamaldehyde is readily biodegradable. In an OECD 301B test, degradation of cinnamaldehyde was 89% after 7 days, 94% after 14 days, and 100% after 28 days, indicating ready biodegradation (ECHA) [Kl. score = 2]. In an OECD 301D test, biodegradation was 24.98% after 5 days. The BOD_5 value was 0.635 mg O_2/mg (ECHA) [Kl. score = 1].

If a chemical is found to be inherently biodegradable or readily biodegradable, it is categorised as Not Persistent since its half-life is substantially less than 60 days (DoEE, 2017).

C. Environmental Distribution

No experimental data are available for cinnamaldehyde. Using KOCWIN in EPISUITE™ (EPA, 2018), the estimated K_{oc} value from log K_{ow} of 2.107 is 55.82 L/kg. The estimated K_{oc} value from the molecular connectivity index (MCI) is 36.82 L/kg. Based on this estimated value, cinnamaldehyde is expected to have very high mobility in soil. If released to water, based on the K_{oc} value and its high water solubility, it is also not expected to adsorb to suspended solids and sediment.

D. Bioaccumulation

A bioaccumulation study in fish was conducted to estimate the bioconcentration factor (BCF) value for cinnamaldehyde. The BCF value was calculated using a log K_{ow} of 1.9 and a regression derived equation. The estimated BCF value for cinnamaldehyde was determined to be 8 which indicates that this chemical is non-bio accumulative in aquatic organisms (ECHA) [KI. score =2].

IV. HUMAN HEALTH HAZARD ASSESSMENT

A. Summary

Cinnamaldehyde is of relatively low acute toxicity by the oral, dermal, and inhalation routes of exposure. It is an irritant to skin and eyes and is considered a sensitizer per the guinea pig maximization test. Oral repeat dose studies suggest that cinnamaldehyde has relatively low toxicity. There are no studies on the inhalation routes of exposure. Dermal repeat studies suggest that cinnamaldehyde has low toxicity. Cinnamaldehyde was not mutagenic in *in vitro* and *in vivo* genotoxicity tests, and it is not carcinogenic. Cinnamaldehyde is a not a reproductive or developmental toxicant.

B. Metabolism

Male Fischer 344 rats were given doses of 5, 50, and 500 mg/kg bw/day of cinnamaldehyde by oral gavage for seven days. Cinnamaldehyde was rapidly absorbed within the body and distributed to the gastrointestinal tract, the kidneys, the liver, and a small amount distributed to fat. Benzoic acid is the major metabolic of cinnamaldehyde. After 24 hours more than 80% of cinnamaldehyde is excreted in the urine and a small amount (<7%) is excreted in the faeces (ECHA) [KI. score =2].

The metabolism of 2 and 250 mg/kg bw/day of cinnamaldehyde was evaluated using male and female CD-1 mice exposed via the intraperitoneal route of exposure for 72 hours. About 94% of the administered dose was recovered in the urine after 72 hours. Less than two percent of the administered dose was remained in the mice after 72 hours. The major urinary metabolites were hippuric acid, 3-hydroxy-3-phenylpropionic acid, benzoic acid, and benzyl glucuronide (ECHA) [KI. score = 2].

C. Acute Toxicity

The 14-day acute oral LD_{50} in male and female Osborne-Mendel rats administered 2220 mg/kg bw/day of cinnamaldehyde via oral gavage was determined to be 2,220 mg/kg bw/day (ECHA) [Kl. Score = 2].

An acute oral toxicity study was conducted using male and female guinea pigs given cinnamaldehyde by oral gavage. The LD_{50} was determined to be 3400 mg/kg bw/day (ECHA) [KI. score =2].

Inhalation

There are no acute inhalation studies are available for cinnamaldehyde. An acute inhalation LC_{50} was predicted for cinnamaldehyde using the QSAR toolbox. The 4-hour LC50 in male and female Wistar rats exposed to cinnamaldehyde was predicted to be 68.889 ppm (ECHA) [KI. score =2].

Dermal

An OECD Guideline (Acute Dermal Toxicity) study was conducted using male and female albino Wistar rats exposed to cinnamaldehyde using occlusive dressing for 14 days. The dermal LD_{50} was determined to be is >2,000 mg/kg bw/day (ECHA) [Kl. Score = 2].

D. Irritation

Skin

Application of 0.1 mL of cinnamaldehyde to the skin of New Zealand white rabbits for 4 hours under semi-occlusive conditions was considered slightly-to-moderate irritating. The primary dermal irritation index (PDII) for cinnamaldehyde after 24, 48, and 72 hours was determined to be 3.25. This data indicates that cinnamaldehyde was moderately severely irritating to the skin of New Zealand white rabbits(ECHA) [Kl. score = 2].

An OECD Guideline 439 (In Vitro Skin Irritation: Reconstructed Human Epidermis Test method) study was conducted using non-transformed keratinocytes in a human skin model. The man tissue viability for cinnamaldehyde, when compared to the control, was determined to be 4.1%. This data indicates that cinnamaldehyde is considered to be irritating to human skin (ECHA) [KI. score =1].

Cinnamaldehyde, at doses of 0.02, 0.1%, and 0.8% in ethanol, was applied to the skin (upper arm) of healthy humans over a six-week period Cinnamaldehyde was determined to be severely irritating to the skin based on results from a human patch test (ECHA)[KI. score =2].

Eye

Instillation of 0.1 mL cinnamaldehyde to the eyes of New Zealand rabbits for 24 hours was considering irritating. The mean of the 24-, 48-, and 72-hours scores were: 1.00 for corneal opacity,

0.00 for iridial lesions, 2.00 for conjunctival redness, and 1.22 for chemosis. All effects were resolved by Day 14 of the observation period (ECHA) [Kl. score = 1].

The ocular irritation potential of cinnamaldehyde was determined using an OECD 492 guideline (Reconstructed Human Cornea-like Epithelium RhCE test method for identifying chemicals not requiring classification and labelling for eye irritation or serious eye damage) study. The mean tissue viability of cinnamaldehyde was determined to be 4.1 %. Cinnamaldehyde was determined to be irritating to the human eye (ECHA) [KI. score =1].

Instillation of 8% of cinnamaldehyde to the human eye was determined to be irritating (ECHA)[KI. score =2].

E. Sensitisation

Cinnamaldehyde was considered a skin sensitizer when tested in a guinea pig maximization test (ECHA) [Kl. score = 2].

F. Repeated Dose Toxicity

Oral

Male and female F344 rats were given in their diet 0, 4,100, 8,200, 16,500, or 33,000 ppm cinnamaldehyde (microcapsulated) for three months in a study conducted by the National Toxicology Program. The average daily intake was 0, 275, 625, 1,300, and 4,000 mg/kg-day for males, and 0, 300, 570, 1,090, and 3,100 mg/kg bw/day-day for females. There was no mortality during the study. Mean body weights were reduced in the ≥16,500 ppm animals as a result of decreased feed consumption from unpalatability of the dosed feed. There was a non-significant increase in serum bile acid concentration at all dose levels suggesting an effect on the liver, but there were no corresponding histopathologic effects. An increase in lesions of the forestomach mucosa was seen in the ≥8,200 ppm animals and included squamous epithelial hyperplasia. There was also chronic active inflammation in the 33,000 ppm males and the ≥16,500 ppm females. The NOAEL was considered to be 4,100 ppm, which corresponds to 275 and 300 mg/kg bw/day in males and females, respectively (Hooth et al., 2004; as cited in ECHA) [Kl. score = 1].

Male and female rats were fed in their diet 0, 1,000, 2,100, or 4,100 ppm cinnamaldehyde for 12 weeks. The average daily intake was 0, 50, 100, or 200 mg/kg bw/day-day. There were no significantly differences between treated and control animals in urine sugar and albumin, blood haemoglobin levels, growth, food intake, or other physiological criteria. The NOAEL for this study is 4,100 ppm for males and females, which corresponds to 200 mg/kg bw/day (ECHA) [Kl. score = 2].

Male and female F344 rats were given in their diet 0, 1,000, 2,100, or 4,100 ppm cinnamaldehyde (microcapsulated) for two years in a study conducted by the National Toxicology Program. The average daily intake was 0, 50, 100, or 200 mg/kg bw/day. The survival of the 4,100 ppm males was greater than the controls. The mean body weights of the 4,100 ppm animals were generally less he controls throughout the study. Feed consumption of the ≥2,100 ppm males and the 4,100 ppm females was less than the controls at the beginning and end of the study. There were no non-neoplastic lesions that were considered to be treatment related. The NOAEL for this study is 4,100 ppm for males and females, which corresponds to 200 mg/kg bw/day (Hooth et al., 2004; as cited in ECHA) [Kl. score = 1].

Male and female B6C3F$_1$ mice were given in their diet 0, 1,000, 2,100, or 4,100 ppm cinnamaldehyde (microcapsulated) for two years in a study conducted by the National Toxicology Program. The average daily intake was 0, 125, 270, or 540 (males) and 570 (females) mg/kg bw/day. Mean body weights of the ≥2,100 ppm animals were generally less than the controls throughout the study. There were no non-neoplastic lesions that were considered to be treatment related. Incidences of minimal olfactory epithelial pigmentation was significantly increased in the 4,100 ppm males and the ≥2,100 ppm females. The NOAEL for this study is 1,000 ppm in males and females, which corresponds to 125 mg/kg bw/day, based on reduced body weights at 270 mg/kg bw/day (Hooth et al., 2004; as cited in ECHA) [Kl. score = 1].

An oral subacute toxicity was conducted using male and female B6C3F1 mice exposed 0,656, 1310,2620, 5250, or 10,500 mg/kg bw/day cinnamaldehyde for 14 days (2 weeks: 5 days/week for a total of 12 doses). There were no significant differences in body weight, liver weight, spleen weight, and kidney weight. There were no statistical differences in organ: body weight ratios between surviving treated mice and the control mice. All of the mice in the two highest dose groups, as well as the all the female mice and three male mice from the 2620 mg/kg bw/day dose group, died withing the first two days of dosing. There were no clinical signs or gross lesions observed in the surviving mice or the dead mice. Mild forestomach hyperplasia was observed in both sexes of mice exposed to cinnamaldehyde. Minimal kidney nephropathy was observed in the mice exposed to dose of more than 1310 mg/kg bw/day. A NOAEL of 656 mg/kg bw/day was established for this study. A LOAEL of 1,310 mg/kg bw/day was established in this study based on body weight, organ weight, and histopathological examinations (ECHA) [KI. score = 2].

Inhalation

There are no studies are available. As shown in Table 1, cinnamaldehyde has a low vapor pressure which suggests that the generation of inhalable vapours is low. Under normal conditions, human exposure to cinnamaldehyde by the inhalation route of exposure is highly unlikely.

Dermal

A dermal sub chronic dermal toxicity study was conducted using female Balb/c mice exposed to 25µl 25 percent (v/v) solution of cinnamaldehyde for 4-5 days. The NOAEL was determined to be 25µl (ECHA) [KI. score =2].

A dermal sub chronic dermal toxicity study was conducted using mice exposed to 750 mg/kg bw/day 3D (intermittent) of cinnamaldehyde. A LOAEL value of 750 mg/kg/3D was established for mice exposed to cinnamaldehyde for three days (ECHA) [KI. score =2].

G. Genotoxicity

In Vitro Studies

The *in vitro* genotoxicity studies on cinnamaldehyde are presented in Table 2.

Table 2: *In vitro* Genotoxicity Studies on cinnamaldehyde

Test System	Results*		Klimisch Score	Reference
	-S9	+S9		
OECD Guideline 471 Bacterial Reverse Mutation Assay (S. typhimurium TA 98, TA100, TA 102, TA 1535, TA1537)	-	-	1	ECHA

Test System	Results*		Klimisch Score	Reference
	-S9	+S9		
OECD Guideline 471 (*In Vitro* Mammalian Chromosome Aberration Test)	-	-	1	ECHA
OECD Guideline 476 (*In Vitro* Mammalian Cell Gene Mutation Test using the Hprt and xprt genes)	-	-	1	ECHA
Bacterial reverse mutation assay (Salmonella typhimurium TA97, TA98, TA100, TA1335, and TA1537)	-	-	2	ECHA
In vitro mammalian cell micronucleus test	-	-	2	ECHA

*+, positive; -, negative

In Vivo Studies

Male and female B6C3F$_1$ mice were administered in their feed 0, 4,100, 8,200, 16,500, or 33,000 ppm cinnamaldehyde (microcapsulated) for three months in a study conducted by the National Toxicology Program. The average daily intake was 650, 1,320, 2,550, and 5,475 mg/kg bw/day for males, and 0, 625, 1,380, 2,680, and 5,200 mg/kg bw/day for females. There were no increases in the frequency of micronucleated normochromatic erythrocytes in the peripheral blood in the treated animals compared to the controls (ECHA) [Kl. score = 2].

A mouse bone marrow micronucleus test was used to evaluate the genotoxic potential of cinnamaldehyde in ddY mice. Male mice were given oral doses of 0, 250, 313, and 500 mg/kg of cinnamaldehyde for 24 hours. Cinnamaldehyde did not induce any gene mutations in male ddY mice (ECHA) [Kl. score = 2].

H. Carcinogenicity

Male and female F344 rats were administered in their diet 0, 1,000, 2,100, or 4,100 ppm cinnamaldehyde (microcapsulated) for two years in a study conducted by the National Toxicology Program. The average daily intake was 0, 50, 100, or 200 mg/kg bw/day-day. The tumour incidences were similar between the treated and control animals. A NOAEL of 200 mg/kg bw/day (4100 ppm) was reported for this study (Hooth et al., 2004; as cited in ECHA) [Kl. score = 2].

Male and female B6C3F$_1$ mice were administered in their diet 0, 1,000, 2,100, or 4,100 ppm cinnamaldehyde (microcapsulated) for two years in a study by the National Toxicology Program. The average daily intake was 0, 125, 270, or 540 (males) and 570 (females) mg/kg bw/day-day. The tumour incidences were similar between the treated and control animals. The NOAEL was considered to be 4100 ppm (540 mg/kg bw/day for males and 570 mg/kg bw/day females (Hooth et al., 2004; as cited in ECHA) [Kl. score = 1].

An OECD Guideline 451 (Carcinogenicity study) was conducted in male and female Fischer 344 rats exposed to 0, 235, 470, 940, 1880, 3750 mg/kg bw/day of cinnamaldehyde by oral gavage for 16 days. There were no effects observed at the lowest dose level while all the animals in the two highest dose groups died within the first seven days of dosing. There was minimal to moderate forestomach hyperplasia observed in the males who received a dose of ≥470 mg/kg bw/day. A NOAEL of 235 mg/kg bw/day was reported in this study based on no occurrence of hyperplastic lesions or forestomach hyperplasia. There was clear evidence of distended gastrointestinal tracts in

animals who were given doses of 1880 or 3750 mg/kg bw/day as well as slightly decreased body weights in females of the 940 mg/kg bw/day dose group. The target organ toxicity value was reported to be 470 mg/kg bw/day (ECHA) [KI. score = 2].

I. Reproductive Toxicity

There are no adequate studies are available.

J. Developmental Toxicity

Pregnant female CD-1 mice were dosed by oral gavage with 0 or 1,200 mg/kg bw/day cinnamaldehyde on gestational days 6 to 13. The dams were allowed to deliver, and the pups were weaned up to postnatal day 3. There was no effect on maternal survival or body weight development and all 34 litters were viable. The number of liveborn per litter, the survival and birthweight of pups and their weight gain was not affected by treatment. The LOAEL for maternal and developmental toxicity is 1,200 mg/kg-day (ECHA) [Kl. score = 2].

An OECD Guideline 414 (Prenatal Developmental Toxicity) study was conducted in Wistar rats exposed to 0, 125, 250, 500 mg/kg bw/day of cinnamaldehyde by oral gavage from gestation day five to gestation day 19. The NOAEL for maternal systemic toxicity was reported to be 250 mg/kg bw/day. This effect level was based on mortality, clinical signs of toxicity, statistically/biologically significant decreased in body weight on gestation day 17 and gestation day 20. There were significant decreased in food intake on gestation day 8 and 11 and several gross/histopathology findings. The NOAEL for developmental toxicity was reported to be 250 mg/kg bw/day based on decreased fetal body weights observed in the 500 mg/kg bw/day (ECHA) [KI. score =1].

V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES

The toxicological reference values developed for cinnamaldehyde follow the methodology discussed in enHealth (2012). The approach used to develop drinking water guidance values is described in the Australian Drinking Water Guidelines (ADWG, 2011).

A. Non-Cancer

<u>Oral</u>

A two-year oral repeat dose study was conducted by the national toxicology program in male and female F344 rats. The lowest NOAEL from this study was reported to be 4,100 ppm which corresponds to a dose level 200 mg/kg bw/day.
The NOAEL of 200 mg/kg bw/day will be used for determining the oral Reference dose (RfD) and the drinking water guidance value.

Oral Reference Dose (oral RfD)

Oral RfD = NOAEL / (UF_A x UF_H x UF_L x UF_{Sub} x UF_D)

Where:

- UF_A (interspecies variability) = 10
- UF_H (intraspecies variability) = 10
- UF_L (LOAEL to NOAEL) = 1
- UF_{Sub} (subchronic to chronic) = 1
- UF_D (database uncertainty) = 1

Oral RfD = 200/ (10 x 10 x 1 x 1 x 1) = 200/100 = 2 mg/kg bw/day

Drinking water guidance value

Drinking water guidance value = (animal dose) x (human weight) x (proportion of intake from water) / (volume of water consumed) x (safety factor)

Using the oral RfD,
Drinking water guidance value = (oral RfD) x (human weight) x (proportion of water consumed) / (volume of water consumed)

Where:
Human weight = 70 kg (ADWG, 2011)
Proportion of water consumed = 10% (ADWG, 2011)
Volume of water consumed = 2L (ADWG, 2011)

Drinking water guidance value = (2x 70 x 0.1)/2 = 7 mg/L

B. Cancer

Cinnamaldehyde was not carcinogenic to rats or mice when given in the diet for two years. Thus, a cancer reference value was not derived.

VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES

Cinnamaldehyde does not exhibit the following physico-chemical properties:

- Explosivity
- Flammability
- Oxidizing potential

VII. ENVIRONMENTAL HAZARD ASSESSMENT

A. Summary

Cinnamaldehyde has low chronic toxicity potential to aquatic organisms. Since cinnamaldehyde is readily biodegradable in water, it was reported to be non-toxic to aquatic fish, invertebrates, and algae at environmentally relevant concentrations.

B. Aquatic Toxicity

Acute Studies

Table 2 lists the results of acute aquatic toxicity studies on cinnamaldehyde.

Table 2: Acute Aquatic Toxicity Studies on Cinnamaldehyde

Test Species	Endpoint	Results (mg/L)	Klimisch score	Reference
Danio rerio (Brachydanio rerio)	96-hr LC_{50}	4.3 (mortality)	1	ECHA
Danio rerio (Brachydanio rerio)	96-hr LC_{50}	2.35 (mortality)	1	ECHA

Test Species	Endpoint	Results (mg/L)	Klimisch score	Reference
Danio rerio (Brachydanio rerio)	96-hr LC_{50}	>3.9- <5.5 (mortality)	1	ECHA
Poecilia reticulata (Guppy fish)	96-hr LC_{50}	>3.5- <6.5	2	ECHA
Lepomis macrochirus (Bluegill fish)	96-hr LC_{50}	>20	2	ECHA
Daphnia magna	48-hr EC_{50}	3.21	2	ECHA
Daphnia magna	48-hr EC_{50}	3.86	2	ECHA
Daphnia magna	48-hr EC_{50}	11.5	2	ECHA
Desmodesmus subspicatus	72-hr EC_{50}	31.6	2	ECHA
Chlorella vulgaris	72-hr EC_{50}	16.09	2	ECHA

Since the test chemical is readily biodegradable in water, the chemical was considered to be non-toxic to aquatic fish, invertebrates and algae at environmentally relevant concentrations (ECHA).

Chronic Studies

In an OECD Guideline 211 (Daphnia magna reproduction test) study, the 21-day EC_{50} was reported to be 0.402 mg/L based on reproduction (ECHA) [KI. score =2].

Based on a prediction completed using ECOSAR version 1.11, a long-term toxicity value for fish was predicted for cinnamaldehyde. Based on effects observed in a flow through freshwater system in fish, the NOEC value for the substance was estimated to be 15.159 mg/L for fish for 28 days of exposure duration. (ECHA) [KI. score = 2].

C. Terrestrial Toxicity

In a short-term toxicity study to birds (avoidance [repellency] test), the 5-day LOEL value was 1% w/w for *Colinus virginianus* (Northern Bobwhite Quail). (ECHA) [KI. score = 2].

D. Calculation of PNEC

The PNEC calculations for cinnamaldehyde follow the methodology discussed in DEWHA (2009).

PNEC Water

Experimental results are available for three trophic levels. Acute $E(L)C_{50}$ values are available for fish (2.35 mg/L), *Daphnia* (3.21 mg/L), and algae (16.09 mg/L). Results from a chronic study in fish was reported to be 15.159 mg/L. On the basis that the data consists of short-term results from three trophic levels and chronic studies on one trophic levels, an assessment factor of 100 has been applied to the lowest reported NOEC of 15.159 mg/L for fish. The $PNEC_{water}$ is 0.152 mg/L.

PNEC Sediment

There are no toxicity data for sediment-dwelling organisms. Therefore, the $PNEC_{sed}$ was calculated using the equilibrium partitioning method. The $PNEC_{sed}$ is 0.179 mg/kg sediment wet weight.

The calculations are as follows:

$PNEC_{sed} = (K_{sed\text{-}water}/BD_{sed}) \times 1000 \times PNEC_{water}$
$= (1.51/1280) \times 1000 \times 0.152$
$= 0.179$ mg/kg

Where:
$K_{sed\text{-}water}$ = suspended matter-water partition coefficient (m^3/m^3)
BD_{sed} = bulk density of sediment (kg/m^3) = 1,280 [default]
$K_{sed\text{-}water} = 0.8 + [(0.2 \times Kp_{sed})/1000 \times BD_{solid}]$
$= 0.8 + [(0.2 \times 1.47/1000 \times 2400]$
$=1.51\ m^3/m^3$

Where:
Kp_{sed} = solid-water partition coefficient (L/kg)
BD_{solid} = bulk density of the solid phase (kg/m^3) = 2,400 [default]
$Kp_{sed} = K_{oc} \times f_{oc}$
$= 36.82 \times 0.04$
$=1.47$ L/kg

Where:
K_{oc} = organic carbon normalised distribution coefficient (L/kg). The K_{oc} for Cinnamaldehyde based on the molecular connectivity index (MCI) is 36.82 L/kg (EPA, 2019).
F_{oc} = fraction of organic carbon in sediment = 0.04 [default].

PNEC Soil

There are no toxicity data for terrestrial or soil organisms. Therefore, the $PNEC_{soil}$ was calculated using the equilibrium partitioning method. The $PNEC_{soil}$ is 0.075 mg/kg soil dry weight.
The calculations are as follows:

$PNEC_{soil} = (Kp_{soil}/BD_{soil}) \times 1000 \times PNEC_{water}$
$= (0.74/1500) \times 1000 \times 0.152$
$= 0.075$

Where:
Kp_{soil} = soil-water partition coefficient (m^3/m^3)
BD_{soil} = bulk density of soil (kg/m^3) = 1,500 [default]
$Kp_{soil} = K_{oc} \times f_{oc}$
$= 36.82 \times 0.02$
$= 0.74$

Where:
K_{oc} = organic carbon normalised distribution coefficient (L/kg). The K_{oc} for cinnamaldehyde based on the molecular connectivity index (MCI) is 36.82 L/kg (EPA, 2019).
F_{oc} = fraction of organic carbon in soil = 0.02 [default].

VIII. PERSISTENCE, BIOACCUMULATION AND TOXICITY (PBT) ASSESSMENT

The methodology for the Persistent, Bioaccumulative and Toxic (PBT) substances assessment is based on the Australian and EU Reach Criteria methodology (DEWHA, 2009; ECHA, 2017).

Cinnamaldehyde is readily biodegradable; thus, it does not meet the screening criteria for persistence.

Based on a measured log K_{ow} of 2.107± 0.0017, cinnamaldehyde does not meet the screening criteria for bioaccumulation.

The NOEC from a chronic fish study was>0.1 mg/L. The acute E(L)C_{50} values for cinnamaldehyde are >1 mg/L. Thus, cinnamaldehyde does not meet the criteria for toxicity.

The overall conclusion is that cinnamaldehyde is not a PBT substance.

IX. CLASSIFICATION AND LABELLING

A. Classification

H315-Skin Irritant Category 2
H319-Eye Irritant Category 2
H317-Skin Sensitizer Category 1
H312-Aquatic Acute Toxicity Category 2
H335-STOT SE3

B. Labelling

Warning!

According to the classification provided by companies to ECHA in REACH registrations this substance causes serious eye irritation, is harmful to aquatic life with long lasting effects, is harmful in contact with skin, causes skin irritation and may cause an allergic skin reaction.

C. Pictogram



X. HANDLING AND SAFETY INFORMATION (OCCUPATIONAL LIMITS AND TRANSPORTATION REQUIREMENTS)

A. First Aid

Eye Contact

First check the victim for contact lenses and remove if present. Flush victim's eyes with water or normal saline solution for 20 to 30 minutes while simultaneously calling a hospital or poison control centre. Do not put any ointments, oils, or medication in the victim's eyes without specific instructions from a physician. IMMEDIATELY transport the victim after flushing eyes to a hospital even if no symptoms (such as redness or irritation) develop. SKIN: IMMEDIATELY flood affected skin with water while removing and isolating all contaminated clothing. Gently wash all affected skin

areas thoroughly with soap and water. If symptoms such as redness or irritation develop, IMMEDIATELY call a physician and be prepared to transport the victim to a hospital for treatment.

Skin Contact

IMMEDIATELY flood affected skin with water while removing and isolating all contaminated clothing. Gently wash all affected skin areas thoroughly with soap and water. If symptoms such as redness or irritation develop, IMMEDIATELY call a physician and be prepared to transport the victim to a hospital for treatment.

Inhalation

IMMEDIATELY leave the contaminated area; take deep breaths of fresh air. If symptoms (such as wheezing, coughing, shortness of breath, or burning in the mouth, throat, or chest) develop, call a physician and be prepared to transport the victim to a hospital. Provide proper respiratory protection to rescuers entering an unknown atmosphere. Whenever possible, Self-Contained Breathing Apparatus (SCBA) should be used; if not available, use a level of protection greater than or equal to that advised under Protective Clothing.

Ingestion

DO NOT INDUCE VOMITING. If the victim is conscious and not convulsing, give 1 or 2 glasses of water to dilute the chemical and IMMEDIATELY call a hospital or poison control centre. Be prepared to transport the victim to a hospital if advised by a physician. If the victim is convulsing or unconscious, do not give anything by mouth, ensure that the victim's airway is open and lay the victim on his/her side with the head lower than the body. DO NOT INDUCE VOMITING. IMMEDIATELY transport the victim to a hospital. (NTP, 1992)

Notes to Physician

Symptoms of exposure to this compound may include inflammation and erosion of gastrointestinal mucosa. The vapor or mist causes irritation of the eyes, mucous membranes and upper respiratory tract. ACUTE/CHRONIC HAZARDS: This chemical may be harmful by inhalation, ingestion or skin absorption. It may cause irritation of the skin, eyes, upper respiratory tract, and mucous membranes. When heated to decomposition it may emit toxic fumes of carbon monoxide and carbon dioxide.

Medical Conditions Aggravated by Exposure

Irritation properties of the substance may aggravate asthma and/or other respiratory conditions.

Emergency Personnel Protection

Personal protective equipment must be used in accordance with known hazards of the substance.

B. Fire Fighting Information

Extinguishing Media

This chemical is combustible. Fires involving this material can be controlled with a dry chemical, carbon dioxide or Halon extinguisher.

Specific Exposure Hazards

May ignite after a delay period in contact with NaOH.

Special Protective Equipment for Firefighters

Use respiratory protection equipment as deemed necessary by hazards associated with the substance.

C. Accidental Release Measures

Personal Precautions

Wash hands before eating, drinking, chewing gum, using tobacco or using the toilet. Remove clothing immediately if substance gets inside. Then wash thoroughly and put on clean clothing.

Environmental Precautions

Do not release to discharge into open drains or waterways.

Steps to be Taken if Material is Released or Spilled

If you spill this chemical, FIRST REMOVE ALL SOURCES OF IGNITION. Then, use absorbent paper to pick up all liquid spill material. Contaminated clothing and absorbent paper should be sealed in a vapor-tight plastic bag for eventual disposal. Solvent wash all contaminated surfaces with 60-70% ethanol followed by washing with a soap and water solution. Do not re-enter the contaminated area until the Safety Officer (or other responsible person) has verified that the area has been properly cleaned.

Wastewater from contaminant suppression, cleaning of protective clothing/equipment, or contaminated sites should be contained and evaluated for subject chemical or decomposition product concentrations. Concentrations shall be lower than applicable environmental discharge or disposal criteria. Alternatively, pre-treatment and/or discharge to a POTW is acceptable only after review by the governing authority. Due consideration shall be given to remediation worker exposure (inhalation, dermal and ingestion) as well as fate during treatment, transfer and disposal.

Do not contaminate water by cleaning of equipment or disposal of wastes

D. Storage and Handling

General Handling

Do not use, pour, spill or store near heat or open flame.

Other Handling Precautions

Observe label precautions. Immediately change contaminated clothing. Apply preventive skin protection. Wash hands and face after working with substance.

Storage

STORAGE PRECAUTIONS: You should keep this material in a tightly closed container under an inert atmosphere and store it at refrigerated temperatures. (NTP, 1992)

E. Exposure Controls / Personal Protection

Occupational Exposure Standards

Workplace Australia has not established an occupational exposure limit for cinnamaldehyde.

Engineering Controls

Good general ventilation should be used. Ventilation rates should be matched to conditions. If applicable, use process enclosures, local exhaust ventilation, or other engineering controls to maintain airborne levels below recommended exposure limits. If exposure limits have not been established, maintain airborne levels to an acceptable level.

Personal Protection Equipment

Respiratory Protection:
Where the neat test chemical is weighed and diluted, wear a NIOSH-approved half face respirator equipped with an organic vapor/acid gas cartridge (specific for organic vapors, HCl, acid gas and SO2) with a dust/mist filter. (NTP, 1992)

Hand Protection:
Chemical resistant gloves.

Skin Protection:
For agricultural use requirements, PPE required for early entry to treated areas that is permitted under applicable Worker Protection Standards and that involves contact with anything that has been treated, such as plants, soil, water, is: Coveralls, waterproof gloves, shoes plus socks.

Eye protection:
Protective eyewear shall be worn at all times.

Other Precautions:
None other specific precautions are stipulated.

F. Transport Information

Cinnamaldehyde is not considered hazardous for purposes of transportation by road or rail. An Australian Dangerous Goods code is not required.

UN 1993

Class: 3

Packaging Group: II

XI. DISPOSAL MANAGEMENT

Disposal should be in accordance with all local, state, and federal regulations.

XII. REGULATORY STATUS

Australian AICS Inventory: Listed.

XIII. REFERENCES

ADWG. (2011). National Water Quality Management Strategy. Australian Drinking Water Guidelines, Section 6, Australian Government, National Health and Medical Research Council, Natural Resource Management Ministerial Council. Updated January 2022. Available: https://www.nhmrc.gov.au/about-us/publications/australian-drinking-water-guidelines

Department of the Environment, Water, Heritage and the Arts [DEWHA]. (2009). Environmental risk assessment guidance manual for industrial chemicals, Department of the Environment, Water, Heritage and the Arts, Commonwealth of Australia. Available: http://www.nepc.gov.au/resource/chemical-risk-assessment-guidance-manuals

Department of the Environment and Energy (DoEE). (2017). Chemical Risk Assessment Guidance Manual: for chemicals associated with coal seam gas extraction, Guidance manual prepared by Hydrobiology and ToxConsult Pty Ltd for the Department of the Environment and Energy, Commonwealth of Australia, Canberra. Available: www.environment.gov.au/water/coal-and-coal-seam-gas/national-assessment-chemicals/consultation-risk-assessment-guidance-manual

ECHA. ECHA REACH database: http://echa.europa.eu/information-on-chemicals/registered-substances

enHealth Human Risk Assessment [HHRA] (2012). Environmental Health Risk Assessment, Guidelines for Assessing Human Health Risks from Environmental Hazards. Office of Health Protection of the Australian Government Department of Health. Available: https://www1.health.gov.au/internet/main/publishing.nsf/Content/health-pubhlth-publicat-environ.htm

European Chemicals Agency [ECHA]. (2017). Guidance on Information Requirements and Chemical Safety Assessment, Chapter R11: PBT Assessment, European Chemicals Agency, Helsinki, Finland. Available: https://echa.europa.eu/guidance-documents/guidance-on-information-requirements-and-chemical-safety-assessment

Klimisch, H.J., Andreae, M., and Tillmann, U. (1997). A systematic approach for evaluating the quality of experimental and toxicological and ecotoxicological data. Regul. Toxicol. Pharmacol. 25:1-5.

U.S. Environmental Protection Agency [EPA] (2018). EPISuite™ v. 4.11, United States Environmental Protection Agency, Office of9Pollution Prevention and Toxics and Syracuse Research Corporation. Available at: https://www.epa.gov/tsca-screening-tools/epi-suitetm-estimation-program-interface.

CITRIC ACID

This dossier on citric acid presents the most critical studies pertinent to the risk assessment of citric acid in its use in coal seam or shale gas extraction activities. This dossier does not represent an exhaustive or critical review of all available data. The information presented in this dossier was obtained primarily from the OECD-SIDS documents on citric acid (OECD, 2001a, b) and the ECHA database that provides information on chemicals that have been registered under the EU REACH (ECHA). Where possible, study quality was evaluated using the Klimisch scoring system (Klimisch et al., 1997).

NICNAS has assessed citric acid in an IMAP Tier 1 assessment and concluded that it poses no unreasonable risk to the environment[1].

I. SUBSTANCE IDENTIFICATION

Chemical Name (IUPAC): 2-hydroxypropane-1,2,3-tricarboxylic acid

CAS RN: 77-92-9

Molecular formula: $C_6H_8O_7$

Molecular weight: 192.122 g/mol

Synonyms: citric acid; 1,2,3-propanetricarboxylic acid, 2-hydroxy-; 2-hydroxy-1,2,3-propanetricarboxylic acid

SMILES: C(C(=O)O)C(CC(=O)O)(C(=O)O)O

Citric acid is a ubiquitous natural substance that is an intermediate in the basic physiological tricarboxylic acid (TCA) cycle in every eukaryote cell.

II. PHYSICO-CHEMICAL PROPERTIES

Table 1: Overview of the Physico-Chemical Properties of Citric Acid

Property	Value	Klimisch Score	Reference
Physical state at 20°C and 101.3 kPa	White crystalline odorless solid	2	ECHA
Melting Point	153°C @ 101.3 kPa	2	ECHA
Boiling Point	Not available due to substance decomposition	2	ECHA
Density	1670 kg/m^3@ 20°C (relative density)	2	ECHA
Vapor Pressure	2.21 x 10^{-6} Pa @ 25°C	2	ECHA
Partition Coefficient (log K_{ow})	-1.5 to -1.8 (temperature not indicated)	2	ECHA

[1] https://www.industrialchemicals.gov.au/chemical-information/search-assessments?assessmentcasnumber=77-92-9+

Property	Value	Klimisch Score	Reference
Water Solubility	592 g/L @ 20 °C (very soluble)	2	ECHA
Flash Point	345°C @ 101.3 kPa	4	ECHA
Flammability	Not flammable	2	ECHA
Auto flammability	1010°C	4	ECHA

III. ENVIRONMENTAL FATE PROPERTIES

A. Summary

Citric acid is readily biodegradable. It is not expected to bioaccumulate. Due to its high-water solubility, citric acid is unlikely to adsorb to soil or sediment.

B. Biodegradation

Citric acid can be considered readily biodegradable based on the results of the ready and inherent aerobic biodegradation studies listed in Table 2.

If a chemical is found to be readily biodegradable, it is categorized as Not Persistent since its half-life is substantially less than 60 days (DoEE, 2017).

Table 2: Biodegradation Studies on Citric Acid (OECD 2001a, b)

Test System	Results*	Notes	Klimisch Score
Modified Sturm	97% (CO_2 evolution); 100% (DOC removal)	Readily biodegradable; exposure period not stated	2
Closed Bottle Test	BOD_{30}/COD Ratio = 90%	Readily biodegradable	2
BOD_5/COD Ratio	BOD_5 = 526 mg; COD = 728 mg; BOD_5/COD Ratio = 0.72	Readily biodegradable; concentration of test substance and activated sludge not stated	2
BOD_1/ThOD Ratio	BOD_1/ThOD Ratio = 13%	-	2
BOD_{20}/ThOD Ratio	BOD_{20}/COD Ratio = 98%	Readily biodegradable; initial test substance concentration 720 mg/L	2
Zahn-Wallen Test	85%, 1 day (DOC removal)	Inherently biodegradable	2
Zahn-Wallen Test	98%, 7 days (DOC removal)	Inherently biodegradable	
Coupled Units Test	93% (COD removal)	Ultimately biodegradable; exposure period not stated.	2

C. Environmental Distribution

No experimental data are available for citric acid. Using KOCWIN program in EPISuite™ (EPA, 2016), the estimated K_{oc} value from the K_{ow} value of -1.08 is 0.3617 L/kg.

Based on this K_{oc} value, citric acid is not expected to adsorb to soil if released and has a high mobility. If citric acid is released to water, it is not expected to adsorb to suspended soils or sediment based on its K_{oc} value and rapid hydrolysis.

D. Bioaccumulation

The log K_{ow} for citric acid is -1.5 to -1.8. Thus, citric acid is not expected to bioaccumulate.

IV. HUMAN HEALTH HAZARD ASSESSMENT

A. Summary

Citric acid exhibits low toxicity by the oral and dermal routes. It is an eye irritant, but slightly to non-irritating to the skin. No adequate studies were found to evaluate the sensitization potential of citric acid. Minimal toxicity and no carcinogenic effects were observed in rats given oral doses of citric acid for up to two years. Citric acid was not mutagenic to bacteria, but *in vitro* studies using human lymphocytes showed genotoxic effects. *In vivo* genotoxicity studies were negative. There were no reproductive or developmental effects in rats given oral doses of citric acid.

B. Acute Toxicity

Oral

The acute oral LD50 in male and female Füllinsdorf albino (SPF) mice exposed to 0,3,4.2, 6, 8.5, and 13 g/kg bw of citric acid via oral gavage was reported to be 5,400 mg/kg bw/day (ECHA) [KI. score =2].

The acute oral LD50 in male ICR-JCL male rats was reported to be 11,700 mg/kg (ECHA) [Kl. score = 2].

The acute oral LD50 values in SD-JCL male mice are 5,400 and 5,790 mg/kg (ECHA) [Kl. score = 2].

Inhalation

There are no reliable studies available.

Dermal

The acute dermal LD_{50} value in rats is >2,000 mg/kg (ECHA) [Kl. score = 1].

C. Irritation

Skin

Application of 0.5 g citric acid powder to the skin of New Zealand white rabbits for 4 hours under semi-occlusive conditions was slightly irritating. The mean of the 24, 48, and 72-hour scores were: 0.3 for erythema and 0.0 for oedema (ECHA) [Kl. score = 1].

Application of citric acid powder to the intact skin of New Zealand white rabbits for 4 hours under semi occlusive conditions was reported to be non-irritating based on a primary dermal irritation index (PDII) score of 0.33/2 (ECHA) [Kl. score = 1].

Application of a 30% solution of citric acid to the intact skin of New Zealand white rabbits was found reported to slightly irritating to rabbits with intact (abraded skin) and non-irritating to rabbits with non-abraded skin based on a primary dermal irritation index (PDII) scores of 0.8/8 and 0/8 respectively (ECHA) [KI. score = 2].

Application of a 50% aqueous solution of citric acid to New Zealand white rabbits for 4 hours under occlusive conditions was reported to be non-irritating (ECHA) [KI. score = 2].

Eye

Instillation of a 30% aqueous solution of citric acid into the eyes of New Zealand white rabbits produced well defined to moderate conjunctival irritation that did not fully resolve after the 14-day observation period (ECHA) [KI. score =1]. Given the fact that the 30% solution effects would have been allowed to dissipate for 21 days, it likely that the test substance would not be considered irritating to the eyes (ECHA).

Instillation of a 10% solution of citric acid into the eyes of New Zealand white rabbits was associated with weak to moderate conjunctival effects, which resolved after 7 days (ECHA) [Kl. score = 1].

Respiratory

In a study preliminary to the evaluation of antitussive agents, citric acid was chosen as most consistent in the cough response elicited as measured by the mean number of coughs produced with five inhalations in human volunteers (ECHA). 10% citric acid gave the highest number of positive reactors.

In a study to develop a method for the use of citric acid in testing antitussive medicines with human volunteers, a training period was used to determine the concentration of citric acid solution able to produce 3-6 coughs after one inhalation (ECHA). There were three test periods one hour apart. 5 inhalations were administered at 3-minute intervals in each test period. The number of coughs was counted after each inhalation. Each subject was given a placebo tablet after the first test period but was informed that they could receive either a placebo or an anti-tussive tablet.

The total number of coughs after each inspiration over the three test periods was compared among subjects and between test periods and inspirations. Statistical variance and F-values were analyzed.

The concentration of citric acid producing between 3 and 6 coughs after a single inhalation was found to vary from 5% to 25%. Adaptation to the citric acid aerosol occurred during the initial training period, but further adaptation during the test period was low, except between the first and second inhalation.

Some reduction in response between the first and second test periods might be attributable to a placebo reaction. It was concluded that the administration of citric acid to induce coughing using the method described would be useful in evaluating antitussive medicines, providing that a double-blind trial using a placebo was used.

A study was conducted to evaluate the effect of inspiratory flow rate on the cough response in humans to citric acid (ECHA). It was considered by the authors that the cough response to citric acid is produced mainly by irritation of the larynx and trachea. Variations in the inspiratory flow rate might lead to changes in deposition of the drug, and consequently in the cough threshold. The effect of inspiratory flow rate was studied in 11 healthy non-smoking volunteers aged 23 to 29 years (9

male, 2 female). The citric acid was administered by inhalation of a nebulized solution via apparatus which limited and measured the inspiratory flow rate to 50, 100 and 150 l/minute of increasing concentrations of citric acid.

The test was finished when a cough was produced after each inhalation at one concentration (cough threshold) or the maximum concentration was reached. Each concentration was given at three different flow rates. The exposures were repeated on 3 days at least 48 hours apart.

The mean cough threshold was determined to be 21 (±9-54) mg/l at an inspiratory flow rate of 50 l/min and 43 (±13-141) mg/l at 150 l/minute. It was concluded that inspiratory flow rate should be controlled when cough challenges with citric acid are performed.

Inhalation of citric acid was shown to cause cough and bronchoconstriction in the guinea pig. The bronchoconstriction seems to involve cholinergic and capsaicin sensitive neurons (ECHA).

Citric acid was seen to elicit a cough response in the guinea pig (ECHA) in a study in which the time-response relationship observed with citric acid showed a maximum response around 5 to 10 minutes of exposure for isolated coughs and a fade in response as the exposure continued.

D. Sensitisation

In a skin prick test, with very limited provided details, it was reported that citric acid, caused positive results in 3 of 91 patients whereof one of the patients also reacted to benzoic and propionic acids (ECHA) [KI. score =4].

In a skin sensitisation, study with limited details, citric acid was concluded to not be a skin irritant or a sensitizer when tested to human volunteers (ECHA) [KI. score = 4]. At induction, patches of 4 % citric acid in a cuticle cream were applied onto the skin of 56 human volunteers, under a semi-occlusive dressing, three times a week for three weeks. At challenge, 4 % citric acid in a cuticle cream was applied dermally to 56 human volunteers two weeks after the last induction (ECHA) [KI. score =4].

E. Repeated Dose Toxicity

<u>Oral</u>

Male and female rats were administered 2000, 4000, 8000, and 16000 mg/kg bw/day of citric acid via oral gavage daily for five successive days. A NOAEL of 4000 mg/kg bw/day was established for both male and female rats based on overall clinical signs, mortality, and body weight. A LOAEL of 8000 mg/kg bw/day was established for male and female rats based on clinical signs, increased mortality, and body weight gain. A 10-day LD_{50} value of 55560 ± 0.44 mg/kg bw/day was also reported in rats (gender not specified) (ECHA) [KI. score = 2].

Mice were administered 1000, 2000, 4000, and 8000 mg/kg bw/day of citric acid via oral gavage daily for ten successive days. A NOAEL of 1000 mg/kg bw/day was established based on clinical signs, mortality, and body weight. A LOAEL of 2000 mg/kg bw/day was established based on clinical signs, increased mortality, and body weight gain (ECHA) [KI. score = 2].

Male rats were given 0, 1.2, 2.4, or 4.8% citric acid in their feed for 6 weeks. The daily intakes were reported to be 1,150, 2,260, or 4,670 mg/kg-day. The high-dose animals had mild blood and urine

parameter changes and slight degeneration of the thymus gland and spleen. The NOAEL is 2.4% in the diet or 2,260 mg/kg-day (OECD, 2001a, b). [Kl. score = 4]

Rats were given 3% or 5% citric acid in their diet for two years. The estimated daily intakes were 1,200 and 2,000 mg/kg/day, respectively. A slight decrease in growth was reported in the 2% group, but no tissue abnormalities in the major organs. The NOAEL is 1,200 mg/kg/day (OECD, 2001a,b). [Kl. score = 4]

Inhalation

No studies are available.

Dermal

No studies are available.

F. Genotoxicity

In vitro Studies

Table 2 presents the results of the *in vitro* genotoxicity studies on citric acid.

Table 2: *In vitro* Genotoxicity Studies on Citric Acid

Test System	Results*		Klimisch Score	Reference
	-S9	+S9		
In vitro mammalian cell micronucleus test (lymphocytes: peripheral human)	-	+	2	ECHA
Bacterial Reverse Mutation Assay (S. typhimurium TA 1535, TA 100, TA 98, TA 1537, TA 92, and TA 94)	-	-	2	ECHA
Comet assay (human lymphocytes)	+	NA	2	ECHA
Chromosome aberration test (human peripheral lymphocytes)	+	NA	2	ECHA

*+, positive; -, negative; NA, not applicable

Citric acid was not mutagenic in bacterial reverse mutation assays with strains of *S. typhimurium* or *E. coli* with and without metabolic activation (OECD, 2001a,b; ECHA). [Kl. score = 2]

Peripheral human lymphocytes were treated with 50 to 3,000 µg/ml citric acid. A statistically significant dose-dependent increase in the micronuclei was observed. In another set of studies by the same laboratory, there was a statistically significant and dose-related increase in the number of cells with aberrations, including sister chromatid unions. The study authors reported that the pH of the medium was unchanged (ECHA). [Kl. score = 2]

In vivo Studies

Citric acid was reported to be non-mutagenic in a rodent dominant lethal assay when male Sprague-Dawley rats were given either a single oral dose of citric acid (1.2, 12.0, or 120 mg/kg) or a single oral

dose on five consecutive days (300, 500, or 3,500 mg/kg) (OECD 2001a,b; as reported in ECHA) [Kl. score = 2].

There were no treatment related increases in cells with chromosomal aberrations in observed in the bone marrow of male Sprague-Dawley rats given either a single oral dose of citric acid (1.2, 12.0, or 120 mg/kg) or a single oral dose on five consecutive days (300, 500, 3000, or3,500 mg/kg) (ECHA) [Kl. score = 2].

G. Carcinogenicity

Oral

There was no evidence of carcinogenicity in rats given 3% or 5% citric acid in feed (1,200 or 2,000 mg/kg/day, respectively) for two years (OECD, 2001a, b). [Kl. score = 4]

In a rat feeding study, animals dosed with 5% citric acid in the diet did not show an excess of tumors in comparison with control animals when tested over a period of 2 years (Horn et al., 1957; as reported in ECHA). However, there was limited evidence that high doses of citrate salts increased the incidence of tumors produced by co-administration of known bladder carcinogens (Inouea et al., 1988; Ono et al., 1992; de Camargo et al., 1991; Fukushima et al.,1986; Behnke et al., 1964; as reported in ECHA). Where citric acid or citrate salts were administered alone during these studies, no dose-related tumors were noted (ECHA).

H. Reproductive Toxicity

In a non-standard repeat dose dietary study (duration and frequency not specified), 5% citric acid in feed did not affect either the number of young born to mice or rats or their subsequent survival up to the point of weaning (ECHA). [Kl. score = 4]

In a reproductive toxicity study, 1.2% w/w citric acid was administered in feed given daily to male and female rats over a period of 90 weeks and it was reported that citric acid did not give rise to any reproductive effects (ECHA).

The no adverse effect level (NOAEL) for reproductive toxicity in rats has been reported as 2500 mg/kg/bw/day (Kim et al, 2013 citing Citric acid SIDS initial assessment report (OECD SIDS, 2001; as cited in ECHA).

I. Developmental Toxicity

Hamsters were administered citric acid via oral gavage daily from gestation day 0 to gestation day 10 resulted in a NOAEL of > 272 mg/kg bw/day based on teratogenicity (ECHA) [KI. Score=2].

Wistar rats were exposed to citric acid by oral gavage from gestation day 6 to gestation day 15. A NOAEL of >295 was established for this study based on teratogenicity (ECHA) [KI. Score =2].

Albino CD-1 mice were exposed to citric acid by oral gavage from gestation day 6 to gestation day 15. A NOAEL of >241 mg/kg bw/day was established for this study based on teratogenicity (ECHA) [KI. score =2].

Pregnant female rats were dosed by oral gavage with 0, 2.95, 13.7, 63.6, or 295 mg/kg citric acid on GD 6-15. No maternal or developmental effects were noted. The NOAEL for maternal and

developmental toxicity is 295 mg/kg-day, the highest dose tested (OECD, 2001a, b; ECHA). [Kl. score = 2]

Pregnant female rats were dosed by oral gavage with 0, 2.41, 11.2, 52, or 241 mg/kg citric acid on GD 6-15. No maternal or developmental effects were noted. The NOAEL for maternal and developmental toxicity is 241 mg/kg-day, the highest dose tested (OECD, 2001a, b; ECHA). [Kl. score = 2]

Pregnant female rabbits were dosed by oral gavage with 0, 4.25, 19.75, 91.70, or 425 mg/kg citric acid on GD 6-18. No maternal or developmental effects were noted. The NOAEL for maternal and developmental toxicity is >425 mg/kg-day, the highest dose tested (OECD, 2001a, b; as cited in ECHA)[KI. score =2].

V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES

The toxicological reference values developed for citric acid follow the methodology discussed in enHealth (2012). The approach used to develop drinking water guidance values is described in the Australian Drinking Water Guidelines (ADWG, 2011).

A. Non-Cancer

Oral

In a two-year dietary study, the only effect seen in rats fed either 3 or 5% citric acid (approx. 1,200 or 2,000 mg/kg/day) was a slight decrease in growth in the 5% dose group. In the absence of statistical analysis of the body weight gain data, a conservative approach was taken, and the 5% dose group was considered an LOAEL. The NOAEL of 3% citric acid in the diet (1,200 mg/kg/day) will be used for determining the oral reference dose (RfD) and the drinking water guidance value.

Oral Reference Dose (oral RfD)

Oral RfD = NOAEL / (UF_A x UF_H x UF_L x UF_{Sub} x UF_D)

Where:

- UF_A (interspecies variability) = 10
- UF_H (intraspecies variability) = 10
- UF_L (LOAEL to NOAEL) = 1
- UF_{Sub} (subchronic to chronic) = 1
- UF_D (database uncertainty) = 1

Oral RfD = 1,200/(10 x 10 x 1 x 1 x 1) = 1,200/100 = 12 mg/kg/day

Drinking water guidance value

Drinking water guidance value = (animal dose) x (human weight) x (proportion of intake from water) / (volume of water consumed) x (safety factor)

Using the oral RfD,

Drinking water guidance value = (oral RfD) x (human weight) x (proportion of water consumed) / (volume of water consumed)

Where:

Human weight = 70 kg (ADWG, 2011)
Proportion of water consumed = 10% (ADWG, 2011)
Volume of water consumed = 2L (ADWG, 2011)

Drinking water guidance value = (12 x 70 x 0.1)/2 = 42 mg/L

B. Cancer

Citric acid was not carcinogenic to rats in a chronic dietary study. Thus, no cancer reference value was derived.

VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES

Citric acid does not exhibit the following physico-chemical properties:

- Explosivity
- Flammability
- Oxidizing potential

VII. ENVIRONMENTAL HAZARD ASSESSMENT

A. Summary

Citric acid is of low toxicity concern to aquatic organisms.

B. Aquatic Toxicity

Acute Studies

The 48-hour LC_{50} values in Leuciscus idus melanotus (golden orfe) from two separate laboratories were 440 mg/L and 760 mg/L (ECHA) [Kl. scores = 2].

The 96-hour LC_{50} in Lepomis macrochirus (fathead minnow) is >100 mg/L (ECHA) [Kl. score = 2).

The 24-hour EC_{50} in Daphnia is 85 mg/L in un-neutralized test solution and 1,535 mg/L in a neutralized solution (OECD, 2001a,b; as cited in ECHA). [Kl. score = 2]

The 8-day toxicity threshold value (EC_0) of 640 mg/L and a NOEC of 425 mg/L was determined for citric acid in Scenedesmus quadricauda (ECHA; OECD, 2001a,b). [Kl. score = 2]

Chronic Studies

Citric acid is essential in the Krebs cycle (or TCA cycle), which in turn is an essential chemical cycle that takes place in all living organisms to generate energy, via the generation of adenosine triphosphate (ATP). This means that citric acid is naturally present inside all living organisms, and it is very unlikely that it will be found in the environment at concentrations high enough to exert hazards to organisms (ECHA). Short-term aquatic toxicity data indicate that citric acid is of low toxicity. Further, the substance is readily biodegradable, has a log K_{ow} <3 and is highly soluble. Therefore, it is very unlikely to persist in the environment long enough to cause long-term effects. As a result, the completion of chronic studies was not required, and no studies are available.

C. Terrestrial Toxicity

No studies are available.

D. Calculation of PNEC

The PNEC calculations for citric acid follow the methodology discussed in DEWHA (2009).

PNEC Water

Experimental results are available for two trophic levels. Acute E(L)C_{50} values are available for fish (440 mg/L) and *Daphnia* (1,535 mg/L, neutralized). On the basis that the data consist of short-term results from two trophic levels, an assessment factor of 1,000 has been applied to the lowest reported effect concentration of 440 mg/L for fish. The $PNEC_{water}$ is 0.44 mg/L.

PNEC Sediment

There are no toxicity data for sediment-dwelling organisms. Therefore, the $PNEC_{sed}$ was calculated using the equilibrium partitioning method. The $PNEC_{sed}$ is 0.277 mg/kg wet weight.

The calculations are as follows:

$PNEC_{sed} = (K_{sed\text{-}water}/BD_{sed}) \times 1000 \times PNEC_{water}$
$= (0.807/1280) \times 1000 \times 0.44$
$= 0.277$ mg/kg

Where:
$K_{sed\text{-}water}$ = suspended matter-water partition coefficient (m^3/m^3)
BD_{sed} = bulk density of sediment (kg/m^3) = 1,280 [default]

$K_{sed\text{-}water} = 0.8 + [0.2 \times Kp_{sed}/1000 \times BD_{soilid}]$
$= 0.8 + [0.2 \times 0.014/1000 \times 2400]$
$= 0.807\ m^3/m^3$

Where:
Kp_{sed} = solid-water partition coefficient (L/kg).

BD_{solid} = bulk density of the solid phase (kg/m^3) = 2,400 [default]

$Kp_{sed} = K_{oc} \times f_{oc}$
$= 0.3617 \times 0.04$
$= 0.014$ L/kg

Where:
K_{oc} = organic carbon normalised distribution coefficient (L/kg). The K_{oc} for citric acid is estimated to be 0.3617 L/kg.
F_{oc} = fraction of organic carbon suspended sediment = 0.04 [default].

PNEC Soil

There are no toxicity data for terrestrial or soil organisms. Therefore, the $PNEC_{soil}$ was calculated using the equilibrium partitioning method. The $PNEC_{soil}$ is 0.002 mg/kg soil dry weight.

The calculations are as follows:

$PNEC_{soil} = (Kp_{soil}/BD_{soil}) \times 1000 \times PNEC_{water}$
$= (0.007/1500) \times 1000 \times 0.44$
$= 0.002$ mg/kg

Where:
Kp_{soil} = soil-water partition coefficient (m^3/m^3)
BD_{soil} = bulk density of soil (kg/m^3) = 1,500 [default]

$Kp_{soil} = K_{oc} \times f_{oc}$
$= 0.3617 \times 0.02$
$= 0.007\ m^3/m^3$

Where:
K_{oc} = organic carbon normalised distribution coefficient (L/kg). The K_{oc} for citric acid is estimated to be 0.3617 L/kg.
F_{oc} = fraction of organic carbon in soil = 0.02 [default].

VIII. PERSISTENCE, BIOACCUMULATION AND TOXICITY (PBT) ASSESSMENT

The methodology for the Persistent, Bioaccumulative and Toxic (PBT) substances assessment is based on the Australian and EU Reach Criteria methodology (DEWHA, 2009, ECHA, 2017).

Citric acid is readily biodegradable; thus, it does not meet the screening criteria for persistence.

The log K_{ow} values for citric acid are -1.5 to -1.8. Thus, citric acid does not meet the screening criteria for bioaccumulation.

There are no chronic aquatic toxicity studies on citric acid. The acute $E(L)C_{50}$ values for citric acid are >1 mg/L in fish and invertebrates. Thus, it does not meet the screening criteria for toxicity.

The overall conclusion is that citric acid is not a PBT substance.

IX. CLASSIFICATION AND LABELLING

The information in this section is for a citric acid solution.

A. Classification

H315: Causes skin irritation
H319: Causes serious eye irritation
H335: May cause respiratory irritation
Eye irritation-category 2A
Skin irritation-category 2
Specific target organ toxicity (single exposure)- category 3

B. Labelling

Warning

C. Pictogram



X. HANDLING AND SAFETY INFORMATION (OCCUPATIONAL LIMITS AND TRANSPORTATION REQUIREMENTS)

A. First Aid

Eye Contact

In the case of contact, immediately flush eyes with plenty of water for at least 15 minutes. If symptoms persist, seek medical advice.

Skin Contact

Wash thoroughly with soap and water.

Inhalation

If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.

Ingestion

Rinse mouth with water and then drink plenty of water. Never give anything by mouth to an unconscious person. If symptoms develop, seek medical advice.

B. Fire Fighting Information

Extinguishing Media

Water spray, carbon dioxide, foam, dry chemical.

Specific Exposure Hazards

No data are available.

Special Protective Equipment for Firefighters

Wear self-contained breathing apparatus.

C. Accidental Release Measures

Personal Precautions

Use appropriate protective equipment.

Environmental Precautions

Prevent from entering sewers, waterways, or low areas.

Steps to be Taken if Material is Released or Spilt

Pick up with absorbent material. Dispose of contaminated material as prescribed.

D. Storage and Handling

General Handling

No special measures necessarily provided product is used correctly.

Other Handling Precautions

Avoid eye and skin contact.

Storage

Keep container tightly closed and in a dry and well-ventilated place. Keep in a cool place.

E. Exposure Controls / Personal Protection

Occupational Exposure Standards

Workplace Australia has not established an occupational exposure standard for citric acid.

Engineering Controls

None

Personal Protection Equipment

Respiratory Protection:

Respiratory protection is not required.

Hand Protection:

Chemical resistant protective gloves.

Skin Protection:

Body protection must be chosen depending on activity and possible exposure.

Eye protection:

Safety glasses with side-shields.

Other Precautions:

Handle in accordance with good industrial hygiene and safety practice. Eyewash fountains and safety showers must be easily accessible.

F. Transport Information

Citric acid is not considered hazardous for purposes of transportation by road or rail. An Australian Dangerous Goods Code is not required.

XI. DISPOSAL MANAGEMENT

Disposal should be in accordance with all local, state, and federal regulations.

XII. REGULATORY STATUS

Australian AICS Inventory: Listed.

XIII. REFERENCES

ADWG. (2011). National Water Quality Management Strategy. Australian Drinking Water Guidelines, Section 6, Australian Government, National Health and Medical Research Council, Natural Resource Management Ministerial Council. Updated January 2022. Available: https://www.nhmrc.gov.au/about-us/publications/australian-drinking-water-guidelines

Behnke, U, Ketz, H A, Taeufel, K, Hoffmann, F, (1964). Effect of Perorally Administered Citric Acid on Butter Yellow Carcinogenesis in Rats. Ernährungsforschung. Berichte und Mitteilungen, 9, 129-137.

de Camargo, J L, Shirai, T, Kato, T, Asamoto, M, Fukushima, S (1991). Summation effects of uracil and other promoters on epithelial lesion development in the F344 rat urinary bladder initiated by N-butyl-N-(4-hydroxybutyl)nitrosamine. Jpn J Cancer Res. 82, 1220-1225.

Department of the Environment, Water, Heritage and the Arts [DEWHA]. (2009). Environmental risk assessment guidance manual for industrial chemicals, Department of the Environment, Water, Heritage and the Arts, Commonwealth of Australia. Available: http://www.nepc.gov.au/resource/chemical-risk-assessment-guidance-manuals

Department of the Environment and Energy (DoEE). (2017). Chemical Risk Assessment Guidance Manual: for chemicals associated with coal seam gas extraction, Guidance manual prepared by Hydrobiology and ToxConsult Pty Ltd for the Department of the Environment and Energy, Commonwealth of Australia, Canberra. Available: www.environment.gov.au/water/coal-and-coal-seam-gas/national-assessment-chemicals/consultation-risk-assessment-guidance-manual

ECHA. ECHA REACH database: http://echa.europa.eu/information-on-chemicals/registered-substances

enHealth Human Risk Assessment [HHRA] (2012). Environmental Health Risk Assessment, Guidelines for Assessing Human Health Risks from Environmental Hazards. Office of Health Protection of the Australian Government Department of Health. Available: https://www1.health.gov.au/internet/main/publishing.nsf/Content/health-pubhlth-publicat-environ.htm

European Chemicals Agency [ECHA]. (2017). Guidance on Information Requirements and Chemical Safety Assessment, Chapter R11: PBT Assessment, European Chemicals Agency, Helsinki, Finland. Available: https://echa.europa.eu/guidance-documents/guidance-on-information-requirements-and-chemical-safety-assessment

Fukushima, S, Thamavit, W, Kurata, Y, Ito, N. (1986). Sodium citrate: a promoter of bladder carcinogenesis. Jpn J Cancer Res. 77, 1-4.

Horn, J. Holland, E.G. Hazleton L.W. (1957) Food Additives, Safety of Adipic Acid as Compared with Citric and Tartaric Acid J. Agric. Food Chem. 5, 759–762

Inouea, T. Imaidaa, K. Suzukib, E. Okadab M. and Fukushima, S. (1988). Combined effects of l-ascorbic acid, citric acid or their sodium salts on tumour induction by N-butyl-N-(4-hydroxybutyl)nitrosamine or N-ethyl-N-(4-hydroxybutyl)nitrosamine in the rat urinary bladder Cancer Letters 40, 265-273.

Kim, H. M., Shim, I. S., Baek, Y. W., Han, H. J., Kim, P. J., & Choi, K. (2013). Investigation of disinfectants for foot-and-mouth disease in the Republic of Korea. Journal of infection and public health, 6(5), 331-338.

Klimisch, H.J., Andreae, M., and Tillmann, U. (1997). A systematic approach for evaluating the quality of experimental and toxicological and ecotoxicological data. Regul. Toxicol. Pharmacol. 25:1-5.

OECD SIDS (2001). SIDS Initial Assessment Report for 11th SIAM (Orlando, Fla., January 2001), for CAS 77-92-9, Citric acid.

OECD (2001a). IUCLID Data Set for Citric acid (CAS No. 77-92-9), UNEP Publications.

OECD (2001b). Screening Information Dataset (SIDS) Initial Assessment Report for Citric acid (CAS No. 77-92-9), UNEP Publications).

Ono S, Kurata Y, Shichino Y, Sano M, Fukushima S. (1992). Synergism of environmental carcinogens and promoters on bladder cancer development initiated by N-butyl-N-(4-hydroxybutyl)nitrosamine in F344 rats. Jpn J Cancer Res. 83, 955-963.

U.S. Environmental Protection Agency [EPA] (2016). EPISuite™ v. 4.11, United States Environmental Protection Agency, Office of Pollution Prevention and Toxics and Syracuse Research Corporation. Available at: https://www.epa.gov/tsca-screening-tools/epi-suitetm-estimation-program-interface.

ACRYLAMIDE/SODIUM ACRYLATE COPOLYMER (CAS NO. 25085-02-3)
ACRYLAMIDE/AMMONIUM ACRYLATE COPOLYMER (CAS NO. 26100-47-0)
ACRYLAMIDE, SODIUM ACRYLATE POLYMER (CAS NO. 25987-30-8)
2-PROPENOIC ACID, POTASSIUM SALT, POLYMER WITH 2-PROPENAMIDE (CAS NO. 31212-13-2)
ACRYLATE TERPOLYMER (CAS NO. 903573-39-7)[1]
SILICONE BASED EMULSION NEUTRALISED POLYACRYLIC BASED STABILISER (NO CAS NO.)

This group contains a sodium salt of a polymer consisting of acrylic acid, methacrylic acid or one of their simple esters and three similar polymers. They are expected to have similar environmental concerns and have consequently been assessed as a group. Information provided in this dossier is based on acrylamide/sodium acrylate copolymer (CAS No. 25085-02-3).

This dossier on acrylamide/sodium acrylate copolymer and similar polymers presents the most critical studies pertinent to the risk assessment of these polymers in their use in coal seam gas activities. This dossier does not represent an exhaustive or critical review of all available data. Where possible, study quality was evaluated using the Klimisch scoring system (Klimisch et al., 1997).

I. SUBSTANCE IDENTIFICATION

Chemical Name (IUPAC): 2-Propenoic acid, sodium salt, polymer with 2-propenamide

CAS RN: 25085-02-3

Molecular formula: $(C_3H_5NO.C_3H_4O_2.NA)_x$-

Molecular weight: No information is available. Based on the type and intended use of the copolymer, the molecular weight would likely range from 100,000 to > 3,000,000 daltons (Hamilton et al., 1997).

Synonyms: Acrylamide/sodium acrylate copolymer; 2-propenamide, polymer with 2-propenoic acid, sodium salt; 2-propenoic acid, sodium salt, polymer with 2-propenamide; 2-Propenamide-sodium 2 propenoate copolymer; sodium acrylate acrylamide polymer; sodium acrylate-acrylamide copolymer

SMILES: Not applicable.

II. PHYSICAL AND CHEMICAL PROPERTIES

No information is available.

III. ENVIRONMENTAL FATE PROPERTIES

No studies are available. The acrylamide/sodium acrylate copolymer is not expected to be readily biodegradable. The physico-chemical properties of the copolymer would preclude it from undergoing significant biodegradation (Guiney et al., 1997). Biodegradation is limited due to the very high molecular weight and the low water solubility of the copolymer. The copolymer will likely bind tightly to organic matter found within soils and sediments (Guiney et al., 1997). The copolymer is not expected to bioaccumulate because of its poor water solubility and high molecular weight.

[1] CAS name: 2-Propenoic acid, polymer with sodium 2-hydroxy-3-(2-propen-1-yloxy)-1-propanesulfonate (1:1) and alpha-sulfo-omega-(2-propen-1-yloxy)poly(oxy-1,2-ethanediyl) ammonium salt (1:1), sodium salt

IV. HUMAN HEALTH HAZARD ASSESSMENT

No studies are available.

NICNAS has assessed acrylamide/sodium acrylate copolymer in an IMAP Tier 1 assessment and considers it a "polymer identified as a low concern to human health by application of expert validated rules[2]."

V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES

No toxicological reference values or drinking water guidance values were developed.

VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES

Acrylamide/sodium acrylate copolymer does not exhibit the following physico-chemical properties:

- Explosivity
- Flammability
- Oxidising potential

VII. ENVIRONMENTAL HAZARD ASSESSMENT

No studies are available. Acrylamide/sodium acrylate copolymer is expected to be a low concern for toxicity to aquatic organisms (Guiney et al., 1997). Due to its poor solubility and high molecular weight, it is not expected to be bioavailable. It does not contain any reactive functional groups (i.e., cationic groups).

A. Calculation of PNEC

No PNEC values were calculated.

VIII. PERSISTENCE, BIOACCUMULATION AND TOXICITY (PBT) ASSESSMENT

The methodology for the Persistent, Bioaccumulative and Toxic (PBT) substances assessment is based on the Australian and EU REACH Criteria methodology (DEWHA, 2009; ECHA, 2008).

Acrylamide/sodium acrylate copolymer is not readily biodegradable; thus, it meets the screening criteria for persistence.

Acrylamide/sodium acrylate copolymer is expected to have a very high molecular weight and poor water solubility. It is not expected to be bioavailable. Thus, this copolymer does not meet the criteria for bioaccumulation.

There are no aquatic toxicity studies on acrylamide/sodium acrylate copolymer. It is expected to have low concern for aquatic toxicity because of its very high molecular weight and poor water solubility. Thus, the copolymer does not meet the criteria for toxicity.

The overall conclusion is that acrylamide/sodium acrylate copolymer is not a PBT substance.

[2] https://www.nicnas.gov.au/chemical-information/imap-assessments/imap-assessments/tier-i-human-health-assessments#cas-A_25085-02-3

IX. CLASSIFICATION AND LABELLING

A. Classification

Not classified.

B. Labelling

No signal word.

C. Pictograms

None.

X. HANDLING AND SAFETY INFORMATION (OCCUPATIONAL LIMITS AND TRANSPORTATION REQUIREMENTS)

A. First Aid

Eye Contact

In case of contact, immediately flush eyes with plenty of water for at least 5 minutes. If symptoms persist, seek medical advice.

Skin Contact

Wash thoroughly with soap and water.

Inhalation

If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.

Ingestion

Rinse mouth with water and then drink plenty of water. Never give anything by mouth to an unconscious person. If symptoms develop, seek medical advice.

B. Fire Fighting Information

Extinguishing Media

Water fog, carbon dioxide, foam, dry chemical.

Specific Exposure Hazards

Burning produces harmful and toxic fumes. Heat from fire may melt, decompose polymer and generate flammable vapours. Combustion products may include: Nitrogen oxides, carbon monoxide, carbon dioxide and unburned hydrocarbons (smoke). Dust can accumulate static charges which can cause an incendiary electrical discharge. Fine dust dispersed in air in sufficient concentrations, and in the presence of an ignition source, is a potential dust explosion hazard.

Special Protective Equipment for Firefighters

Wear self-contained breathing apparatus.

C. Accidental Release Measures

Personal Precautions

Use appropriate protective equipment. Potential combustible dust hazard. Avoid generating dust. Creates dangerous slipping hazard on any hard smooth surface.

Environmental Precautions

Prevent from entering sewers, waterways or low areas.

Steps to be Taken if Material is Released or Spilled

Scoop up and remove.

D. Storage and Handling

General Handling

Avoid dust accumulation in enclosed space. Avoid generating dust; fine dust dispersed in air in sufficient concentrations, and in the presence of an ignition source is a potential dust explosion hazard. Electrostatic charge may build up during handling. Equipment, container and metal containers should be grounded and bonded.

Storage

Keep container tightly closed and in a dry and well-ventilated place. Keep in a cool place. Use adequate ventilation to avoid excessive dust accumulation. Store away from excessive heat and away from strong oxidising agents. Take measures to prevent the build-up of electrostatic charge.

E. Exposure Controls / Personal Protection

Occupational Exposure Standards

Workplace Australia has not established an occupational exposure limit for acrylamide/sodium acrylate copolymer.

Engineering Controls

Use in a well-ventilated area. Avoid creating dust. Take precautionary measures against static charge.

Personal Protection Equipment

Respiratory Protection: Not normally needed; however, if significant exposures are possible, then the following respirator is recommended: Dust/mist respirator.

Hand Protection: Normal work gloves.

Skin Protection: Normal work coveralls.

Eye Protection: Wear safety glasses or goggles to protect against exposure.

Other Precautions: Handle in accordance with good industrial hygiene and safety practice. Eyewash fountains and safety showers must be easily accessible.

F. Transport Information

Acrylamide/sodium acrylate copolymer is not considered hazardous for purposes of transportation by road or rail. An Australian Dangerous Goods code is not required.

XI. DISPOSAL MANAGEMENT

Disposal should be in accordance with all local, state and federal regulations.

XII. REGULATORY STATUS

Australian AICS Inventory: Listed.

XIII.REFERENCES

Department of the Environment, Water, Heritage and the Arts (DEWHA). (2009). Environmental risk assessment guidance manual for industrial chemicals, Department of the Environment, Water, Heritage and the Arts, Commonwealth of Australia.

European Chemicals Agency (ECHA). (2008). Guidance on Information Requirements and Chemical Safety Assessment, Chapter R11: PBT Assessment, European Chemicals Agency, Helsinki, Finland.

Guiney, P. D., McLaughlin, J. E., Hamilton, J. D., and Reinert, K. H. (1997). Dispersion Polymers. In: Ecological Assessment of Polymers Strategies for Product Stewardship and Regulatory Programs (Hamilton, J.D. and Sutcliffe, R. eds.), pp. 147-165, Van Nostrand Reinhold.

Hamilton, J. D., Vasconcellos, S. R., and Keener, R. L. (1997). Introduction. In: Ecological Assessment of Polymers Strategies for Product Stewardship and Regulatory Programs (Hamilton, J.D. and Sutcliffe, R. eds.), pp. 3-15, Van Nostrand Reinhold.

Klimisch, H. J., Andreae, M., and Tillmann, U. (1997). A systematic approach for evaluating the quality of experimental and toxicological and ecotoxicological data. Regul. Toxicol Pharmacol. 25:1-5.

CRYSTALLINE SILICA, QUARTZ (CAS No. 14808-60-7)
CRYSTALLINE SILICA, CRISTOBALITE (CAS No. 14464-46-1)
CRYSTALLINE SILICA, TRIDYMITE (CAS No. 15468-32-3)
NON-CRYSTALLINE SILICA (IMPURITY) (CAS No. 7631-86-9)
DIATOMACEOUS EARTH (CAS No. 61790-53-2)
DIATOMACEOUS EARTH, CALCINED (CAS No. 91053-39-3)

This dossier on crystalline silica, quartz, cristobalite and tridymite; non-crystalline silica (impurity); diatomaceous earth; and diatomaceous earth, calcined presents the most critical studies pertinent to the risk assessment of these substances in their use in coal seam or shale gas extraction activities. This dossier does not represent an exhaustive or critical review of all available data. The majority of information presented in this dossier was obtained from the ECHA database that provides information on chemicals that have been registered under the EU REACH (ECHA). Where possible, study quality was evaluated using the Klimisch scoring system (Klimisch et al., 1997).

For the purpose of this dossier, crystalline silica, quartz (CAS No. 14808-60-7) has been reviewed as representative of crystalline silica cristobalite and tridymite, and non-crystalline silica (impurity). Crystalline silica, quartz is also considered representative of diatomaceous earth and diatomaceous earth, calcined, as they both consist mainly of silicon dioxide.

NICNAS has assessed crystalline silica in an IMAP Tier 1 assessment and concluded that it poses no unreasonable risk to the environment.

I. SUBSTANCE IDENTIFICATION

Chemical Name (IUPAC): dioxosilane

CAS RN: 14808-60-7

Molecular formula: SiO_2

Molecular weight: 60.084 g/mol

Synonyms: Cristobalite, Dioxide, Silicon

SMILES: O=[Si]=O

II. PHYSICO-CHEMICAL PROPERTIES

Silica is an off-white granule that occurs naturally in various crystalline and amorphous or other non-crystalline forms. Crystalline silica is characterised by silicon dioxide (SiO_2) molecules oriented in fixed, periodic patterns to form stable crystals. The primary crystalline form of silica is quartz. Other crystalline forms of silica include cristobalite, tripoli and tridymite. Particle size is a key determinate of silica toxicity, since toxicity is restricted to particles that are small enough to be deposited into the target regions of the respiratory tract (OECD, 2011).

III. ENVIRONMENTAL FATE PROPERTIES

A. Summary

Crystalline silica is characterised by silicon dioxide (SiO_2) molecules oriented in fixed, periodic patterns to form stable crystals. The primary crystalline form of silica is quartz. It is a stable solid under typical environmental conditions. It will not biodegrade, bioaccumulate, nor will it sorb to sediments or soils.

B. Biodegradation

No data are available. Based on the crystalline form of the substance, it is not expected to biodegrade.

C. Environmental Distribution

No experimental data are available for crystalline silica. As a stable inorganic solid, it is not soluble in water, and it will not sorb to soils or sediment.

D. Bioaccumulation

There are no bioaccumulation studies on crystalline silica.

IV. HUMAN HEALTH HAZARD ASSESSMENT

A. Summary

Human exposure to crystalline silica via inhalation can lead to silicosis, lung cancer and pulmonary tuberculosis (WHO, 2000).

B. Acute Toxicity

No adequate acute oral, dermal or inhalation exposure studies are available for quartz, cristobalite or tridymite.

Most acute toxicity studies for quartz or cristobalite were conducted using intratracheal instillation. Intratracheal instillation is the introduction of the substance directly to the trachea and is used to test respiratory toxicity of a substance.

Single intratracheal instillation of quartz caused inflammatory effects and formation of discrete silicotic nodules in rats, mice and hamsters (IARC, 2012; WHO, 2000). Other effects like oxidative stress, cellular proliferation and increases in water, protein and phospholipid content of rat lungs, apoptosis (programmed cell death) and lung cancer were also noted.

In an acute dose study, rats were dosed once with 0, 0.75, 1.5, 3.0, 6.0 or 12 mg/kg bw/day quartz by intratracheal instillation (Seiler et al., 2001). The lowest observed adverse effect level (LOAEL) of 0.75 mg/kg bw/day was derived from these studies.

Two other similar studies of single intratracheal instillation of quartz reported higher LOAELs in rats (3 and 40 mg/kg bw/day) based on inflammation and fibrosis (Saffiotti et al., 1996).

C. Irritation

No data available.

D. Sensitisation

No data available.

E. Repeated Dose Toxicity

Oral

No data available.

Inhalation

Repeated inhalation exposure of crystalline is known to cause adverse effects (IARC, 2012). Silicosis has been identified as the main non-cancer effect of silica exposure, although available epidemiologic data as well as animal data provide evidence for several other effects associated with silica exposure, such as silicotuberculosis, enlargement of the heart (cor pulmonale), interference with the body's immune system and damage to the kidneys (Health Canada, 2013).

Dermal

No data available.

F. Genotoxicity

No data available.

G. Carcinogenicity

Oral

No data available.

Inhalation

The International Agency for Research on Cancer (IARC) has classified crystalline silica as a Group 1 carcinogen, as there was sufficient evidence for carcinogenicity in experimental animals and sufficient evidence for carcinogenicity of inhaled crystalline silica from occupational sources (IARC, 1997; IARC, 2012).

H. Reproductive Toxicity

No data available.

I. Developmental Toxicity

No data available.

V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES

The toxicity information on crystalline silica is inadequate and/or unreliable for deriving toxicological reference and drinking water guidance values for this substance.

VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES

Crystalline silica does not exhibit the following physico-chemical properties:

- Explosivity
- Flammability
- Oxidising potential

VII. ENVIRONMENTAL HAZARD ASSESSMENT

A. Summary

Although no data are available, crystalline silica is expected to exhibit low acute toxicity to aquatic organisms.

B. Aquatic Toxicity

No aquatic toxicity data were available.

C. Terrestrial Toxicity

No terrestrial toxicity data were available.

D. Calculation of PNEC

No PNEC values were calculated.

VIII. PERSISTENCE, BIOACCUMULATION AND TOXICITY (PBT) ASSESSMENT

The methodology for the Persistent, Bioaccumulative and Toxic (PBT) substances assessment is based on the Australian and EU REACH Criteria methodology (DEWHA, 2009; ECHA, 2008).

Crystalline silica is an inorganic mineral. Thus, biodegradation is not applicable to this substance. For the purposes of this PBT assessment, the persistent criteria are not considered applicable to crystalline silica.

As an inorganic complex it is not expected to bioaccumulate. Thus, crystalline silica does not meet the screening criteria for bioaccumulation.

Crystalline silica is not expected to cause adverse effects in environmental receptors. Thus, this substance does not meet the screening criteria for toxicity.

Therefore, crystalline silica is not a PBT substance.

IX. CLASSIFICATION AND LABELING

A. Classification

H373 – may cause damage to organs through prolonged or repeated exposure.

B. Labelling

Warning

C. Pictogram



X. HANDLING AND SAFETY INFORMATION (OCCUPATIONAL LIMITS AND TRANSPORTATION REQUIREMENTS)

A. First Aid

Eye Contact

Immediately flush open eyes with plenty of water for at least 15 minutes. Remove contacts, if present and easy to do. Get medical attention if symptoms persist.

Skin Contact

For minor skin contact, avoid spreading material on unaffected skin. Remove and isolate contaminated clothing. Wash the contaminated area of body with soap and fresh water. Launder contaminated clothing before reuse.

Inhalation

Move person to fresh air. Get medical attention if respiratory irritation develops or breathing becomes difficult.

Ingestion

Rinse mouth. Do not induce vomiting. Get medical attention if symptoms occur.

Notes to Physician

All treatments should be based on observed signs and symptoms of distress in the patient.

B. Fire Fighting Information

Extinguishing Media

Use extinguishing media appropriate for surrounding material.

Specific Exposure Hazards

Reacts with hydrofluoric acid (HF) forming toxic gas (SiF_4).

Special Protective Equipment for Firefighters

Wear self-contained breathing apparatus and chemical-protective clothing.

C. Accidental Release Measures

Personal Precautions

Isolate area. Keep unnecessary and unprotected personnel from entering the area. Use personal protective clothing. Ensure adequate ventilation. Wear respiratory protection if ventilation is inadequate. Do not breath mist, vapours or spray. Avoid contact with skin, eyes and clothing. Eliminate all sources of ignition.

Environmental Precautions

Prevent from entering sewers, waterways or low areas.

Steps to be Taken if Material is Released or Spilled

Pick up mechanically – vacuum up. Avoid generating dust. If formation of dust cannot be avoided, use respiratory filter device. Dispose of the material collected according to regulations.

D. Storage And Handling

General Handling

Handle in accordance with good industrial hygiene and safety practice. Avoid contact with eyes, skin and clothing. Avoid dust formation. Do not breathe dust. Wash thoroughly after handling. Use with adequate ventilation.

Storage

Provide adequate exhaust ventilation at places where dust is formed. Keep airborne concentrations below exposure limits. Keep containers tightly closed in a dry, cool, well-ventilated area.

E. Exposure Controls / Personal Protection

Occupational Exposure Standards

Workplace Australia has established an occupational exposure standard for exposure to crystalline silica of an 8-hour time weighed average (TWA) exposure limit of 0.05 mg/m^3.

Engineering Controls

Good general ventilation should be used. Ventilation rates should be matched to conditions. If applicable, use process enclosures, local exhaust ventilation or other engineering controls to maintain airborne levels below recommended exposure limits. If exposure limits have not been established, maintain airborne levels to an acceptable level.

Personal Protection Equipment

Respiratory Protection: If workers are exposed to concentrations above the exposure limit, they must use appropriate, certified respirators. If there are no applicable exposure limit requirements or guidelines, use an approved respirator. Selection of air-purifying or positive pressure supplied-air will depend on the specific operation and the potential airborne concentration of the product. For emergency conditions, use an approved positive-pressure self-contained breathing apparatus. The following should be effective types of air-purifying respirators: organic vapour cartridge with a particulate pre-filter.

Hand Protection: Use gloves chemically resistant to this material. Consult the SDS for appropriate glove barrier materials.

Skin Protection: Use protective clothing chemically resistant to this material. Selection of specific items such as face shield, boots, apron or full body suit will depend on the task.

Eye Protection: Use chemical goggles.

Other Precautions: Wash hands, forearms and face thoroughly after handling chemical products; as well as before eating, smoking and using the lavatory; and at the end of the working period. Appropriate techniques should be used to remove potentially contaminated clothing. Wash contaminated clothing before reusing. Ensure that eyewash stations and safety showers are close to the workstation location.

F. Transport Information

Crystalline silica is not considered hazardous for purposes of transportation by road or rail. An Australian Dangerous Goods code is not required.

XI. DISPOSAL MANAGEMENT

Disposal should be in accordance with all local, state and federal regulations.

XII. REGULATORY STATUS

Australian AICS Inventory: Listed.

XIII. REFERENCES

Department of the Environment, Water, Heritage and the Arts [DEWHA]. (2009). Environmental risk assessment guidance manual for industrial chemicals, Department of the Environment, Water, Heritage and the Arts, Commonwealth of Australia.

ECHA. ECHA REACH database: http://echa.europa.eu/information-on-chemicals/registered-substances

European Chemicals Agency [ECHA]. (2008). Guidance on Information Requirements and Chemical Safety Assessment, Chapter R11: PBT Assessment, European Chemicals Agency, Helsinki, Finland.

Health Canada. (2013). Environment Canada, Health Canada. Screening Assessment for the Challenge: Quartz (CAS 14808-60-7) and Cristobalite (CAS 14464-46-1). June 2013. https://www.ec.gc.ca/ese-ees/1EB4F4EF-88EE-4679-9A6C-008F0CBC191C/FSAR_B12%20-%2014464-46-1%20%26%2014808-60-7%20%28QC%29_EN.pdf

IARC. (1997). Silica, some silicates, coal dust and Para-aramid fibrils. International Agency for Research on Cancer (IARC) working group on the evaluation of carcinogenic risks to humans, Lyon, France, 15-22 October 1996. IARC Monogr Eval Carcinog Risks Hum. 1997;68:1–475.

IARC. (2012). Silica dust, crystalline, in the form of quartz or cristobalite. International Agency for Research on Cancer (IARC) working group on the evaluation of carcinogenic risks to humans, Lyon, France, 17-24 March, 2009. IARC Monogr Eval Carcinog Risks Hum. 2012;100C:355–405

Klimisch, H.J., Andreae, M., and Tillmann, U. (1997). A systematic approach for evaluating the quality of experimental and toxicological and ecotoxicological data. Regul. Toxicol. Pharmacol. 25:1-5.

OECD. (2011). OECD -SIDS Initial Targeted Assessment Profile on Quartz and Cristobalite, SIAM 32, 19-21 April 2011. https://hpvchemicals.oecd.org/ui/handler.axd?id=b68bb357-e6dd-4db9-b05c-8148223fc0ff.

Saffiotti, U., Williams, O., Lambert, N., Daniel, N., Kaighn, M.E., Mao, Y., Shi, X. (1996). Carcinogenesis by crystalline silica: animal, cellular, and molecular studies. In:Castranova V, Vallyathan V, Wallace WE, eds. Silica and silica-induced lung diseases. Boca Raton, FL, CRC Press, pp. 345–381.

Seiler, F., Rehn, B. and Bruch, J. (2001). Evidence of a no-effect level in silica–induced rat lung mutagenicity but not in fibrogenicity. Archives of Toxicology 74: 716-719.

WHO. (2000). Concise International Chemical Assessment Document 24 - Crystalline Silica, Quartz. Produced within the framework of the Inter-Organization Programme for the Sound Management of Chemicals. WHO Geneva.

ETHOXYLATED DECANOL

This dossier on ethoxylated decanol presents the most critical studies pertinent to the risk assessment of ethoxylated decanol in its use in coal seam or shale gas extraction activities. This dossier does not represent an exhaustive or critical review of all available data. The majority of information presented in this dossier was obtained from the ECHA database that provides information on chemicals that have been registered under the EU REACH (ECHA). Where possible, study quality was evaluated using the Klimisch scoring system (Klimisch et al., 1997).

I. SUBSTANCE IDENTIFICATION

Chemical Name (IUPAC): Decan-1-ol, ethoxylated

CAS RN: 26183-52-8

Molecular formula: $(C_2H_4O)nC_{10}H_{22}O$ (UVCB)

Molecular weight:202.33 g/mol (monomer)

Synonyms: Ethoxylated decanol; decyl alcohol, ethoxylated; Poly(oxy-1,2-ethanediyl), .alpha.-decyl-.omega.-hydroxydecyl alcohol; ethoxylated alpha-decyl-omega-hydroxypoly(oxy-1,2-ethanediyl); polyethylene glycol decyl ether; decyl alcohol ethoxylated; 2-decoxyethanol l

SMILES: C(CCCOCCO)CCCCCC

II. PHYSICO-CHEMICAL PROPERTIES

Key physical and chemical properties for the substance are shown in Table 1.

Table 1: Overview of the Physico-Chemical Properties of Ethoxylated Decanol

Property	Value	Klimisch Score	Reference
Physical state at 20°C and 101.3 kPa	Clear liquid with characteristic mild odor	1	ECHA
Melting Point	-27°C @ 101 kPa	1	ECHA
Boiling Point	224°C @ 101 kPa	1	ECHA
Density	880 kg/m³ @ 25 °C	2	ECHA
Vapor Pressure	100 Pa @ 20 °C	2	ECHA
Partition Coefficient (log K_{ow})	3.51 @25 °C	2	ECHA
Water Solubility	0.0000759-0.000082 g/L @ 25 °C	2	ECHA
Flash Point	118.7°C @ 101.3 kPa	2	ECHA
Auto flammability	220°C @ 101.3 kPa	2	ECHA
Viscosity	13.911 mm²/s @ 25°C	2	ECHA

III. ENVIRONMENTAL FATE PROPERTIES

A. Summary

Ethoxylated decanol is readily biodegradable. It is not expected to bioaccumulate and has a low tendency to adsorb to soil or sediment.

B. Biodegradation

An OECD Guideline 301 B (Ready Biodegradability: CO_2 Evolution Test) was performed. Ethoxylated decanol (6 EO) was tested for ready biodegradability according to OECD 301B. The degradation of the test item was 83% within 28 days (after acidification). The biodegradation of the test item reached the criterion for ready biodegradability (ECHA) [Kl. score = 1].

If a chemical is found to be readily biodegradable, it is categorised as Not Persistent since its half-life is substantially less than 60 days (DoEE, 2017).

C. Environmental Distribution

The adsorption potential of ethoxylated decanol was determined using EPIWIN QSAR model (SRC KOCWIN v2.01). Determination of the K_{oc} for the mixture was not possible but the K_{oc} value for the pure homologues in the mixture were calculated. The Log K_{oc} values from the KOCWIN calculation for ethoxylated decanol ranged from 68.45-127.1 L/kg (MCI method) and 75.71-231.5 9l (log K_{ow} method) (ECHA) [KI. score = 2].

The K_{oc} for ethoxylated decanol was determined using a more specific QSAR method where the adsorption of several radio-labelled specific alcohol ethoxylates homologues were investigated in activated sludge and river water solids. The K_{oc} value for ethoxylated decanol was determined to be 1057-1462 L/kg and the log K_{oc} value was determined to be 3-3.2 at 25 °C. These values indicate that ethoxylated decanol has low mobility in soil (ECHA) [KI.score = 2].

D. Bioaccumulation

A bioconcentration factor (BCF) value of 237 L/kg at 24- hours was determined using the fathead minnow (ECHA) [Kl score = 2].

IV. HUMAN HEALTH HAZARD ASSESSMENT

A. Summary

Ethoxylated decanol has low acute toxicity by the oral route of exposure and limited acute toxicity by the dermal route. It has moderate acute toxicity by the inhalation route of exposure. It is not a skin and eye irritant nor is it a skin sensitiser. Repeated exposure studies in rodents caused limited toxicity. There are data available to evaluate carcinogenic effects of decanol, ethoxylate although the lack of mutagenic effects suggests that decanol, ethoxylate is not expected to be a carcinogen. Ethoxylated decanol is not expected to have an effect on reproduction based on findings in animals exposed to similar compounds. There was no evidence of developmental toxicity observed in animals exposed to ethoxylated decanol by the dermal route of exposure.

B. Acute Toxicity

Oral

An OECD Guideline 401 (Acute Oral Toxicity) study was performed using male and female Sprague-Dawley rats. Decanol, ethoxylate was administered to the rats via oral: gavage at a dose of 5,050 mg/kg bw/day. The LD_{50} was determined to be > 5,050 mg/kg bw based on clinical signs of toxicity which included decreased activity, diarrhea, piloerection, and polyuria (ECHA) [Kl score = 1].

Inhalation

An OECD Guideline 403 (Acute Inhalation Toxicity) study was performed using male and female Sprague-Dawley rats exposed to an aerosol of ethoxylated decanol via the inhalation route of exposure. The mass median aerodynamic diameter was 1.90 ± 1.82. The four-hour LC_{50} was determined to be > 1,600 mg/m³ air or >1.6 mg/L (ECHA) [Kl score = 2].

An OECD Guideline 403 (Acute Inhalation Toxicity) study was performed using male and female Wistar rats exposed to a vapour of ethoxylated decanol via the inhalation route of exposure. The six-hour LC_{50} was determined to be >100 mg/m3 which represents the calculated saturated vapor pressure (ECHA) [Kl. score = 2].

Dermal

An OECD Guideline 402 (Acute Dermal Toxicity) study was performed using male and female Wistar rats exposed to decanol, ethoxylate via occlusive dressing. A24 hour LD_{50} of > 2,000 mg/kg bw/day was determined for decanol, ethoxylate (ECHA) [Kl. score = 2].

C. Irritation

Skin

An OECD Guideline 404 (Acute Dermal Irritation / Corrosion) was performed using New Zealand White rabbits exposed to decanol, ethoxylate via semiocclusive dressing for four hours. Very slight erythema (max score = 1) was present at each observation through 24 hours in three animals. Oedema (max score = 0) was not observed at any observation timepoint throughout the study. The reported skin irritation results for the test animals indicate that decanol, ethoxylate is not a dermal irritant (ECHA) [Kl score = 2].

Eye

An OECD Guideline 405 (Acute Eye Irritation / Corrosion) study was conducted using New Zealand White rabbits exposed to 0.2 mL of decanol, ethoxylate. The 24-, 48-, and 72-hour cornea opacity score (max score = 4), the iris score (max score = 0), the conjunctivae score (max score =0), and the chemosis (max score = 0) score indicated that the decanol ethoxylate was not irritating to the eye (ECHA) [Kl. score = 2].

D. Sensitisation

An OECD Guideline 406 (Skin Sensitisation) was performed using female Dunkin-Hartley guinea pigs exposed to decanol, ethoxylate via intradermal and epicutaneous routes of exposure.

A study was performed to assess the contact sensitisation potential of the test material in the albino guinea pig. Ten test and five control animals were used for the main study. Based on the results of sighting test, the concentration of the test material for the induction and challenge phases were selected as follows:

- Intradermal Induction: 1% w/v in arachis oil
- Topical Induction: undiluted as supplied
- Topical Challenge: 50% and 25% v/v in arachis oil

The decanol, ethoxylate produced a 0% (0/10) sensitisation rate and was classified as non-sensitiser to guinea pig skin (ECHA) [Kl score = 1].

E. Repeated Dose Toxicity

Oral

An OECD Guideline 408 (Repeated Dose 90-Day Oral Toxicity Study in Rodents) was performed using male and female Wistar rats. The oral repeated dose toxicity of the target substance was estimated based on an adequate and reliable sub chronic oral toxicity key study performed with a structural analogue source substance. Daily oral exposure of male and female rats via the diet for 90 consecutive days to the test substance did not result in any toxicologically relevant effects. The NOAEL was determined to be > 500 mg/kg bw/day, corresponding to the highest dose tested. The result of the key study is further supported by additional (supporting) studies of various structural analogue source substances. Therefore, a systemic NOAEL after oral exposure for the target substance of ≥ 500 mg/kg bw/day was established. The differences in molecular structure between the target and the source substances are unlikely to lead to differences in oral repeated dose toxicity (ECHA) [Kl. score = 2].

Inhalation.

There are no inhalation studies available.

Dermal

There are no dermal repeat dose studies available.

F. Genotoxicity

In vitro Studies

The results of the *in vitro* genotoxicity studies on ethoxylated decanol are presented in Table 2.

Table 2: *In vitro* Genotoxicity Studies on Ethoxylated Decanol

Test System	Results*		Klimisch Score	Reference
	-S9	+S9		
OECD Guideline 471 (Bacterial reverse mutation assay) *S. typhimurium* TA 1535, TA 1537, TA 98, TA 100, and TA 1538) **	-	-	2	ECHA
OECD Guideline 482 (Genetic Toxicology: DNA damage and repair unscheduled DNA synthesis in mammalian cells *in vitro*)	-	-	2	ECHA

Test System	Results*		Klimisch Score	Reference
	-S9	+S9		
OECD Guideline 473 (*In vitro* mammalian chromosome aberration test)	-	-	2	ECHA

*+, positive; -, negative

In vivo Studies

An OECD Guideline 475 (Mammalian Bone Marrow Chromosome Aberration) test was performed using male and female Sprague-Dawley rats. The rats were administered single doses of 450, 900 and 1500 mg/kg bw/day of decanol, ethoxylate via oral gavage. Post euthanasia, femoral bone marrow smears were prepared. There were no chromosomal aberrations observed post-treatment. Therefore, decanol, ethoxylate was determined to be non-mutagenic *in vivo* (ECHA) [Kl. score = 2].

An OECD Guideline 474 (Mammalian Erythrocyte Micronucleus Test) was performed using male and female CD-1 mice exposed to 100 mg/kg bw/day dose of decanol, ethoxylate via a single intraperitoneal injection. Decanol, ethoxylate was determined to be non-mutagenic *in vivo* (ECHA) [KI. score =2].

An OECD Guideline 474 (Mammalian Erythrocyte Micronucleus Test) was performed using male and female Swiss Webster mice exposed to 200, 400, and 640 mg/kg bw/day of decanol, ethoxylate. Decanol, ethoxylate was determined to be non-mutagenic *in vivo* (ECHA) [KI. score =2].

G. Carcinogenicity

There are no studies are available.

H. Reproductive Toxicity

An OECD Guideline 416 (Two-Generation Reproduction Toxicity) study was performed using male and female Fischer 344 rats. Animals were treated dermally with doses of 1, 10, and 25% (w/v) to shaved dorsal region. The reproductive toxicity of the target substance is estimated based on an adequate and reliable two-generation reproductive toxicity study of a structural analogue source substance with subsequent detailed examination of foetuses. Dermal treatment of pregnant rats with the test substance at doses of 10, 100 and 250 mg/kg bw/day resulted in no maternal toxicity and hence a dermal NOAEL for maternal systemic toxicity of ≥250 mg/kg bw/day. The NOAEL for reproductive toxicity, based on observations in the P0, F1 and F2 generations was determined to be ≥ 250 mg/kg/day [Kl. score = 2].

I. Developmental Toxicity

An OECD Guideline 416 (Two-Generation Reproduction Toxicity Study) was performed using male and female Fischer 344 rats. Animals were treated dermally with doses of 1, 10 and 25% (w/v) to shaved dorsal region. The developmental toxicity of the target substance is estimated based on an adequate and reliable two-generation reproductive toxicity study of a structural analogue source substance with subsequent detailed examination of foetuses. Dermal treatment of pregnant rats with the test substance at doses of 10, 100 and 250 mg/kg bw/day resulted in no maternal toxicity and hence a dermal NOAEL for maternal systemic toxicity of ≥250 mg/kg bw/day. Foetal abnormalities observed include malformations of eyes and front as well as hind limbs. All developmental effects were due to spontaneous occurrence and were considered not to be

treatment-related. The dermal developmental NOAEL was thus determined to be ≥250 mg/kg bw/day. No developmental toxicity is therefore expected for the target substance. As explained in the category justification, the differences in molecular structure between the target and the source substances are unlikely to lead to differences in the developmental toxicity and teratogenicity (ECHA) [KI. score =2].

V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES

The toxicological reference values developed for ethoxylated oleic acid follow the methodology discussed in enHealth (2012). The approach used to develop drinking water guidance values is described in the Australian Drinking Water Guidelines (ADWG, 2011).

A. Non-Cancer

Oral

Two-year chronic studies have been conducted in rats given dermal doses of ethoxylated decanol. The lowest NOAEL from these studies is ≥250 mg/kg/day, based on reproductive toxicity. The NOAEL of 250 mg/kg/day will be used for determining the oral Reference Dose (RfD) and the drinking water guidance value.

Oral Reference Dose (oral RfD)

Oral RfD = NOAEL / (UF_A x UF_H x UF_L x UF_{Sub} x UF_D)

Where:
- UF_A (interspecies variability) = 10
- UF_H (intraspecies variability) = 10
- UFr (route to route variability) = 10
- UF_L (LOAEL to NOAEL) = 1
- UF_{Sub} (subchronic to chronic) = 1
- UF_D (database uncertainty) = 1

Oral RfD = 250/ (10 x 10 x 10 x 1 x 1 x 1) = 250/1000 = 0.25 mg/kg/day

Drinking water guidance value

Drinking water guidance value = (animal dose) x (human weight) x (proportion of intake from water) / (volume of water consumed) x (safety factor)

Using the oral RfD,

Drinking water guidance value = (oral RfD) x (human weight) x (proportion of water consumed) / (volume of water consumed)

Where:
- Human weight = 70 kg (ADWG, 2011)
- Proportion of water consumed = 10% (ADWG, 2011)
- Volume of water consumed = 2L (ADWG, 2011)

Drinking water guidance value = (0.25 x 70 x 0.1)/2 = 0.875 mg/L

B. Cancer

There are no carcinogenic studies available for ethoxylated decanol. Therefore, a cancer reference value was not derived.

VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES

Ethoxylated decanol does not exhibit the following physico-chemical properties:

- Explosivity
- Flammability
- Oxidising potential

VII. ENVIRONMENTAL HAZARD ASSESSMENT

A. Summary

Ethoxylated decanol is moderately toxic to aquatic organisms.

B. Aquatic Toxicity

Acute Studies

Table 3 lists the results of acute aquatic toxicity studies conducted on decanol ethoxylate.

Table 3: Acute Aquatic Toxicity Studies on Ethoxylated Decanol

Test Species	Endpoint	Results (mg/L)	Klimisch Score	Reference
Danio rerio (zebrafish)	96-hour LC_{50}	1.2 (mortality)	2	ECHA
Cyprinus carpio	96-hour LC_{50}	1.2 (mortality)	1	ECHA
Daphnia magna	48-hour EC_{50}	0.39-0.53 (mobility)	2	ECHA
Daphnia magna	48-hour EC_{50}	0.91	2	ECHA
Desmodesmus subspicatus	72-hour EC_{50}	0.18 (growth rate)	2	ECHA
Desmodesmus subspicatus	72-hour EC_{50}	1.8 (growth rate)	2	ECHA
Desmodesmus subspicatus	72-hour EC_{50}	1.6 (growth rate)	2	ECHA

Chronic Studies

Table 4 lists the results of chronic aquatic toxicity studies conducted on decanol ethoxylate.

Table 4: Chronic Aquatic Toxicity Studies on Ethoxylated Decanol

Test Species	Endpoint	Results (mg/L)	Klimisch Score	Reference
Lepomis macrochirus (bluegill sunfish)	10-day NOEC	0.16 (mortality)	2	ECHA
Lepomis macrochirus (bluegill sunfish)	30-day NOEC	>0.33 (growth rate)	2	ECHA
Daphnia magna	21-day NOEC	0.77 (reproduction)	2	ECHA
Desmodesmus subspicatus	72-hour NOEC	0.4 (growth rate)	2	ECHA

C. Terrestrial Toxicity

In an acute toxicity test, according to OECD 207, there was no effect on earth worm *Eisenia fetida* was observed up to the highest test item concentration of 1,000 mg/kg soil dw after 13-days. Therefore, the $LC_{50}$was determined to be >1,000 mg/kg dw (ECHA) [Kl. score = 2].

D. Calculation of PNEC

The PNEC calculations for ethoxylated oleic acid follow the methodology discussed in DEWHA (2009).

PNEC Water

Experimental results are available for three trophic levels. Acute E (L)C_{50} values are available for fish (1.2 mg/L), invertebrates (0.39 mg/L), and algae (0.18 mg/L). Results from chronic studies are available for fish (0.16 mg/L), invertebrates (0.77 mg/L) and algae (0.4 mg/L). On the basis that the data consists of short-term and long-term studies from three trophic levels, an assessment factor of 10 has been applied to the lowest reported NOEC value of 0.16 mg/L for fish. The $PNEC_{water}$ is 0.016 mg/L.

PNEC Sediment

There are no toxicity data for sediment-dwelling organisms. However, it can be expected that the substance will be mineralized under environmental conditions within a short time period. Long-term exposure of sediment organisms to ethoxylated decanol and/or degradation products of this substance is therefore unlikely (ECHA). Therefore, a $PNEC_{sed}$ was not calculated.

PNEC Soil

There is only one acute toxicity study using terrestrial receptors (i.e., NOAEL >1000 mg/kg soil). Given the limited data for the soil compartment, an assessment factor of 1000 was applied to derive a $PNEC_{soil}$ of 1 mg/kg dw.

VIII. PERSISTENCE, BIOACCUMULATION AND TOXICITY (PBT) ASSESSMENT

The methodology for the Persistent, Bioaccumulative and Toxic (PBT) substances assessment is based on the Australian and EU REACH Criteria methodology (DEWHA, 2009; ECHA, 2017).

Decanol, ethoxylated is readily biodegradable; thus it does not meet the screening criteria for persistence.

The BCF value for ethoxylated decanol is 237 L/kg. Therefore, ethoxylated decanol does not meet the screening criteria for bioaccumulation.

The NOECs from the chronic aquatic toxicity studies on ethoxylated decanol are > 0.1 mg/L. ethoxylated decanol. Thus, decanol, ethoxylate does not meet the screening criteria for toxicity.

Therefore, decanol, ethoxylate is not a PBT substance.

IX. CLASSIFICATION AND LABELLING

A. Classification

Acute toxicity (ingestion)-category 4

Eye damage-category 1

Skin irritation-category 2

H302-Harmful if swallowed

H3180 Causes serious eye damage

H315- Causes skin irritation

B. Labelling

Danger

C. Pictogram



X. HANDLING AND SAFETY INFORMATION (OCCUPATIONAL LIMITS AND TRANSPORTATION REQUIREMENTS)

A. First Aid

Eye Contact

Immediately flush open eyes with plenty of water for at least 15 minutes. Remove contacts, if present and easy to do. Get medical attention immediately, preferably a physician for an ophthalmologic examination.

Skin Contact

For minor skin contact, avoid spreading material on unaffected skin. Remove and isolate contaminated clothing. Wash the contaminated area of body with soap and fresh water. Get medical attention. Launder contaminated clothing before reuse.

Inhalation

Move person to fresh air. Administer oxygen if breathing is difficult. Do not use mouth-to-mouth method if victim inhaled the substance; give artificial respiration with the air of a pocket mask equipped with a one-way valve or other proper respiratory medical device. Give artificial respiration if victim is not breathing. Get medical attention immediately.

Ingestion

Do not induce vomiting. Get medical attention immediately.

Notes to Physician

All treatments should be based on observed signs and symptoms of distress in the patient.

B. Fire Fighting Information

Extinguishing Media

Use water spray or fog, foam, dry chemical or carbon dioxide.

Specific Exposure Hazards

Emits toxic fumes under fire conditions. Depending on conditions, decomposition products may include the following: carbon dioxide, carbon monoxide.

Special Protective Equipment for Firefighters

Wear self-contained breathing apparatus and chemical-protective clothing.

C. Accidental Release Measures

Personal Precautions

Isolate area. Keep unnecessary and unprotected personnel from entering the area. Use personal protective clothing. Ensure adequate ventilation. Wear respiratory protection if ventilation is inadequate. Do not breath mist, vapours or spray. Avoid contact with skin, eyes and clothing. Eliminate all sources of ignition.

Environmental Precautions

Prevent from entering sewers, waterways or low areas.

Steps to be Taken if Material is Released or Spilled

Eliminate all sources of ignition. Pick up with suitable absorbent material and transfer to a container for chemical waste. For large amounts: dike spillage and pump off product into container for chemical waste. Dispose of contaminated material as prescribed.

D. Storage And Handling

General Handling

Keep away from heat, sparks and flame. Avoid contact with eyes, skin and clothing. Avoid breathing vapor. Wash thoroughly after handling. Keep container closed. Use with adequate ventilation.

Storage

Keep container tightly closed. Store away from heat and light.

E. Exposure Controls / Personal Protection

Occupational Exposure Standards

Workplace Australia has not established an occupational exposure standard for ethoxylated decanol.

Engineering Controls

Good general ventilation should be used. Ventilation rates should be matched to conditions. If applicable, use process enclosures, local exhaust ventilation or other engineering controls to maintain airborne levels below recommended exposure limits. If exposure limits have not been established, maintain airborne levels to an acceptable level.

Personal Protection Equipment

Respiratory Protection: If workers are exposed to concentrations above the exposure limit, they must use appropriate, certified respirators. If there are no applicable exposure limit requirements or guidelines, use an approved respirator. Selection of air-purifying or positive pressure supplied-air will depend on the specific operation and the potential airborne concentration of the product. For emergency conditions, use an approved positive-pressure self-contained breathing apparatus. The following should be effective types of air-purifying respirators: organic vapor cartridge with a particulate pre-filter.

Hand Protection: Use gloves chemically resistant to this material. Consult the SDS for appropriate glove barrier materials.

Skin Protection: Use protective clothing chemically resistant to the material. Selection of specific items such as face shield, boots, apron or full body suit will depend on the task.

Eye protection: Use chemical goggles.

Other Precautions: Wash hands, forearms and face thoroughly after handling chemical products, as well as before eating, smoking and using the lavatory and at the end of the working period. Appropriate techniques should be used to remove potentially contaminated clothing. Wash contaminated clothing before reusing. Ensure that eyewash stations and safety showers are close to the workstation location.

F. Transport Information

The substance is not considered hazardous for purposes of transportation by road or rail. An Australian Dangerous Goods code is not required.

UN 1993

Class: 3

Packaging Group: II

XI. DISPOSAL MANAGEMENT

Disposal should be in accordance with all local, state, and federal regulations.

XII. REGULATORY STATUS

Australian AICS Inventory: Listed.

XIII. REFERENCE

ADWG. (2011). National Water Quality Management Strategy. Australian Drinking Water Guidelines, Section 6, Australian Government, National Health and Medical Research Council, Natural Resource Management Ministerial Council. Updated January 2022. Available: https://www.nhmrc.gov.au/about-us/publications/australian-drinking-water-guidelines

Department of the Environment, Water, Heritage and the Arts [DEWHA]. (2009). Environmental risk assessment guidance manual for industrial chemicals, Department of the Environment, Water, Heritage and the Arts, Commonwealth of Australia. Available: http://www.nepc.gov.au/resource/chemical-risk-assessment-guidance-manuals

Department of the Environment and Energy (DoEE). (2017). Chemical Risk Assessment Guidance Manual: for chemicals associated with coal seam gas extraction, Guidance manual prepared by Hydrobiology and ToxConsult Pty Ltd for the Department of the Environment and Energy, Commonwealth of Australia, Canberra. Available: www.environment.gov.au/water/coal-and-coal-seam-gas/national-assessment-chemicals/consultation-risk-assessment-guidance-manual

ECHA. ECHA REACH database: http://echa.europa.eu/information-on-chemicals/registered-substances

enHealth Human Risk Assessment [HHRA] (2012). Environmental Health Risk Assessment, Guidelines for Assessing Human Health Risks from Environmental Hazards. Office of Health Protection of the Australian Government Department of Health. Available: https://www1.health.gov.au/internet/main/publishing.nsf/Content/health-pubhlth-publicat-environ.htm

European Chemicals Agency [ECHA]. (2017). Guidance on Information Requirements and Chemical Safety Assessment, Chapter R11: PBT Assessment, European Chemicals Agency, Helsinki, Finland. Available: https://echa.europa.eu/guidance-documents/guidance-on-information-requirements-and-chemical-safety-assessment

Klimisch, H.J., Andreae, M., and Tillmann, U. (1997). A systematic approach for evaluating the quality of experimental and toxicological and ecotoxicological data. Regul. Toxicol. Pharmacol. 25:1-5.

DIAMMONIUM PEROXODISULPHATE

This dossier on diammonium peroxodisulphate presents the most critical studies pertinent to the risk assessment of diammonium peroxodisulphate in its use in coal seam or shale gas extraction activities. It does not represent an exhaustive or critical review of all available data. The information presented in this dossier was obtained primarily from the ECHA database that provides information on chemicals that have been registered under the EU REACH (ECHA). Where possible, study quality was evaluated using the Klimisch scoring system (Klimisch et al., 1997).

I. SUBSTANCE IDENTIFICATION

Chemical Name (IUPAC): Diammonium peroxodisulphate

CAS RN: 7727-54-0

Molecular formula: $H_8N_2O_8S_2$

Molecular weight: 228.21 g/mol

Synonyms: Ammonium persulfate; Diammonium peroxydisulfate; Diammonium peroxydisulphate; Diammonium persulfate; Peroxydisulfuric acid (((HO)S(O)2)2O2), ammonium salt (1:2); Peroxydisulfuric acid (((HO)S(O)2)2O2), diammonium salt; Peroxydisulfuric acid, diammonium salt; ammonium persulphate

SMILES: [NH4+].[NH4+].[O-]S(=O)(=O)OOS(=O)(=O)[O-]

II. PHYSICO-CHEMICAL PROPERTIES

Key physical and chemical properties for the substance are shown in Table 1.

Table 1: Overview of the Physico-Chemical Properties of Diammonium Peroxodisulphate

Property	Value	Klimisch Score	Reference
Physical state at 20°C and 101.3 kPa	White, odourless, crystalline solid	1	ECHA
Melting Point	ND. Decomposes at ca. 120°C at 100.66 kPa	1	ECHA
Boiling Point	ND. Decomposes at ca. 393 K (= 120°C) at 100.79 kPa	1	ECHA
Density	1260 kg/m³ at 20°C	1	ECHA
Vapour Pressure	0 Pa @ 25°C	2	ECHA
Partition Coefficient (log K_{ow})	Not applicable as substance is inorganic salt	-	ECHA
Water Solubility	850 g/L @ 25°C	2	ECHA
Viscosity	ND. Substance is a solid at room temperature	-	ECHA

Property	Value	Klimisch Score	Reference
Dissociation constant (pKa)	Diammonium persulfate dissociates completely to ammonium cation and persulfate anion when it is dissolved in water.	-	ECHA

ND = not determined

III. ENVIRONMENTAL FATE PROPERTIES

A. Summary

Diammonium peroxodisulphate dissociates in aqueous media to the ammonium cation and persulfate anion. Biodegradation is not applicable to inorganic compounds. Diammonium peroxodisulphate is not expected to bioaccumulate; it will dissociate to ions that are ubiquitous in the environment. Diammonium peroxodisulphate is not expected to adsorb to soil or sediment because of its dissociation properties and high water solubility.

B. Partitioning

Persulfates dissociate in water to the corresponding cation and persulfate anion. Hydrolysis is temperature and pH dependent. The persulfate anion, independent from the cation, undergoes decomposition in normal water or acid conditions, readily oxidizing water to oxygen, producing acid conditions. All degradation products are ubiquitous to the environment (ECHA).

Diammonium peroxodisulphate was shown to be hydrolytically stable at 10 °C and pH 4, 7 and 9, a minor hydrolysis was observed at 25 °C, whereas a very strong hydrolysis at 60 °C was observed within 4 days. The DT_{50} at pH 4 and 60 °C was determined to be 27.2 h, at pH 7 and 9 and 60 °C the DT_{50} was determined to be 36.5 h. The DT_{50} at environmentally relevant temperature (12 °C) and pH 7 was extrapolated to be 1698.18 h (70.76 d). (ECHA) [Kl. Score = 1].

C. Biodegradation

Biodegradation is not applicable to inorganic compounds.

D. Environmental Distribution

No experimental data are available for diammonium peroxodisulphate. Persulfates are soluble in water and their vapour pressures are negligible. Thus, persulfates released into the environment are distributed into the water compartment in ionic form of the cation and persulfate ion. Persulfates are not expected to sorb to soil due to their dissociation properties, instability (hydrolysis) and high water solubility. They behave as free ions and decompose into sulphate and bisulphate ions. All decomposition products are ubiquitous in the environment (ECHA).

E. Bioaccumulation

There are no bioaccumulation studies on diammonium peroxodisulphate. Substances of the Persulfate Category are inorganic salts sharing the same anionic persulfate moiety. Persulfates are very soluble in water and are not expected to bioaccumulate in soil or aqueous solutions. They will decompose into organic sulphate or bisulphate (ECHA).

IV. HUMAN HEALTH HAZARD ASSESSMENT

A. Summary

Diammonium peroxodisulphate exhibits moderate acute toxicity by the oral route, and low acute toxicity by the inhalation and dermal routes. In humans, diammonium peroxodisulphate has the potential for skin irritation; it is also a skin sensitiser to guinea pigs and humans. Human exposure to persulfates (including diammonium peroxodisulphate) have been linked to a variety of skin and respiratory complaints indicative of sensitisation. Repeated oral exposure to diammonium peroxodisulphate resulted in irritation to the gastrointestinal tract; and respiratory irritation was seen in rats repeatedly exposed by inhalation to diammonium peroxodisulphate. It is not genotoxic or carcinogenic. It is not a reproductive or developmental toxicant.

B. Acute Toxicity

The oral LD_{50} values in rats are 300 and 700 milligrams per kilogram (mg/kg) for males and females, respectively (ECHA) [Kl. score = 1].

The inhalation 4-hour LC_{50} in rats is >2.95 milligrams per litre (mg/L). Particles sizes of <10 micrometre (μm) and <7 μm were 96.6% – 97.4% and 84.6% – 86%, respectively (ECHA) [Kl. score = 1].

The dermal LD_{50} in rats is >2,000 mg/kg (ECHA) [Kl. score = 1].

C. Irritation

Application of 0.5 g. diammonium peroxodisulphate to the skin of rabbits for 4 hours under occlusive conditions was not irritating. The mean of the 24-, 48-, and 72-hours scores were 0.00 for both erythema and oedema (ECHA) [Kl. score = 2].

Studies in humans indicate that persulfates have the potential for skin irritation (NICNAS, 2001). Calnan and Schuster (1963) reported skin irritation in a human patch test with 5% diammonium peroxodisulphate. Jordan (1998) reported that a mixture with 17.5% persulfates (ammonium, potassium, and sodium) induced skin irritation in human subjects from patches applied under occlusive conditions.

Instillation of 0.1 mL diammonium peroxodisulphate into the eyes of rabbits was considered slightly irritating. The mean of the 24-, 48-, and 72-hours scores were: 1.33 for corneal opacity; 0.00 for iridial lesions; 1.00 for conjunctival redness; and 0.33 for chemosis (ECHA) [Kl. score = 1].

D. Sensitisation

Diammonium peroxodisulphate was considered a skin sensitiser in a guinea pig maximization test (ECHA) [Kl. score = 2].

Human exposure to persulfates have been linked to a variety of skin and respiratory complaints indicative of sensitisation. The complaints consist of immediate and delayed contact hypersensitivity, contact urticarial, rhinitis, bronchitis, and asthma (NICNAS, 2001).

E. Repeated Dose Toxicity

Oral

Male and female CR-CD rats were fed 0, 100, 300, or 600 parts per million (ppm) diammonium peroxodisulphate in their diet for 28 days. The estimated daily intakes are 0, 13, 41, and 82 mg/kg-day. There were no treatment-related effects. The no observed adverse effects level (NOAEL) is 82 mg/kg-day, the highest dose tested (ECHA) [Kl. score = 2].

Male and female CR strain rats were fed 0, 300, 1,000 or 3,000 ppm sodium persulfate in their diet for 90-days. On day 48 of the study, the dietary concentration of the group receiving 1,000 ppm was increased to 5,000 ppm for the remainder of the study. Body weights was decreased in the two highest dose groups during the last six weeks of treatment. There were no treatment-related effects on urinalysis, clinical chemistry or hematology parameters. Histopathological findings were limited to the 3,000-ppm group only and consisted of necrosis and atrophy of the gastrointestinal tract epithelial lining. The absence of the gastrointestinal lesions in the group receiving 1,000 ppm for 8 weeks, followed by 5,000 ppm for 5 weeks, indicates that the lesions are related both to concentration in diet (dose) and length of exposure. A clear NOAEL for this study is 300 ppm, which is estimated to be 22 mg/kg-day. Another NOAEL may be the 1,000-ppm dietary group for an 8-week exposure period. (ECHA; OECD, 2005a,b). [Kl. score = 2].

Inhalation

Male and female SD rats were exposed (whole-body) to 0, 5, 10.3, or 25 milligrams per cubic metre (mg/m^3) diammonium peroxodisulphate dust by inhalation, 6 hours/day, 5 days/week for 13 weeks. Additional groups of animals were exposed for 13 weeks, followed by either a 4- or 13-week recovery period. The MMAD was 2.5, 2.7, and 2.5 µm for the 5, 10, and 25 mg/m^3 groups, respectively. No deaths occurred during the study that were considered to be exposure-related. The 25 mg/m^3 animals showed increased respiration rates, as well as a few of the 25 mg/m^3 animals. This clinical sign disappeared during the first few weeks of the recovery period. Body weights of the 25 mg/m^3 animals were significantly lower during most of the exposure period; by the end of the recovery period the body weights were comparable to the controls. Lung weights were increased in the 25 mg/m^3 animals at the end of the 13-week exposure period but were similar to controls after 6 weeks in the recovery period. Histopathologic changes indicative of irritation was seen in the trachea and bronchi/bronchioles in the 25 mg/m^3 animals; these lesions were not seen after 6 weeks in the recovery period. The NOAEL for this study is 10.3 mg/m^3 (ECHA). [Kl. score = 1]

Dermal

No studies are available.

F. Genotoxicity

In vitro Studies

There are no available genotoxicity studies on diammonium peroxodisulphate. The *in vitro* genotoxicity studies on sodium persulfate are presented below in Table 2.

Table 2: *In vitro* Genotoxicity Studies on Sodium Persulfate

Test System	Results*		Klimisch Score	Reference
	-S9	+S9		
Bacterial reverse mutation (*S. typhimurium* strains)	-	-	1	ECHA
Unscheduled DNA synthesis (rat hepatocytes)	NA	-	1	ECHA

*+, positive; -, negative; NA, not applicable

In vivo Studies

Sodium persulfate did not induce micronuclei in the bone marrow cells of male and female mice given a single intraperitoneal injection of 0, 85, 169, or 338 mg/kg sodium persulfate (ECHA) [Kl. score = 2].

G. Carcinogenicity

A 51-week dermal study in female SENCAR mice exposed to 0.2 ml of a 200 milligrams per millilitre (mg/mL) solution of diammonium peroxodisulphate showed that diammonium peroxodisulphate is neither a tumour promoter nor a complete carcinogen when applied to the skin (OECD, 2005a,b; ECHA). [Kl. score = 2]

H. Reproductive and Developmental Toxicity

A reproductive and developmental toxicity screening study (OECD 421) has been conducted on diammonium peroxodisulphate. Male and female Crl:CD (SD)GS BR rats were fed 0, 40, 100, or 250 mg/kg diammonium peroxodisulphate in their diet. In the parental animals, there was no treatment-related mortality, clinical signs, body or organ weight changes, or effects seen in gross necropsy. There were no effects on reproductive performance, fertility, foetal anomalies, foetal viability, spermatogenesis, spermatogenic cycle. The NOAEL for reproductive and developmental toxicity and parental toxicity is 250 mg/kg-day, the highest dose tested (ECHA). [Kl. score = 1]

V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES

The toxicological reference values developed for diammonium peroxodisulphate follow the methodology discussed in enHealth (2012). The approach used to develop drinking water guidance values is described in the Australian Drinking Water Guidelines (ADWG, 2011).

A. Non-Cancer

Toxicological reference values were not derived. Diammonium peroxodisulphate dissociates in water to ammonium and persulfate ions. The persulfate ions will further hydrolyse to sulphate ions.

The Australian drinking water guideline value for sulphate is 500 mg/L based on health. Concentrations of > 500 mg/L can have purgative effects. There is also an Australian drinking water guideline value for sulphate of 250 mg/L based on aesthetics; it is the taste threshold (ADWG, 2011).

B. Cancer

There are no valid carcinogenicity studies on diammonium peroxodisulphate. Thus, a cancer reference value was not derived.

VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES

Diammonium peroxodisulphate does not exhibit the following physico-chemical properties:

- Explosivity
- Flammability
- Oxidising potential

VII. ENVIRONMENTAL HAZARD ASSESSMENT

A. Summary

Diammonium peroxodisulphate is of low toxicity concern to aquatic and terrestrial organisms.

NICNAS has assessed diammonium peroxodisulphate in an IMAP Tier 1 environmental assessment and it was concluded that it poses no unreasonable risk to the environment[1].

B. Aquatic Toxicity

Acute Studies

Table 3 lists the results of acute aquatic toxicity studies conducted on diammonium peroxodisulphate.

Table 3: Acute Aquatic Toxicity Studies on Diammonium Peroxodisulphate

Test Species	Endpoint	Results (mg/L)	Klimisch Score	Reference
Oncorhynchus mykiss	96-hour LC_{50}	76.3	1	ECHA
Daphnia magna	48-hour EC_{50}	120	1	ECHA
Phaeodactylum tricornutum	72-hour EC_{50}	320	1	ECHA

Chronic Studies

Long-term toxicity testing to fish was considered scientifically unjustified, due to the results obtained in the short-term toxicity to fish studies, the substance physical-chemical properties and hydrolysis behaviour (ECHA).

An OECD Guideline 211 (Daphnia magna Reproduction Test) was performed and yielded a 21-day NOEC of 20.8 mg/L based on reproduction (ECHA) [Kl Score = 1].

An OECD Guideline 201 (Alga, Growth Inhibition Test) study was performed and yielded a NOEC of 32 mg/L (ECHA) [Kl. Score = 1].

[1] https://www.industrialchemicals.gov.au/chemical-information/search-assessments?assessmentcasnumber=7727-54-0

C. Terrestrial Toxicity

No terrestrial toxicity studies are available.

Persulfates are not expected to be distributed into the terrestrial compartment and consequently not to cause toxicity to terrestrial organisms and plants (ECHA).

D. Calculation of PNEC

The PNEC calculations for diammonium peroxodisulphate follow the methodology discussed in DEWHA (2009).

PNEC Water

Experimental results are available for three trophic levels. Acute E(L)C_{50} values are available for fish (76.3 mg/L), Daphnia (120 mg/L), and algae (136 mg/L). Results from chronic studies are available for invertebrates (20.8 mg/L) and algae (32 mg/L). On the basis that the data consists of short-term results from three trophic levels and long-term results from two trophic levels, an assessment factor of 50 has been applied to the lowest reported NOEC value of 20.8 mg/L for invertebrates. The $PNEC_{water}$ is 0.4 mg/L.

PNEC Sediment

No experimental toxicity data on sediment organisms are available. Diammonium peroxodisulphate dissociates completely in water with its environmental distribution is dominated by its high-water solubility. K_{ow} and K_{oc} parameters do not readily apply to inorganics, such as diammonium peroxodisulphate. Thus, the equilibrium partitioning method cannot be used to calculate the $PNEC_{sediment}$. Based on its properties, no adsorption of diammonium peroxodisulphate to sediment is to be expected, and the assessment of this compartment will be covered by the aquatic assessment.

PNEC Soil

No experimental toxicity data on terrestrial organisms are available. The environmental distribution of diammonium peroxodisulphate is dominated by its water solubility. Sorption of diammonium peroxodisulphate should probably be regarded as a reversible situation, i.e., the substance is not tightly nor permanently bound. K_{oc} and K_{ow} parameters do not readily apply to inorganics, such as diammonium peroxodisulphate. Thus, the equilibrium partitioning method cannot be used to calculate the $PNEC_{soil}$. Based on its properties, diammonium peroxodisulphate is not expected to significantly adsorb to soil, and the assessment of this compartment will be covered by the aquatic assessment.

VIII. PERSISTENCE, BIOACCUMULATION AND TOXICITY (PBT) ASSESSMENT

The methodology for the Persistent, Bioaccumulative and Toxic (PBT) substances assessment is based on the Australian and EU REACH Criteria methodology (DEWHA, 2009; ECHA, 2017).

Diammonium peroxodisulphate is an inorganic salt that dissociates to respective cations and anions. Biodegradation is not applicable to these inorganic ions. For the purposes of this PBT assessment, the persistent criteria are not considered applicable to this inorganic salt.

Diammonium peroxodisulphate is not expected to bioaccumulate; it will dissociate to ions that are ubiquitous in the environment. Thus, the substance does not meet the screening criteria for bioaccumulation.

Chronic aquatic toxicity data is > 0.1 mg/L and acute aquatic toxicity data is >1 mg/L. Thus, diammonium peroxodisulphate does not meet the screening criteria for toxicity.

The overall conclusion is that diammonium peroxodisulphate is not a PBT substance.

IX. CLASSIFICATION AND LABELING

A. Classification

Oxidising Solid Category 3
Acute Toxicity Category 4 [Oral]
Skin Irritant Category 2
Eye Irritant Category 2
Skin Sensitiser Category 1
Respiratory Sensitisation Category 1
STOT SE Category 3 [Respiratory Irritation]

B. Labelling

Danger

C. Pictogram



X. HANDLING AND SAFETY INFORMATION (OCCUPATIONAL LIMITS AND TRANSPORTATION REQUIREMENTS)

A. First Aid

Eye Contact

Immediately flush open eyes with plenty of water for at least 15 minutes. Remove contacts, if present and easy to do. Get medical attention.

Skin Contact

Wash thoroughly with soap and water.

Inhalation

If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.

Ingestion

Rinse mouth with water and then drink plenty of water. Get medical attention. Never give anything by mouth to an unconscious person.

B. Fire Fighting Information

Extinguishing Media

Water spray, carbon dioxide, foam, dry chemical.

Specific Exposure Hazards

May emit toxic fumes under fire conditions. Depending on conditions, decomposition products may include the following: sulphur oxides.

Special Protective Equipment for Firefighters

Wear self-contained breathing apparatus and chemical-protective clothing.

C. Accidental Release Measures

Personal Precautions

Use personal protective clothing. Avoid dust formation. Ensure adequate ventilation. Do not breathe dust. Wear respiratory protection if ventilation is inadequate. Avoid contact with skin, eye, and clothing.

Environmental Precautions

Prevent from entering sewers, waterways, or low areas.

Steps to be Taken if Material is Released or Spilled

Scoop up and remove.

D. Storage and Handling

General Handling

Good general ventilation should be used. Ventilation rates should be matched to conditions. If applicable, use process enclosures, local exhaust ventilation, or other engineering controls to maintain airborne levels below recommended exposure limits.

Other Handling Precautions

Avoid eye and skin contact. Avoid creating or inhaling dust.

Storage

Keep container tightly closed and in a dry and well-ventilated place. Keep in a cool place. Do not store with alkalis, acids, or reducing agents.

E. Exposure Controls / Personal Protection

Occupational Exposure Standards

The workplace exposure standard for diammonium peroxodisulphate in Australia is 0.01 mg/m^3 as a time-weighted average (TWA) peak exposure. A peak limitation is defined by Safe Work Australia as a maximum or peak airborne concentration of a substance determined over the shortest analytically practicable period of time which does not exceed 15 minutes.

Engineering Controls

Ensure adequate ventilation. Localized ventilation should be used to control dust levels below permissible exposure limits.

Personal Protection Equipment

Respiratory Protection:

Use respiratory protection when airborne concentrations are expected to be high.

Hand Protection:

Chemical resistant protective gloves.

Skin Protection:

Body protection must be chosen depending on activity and possible exposure.

Eye protection:

Safety glasses with side-shields.

Other Precautions:

Handle in accordance with good industrial hygiene and safety practice. Eyewash fountains and safety showers must be easily accessible. Remove and wash contaminated clothing before re-use. Contaminated work clothing should not be allowed out of the workplace.

F. Transport Information

UN1444 AMMONIUM PERSULPHATE

Class: 5.1

Packing Group: III

XI. DISPOSAL MANAGEMENT

Disposal should be in accordance with all local, state, and federal regulations.

XII. REGULATORY STATUS

Australian AICS Inventory: Listed

XIII. REFERENCES

ADWG. (2011). National Water Quality Management Strategy. Australian Drinking Water Guidelines, Section 6, Australian Government, National Health and Medical Research Council, Natural Resource Management Ministerial Council. Updated January 2022. Available: https://www.nhmrc.gov.au/about-us/publications/australian-drinking-water-guidelines

Calnan, C.D., and Shuster, S. (1963). Reactions to ammonium persulfate. Arch. Dermatol. 46: 812-815.

Department of the Environment, Water, Heritage and the Arts (DEWHA). (2009). Environmental risk assessment guidance manual for industrial chemicals, Department of the Environment, Water, Heritage and the Arts, Commonwealth of Australia. Available: http://www.nepc.gov.au/resource/chemical-risk-assessment-guidance-manuals

ECHA. ECHA REACH database: https://echa.europa.eu/information-on-chemicals/registered-substances

European Chemicals Agency (ECHA). (2017). Guidance on Information Requirements and Chemical Safety Assessment, Chapter R11: PBT Assessment, European Chemicals Agency, Helsinki, Finland. Available: https://echa.europa.eu/guidance-documents/guidance-on-information-requirements-and-chemical-safety-assessment

Jordan, W.P. (1998). Human sensitization study of three persulfates in a representative vehicle used for bleaching hair. Unpublished data submitted to CFFA; cited in Pang and Fiume (2001).

Klimisch, H.J., Andreae, M., and Tillmann, U. (1997). A systematic approach for evaluating the quality of experimental and toxicological and ecotoxicological data. Regul. Toxicol, Pharmacol. 25:1-5.

National Industrial Chemicals Notification and Assessment Scheme [NICNAS] (2001). Ammonium, Potassium and Sodium Persulfate. Priority Existing Chemical Assessment Report No. 18. Available at: https://www.nicnas.gov.au/chemical-information/pec-assessments.

OECD. (2005a). IUCLID Data Set for Ammonium persulfate (CAS No. 7727-54-0); Potassium persulfate (CAS No. 7727- 27-1); Sodium persulfate (CAS No. 7775-27-1), UNEP Publications. Available at: http://webnet.oecd.org/Hpv/UI/SIDS_Details.aspx?id=5D4B16BE-8BA8-4BE4-8787-469DE31A76E9.

OECD. (2005b). Screening Information Dataset (SIDS) Initial Assessment Report for Ammonium persulfate (CAS No. 7727-54-0); Potassium persulfate (CAS No. 7727- 27-1); Sodium persulfate (CAS No. 7775-27-1), UNEP Publications. Available at: http://webnet.oecd.org/Hpv/UI/SIDS_Details.aspx?id=5D4B16BE-8BA8-4BE4-8787-469DE31A76E9.

DIISOBUTYL ADIPATE (CAS RN 141-04-8)
DIISOBUTYL GLUTARATE (CAS RN 71195-64-7)
DIISOBUTYL SUCCINATE (CAS RN 925-06-4)

This group contains information on diisobutyl adipate (CAS RN 141-04-8), diisobutyl glutarate (CAS RN 71195-64-7) and diisobutyl succinate (CAS RN 925-06-4). They are expected to have similar environmental concerns and have consequently been assessed as a group. Information provided in this dossier is based on diisobutyl adipate (CAS RN 141-04-8).

This dossier presents the most critical studies pertinent to the risk assessment of the diisobutyl compounds and their use in coal seam or shale gas extraction activities. This dossier does not represent an exhaustive or critical review of all available data. The majority of information presented in this dossier was obtained from the ECHA database that provides information on chemicals that have been registered under the EU REACH (ECHA). Where possible, study quality was evaluated using the Klimisch scoring system (Klimisch et al., 1997).

I. SUBSTANCE IDENTIFICATION

Chemical Name (IUPAC): Hexanedioic acid, 1, 6-bis(2-methylpropyl) ester

CAS RN: 141-04-8

Molecular formula: $C_{14}H_{26}O_4$

Molecular weight: 258.18 g/mol

Synonyms: diisobutyl adipate; adipate, diisobutyl; adipic acid, diisobutyl ester; Hexanedioic acid, bis(2-methylpropyl) ester; hexanedioic acid, 1,6-bis(2-methylpropyl) ester; hexanoic acid, dibutyl ester; diisobutyl hexanedioate

SMILES: CC(C)COC(=O)CCCCC(=O)OCC(C)C

Chemical Name (IUPAC): Pentanedioic acid, bis(2-methylpropyl) ester

CAS RN: 71195-64-7

Molecular formula: $C_{13}H_{24}O_4$

Molecular weight: 244.17 g/mol

Synonyms: diisobutyl glutarate; glutaric acid, diisobutyl ester; pentanedioate, bis(2-methylpropyl);

SMILES: CC(C)COC(=O)CCCC(=O)OCC(C)C

Chemical Name (IUPAC): Butanedioic acid, bis(2-methylpropyl) ester

CAS RN: 925-06-4

Molecular formula: $C_{12}H_{22}O_4$

Molecular weight: 230.16 g/mol

Synonyms: diisobutyl succinate; butanedioate, bis(2-methylpropyl); butanedioic acid, 1,4-bis(2-methylpropyl) ester; succinic acid diisobutyl ester; bis(2-methylpropyl) butanedioate

SMILES: CC(C)COC(=O)CCC(=O)OCC(C)C

II. PHYSICO-CHEMICAL PROPERTIES

Table 1: Overview of the Physico-Chemical Properties of Diisobutyl Adipate (CAS RN 141-04-8)

Property	Value	Klimisch Score	Reference
Physical state at 20°C and 101.3 kPa	Liquid	1	ECHA
Melting Point	<-20.0°C (pressure not provided)	-	ECHA
Boiling Point	284.5 °C @98.1 kPa	1	ECHA
Density	951 kg/m^3 @ 20°C	1	ECHA
Vapour Pressure	15.1 Pa @ 20°C	1	ECHA
Partition Coefficient (log K_{ow})	4.3 @ 30°C	2	ECHA
Water Solubility	0.0427 g/L @ 25°C	1	ECHA
Flash Point	157 °C @ 101.3 kPa	1	ECHA

Table 2: Overview of the Physico-Chemical Properties of Diisobutyl Glutarate (CAS RN 71195-64-7)

Property	Value	Klimisch Score	Reference
Physical state at 20°C and 101.3 kPa	Liquid	-	ECHA
Melting Point	-21.8 °C (predicted average) (pressure not provided)	-	CompTox
Boiling Point	271 °C (predicted average) (pressure not provided)	-	CompTox
Density	966 kg/m^3 (predicted average) (temperature not indicated)	-	CompTox
Vapour Pressure	485 Pa (predicted average) (temperature not indicated)	-	CompTox
Partition Coefficient (log K_{ow})	3.34 (temperature not indicated)	-	CompTox
Water Solubility	0.264 g/L (predicted average) (temperature not indicated)	-	CompTox
Flash Point	120 °C (pressure not provided)	-	CompTox

Table 3: Overview of the Physico-Chemical Properties of Diisobutyl Succinate (CAS RN 925-06-4)

Property	Value	Klimisch Score	Reference
Physical state at 20°C and 101.3 kPa	Liquid	-	ECHA
Melting Point	-25.0 °C (predicted average) (pressure not provided)	-	CompTox
Boiling Point	252 °C (predicted average) (pressure not provided)	-	CompTox
Density	978 kg/m^3 (predicted average) (temperature not indicated)	-	CompTox
Vapour Pressure	950 Pa (predicted average) (temperature not indicated)	-	CompTox
Partition Coefficient (log K_{ow})	2.84 (temperature not indicated)	-	CompTox
Water Solubility	0.552 g/L (predicted average) (temperature not indicated)	-	CompTox
Flash Point	110 °C (pressure not provided)	-	CompTox

III. ENVIRONMENTAL FATE PROPERTIES

A. Summary

Diisobutyl adipate is readily biodegradable. It is not expected to bioaccumulate. It has a moderate potential to adsorb to soil or sediment.

B. Biodegradation

Diisobutyl adipate is readily biodegradable in water. Using the OECD 301C Readily Biodegradability: Modified MITI Test (ECHA), approximately 86-95% of the material was biodegraded by 28 days (ECHA). [Kl. Score = 1].

If a chemical is found to be readily biodegradable, it is categorised as Not Persistent since its half-life is substantially less than 60 days (DoEE, 2017).

C. Environmental Distribution

No experimental data are available for diisobutyl adipate. Using KOCWIN in EPISuite™ (USEPA, 2017), the estimated K_{oc} value from log K_{ow} is 1293 L/kg. The estimated K_{oc} value from the molecular connectivity index (MCI) is 246.5 L/kg. Based upon these K_{oc} values, if released to soil, diisobutyl adipate is not expected to significantly adsorb to soil and has a moderate potential for mobility.

D. Bioaccumulation

No experimental data are available for diisobutyl adipate. Using the bioconcentration factor/bioaccumulation factor (BCFBAF) model in EPISuite™ (USEPA, 2017), the estimated BCF for diisobutyl adipate is 268.7 L/kg based on a regression based estimate. Based on this BCF value, this substance has a low potential for bioaccumulation.

IV. HUMAN HEALTH HAZARD ASSESSMENT

A. Summary

Diisobutyl adipate exhibits low acute toxicity by the oral route. Diisobutyl adipate is non-irritating to the skin and eyes. Diisobutyl adipate are not a skin sensitiser. In repeated dose toxicity study (28-day Oral), the no observed effect level (NOEL) for systemic toxicity was determined to be 1,000 mg/kg bw/day. Diisobutyl adipate is not genotoxic and is not carcinogenic. In a reproductive toxicity study, the no observed adverse effect level (NOAEL) was 1,000 mg/kg/day for reproduction in male and female rats and 300 mg/kg/day for the F1 generation.

B. Acute Toxicity

Oral

An OECD 401 Acute Oral Toxicity test was conducted. The acute oral LD_{50} of diisobutyl adipate was determined to be 12.1 ml/ kg bw (ECHA). [Kl. Score = 2]

Dermal

No experimental data are available for diisobutyl adipate.

Inhalation

No experimental data are available for diisobutyl adipate.

C. Irritation

Skin

Skin irritation testing was conducted under OECD 404: Acute Dermal; Irritation / Corrosion guidelines. Mice were exposed twice a day for 14 days with 100% diisobutyl adipate. At 100%, diisobutyl adipate was non-irritating to the skin (ECHA). [Kl. Score = 2].

Eye

Eye irritation testing was conducted under OECD 405: Acute Eye Irritation guidelines. Rabbits were exposed to 100% diisobutyl adipate. At 100%, diisobutyl adipate was non-irritating to the eye (ECHA). [Kl. Score = 2].

D. Sensitisation

Skin sensitization testing was conducted under OECD 406: Skin Sensitization guidelines. Diisobutyl adipate was applied to humans. Following the first application, a challenge dose was applied at 12 hrs. with a rechallenge at 24 hrs. There were no indication that diisobutyl adipate was a skin sensitizer (ECHA). [Kl. Score = 2].

E. Repeated Dose Toxicity

Oral

An OECD 407: Repeated Dose 28-day Oral Toxicity Study was conducted in rodents. Sprague Dawley rats were administered dose levels of 0, 20, 140, 1,000 milligrams per kilogram body weight per day (mg/kg bw/day) via oral gavage for 28 days. No effects were observed at any dose. Therefore, the NOEL for systemic toxicity was determined to be 1,000 mg/kg bw/day, the highest tested dose (ECHA). [Kl. Score = 2].

Inhalation

No data were available.

Dermal

No data were available.

F. Genotoxicity

In vitro Studies

The results of the *in vitro* genotoxicity studies on diisobutyl adipate are presented in Table 4.

Table 4: *In vitro* Genotoxicity Studies on Diisobutyl Adipate

Test System[1]	Results*		Klimisch Score	Reference
	-S9	+S9		
OECD Guideline 471 (Bacterial Reverse Mutation Assay) S. typhimurium (TA98, TA100, TA135, TA1537, and TA1538)	-	-	1	ECHA
OECD Guideline 472 (Genetic Toxicity: E. coli, Reverse Mutation Assay)	-	-	1	ECHA

*+, positive; -, negative.

In vivo Studies

No data available.

G. Carcinogenicity

No data available.

H. Reproductive Toxicity

Oral

An OECD 421: Reproduction / Developmental Toxicity Screen Test was conducted in rodents. Sprague Dawley rats were administered dose levels of 0, 100, 300, 1,000 mg/kg bw via oral gavage daily for 14 days during the premating exposure period. Treatment continued for 42 days in males and to day 3 of lactation for females.

Copulation, ovulation, fertility, maintenance of pregnancy, and parturition and lactation were not affected by the test compound.

Reproductive parameters (i.e., duration of gestation, number of corpora lutea, implantations and resorptions, litter size, and sex ratio distribution) were comparable among all four groups including controls. In the 1,000 mg/kg group, pup weight on postnatal days 0 and 4 was slightly decreased along with viability on postnatal day 4. Thus, the NOEL was considered to be 1,000 mg/kg/day for reproduction in male and female rats and 300 mg/kg/day for the F1 generation.

Concerning maternal and paternal general toxicity, no mortalities occurred in any group. There were no toxic effects of this chemical on the general condition of male and female animals. Slight suppression of body weight gain was observed in males in 1,000 mg/kg group, while body weight change in females and food consumption in male and female animals in all compound-treated groups were comparable to those in the controls. Macroscopic findings at necropsy and histological findings for the internal genitalia showed no abnormalities. Kidney weights were increased in males and females of the 1,000 mg/kg groups as compared to the control values. Thus the NOEL for general toxicity of this chemical in parent animals was considered to be 300 mg/kg/day (ECHA). [Kl. Score = 2].

Dermal

No data available.

I. Developmental Toxicity

No data available.

V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES

The toxicological reference values developed for diisobutyl adipate follow the methodology discussed in enHealth (2012). The approach used to develop drinking water guidance values is described in the Australian Drinking Water Guidelines (ADWG, 2011).

A. Non-Cancer

Oral

A subchronic repeat dose oral toxicity study was conducted in rodents. No effects were observed at any dose. Therefore, the NOEL for systemic toxicity was determined to be 1,000 mg/kg bw/day, the highest tested dose). The NOEL of 1,000 mg/kg bw/day will be used for determining the oral reference dose (RfD) and the drinking water guidance value.

Oral Reference Dose (oral RfD)

Oral RfD = NOAEL / (UF_A x UF_H x UF_L x UF_{Sub} x UF_D)

Where:

UF_A (interspecies variability) = 10
UF_H (intraspecies variability) = 10
UF_L (LOAEL to NOAEL) = 1
UF_{Sub} (subchronic to chronic) = 10
UF_D (database uncertainty) = 1
Oral RfD = 1000/(10 x 10 x 1 x 10 x 1) = 1000/1000 = 1 mg/kg/day

Drinking water guidance value

Drinking water guidance value = (animal dose) x (human weight) x (proportion of intake from water) / (volume of water consumed) x (safety factor)

Using the oral RfD,

Drinking water guidance value = (oral RfD) x (human weight) x (proportion of water consumed) / (volume of water consumed)

Where:

Human weight = 70 kg (ADWG, 2011)
Proportion of water consumed = 10% (ADWG, 2011)
Volume of water consumed = 2L (ADWG, 2011)
Drinking water guidance value = (1 x 70 x 0.1)/2 = 3.5 mg/L

B. Cancer

Studies on carcinogenicity were not available. Thus, a cancer reference value was not derived.

VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES

Diisobutyl adipate does not exhibit the following physico-chemical properties:

- Explosivity
- Flammability
- Oxidising potential

VII. ENVIRONMENTAL HAZARD ASSESSMENT

A. Summary

Diisobutyl adipate is of low toxicity concern to aquatic organisms.

B. Aquatic Toxicity

Acute Studies

Table 5 lists the results of acute aquatic toxicity data for diisobutyl adipate.

Table 5: Acute Aquatic Toxicity Studies on Diisobutyl Adipate

Test Species	Endpoint	Results (mg/L)	Klimisch Score	Reference
Oryzias latipes	96-hour LC_{50}	3.7	1	ECHA
Daphnia magna	24-hour LC_{50}	17	1	ECHA
Selenastrum sp.	72-hour EC_{50}	2.8	1	ECHA

Chronic Studies

Long-term aquatic toxicity test of diisobutyl adipate was conducted in invertebrates. The chronic toxicity to Daphnia magna (OECD 211) was studied with a 21-d reproduction test in a semistatic system. The test solution was renewed 3 times per week. The 21-day no observed effect concentration (NOEC) was determined to be 5.6 mg/L for reproduction and survival of the adult test animals (ECHA) [Kl. Score = 1].

Diisobutyl adipate has also been evaluated for its toxicity towards the fresh water algae *Selenastrum capricornutum* in an Alga growth inhibition test according to OECD 201 under GLP requirements. The exposure duration was 72 hours under static conditions. The 72-hr NOEC (biomass) determined from the study was 2 mg/L (ECHA) [Kl. Score = 1].Sediment Toxicity

No data available

C. Terrestrial Toxicity

No data available

D. Calculation of PNEC

The PNEC calculations for siloxanes follow the methodology discussed in DEWHA (2009).

PNEC Water

Experimental results are available for three trophic levels. Acute E(L)C_{50} values are available for fish (3.7mg/L), invertebrates (17 mg/L) and algae (2.8 mg/L). Results from chronic studies are also available for two trophic levels (invertebrates and algae), with the lowest NOEC value being 2 mg/L for algae. On the basis that the data consists of short-term studies for three trophic levels and long-term results studies for two trophic levels, an assessment factor of 50 has been applied to the lowest reported NOEC of 2 mg/L for algae. The $PNEC_{water}$ is 0.04 mg/L.

PNEC Sediment

There are no toxicity data for sediment-dwelling organisms. Therefore, the $PNEC_{sed}$ was calculated using the equilibrium partitioning method. The $PNEC_{sed}$ is 0.17 mg/kg sediment wet weight.

The calculations are as follows:

$PNEC_{sed} = (K_{sed\text{-}water}/BD_{sed}) \times 1{,}000 \times PNEC_{water}$

$= (5.53/1{,}280) \times 1{,}000 \times 0.04$

$= 0.17$ mg/kg

Where:

$K_{sed\text{-}water}$ = suspended matter-water partition coefficient (cubic metre per cubic metre [m^3/m^3])

BD_{sed} = bulk density of sediment (kg/m^3) = 1,280 [default]

$K_{sed\text{-}water} = 0.8 + [(0.2 \times Kp_{sed})/1{,}000 \times BD_{solid}]$

$= 0.8 + [(0.2 \times 9.86/1{,}000 \times 2{,}400]$

$= 5.53\ m^3/m^3$

Where:

Kp_{sed} = solid-water partition coefficient (L/kg).

BD_{solid} = bulk density of the solid phase (kg/m^3) = 2,400 [default]

$Kp_{sed} = K_{oc} \times f_{oc}$

= 246.5 x 0.04

= 9.86 L/kg

Where:

K_{oc} = organic carbon normalized distribution coefficient (L/kg). The K_{oc} for diisobutyl adipate calculated from EPISUITE™ using the MCI is 246.5 L/kg .

F_{oc} = fraction of organic carbon in sediment = 0.04 [default].

PNEC Soil

There is no toxicity data for terrestrial or soil organisms. Therefore, the $PNEC_{soil}$ was calculated using the equilibrium partitioning method. The $PNEC_{soil}$ is 0.13 mg/kg soil dry weight.

The calculations are as follows:

$PNEC_{soil} = (Kp_{soil}/BD_{soil}) \times 1000 \times PNEC_{water}$

= (4.93/1500) x 1000 x 0.04

= 0.13 mg/kg

Where:

Kp_{soil} = soil-water partition coefficient (m^3/m^3)

BD_{soil} = bulk density of soil (kg/m^3) = 1,500 [default]

$Kp_{soil} = K_{oc} \times f_{oc}$

= 246.5 x 0.02

= 4.93 m^3/m^3

Where:

K_{oc} = organic carbon normalised distribution coefficient (L/kg). The K_{oc} for diisobutyl adipate calculated from EPISUITE™ using the MCI is 246.5 L/kg .

VIII. PERSISTENCE, BIOACCUMULATION AND TOXICITY (PBT) ASSESSMENT

The methodology for the Persistent, Bioaccumulative and Toxic (PBT) substances assessment is based on the Australian and EU REACH Criteria methodology (DEWHA, 2009; ECHA, 2017).

Diisobutyl adipate is readily biodegradable and thus does not meet the screening criteria for persistence.

Based on a measured log K_{ow} of 4.3 diisobutyl adipate does not meet the screening criteria for bioaccumulation.

The lowest chronic NOEC for diisobutyl adipate is >0.1 mg/L. The acute $E(L)C_{50}$ values are >1 mg/L. Thus, diisobutyl adipate does not meet the screening criteria for toxicity.

The overall conclusion is that diisobutyl adipate is not a PBT substance.

IX. CLASSIFICATION AND LABELLING

A. Classification

None

B. Signal word

No signal word

C. Pictogram

Not applicable

X. HANDLING AND SAFETY INFORMATION (OCCUPATIONAL LIMITS AND TRANSPORTATION REQUIREMENTS)

A. First Aid

Please refer to the product safety data sheet (SDS) for additional information and for confirmation of the information provided herein.

Eye Contact

Immediately flush open eyes with plenty of water for at least 15 minutes. Remove contacts, if present and easy to do. Get medical attention immediately, preferably a physician for an ophthalmologic examination.

Skin Contact

For minor skin contact, avoid spreading material on unaffected skin. Remove and isolate contaminated clothing. Wash the contaminated area of the body with soap and fresh water. Get medical attention. Launder contaminated clothing before reuse.

Inhalation

Move person to fresh air. Administer oxygen if breathing is difficult. Do not use mouth-to-mouth method if victim inhaled the substance; give artificial respiration with the air of a pocket mask equipped with a one-way valve or other proper respiratory medical device. Give artificial respiration if victim is not breathing. Get medical attention immediately.

Ingestion

Do not induce vomiting. Get medical attention immediately.

Notes to Physician

All treatments should be based on observed signs and symptoms of distress in the patient.

B. Fire Fighting Information

Extinguishing Media

Use water spray or fog, foam, dry chemical or carbon dioxide.

Specific Exposure Hazards

Emits toxic fumes under fire conditions. Depending on conditions, decomposition products may include the following: carbon dioxide, carbon monoxide.

Special Protective Equipment for Firefighters

Wear self-contained breathing apparatus and chemical-protective clothing.

C. Accidental Release Measures

Personal Precautions

Isolate area. Keep unnecessary and unprotected personnel from entering the area. Use personal protective clothing. Ensure adequate ventilation. Wear respiratory protection if ventilation is inadequate. Do not breath mist, vapours or spray. Avoid contact with skin, eyes and clothing. Eliminate all sources of ignition.

Environmental Precautions

Prevent from entering sewers, waterways or low areas.

Steps to be Taken if Material is Released or Spilled

Eliminate all sources of ignition. Pick up with suitable absorbent material and transfer to a container for chemical waste. For large amounts: dike spillage and pump off product into container for chemical waste. Dispose of contaminated material as prescribed.

D. Storage And Handling

General Handling

Keep away from heat, sparks and flame. Avoid contact with eyes, skin and clothing. Avoid breathing vapour. Wash thoroughly after handling. Keep container closed. Use with adequate ventilation.

Storage

Keep container tightly closed. Store away from heat and light.

E. Exposure Controls / Personal Protection

Occupational Exposure Standards

Workplace Australia has not established an occupational exposure standard for diisobutyl adipate.

Engineering Controls

Good general ventilation should be used. Ventilation rates should be matched to conditions. If applicable, use process enclosures, local exhaust ventilation, or other engineering controls to maintain airborne levels below recommended exposure limits. If exposure limits have not been established, maintain airborne levels to an acceptable level.

Personal Protection Equipment

Respiratory Protection: If workers are exposed to concentrations above the exposure limit, they must use appropriate, certified respirators. If there are no applicable exposure limit requirements or guidelines, use an approved respirator. Selection of air-purifying or positive pressure supplied-air will depend on the specific operation and the potential airborne concentration of the product. For emergency conditions, use an approved positive-pressure self-contained breathing apparatus. The following should be an effective type of air-purifying respirator: organic vapour cartridge with a particulate pre-filter.

Hand Protection: Use gloves chemically resistant to this material. Consult the SDS for appropriate glove barrier materials.

Skin Protection: Use protective clothing chemically resistant to the material. Selection of specific items such as face shield, boots, apron or full body suit will depend on the task.

Eye Protection: Use chemical goggles.

Other Precautions: Wash hands, forearms and face thoroughly after handling chemical products; before eating, smoking and using the lavatory; and at the end of the working period. Appropriate techniques should be used to remove potentially contaminated clothing. Wash contaminated clothing before reusing. Ensure that eyewash stations and safety showers are close to the workstation location.

F. Transport Information

UN number: none

XI. DISPOSAL MANAGEMENT

Disposal should be in accordance with all local, state and federal regulations.

XII. REGULATORY STATUS

Australian AICS Inventory: Listed.

XIII. REFERENCES

ADWG. (2011). National Water Quality Management Strategy. Australian Drinking Water Guidelines, Section 6, Australian Government, National Health and Medical Research Council, Natural Resource Management Ministerial Council. Updated January 2022. Available: https://www.nhmrc.gov.au/about-us/publications/australian-drinking-water-guidelines

Department of the Environment, Water, Heritage and the Arts (DEWHA). (2009). Environmental risk assessment guidance manual for industrial chemicals, Department of the Environment, Water, Heritage and the Arts, Commonwealth of Australia. Available: http://www.nepc.gov.au/resource/chemical-risk-assessment-guidance-manuals

Department of the Environment and Energy (DoEE). (2017). Chemical Risk Assessment Guidance Manual: for chemicals associated with coal seam gas extraction, Guidance manual prepared by Hydrobiology and ToxConsult Pty Ltd for the Department of the Environment and Energy, Commonwealth of Australia, Canberra.

ECHA. ECHA REACH database: http://echa.europa.eu/information-on-chemicals/registered-substances

enHealth Human Risk Assessment (HHRA). (2012). Environmental Health Risk Assessment, Guidelines for Assessing Human Health Risks from Environmental Hazards. Office of Health Protection of the Australian Government Department of Health. Available: https://www1.health.gov.au/internet/main/publishing.nsf/Content/health-pubhlth-publicat-environ.htm

European Chemicals Agency (ECHA). (2017). Guidance on Information Requirements and Chemical Safety Assessment, Chapter R11: PBT Assessment, European Chemicals Agency, Helsinki, Finland. Available: https://echa.europa.eu/guidance-documents/guidance-on-information-requirements-and-chemical-safety-assessment

Klimisch, H.J., Andreae, M., and Tillmann, U. (1997). A systematic approach for evaluating the quality of experimental and toxicological and ecotoxicological data. Regul. Toxicol. Pharmacol. 25:1-5.

United States Environmental Protection Agency (USEPA). (2017). EPISuite™ v. 4.11, United States Environmental Protection Agency, Office of Pollution Prevention and Toxics and Syracuse Research Corporation. Available: https://www.epa.gov/tsca-screening-tools/epi-suitetm-estimation-program-interface.

USEPA. CompTox Chemicals Dashboard. https://comptox.epa.gov/dashboard/

DIETHYLENE TRIAMINE PENTA(METHYLENE PHOSPONIC ACID), SODIUM SALT

This dossier on diethylene triamine penta(methylene phosphonic acid), sodium salt (DTPMP sodium salt) presents the most critical studies pertinent to the risk assessment of DTPMP sodium salt in coal seam or shale gas extraction activities. It does not represent an exhaustive or critical review of all available data. The information presented in this dossier was obtained primarily from the ECHA database that provides information on chemicals that have been registered under the EU REACH (ECHA), and from the OECD-SIDS documents on the Phosphonic Acid Compounds Group 3 category, which includes DTPMP and its sodium salts (OECD, 2004a,b). Where possible, study quality was evaluated using the Klimisch scoring system (Klimisch et al., 1997).

I. SUBSTANCE IDENTIFICATION

Chemical Name (IUPAC): [bis[2-[bis(phosphonomethyl)amino]ethyl]amino]methylphosphonic acid; sodium salt

CAS RN: 22042-96-2

Molecular formula: $C_9H_{28}N_3O_{15}P_5.xNa$

Molecular weight: Not applicable. This substance is a UVCB substance.

Synonyms: Diethylene triamine penta(methylene phosphonic acid), sodium salt; [[(phosphonomethyl)imino]bis[(ethylenenitrilo)bis(methylene)]]tetrakisphosphonic acid, sodium salt phosphonic acid, ((bis(2-(bis(phosphonomethyl)amino)ethyl)amino)methyl)-, sodium salt; hepta sodium salt of diethylene triamine penta (methylene phosphonic acid)

SMILES: [Na+].OP(=O)(O)CN(CCN(CP(=O)(O)O)CP(=O)(O)O)CCN(CP(=O)(O)O)CP(=O)(O)[O-]

II. PHYSICO-CHEMICAL PROPERTIES

Key physical and chemical properties for the substance are shown in Table 1.

Table 1: Overview of the Physico-Chemical Properties of DTPMP (CAS-RN 15827-60-8) and DTPMP Sodium Salt

Property	Value	Klimisch Score	Reference
Physical state at 20°C and 101.3 kPa	Brown liquid	2	ECHA
Melting Point	>450°C (DTPMP) (pressure not provided)	1	ECHA
Boiling Point	>480°C (DTPMP) (pressure not provided_	1	ECHA
Density	1300 to 1400 kg/m^3 (DTPMP) @ 20°C	2	ECHA
Vapour Pressure	Negligible	2	ECHA
Partition Coefficient (log K_{ow})	-3.4 (DTPMP) (temperature not provided)	2	ECHA
Water Solubility	>520 g/L @ 25°C (DTPMP)	2	ECHA
Dissociation Constant (pKa)	1.03 – 12.58 (temperature not provided)	2	ECHA

DTPMP can ionise by loss of a hydrogen ion up to six times. Thus, it is a strong complexing agent and is highly hydrophilic. The sodium salts of DTPMP will dissolve readily in water to give a speciation state that is dictated by the pH of the aqueous medium. DTPMP has 10 possible ionisation states. Eight pK_a values were reported by Martell and Sillen (1968): 2.8, 4.45, 5.5, 6.38, 7.17, 8.15, 10.1, and 12.04, which were measured in 0.1 M potassium chloride. In a source giving no experimental details, DTPMP is described as having 10 pK_a values: 1.03, 2.08, 3.11, 4.15, 5.19, 6.23, 7.23, 8.30, 11.18, and 12.58 (Tomson et al., 1994).

At pH 7, DTPMP will be almost fully ionised in water five times, with a majority of the molecules ionised six times, and some seven or eight times.

DTPMP, sodium salt (CAS RN 22042-96-2) is a UVCB substance (unknown variable composition or biological substance) that can potentially have 1-10 sodium salts.

This dossier contains information on DTPMP (CAS RN 15827-60-8), as well as the sodium salts of DTPMP. The read-across of the acid to the sodium salts is justified because sodium is not significant with respect to the properties under consideration in this dossier. In dilute aqueous conditions of defined pH, a salt will be completely dissociated and will behave no differently to the parent acid, at the identical concentration of the particular speciated form present. Thus, some properties (measured or expressed in aqueous media) for a salt can be directly read-across (with suitable mass correction) to the parent acid and vice versa; the effect of the sodium ion, in this case, will not be significant. In biological systems and the environment, polyvalent metal ions will be present, and the phosphonate ions show very strong affinity to them (OECD, 2004b).

III. ENVIRONMENTAL FATE PROPERTIES

A. Summary

DTPMP sodium salt is not biodegradable, and it adsorbs strongly to sediment and soil. However, there are degradation modes operative in the environment which could prevent long-term persistence. DTPMP sodium salt has a low potential for bioaccumulation.

B. Partitioning

As discussed earlier, DTPMP acid and its salts behave in aqueous medium in accordance with the pH and composition of the medium. DTPMP acid and its salts will partition primarily to water and suspended sediments. It is highly soluble.

Photodegradation in the presence of common metal ions has been observed. Half-lives less than 1 hour were measured for sodium salt of DTPMP in water at pH 3, pH 5-6 and at pH 10, irradiated by a middle pressure mercury lamp emitting between 190 and 600 nanometres. Half-lives were found to be shorter in the presence of iron ions at environmentally relevant concentrations (Lesueur et al., 2005).

C. Biodegradation

In a Zahn-Wellens/EMPA (OECD 302B) test, there was no biodegradation after 28 days (ECHA) [Kl. score = 2]. There was also no biodegradation after 28 days in an OECD 301E test (ECHA) [Kl. score = 1].

Using [^{14}C]-DTPMP, there was 64% and 62.6% biodegradation in riverbank soil and silt loam soil, respectively, after 148 days (ECHA) [Kl. score = 2].

There are degradation modes operative in the environment that could prevent long-term persistence. For instance, although biodegradation in soil has not been demonstrated for DTPMP and its salts, the role of abiotic removal processes is significant. The key data for soil adsorption are from the study by Michael (undated). There is no evidence for desorption occurring. Effectively irreversible binding is entirely consistent with the known behaviour of complexation and binding within crystal lattices. Largely irreversible binding is interpreted as a removal process; 5% remaining after 40 to 50 days, which is equivalent to a half-life of 10 days (Monsanto internal report, cited by Gledhill and Feijtel, 1992). This abiotic removal rate is used in the chemical safety assessment of DTPMP and its salts. The available weight of evidence shows that removal from solution to a non-bioavailable bound form, and abiotic mechanisms, are important in the environmental exposure and risk assessment (ECHA).

D. Environmental Distribution

DTPMP sodium salt adsorbs strongly to inorganic surfaces, soils, and sediments. The nature of the adsorption is believed to be primarily due to interaction with inorganic substrates and not to organic carbon (OECD, 2004b).

A K_{oc} value of 9,748 was obtained for DTPMP by evaluating $K_{p(sediment\text{-}water)}$ data from a study by Michael (1979).

Based on this K_{oc} value and its solubility value (> 520 g/L), and assuming no biodegradability, if released to water DTPMP sodium salt will partition primarily to water and suspended sediments.

E. Bioaccumulation

DTPMP exhibits a low potential for bioaccumulation. After 28 days, the BCF values in carp were <10 and <94 for concentrations of 18.8 and 2.03 milligrams per litre (mg/L), respectively (ECHA). [Kl. score = 1]

IV. HUMAN HEALTH HAZARD ASSESSMENT

A. Summary

The acute toxicity of DTPMP sodium salt is low by the oral and dermal routes. DTPMP sodium salt is slightly irritating to the skin and non-irritating to the eyes. DTPMP is not a skin sensitiser. Rats given repeated oral doses of DTPMP sodium salt in their diet showed alterations in iron and calcium homeostasis as evidenced by certain haematological changes and bone density, respectively. The changes in calcium homeostasis were not sufficient to alter serum calcium levels. While one *in vitro* genotoxicity study showed a positive response, other genotoxicity studies conducted both *in vitro* and *in vivo* showed no mutagenic or genotoxic response. Rat studies given high oral DTPMP sodium salt by oral gavage showed a low potential for reproductive and developmental toxicity.

B. Acute Toxicity

<u>Oral</u>

The oral LD_{50} of the heptasodium salt of DTPMP (CAS RN 68155-78-2) in rats was >10 mL/kg, which was calculated to be equivalent to >5,838 mg active salt/kilogram (kg) (ECHA) [Kl. score = 1]. The oral LD_{50} of a heptasodium salt of DTPMP was <15 mL/kg or <6,881 mg active salt/kg (ECHA) [Kl. score = 1]. The oral LD_{50} of a heptasodium salt of DTPMP was >5,000 mg/kg or >1,650 mg active salt/kg

(ECHA) [Kl. score = 2]. The oral LD_{50} of a heptasodium salt of DTPMP was >9,000 mg/kg or >3,870 mg active salt/kg (ECHA) [Kl. score = 2].

Inhalation

No inhalation studies are available.

Dermal

The dermal LD_{50} of a sodium salt of DTPMP was >10 mL/kg, which was calculated to be >5,838 mg active salt/kg or >4,602 mg parent acid/kg (ECHA) [Kl. score = 1]. The dermal LD_{50} of a sodium salt of DTPMP was >2,000 mg/kg, which was calculated to be >860 mg active salt/kg (ECHA) [Kl. score = 2]. The dermal LD_{50} of a heptasodium salt of DTPMP was >5 mL/kg, which was calculated to be >2,145 mg active salt/kg (ECHA) [Kl. score = 2].

C. Irritation

Application of 0.5 millilitres (mL) DTPMP sodium salt to the skin of rabbits for four hours under semi-occlusive conditions was only slightly irritating. The primary dermal irritation index was 0.75 (ECHA). [Kl. score = 1]

Instillation of 0.1 mL DTPMP sodium salt into the eyes of rabbits was not irritating (ECHA). [Kl. score = 1

D. Sensitisation

DTPMP sodium salt was not a skin sensitizer in a guinea pig maximization test (ECHA). [Kl. score = 2]

E. Repeat Dose Toxicity

Oral

Male and female Wistar rats were given 0, 100, 1,000, or 10,000 parts per million (ppm) DTPMP sodium salt in their diet for 90 days. The calculated daily intakes were: 0, 8.2, 82.3, and 841.9 mg/kg-day for males; and 0, 9.2, 92.3, and 902.6 mg/kg-day for females. There were no deaths during the study. At 10,000 ppm, minor changes were seen in haematological parameters (red blood cell count was significantly increased; mean cell volume and mean cell haemoglobin concentration were significantly decreased). Total serum iron was decreased in the 10,000 ppm females only, while total serum iron binding capacity was increased in the 10,000 ppm males only. A reduction in iron complexes and reduced pigmentation for age was noted in the spleens of the 10,000 ppm animals. The changes in haematological parameters and serum iron and binding capacity were considered by the study authors to be perturbations of iron homeostasis as a result of the iron binding capacity of DTPMP, which is a chelating agent. Bone density was significantly increased in both sexes in the 10,000-ppm dose group, and the incidence of microlithiasis (formation of minute calculi) in the kidney was reduced in all dose groups; these changes were considered indicative of the effect of the test material on calcium homeostasis due to its chelating ability. There was, however, no change in calcium plasma levels. The no observed adverse effect level (NOAEL) for this study is 1,000 ppm based on the changes in hematology and bond density; this corresponds to 82.5 and 92.3 mg/kg-day for males and females, respectively (ECHA, OECD 2002a). [Kl. score = 1]

Inhalation

No studies are available.

Dermal

No studies are available.

F. Genotoxicity

The results of the *in vitro* genotoxicity studies on DTPMP sodium salts are presented in Table 2.

In vitro Studies

Table 2: *In vitro* Genotoxicity Studies on DTPMP Sodium Salts

Test System	Results*		Klimisch Score	References
	-S9	+S9		
Bacterial reverse mutation (S. typhimurium and E. coli strains)	-	-	1	ECHA, OECD (2004a, b)
Mammalian cell gene mutation (mouse lymphoma L5178Y cells)	-	-	2	ECHA, OECD (2004a, b)
Chromosomal aberration (Chinese hamster lung cells)	**	**	1	ECHA

*+, positive; -, negative
**For the 6-hour pulse treatment and the 24-hour continuous treatment, the results were negative with and without metabolic activation. For the 48-hour continuous treatment, the results were positive, but no information is provided on whether this occurred with and/or without metabolic activation.

In vivo Studies

Male and female SD rats were given a single oral dose of an aqueous solution containing 19.7% DTPMP sodium salt (neutralized to pH 7) at doses of 0, 200, 660, and 1,970 mg active acid/kg. At the high dose, 25% of the animals died, and there were mild clinical signs of toxicity and reduced body weights in both sexes. There was no evidence of chromosomal aberrations in the bone marrow cells in either sex at any dose level (ECHA; OECD, 2004a,b). [Kl. score = 2]

G. Carcinogenicity

No studies are available.

H. Reproductive Toxicity

A reproductive toxicity study was conducted on DTPMP sodium salt in rats via the diet. The females were treated over two generations and males over one generation. concentrations were 0, 300, 1,000, and 3,000 ppm; the daily intakes were calculated to be 0, 28, 97, and 294 mg/kg-day for males and 0, 32, 108, and 312 mg/kg-day for females. The 3,000 ppm F0 females delivered fewer live pups with lower body weights (both effects were not statistically significant). Pregnancy rate (not statistically significant) and a reduced pup weight (statistically significant) was seen in the F2a litters from the 3,000 ppm dams. These changes were not seen in the F1 litters or replicated in the F2b

litters. The NOAEL for reproductive toxicity was determined to be 3,000 ppm, which corresponds to 294 and 312 mg/kg-day for males and females, respectively (ECHA; OECD 2004a,b). [Kl. score = 2]

A three-generation reproductive toxicity study was conducted on DTPMP sodium salt in rats via the diet. The concentrations were 0, 300, 1,000, and 3,000 ppm. There was no systemic, reproductive or developmental toxicity at any dose level. The NOAEL for this study is 3,000 ppm, which was calculated to be 275 mg/kg-day for males and 310 mg/kg-day for females (ECHA). [Kl. score = 2]

I. Developmental Toxicity

Pregnant female SD rats were dosed by oral gavage with 0, 500, 1,000, or 2,000 mg/kg DTPMP during GD 6-15. Toxicity was observed in the 2,000 mg/kg dams as evidenced by an approximate 30% decrease in body weight gain and by the appearance of soft stools. There was no developmental toxicity. The NOAELs for maternal and developmental toxicity were 1,000 and 2,000 mg/kg-day, respectively (ECHA; OECD 2004a,b). [Kl. score = 2]

Pregnant female CD-1 mice were dosed by oral gavage with 0, 100, 500, or 1,000 mg/kg DTPMP during GD 6-15. There were no maternal or developmental toxicity. The NOAEL for maternal and developmental toxicity is 1,000 mg/kg-day, the highest dose tested (ECHA). [Kl. score = 2].

V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES

The toxicological reference values developed for DTPMP follow the methodology discussed in enHealth (2012). The approach used to develop drinking water guidance values is described in the Australian Drinking Water Guidelines (ADWG, 2011).

A. Non-Cancer

<u>Oral</u>

A 90-day dietary study was conducted on a sodium salt of DTPMP using rats. The rats of both sexes showed changes in hematology and bone density that were indicative of alterations in iron and calcium homeostasis, due to the chelating ability of DTPMP. The NOAEL for this study was 10,000 ppm, which corresponds to 82.5 and 92.3 mg/kg-day for males and females, respectively. The NOAEL of 82.5 mg/kg-day will be used for determining the oral Reference dose (RfD) and the drinking water guidance value.

Oral Reference Dose (oral RfD)

Oral RfD = NOAEL / (UF_A x UF_H x UF_L x UF_{Sub} x UF_D)

Where:
UF_A (interspecies variability) = 10
UF_H (intraspecies variability) = 10
UF_L (LOAEL to NOAEL) = 1
UF_{Sub} (subchronic to chronic) = 3
UF_D (database uncertainty) = 1

Oral RfD = 82.5/(10 x 10 x 1 x 3 x 1) = 82.5/300 = <u>0.3 mg/kg-day</u>

Drinking water guidance value

Drinking water guidance value = (animal dose) x (human weight) x (proportion of intake from water) / (volume of water consumed) x (safety factor)

Using the oral RfD,

Drinking water guidance value = (oral RfD) x (human weight) x (proportion of water consumed) / (volume of water consumed)

Where:
Human weight = 70 kg (ADWG, 2011)
Proportion of water consumed = 10% (ADWG, 2011)
Volume of water consumed = 2L (ADWG, 2011)

Drinking water guidance value = (0.3 x 70 x 0.1)/2 = 1.0 mg/L

B. Cancer

There are no carcinogenicity studies on DTPMP and its sodium salts. Thus, a cancer reference value was not derived.

VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES

DTPMP sodium salt does not exhibit the following physico-chemical properties:

- Explosivity
- Flammability
- Oxidising potential

VII. ENVIRONMENTAL HAZARD ASSESSMENT

A. Summary

DTPMP and its sodium salts are of low toxicity concern to aquatic organisms.

B. Aquatic Toxicity

Acute Studies

No acute toxicity studies are available for the sodium salts of DTPMP. Table 3 lists the results of acute aquatic toxicity studies on DTPMP.

Table 3: Acute Aquatic Toxicity Studies on DTPMP

Test Species	Endpoint	Results (mg active acid/L)	Klimisch Score	Reference
Oncorhynchus mykiss	96-hour LC_{50}	180 - 252 (mean: 216)	2	ECHA
Chironomus tentans	48-hour EC_{50}	7,589	2	ECHA

Algal studies have also been conducted on DTPMP and its sodium salts, but the results have not been provided because of the following confounding factors:

1. Algal growth may be stimulated by the presence of supplementary phosphorus released by the photolytic degradation of phosphonic acids.
2. Algal growth may be inhibited by the complexation of micronutrients (trace metals) by phosphonic acids. This inhibition is an algistatic rather than algicidal effect. Under the standard test conditions used for most studies, the trace metals will be fully and strongly bound to the DTPMP, with the strong possibility that their bioavailability will have been reduced considerably.

Chronic Studies

The 60-day NOEC of DTPMP in *Oncorhynchus mykiss* was determined to be 25.6 mg active acid/L (ECHA). [Kl. score = 1]

The value of 25.6 mg equivalent active acid/L can be converted to units of mg DTPMP-xNa salt/L at relevant conditions of pH by considering the ionisation state of DTPMP (CAS No. 15827-60-8) at the 25.6 mg/L concentration. At pH 6 (the expected value of the test medium), DTPMP is ionised six times (pK_a6 = pH 6.23). Also for the calculation, the number of hydrogen atoms substituted by the sodium salt is removed, which is seven. The calculation is as follows:

MW of DTPMP-7Na / MW of DTPMP = 573.2 + ((21.982 – 1.008) x 6) / 573.2 = 1.22

25.6 mg DTPMP/L x 1.22 = 31 mg DTPMP-xNa/L

C. Terrestrial Toxicity

The 14-day dietary LC_{50} values to the Mallard duck (*Anas platyrhynchos*) and Bobwhite quail (*Colunus virginianus*) are >454 mg/kg; there was no mortality at the highest dose tested (OECD, 2004a, b).

D Calculation of PNEC

The PNEC calculations for DTPMP sodium salt follow the methodology discussed in DEWHA (2009).

PNEC Water

Experimental results are available for two trophic levels for DTPMP, but not for the sodium salts of DTPMP. Acute E(L)C50 values are available for fish (216 mg/L) and invertebrates (7,589 mg/L). Results are available for a fish chronic study (31 mg DTPMP sodium salt/L). On the basis that the data consists of short-term results from two trophic levels and long-term results from onetrophic level, an assessment factor of 100 has been applied to the chronic NOEC of 31 mg/L for fish. The $PNEC_{water}$ is 0.31 mg DTPMP sodium salt/L.

PNEC Sediment

There are no toxicity data for sediment-dwelling organisms. Therefore, the $PNEC_{sed}$ was calculated using the equilibrium partitioning method. The $PNEC_{sed}$ is 46 mg DTPMP sodium salt/kg sediment wet weight.

The calculations are as follows:

$PNEC_{sed} = (K_{sed\text{-}water}/BD_{sed}) \times 1000 \times PNEC_{water}$
$= (188/1280) \times 1000 \times 0.31$
$= 46$ mg/kg

Where:
$K_{sed\text{-}water}$ = suspended matter-water partition coefficient (m^3/m^3)
BD_{sed} = bulk density of sediment (kg/m^3) = 1,280 [default]
$K_{sed\text{-}water} = 0.8 + [0.2 \times (Kp_{sed}/1000) \times BD_{solid}]$
$= 0.8 + [0.2 \times (390/1000) \times 2400]$
$= 188\ m^3/m^3$

Where:
Kps_{ed} = solid-water partition coefficient (L/kg).
BD_{solid} = bulk density of the solid phase (kg/m3) = 2,400 [default]
$Kp_{sed} = K_{oc} \times f_{oc}$
$= 9,748 \times 0.04$
$= 390$ L/kg

Where:
K_{oc} = organic carbon normalized distribution coefficient (L/kg). The K_{oc} for DTPMP was estimated to be 9,748 L/kg (OECD 2004a,b).

F_{oc} = fraction of organic carbon in sediment = 0.04 [default].

PNEC Soil

There are no toxicity data for terrestrial or soil organisms. Therefore, the $PNEC_{soil}$ was calculated using the equilibrium partitioning method. The $PNEC_{soil}$ is 40 mg DTPMP sodium salt/kg soil dry weight.

The calculations are as follows:

$PNEC_{soil} = (Kp_{soil}/BD_{soil}) \times 1000 \times PNEC_{water}$
$= (195/1500) \times 1000 \times 0.31$
$= 40$ mg/kg

Where:
Kpsoil = soil-water partition coefficient (m^3/m^3)
BDsoil = bulk density of soil (kg/m3) = 1,500 [default]

$Kp_{soil} = K_{oc} \times f_{oc}$
$= 9,748 \times 0.02$
$= 195\ m^3/m^3$

Where:
K_{oc} = organic carbon normalised distribution coefficient (L/kg). The K_{oc} for DTPMP was estimated to be 9,748 L/kg (OECD 2004a,b).
F_{oc} = fraction of organic carbon in soil = 0.02 [default].

VIII. PERSISTENCE, BIOACCUMULATION AND TOXICITY (PBT) ASSESSMENT

The methodology for the Persistent, Bioaccumulative and Toxic (PBT) substances assessment is based on the Australian and EU REACH Criteria methodology (DEWHA, 2009; ECHA, 2017).

DTPMP and its sodium salts are not readily biodegradable; thus, they meet the screening criteria for persistence.

The BCF values from a fish study are <10 and <94 for concentrations of 18.8 and 2.03 mg/L, respectively. Thus, DTPMP sodium salt does not meet the screening criteria for bioaccumulation.

The NOEC from a chronic fish study on DTPMP is >0.1 mg/L. Thus, DTPMP and its sodium salts do not meet the screening criteria for toxicity.

The overall conclusion is that DTPMP sodium salt is not a PBT substance.

IX. CLASSIFICATION AND LABELLING

A. Classification

Metal Corrosive Category 1

B. Labelling

Warning

C. Pictogram



X. HANDLING AND SAFETY INFORMATION (OCCUPATIONAL LIMITS AND TRANSPORTATION REQUIREMENTS)

A. First Aid

Eye Contact

In case of contact, immediately flush eyes with plenty of water for at least 15 minutes.

Skin Contact

Wash thoroughly with soap and water.

Ingestion

Rinse mouth with water and then drink plenty of water. Never give anything by mouth to an unconscious person.

Inhalation

If inhaled, remove from area to fresh air. Get medical attention.

B. Fire Fighting Information

Extinguishing Media

Water spray, carbon dioxide, foam, dry chemical.

Specific Exposure Hazards

Keep product and empty container away from heat and sources of ignition. May emit toxic fumes under fire conditions. Depending on conditions, decomposition products may include the following: carbon monoxide carbon dioxide nitrogen oxides phosphorus oxides, phosphine.

Special Protective Equipment for Firefighters

Wear self-contained breathing apparatus and chemical-protective clothing.

C. Accidental Release Measures

Personal Precautions

Use appropriate protective equipment. Handle in accordance with good industrial hygiene and safety practice.

Environmental Precautions

Prevent from entering sewers, waterways, or low areas.

Steps to be Taken if Material is Released or Spilled

Soak up with inert absorbent material. Dispose of contaminated material as prescribed.

D. Storage And Handling

General Handling

Keep product and empty container away from heat and sources of ignition. Ensure adequate ventilation, especially in confined areas.

Storage

Keep container tightly closed and in a dry and well-ventilated place. Keep in a cool place.

E. Exposure Controls / Personal Protection

Occupational Exposure Standards

Workplace Australia has not established an occupational exposure standard for DTPMP sodium salt.

Engineering Controls

Good general ventilation should be used.

Personal Protection Equipment

Respiratory Protection: Respiratory protection is not required.

Hand Protection: Chemical resistant protective gloves.

Skin Protection: Body protection must be chosen depending on activity and possible exposure.

Eye protection: Safety glasses with side-shields.

Other Precautions: Handle in accordance with good industrial hygiene and safety practice. Wearing of closed work clothing is recommended. Ensure that eyewash stations and safety showers are close to the workstation location.

F. Transport Information

UN 3265 CORROSIVE LIQUID, ACIDIC, ORGANIC N.O.S. (diethylene triamine penta(methylene phosphonic acid) sodium salt)

Class: 8

Packing Group: III

XI. DISPOSAL MANAGEMENT

Disposal should be in accordance with all local, state and federal regulations.

XII. REGULATORY STATUS

Australian AICS Inventory: Listed.

XIII. REFERENCES

ADWG. (2011). National Water Quality Management Strategy. Australian Drinking Water Guidelines, Section 6, Australian Government, National Health and Medical Research Council, Natural Resource Management Ministerial Council. Updated January 2022. Available: https://www.nhmrc.gov.au/about-us/publications/australian-drinking-water-guidelines

Department of the Environment, Water, Heritage and the Arts (DEWHA). (2009). Environmental risk assessment guidance manual for industrial chemicals, Department of the Environment, Water, Heritage and the Arts, Commonwealth of Australia. Available: http://www.nepc.gov.au/resource/chemical-risk-assessment-guidance-manuals

enHealth Human Risk Assessment (HHRA). (2012). Environmental Health Risk Assessment, Guidelines for Assessing Human Health Risks from Environmental Hazards. Office of Health Protection of the Australian Government Department of Health. Available: https://www1.health.gov.au/internet/main/publishing.nsf/Content/health-pubhlth-publicat-environ.htm

European Chemicals Agency (ECHA). (2017). Guidance on Information Requirements and Chemical Safety Assessment, Chapter R11: PBT Assessment, European Chemicals Agency, Helsinki, Finland. Available: https://echa.europa.eu/guidance-documents/guidance-on-information-requirements-and-chemical-safety-assessment

ECHA. ECHA REACH database: https://echa.europa.eu/information-on-chemicals/registered-substances

Gledhill, W E and Feijtel, T C J (1992). Environmental Properties and safety assessment of organic phosphonates used for detergent and water treatment applications. Handbook of Environmental Chemistry, Volume 3, Part F., Hutzinger, O. Ed. Springer-Verlag, Berlin; cited in ECHA.

Klimisch, H.J., Andreae, M., and Tillmann, U. (1997). A systematic approach for evaluating the quality of experimental and toxicological and ecotoxicological data. Regul. Toxicol. Pharmacol. 25:1-5.

Martell, A.E., and Sillen, L.G. (1968). Stability constants – Supplement No. 1 Special Publication 25. The London Chemical Society, Alden Press, London; cited in OECD (2004b).Lesueur C., et al. (2005). Photodegradation of phosphonates in water. Chemosphere 59 (2005) 685-691; cited in ECHA.

Michael, P.R. (undated, but believed to be 1979). Monsanto Report ES-79-SS-15; cited in OECD (2004b).

OECD (2004a). SIDS Dossier on [[(phosponomethyl)imino) bis[(ethylenenitrilo) bis(methylene)]]tetrakisphosphonic acid, sodium salt (CAS No. 22042-96-0). Available at: https://hpvchemicals.oecd.org/UI/SIDS_Details.aspx?id=0AA9E84E-9D74-4DE7-8E26-1B3F943CD10A.

OECD (2004b). SIDS Initial Assessment Report on Phosphonic Acid Compounds Group 3. Available at: https://hpvchemicals.oecd.org/UI/SIDS_Details.aspx?id=0AA9E84E-9D74-4DE7-8E26-1B3F943CD10A.

Tomson, M.B., Kan, A.T., Oddo, J.E. (1994). Acid/base and metal complex solution chemistry of the polyphosphonate DTPMP versus temperature and ionic strength. Langmuir 10: 1442-1449; cited in OECD (2004b).

ETHYLENE OXIDE/PROPYLENE OXIDE COPOLYMER (CAS RN 9003-11-6)
ETHYLENE OXIDE/PROPYLENE OXIDE COPOLYMER (CAS RN 9082-00-2)
2-ETHYLHEXANOL EO/PO POLYMER (CAS RN. 64366-70-7)

This group contains information on ethylene oxide/propylene oxide copolymers (CAS RN 9003-11-6 and CAS RN 9082-00-2) and 2-ethylhexanol EO/PO polymer (CAS RN 64366-70-7). They are expected to have similar environmental concerns and have consequently been assessed as a group.

This dossier presents the most critical studies pertinent to the risk assessment of EO/PO copolymer in its use in coal seam or shale gas extraction activities. This dossier does not represent an exhaustive or critical review of all available data. The majority of information presented in this dossier was obtained from the Cosmetic Ingredient report (CIR, 2008) , the Dow Company report (Dow, 2014) and ECHA database that provides information on chemicals that have been registered under the EU REACH (ECHA). Where possible, study quality was evaluated using the Klimisch scoring system (Klimisch et al., 1997).

NICNAS has assessed poloxalene (CAS RN 9003-11-6) in an IMAP Tier 1 assessment and considers it a polymer of low concern[1]. AICIS has assessed oxirane, methyl-, polymer with oxirane, mono(2-ethylhexyl) ether (CAS RN 64366-70-7) and also considers it a polymer of low concern.[2]

I. SUBSTANCE IDENTIFICATION

Chemical Name (IUPAC): Oxirane, methyl-, polymer with oxirane

CAS RN: 9003-11-6

Molecular formula: $(C_3H_6O.C_2H_4O)_x$-

Molecular weight: Variable (polymer)

Synonyms: ethylene oxide, propylene oxide block polymer; poloxalene; poloxamer; polyethylene glycol, propoxylated; polyethylene-polypropylene glycol; polyoxyethylene-oxy-propylene; oxirane, 2-methyl-, polymer with oxirane; oxirane, methyl-, polymer with oxirane

SMILES: Not applicable

The generic CAS RN 9003-11-6 refers to polymers that are synthetic block copolymers of ethylene oxide and propylene oxide. There are over 50 various amphiphilic non-ionic block polymers of hydrophobic propylene oxide (PO) and hydrophilic ethylene oxide (EO) (CIR, 2008). These copolymers consist of a central polyoxypropylene molecule, flanked on both sides by two hydrophilic polyoxyethylene chains.

EO/PO copolymers are also known as Poloxamers.

Chemical Name (IUPAC): Oxirane, methyl-, polymer with oxirane, ether with 1,2,3-propanetriol (3:1)

[1] https://www.nicnas.gov.au/chemical-information/imap-assessments/how-chemicals-are-assessed/Low-concern-polymers.
[2] https://www.industrialchemicals.gov.au/sites/default/files/2022-05/EVA00086%20-%20Evaluation%20statement%20-%2030%20May%202022.pdf

CAS RN: 9082-00-2

Molecular formula: $C_3H_8O_3.3(C_3H_6O.C_2H_4O)_x$-

Molecular weight: Variable (polymer)

Synonyms: Ethylene oxide-propylene oxide copolymer ether with glycerol (3:1); ethylene oxide-propylene oxide copolymer glycerol ether; glycerol, ethylene oxide, propylene oxide polymer;

glycerol poly (oxyethylene, oxypropylene) ether; propylene oxide ethylene oxide polymer, ether with glycerol (3:1); glycerol, propylene oxide, ethylene oxide polymer.

SMILES: Not applicable

Chemical Name (IUPAC): Oxirane, methyl-, polymer with oxirane, mono(2-ethylhexyl) ether

CAS RN: 64366-70-7

Molecular formula: C_8-H_{18}-O. (C_3H_6-O.C_2-H_4-O)$_x$-

Molecular weight: 232.35 g/mol (monomer); variable (polymer)

Synonyms: 2-ethylhexanol EO/PO polymer; oxirane, methyl-, polymer with oxirane, monoether with 2-ethylhexanol; oxirane, 2-methyl-, polymer with oxirane, mono(2-ethylhexyl) ether; oxirane, methyl-,polymer with oxirane, mono(2-ethylhexyl) ether2-((1-((2-ethylhexyl)poly-oxy)poly-propan-2-yl)oxy)ethanol; PEG-14 PPG-7 ethylhexyl ether; PEG-3 PPG-7 ethylhexyl ether; PEG-6 PPG-7 ethylhexyl ether; PEG-9 PPG-7 ethylhexyl ether.

SMILES: not applicable

II. PHYSICO-CHEMICAL PROPERTIES

The physico-chemical properties of the EO/PO copolymers are listed in Table 1.

Table 1 Overview of the Physico-chemical Properties of Selected EO/PO Copolymers (CIR, 2008)

Properties	Poloxamer 124	Poloxamer 188	Poloxamer 407
Avg. molecular weight (g/mol)	2090-2360	7680-9510	9840-14600
Description	Colourless liquid	White solid	Solid
Wt. % oxyethylene	46.7 $\pm$ 1.9	81.8 $\pm$ 1.9	73.2 $\pm$ 1.7
Melting point (^{o}C)	16	52	56
Solubility	Soluble in water	Soluble in water	Soluble in water

The Dow Chemical Company's Product Safety Assessment document (Dow, 2014) on their EO/PO copolymer products with CAS RN 9003-11-6 and CAS RN 53637-25-5 states the following: "Polyglycol EP Series Polymers are liquid polyalkylene glycol block copolymers that are colorless to yellow in appearance and odorless or with a mild, ether odor."

III. ENVIRONMENTAL FATE PROPERTIES

A. Summary

No studies are available.

The following information is from the Dow Chemical Company's Product Safety Assessment document on their EO/PO copolymer products with CAS RN 9003-11-6 and CAS RN 53637-25-5 (Dow, 2014):

> "Polyglycol EP Series Polymers are non-volatile (do not evaporate) and vary in water solubility. If released to water or soil, they would tend to remain in and be transported with the surface or ground water to which they are emitted and will be adsorbed to soil and sediment particles. Polyglycol EP Series Polymers are unlikely to persist in the environment, as all products are known or expected to be either readily biodegradable (>65% biodegraded in 28 days per OECD 301F test) or inherently biodegradable according to Organisation for Economic and Co-operation and Development (OECD) test guidelines. As such, these products will be efficiently removed during treatment in biological wastewater-treatment facilities.
>
> These products are not expected to accumulate in the food chain (low bioconcentration potential)."

IV. HUMAN HEALTH HAZARD ASSESSMENT

A. Summary

The acute toxicity of EO/PO polymers are very low by the oral route. These polymers are not skin irritants or sensitisers. No systemic toxicity was observed in rats given very high oral doses of EO/PO polymers for up to two years. A slight inflammation response was seen in rats that inhaled a very high concentration of an aerosol or dust of these polymers over a two-week period. Repeated dermal applications of an EO/PO polymer to the skin of rabbits produced a slight irritating response, but no systemic toxicity. An EO/PO polymer was not mutagenic when tested in a bacterial reverse mutation assay. No studies are available to evaluate reproductive or developmental toxicity.

B. Acute Toxicity

The oral LD_{50} values in rats for Poloxamer 124, 182, 188, and 235 were 5,000, 5,500, >15,000, and 34,600 mg/kg (Leaf, 1967). No acute dermal or inhalation studies were located.

C. Irritation

The EO/PO copolymers are not skin irritants to laboratory animals or humans (CIR, 2008).

D. Sensitisation

The EO/PO copolymers are not dermal sensitiser (CIR, 2008).

E. Repeated Dose Toxicity

Oral

Rats were fed diets containing 0, 3, or 5% Poloxamer 188 for 6 months. During the study, 2 and 14 animals died in the mid- and high-dose groups, respectively. Deaths were attributed to a combination of infection and inanition. There were no histopathologic effects that were considered to be treatment related (Leaf, 1967).

Rats were fed diets containing Poloxamers 331, 235, or 338 for 90 days. The doses were: 40, 200, or 500 mg/kg Poloxamer 331; 40, 200, or 500 mg/kg Poloxamer 235; 200, 1,000 or 5,000 mg/kg Poloxamer 338. There was no treatment-related mortality. The rats in the 5,000 mg/kg Poloxamer 338 dose group had diarrhoea. No other details were given (Leaf, 1967).

Rats were fed diets containing 0, 3, 5, or 7.5% Poloxamer 188 for two years. There was no treatment-related mortality. At the two higher doses, the rats had continuous moderate diarrhoea, but not other adverse reactions. A small decrease in growth was seen in the 7.5% group (no statistical analysis and not information on the amount of change), but there were no treatment-related histopathological effects at any dose level. The NOAEL for this study is 5% in the diet. Using 0.05 as the fraction of body weight that rats consume per day as food (U.S. EPA), the NOAEL corresponds to 2,500 mg/kg-day (Leaf, 1967).

Male and female rats were fed diets containing 0, 40, 200, or 500 mg/kg Poloxamer 182 for two years. Deaths occurred in all groups of rats due to chronic respiratory infections unrelated to administration of Poloxamer 182. There were no clinical signs of toxicity, and blood and urine chemistry parameters were comparable across all groups. There were no gross pathological changes noted. It is unclear from the summary in CIR (2008) whether a histopathologic examination was conducted. The NOAEL for this study is 500 mg/kg-day (Leaf, 1967).

Inhalation

Male SD rats were exposed by inhalation to 0 or 97 mg/m3 Poloxamer 101 aerosol for 6 hours/day, 5 days/week over a two-week period. A separate group of rats was exposed for two weeks followed by a two-week recovery period. All animals survived until the end of the study. The only adverse effect observed was slight alveolitis in the Poloxamer 101-exposed rats, which subsided by the end of a two-week recovery (Ulrich et al., 1992).

Dermal

New Zealand rabbits were given dermal applications of 0, 100, 300 or 1,000 mg/kg Poloxamer 184 5 days/week for a total of 20 applications. The skin of the treated animals showed slight intradermal inflammatory responses, but no systemic effects (CIR, 2008).

F. Genotoxicity

Poloxomer 407 was not mutagenic to S. typhimurium strains TA97, TA98, TA100, TA1535, and TA1537 in the absence and presence of metabolic activation (CIR, 2008).

G. Carcinogenicity

Oral

There are no studies available.

Inhalation

There are no studies available.

Dermal

There are no studies available.

H. Reproductive Toxicity

There are no studies available.

I. Developmental Toxicity

Oral

There are no studies available.

Inhalation

There are no studies available.

Dermal

There are no studies available.

V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES

The toxicological reference values developed for EO/PO copolymers follow the methodology discussed in enHealth (2012). The approach used to develop drinking water guidance values is described in the Australian Drinking Water Guidelines (ADWG, 2011).

A. Non-Cancer

Oral

EO/PO copolymers have been tested in two chronic rat dietary studies. In the first study, the only effect observed was slightly reduced growth in the rats fed 7.5% (3,750 mg/kg-day) EO/PO copolymer; no effects were seen in the 5% (2,500 mg/kg-day) and lower dose groups. No statistical analysis was provided on whether the change in body weight gain was statistically significant, or whether the change is of sufficient magnitude to be considered an adverse effect. For the purposes of this risk assessment, 3,750 and 2,500 mg/kg-day will be considered a LOAEL and NOAEL, respectively. In the second feeding study, there were no effects seen in the rats at oral doses up to 500 mg/kg-day (highest dose tested).

The NOAEL of 2,500 mg/kg-day EO/PO copolymer in the diet will be used to derive an oral reference dose (RfD) and a drinking water guidance value.

Oral Reference Dose (oral RfD)

Oral RfD =2,500 / (UF_A x UF_H x UF_L x UF_{Sub} x UF_D)

Where:

UF_A (interspecies variability) = 10
UF_H (intraspecies variability) = 10
UF_L (LOAEL to NOAEL) = 1
UF_{Sub} (subchronic to chronic) = 1
UF_D (database uncertainty) = 1
Oral RfD = 2,500/ (10 x 10 x 1 x 1 x 1) = 2,500/100 = 25 mg/kg/day

Drinking water guidance value

Drinking water guidance value = (animal dose) x (human weight) x (proportion of intake from water) / (volume of water consumed) x (safety factor)

Using the oral RfD,

Drinking water guidance value = (oral RfD) x (human weight) x (proportion of water consumed) / (volume of water consumed)

Where:

Human weight = 70 kg (ADWG, 2011)
Proportion of water consumed = 10% (ADWG, 2011)
Volume of water consumed = 2L (ADWG, 2011)
Drinking water guidance value = (25 x 70 x 0.1)/2 = 88 mg/L

B. Cancer

No carcinogenicity studies were located. Therefore, a toxicological reference value was not derived.

VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES

EO/PO copolymers do not exhibit the following physico-chemical properties:

- Explosivity
- Flammability
- Oxidising potential

VII. ENVIRONMENTAL HAZARD ASSESSMENT

A. Summary

EO/PO copolymers are practically acutely non-toxic to aquatic organisms.

B. Aquatic Toxicity

No studies are available.

The following information is from the Dow Chemical Company's Product Safety Assessment document on their EO/PO copolymer products with CAS RN 9003-11-6 and 53637-25-5 (Dow, 2014):

"[EO/PO copolymers] are practically non-toxic to aquatic organisms (LC_{50}/EC_{50} >100 mg/L for the most sensitive species tested) on an acute basis."

C. Terrestrial Toxicity

There are no studies available.

D. Calculation of PNEC

The PNEC calculations for EO/PO copolymers follow the methodology discussed in DEWHA (2009).

PNEC Water

No experimental studies were found. However, Dow Chemical's Product Safety Assessment document on their EO/PO copolymers indicates that acute toxicity testing has been conducted on these copolymers and the E(L)C50 value for the most sensitive species is >100 mg/L. On the basis of the short-term results, an assessment factor of 1,000 has been applied to the lowest reported effect concentration of 100 mg/L. The $PNEC_{water}$ is 0.1 mg/L.

PNEC Sediment

A $PNEC_{sed}$ value was not calculated for EO/PO copolymers. There are no experimental toxicity data on sediment organisms and a K_{oc} value EO/PO copolymer is unavailable for calculating the $PNEC_{sed}$ using the equilibrium partition method. A K_{oc} value for the EO/PO polymers has not been determined experimentally, and QSAR models are invalid for high molecular weight polymers, such as EO/PO polymers.

PNEC Soil

A $PNEC_{soil}$ value was not calculated for EO/PO copolymers. There are no experimental toxicity data on soil organisms and a K_{oc} value for EO/PO copolymer is unavailable for calculating the $PNEC_{soil}$ using the equilibrium partition method. A K_{oc} value for the EO/PO copolymers has not been determined experimentally, and QSAR models are invalid for high molecular weight polymers, such as EO/PO polymers.

VIII. PERSISTENCE, BIOACCUMULATION AND TOXICITY (PBT) ASSESSMENT

The methodology for the Persistent, Bioaccumulative and Toxic (PBT) substances assessment is based on the Australian and EU REACH Criteria methodology (DEWHA, 2009; ECHA, 2017).

EO/PO copolymers are readily biodegradable or inherently biodegradable and thus does not meet the screening criteria for persistence.

EO/PO copolymers are expected to have high molecular weights and are not expected to be bioavailable. Thus, the copolymers do not meet the criteria for bioaccumulation.

There are no chronic aquatic toxicity studies on EO/PO copolymers. However, the acute E(L)C50 on these copolymers are >1 mg/L in aquatic organisms based on information from Dow Chemical's

Product Safety Assessment (Dow, 2014). EO/PO copolymers also have a high molecular weight and are not expected to be bioavailable. Thus, they do not meet the screening criteria for toxicity.

The overall conclusion is that EO/PO copolymers are not PBT substances.

IX. CLASSIFICATION AND LABELLING

A. Classification

H412-Aquatic Chronic 3

B. Labelling

Warning

A. Pictogram



X. HANDLING AND SAFETY INFORMATION (OCCUPATIONAL LIMITS AND TRANSPORTATION REQUIREMENTS)

A. First Aid

Please refer to the product SDS for additional information and confirmation of the information provided herein.

Eye Contact

In case of contact, immediately flush eyes with plenty of water for at least 15 minutes.

Skin Contact

Wash thoroughly with soap and water.

Inhalation

If inhaled, remove from area to fresh air. Get medical attention.

Ingestion

Rinse mouth with water and then drink a glass of water. Get medical attention. Never give anything by mouth to an unconscious person.

B. Fire Fighting Information

Extinguishing Media

Water spray, carbon dioxide, foam, dry chemical.

Specific Exposure Hazards

Keep product and empty container away from heat and sources of ignition. May emit toxic fumes under fire conditions. Depending on conditions, decomposition products may include the following: carbon monoxide, carbon dioxide and unburned hydrocarbons (smoke).

Dust can accumulate static charges which can cause an incendiary electrical discharge. Fine dust dispersed in air in sufficient concentrations, and in the presence of an ignition source, is a potential dust explosion hazard.

Special Protective Equipment for Firefighters

Wear self-contained breathing apparatus.

C. Accidental Release Measures

Personal Precautions

Use appropriate protective equipment. Handle in accordance with good industrial hygiene and safety practice.

Environmental Precautions

Prevent from entering sewers, waterways or low areas.

Steps to be Taken if Material is Released or Spilled

For large amounts: dike spillage and pump off product. For residues: pick up with suitable absorbent material. Dispose of contaminated material as prescribed.

D. Storage And Handling

General Handling

Keep product and empty container away from heat and sources of ignition. Ensure adequate ventilation, especially in confined areas.

Storage

Keep container tightly closed and in a dry and well-ventilated place. Keep in a cool place.

E. Exposure Controls / Personal Protection

Occupational Exposure Standards

There are no workplace exposure standards available for EO/PO copolymers in Australia.

Engineering Controls

Good general ventilation should be used.

Personal Protection Equipment

Respiratory Protection: Respiratory protection is not required.

Hand Protection: Chemical resistant protective gloves.

Skin Protection: Body protection must be chosen depending on activity and possible exposure.

Eye protection: Safety glasses with side-shields.

Other Precautions: Handle in accordance with good industrial hygiene and safety practice. Wearing of closed work clothing is recommended. Ensure that eyewash stations and safety showers are close to the workstation location.

F. Transport Information

EO/PO copolymers are not considered hazardous for purposes of transportation by road or rail. An Australian Dangerous Goods code is not required.

XI. DISPOSAL MANAGMENT

Disposal should be in accordance with all local, state and federal regulations.

XII. REGULATORY STATUS

Australian AICS Inventory: Listed.

XIII. REFERENCES

ADWG. (2011). National Water Quality Management Strategy. Australian Drinking Water Guidelines, Section 6, Australian Government, National Health and Medical Research Council, Natural Resource Management Ministerial Council. Updated January 2022. Available: https://www.nhmrc.gov.au/about-us/publications/australian-drinking-water-guidelines

Cosmetic Ingredient Review (CIR). (2008). Safety Assessment of Poloxamers 101, 105, 108, 122, 123, 124, 181, 182, 183, 184, 185, 188, 212, 215, 217, 231, 234, 235, 237, 238, 282, 284, 288, 331, 333, 334, 334, 338, 401, 402, 403, and 407, Poloxamer 105 benzoate, and Poloxamer 182 dibenzoate as used in cosmetics. Int. J. Toxicol. 27 (Suppl. 2): 93-128

Department of the Environment, Water, Heritage and the Arts [DEWHA]. (2009). Environmental risk assessment guidance manual for industrial chemicals, Department of the Environment, Water, Heritage and the Arts, Commonwealth of Australia. Available: http://www.nepc.gov.au/resource/chemical-risk-assessment-guidance-manuals

Department of the Environment and Energy [DoEE]. (2017). Chemical Risk Assessment Guidance Manual: for chemicals associated with coal seam gas extraction, Guidance manual prepared by Hydrobiology and ToxConsult Pty Ltd for the Department of the Environment and Energy, Commonwealth of Australia, Canberra.

Dow Chemical Company. (Dow). (2014). Product Safety Assessment from Dow Chemical Company on their Polyglycol EP Series Polymers/FLUENT Brand Polyglycols/SYNALOX™ Fluids, revised June 5, 2014. Available at: http://SDSsearch.dow.com/PublishedLiteratureDOWCOM/dh_090c/0901b8038090c665.pdf?filepath=productsafety/pdfs/noreg/233-01006.pdf&fromPage=GetDoc

ECHA. ECHA REACH database: http://echa.europa.eu/information-on-chemicals/registered-substances

enHealth Human Risk Assessment [HHRA]. (2012). Environmental Health Risk Assessment, Guidelines for Assessing Human Health Risks from Environmental Hazards. Office of Health Protection of the Australian Government Department of Health. Available: https://www1.health.gov.au/internet/main/publishing.nsf/Content/health-pubhlth-publicat-environ.htm

European Chemicals Agency [ECHA]. (2017). Guidance on Information Requirements and Chemical Safety Assessment, Chapter R11: PBT Assessment, European Chemicals Agency, Helsinki, Finland. Available: https://echa.europa.eu/guidance-documents/guidance-on-information-requirements-and-chemical-safety-assessment

Klimisch, H.J., Andreae, M., and Tillmann, U. (1997). A systematic approach for evaluating the quality of experimental and toxicological and ecotoxicological data. Regul. Toxicol. Pharmacol. 25:1-5.

Leaf, C.W. (1967). Toxicology of some non-ionic surfactants. Soap Chem. Spec. 43: 48; cited in CIR (2008).

Ulrich, C.E., Geil, G., Tyler, R.R., Kennedy, G.L., and Birnbaum, H.A. (1992). Two-week aerosol inhalation study in rats of ethylene oxide/propylene oxide copolymers. Drug Chem. Toxicol. 15: 269-270; cited in CIR (2008).

U.S. Environmental Protection Agency [EPA]. (2017). EPISuite™ v. 4.11, United States Environmental Protection Agency, Office of Pollution Prevention and Toxics and Syracuse Research Corporation. Available: https://www.epa.gov/tsca-screening-tools/epi-suitetm-estimation-program-interface.

ETHYLENE GLYCOL

This dossier on ethylene glycol presents the most critical studies pertinent to the risk assessment of ethylene glycol in its use in coal seam or shale gas extraction activities. This dossier does not represent an exhaustive or critical review of all available data. The majority of information presented in this dossier was obtained from the ECHA database that provides information on chemicals that have been registered under the EU REACH (ECHA). Where possible, study quality was evaluated using the Klimisch scoring system (Klimisch et al., 1997).

NICNAS has assessed ethylene glycol in an IMAP Tier 1 assessment and concluded that it poses no unreasonable risk to the environment

I. SUBSTANCE IDENTIFICATION

Chemical Name (IUPAC): Ethane-1,2-diol

CAS RN: 107-21-1

Molecular formula: $C_2H_6O_2$ ($HOCH_2CH_2OH$)

Molecular weight: 62.07 g/mol

Synonyms: Ethylene glycol; ethane-1,2-diol; 1,2-ethanediol, 2-hydroxyethanol; monoethylene glycol; MEG; glycol alcohol; EG

SMILES: C(CO)O

II. PHYSICO-CHEMICAL PROPERTIES

Table 1: Overview of the Physico-Chemical Properties of Ethylene Glycol

Property	Value	Klimisch Score	Reference
Physical state at 20oC and 101.3 kPa	Colourless and odourless syrupy liquid	2	ECHA
Melting Point	-13^{o}C @ 101.3 kPa	2	ECHA
Boiling Point	197.4^{o}C @ 101.3 kPa	2	ECHA
Density	1110 kg/m3@ 20^{o}C	2	ECHA
Vapour Pressure	12.3 Pa @ 25^{o}C	2	ECHA
Partition Coefficient (log K_{ow})	-1.36 (calculated) @ 25^{o}C	2	ECHA
Water Solubility	1000 g/L @ 20^{o}C	2	ECHA
Flash Point	111^{o}C	2	ECHA
Auto flammability	398^{o}C	2	ECHA
Viscosity	16.1 mPa s @ 25^{o}C	2	ECHA
Henry's Law Constant	0.133 @ 25^{o}C (QSAR)	2	ECHA

III. ENVIRONMENTAL FATE PROPERTIES

A. Summary

Ethylene glycol is readily biodegradable, and it is not expected to bioaccumulate. Ethylene glycol has low potential to adsorb to soil and sediment.

B. Biodegradation

Ethylene glycol was readily biodegradable in an OECD 301A test. After 10 days, degradation was 90-100% (ECHA) [Kl. score = 1]. There was 97% degradation after 20 days in a BOD test; and 96% degradation after 28 days in an OECD 301D test (Waggy et al., 1994; OECD, 2004a,b) [Kl. score = 2]. If a chemical is found to be readily biodegradable, it is categorised as Not Persistent since its half-life is substantially less than 60 days (DoEE, 2017).

The aerobic degradation of ethylene glycol was measured from grab river water samples at 4, 8 and 20°C. At 20°C, ethylene glycol was completely degraded in three days in all river waters tested; at 8°C, degradation was complete within 14 days. Degradation at 4°C was substantially slower, with degradation of < 20% after 14 days in river samples with limited suspended matter and a starting concentration of 10 mg/L (Evans and David, 1974).

C. Environmental Distribution

No experimental data are available for ethylene glycol. Using KOCWIN in EPISuite™ (USEPA, 2017), the estimated K_{oc} values from the molecular connectivity index (MCI) and from the log K_{ow} are 1 and 0.2239 L/kg, respectively.

Based upon these K_{oc} values, if released to soil, ethylene glycol is expected to have low potential for adsorption and a high potential for mobility. If released to water, based on its K_{oc} and high water solubility values, ethylene glycol is likely to remain in water and not adsorb to sediment. From the water surface, the substance will not evaporate into the atmosphere (ECHA).

D. Bioaccumulation

The calculated log K_{ow} for ethylene glycol is -1.36 (ECHA). The BCF for ethylene glycol in golden ide (*Leuciscus idus melanotus*) after three days of exposure was determined to be 10 (Freitag *et al.*, 1985). Bioaccumulation is not to be expected.

IV. HUMAN HEALTH HAZARD ASSESSMENT

A. Summary

Following acute ingestion of ethylene glycol, the critical effects in humans in three subsequent stages are central nervous system toxicity, metabolic acidosis and kidney toxicity. The lethal effects of ethylene glycol in human adults occur at oral doses of $\geq$ 1,600 mg/kg. Ethylene glycol is not a skin irritant or a skin sensitiser in laboratory animals. In humans, ethylene glycol may cause skin irritation; there is also a low potential for skin sensitisation. It is not an eye irritant. The kidney is the primary target organ from repeated exposures. The proposed mode-of-action (MOA) for the kidney damage involves the formation of a precipitate or crystals from the ethylene glycol metabolite oxalic acid with calcium in the urine. Ethylene glycol is not genotoxic or carcinogenic to rodents. Ethylene glycol did not affect fertility in animal studies, but it did cause developmental effects. In rodents, the

developmental effects caused by oral doses of ethylene glycol include teratogenic effects (craniofacial and axial-skeletal malformations and variations). In contrast, no developmental toxicity was seen in rabbit studies. The relevant metabolite for the developmental toxicity seen in rodent, but not rabbit, studies appears to be glycolic acid. This metabolite can be reached at higher concentrations in rats than in rabbits. Based on a physiologically-based pharmacokinetic (PBPK) model for ethylene glycol, humans are unlikely to achieve blood levels of glycolic acid necessary for developmental toxicity.

B. Metabolism

Ethylene glycol is almost completely absorbed in laboratory animals by the oral route (OECD, 2004a; Frantz et al., 1996a). A range of 1-51% of ethylene glycol is absorbed by the dermal route based on *in vivo* studies in rodents (Frantz et al., 1996a,b).

The main metabolic pathway for metabolism of ethylene glycol is oxidation via alcohol dehydrogenases and aldehyde dehydrogenases. The main metabolites of ethylene glycol are carbon dioxide, oxalic acid and glycolic acid (OECD, 2004a).

The relevant metabolite for the repeated dose toxicity studies is oxalic acid, which is slowly transported from the liver to the kidneys, where is forms calcium-oxalate crystals (Corley et al., 2005a).

The relevant metabolite for the developmental toxicity seen in rodent, but not rabbit, studies appears to be glycolic acid. This metabolite can be reached at higher concentrations in rats than in rabbits (Carney et al., 1998).

A physiologically-based pharmacokinetic (PBPK) model has been developed for ethylene glycol. When internal dose surrogates were compared in rats and humans over a wide range of exposures, it has been concluded that humans are unlikely to achieve blood levels of glycolic acid necessary for developmental toxicity (Corley et al., 2005b).

C. Acute Toxicity

The oral LD_{50} in rats was reported to be 7,712 mg/kg (ECHA) [Kl. score = 2]. The 6-hour inhalation LC_{50} value for male and female rats was > 2.5 mg/L (Tyl et al., 1995a) [Kl. score = 2]. The dermal LD_{50} for male and female mice is > 3,500 mg/kg (Tyl et al., 1995b) [Kl. score = 2].

Following acute ingestion of ethylene glycol, the critical effects in humans in three subsequent stages are central nervous system toxicity, metabolic acidosis and kidney toxicity (ECHA). The lethal effects of ethylene glycol in human adults occur at oral doses of $\geq$ 1,600 mg/kg (Hess et al., 2004).

D. Irritation

Application of 0.5 mL of ethylene glycol to the skin of rabbits for 23 hours under occlusive conditions was not irritating (Guillot et al., 1982) [Kl. score = 2].

In a Human Repeated Insult Patch Test (HRIPT), ethylene glycol was applied to the skin for 24 hours under occlusive or semi-occlusive conditions for nine times during the induction phase. The induction phase was followed by a rest period of two weeks, followed by a 24-hour challenge on the sixth week of the study. Erythema was seen in a small proportion of the 401 subjects that completed the study. Under the conditions of the study, three subjects had reactions on challenge that were

indicative of possible irritation and/or low-level sensitisation. These three subjects were re-challenged under occlusive or semi-occlusive conditions one or two weeks later. Re-challenge testing was negative for one subject, but the other two subjects were judged to have irritant reactions to ethylene glycol since their reactions were similar or lesser compared to the skin responses observed during the induction period, and the skin reactions were not greater over time after the challenge or re-challenge (ECHA).

Instillation of 0.05 mL of ethylene glycol into the eyes of rabbits was not irritating (ECHA) [Kl. score = 2].

E. Sensitisation

Ethylene glycol was not a skin sensitiser to guinea pigs in a Magnusson and Kligman test (Kurihara et al., 1996) [Kl. score = 2]. In a HRIPT, ethylene glycol was considered to have a low potential for dermal sensitisation in humans (ECHA).

F. Repeated Dose Toxicity

Oral

Male and female Fischer 344 rats were given in their feed 0, 0.32, 0.63, 1.25, 2.5 or 5% ethylene glycol for 13 weeks. Mortality was seen in the 5% males, but not in females. Mean weight gain was significantly decreased in the 2.5 and 5% males; there was no significant differences in female rats. Feed consumption was similar across all groups. A significant increase was seen in the left kidney weight in the 2.5 and 5% dose groups (both sexes); this was not seen in the right kidneys. Mean thymus ratio to terminal body weight was significantly decreased in the 5% males. Serum urea nitrogen levels were significantly increased in the 2.5 and 5% males, and significantly increased in the ≥ 0.32% females. Creatinine levels were decreased in the 0.32% groups and significantly increased in the 2.5 and 5% groups. The 2.5% and 5% male rats had kidneys that were rough, granular and/or pitted appearances. The 5% females showed nephrosis, and the 5% males had clusters of crystals in the brain. The NOAEL for this study is 1.25%, which was estimated to be 600 to 1,000 mg/kg/day (Melnick, 1984) [Kl. score = 2]

Male and female Sprague Dawley rats were given in their drinking water ethylene glycol for 90 days. The concentrations for females were 0, 0.5, 1.0, 2.0 or 4.0% (0, 597, 1,145, 3,087 or 5,744 mg/kg/day). The concentrations for males were 0, 0.25, 0.5, 1.0 or 2.0% (0, 205, 407, 947 or 3,134 mg/kg/day). In the 4% groups, there was mortality and decreased body weights (males only). Significant organ weights were noted only in males. Kidney weights were significantly increased in the 1% and 2% males; heart, liver and lung were significantly decreased in the 2% males. The 4% males also had a significant increase in the brain and gonads relative to body weights. Leukocyte levels were significantly decreased in the 0.5, 2 and 4% females, but not in males. Significant differences were noted in LDH, creatinine, ALT, calcium and glucose in the 1% males; and phosphorus, BUN and creatinine in the 2% males. There were significant increases in phosphorus in the 1% females and glucose in the 0.5 and 4% females. Kidney lesions were seen in the ≥ 2% females and in the ≥ 1% males, with the lesions more prominent in males than in females. The kidney changes consisted of tubular dilation, tubular degeneration, acute inflammation, birefringent crystals in tubules and pelvic epithelium. The NOAEL for this study is 407 mg/kg/day for males. The LOAEL for females is 597 mg/kg/day; a NOAEL was not established (Robinson et al., 1990) [Kl. score = 2]

Male and female B6C3F$_1$ mice were given in their feed 0, 0.32, 0.63, 1.25, 2.5 or 5.0% ethylene glycol for 13 weeks. There was no mortality and no treatment-related effect on mean weight gain and feed consumption. Organ/body weight ratios were similar across all groups. Serum urea nitrogen and creatinine levels were unaffected. Kidney effects were seen in the male, but not female, mice. Kidney lesions were observed in half of the 5% male mice and one mouse in the 2.5% dose level. Lesions were tubular dilation, cytoplasmic vacuolisation and regenerative hyperplasia of tubular cells. There was no evidence of crystal formation in the tubules. These changes were focal, randomly distributed and of minimal to mild severity. Hyaline degenerative of the liver was present in the centrilobular hepatocytes in all of the 2.5% and 5% males. These cells showed cytoplasmic accumulations of non bifringent, eosinophilic (hyaline), globular or crystalline material which resembled erythrocytes in size, shape and tinctorial properties. The NOAEL for this study is 1.25%, which was estimated to be 600 to 1,000 mg/kg/day (Melnick, 1984) [Kl. score = 2].

Male Fischer 344 and Wistar rats were given in their feed 0, 150, 500 or 1,000 mg/kg ethylene glycol for 16 weeks. At 1000 mg/kg, the following effects were seen: mortality in Wistar strain (2/10) with prior clinical observations of emaciation and dermal atonia and macroscopic findings of changes in kidneys (pale, calculi) and small seminal vesicles in these animals; mean body weight losses, lower mean body weights and mean cumulative body weight changes in Wistar strain (weeks 2 – 16); lower mean food consumption in Wistar strain; higher mean water consumption in both F344 and Wistar strains; lower mean specific gravity and higher mean total urine volume in both F344 and Wistar strains; macroscopic findings of pale kidneys, presence of calculi, rough surface and dilated pelvis; higher mean absolute and relative kidney weights in both F344 and Wistar strains; renal macroscopic findings of crystal nephropathy in Wistar and F-344 rats, with more severe nephropathy in Wistar strain than in the F344 strain. At 500 mg/kg, the following effects were seen: lower mean body weights (study weeks 3, 6-8 and 10-12) and mean cumulative body weight changes in the Wistar strain throughout the study with slightly lower mean food consumption throughout the study; higher mean water consumption in the Wistar strain; lower mean urine specific gravity and higher mean total urine volume in the Wistar strain; macroscopic findings in the Wistar strain consisting of predominantly pale kidneys, presence of calculi, rough surface and dilated pelvis; higher mean absolute and relative kidney weight in the Wistar strain; renal macroscopic findings of crystal nephropathy in Wistar and F-344 strains, with more severe nephropathy in the Wistar strain than in the F344 strain. The NOAEL in both the F344 and Wistar rats is 150 mg/kg/day (Cruzan et al., 2004) [Kl. score = 2].

Male Wistar rats were given in their feed 0, 50, 150, 300 or 400 mg/kg ethylene glycol for 12 months. There was mortality in the 300 and 400 mg/kg dose groups (5/20 and 4/20, respectively); the remaining 400 mg/kg animals were euthanised early (Day 203) due to excessive weight loss. The 300 mg/kg animals had increased water consumption and urine volume with decreased specific gravity, most likely due to osmotic diuresis. Calculi (calcium oxalate crystals) were found in the bladder and kidney pelvis in the ≥ 300 mg/kg animals. The ≥ 300 mg/kg rats that died prematurely had transitional cell hyperplasia with inflammation and haemorrhage of the bladder wall. Crystal nephropathy (basophilic foci, tubule or pelvic dilatation, birefringent crystals in the pelvic fornix, or transitional cell hyperplasia) was seen in all of the 400 mg/kg and most of the 300 mg/kg rats. These effects were not seen in the 50 or 150 mg/kg rats. Kidney oxalate levels, the metabolite responsible for the kidney toxicity, was not increased in the 50 and 150 mg/kg animals compared to the controls. The NOAEL for this study is 150 mg/kg/day (Corley et al., 2005) [Kl. score = 1].

Male and female Sprague-Dawley rats were given in their feed 0, 0.1, 0.2, 0.5, 1.0 or 4.0% ethylene glycol for two years. There was significant reduction in growth in the 4% males after week 16, and in the 1% males after week 70. The 4% females did not gain any weight past the first year of the study. Water consumption was double that of the controls in the 4% males that initiated soon after the

start of the study. The 1% males had significant increases in water consumption after 6 months and some increase was observed in the 0.5% males. Females only showed increased water consumption in the 4% group. There was 100% mortality in the 1 and 4% males, while mortality of additional dose levels were below that of the controls. There was 100% mortality in the 4% females, while the 1% females were similar to the controls; the 0.1, 0.2 and 0.5% females were increased compared to the controls. Since the 1 and 4% males and the 4% females all died before the study termination date, there are no data for these groups on terminal organ weight. For males, the terminal organ weights were decreased in all dose levels compared to the controls. For females, the organ weights were similar to the controls. The 1 and 4% males and females had kidneys with stones and crystals. The NOAEL for this study is 0.2% (data was insufficient to calculate the dose) (Blood, 1965) [Kl. score = 2].

Male and female Fischer 344 rats were given in their feed 0, 40, 200 or 1,000 mg/kg ethylene glycol for 24 months. There were numerous adverse effects in the 1,000 mg/kg males and, to a lesser degree, in the 1,000 mg/kg females. The most remarkable effect was the production of urinary calculi in the kidneys, ureters and urinary bladders of the 1,000 mg/kg males, along with the presence of high levels of calcium oxalate in the urine. Increased incidences of tubular cell hyperplasia, tubular dilation, peritubular nephritis and focal granulomatous nephritis occurred in the 1,000 mg/kg males. Other significant findings in these males were markedly lower body weight gain, increased absolute and relative kidney weights, decreased absolute and relative liver weights, various hematopoietic changes and increased water consumption (likely a result of impaired kidney function). Histopathological changes in the 1,000 mg/kg males were mineralisation of the heart, lungs, stomach and vas deferens being the most noteworthy. The various adverse effects in these males resulted in reduced survival; there was increased mortality which became apparent by 8 months, with all males in this group died by month 16. Although calcium oxalate crystals were found in the urine of the 1,000 mg/kg females, no urinary calculi were seen. Absolute and relative kidney weights were increased in these rats. The most significant histopathologic finding in the 1,000 mg/kg females was fatty metamorphosis of the liver. There were transient changes in organ weights, erythroid parameters, water consumption rates and urine specific gravity in the 200 and 40 mg/kg rats; these effects were considered to be statistical artifacts attributable to chance. Focal soft mineralisation was observed in certain organs of the 200 and 40 mg/kg rats, which were considered to be the result of altered calcium metabolism associated with ingestion of ethylene glycol. The NOAEL for this study is considered to be 200 mg/kg/day (DePass et al., 1986a; ECHA) [Kl. score = 2].

Male and female B6C3F_1 mice were given in their feed 0, 6,250 ppm (males only), 12,500 and 25,000 ppm (males and females) or 50,000 ppm (females only) for 103 weeks. These concentrations are approximately equivalent to 0, 1,500, 3,000, 6,000 or 12,000 mg/kg/day. Survival, mean body weights and feed consumption was similar across all groups. There were no treatment-related clinical signs of toxicity. Liver lesions (males only) and arterial hyperplasia (females only) were observed at 12,500 ppm, but no adverse effects were observed at 6,250 ppm. The NOAEL for this study is 6,250 ppm in males, which corresponds to 1,500 mg/kg/day (NTP, 1993) [Kl. score = 2].

Inhalation

No studies are available.

Dermal

No studies in rodents or rabbits are available.

G. Genotoxicity

In vitro Studies

The *in vitro* genotoxicity studies on ethylene glycol are presented in Table 2.

Table 2: *In vitro* Genotoxicity Studies on Ethylene Glycol

Test System	Results*		Klimisch Score	Reference
	-S9	+S9		
Bacterial reverse mutation (*S. typhimurium* and *E. coli* strains)	-	-	1	ECHA
Bacterial reverse mutation (*S. typhimurium* and *E. coli* strains)	-	-	2	ECHA
Mammalian cell gene mutation (mouse lymphoma L5178Y cells)	+/-	-	2	McGregor et al. (1991)
Chromosomal aberration (CHO cells)	-	-	2	ECHA

*+, positive; -, negative

In vivo Studies

A dominant lethal study was conducted in F344 rats given 0, 40, 200 or 1,000 mg/kg/day ethylene glycol in feed. There were slight increases in the dominant lethal mutation index in the high-dose and low-dose groups; these appear to be random occurrences and were not considered to be treatment-related. It was concluded that ethylene glycol was not genotoxic in this study (DePass et al., 1986b) [Kl. score = 2].

H. Carcinogenicity

Oral

Male and female Fischer 344 rats were given in their feed 0, 40, 200 or 1,000 mg/kg ethylene glycol for 24 months. There was increased mortality in the 1,000 mg/kg males, starting at 8 months and resulting in all males in this group dead by 16 months. Survival for the 1,000 mg/kg females and the 200 and 40 mg/kg males and females were similar to the controls. The incidence of mononuclear cell leukemia was statistically significantly higher in the 200 mg/kg males compared to the male controls, but not when compared to the pooled controls (males and females). Evaluation of the data by the method of Thomas et al. (2007), however, showed no treatment-related effect. It was concluded that ethylene glycol was not carcinogenic to rats in this study (DePass et al., 1986) [Kl. score = 2].

Male and female B6C3F_1 mice were given in their feed 0, 6,250 ppm (males only), 12,500 and 25,000 ppm (males and females) or 50,000 ppm (females only) ethylene glycol. These concentrations were approximately equivalent to 0, 1,500, 3,000, 6,000 or 12,000 mg/kg/day. Body weights, survival and incidence of tumours were similar between treated and control mice (NTP, 1993) [Kl. score = 2].

Inhalation

No studies are available.

Dermal

No studies are available.

I. Reproductive Toxicity

Ethylene glycol was assessed in a Reproductive Assessment by Continuous Breeding (RACB) protocol (Chapin and Sloane, 1997). The parental mice were administered ethylene glycol via drinking water during pre-mating exposure, cohabitation, pregnancy and lactation. The F_1 generation received prenatal exposure via maternal exposure during gestation, with the exposure continuing during lactation, weaning and mating of F_1 animals and production of an F_2 litter. The doses were 0, 0.25, 0.5 or 1% ethylene glycol, which corresponded to approximately 0, 410, 840 or 1,640 mg/kg/day. No adverse effects were noted in the parental animals at doses up to 1%. There was a small, but statistically significant, effects on the numbers of litters per fertile pair, the number of live pups per litter, and live pup weight in the 1% dose group. Neither the 0.25 nor 0.5% dose groups were significantly affected. The number of live pups per litter was lower in the treated groups, but differences were not statistically significant. Unusual facial features (i.e., shorter snout and wide-set eye) and skeletal defects (shortened frontal, nasal and parietal bones; fused ribs abnormally shaped or missing sternebrae, abnormally shaped vertebrae; and twisting of the spine) were noted on some of the offspring of the treated mice in the 1% group, but not in the controls. The parental NOAEL is 1% (approximately 1,640 mg/kg/day), and the NOAEL for reproductive toxicity is 0.5% (approximately 840 mg/kg/day (Lamb et al., 1985) [Kl. score = 2].

In a three-generation reproductive toxicity study, Fischer 344 rats were given in their diet 0, 40, 200 or 1,000 mg/kg/day ethylene glycol. There were no treatment-related effects on clinical signs of toxicity or survival in the parental animals. There were no significant effects on fertility index, gestation index, gestation survival for all three generations. Mean pup weights for each of the hree generations were similar between treated and control animals. The NOAEL for parental and reproductive toxicity is 1,000 mg/kg/day (DePass et al., 1986b) [Kl. score = 2].

J. Developmental Toxicity

Pregnant Sprague-Dawley rats were dosed by oral gavage with 0, 50, 150, 500, 1,000 or 2,500 mg/kg ethylene glycol during gestational days (GD) 6-15. Maternal toxicity was observed in the 2,500 mg/kg group and consisted of significantly decreased body weights, increased water consumption, decreased uterine weights, increased kidney weights and increased relative liver weights. At 500 mg/kg, there were developmental effects, which included reduced foetal body weights, extra or missing ribs, missing arches and poor ossification in thoracic and lumbar centra. In the 2,500 mg/kg group, in addition to skeletal malformations, there was gastroschisis, hydrocephaly, lateral ventricle dilated (tissue depressed), umbilical hernia and atelectasis. The NOAELs for maternal and developmental toxicity are 1,000 and 500 mg/kg/day, respectively (Neeper-Bradley et al., 1995) [Kl. score = 2].

Pregnant CD rats were dosed by oral gavage with 0, 1,250 2,500 or 5,000 mg/kg ethylene glycol during GD 6-15. In the ≥ 2,500 mg/kg groups, the dams had increased relative kidney weights, decreased gravid uterine weight and increased water consumption. Maternal body weight gain was significantly decreased in the 1,250 mg/kg group. Live litter size was significantly decreased in the 5,000 mg/kg group and foetal body weights were decreased in the 1,250 and 5,000 mg/kg groups. Litters with malformed foetuses were observed in the ≥ 1,250 mg/kg groups. The LOAELs for maternal and developmental toxicity are 1,250 mg/kg/day; NOAELs were not established (Price et al., 1985) [Kl. score = 2].

Pregnant Fischer 344 rats were given by oral gavage 0, 40, 200 or 1,000 mg/kg ethylene glycol during GD 6-15. No maternal toxicity was observed at any dose level. There were no significant effects on preimplantation loss, foetal length, foetal weight, total implantations or litter size. There was an increased incidence of skeletal alterations in the 1,000 mg/kg group, which consisted of poorly ossified and unossified vertebral centra. No significant increases in the incidence of major malformations were observed. The NOAELs for maternal and developmental toxicity are 1,000 and 400 mg/kg/day (Maronpot et al., 1983) [Kl. score = 2].

Pregnant CD-1 mice were dosed by oral gavage with 0, 50, 150, 500 or 1,500 mg/kg ethylene glycol during gestational days (GD) 6 to 15. There was no maternal toxicity. At 1,500 mg/kg, there were reduced foetal body weights, fused ribs and arches, poor ossification in thoracic and lumbar centra and increased occurrence of an extra 14^{th} rib. At 500 mg/kg, there was slight reductions in foetal body weight and increased incidences of extra ribs. The NOAELs for maternal and developmental toxicity were 1,500 and 150 mg/kg/day, respectively (Neeper-Bradley et al., 1995) [Kl. score = 2].

Pregnant CD-1 mice were dosed by oral gavage with 0, 750, 1,500 or 3,000 mg/kg ethylene glycol during GD 6 to 15. There was a significant decrease in maternal gain, gravid uterine weights and liver weights in the 1,500 mg/kg group. A decreased number of implantation sites per litter was observed in the 1,500 mg/kg group. Significant decrease in liver litter size was observed in the 3,000 mg/kg group and decreased foetal body weights were seen at ≥ 750 mg/kg. Litters with a significant increase in malformed foetuses were observed in the ≥ 750 mg/kg groups. There was a significant dose-related increase in post-implantation loss per litter, though there were no significant pairwise comparisons. The NOAEL for maternal toxicity is 750 mg/kg/day. The LOAEL for developmental toxicity is 750 mg/kg/day; the NOAEL was not established (Price et al., 1985) [Kl. score = 2].

In a short-term reproductive and developmental toxicity screen test, male and female Swiss Crl:CD-1 mice were allowed to mate over a three-day period. The males were dosed by oral gavage from study Day 3 to study Day 20. The Group A females were exposed throughout the 21-day test period; the Group B females were exposed during GD 8-14. The doses were 0, 250, 700 or 2,500 mg/kg ethylene glycol. The Group A females were sacrificed after 19 days of treatment, and the Group B females were allowed to litter and rear to postnatal day (PND) 4. There was no maternal or paternal toxicity. The 2,500 mg/kg females in Group A had significantly fewer liver implants and more dead implants. The 2,500 mg/kg in Group B had significantly lower total litter weights on PND 1 and 4. The NOAELs for parental and developmental toxicity are 2,500 and 700 mg/kg/day (Harris et al., 1992) [Kl. score = 2].

In a Chernoff/Kavlock assay, pregnant CD-1 mice were dosed by oral gavage with 0 or 11,090 mg/kg ethylene glycol during GD 7-14. The females were allowed to litter and rear to PND 3. Ten percent of the maternal animals died. The number of surviving pups per litter (40% survived), birth weight and pup weight gain were reduced. The LOAELs for maternal and developmental toxicity are 11,090 mg/kg; NOAELs were not established (Schuler et al., 1984; Hardin et al., 1987) [Kl. score = 2].

Pregnant female New Zealand White rabbits were dosed by oral gavage with 0, 100, 500, 1,000 or 2,000 mg/kg ethylene glycol on GD 6 to 19. At 2,000 mg/kg, eight of the 17 does (42.1%) died. Maternal body weights and body weight gain were similar across all groups. There was no developmental toxicity. The NOAEL for maternal toxicity is 1,000 mg/kg/day. The NOAEL for developmental toxicity is 2,000 mg/kg/day, the highest dose tested (ECHA) [Kl. score = 2].

Pregnant female CD rats were dosed by oral gavage with 0, 250, 1,250 or 2,250 mg/kg ethylene glycol on GD 6 to 20. At 2,250 mg/kg, maternal body weight, body weight gain, kidney weight and postpartum uterine weight were significantly reduced. At 1,250 mg/kg, the gestational period was

lengthened, and maternal kidney histopathological effects were noted. Developmental toxicity was noted in the 2,250 mg/kg group and included reduced pup weight, reduced viability and increased malformations (primarily hydrocephaly and abnormalities of the axial skeleton). No developmental toxicity was seen in the 1,250 mg/kg group. The NOAEL for maternal and developmental toxicity is 250 mg/kg/day (ECHA) [Kl. score = 2].

Inhalation

Pregnant female CD rats were exposed by inhalation (whole-body) to 0, 150, 1,000 or 2,500 mg/m^3 ethylene glycol aerosol 6 hours/day on gestational days 6 to 15. There was no treatment-related mortality; a dose-related increased in clinical signs (red fur discoloration on the head and neck) was noted, which was considered to be a non-specific indication of stress. Body weights and body weight gain were unaffected by treatment. There was some evidence of treatment-related reductions in ossification of the foetal skeleton at 1,000 and 2,500 mg/m^3 (considered as fetotoxicity). The NOAECs from inhalation exposure cannot be determined due to confounding oral exposure during whole-body exposure. However, there was no maternal or embryotoxicity at 150 mg/m^3 and no teratogenicity at any aerosol concentration tested (Tyl et al., 1995a) [Kl. score = 2].

Pregnant female CD-1 mice were exposed by inhalation (whole-body) to 0, 150, 1,000 or 2,500 mg/m^3 ethylene glycol aerosol 6 hours/day on gestational days 6 to 15. Reduced maternal body weight was observed in the 2,500 mg/m^3 group on GD 12,15 and 18 and in the 1,000 mg/m^3 group on GD 18. Reduced maternal weight gain was also seen during GD 6-12, 6-15 and GD 6-18 for the ≥ 1000 mg/m^3 groups and for GD 5-18 for the 2,500 mg/m^3 group. Terminal body weights were reduced in the ≥ 1,000 mg/m^3 groups. Gravid uterine weight was also reduced in the ≥ 1,000 mg/m^3 groups, so that body weight corrected for gravid uterine weight was unaffected. The number of viable implantations per litter was reduced at 2,500 mg/m^3. The number of non-viable implantations per litter was elevated at ≥ 1,000 mg/m^3 because of a significant increase in late resorptions at 1,000 mg/m^3, and a significant increase in late resorptions and in dead foetuses at 2,500 mg/m^3. The number of early resorptions at 2,500 mg/m^3 was also elevated but not statistically. foetal body weights per litter (male, female and total) were reduced at ≥ 1,000 mg/m^3. There was a significant increase in the incidence of a number of external, visceral and skeletal malformation, as well as skeletal variations, at ≥ 1,000 mg/m^3. There was no observable maternal or developmental toxicity at 150 mg/m^3. However, a NOAEC cannot be determined because of the amount of ethylene glycol that may have been ingested from the presence of ethylene glycol on the fur (Tyl et al., 1995a) [Kl. score = 2].

Pregnant female CD-1 mice were exposed by inhalation (nose-only) to 0, 500, 1,000 or 2,500 mg/m^3. The study also included a group exposed to 2,100 mg/m^3 (not discussed here). Reduced maternal body weight gain were seen in the 2,500 mg/m^3 for GD 9-12, 12-15, 6-15 and 0-18. Absolute kidney weights were increased in the ≥ 1,000 mg/m^3 groups. foetal body weights per litter were significantly reduced for the 2,500 mg/m^3. In the 2,500 mg/m^3, there was a significant increase in one skeletal malformation (fusion of the ribs) and an increased incidence of skeletal variations. No other teratogenic effects were observed. The NOECs for maternal and developmental toxicity are 500 and 1,000 mg/m^3, respectively (Tyl et al., 1995c) [Kl. score = 2].

Dermal

Pregnant CD-1 mice were administered by dermal applications of 0, 400, 1,677 or 3,549 mg/kg ethylene glycol 6 hours/day on GD 6-15. There was minimal, if any, treatment-related maternal toxicity. Copora lutea, total implants, percentage of live foetuses per litter, foetal body weights and incidence of external or visceral malformations were unaffected by treatment. There was, however,

a significant increase in two skeletal variations in the 3,549 mg/kg group. The NOAELs for maternal and developmental toxicity were considered to be 3,549 mg/kg/day (Tyl et al., 1995b) [Kl. score = 2].

V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES

The toxicological reference values developed for ethylene glycol follow the methodology discussed in enHealth (2012). The approach used to develop drinking water guidance values is described in the Australian Drinking Water Guidelines (ADWG, 2021).

A. Non-Cancer

Oral

The NOAEL from a 24-month rat dietary study was reported to be 200 mg/kg/day based on kidney lesions in male F344 rats at 1,000 mg/kg/day (DePass et al., 1986b). A subsequent 12-month rat dietary study using male Wistar rats reported a NOAEL of 150 mg/kg/day also based on kidney toxicity at 300 mg/kg/day and higher (Corley et al., 2008). The Wistar rat strain was shown to be more sensitive (approximately three-fold) to the kidney toxicity of ethylene glycol than F344 rats (Cruzan et al., 2004). The NOAEL of 150 mg/kg/day will be used for determining the oral reference dose (RfD) and the drinking water guidance value.

Oral Reference Dose (oral RfD)

Snellings et al. (2013) derived an oral reference dose for ethylene glycol using benchmark dose modelling, with toxicokinetic (PBPK modelling) and toxicodynamic data. The human equivalent dose ($[BMDL_{05}]_{HED}$) was calculated to be 150 mg/kg/day.

Oral RfD = $[BMDL_{05}]_{HED}$ / (UF_A x UF_H x UF_L x UF_{Sub} x UF_D)

Where:

UF_A (interspecies variability) = 1
UF_H (intraspecies variability) = 10
UF_L (LOAEL to NOAEL) = 1
UF_{Sub} (subchronic to chronic) = 1
UF_D (database uncertainty) = 1
Oral RfD = 150/(1 x 10 x 1 x 1 x 1) = 150/10 = 15 mg/kg/day

Drinking water guidance value

Drinking water guidance value = (animal dose) x (human weight) x (proportion of intake from water) / (volume of water consumed) x (safety factor)

Using the oral RfD,

Drinking water guidance value = (oral RfD) x (human weight) x (proportion of water consumed) / (volume of water consumed)

Where:

Human weight = 70 kg (ADWG, 2021)
Proportion of water consumed = 10% (ADWG, 2021)
Volume of water consumed = 2L (ADWG, 2021)
Drinking water guidance value = (15 x 70 x 0.1)/2 = 53 mg/L

B. Cancer

Ethylene glycol was not carcinogenic to rats and mice in two-year dietary studies. Thus, a cancer reference value was not derived.

VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES

Ethylene glycol does not exhibit the following physico-chemical properties:

- Explosivity
- Flammability
- Oxidising potential

VII. ENVIRONMENTAL HAZARD ASSESSMENT

A. Summary

Ethylene glycol is of low toxicity concern to aquatic organisms.

B. Aquatic Toxicity

Acute Studies

Table 3 lists the results of acute aquatic toxicity studies conducted on ethylene glycol.

Table 3: Acute Aquatic Toxicity Studies on Ethylene Glycol

Test Species	Endpoint	Results (mg/L)	Klimisch Score	Reference
Pimephales promelas	96-hour LC_{50}	>72,860	1	Pillard (1995)
Oncorhynchus mykiss	96-hour LC_{50}	22,810 24,591	2	OECD (2004a,b)
Daphnia magna	48-hour EC_{50}	>100	1	ECHA
Daphnia magna	48-hour EC_{50}	46,300	2	Gersich et al. (1986)
Ceriodaphnia dubia-affinis	48-hour EC_{50}	25,800 (20°C) 10,000 (24°C)	2	Cowgill et al. (1985)
Daphnia magna	48-hour EC_{50}	46,300 (20°C) 51,000 (24°C)	2	Cowgill et al. (1985)
Selenastrum capricornutum	96-hour IC_{50} NOEC	10,940 10,000	2	Pillard and DuFresne (1999)

Chronic Studies

Table 4 lists the results of chronic aquatic toxicity studies conducted on ethylene glycol.

Table 4: Chronic Aquatic Toxicity Studies on Ethylene Glycol

Test Species	Endpoint	Results (mg/L)	Klimisch Score	Reference
Pimephales promelas	7-day NOEC	15,380	2	Pillard (1995)
Ceriodaphnia dubia	7-day NOEC (reproduction)	8,590	2	Pillard (1995)
Pseudokirchneriella subcapitata	72-hr NOEC	>100 *	2	ECHA

*Read-across to pentaethylene glycol (CAS No. 4792-15-8)

C. Terrestrial Toxicity

No guideline studies have been conducted on ethylene glycol.

D. Calculation of PNEC

The PNEC calculations for ethylene glycol follow the methodology discussed in DEWHA (2009).

PNEC Water

Experimental results are available for three trophic levels. Acute E(L)C_{50} values are available for fish (22,810 mg/L), *Daphnia* (>100 mg/L), and algae (10,940 mg/L). NOEC values from long-term studies are available for fish (15,380 mg/L), invertebrates (8,590 mg/L) and algae (10,000 mg/L). On the basis that the data consists of short-term and long-term results from three trophic levels, an assessment factor of 10 has been applied to the lowest reported E(L)C_{50} value of 100 mg/L for Daphnia. The E(L)C_{50} value is used because the value for fish is lower than the NOEC values for all three trophic levels. The $PNEC_{aquatic}$ is 10 mg/L.

PNEC Sediment

There are no toxicity data for sediment-dwelling organisms. Therefore, the $PNEC_{sed}$ was calculated using the equilibrium partitioning method. The $PNEC_{sed}$ is 6.4 mg/kg sediment wet weight.

The calculations are as follows:

$PNEC_{sed} = (K_{sed\text{-}water}/BD_{sed}) \times 1000 \times PNEC_{water}$
$= (0.82/1280) \times 1000 \times 10$
$= 6.4$ mg/kg

Where:
$K_{sed\text{-}water}$ = suspended matter-water partition coefficient (m^3/m^3)
BD_{sed} = bulk density of sediment (kg/m^3) = 1,280 [default]
$K_{sed\text{-}water} = 0.8 + [(0.2 \times Kp_{sed})/1000 \times BD_{solid}]$
$= 0.8 + [(0.2 \times 0.04/1000 \times 2400]$
$= 0.82\ m^3/m^3$

Where:

Kp_{sed} = solid-water partition coefficient (L/kg)

BD_{solid} = bulk density of the solid phase (kg/m^3) = 2,400 [default]

$Kp_{sed} = K_{oc} \times f_{oc}$

= 1 x 0.04

= 0.04 L/kg

Where:

K_{oc} = organic carbon normalised distribution coefficient (L/kg). The K_{oc} for ethylene glycol calculated from EPISUITE™ using the MCI is 1 L/kg.

F_{oc} = fraction of organic carbon in sediment = 0.04 [default].

PNEC Soil

There are no toxicity data for terrestrial or soil organisms. Therefore, the $PNEC_{soil}$ was calculated using the equilibrium partitioning method. The $PNEC_{soil}$ is 0.13 mg/kg soil dry weight.

The calculations are as follows:

$PNEC_{soil} = (Kp_{soil}/BD_{soil}) \times 1000 \times PNEC_{water}$

= (0.02/1500) x 1000 x 10

= 0.13 mg/kg

Where:

Kp_{soil} = soil-water partition coefficient (m^3/m^3)

BD_{soil} = bulk density of soil (kg/m^3) = 1,500 [default]

$Kp_{soil} = K_{oc} \times f_{oc}$

= 1 x 0.02

= 0.02 m^3/m^3

Where:

K_{oc} = organic carbon normalised distribution coefficient (L/kg). The K_{oc} for ethylene glycol calculated from EPISUITE™ using the MCI is 1 L/kg.

F_{oc} = fraction of organic carbon in soil = 0.02 [default].

VIII. PERSISTENCE, BIOACCUMULATION AND TOXICITY (PBT) ASSESSMENT

The methodology for the Persistent, Bioaccumulative and Toxic (PBT) substances assessment is based on the Australian and EU REACH Criteria methodology (DEWHA, 2009; ECHA, 2008).

Ethylene glycol is readily biodegradable and thus does not meet the screening criteria for persistence.

The measured BCF in fish is 10. Thus, ethylene glycol does not meet the criteria for bioaccumulation.

The NOECs from the chronic aquatic toxicity studies on ethylene glycol are > 0.1 mg/L. The acute $E(L)C_{50}$ values from the acute aquatic toxicity studies on ethylene glycol are > 1 mg/L. Thus, ethylene glycol does not meet the criteria for toxicity.

The overall conclusion is that ethylene glycol is not a PBT substance.

IX. CLASSIFICATION AND LABELLING

A. Classification

STORE Category 2 (target organ: kidney)

B. Labelling

Warning

A. Pictogram



IX. HANDLING AND SAFETY INFORMATION (OCCUPATIONAL LIMITS AND TRANSPORTATION REQUIREMENTS)

A. First Aid

Eye Contact

In case of contact, immediately flush eyes with plenty of water for at least 15 minutes.

Skin Contact

Wash thoroughly with soap and water.

Inhalation

If inhaled, remove from area to fresh air. Get medical attention.

Ingestion

Rinse mouth with water and then drink a glass of water. Get medical attention. Never give anything by mouth to an unconscious person.

B. Fire Fighting Information

Extinguishing Media

Water spray, carbon dioxide, foam, dry chemical.

Specific Exposure Hazards

Keep product and empty container away from heat and sources of ignition. May emit toxic fumes under fire conditions. Depending on conditions, decomposition products may include the following: carbon monoxide, carbon dioxide.

Special Protective Equipment for Firefighters

Wear self-contained breathing apparatus.

C. Accidental Release Measures

Personal Precautions

Use appropriate protective equipment. Handle in accordance with good industrial hygiene and safety practice.

Environmental Precautions

Prevent from entering sewers, waterways or low areas.

Steps to be Taken if Material is Released or Spilled

For large amounts: dike spillage and pump off product. For residues: pick up with suitable absorbent material. Dispose of contaminated material as prescribed.

D. Storage And Handling

General Handling

Keep product and empty container away from heat and sources of ignition. Ensure adequate ventilation, especially in confined areas.

Storage

Keep container tightly closed and in a dry and well-ventilated place. Keep in a cool place.

E. Exposure Controls / Personal Protection

Occupational Exposure Standards

The workplace exposure standards for ethylene glycol in Australia is as follows: 10 mg/m^3 as an 8-hour TWA for ethylene glycol (particulate); 20 ppm (52 mg/m^3) as an 8-hour TWA for ethylene glycol (vapour). There is also a skin notation indicating that absorption through the skin may be significant source of exposure.

Engineering Controls

Good general ventilation should be used.

Personal Protection Equipment

Respiratory Protection: Respiratory protection is not required.

Hand Protection: Chemical resistant protective gloves.

Skin Protection: Body protection must be chosen depending on activity and possible exposure.

Eye protection: Safety glasses with side-shields.

Other Precautions: Handle in accordance with good industrial hygiene and safety practice. Wearing of closed work clothing is recommended. Ensure that eyewash stations and safety showers are close to the workstation location.

X. TRANSPORT INFORMATION

Ethylene glycol is not considered hazardous for purposes of transportation by road or rail. An Australian Dangerous Goods code is not required.

XI. DISPOSAL

Disposal should be in accordance with all local, state and federal regulations.

XII. REGULATORY STATUS

Australian AICS Inventory: Listed.

XIII. REFERENCES

ADWG. (2011). National Water Quality Management Strategy. Australian Drinking Water Guidelines, Section 6, Australian Government, National Health and Medical Research Council, Natural Resource Management Ministerial Council.

Blood, F.R. (1965). Chronic toxicity of ethylene glycol in the rat. Food Cosmet. Toxicol. 3: 229-234.

Carney, E.W., Pottenger, L.H., Bartels, M.J., Jaeckh, R., and Quast, J.F. (1998). Comparative pharmacokinetics and metabolism of ethylene glycol in pregnant rats and rabbits. Toxicol. Lett. 95: 208.

Chapin, R.E. and R.A. Sloane. (1997). Reproductive assessment by continuous breeding: evolving study design and summaries of ninety studies. Environ Health Perspect. 1997 Feb; 105(Suppl 1): 199–205.

Corley, R.A., Meek, M.E., and Carney, E.W. (2005a). Mode of action: oxalate crystal-induced renal tubule degeneration and glycolic acid-induced dysmorphogenesis – renal and developmental effects of ethylene glycol. Crit. Rev. Toxicol. 35: 691-702.

Corley, R.A., Bartels, M.J., Carney, E.W., Weitz, K.K., Soelberg, J.J., and Gies, R.A. (2005b). Development of a physiologically based pharmacokinetic model for ethylene glycol and its metabolite, glycolic acid, in rats and humans. Toxicol. Sci. 85: 476-490.

Corley, R.A., Wilson, D.M., Hard, G.C., Stebbins, K.E., Bartels, M.J., Soelberg, J.J., Dryzga, M.D., Gingell, K.E and Snellings, W.M.(2008). Dosimetry considerations in the enhanced sensitivity of male Wistar rats to chronic ethtlene glocol-induced nephrotoxicity. Toxicology and Applied Pharmacology. Volume 228, Issue 2: 165-178.

Cowgill, U.M., Takahash, I.T., and Applegath, S.L. (1985). A comparison of the effect of four benchmark chemicals on Daphnia magna and Ceriodaphnia dubia-affinis tested at two different temperatures. Environ. Toxicol. Chem. 4: 415-422.

Cruzan, G., Corley, R.A., Hard, G.C., Mertens, J.J., McMartin, K.E., Snellings, W.M., Gingell, R., and Deyo, J.A. (2004). Subchronic toxicity of ethylene glycol in Wistar and F-344 rats related to metabolism and clearance of metabolites. Toxicol Sci. 81: 502-11.

Department of the Environment, Water, Heritage and the Arts [DEWHA]. (2009). Environmental risk assessment guidance manual for industrial chemicals, Department of the Environment, Water, Heritage and the Arts, Commonwealth of Australia.

DePass, L.R., Garman, R.F., Woodside, M.D., Giddens, W.E., Maronpot, R.R., and Weil, C.S. (1986a). Chronic toxicity and oncogenicity studies of ethylene glycol in rats and mice. Fundam. Appl. Toxicol. 7: 547-565.

DePass, L.R., Woodside, M.D., Maronpot, R.R., and Weil, C.S. (1986b). Three-generation reproduction and dominant lethal mutagenesis studies with ethylene glycol in the rat. Fundam. Appl. Toxicol. 7: 566-572.

Department of the Environment and Energy [DoEE]. (2017). Chemical Risk Assessment Guidance Manual: for chemicals associated with coal seam gas extraction, Guidance manual prepared by Hydrobiology and ToxConsult Pty Ltd for the Department of the Environment and Energy, Commonwealth of Australia, Canberra.

ECHA. ECHA REACH database: http://echa.europa.eu/information-on-chemicals/registered-substances

enHealth Human Risk Assessment [HHRA]. (2012). Environmental Health Risk Assessment, Guidelines for Assessing Human Health Risks from Environmental Hazards. Office of Health Protection of the Australian Government Department of Health.

European Chemicals Agency [ECHA]. (2008). Guidance on Information Requirements and Chemical Safety Assessment, Chapter R11: PBT Assessment, European Chemicals Agency, Helsinki, Finland.

Evans, W.H., and David, E.J. (1974). Biodegradation of mono-, di-, and triethylene glycols in river waters under controlled laboratory conditions. Water Res. 8: 97-100.

Frantz, S.W., Beskitt, J.L., Grosse, C.M., Tallant, M.J., Dietz, F.K., and Ballantyne, B. (1996a). Pharmacokinetics of ethylene glycol. I. Plasma disposition after single intravenous, peroral, or percutaneous doses in female Sprague-Dawely rats and CD-1 mice. Drug Metab. Dispos. 24: 911-921.

Frantz, S.W., Beskitt, J.L., Grosse, C.M., Tallant, M.J., Dietz, F.K., and Ballantyne, B. (1996b). Pharmacokinetics of ethylene glycol. II. Tissue distribution, dose dependent elimination, and identification of urinary metabolites following single intravenous, peroral, or percutaneous doses in female Sprague-Dawely rats and CD-1 mice. Xenobiotica 26: 1195-1220.

Freitag, D., Ballhorn, L., Geyer, H., and Korte, F. (1985). Environmental hazard profile of organic chemicals. Chemosphere 14: 1589-1616.

Gersich, F.M., Blanchard, F.A., Applegath, S.L., and Park, C.N. (1986). The precision of Daphnid (Daphnia magna Straus, 1820) static acute toxicity tests. Arch. Environ. Contam. Toxicol. 15: 741-749.

Guillot, J.P., Martini, M.C., Giauffret, J.Y., Gonnet, J.F., and Guyot, J.Y. (1982). Safety evaluation of some humectants and moisturizers used in cosmetic formulations. Int. J. Cosmetic Science 4: 67-80.

Hardin, B.D., Schuler, R.L., Burg, J.R., Booth, G.M., Hazelden, K.P., MacKenzie, K.M., Piccirillo, V., Jr, and Smith, K.N. (1987). Evaluation of 60 chemicals in a preliminary developmental toxicity test. Terat. Carcinogen. Mutagen. 7: 29-48.

Harris, M.W., Chapin, R.E., Lockhart, A.C., and Jokinen, M.P. (1992). Assessment of a short-term reproductive and developmental toxicity screen. Fundam. Appl. Toxicol. 19: 186-196.

Hess, R., Bartels, M.J., and Pottenger, L.H. (2004). Ethylene glycol: an estimate of tolerable levels of exposure based on a review of animal and human data. Arch. Toxicol. 78: 671-680.

Klimisch, H.J., Andreae, M., and Tillmann, U. (1997). A systematic approach for evaluating the quality of experimental and toxicological and ecotoxicological data. Regul. Toxicol. Pharmacol. 25:1-5.

Kurihara, A., Manabe, A., Katsuno, K., Itoh, K., Hisamitsu, H., Wakumoto, S., and Yoshida, T. (1996). Evaluation of skin irritation and sensitization of two diol solutions used as experimental dentin primers in humans and guinea pigs. Dent. Mater. J., 15: 226-232.

Lamb, J.C., IV, Maronpot, R.R., Gulati, D.K., Russel, V.S., Hommel-Barnes, L., and Sabharwa, l. P.S. (1985). Reproductive and developmental toxicity of ethylene glycol in the mouse. Toxicol. Appl. Pharmacol. 81: 100-112.

McGregor, D.B., Brown, A.G., Howgate, S., McBride, D., Riach, C., and Caspary, W.J. (1991). Responses of the L5178Y mouse lymphoma cell forward mutation assay. V: 27 coded chemicals. Environ. Mol. Mutagen. 17: 196-219.

Melnick, R.L. (1984). Toxicities of ethylene glycol and ethylene glycol monoether in Fischer 344/N rats and B6C3F1 mice. Environ. Health Perspect. 57: 147-155.

Neeper-Bradley, T.L., Tyl, R.W., Fisher, L.C., Kubena, M.F., Vrbanic, M.A., and Losco P.E. (1995). Determination of a no-observed-effect level for developmental toxicity of ethylene glycol administered by gavage to CD rats and CD-1 mice. Fundam. Appl. Toxicol. 27: 121-130.

National Toxicology Program [NTP]. (1993). Toxicology and Carcinogenesis Studies of Ethylene Glycol in B6C3F1 Mice (Feed Studies). National Toxicology Program Technical Report Series No. 413.

OECD. (2004a). SIDS Dossier on the HPV Chemical Ethylene Glycol (CAS No. 107-21-1).

OECD. (2004b). SIDS Initial Assessment Report on the Ethylene Glycol Category: Ethylene Glycol (CAS No. 107-21-1), Diethylene Glycol (CAS No. 111-46-6), Triethylene Glycol (CAS No. 112-27-6), Tetraethylene Glycol (CAS No. 112-60-7), Pentaethylene glycol (CAS No. 4792-15-8).

Pillard, D. (1995). Comparative toxicity of formulated glycol deicers and pure ethylene and propylene glycol to Ceriodaphnia dubia and Pimephales promelas. Environ. Toxicol. Chem. 14: 311-315.

Pillard, D.A. and DuFresne, D.L. (1999). Toxicity of formulated glycol deicers and ethylene and propylene glycol to lactuca sative, lolium perenne, selenastrum capricornutum, and lemna minor. Arch Environ. Contam. Toxicol. 37(1):29-35.

Price, C.J., Kimmel, C.A., Tyl, R.W., and Marr, M.C. (1985). The developmental toxicity of ethylene glycol in rats and mice. Toxicol. Appl. Pharmacol. 81: 113-127.

Robinson, M., Pond, C.L., Laurie, R.D., Bercz, J.P., Henningsen, G., and Condie L.W. (1990). Subacute and subchronic toxicity of ethylene glycol administered in drinking water to Sprague-Dawley rats. Drug Chem. Toxicol .13: 43-70.

Schuler, R.L., Hardin, B.D., Niemeier, R.W., Booth, G., Hazelden, K., Piccirillo, V., and Smith, K. (1984). Results of testing 15 glycol ethers in a short-term in vivo reproductive toxicity assay. Environ. Health Perspect. 57: 141-146.

Snellings, W.M., Corley, R.A., McMartin, K.E., Kirman, C.R., and Bobst, S.M. (2013). Oral reference dose for ethylene glycol based on oxalate crystal-induced renal tubule degeneration as the critical effect. Regul. Toxicol. Pharmacol. 65: 229-241.

Thomas, J., Haseman, J.K., Goodman, J.I., Ward, J.M., Loughran, Jr., T.P., and Spencer, P. (2007). A review of large granular lymphocytic leukemia in Fischer 344 rats as an intial step toward evaluating the implication of the endpoint to human cancer risk assessment. Toxicol. Sci. 99: 3-19.

Tyl, R.W., Ballantyne, B., Fisher, L.C., Fait, D.L., Savine, T.A., Dodd, D.E., Klonne, D.R., and Pritts, I.M. (1995a). Evaluation of the developmental toxicity of ethylene glycol aerosol in the CD rat and CD-1 mouse by whole-body exposure. Fundam. Appl. Toxicol. 24: 57-75.

Tyl, R.W., Fisher, L.C., Kubena, M.F., Vrbanic, M.A., and Losco, P.E. (1995b). Assessment of the developmental toxicity of ethylene glycol applied cutaneously to CD-1 mice. Fundam. Appl. Toxicol. 27: 155-166.

Tyl, R.W., Ballantyne, B., Fisher, L.C., Dodd, D.E., Klonne, D.R., Pritts, M., and Losco, P.E. (1995c). Evaluation of the developmental toxicity of ethylene glycol aerosol in CD-1 mice by nose-only exposure. Fundam. Appl. Toxicol. 27: 49-62.

U.S. Environmental Protection Agency [EPA]. (2017). EPISuite™ v. 4.11, United States Environmental Protection Agency, Office of Pollution Prevention and Toxics and Syracuse Research Corporation. Available at: https://www.epa.gov/tsca-screening-tools/epi-suitetm-estimation-program-interface.

Waggy, G.T., Conway, R.A., Hansen, J.L., and Blessing, R.I. (1994). Comparison of 20-d BOD and OECD closed-bottle biodegradation tests. Environ. Toxicol. Chem. 13: 1277-1280.

FORMIC ACID

This dossier on formic acid presents the most critical studies pertinent to the risk assessment of formic acid in its use in coal seam or shale gas extraction activities. This dossier does not represent an exhaustive or critical review of all available data. The majority of information presented in this dossier was obtained from the ECHA database that provides information on chemicals that have been registered under the EU REACH (ECHA). Where possible, study quality was evaluated using the Klimisch scoring system (Klimisch et al., 1997).

NICNAS has assessed formic acid in an IMAP Tier 1 assessment and concluded that it poses no unreasonable risk to the environment[1] .

I. SUBSTANCE IDENTIFICATION

Chemical Name (IUPAC): formic acid

CAS RN: 64-18-6

Molecular formula: CH_2O_2

Molecular weight: 46.025 g/mol

Synonyms: formic acid, methanoic acid, formylic acid, aminic acid

SMILES: OC=O

II. PHYSICO-CHEMICAL PROPERTIES

Table 1: Overview of the Physico-chemical Properties of formic acid

Property	Value	Klimisch Score	Reference
Physical state at 20oC and 101.3 kPa	Clear and colourless organic liquid	1	ECHA
Melting Point	8°C (pressure not provided)	1	ECHA
Boiling Point	100.23°C @ 101.3 kPa	1	ECHA
Density	1220 kg/m^3 @ 20°C	1	ECHA
Vapour Pressure	4,271 Pa @ 20°C	1	ECHA
Partition Coefficient (log K_{ow})	-2.1@ 23°C and pH 7	1	ECHA
Water Solubility	Completely miscible	2	ECHA
Flash Point	49.5°C @ 101.3 kPa	1	ECHA
Auto flammability	528°C @ 100.6-101.0 kPa	1	ECHA
Viscosity	1.8 mPa s @ 20°C	1	ECHA

[1] https://www.industrialchemicals.gov.au/chemical-information/search-assessments?assessmentcasnumber=64-18-6%2C+

Property	Value	Klimisch Score	Reference
Henry's Law Constant	0.017 Pa-m^3/mole @ 20°C	1	ECHA

III. ENVIRONMENTAL FATE PROPERTIES

A. Summary

Formic acid is readily biodegradable, is not expected to bioaccumulate, and has a low potential to adsorb to soil or sediment.

B. Partitioning

The pKa of formic acid is 3.7, indicating that this substance will exist partially in anion form in the environment and anions generally do not adsorb more strongly to soils containing organic carbon and clay than their neutral counterparts (PubChem).

Volatilisation of formic acid from water and moist soil surfaces is expected to be an important fate process given a Henry's Law constant of 0.017 Pa-m^3/mole (ECHA). Formic acid is expected to volatilise from dry soil surfaces based upon its vapour pressure.

Hydrolysis is not expected to be an important environmental fate process since this substance lacks functional groups that hydrolyse under environmental conditions (PubChem).

C. Biodegradation

Formic acid and the formate ion were readily biodegradable in OECD 301 D tests. In the two tests, biodegradation rates of 82% and 92 % related to the biological oxygen demand were estimated. (ECHA) [Kl. score = 1 and Kl. Score =2].

If a chemical is found to be readily biodegradable, it is categorised as Not Persistent since its half-life is substantially less than 60 days (DoEE, 2017).

D. Environmental Distribution

The log K_{oc} of the non-dissociated species of formic acid was measured to be < 1.25 in a GLP test according to OECD guideline 121 (ECHA) [KI. score =1]. As this value refers to the uncharged molecule, which will only be present under highly acidic conditions, the K_{oc} and log K_{oc} of the dissociated, charged form at realistic environmental pH values was calculated by using the pKa (= 3.70) and the log P_{ow} of the uncharged molecule (= -0.46) for a corrected log K_{oc} according to Franco et al. (2008). For the formate ion which will be present at environmental relevant pH values, slightly higher adsorption rates were estimated (K_{oc} = 31, log K_{oc} = 1.49) (BASF SE, 2009, as cited in ECHA) [Kl. Score = 2].

Based on these values, formic acid has a low potential for adsorption to soil and sediment and is expected to have very high mobility in soil. Likewise, if released to water, formic acid is also not expected to adsorb to suspended solids or sediments.

E. Bioaccumulation

No bioconcentration studies have been conducted on formic acid. Formic acid is not expected to bioaccumulate based on the experimental log K_{ow} of -2.1 (ECHA) [KI. Score = 1].

IV. HUMAN HEALTH HAZARD ASSESSMENT

A. Summary

Formic acid is metabolized to formate and formate salts in the body. Formic acid rapidly absorbed after ingestion, and it excreted in urine. Formic acid moderate acute toxicity via oral and dermal routes of exposure. Formic acid has high acute toxicity via the inhalation route of exposure. Formic acid is corrosive to the skin and eyes. It is not a skin sensitiser. Formic acid did not elicit systemic toxicity in repeated dose toxicity studies. Formic acid is not a genotoxin, it is not carcinogenic, nor is it a reproductive or developmental toxicant.

B. Metabolism

The toxicokinetic behaviour of formic acid was examined in human volunteers who ingested up to 2 grams of formic acid. Formate and formic acid are both rapidly absorbed, and they reach peak plasma levels withing 10-30 minutes after ingestion. Resorption of the unprotonated acid begins in the stomach. Sodium formate is converted to the unprotonated acid under the pH conditions of the stomach. Formate is eliminated from the plasma with a half-life time of $t_{1/2}$ =45 minutes. Urinary excretion is rapid within the first six hours after ingestion and returns to normal levels at 12 hours after dosing. Urinary excretion is generally low, and it accounts from approximately 2.1-3.3% of the administered dose. The blood pH remains unchanged following single formate or formic acid doses that are equivalent to 3,000 mg formic acid. Urine volume and pH were increased if formate is excreted by the urine (ECHA) [KI. score =2].

Formate is the common metabolite of formic acid and formate salts. Formate is formed from precursors in the intermediary metabolism and is used as an important constituent of the C1 intermediary metabolism which is required for the biosynthesis of amino acids and nucleic acid bases (purines and pyrimidines). Formate may also be formed from ingested methanol via formaldehyde and further oxidation to formate.

Pharmacokinetic models have been established from methanol inhalation studies which allow calculating the time course of all metabolites including formate in good correlation with animal studies. Peak plasma formate levels were reached within 1 hour (rabbits) and 4-5 hours (pigs) after oral administration of potassium diformate. The elimination from blood follows first order kinetics and the blood levels rapidly return to background levels in all species, i.e., formate does not persist or accumulate. However, there are significant species differences in the elimination rates and the elimination half-lives (from plasma): rat (12 minutes) < guinea pig (22 minutes) < rabbit (32 minutes) < humans (45 minutes) < cat (67 minutes) < dog (77 minutes) < pig (87 minutes). This reflects the species differences in the hepatic concentrations of folates and folate-dependent enzymes which affect the formate degradation to CO_2. Only minor quantities are excreted unchanged via urine in all species.

High formate plasma levels may occur in humans under special conditions, i.e., if the formate elimination capacity is exceeded, for example after ingestion of large amounts of formate salts. Photoreceptor toxicity and damage to the eye may occur in humans under such conditions.

Formic acid and formate salts may be absorbed via the oral route. Formic acid may generate vapours that can be taken up by inhalation. Dermal uptake may also occur with formic acid.

Local toxicity due to corrosivity: skin and eye after direct contact; upper inhalation tract after inhalation; mouth, larynx, pharynx, oesophagus, stomach, intestines after oral ingestion.

Dermal absorption of formic acid is known to occur. Systemic toxicity, acidosis, and elevated formate blood levels were described in clinical case reports following incidental poisoning (ECHA) [KI. score =1].

C. Acute Toxicity

Oral

An OECD guideline 401 (Acute Oral Toxicity) study was conducted using male and female Bor: WISW rats who were administered 501, 631, 794, and 1000 mg/kg bw of formic acid. Clinical signs were reported 30 minutes after dosing. Symptoms of unkept fur, hunched posture, stagger, and blood in urine were observed. At times hypothermia, body weight loss and pale limbs were also observed. The acute oral LD_{50} was reported to be 730 mg/kg bw (ECHA) [KI. score =1].

Inhalation

An OECD Guideline 403 (Acute Inhalation Toxicity) study was conducted using male and female Sprague-Dawley rats administered formic acid via whole body vapour inhalation. The clinical signs indicted corrosive properties of formic acid as evidenced by the occurrence of corneal opacity and corrosion of the dorsal nose in some cases. The symptoms persisted until termination 14 days after the rats were exposed to 7.29 mg/L of formic acid. There were no changes in animals that survived. Inflated lungs and dilated hearts were observed in the animals that died. The four-hour LC_{50} was reported to be 7.85 mg/L air (ECHA) [KI. score 1].

Dermal

The acute dermal toxicity was not examined in animals because of the corrosive properties of formic acid. In addition to this, the dermal toxicity of the salts is low, LD_{50} of sodium formate was >2,000 mg/kg (BASF, 2007, as cited in ECHA).

D. Irritation

There is sufficient human data and information from animal testing which indicates that formic acid is corrosive to the skin and causes eye damage. Therefore, skin irritation and corrosion testing was not conducted because there are studies which indicate that formic acid is corrosive (ECHA).

E. Sensitisation

An OECD Guideline 406 (Skin sensitisation) study was conducted using female Hsd Poc: DH guinea pigs exposed to 2 or 5% formic acid via epicutaneous occlusive dressing. Formic acid had no sensitizing effect on the skin of guinea pigs in this study (ECHA) [KI. score =1].

F. Repeated Dose Toxicity

Oral

An OECD Guideline 453 (combined chronic toxicity/carcinogenicity) study was conducted using male and female Crl:HanWist (glx:BRL) BR rats exposed to 0, 50, 400, and 2,000 mg/kg bw/day of potassium formate (1:2) in their feed for 52 weeks. Treatment related findings were noted at 2,000 mg/kg bw/day and included a statistically significant depression of body weight gain and at terminal kill a thickening of the stomach confirmed as basal cell hyperplasia or foveolar epithelium hyperplasia in the majority of the high dose animals. These changes were less pronounced than in a previous 90-day rat study. There was no evidence of systemic target organ toxicity. The NOAEL for local and systemic toxicity was reported to be 400 mg/kg bw/day based on local effects in the stomach and reduced body weight in the high dosed rats. Taking the molecular weights and stoichiometry into account, this corresponds to a NOAEL of 142 mg formic acid/kg bw/day, and 283 mg formate/kg bw/day (ECHA) [KI. score =1].

An OECD Guideline 408 (Repeated dose 90-day toxicity) study was conducted using male and female Crl:CDBR rats exposed to 0, 600, 1200, and 3000 mg/kg bw/day potassium formate in their feed for 13 weeks. There was no overt toxicity observed after 13 weeks of treatment. Minor irritation occurred in the forestomach of both sexes, with effects being seen in the males at all dose levels. A NOAEL was not derived in this study but is considered to be <600 mg/kg bw/day based on irritation of the forestomach and the squamous cell hyperplasia seen at 600 mg/kg bw/day in both sexes. Systemic toxicity was not observed up to 3,000 mg/kg bw/day. A systemic NOAEL or LOAEL could not be derived for this study (ECHA) [KI. score =1].

Inhalation

An OECD Guideline 413 (Subchronic Inhalation Toxicity: 90-day) study was conducted in male and female in Fischer 344 rats exposed to 0,0.015,0.030,0.062, 0.122, or 0.244 mg/L (0, 8, 16, 32, 64, or 128 ppm) formic acid via whole body vapor inhalation (6 hours/day, 5 days/week) for 13 weeks. There were no mortalities nor clinical signs or systemic toxicity in male and female rats exposed to 8, 16, 32, 64, or 128 ppm for 13 weeks (5 days/week, 6 h/day). There were no unusual gross lesions noted during necropsy, organ weights were not affected by treatment. Male and female reproductive parameters (sperm motility, density, and testicular or epididymal weight; length of the oestrous cycle) were not affected. Histopathology revealed increased incidences of squamous metaplasia of the respiratory epithelium and degeneration of the olfactory epithelium in the high-dose male and female rat groups where most of the animals were affected. However, the severity was generally minimal to mild. A systemic LOAEC was not achieved. The authors suggested that the lack of systemic effects in both 2-week and 13-week NTP inhalation studies is possibly related to the rapid metabolizing capacity of formate to CO_2, due to high tetrahydrofolate and 10-formyl tetrahydrofolate dehydrogenase levels in rodents. These levels are much lower in humans who are significantly more sensitive to the formate toxicity. Therefore, caution should be used in considering the results obtained with rodents in determining potential human risks associated with systemic exposure to formic acid. Nevertheless, human experience does not indicate that formic acid represents a significant systemic thread to humans unless at high concentrations following intended or incidental ingestion or large-scale skin contact, where the caustic effect also governs the toxic mode of action. Based on the local histopathological changes in the respiratory tract the NOAEC in this study was determined to be 64 ppm (0.122 mg/l), and the LOAEC was 128 ppm (0.244 mg/l). The systemic NOAEC was 128 ppm (0.244 mg/l), the highest concentration tested (ECHA) [KI. score =1].

An OECD Guideline 413 (Subchronic Inhalation Toxicity: 90-day) study was conducted using male and female B6C3F1 mice exposed to 0, 8,16,32,64, and 128 ppm formic acid via whole body inhalation (5

days/week, 6 hours/day) for 13 weeks. There were no mortalities or treatment-related signs of toxicity in male and female mice exposed to formic acid at up to 128 ppm (0.244 mg/l) for 13 weeks. Systemic toxicity was generally low, but body weight gain was reduced in both sexes at 128 ppm, resulting in terminal body weights that were 16-20% below those of the controls. A small, but statistically significant increase of liver weight was noted in males at 32 and 64 ppm. Findings of histopathology were limited to few cases of minimal degeneration of the olfactory epithelium. Sperm motility and oestrous cycle length were not affected. The NOAEC in this study was determined to be 32 ppm (0.062 mg/l), based on histopathological changes of the respiratory tract (ECHA) [KI. score =1].

Dermal

There are no studies available based formic acid is corrosive.

G. Genotoxicity

In vitro Studies

The *in vitro* genotoxicity studies on formic acid are presented in Table 2.

Table 2: *In vitro* Genotoxicity Studies on Formic Acid

Test System	Results*		Klimisch Score	Reference
	-S9	+S9		
OECD Guideline 471 (Bacterial Reverse Mutation Assay) S. typhimurium TA97, TA98, TA100, and TA1535	-	-	1	ECHA
OECD Guideline 479 (Genetic Toxicology: In Vitro Sister Chromatid Exchange Assay in Mammalian Cells) Chinese hamster lung fibroblasts V79	-	-	1	ECHA
OECD Guideline 479 (Genetic Toxicology: In Vitro Sister Chromatid Exchange Assay in Mammalian Cells) mammalian cells: human lymphocytes	-	-	1	ECHA
OECD Guideline 476 (In Vitro Mammalian Cell Gene Mutation Test)	-	-	1	ECHA
OECD Guideline 473 (In Vitro Mammalian Chromosome Aberration Test) Chinese hamster ovary (CHO)	-	-	2	ECHA

*+, positive; -, negative

In vivo Studies

An OECD Guideline 477 (Genetic Toxicology: Sex-linked Recessive lethal Test in Drosophilia melanogaster) study was conducted using male Drosophila melanogaster exposed to 0.1% formic acid via their feed. Following exposure to 0.1% formic acid, the number of mutants was significantly increased compared to the historical controls in this study. However, an increase was also seen with 0.1% formic acid in a subsequent feeding experiment, but without gaining statistical significance. Sodium formate (produced by neutralization of formic acid) at the same molar concentration in the feed was negative in the Drosophila SLRL test. The authors concluded that the mutations observed

with formic acid were related to the acidic pH, rather than to the acid or the formate molecule itself. Therefore, it was concluded that formic acid and sodium formate did not induce mutations in this *in vivo* study (ECHA) [KI. score =1].

H. Carcinogenicity

Oral

An OECD Guideline 453 (Combined Chronic Toxicity/Carcinogenicity) study was conducted using male and female Crl:HanWist(Glx:BRL)BR rats exposed to 0, 50, 400, and 2,000 potassium formate in their feed for 104 weeks. All of the doses of potassium formate were well tolerated including the top dose without effects on clinical condition or survival. Depression of food consumption and body weight with sequel was observed in rats at 2000 mg/kg bw/day. The NOAEL for systemic toxicity was 400 mg potassium diformate/kg bw/day. Adaptive hyperplastic changes in the stomach and the gastro-intestinal tract were seen in rats at 400 and, to a higher extend, at 2000 mg/kg bw/day. The NOEL was 50 mg potassium diformate/kg bw/day for these effects. There was no evidence of a tumorigenic effect in the stomach or any other tissue, i.e. the NOAEL for carcinogenic effects was 2000 mg potassium diformate/kg bw/day. Taking the molecular weights of potassium diformate (130.1) and formic acid (46.03) into consideration, the following dose descriptors are calculated for formic acid from the above figures using a multiplier of 0.354 (46/136 = 0.354): NOEL gastro-intestinal changes:17.7 mg formic acid/kg bw/day; NOAEL systemic toxicity:142 mg formic acid/ kg bw/day; NOAEL carcinogenicity:708 mg formic acid/kg bw/day(ECHA) [KI. score=1].

An OECD Guideline 453 (Combined Chronic Toxicity/Carcinogenicity) study was conducted using male and female Crl:CD-1 (ICR) BR mice exposed to 0, 50, 400, and 2000 mg/kg bw potassium formate (1:2) in their feed for 80 weeks. All of the doses of potassium formate were well tolerated and did not adversely affect clinical conditions or survival, or the pattern or incidence of neoplastic lesions at any dose level. Treatment related changes were limited to high dose males and included minor disturbances of body weight (overall body weight gain reduced by 15%, level of statistical significance not reached) and food consumption (up to 5% increased), and an increased incidence of limiting ridge hyperplasia in the forestomach. The incidence and nature of tumours was not affected by the test substance, i.e., the test substance was not carcinogenic. The NOAEL for local effects and systemic toxicity was 400 mg potassium diformate/kg bw and day in male mice. The systemic NOAEL was 2000 mg potassium diformate/kg bw/day in female mice. The NOAEL for carcinogenicity was 2000 mg potassium diformate/kg bw/day in both sexes. Taking into consideration the molecular weights of potassium diformate (130.1) and formic acid (46.03), the following dose descriptors are calculated for formic acid from the above figures using a multiplier of 0.354 (46/136 = 0.354):NOEL gastro-intestinal changes, systemic toxicity (males):142 mg formic acid/ kg bw/day; NOAEL systemic toxicity, females:708 mg formic acid/ kg bw/day; NOAEL carcinogenicity 708 mg formic acid/ kg bw/day (ECHA)[KI. score =1].

Inhalation

There are no studies available.

Dermal

There are no studies available.

I. Reproductive Toxicity

Oral

A two generation OECD Guideline 416 (Two-generation reproduction toxicity) study was conducted using male and female Wistar rats exposed to 0, 100, 300, and 1000 mg/kg bw/day sodium formate in their feed. There were no clinical signs of toxicity or mortalities in any of the F0 or F1 parental dose groups. Food consumption and body weights were comparable to that of the concurrent controls. Necropsy and pathology revealed no gross findings or organ weight changes that could be treatment related. There were no indications that sodium formate adversely affected fertility or reproductive performance of the F0 and F1 parental animals at dose levels as high as 1000 mg/kg body weight/day. Mating behaviour, conception, gestation, parturition, lactation and weaning as well as sexual organ weights and gross findings of these organs were comparable between the rats of the test substance-treated test groups and the corresponding controls and ranged within the historical control data of the test facility. There were no effects on male and female reproduction organs. Sperm parameters and oestrous cycle were not affected. No test substance induced signs of developmental toxicity were noted in the progeny of the F0 and F1 parents at dose levels as high as 1000 mg/kg body weight/day. The number of delivered pups/litter, the sex ratio, their postnatal survival on days 4 and 21 after parturition, their body weights, and their sexual maturation remained unaffected by the test substance. Clinical and/or gross necropsy examinations of the F1 and F2 pups revealed only findings which were considered to be spontaneous in nature. The type and incidence of findings was within the range of the concurrent and/or the historical controls. Based on the above, the NOAEL values were as follows: NOAEL 1000 mg/kg bw/day for general systemic toxicity for F0 and F1 parental animals; NOAEL 1000 mg/kg bw/day for fertility and reproductive performance for the F0 and F1 parental rats; NOAEL 1000 mg/kg bw/day for developmental toxicity, in the F1 and F2 progeny. For read across purposes, the NOAEL for the formate anion may be calculated, taking into account formula weights. The calculation (1000 mg sodium formate/kg /69 x 45 = 650 mg/kg bw/day) gives a NOAEL of approx. 650 mg formate/kg bw/day (ECHA)[KI.score =1].

Inhalation

An OECD Guideline 413 (Subchronic Inhalation Toxicity:90-day) study was conducted using male and female Fischer 344 rats exposed to 0,0.015, 0.030, 0.122, 0.244 mg/L (0,8, 16, 32, 64, 128 ppm) formic acid via whole body vapor inhalation (5 days/week, 6 hours per day) for 13 weeks. There were no findings that would indicate adverse effects on male and female reproductive organs at any dose in this 13-week inhalation study. A NOAEC of 0.244 mg/L air was established for this study (ECHA)[KI. score =1].

An OECD Guideline 413 (Subchronic Inhalation Toxicity: 90-day) study was conducted using male and female B6C3F1 mice exposed to 0, 0.015, 0.030, 0.062, 0.122, or 0.244 mg/L (0, 8, 16, 32, 64, or 128 ppm formic acid via whole body inhalation (5 days/week, 6h/day) for 13 weeks. In mice, sperm motility values were lower at all concentrations, but no dose-response relationship was seen, and the values were within the range of historical controls. There were no effects in female mice. The NOAEC was therefore 0.244 mg/L, the highest concentration used (ECHA)[KI. score =1].

Dermal

There are no studies available.

J. Developmental Toxicity

Oral

An OECD Guideline 414 (Prenatal Developmental Toxicity Study) was conducted using Himalayan rabbits exposed to 0, 100, 300, and 1000 mg/kg bw/day sodium formate via oral gavage for 22 days. There were no treatment-related effects in mortality, clinical signs, body weight, food consumption, caesarean parameters, and terminal necropsy in the does. The maternal NOAEL is therefore 1000 mg sodium formate/kg bw/day. There were no treatment-related effects in developmental parameters. Foetal weight at birth, sex distribution, placenta weight, pre- and post-implantation loss was not affected. There were no unusual or increased incidences of external, soft tissue or skeletal malformations attributable to the treatment. The developmental NOAEL is therefore 1000 sodium formate mg/kg bw/day or 667 mg/kg bw/day of formic acid. The NOAEL for teratogenicity is also 1000 sodium formate mg/kg bw/day (the highest dose tested) or 667 mg/kg bw/day formic acid. Generally, formate salts are used as test material in studies requiring repeated dosing, due to the corrosivity of formic acid. NOAEL values obtained in such studies may be used to calculate the NOAEL for the formate anion which may be read across to other salts or formic acid, taking into account stoichiometry and formula weights (ECHA) [KI. score =1].

An OECD Guideline 414 (Prenatal Developmental Toxicity) study was conducted using Wistar rats exposed to 0,59,236, 945, g/kg bw/day sodium formate via oral gavage for 17 days. There was no evidence of maternal toxicity, embryo/foetal toxicity, or teratogenicity at dose level in this study. In addition to this, there was no maternal toxicity observed. Gestational parameters were not influenced and there were no effects on the developing foetuses. No malformations or skeletal variations were seen. The NOAEL for maternal and developmental toxicity was 945 mg sodium formate/kg bw/day of sodium formate (the highest dose tested) or 630 mg/kg bw/day formic acid. Generally, formate salts are used as test material in studies requiring repeated dosing, due to the corrosivity of formic acid. NOAEL values obtained in such studies may be used to calculate the NOAEL for the formate anion which may be read across to other salts or formic acid, considering stoichiometry and formula weights (ECHA) [KI. score =1].

Inhalation

There are no studies available.

Dermal

There are no studies available.

V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES

The toxicological reference values developed for formic acid follow the methodology discussed in enHealth (2012). The approach used to develop drinking water guidance values is described in the Australian Drinking Water Guidelines (ADWG, 2011).

A. Non-Cancer

Oral

An OECD Guideline 453 (Combined Chronic Toxicity/Carcinogenicity) study was conducted using male and female Crl:HanWist(Glx:BRL)BR rats exposed to 0, 50, 400, and 2,000 potassium formate in

their feed for 104 weeks. The NOAEL for systemic toxicity was 142 mg/kg bw/day. This value will be used for determining the oral reference dose (RfD) and the drinking water guidance value.

Oral Reference Dose (oral RfD)

Oral RfD = NOAEL / (UF_A x UF_H x UF_L x UF_{Sub} x UF_D)

Where:

UF_A (interspecies variability) = 10
UF_H (intraspecies variability) = 10
UF_L (LOAEL to NOAEL) = 1
UF_{Sub} (subchronic to chronic) = 1
UF_D (database uncertainty) = 1
Oral RfD = 142/(10 x 10 x 1 x 1 x 1) = 142/100 = 1.42 mg/kg/day

Drinking water guidance value

Drinking water guidance value = (animal dose) x (human weight) x (proportion of intake from water) / (volume of water consumed) x (safety factor)

Using the oral RfD,

Drinking water guidance value = (oral RfD) x (human weight) x (proportion of water consumed) / (volume of water consumed)

Where:

Human weight = 70 kg (ADWG, 2011)
Proportion of water consumed = 10% (ADWG, 2011)
Volume of water consumed = 2L (ADWG, 2011)
Drinking water guidance value = (1.42 x 70 x 0.1)/2 = 4.97 mg/L

B. Cancer

There is no evidence that formic acid is carcinogenic. Therefore, a value for carcinogenicity was not derived in this dossier.

VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES

Formic acid does exhibit the following physico-chemical properties:

- Explosivity
- Flammability
- Oxidising potential

VII. ENVIRONMENTAL HAZARD ASSESSMENT

A. Summary

Formic acid is of low toxicity to aquatic organisms on an acute and chronic basis.

B. Aquatic Toxicity

Acute Studies

Table 3 lists the results of acute aquatic toxicity studies conducted on formic acid.

Table 3: Acute Aquatic Toxicity Studies on formic acid

Test Species	Endpoint	Results (mg/L)	Klimisch Score	Reference
Zebrafish (Brachydanio rerio)	96-hr LC_{50}	130**	1	ECHA
Rainbow trout (Oncorhynchus mykiss)	96-hr LC_{50}	3,500*	2	ECHA
Daphnia magna	48-hr EC_{50}	365**	1	ECHA
Daphnia magna	48-hr EC_{50}	540*	2	ECHA
Pseudokirchneriella subcapitata	72-hr EC_{50}	1,240**	1	ECHA

*Potassium formate

**Ammonium formate

Chronic Studies

In a 21-day *Daphnia* reproduction study, the measured NOEC for formic acid was 100 mg/L (ECHA). [Kl. score = 1]

C. Terrestrial Toxicity

There are no studies available.

D. Calculation of PNEC

The PNEC calculations for formic acid follow the methodology discussed in DEWHA (2009).

PNEC Water

Experimental results are available for three trophic levels. Acute E(L)C_{50} values are available for fish (130 mg/L), *Daphnia* (365 mg/L), and algae (1,240 mg/L). Results from long-term studies are available for invertebrates (100 mg/L). On the basis that the data consists of short-term studies for three trophic levels and long-term studies from one trophic level, an assessment factor of 100 has been applied to the available NOEC value of 100 mg/L for invertebrates. The NOEC value is used because the value for invertebrates is lower than the lowest acute E(L)C_{50} values. The $PNEC_{water}$ is 10 mg/L.

PNEC Sediment

There are no toxicity data for sediment-dwelling organisms. Therefore, the $PNEC_{sed}$ was calculated using the equilibrium partitioning method. The $PNEC_{sed}$ is 10.9 mg/kg sediment wet weight.

The calculations are as follows:

$PNEC_{sed} = (K_{sed\text{-}water}/BD_{sed}) \times 1000 \times PNEC_{water}$
= (1.40/1280) x 1000 x 10
= 10.9 mg/kg

Where:
$K_{sed\text{-}water}$ = suspended matter-water partition coefficient (m^3/m^3)
BD_{sed} = bulk density of sediment (kg/m^3) = 1,280 [default]
$K_{sed\text{-}water} = 0.8 + [(0.2 \times Kp_{sed})/1000 \times BD_{solid}]$
= 0.8 + [(0.2 x 1.24/1000 x 2400]
= 1.40 m^3/m^3

Where:
Kp_{sed} = solid-water partition coefficient (L/kg)
BD_{solid} = bulk density of the solid phase (kg/m^3) = 2,400 [default]
$Kp_{sed} = K_{oc} \times f_{oc}$
= 31 x 0.04
= 1.24 L/kg

Where:
K_{oc} = organic carbon normalised distribution coefficient (L/kg). The K_{oc} for formic acid was estimated from an OECD guideline 121 study is 31 L/kg(ECHA) [KI. score =1].
F_{oc} = fraction of organic carbon in sediment = 0.04 [default].

PNEC Soil

There are no toxicity data for terrestrial or soil organisms. Therefore, the $PNEC_{soil}$ was calculated using the equilibrium partitioning method. The $PNEC_{soil}$ is 4.13 mg/kg soil dry weight.

The calculations are as follows:

$PNEC_{soil} = (Kp_{soil}/BD_{soil}) \times 1000 \times PNEC_{water}$
= (0.62/1500) x 1000 x 10
= 4.13 mg/kg

Where:
Kp_{soil} = soil-water partition coefficient (m^3/m^3)
BD_{soil} = bulk density of soil (kg/m^3) = 1,500 [default]
$Kp_{soil} = K_{oc} \times f_{oc}$
= 31 x 0.02
= 0.62 m^3/m^3

Where:
K_{oc} = organic carbon normalised distribution coefficient (L/kg). The K_{oc} for formic acid was estimated from an OECD guideline 121 study is 31 L/kg(ECHA) [KI. score =1].
F_{oc} = fraction of organic carbon in soil = 0.02 [default].

VIII. PERSISTENCE, BIOACCUMULATION AND TOXICITY (PBT) ASSESSMENT

The methodology for the Persistent, Bioaccumulative and Toxic (PBT) substances assessment is based on the Australian and EU REACH Criteria methodology (DEWHA, 2009; ECHA, 2017).

Formic acid is readily biodegradable and thus does not meet the screening criteria for persistence.

The log K_{ow} formic acid is -2.1. Thus, formic acid does not meet the criteria for bioaccumulation.

The NOECs from the chronic aquatic toxicity studies on formic acid are > 0.1 mg/L. The acute E(L)C_{50} values from the acute aquatic toxicity studies on formic acid are > 1 mg/L. Thus, formic acid does not meet the criteria for toxicity.

The overall conclusion is that formic acid is not a PBT substance.

IX. CLASSIFICATION AND LABELLING

A. Classification

H314-Causes severe skin burns and eye damage

Specific target organ toxicity-category 3

Skin corrosion-category 1

Acute toxicity (ingestion)-category 4

Acute toxicity (inhalation)- category 3

STORE Category 2 (target organ: kidney)

B. Labelling

Danger

A. Pictogram



X. HANDLING AND SAFETY INFORMATION (OCCUPATIONAL LIMITS AND TRANSPORTATION REQUIREMENTS)

A. First Aid

Please refer to the product SDS for additional information and confirmation of the information provided herein.

Eye Contact

In case of contact, immediately flush eyes with plenty of water for at least 15 minutes.

Skin Contact

Wash thoroughly with soap and water.

Inhalation

If inhaled, remove from area to fresh air. Get medical attention.

Ingestion

Rinse mouth with water and then drink a glass of water. Get medical attention. Never give anything by mouth to an unconscious person.

B. Fire Fighting Information

Extinguishing Media

Water spray, carbon dioxide, foam, dry chemical.

Specific Exposure Hazards

Keep product and empty container away from heat and sources of ignition. May emit toxic fumes under fire conditions. Depending on conditions, decomposition products may include the following: carbon monoxide, carbon dioxide.

Special Protective Equipment for Firefighters

Wear self-contained breathing apparatus.

C. Accidental Release Measures

Personal Precautions

Use appropriate protective equipment. Handle in accordance with good industrial hygiene and safety practice.

Environmental Precautions

Prevent from entering sewers, waterways or low areas.

Steps to be Taken if Material is Released or Spilled

For large amounts: dike spillage and pump off product. For residues: pick up with suitable absorbent material. Dispose of contaminated material as prescribed.

D. Storage And Handling

General Handling

Keep product and empty container away from heat and sources of ignition. Ensure adequate ventilation, especially in confined areas.

Storage

Keep container tightly closed and in a dry and well-ventilated place. Keep in a cool place.

E. Exposure Controls / Personal Protection

Occupational Exposure Standards

The workplace exposure standards for formic acid in Australia is as follows: 9.4 mg/m^3. The short term exposure limit is 19 mg/m^3.

Engineering Controls

Good general ventilation should be used.

Personal Protection Equipment

Respiratory Protection: Respiratory protection is not required.

Hand Protection: Chemical resistant protective gloves.

Skin Protection: Body protection must be chosen depending on activity and possible exposure.

Eye protection: Safety glasses with side-shields.

Other Precautions: Handle in accordance with good industrial hygiene and safety practice. Wearing of closed work clothing is recommended. Ensure that eyewash stations and safety showers are close to the workstation location.

F. Transport Information

Formic acid is not considered hazardous for purposes of transportation by road or rail. An Australian Dangerous Goods code is not required.

XI. DISPOSAL MANAGMENT

Disposal should be in accordance with all local, state and federal regulations.

XII. REGULATORY STATUS

Australian AICS Inventory: Listed.

XIII. REFERENCES

ADWG. (2011). National Water Quality Management Strategy. Australian Drinking Water Guidelines, Section 6, Australian Government, National Health and Medical Research Council, Natural Resource Management Ministerial Council. Updated January 2022. Available: https://www.nhmrc.gov.au/about-us/publications/australian-drinking-water-guidelines

Department of the Environment, Water, Heritage and the Arts [DEWHA]. (2009). Environmental risk assessment guidance manual for industrial chemicals, Department of the Environment, Water, Heritage and the Arts, Commonwealth of Australia. Available: http://www.nepc.gov.au/resource/chemical-risk-assessment-guidance-manuals

Department of the Environment and Energy [DoEE]. (2017). Chemical Risk Assessment Guidance Manual: for chemicals associated with coal seam gas extraction, Guidance manual prepared by Hydrobiology and ToxConsult Pty Ltd for the Department of the Environment and Energy, Commonwealth of Australia, Canberra.

ECHA. ECHA REACH database: http://echa.europa.eu/information-on-chemicals/registered-substances

enHealth Human Risk Assessment [HHRA]. (2012). Environmental Health Risk Assessment, Guidelines for Assessing Human Health Risks from Environmental Hazards. Office of Health Protection of the Australian Government Department of Health. Available: https://www1.health.gov.au/internet/main/publishing.nsf/Content/health-pubhlth-publicat-environ.htm

European Chemicals Agency [ECHA]. (2017). Guidance on Information Requirements and Chemical Safety Assessment, Chapter R11: PBT Assessment, European Chemicals Agency, Helsinki, Finland. Available: https://echa.europa.eu/guidance-documents/guidance-on-information-requirements-and-chemical-safety-assessment

Klimisch, H.J., Andreae, M., and Tillmann, U. (1997). A systematic approach for evaluating the quality of experimental and toxicological and ecotoxicological data. Regul. Toxicol. Pharmacol. 25:1-5.

U.S. Environmental Protection Agency [EPA]. (2017). EPISuite™ v. 4.11, United States Environmental Protection Agency, Office of Pollution Prevention and Toxics and Syracuse Research Corporation. Available: https://www.epa.gov/tsca-screening-tools/epi-suitetm-estimation-program-interface.

GLUTARALDEHYDE

This dossier on glutaraldehyde presents the most critical studies pertinent to the risk assessment of glutaraldehyde in its use in coal seam gas extraction activities. This dossier does not represent an exhaustive or critical review of all available data. The majority of information presented in this dossier was obtained from NICNAS (1994) and the ECHA database that provides information on chemicals that have been registered under the EU REACH (ECHA). Where possible, study quality was evaluated using the Klimisch scoring system (Klimisch et al., 1997).

I. SUBSTANCE IDENTIFICATION

Chemical Name (IUPAC): Glutaraldehyde

CAS RN: 111-30-8

Molecular formula: $C_7H_8O_2$

Molecular weight: 100.12 g/mol

Synonyms: Pentanedial; glutaral; glutaric dialdehyde; 1,3-diformylpropane; 1,5-pentanedial; glutaric aldehyde; glutaric acid dialdehyde; dioxopentane; glutardialdehyde; 1,5-pentanedione; Algicide®C

SMILES: C(CC=O)CC=O

II. PHYSICAL AND CHEMICAL PROPERTIES

Table 1: Overview of the Physico-Chemical Properties of Glutaraldehyde

Property	Value	Klimisch Score	Reference
Physical state at 20°C and 101.3 kPa*	Sweetish smelling, clear water liquid	1	ECHA
Melting Point*	-33°C (pressure not provided)	1	ECHA
Boiling Point*	101.5°C @ 98.71 kPa	1	ECHA
Density*	1,130 kg/m^3 @ 20°C	1	ECHA
Vapour Pressure*	21 Pa @ 25°C	1	ECHA
Partition Coefficient (log K_{ow})*	-0.36 @ 23°C and pH 7	1	ECHA
Water Solubility*	Miscible @ 20°C	2	ECHA
Flash Point*	Not measurable	1	ECHA
Auto flammability*	395°C @ ~1,000hPa	1	ECHA
Viscosity*	12.75 mm^2/s (static) at 25°C	1	ECHA
Henry's Law Constant	0.011 Pa m^3/mol at 25°C [QSAR]	2	ECHA

*ca. 50% glutaraldehyde solution (in water)
1 ppm = 4.095 mg/m3
1 mg/m3 = 0.244 ppm

III. ENVIRONMENTAL FATE PROPERTIES

A. Summary

Glutaraldehyde is considered readily biodegradable. It is also expected to have a low potential for bioaccumulation. The K_{oc} values for glutaraldehyde indicate that it will have low potential for adsorption to suspended solids and sediment in water and moderate adsorption to soil. Glutaraldehyde is not expected to undergo hydrolysis in the environment. Overall, glutaraldehyde shows limited persistence in the environment.

B. Partitioning

In an OECD TG 111 test (hydrolysis as a function of pH), glutaraldehyde was hydrolytically stable at pH 4 and pH 7 but decomposed at pH 9 (ECHA) [Kl. score = 2].

Photolytic degradation of glutaraldehyde occurred in water under sensitised conditions: the half-life was 18 days when equivalent to 36 days of natural sunlight (12 hours/day; sensitised acetone system); and 49 days when equivalent to 34 days of natural sunlight (12 hours/day; sensitised acetonitrile system). There was no photodegradation of glutaraldehyde under darkness or non-sensitised conditions (ECHA) [Kl. score = 2].

C. Biodegradation

Glutaraldehyde was considered readily biodegradable in an OECD 301A (DOC die away test). Degradation was 90-100% in 28 days (ECHA) [Kl. score = 1].

In a simulation test involving aerobic sewage treatment [activated sludge units] (OECD TG 303A), glutaraldehyde degraded 97% after 73 days based on DOC removal (ECHA) [Kl. score = 1].

In an aerobic aquatic metabolism test, [^{14}C]-glutaraldehyde had a half-life of 10.6 hours in the water/sediment system. A minor transformation product was glutaric acid: the maximum yield was 18.9 to 21.5% at 12 hours, which then declined rapidly to 10.1 to 11% by 24 hours; and was not observed at the end of the study period in the aqueous phase (ECHA) [Kl. score = 1].

In an anaerobic aquatic metabolism test, [^{14}C]-glutaraldehyde was rapidly metabolised with the first-order half-life being 7.7 hours. Glutaraldehyde was transformed to 5-hydroxypentanal (ca 37% of applied radioactivity) on day 1; after that, it declined to < 10%; it was not detected at all after 30 days. The second stable transformation product was 1,5-pentanediol (35% of radioactivity on Day 1), which accounted for 70% of the radioactivity at the end of the test. A minor transformation product was a compound formed via Aldol condensation, cyclisation and dehydration. This compound accounted for about 10-20% of total radioactivity from Day 1 onwards (ECHA) [Kl. score = 1].

In an aerobic soil metabolism test, the half-life of the degradation of [^{14}C]-glutaraldehyde was calculated to be 1.7 days, indicating rapid degradation in soil by microbial biotransformation. Degradation products were measured but not identified (ECHA) [Kl. score = 1].

If a chemical is found to be readily biodegradable, it is categorised as Not Persistent since its half-life is substantially less than 60 days (DoEE, 2017).

D. Environmental Distribution

The organic carbon/water partition coefficients (K_{oc}) values were determined for sediment and four types of soil. The values are as follows: 120 for sediment; 210 for sandy loam; 500 for silty clay loam; 340 for silt loam; and 460 for loamy sand (ECHA; Leung, 2001) [Kl. score = 1].

Based on these K_{oc} values, glutaraldehyde is considered to be moderately mobile in soil. If released to water, based on these K_{oc} values and its water solubility, it has moderate potential for adsorption to suspended solids or sediments.

E. Bioaccumulation

Glutaraldehyde is not expected to bioaccumulate. The measured log K_{ow} at pH 5, 7 and 9 are -0.41, -0.36 and -0.80, respectively (ECHA).

IV. HUMAN HEALTH HAZARD ASSESSMENT

A. Summary

Glutaraldehyde has moderate-to-high acute toxicity by the oral route, low-to-moderate toxicity by the dermal route, and moderate-to-high toxicity by the inhalation route. Acute inhalation exposure may cause respiratory irritation. Glutaraldehyde is corrosive to the skin and eyes; it is also a skin and respiratory sensitiser. Repeated oral exposures via drinking water to rats have resulted in general systemic toxicity, but no target organ effects. In contrast, the upper respiratory tract, particularly the nasal cavity, is the target organ in rodents from repeated inhalation exposure. Glutaraldehyde may exhibit weak genotoxic effects in some *in vitro* tests, whereas the *in vivo* studies consistently show no genotoxic activity. Glutaraldehyde is not a reproductive toxicant; developmental toxicity can occur at maternally toxic doses, but there is no teratogenicity.

B. Toxicokinetics

Dermal Absorption

[1,5-^{14}C]-glutaraldehyde was applied to the skin of male and female F344 rats. Doses were 0.75% and 7.5%: this corresponds to approximately 6.5 and 63 mg/kg for males; and approximately 8.7 and 102 mg/kg for females. The dermal absorption data are presented in Table 2. The results indicate that glutaraldehyde has a low rate of absorption by the dermal route (ECHA).

Table 2: Dermal Absorption Data in Rats on Glutaraldehyde (ECHA)

Sex	Absorption rate constant/hr		% of applied dose	
	Low Dose	High Dose	Low Dose	High Dose
Males	1.5	0.7	0.7	1.3
Females	1.8	0.9	0.3	2.1

An *in vitro* percutaneous absorption study was conducted on glutaraldehyde using excised skin from rats, rabbits, mice, guinea pigs and humans. The skin samples were placed in a flow-through skin penetration chamber, and [^{14}C]-glutaraldehyde was added at doses of 0.75% and 7.5%. The results are presented in Table 3. Glutaraldehyde did not penetrate any of the skin samples to a significant degree, suggesting that only minimal amounts of glutaraldehyde may be available for systemic

uptake and distribution after skin exposure. The results also show that skin absorption was greater for the animal species used in toxicity tests than human skin (ECHA; Frantz et al., 1993).

Table 3: *In vitro* Percutaneous Absorption (mg/cm^2) of Glutaraldehyde (ECHA; Frantz et al., 1993)

Species	Low Dose	High Dose
Animal*	0.006	0.08
Human	0.002	0.02

*Percutaneous absorption in rats, mice, guinea pigs, mice and rabbits were similar to each other and were reported as a single value.

C. Acute Toxicity

The oral LD_{50} values are: 123 to 820 mg/kg in rats; 100 to 352 mg/kg in mice; and 50 mg/kg in guinea pigs (NICNAS, 1994).

The dermal LD_{50} values are: 640 to 2,000 mg/kg in rabbits; > 2,500 mg/kg in rats; and > 4,500 mg/kg in mice (NICNAS, 1994).

The 4-hour inhalation LC_{50} values for glutaraldehyde are listed in Table 4:

Table 4: Acute inhalation LC_{50} values for Glutaraldehyde

Test Material	LC_{50} (males) [mg/L]	LC_{50} (females) [mg/L]	LC_{50} (both sexes) [mg/L]	Reference
50% aq. aerosol	0.52	0.45	-	OECD, 1995
25% aq. aerosol	-	-	0.8	OECD, 1995
50% aq. aerosol	0.35	0.28	-	OECD, 1995
5% soln. vapour	0.096	0.164	-	OECD, 1995

During the exposure period, the animals showed signs of eye and respiratory irritation, as indicated by laboured and audible breathing, and wetness and encrustation around the nose and eyes.

D. Irritation

Glutaraldehyde is corrosive to the skin and eyes of rabbits (NICNAS, 1994; ECHA). Signs of irritation occurred at a concentration of 2% for skin and 0.2% for eyes (NICNAS, 1994). In the acute inhalation studies, rats exposed to aerosols or vapours of glutaraldehyde showed signs of eye and respiratory irritation (OECD, 1995).

E. Sensitisation

Glutaraldehyde is a skin sensitiser to guinea pigs and humans. Information on the individual studies can be found in NICNAS (1994) and in the ECHA REACH database (ECHA).

Asthmatic symptoms, such as wheezing, coughing, chest tightness, breathing difficulties and non-specific hyper-responsiveness have been reported to occur in humans occupationally exposed to glutaraldehyde (NICNAS, 1994). It is unclear whether the asthma is an allergic hypersensitivity response or a result of the aggravation of pre-existing asthma due to the irritating properties of

glutaraldehyde. Nevertheless, glutaraldehyde should be considered a respiratory sensitiser, although one of low potency.

F. Repeated Dose Toxicity

Oral

Male and female Wistar rats were given in their drinking water 0, 100, 500, or 2,000 ppm glutaraldehyde for 90 days. The approximate daily intakes were 0, 3, 15 or 53 mg/kg/day for males, and 0, 4, 19 or 72 mg/kg/day for females. There were no signs of neurotoxicity at any dose level. There was slight impairment of food consumption in the 2,000 ppm animals, as well as slight impairment of body weight and body weight gain. Impaired water consumption was seen in the 100 and 500 ppm females. The NOAEL for males is 500 ppm (15 mg/kg/day). The NOAEL for females is 100 ppm (4 mg/kg/day) since the impaired water consumption in the 100 ppm females was considered a palatability problem and not an adverse effect (ECHA) [Kl. score = 1].

Male and female F344 rats were given in their drinking water 0, 50, 250 or 1,000 ppm glutaraldehyde for 13 weeks. Additional groups of animals were given in their drinking water 0 or 1,000 ppm glutaraldehyde for 13 weeks followed by a 4-week recovery period. The approximate daily intakes were 0, 5, 25 or 100 mg/kg/day for males; and 0, 7, 35 or 120 mg/kg/day for females. Water consumption was reduced in a dose-dependent manner in the $\geq$ 250 ppm males and 1,000 ppm females, which was attributed to an aversion to the taste and/or odour of glutaraldehyde in the water. There was also a reduction in food consumption in the 1,000 ppm animals with a parallel reduction in body weights. It is unclear whether the reduction in food consumption was related to the decreased water consumption. Urine volume was decreased with an increase in specific gravity, along with a slight increase in protein and ketone concentration, in the $\geq$ 250 ppm animals, which was probably related to the decreased water consumption. There were no treatment-related changes in the haematology parameters measured. Blood urea nitrogen was increased in a dose-related manner in the $\geq$ 250 ppm females at the 6-week time point, but not at the 13-week or 17-week time points. Relative kidney weights were increased in a dose-related manner in the $\geq$ 250 ppm males and females and increased absolute kidney weights in the females. Histopathological examination showed no treatment-related effects. The NOAEL is 50 ppm (5 and 7 mg/kg/day for males and females, respectively) based on dose-related increase in kidney weights at $\geq$ 250 ppm (ECHA) [Kl. score = 2].

Male and female Wistar rats were given in their drinking water 0, 100, 500 or 2,000 ppm glutaraldehyde for 12 months. The approximate daily intakes were: 0, 6.4, 30.5, or 116.6 mg/kg/day for males; and 0. 9.6, 46, or 153 mg/kg/day for females. There was no treatment-related mortality. At 2,000 ppm, treatment-related effects included respiratory sounds (both sexes), decrease in body weight (males), decrease in body weight gain (both sexes), decrease in food consumption (both sexes), reduced water consumption (both sexes), lesions within the glandular stomach (both sexes showed erosion/ulceration of the glandular stomach), increased incidence of clear cell foci in the liver (males) and a single case of slight diffuse squamous metaplasia in the epithelium of the larynx (male). At 500 ppm, water consumption was reduced in males which was considered to be a palatability (bad taste) problem and not an adverse effect. No effects were seen in the 100 ppm animals. The NOAEL for this study is 500 ppm, which corresponds to 30.5 and 46 mg/kg/day for males and females, respectively (ECHA) [Kl. score = 1].

Male and female Fischer 344 rats were given in their drinking water 0, 50, 250 or 1000 ppm glutaraldehyde for 104 weeks. The mean glutaraldehyde consumption was 0, 4, 17 and 64 mg/kg/day for males and 0, 6, 25 and 86 mg/kg/day for females. There were no treatment-related mortalities or clinical symptoms of toxicity. In the 250 and 1,000 ppm groups, there was reduction in

body weight and body weight gain; reduction in food and water consumption; increased statistically significant incidence of nucleated erythrocytes and of large monocytes; decreases in alanine aminotransferase (ALT), aspartate aminotransferase (AST), and glutamate dehydrogenase; dose-related decrease in urine volume accompanied by a dose-related increase in osmolality; changes in absolute and relative kidney weight; gastric irritation; increases in bone marrow hyperplasia; and increased incidence of renal tubular pigmentation. The decreased water consumption was considered to be due to the bad taste, smell and/or irritancy of the test substance in the drinking water; thus, it is of no toxicological relevance. As a result of reduced water intake, there are renal physiological adaptation, such as decreased urine, increased osmolality and changes in kidney weight. The haematological and clinical chemistry parameter changes were marginal and were considered to be of no toxicological relevance. The main haematological finding seen at the end of the study, which consisted of the appearance of nucleated erythrocytes and large monocytes in all treated groups (statistically significant for the $\geq$250 ppm males), was related to the incidence of large granular lymphocytic leukaemia (LGLL) in the spleen. The bone marrow hyperplasia and renal tubular pigmentation are related to the occurrence/incidence of LGLL and were considered by the authors of the study as being secondary to low-grade haemolytic anaemia in animals with LGLL. The NOAEL for this study is 50 ppm which corresponds to 4 and 6 mg/kg/day for males and females, respectively (Van Miller et al., 2002) [Kl. score = 2].

Inhalation

Male and female F344 rats were exposed by inhalation to 0, 0.0625, 0.125, 0.25, 0.5 or 1.0 ppm (0, 0.26, 0.5, 1, 2 or 4.1 mg/m^3) glutaraldehyde for 6.5 hours/day, 5 days/week for 13 weeks. The study focused on the respiratory tract, using histopathology and epithelial cell labelling index as end points. Histopathological lesions in the nasal passages and turbinates were seen at $\geq$ 0.25 ppm. Treatment-related effects were primarily the respiratory mucosa (nasal cavity and tips of the turbinates) and the olfactory epithelium (dorsal meatus). Hyperplasia, squamous metaplasia, olfactory degeneration, squamous exfoliation (accumulation of keratin, cell debris and bacteria in the lumen of the nasal vestibule) and focal erosions were reported for both sexes, and the severity and incidence of the findings increased with increasing concentration of glutaraldehyde. The NOAEL for this study is 0.125 ppm (Gross et al., 1994) [Kl. score = 1].

Male and female B6C3F$_1$ mice were exposed by inhalation to 0, 0.0625, 0.125, 0.25, 0.5 or 1.0 ppm (0, 0.26, 0.5, 1, 2 or 4.1 mg/m^3) glutaraldehyde for 6.5 hours/day, 5 days/week for 13 weeks. The study focused on the respiratory tract, using histopathology and epithelial cell labelling index as end points. Histopathologic lesions in the nasal passages and turbinates were seen at all exposure concentrations ($\geq$ 0.0625 ppm). Treatment-related lesions were primarily the respiratory mucosa (nasal cavity and tips of the turbinates) and the olfactory epithelium (dorsal meatus). Hyperplasia, squamous metaplasia, olfactory degeneration, squamous exfoliation (accumulation of keratin, cell debris and bacteria in the lumen of the nasal vestibule) and focal erosions were reported for both sexes, and the severity and incidence of the findings increased with increasing test concentration. Furthermore, neutrophilic inflammation was seen at $\geq$ 0.062 ppm, and squamous metaplasia as well as necrosis were seen in the larynx at 1 ppm. The LOAEL for this study is 0.0625 ppm; a NOAEL was not established (Gross et al*.,* 1994) [Kl. score = 1].

Male and female B6C3F$_1$ mice were exposed by inhalation to 0 or 0.1 ppm (0 or 0.41 mg/m^3) glutaraldehyde for 6 hours/day, 5 days/week for 52 and 78 weeks. Survival was similar between treated and control groups. Hyperplasia of the squamous epithelium lining of the dorsal wall of the nasal passages and the lateral aspect of the atrioturbinate was seen in a greater number of exposed females than in controls. Epidermal erosion and ulceration as well as squamous and inflammatory exfoliation were also seen in the nasal lumens. All of these changes were dependent on the length of

glutaraldehyde exposure. The authors concluded that, since the induced lesions occurred in the more anterior part of the nasal passages, that they were likely the result of an irritation mechanism (Zissu et al., 1998) [Kl. score = 2].

Male and female Fischer 344 rats were exposed by inhalation to 0, 0.25, 0.5, or 0.75 ppm (0, 1, 2, or 3.1 mg/m^3) glutaraldehyde for 6 hours/day, 5 days/week for two years. Survival in the mid- and high-dose females was statistically significantly decreased compared to controls. Mean body weights of all exposed males and the mid- and high-dose females were generally less than those of the controls. Non-neoplastic lesions were limited primarily to the most anterior region of the nasal cavity. Effects included hyperplasia and inflammation of the squamous epithelium; hyperplasia, goblet cell hyperplasia, inflammation and squamous metaplasia of the respiratory epithelium; and hyaline degeneration of the olfactory epithelium. The LOAEL for this study is 0.25 ppm based on hyperplasia and inflammation of the squamous epithelium of the nose in both sexes. A NOAEL was not established (van Birgelen et al., 2000) [Kl. score = 2].

Male and female B6C3F$_1$ mice were exposed by inhalation to 0, 0.0625, 0.125 or 0.25 ppm (0, 0.26, 0.5 or 1 mg/m^3) glutaraldehyde for 6 hours/day, 5 days/week for two years. Survival of the treated animals was similar to controls. Mean body weights of the high-dose females were generally lower than the controls. Non-neoplastic lesions were limited primarily to the anterior region of the nasal cavity; the effects were qualitatively similar to those seen in the rats (see accompanying summary on the two-year rat study by van Birgelen et al. [2000]). Squamous metaplasia of the respiratory epithelium was observed in both sexes of mice while female mice also had inflammation and hyaline degeneration of the respiratory epithelium. The incidence and severity grade (in parentheses) of the hyaline degeneration were: 16/50 (1.4), 35/49 (1.4), 32/50 (1.3) and 30/50 (1.1) for the 0, 0.0625, 0.125 and 0.25 ppm dose groups, respectively. The LOAEL for this study is 0.0625 ppm based on hyaline degeneration of the respiratory epithelium in female mice. A NOAEL was not established (van Birgelen et al., 2000) [Kl. score = 2].

Dermal

Applications of a 50% solution of glutaraldehyde was applied to the skin of male and female SD rats for 13 weeks. The doses were 0, 50, 100 and 150 mg/kg glutaraldehyde. At the application site, there were signs of irritation (scabs, desquamation and very slight or well-defined erythema). There was no treatment-related mortality, clinical signs, body weights, feed consumption and ophthalmoscopic effects. There were no changes in the haematology and clinical chemistry parameters that were considered to be biologically or toxicologically relevant. Organ weights were similar between treated and control animals. Histopathological examination showed treatment-related effects in the skin associated with chronic irritation; no other changes were noted that were considered to be treatment-related. The NOAEL for this study is 150 mg/kg, the highest dose tested (ECHA) [Kl. score = 1].

G. Genotoxicity

In Vitro Studies

Glutaraldehyde may exhibit weak genotoxic effects in some *in vitro* tests. The bacterial reverse mutation assays have been the most consistent. Variable results have been reported for the forward gene mutation tests; and for sister chromatid exchange (SCE), chromosomal aberration and Unscheduled DNA Synthesis (UDS) tests (Vergnes and Ballantyne, 2002).

In vivo Studies

The *in vivo* studies conducted on glutaraldehyde are presented in Table 5. All the studies show that glutaraldehyde is not mutagenic or genotoxic.

Table 5: *In vivo* Genotoxicity Studies on Glutaraldehyde

Test System	Results*	Klimisch Score	Reference
Rat bone marrow (chromosomal aberration)	-	1	ECHA
Rat bone marrow (chromosomal aberration)	-	2	ECHA
Mouse bone marrow (micronucleus)	-	1	ECHA
Rat bone marrow (chromosomal aberration)	-	2	ECHA
Rat germ cell cytogenetic assay (alkaline elution)	-	2	ECHA
Drosophila SLRL Test	-	2	ECHA
Rat liver UDS Assay	-	1	ECHA
Rat germ cell cytogenetic assay (alkaline elution)	-	2	ECHA
Mouse peripheral blood micronucleus study	-	2	Vernes and Ballantyne (2002)
Rat liver UDS Assay	-	2	Mirsalis *et al.* (1989)

* +, positive; -, negative

H. Carcinogenicity

Oral

Male and female Fischer 344 rats were given in their drinking water 0, 50, 250 or 1,000 ppm glutaraldehyde for 104 weeks. The mean glutaraldehyde consumption was 0, 4, 17 and 64 mg/kg/day for males and 0, 6, 25 and 86 mg/kg/day for females. Mortality rates were 25-30% and 19-23% for males and females, respectively, with no dose-related increase. The major cause of death in all dose groups including the controls was LGLL. There was an increased incidence of LGLL in the liver and spleen in all treated females ($\geq$ 50 ppm). The incidence of LGLL was not significantly increased in the treated males compared to the controls. No other treatment-related increased incidence of tumours was seen (Van Miller et al., 2002) [Kl. score = 2].

Male and female Wistar rats were given in their drinking water 0, 100, 500 or 2,000 ppm glutaraldehyde for two years. The mean daily intake of glutaraldehyde was as follows: 0, 6.1, 31.9 and 120.7 mg/kg/day for males; and 0, 10.5, 48.5 and 176.4 mg/kg/day for females. In the high-dose animals, there was mortality (2 males and 9 females) from asphyxia, and mean terminal body weights were significantly decreased compared to the controls. There were no treatment-related neoplastic effects (ECHA) [Kl. score = 1].

Inhalation

Male and female $B6C3F_1$ mice were exposed by inhalation to 0 or 0.1 ppm (0 or 0.4 mg/m^3) glutaraldehyde for 6 hours/day, 5 days/week for 52 and 78 weeks. No exposure-related neoplastic lesions were observed in either males or females (Zissu et al., 1998) [Kl. score = 2].

Male and female Fischer 344 rats were exposed by inhalation to 0, 0.25, 0.5 or 0.75 ppm (0, 1, 2 or 3.1 mg/m^3) glutaraldehyde for 6 hours/day, 5 days/week for two years. Survival in the mid- and high-dose females was statistically significantly decreased compared to controls. Survival of the treated males was similar to controls. No exposure-related neoplastic lesions were observed in either males or females (van Birgelen et al., 2000) [Kl. score = 2].

Male and female B6C3F$_1$ mice were exposed by inhalation to 0, 0.0625, 0.125 or 0.25 ppm (0, 0.26, 0.5 or 1 mg/m^3) glutaraldehyde for 6 hours/day, 5 days/week for two years. Survival of the treated animals was similar to controls. No exposure-related neoplastic lesions were observed in either males or females (van Birgelen et al., 2000) [Kl. score = 2].

I. Reproductive Toxicity

A two-generation reproductive toxicity study was conducted in Wistar rats given 0, 100, 500 and 2,000 ppm glutaraldehyde in their drinking water. The approximately mean daily intake is 0, 12, 58 and 199 mg/kg/day for the parental males and females of the F_0 and F_1 generation during premating. There were no adverse effects on reproductive performance or fertility. Oestrous cycle data, mating behaviour, conception, gestation, parturition, lactation and weaning as well as sperm parameters, sexual organ weights, gross and histopathological findings of these organs were similar between treated and control groups. In the high-dose animals, there was decreased water and/or food consumption; and decreased body weights and/or reduced body weight gains during the premating periods in the F_0 and F_1 parental females during premating, gestation and/or lactation. The high-dose F_1 parental females also had increased the number of erosions/ulcers with microscopic erosion(s) or inflammatory oedema in the mucosa/submucosa of the glandular stomach. There were no adverse effects in the 500 ppm animals except for slight decreases in water consumption due to a palatability (bad taste) problem. Treatment-related signs of developmental toxicity were seen in the progeny of the high-dose F_0 and F_1 parental generation and included impairment in body weight and consequently in organ weights in the respective F_1 and F_2 pups. The NOAEL for reproductive toxicity is 2,000 ppm (199 mg/kg/day), the highest dose tested. The NOAEL for parental systemic toxicity is 500 ppm (58 mg/kg/day). The NOAEL for developmental toxicity is 500 ppm or 58 mg/kg/day (ECHA) [Kl. score = 1].

A two-generation reproductive toxicity study was conducted in Crj: CD(SD) rats given 0, 50, 250 and 1,000 ppm glutaraldehyde in their drinking water. Mean daily intake was not calculated. Parental body weights and body weight gains were significantly reduced at 1,000 ppm at some periods, particularly during pre-mating. Food consumption was significantly reduced at 1,000 ppm for the F_0 and F_1 parental animals during pre-mating and gestation, and F_1 females during lactation. Water consumption was reduced throughout the pre-mating period for the F_0 and F_1 250 and 1,000 ppm parental animals. There was no indication of adverse effects on reproductive performance or fertility at any dose level. For the F_1 1,000 ppm offspring, body weights were reduced from lactation days 21-28. The NOAEL for reproductive toxicity is 1,000 ppm, the highest dose tested. The NOAEL for parental systemic toxicity is 50 ppm. The NOAEL for developmental toxicity is 250 ppm (Neeper-Bradley and Ballantyne, 2000) [Kl. score = 2].

J. Developmental Toxicity

Pregnant Wistar rats were given in their drinking water 0, 50, 250 or 750 ppm (0, 5, 26 or 68 mg/kg) glutaraldehyde from GD 6 to 16. Water consumption was reduced in a dose-related manner in the $\geq$ 250 ppm dams, and was considered not to be a toxic response, but due to the palatability (bad taste) of the drinking test solution. No other maternal effects were seen in the study. There were no significant differences between treated and controls in the sex distribution, placental weights, foetal

weights, malformations or variations. The NOAEL for maternal and developmental toxicity in this study is 68 mg/kg/day, respectively (ECHA) [Kl. score = 1].

Pregnant Wistar rats were dosed by oral gavage with 0, 25, 50 or 100 mg/kg glutaraldehyde on GD 6 to 15. Mortality was significantly increased in the high-dose group (5/26); there were 2/21 deaths in the mid-dose group. Clinical signs (piloerection) occurred in all treated groups in a dose-dependent manner. Maternal body weight gain and feed consumption were significantly reduced in the high-dose dams, but not at the lower doses. The necropsy findings showed evidence of stomach irritation in almost all of the animals that died during the study and in 12/21 of the surviving dams in the high-dose group. The number of implantations per litter, resorptions and dead foetuses per litter, live foetuses per litter and incidence of post-implantation loss per litter was similar across all groups. The mean foetal body weights for male and female foetuses were significantly reduced in the high-dose group; this was attributed to the reduced food consumption of the dams during gestation rather than a direct effect of treatment. There was no evidence of a treatment-related teratogenic effect. The NOAEL for maternal and developmental toxicity is 50 mg/kg/day, respectively (Ema et al., 1992) [Kl. score = 2].

Pregnant Himalayan rabbits were dosed by oral gavage with 0, 5, 15 or 45 mg/kg glutaraldehyde on GD 7 to 19. In the high-dose group, 5/15 died on GD 9-11. Food consumption and body weight gain were also significantly reduced in the high-dose group. Clinical observations in 12/15 high-dose does included soft faces, diarrhoea and blood in the bedding. The mean gravid uterus weight was significantly reduced in the high-dose group. Post-implantation loss was greatly increased (94.3%) in the high-dose group: no viable foetuses in 9/15 of the high-dose does, only early resorptions; only one female gave four alive foetuses on the scheduled date. There were reduced placental and foetal body weights in the only four foetuses. No significant maternal or developmental effects were seen in the mid- and low-dose groups. The NOAEL for maternal and developmental toxicity in this study is 15 mg/kg/day (ECHA) [Kl. Score = 2].

V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES

The toxicological reference values developed for glutaraldehyde follow the methodology discussed in enHealth (2012). The approach used to develop drinking water guidance values is described in the Australian Drinking Water Guidelines (ADWG, 2011).

A. Non-Cancer

The lowest NOAEL values from key toxicity studies on glutaraldehyde are listed in Table 6.

Table 6: Lowest NOAEL Values from Key Toxicity Studies on Glutaraldehyde by the Oral Route

Species/Sex	Study Duration	mg/kg/day	Endpoint	Reference
Rats, female	90/days	4	Decreased body weights, food and water consumption	ECHA
Rats, male	13-wk (drinking water)	5	Increased kidney weights	ECHA

Species/Sex	Study Duration	mg/kg/day	Endpoint	Reference
Rats, male	12-months (drinking water)	30.5	Clinical signs; decreased body weights and food consumption; increased clear cell foci in liver	ECHA
Rats, male	2-yr (drinking water)	4	Reduced body weight, body-weight gain, and food consumption	Van Miller *et al.* (2002)
Rats	2-generation (drinking water)	58	Systemic toxicity	ECHA
Rats	GD 6-16 (drinking water)	68	Developmental toxicity	ECHA
Rats	GD 6-15 (oral gavage)	50	Developmental toxicity	Ema *et al.* (1992)
Rabbits	GD 7-19 (oral gavage)	15	Developmental toxicity	ECHA

The lowest NOAEL from these studies is 4 mg/kg/day based on reduced body weights, body weight gain and feed consumption in male rats from the two-year drinking water study (Van Miller et al., 2002). The NOAEL of 4 mg/kg/day will be used for determining the oral Reference Dose (RfD) and the drinking water guidance value.

Oral Reference Dose (oral RfD)

Oral RfD = NOAEL / (UF_A x UF_H x UF_L x UF_{Sub} x UF_D)

Where:

UF_A (interspecies variability) = 10
UF_H (intraspecies variability) = 10
UF_L (LOAEL to NOAEL) = 1
UF_{Sub} (subchronic to chronic) = 1
UF_D (database uncertainty) = 1
Oral RfD = 4/(10 x 10 x 1 x 1 x 1) = 4/100 = <u>0.04 mg/kg/day</u>

Drinking water guidance value

Drinking water guidance value = (animal dose) x (human weight) x (proportion of intake from water) / (volume of water consumed) x (safety factor)

Using the oral RfD: Drinking water guidance value = (oral RfD) x (human weight) x (proportion of water consumed) / (volume of water consumed)

Where:

Human weight = 70 kg (ADWG, 2011)
Proportion of water consumed = 10% (ADWG, 2011)
Volume of water consumed = 2 L (ADWG, 2011)
Drinking water guidance value = (0.04 x 70 x 0.1)/2 = <u>0.14 mg/L</u>

B. Cancer

Increased incidence of large granular cell lymphatic leukaemia (LGLL) was observed in all groups of male and female Fischer 344 rats given glutaraldehyde in their drinking water, including the controls (Van Miller *et al.,* 2002). For the males, the incidence of LGLL was not statistically significantly increased. However, for the females, the incidence of LGLL was significantly increased in all treated females (≥ 50 ppm). Inhalation exposure of Fischer 344 rats to glutaraldehyde did not result in an increased incidence of tumours, including LGLL.

LGLL, also known as mononuclear cell leukaemia, is an extremely common spontaneous neoplastic disease of the ageing F344 rat (Stromberg, 1985; Ward *et al.* 1990; Thomas et al., 2007). Consistent features are splenomegaly, anaemia, thrombocytopenia and leukemic infiltration of the spleen, liver, lung, and in an advanced stage, of several other organs. The incidence is variable but has been increasing progressively with time and can exceed 70% in controls in some studies. This compares with background incidence of less than 1% in other strains of commonly used laboratory rats (Haseman et al., 1998; Thomas et al., 2007). The incidence in F344 rats is modulated by a variety of factors not clearly related to carcinogenicity. Corn oil gavage, for example, has been shown consistently to reduce the incidence of MCL in male, but not female, controls (reviewed in Thomas et al., 2007).

The neoplastic mononuclear cells appear to be derived from large granular lymphocytes (LULs) (reviewed in Thomas et al., 2007). The tumour cell is of the NK type in most, if not all, cases. LGL leukaemia, although uncommon, does occur in humans. There are two types: T-LGL leukaemia which has a chronic course characterised by neutropenia, recurrent infections, splenomegaly and accompanying rheumatoid arthritis, and the much rarer NK-LGL leukaemia which has an acute course, more pronounced splenomegaly, and thrombocytopenia. The latter type appears to resemble more closely the disease in the F344 rat than the former. The aetiology of human LGL leukaemia is unknown. There is some evidence that viral infection may play a role but no evidence that a chemically-related increased of LGLL in the F344 rat is indicative of the potential to induce LGL leukaemia in humans.

To extrapolate results from an animal model that has a clear predisposition (high spontaneous rates) to a tumour type to humans, of which this is not the case, seems inappropriate if the mechanism(s) for LGLL formation in that strain is not understood. Although that rat strain may be useful for understanding the disease process in humans, it does not seem reasonable to use the results from that rat strain for risk assessment purposes. There should be confirmation of a putative leukemogenic effect in the F344 rat in another strain before any conclusions are made about the use of this tumour type for human health risk assessment purposes.

VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES

Glutaraldehyde does not exhibit the following physico-chemical properties:

- Explosivity
- Flammability
- Oxidising potential

VII. ENVIRONMENTAL HAZARD ASSESSMENT

A. Summary

Glutaraldehyde has a moderate acute toxicity concern to fish and invertebrates, but is highly toxic to algae. It is of low toxicity concern to terrestrial invertebrates and plants. To birds, glutaraldehyde is moderately toxic on an acute basis and slightly toxic on a subacute dietary basis.

B. Aquatic Toxicity

Acute Studies

Table 7 lists the results of acute aquatic toxicity studies conducted on glutaraldehyde.

Table 7: Acute Aquatic Toxicity Studies on Glutaraldehyde

Test Species	Endpoint	Results (mg/L)	Klimisch score	Reference
Bluegill sunfish	96-hr LC_{50}	13	2	ECHA
Oncorhynchus mykiss	96-hr LC_{50}	10	2	ECHA
Daphnia magna	48-hr LC_{50}	14.87	2	ECHA
Daphnia magna	48-hr LC_{50}	14	2	ECHA
Scenedesmus subspicatus	72-hr EC_{50}	0.375 (biomass) 0.6 (growth rate) 0.025 (NOEC)	1	ECHA
Scenedesmus subspicatus	72-hr EC_{50}	0.92 (growth rate) 0.61(biomass) 0.33 (NOEC)	2	ECHA; Leung, 2001
Scenedesmus subspicatus	72-hr EC_{50}	0.61 (growth rate)	2	ECHA

Chronic Studies

The chronic aquatic toxicity studies conducted on glutaraldehyde are listed in Table 8.

Table 8: Chronic Aquatic Toxicity Studies on Glutaraldehyde

Test Species	Endpoint	Results (mg/L)	Kl. score	Reference
Oncorhynchus mykiss	97/day (OECD 210)	LOEC = 5 NOEC = 1.6	1	ECHA
Daphnia magna	21/day	NOEC = 5	1	ECHA

C. Terrestrial Toxicity

Table 9 lists the results of toxicity studies conducted on glutaraldehyde with earthworms, soil microorganisms and birds.

Table 9: Terrestrial Toxicity Studies on Glutaraldehyde

Test Species (method)	Endpoint	Results	Kl. score	Reference
Earthworm *Eisenia fetida* (OECD 207)	14-d LC_{50}	> 500 mg/kg soil dw	1	ECHA
Soil microorganisms* (OECD 216)	28-d EC_{50} 28-d EC_{10}	360 mg/kg soil dw 11.5 mg/kg soil dw	1	ECHA
Soil microorganisms* (OECD 217)	28-d EC_{50} 28-d EC_{10}	> 593 mg/kg soil dw 1.5 mg/kg soil dw	1	ECHA
Mallard ducks	Single-dose (oral gavage) LC_{50}	206 mg/kg	2	ECHA
Mallard ducks	5-d (dietary) NOEC	> 2,500 ppm	1	ECHA

*organic carbon content of soil = 1.34% dry weight

Glutaraldehyde has also been evaluated in a terrestrial plants test: seedling emergence and seedling growth test (OECD TG 208). The test material contained 48.9% glutaraldehyde. The results are as follows:

Avena sativa (oats): 19/day EC_{50} value is > 1,000 mg/kg soil dry weight based on emergence rate, dry weight and shoot length. The NOECs for *Avena sativa* (oats) were $\geq$ 1,000 mg/kg dry weight on all three parameters tested.

Brassica napus (rapeseed): 19/day EC_{50} is > 1,000 mg/kg soil dry weight based on emergence rate and shoot length and 994 mg/kg soil dry weight based on dry weight. The NOECs were $\geq$ 1,000, 500 and 250 mg/kg soil dry weight for emergence rate, dry matter and shoot length, respectively.

Vicia sativa (vetch): 19/day EC_{50} is > 1,000 mg/kg soil dry weight based on emergence rate and shoot length, and 901 mg/kg soil dry weight based on dry weight. The NOECs were $\geq$ 1,000, 125 and 125 mg/kg soil dry weight for emergence rate, dry matter, and shoot length, respectively (ECHA) [Kl. score = 1].

D. Calculation of PNEC

The PNEC calculations for glutaraldehyde follow the methodology discussed in DEWHA (2009).

PNEC water

Experimental results are available for three trophic levels. Acute $E(L)C_{50}$ values are available for fish (10 mg/L), *Daphnia* (14 mg/L) and algae (0.375 mg/L). Results from chronic studies are also available for all three trophic levels, with the lowest NOEC being 0.025 mg/L for algae. On the basis that the data consists of short-term and long-term results from three trophic levels, an assessment factor of 10 has been applied to the lowest reported NOEC of 0.025 mg/L for algae. The $PNEC_{water}$ is 0.0025 mg/L.

PNEC sediment

There are no toxicity data for sediment-dwelling organisms. Therefore, the $PNEC_{sed}$ was calculated using the equilibrium partitioning method. The $PNEC_{sed}$ is 0.006 mg/kg wet weight.

The calculations are as follows:

$PNEC_{sed} = (K_{sed\text{-}water}/BD_{sed}) \times 1000 \times PNEC_{water}$
= (3.1/1280) x 1000 x 0.0025
= 0.006 mg/kg

Where:
$K_{sed\text{-}water}$ = suspended matter-water partition coefficient (m^3/m^3)
BD_{sed} = bulk density of sediment (kg/m^3) = 1,280 [default]
$K_{sed\text{-}water} = 0.8 + [0.2 \times Kp_{sed}/1000 \times BD_{solid}]$
= 0.8 + [(0.2 x 4.8)/1000 x 2400]
= 3.1 m^3/m^3

Where:
Kp_{sed} = solid-water partition coefficient (L/kg).
BD_{solid} = bulk density of the solid phase (kg/m^3) = 2,400 [default]
$Kp_{sed} = K_{0c} \times f_{oc}$
= 120 x 0.04
= 4.8 L/kg

Where:
K_{oc} = organic carbon normalised distribution coefficient (L/kg). The K_{oc} for glutaraldehyde in sediment is 120.
F_{oc} = fraction of organic carbon suspended sediment = 0.04 [default].

PNEC soil

Experimental results are available for three trophic level. An acute LC_{50} value is available for earthworms (> 500 mg/kg). Results from long-term studies are available for two trophic levels, with the lowest NOEC or EC_{10} being 1.5 mg/kg soil dry weight for soil organisms.

The EC_{10} value is corrected for bioavailability of glutaraldehyde in soil by normalising to the fraction organic carbon matter content (Fom) in the soil using the following equation:

$EC_{10(std)} = EC_{10(exp)} \times Fom_{soil(std)}/Fom_{soil(exp)}$

Where:
$Fom_{soil(std)}$ = 1% (default soil fraction organic matter)
$Fom_{soil(exp)}$ = 1.34% (see Table 9)
$EC_{10(std)}$ = 1.5 mg/kg x 1/1.34 = 1.12 mg/kg

On the basis that the data consists of one short-term result from one trophic level and two long-term results from two additional levels, an assessment factor of 50 has been applied to the lowest reported long-term EC_{10} of 1.12 mg/kg soil dry weight [corrected for organic carbon content] for soil organisms. The $PNEC_{soil}$ is 0.02 mg/kg soil dry weight.

VIII. PERSISTENCE, BIOACCUMULATION AND TOXICITY (PBT) ASSESSMENT

The methodology for the Persistent, Bioaccumulative and Toxic (PBT) substances assessment is based on the Australian and EU REACH Criteria methodology (DEWHA, 2009; ECHA, 2008).

Glutaraldehyde is readily biodegradable and thus does not meet the screening criteria for persistence.

The log K_{ow} for glutaraldehyde at different pH values ranges from -0.36 to -0.80. Thus, glutaraldehyde does not meet the screening criteria for bioaccumulation.

The lowest NOEC value from chronic aquatic toxicity studies is < 0.1 mg/L. Thus, glutaraldehyde meets the screening criteria for toxicity.

The overall conclusion is that glutaraldehyde is not a PBT substance.

IX. CLASSIFICATION AND LABELLING

A. Classification

Acute Toxicity Category 3 [oral]

Acute Toxicity Category 2 [inhalation]

Skin Corrosion Category 1B

Eye Damage Category 1

Respiratory Sensitiser 1A

Skin Sensitiser 1A

STOT Single Exposure Category 3 [respiratory irritation]

Aquatic Acute Category 1

Aquatic Chronic Category 2

The appropriate hazard statements corresponding the GHS classifications are to be added to the SDS, including the non-GHS hazard statement “AUH071: Corrosive to the Respiratory Tract”.

B. Labelling

Danger

C. Pictograms



X. HANDLING AND SAFETY INFORMATION (OCCUPATIONAL LIMITS AND TRANSPORTATION REQUIREMENTS)

A. First Aid

First aid information was obtained from the ECHA REACH database (ECHA).

Eye Contact

Wash immediately and continuously with flowing water for at least 30 minutes. Remove contact lenses after the first 5 minutes and continue washing. Obtain prompt medical consultation, preferably from an ophthalmologist. Eye wash fountain should be located in immediate work area.

Skin Contact

Take off contaminated clothing. Wash skin with soap and plenty of water for 15-20 minutes. Call a poison control centre or doctor for treatment advice. Wash clothing before reuse. Shoes and other leather items which cannot be decontaminated should be disposed of properly. Safety shower should be located in immediate work area.

Inhalation

Move person to fresh air. If a person is not breathing, call an emergency responder or ambulance, then give artificial respiration; if by mouth-to-mouth use rescuer protection (pocket mask, etc.). Call a poison control centre or doctor for treatment advice. If breathing is difficult, oxygen should be administered by qualified personnel.

Ingestion

If the person is fully alert and cooperative, have the person rinse mouth with plenty of water. In cases of ingestion have the person drink 4 to 10 ounces (120-300 mL) of water. Do not induce vomiting. Do not attempt mouth rinse if the person has respiratory distress, altered mental status, or nausea and vomiting. Call a physician and/or transport to an emergency facility immediately. See Note to Physician. Seek medical attention immediately.

Notes to Physician

Maintain adequate ventilation and oxygenation of the patient. May cause asthma-like (reactive airways) symptoms. Bronchodilators, expectorants, antitussives and corticosteroids may be of help. Glutaraldehyde may transiently worsen reversible airways obstruction including asthma or reactive airways disease. Chemical eye burns may require extended irrigation. Obtain prompt consultation, preferably from an ophthalmologist. If the burn is present, treat as any thermal burn, after decontamination. Due to irritant properties, swallowing may result in burns/ulceration of mouth, stomach and lower gastrointestinal tract with subsequent stricture. Aspiration of vomitus may cause lung injury. Suggest endotracheal/oesophagal control if lavage is done. Probable mucosal damage may contraindicate the use of gastric lavage. Inhalation of vapours may result in skin sensitisation. In sensitised individuals, re-exposure to very small amounts of vapour, mist or liquid may cause a severe allergic skin reaction. No specific antidote. Treatment of exposure should be directed at the control of symptoms and the clinical condition of the patient. Have the Safety Data Sheet, and if available, the product container or label with you when calling a poison control centre or doctor, or going for treatment.

Medical Conditions Aggravated by Exposure

Excessive exposure may aggravate pre-existing asthma and other respiratory disorders (e.g., emphysema, bronchitis, reactive airways dysfunction syndrome).

Emergency Personnel Protection

First Aid responders should pay attention to self-protection and use the recommended protective clothing (chemical resistant gloves, splash protection). If the potential for exposure exists, refer to Section 8 of the Safety Data Sheet for specific personal protective equipment.

B. Fire Fighting Information

Firefighting information was obtained from the ECHA REACH database (ECHA).

Extinguishing Media

Use water fog, carbon dioxide, dry chemical or foam to extinguish combustible residues of this product

Specific Exposure Hazards

This material will not burn until the water has evaporated. Residue can burn. Some components of this product may decompose under fire conditions. The smoke may contain unidentified toxic and/or irritating compounds. Combustion products may include, and are not limited to, carbon monoxide and carbon dioxide.

Special Protective Equipment for Firefighters

Wear positive-pressure self-contained breathing apparatus (SCBA) and protective firefighting clothing (includes firefighting helmet, coat, trousers, boots and gloves). Avoid contact with this material during firefighting operations. If contact is likely, change to full chemical resistant firefighting clothing with self-contained breathing apparatus. If this is not available, wear full chemical resistant clothing with self-contained breathing apparatus and fight the fire from a remote location.

C. Accidental Release Measures

Information on accidental release measures was obtained from the ECHA REACH database (ECHA).

Personal Precautions

Use appropriate safety equipment. Evacuate area. Keep upwind of the spill. Ventilate area of leak or spill. Only trained and properly protected personnel must be involved in clean-up operations.

Environmental Precautions

Spills or discharge to natural waterways is likely to kill aquatic organisms. Prevent from entering into soil, ditches, sewers, waterways and/or groundwater.

Steps to be Taken if Material is Released or Spilt

Avoid making contact with spilt material; glutaraldehyde will be absorbed by most shoes. Always wear the correct protective equipment, consisting of splash-proof mono-goggles, or both safety glasses with side shields and a wraparound full-face shield, appropriate gloves and protective clothing. A self-contained breathing apparatus or respirator and absorbents may be necessary, depending on the size of the spill and the adequacy of ventilation.

Small spills: Wear the correct protective equipment and cover the liquid with absorbent material. Collect and seal the material and the dirt that has absorbed the spilt material in polyethylene bags and place in a drum for transit to an approved disposal site. Rinse away the remaining spilt material with water to reduce odour, and discharge the rinsate into a municipal or industrial sewer.

Large spills: In the case of nasal and respiratory irritation, vacate the room immediately. Personnel cleaning up should be trained and equipped with a self-contained breathing apparatus, or an officially approved or certified full-face respirator equipped with an organic vapour cartridge, gloves, and clothing impervious to glutaraldehyde, including rubber boots or shoe protection. Deactivate with sodium bisulphite (2-3 parts [by weight] per part of active substance glutaraldehyde), collect the neutralised liquid and place in a drum for transit to an approved disposal site.

D. Storage and Handling

Information on storage and handling was obtained from the ECHA REACH database (ECHA).

General Handling

Do not get in eyes, on skin, on clothing. Avoid breathing vapour. Do not swallow. Keep container closed. Use with adequate ventilation. Wear goggles, protective clothing and butyl or nitrile gloves. Wash thoroughly with soap and water after handling. Remove contaminated clothing and wash before reuse.

Other Handling Precautions

Do not spray or aerosolise the undiluted form of the product. Full personal protective equipment (including skin covering and full-face SCBA respirator) is required for dilutions or mixtures of the product used in a spray application.

Storage

Do not store in: Aluminium. Carbon steel. Copper. Mild steel. Iron. Shelf life: Use within 12 Months.

E. Exposure Controls / Personal Protection

Occupational Exposure Standards

The workplace exposure standard for glutaraldehyde in Australia is 0.1 ppm (0.41 mg/m^3) as a peak limitation, with a sensitisation notation. A peak limitation is defined by Safe Work Australia as a maximum or peak airborne concentration of a substance determined over the shortest analytically practicable period of time which does not exceed 15 minutes.

The information below on exposure controls and personal protection was obtained from the Halliburton Safety Data Sheet (SDS) on ALDACIDE® G ANTIMICROBIAL (revision date: 11-Dec-2014).

Engineering Controls

Use in a well-ventilated area. Local exhaust ventilation should be used in areas without good cross ventilation. If vapours are strong enough to be irritating to the nose or eyes, the TLV is probably being exceeded, and special ventilation or respiratory protection may be required.

Personal Protection Equipment

Respiratory Protection: If engineering controls and work practices cannot keep exposure below occupational exposure limits or if exposure is unknown, wear a NIOSH-certified, European Standard EN 149, AS/NZS 1715:2009, or equivalent respirator when using this product. Selection of and instruction on using all personal protective equipment, including respirators, should be performed by an Industrial Hygienist or other qualified professional. Full Facepiece Respirator with Organic vapour cartridge with particulate pre-filter.

Hand Protection: Chemical-resistant protective gloves (EN 374). Suitable materials for longer, direct contact (recommended: protection index 6, corresponding to > 480-minute permeation time as per EN 374): Butyl rubber gloves. (>= 0.7 mm thickness). This information is based on literature references and on information provided by glove manufacturers or is derived by analogy with similar substances. Please note that in practice the working life of chemical-resistant protective gloves may be considerably shorter than the permeation time determined in accordance with EN 374 as a result of the many influencing factors (e.g., temperature). If signs of wear and tear are noticed, then the gloves should be replaced. Manufacturer's directions for use should be observed because of the great diversity of types.

Skin Protection: Butyl coated apron or clothing.

Eye protection: Splash proof chemical mono-goggles or safety glasses with side shield in conjunction with a face shield. Do NOT wear contact lenses.

Other Precautions: Eyewash fountains and safety showers must be easily accessible.

F. Transport Information

For aqueous glutaraldehyde solutions at a concentration that is corrosive (i.e., 30% and higher):

Australia Dangerous Goods

UN3265, Corrosive Liquid, Acidic, Organic, N.O.S. (Contains Glutaraldehyde)

Class 8

Packing Group III

Environmentally Hazardous Substance

XI. DISPOSAL MANAGEMENT

Disposal should be in accordance with all local, state, and federal regulations.

XII. REGULATORY STATUS

Australian AICS Inventory: Listed.

XIII. REFERENCES

ADWG. (2011). National Water Quality Management Strategy. Australian Drinking Water Guidelines, Section 6, Australian Government, National Health and Medical Research Council, Natural Resource Management Ministerial Council.

Department of the Environment, Water, Heritage and the Arts (DEWHA). (2009). Environmental risk assessment guidance manual for industrial chemicals, Department of the Environment, Water, Heritage and the Arts, Commonwealth of Australia.

Department of the Environment and Energy [DoEE]. (2017). Chemical Risk Assessment Guidance Manual: for chemicals associated with coal seam gas extraction, Guidance manual prepared by Hydrobiology and ToxConsult Pty Ltd for the Department of the Environment and Energy, Commonwealth of Australia, Canberra.

ECHA. ECHA REACH database: http://echa.europa.eu/information-on-chemicals/registered-substances

Ema, M., Itami, T., and Kawasaki, H. (1992). Teratological assessment of glutaraldehyde in rats by gastric intubation. Toxicol. Lett. 63: 147-153.

enHealth Human Risk Assessment (HHRA). (2012). Environmental Health Risk Assessment, Guidelines for Assessing Human Health Risks from Environmental Hazards. Office of Health Protection of the Australian Government Department of Health.

European Chemicals Agency (ECHA). (2008). Guidance on Information Requirements and Chemical Safety Assessment, Chapter R11: PBT Assessment, European Chemicals Agency, Helsinki, Finland.

Frantz, S.W., Beskitt, J.L., Tallant, M.J., Futrell, J.W., and Ballantyne, B. (1993). Glutaraldehyde: species comparisons of in vitro skin penetrations. J. Toxicol.-Cut. & Ocular Toxicol. 12: 349-361.

Gross, E.A., Mellick, P.W., Kari, F.W., Miller, F.J., and Morgan, K.T. (1994). Histopathology and cell replication responses in the respiratory tract of rats and mice exposed by inhalation to glutaraldehyde for up to 13 weeks. Fundam. Appl. Toxicol. 23: 348-362.

Haseman, J.K., Hailey, J.R., and Morris, R.W. (1998). Spontaneous neoplasm incidences in Fischer 344 rats and B6C3F_1 mice in two-year carcinogenicity studies: A National Toxicology Program update. Toxicol. Pathol. 26: 428-441.

Klimisch, H.J., Andreae, M., and Tillmann, U. (1997). A systematic approach for evaluating the quality of experimental and toxicological and ecotoxicological data. Regulatory Toxicology and Pharmacology 25:1-5.

Leung, H.W. (2001). Ecotoxicology of glutaraldehyde: review of environmental fate and effects studies. Ecotoxicol. Environ. Safety 49: 26-39.

Mirsalis, J.S., Tyson, C.K., Steinmetz, K.L., Loh, E.K., Hamilton, C.M., Bakke, J.P., and Spalding, J.W. (1989). Measurement of unscheduled DNA synthesis and S-phase synthesis in rodent hepatocytes following in vivo treatment: testing of 24 compounds. Environ. Mol. Mutagen. 14: 155-164.

Neeper-Bradley, T.L., and Ballantyne, B. (2000). Two-generation reproduction study by dosing with glutaraldehyde in the drinking water of CD rats. J. Toxicol. Environ. Health A 61: 107-129.

NICNAS. (1994). Glutaraldehyde – Full Public Report. National Industrial Chemicals Notification and Assessment Scheme (NICNAS), AGPS, Canberra, Australia.

OECD. (1995). OECD-SIDS document on Glutaraldehyde, CAS No. 111-30-8, UNEP Publications. Accessed at: http://webnet.oecd.org/hpv/ui/SIDS_Details.aspx?id=b13f2e48-0425-4a8a-b7b8-c04cfaab06e8

Stromberg, P.C. (1985). Large granular lymphocyte leukaemia in F344 rats: Model for human T lymphoma, a malignant histiocytosis and T-cell chronic lymphocytic leukaemia. Am. J. Pathol. 119: 517-519.

Thomas, J., Haseman, J.K., Goodman, J.I., Ward, J.M., Loughran, Jr., T.P., and Spencer, P.J. (2007). A review of large granular lymphocytic leukaemia in Fischer 344 rats as an intial step toward evaluating the implication of the endpoint to human cancer risk assessment. Toxicol. Sci. 99: 3-19.

van Birgelen, A.P.J.M., Chou, B.J., Renne, R.A., Grumbein, S.L., Roycroft, J.H., Hailey, J.R., and Bucher, J.R. (2000). Effects of glutaraldehyde in a 2-year inhalation study in rats and mice. Toxicol. Sci. 55: 195-205.

Van Miller, J.P., Hermansky, S.J., Losco, P.E., and Ballantyne, B. (2002). Chronic toxicity and oncogenicity study with glutaraldehyde dosed in the drinking water of Fischer 344 rats. Toxicol. 175: 177-189.

Vergnes, J.S., and Ballantyne, B. (2002). Genetic toxicology studies with glutaraldehyde. J. Appl. Toxicol. 22: 45-60.

Ward, J.M., Rehm, S., and Reynolds, C.W. (1990). Tumours of the haematopoietic system. In: Pathology of Tumours in Laboratory Animals, Vol. 1, Second Edition (Turusov, V.S., and Mohr, U., Eds.), pp. 625-657, International Agency for Research on Cancer, Lyon, France.

Zissu, D., Bonnet, P., and Binet, S. (1998). Histopathological study in B6C3F1 mice chronically exposed by inhalation to glutaraldehyde. Toxicol. Lett. 95: 131-139.

GLYCERINE
[GLYCEROL]

This dossier on glycerine presents the most critical studies pertinent to the risk assessment of glycerine in its use in coal seam or shale gas extraction activities. This dossier does not represent an exhaustive or critical review of all available data. The majority of information presented in this dossier was obtained from the ECHA database that provides information on chemicals that have been registered under the EU REACH (ECHA). Where possible, study quality was evaluated using the Klimisch scoring system (Klimisch et al., 1997).

I. SUBSTANCE IDENTIFICATION

Chemical Name (IUPAC): Glycerol

CAS RN:56-81-5

Molecular formula: $C_3H_8O_3$

Molecular weight: 92.09 g/mol

Synonyms: glycerin; alkyl alcohol; 2-propanol; 1,3-dihydroxy-; propanetriol; 1,2,3-propanetriol

SMILES: OCC(O)CO

II. PHYSICO-CHEMICAL PROPERTIES

Table 1: Overview of the Physico-Chemical Properties of Glycerine

Property	Value	Klimisch Score	Reference
Physical state at 20°C and 101.3 kPa	Clear, water-white, viscous, sweet-tasting hygroscopic liquid	2	ECHA
Melting Point	18.17°C @ 101.3 kPa	2	ECHA
Boiling Point	290°C @ 101.3 kPa	2	ECHA
Density	1,261 kg/m^3@ 20°C	2	ECHA
Vapour Pressure	0.01 Pa @ 20°C	2	ECHA
Partition Coefficient (log K_{ow})	-1.75 @ 25°C (measured)	2	ECHA
Water Solubility	1,000 g/L @ 25°C (completely miscible)	2	ECHA
Flash Point	199 °C	2	ECHA
Auto flammability	370°C	2	ECHA
Viscosity	1,412 mPa s @ 20°C	2	ECHA
Henry's Law Constant	Not Applicable	-	ECHA

III. ENVIRONMENTAL FATE PROPERTIES

A. Summary

Glycerine is readily biodegradable. It is not expected to bioaccumulate. Based on the estimated K_{oc} value, glycerine is expected to be highly mobile in sediment and soil.

B. Biodegradation

Glycerine was readily biodegradable in an OECD 301D test. Degradation was 57% after 5 days, 84% after 15 days, and 92% after 30 days (OECD, 2002) [Kl. score = 2].

If a chemical is found to be readily biodegradable, it is categorised as Not Persistent since its half-life is substantially less than 60 days (DoEE, 2017).

C. Environmental Distribution

No experimental data are available for glycerine. Using KOCWIN in EPISuite™ (US EPA, 2017), the estimated K_{oc} value from log K_{ow} is 0.1345 L/kg. The estimated K_{oc} value from the molecular connectivity index (MCI) is 1 L/kg.

Based upon these K_{oc} values, if released to soil, glycerine is expected to have low potential for adsorption and a high potential for mobility. If released to water, based on its K_{oc} and high-water solubility, glycerine is likely to remain in water and not adsorb to sediment.

D. Bioaccumulation

No bioconcentration studies have been conducted on glycerine. Glycerine is not expected to bioaccumulate based on the experimental log K_{ow} of -1.75 (ECHA).

IV. HUMAN HEALTH HAZARD ASSESSMENT

A. Summary

Glycerine has virtually no acute toxicity by the oral and dermal routes. It is non-irritating to the skin and eye and is not a skin sensitizer. No systemic toxicity was seen in animals repeatedly exposed by the dermal and inhalation routes, but liver effects were seen in rats given very high doses in the diet. Glycerine is not genotoxic. Lifetime dietary studies showed no carcinogenic effects in rats. No reproductive or developmental effects were seen in animals given high doses of glycerine in the diet.

B. Metabolism

Glycerine is an intermediate in carbohydrate and lipid metabolism in living organisms.

C. Acute Toxicity

The oral LD_{50} values are >5,000 to 58,400 mg/kg in rats, 4,250 to 38,000 mg/kg in mice, 7,750 and 10,000 mg/kg in guinea pigs (OECD, 2002). The oral LD_{50} value of 4,250 mg/kg in mice is not consistent with the range of values found in the available literature and is considered unreliable because of the lack of documentation of the study (OECD, 2002).

All rats died following a 2-hour exposure to saturated vapours of glycerine, while there was no mortality when the exposure was for only one hour (ECHA) [Kl. score = 2].

No deaths were seen in rabbits following dermal application for 8 hours under occlusive conditions. The dermal LD_{50} is >18,700 mg/kg (Hine et al., 1953).

D. Irritation

Application of 0.5 mL glycerine to the skin of rabbits for 24 hours under occlusive conditions was not irritating (Weil and Scala, 1971; ECHA) [Kl. score = 2].

Instillation of 0.1 ml glycerine into the eyes of rabbits was non-irritating (Weil and Scala, 1971; ECHA).

E. Sensitisation

Male guinea pigs were given ten 0.1 mL injections of a 0.1% solution of synthetic or natural glycerine in isotonic saline every other day over 20 days. Following a two-week period, an 0.05 mL injection was given of the 0.1% glycerine solution. There was no sensitising response (Hine et al., 1953).

F. Repeated Dose Toxicity

Oral

Male and female rats were given in their feed 0, 5, or 20% glycerine for 90 days. Glycerine samples from different companies were compared in separate groups of animals. Body weight gain was higher in the treated rats compared to the controls. The 20% males had increased liver weights relative to body weights with histopathologic changes of generalized cloudy swelling and hypertrophy of the parenchymal cells. The 20% females showed increased relative liver weights but had generalized cloudy swelling in the liver. For the liver changes, there were no differences between the three glycerine samples. Relative heart weights were significant reduced in the 20% females from one glycerine sample, and relative kidney weights were increased in the 20% females from another glycerine sample; these changes were not accompanied by histopathological changes. The NOAEL for this study is 5% glycerine in the diet, which corresponds to an estimated daily intake of 4,580 and 6,450 mg/kg-day for males and females, respectively (ECHA) [Kl. score = 2]

Inhalation

Male and female SD rats were exposed by inhalation (nose-only) to 0, 33, 165, or 660 mg/m^3 of aerosolized glycerine 6 hours/day, 5 days/week for 13 weeks. The mass median aerodynamic diameter (MMAD) was <2.0 µm (respirable). The only effect seen was localized irritation of the upper respiratory tract. The NOAEC for systemic toxicity is 660 mg/m3, the highest exposure concentration tested. The NOAEC for localized effects (irritation) is 167 mg/m^3 (Renne, 1992; ECHA) [Kl. score = 2]

Dermal

Rabbits were given dermal applications of 0.5 to 5.4 ml/kg glycerine 8 hours/day for 45 weeks. No effects including irritation were noted. The NOAEL is 5.4 ml/kg, which is calculated to be 5,040 mg/kg-day (ECHA)[Kl. score = 2]

G. Genotoxicity

In vitro Studies

The *in vitro* genotoxicity studies on glycerine are presented in Table 2.

Table 2: *In vitro* Genotoxicity Studies on Glycerine

Test System	Results*		Klimisch Score	Reference
	-S9	+S9		
Bacterial reverse mutation (S. typhimurium strains)	-	-	2	Haworth et al., 1983; ECHA
Bacterial reverse mutation (S. typhimurium strains)	-	-	2	Doolittle et al., 1988; ECHA
Mammalian cell gene mutation (CHO cells)	-	-	2	Doolittle et al., 1988; ECHA
Sister chromatid exchange (human lymphocytes)	-	-	2	Doolittle et al., 1988; ECHA
Unscheduled DNA synthesis (rat hepatocytes)	-	-	2	Doolittle et al., 1988; ECHA
Chromosomal aberrations (CHO cells)	-	-	2	Doolittle et al., 1988; ECHA

*+, positive; -, negative

In vivo Studies

There are no studies available.

H. Carcinogenicity

Oral

Male and female Long-Evans rats were given in their feed 0, 5, 10, or 20% glycerine for two years (the 20% group were for 1 year only). The estimated daily intakes are 0, 2,000, 4,000, and 8,000 mg/kg-day for males: and 0, 2,500, 5,000, and 10,000 mg/kg-day for females. Treatment was discontinued after one year for the 20% animals for reasons that were not stated in the report. Data on mortality and clinical observations were not reported. The tumour incidences were similar between treated and control animals (Hine et al., 1953; ECHA) [Kl. score = 2].

Inhalation

There are no studies available.

Dermal

There are no studies available.

I. Reproductive Toxicity

In a two-generation reproductive toxicity study, male and female rats were dosed by oral gavage with 0 or 20% glycerine solution (in water). There were no treatment-related effects on growth, reproductive performance, fertility, and no histopathological changes in the tissues examined. The NOAEL for this study is 20% glycerine in water, which the daily intake was estimated to be 2,000 mg/kg-day (OECD, 2002; ECHA) [Kl. score = 2].

J. Developmental Toxicity

Oral

Pregnant female Wistar rats were dosed by oral gavage with 0, 13.1, 60.8, 282, or 1,310 mg/kg-day glycerine during gestational days 6 to 15. There was no maternal or developmental toxicity. The NOAEL for maternal and developmental toxicity is 1,310 mg/kg-day, the highest dose tested (ECHA). [Kl. score = 2]

Pregnant female CD-1 mice were dosed by oral gavage with 0, 12.8, 59.4, 276, or 1,280 mg/kg-day glycerine during gestational days 6 to 15. There was no maternal or developmental toxicity. The NOAEL for maternal and developmental toxicity is 1,280 mg/kg-day, the highest dose tested (ECHA) [Kl. score = 2]

Pregnant female Dutch rabbits were dosed by oral gavage with 0, 11.8, 54.8, 254.5, or 1,180 mg/kg-day glycerine during gestational days 6 to 18. There was no maternal or developmental toxicity. The NOAEL for maternal and developmental toxicity is 1,280 mg/kg-day, the highest dose tested (ECHA)[Kl. score = 2]

Inhalation

There are no studies available.

Dermal

There are no studies available.

V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES

The toxicological reference values developed for Glycerine follow the methodology discussed in enHealth (2012). The approach used to develop drinking water guidance values is described in the Australian Drinking Water Guidelines (ADWG, 2011).

A. Non-Cancer

Oral

Liver effects were seen in male and female rats in a 90-day dietary study, with a NOAEL of 5% glycerine in the diet. This dose corresponds to an estimate daily intake of 4,580 and 6,450 mg/kg-day for males and females, respectively (ECHA). In a two-year dietary study, no effects were seen in male or female rats at a dose of 20% glycerine in the diet. It should be noted, however, that the treatment at the dietary level of 20% was for only one year, while the lower doses (5 and 10%) were for two years. No liver effects were noted at any dose level. The NOAEL for the two-year dietary study is the

20% dietary level which corresponds to estimated daily intakes of 8,000 and 10,000 mg/kg-day, for males and females, respectively (Hines et al., 1953; ECHA).

The NOAEL of 4,580 mg/kg-day from the male rats in the 90-day dietary study will be used for determining the oral Reference dose (RfD) and the drinking water guidance value.

Oral Reference Dose (oral RfD)

Oral RfD = NOAEL / (UF_A x UF_H x UF_L x UF_{Sub} x UF_D)

Where:

UF_A (interspecies variability) = 10
UF_H (intraspecies variability) = 10
UF_L (LOAEL to NOAEL) = 1
UF_{Sub} (subchronic to chronic) = 10
UF_D (database uncertainty) = 1
Oral RfD = 4,580/ (10 x 10 x 1 x 10 x 1) = 4,580/1,000 = 4.6 mg/kg-day

Drinking water guidance value

Drinking water guidance value = (animal dose) x (human weight) x (proportion of intake from water) / (volume of water consumed) x (safety factor)

Using the oral RfD,

Drinking water guidance value = (oral RfD) x (human weight) x (proportion of water consumed) / (volume of water consumed)

Where:

Human weight = 70 kg (ADWG, 2011)
Proportion of water consumed = 10% (ADWG, 2011)
Volume of water consumed = 2L (ADWG, 2011)
Drinking water guidance value = (4.6 x 70 x 0.1)/2 =16.1 mg/L

B. Cancer

Glycerine was not carcinogenic to rats in a two-year dietary study. Therefore, a cancer reference value was not derived.

VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES

Glycerine does not exhibit the following physico-chemical properties:

- Explosivity
- Flammability
- Oxidising potential

VII. ENVIRONMENTAL HAZARD ASSESSMENT

A. Summary

Glycerine is of low toxicity concern to aquatic and terrestrial organisms. Glycerine as fatty acid glyceride and as metabolite of fatty acid glycerides is part of (almost) all organisms (ECHA).

B. Aquatic Toxicity

Acute Studies

Table 3 lists the results of acute aquatic toxicity studies conducted on glycerine.

Table 3: Acute Aquatic Toxicity Studies on Glycerine

Test Species	Endpoint	Results (mg/L)	Klimisch Score	Reference
Oncorhynchus mykiss	96-h LC_{50}	54,000	2	ECHA
Pimephales promelas	96-h LC_{50}	885	2	ECHA
Carassius auratus	96-h LC_{50}	>5000	2	ECHA
Daphnia magna	24-h EC_{50}	>10,000	1	ECHA
Daphnia magna	48-h LC_{50}	1,955	2	ECHA

Chronic Studies

Glycerine is a naturally occurring substance and part of fish organisms. Chronic studies conducted on fish have determined NOEC values greater than 100 mg/L (ECHA).

Glycerine is used as part of commercial fish feed. And as such shows no hazard towards fish in tested fish feed concentrations up to 7.5% for 12 months. (ECHA)[KI. score =2]

Using USEPA's EPISUITE, the QSAR estimation (ECOSAR v1.11 KOWWIN version 1.67) of chronic fish toxicity resulted in a 30 day chronic value of 9471 mg/L. This result is far above the limit dose of chronic fish testing (100 mg/L). According to this QSAR estimation no chronic hazard for fish can be identified. (ECHA)[KI. score =2].

The chronic toxicity of glycerine to fish was estimated to be 724,000 mg/L based on results from a trend analysis in the OECD QSAR toolbox (version 4.4.1) (ECHA)[KI. score =2].

The chronic toxicity (NOEC) of glycerine to Daphnia magna was estimated to be 897 mg/L based on results from a trend analysis in the OECD QSAR toolbox (version 4.4.1) (ECHA)[KI. score =2].

Using USEPA's EPISUITE, the QSAR estimation (ECOSAR v1.11 KOWWIN version 1.67) of chronic toxicity to Daphnia magna resulted in a 16 day chronic value of 2,230 mg/L (ECHA)[KI. score =2].

C. Terrestrial Toxicity

There are no studies available. Glycerine is considered a primordial biomolecule common to all species (Lehninger, 1970).

D. Calculation of PNEC

The PNEC calculations for glycerine follow the methodology discussed in DEWHA (2009).

PNEC Water

Experimental results are available for two trophic levels. Acute E(L)C_{50} values are available for fish (885 mg/L) and Daphnia (1,955 mg/L). NOEC values from long term studies are also available for fish (9,471 mg/L) and Daphnia (897 mg/L). On the basis that the data consists of short-term and long-term results from two trophic levels, an assessment factor of 50 has been applied to the lowest reported NOEC value of 897 mg/L for Daphnia. The $PNEC_{water}$ is 18 mg/L.

PNEC Sediment

There are no toxicity data for sediment-dwelling organisms. Therefore, the $PNEC_{sed}$ was calculated using the equilibrium partitioning method. The $PNEC_{sed}$ is 11.5 mg/kg sediment wet weight.

The calculations are as follows:

$PNEC_{sed} = (K_{sed\text{-}water}/BD_{sed}) \times 1000 \times PNEC_{water}$
$= (0.82/1280) \times 1000 \times 18$
$= 11.5$ mg/kg

Where:

$K_{sed\text{-}water}$ = suspended matter-water partition coefficient (m^3/m^3)
BD_{sed} = bulk density of sediment (kg/m^3) = 1,280 [default]
$K_{sed\text{-}water} = 0.8 + [(0.2 \times Kp_{sed})/1000 \times BD_{solid}]$
$= 0.8 + [(0.2 \times 0.04/1000 \times 2400]$
$= 0.82\ m^3/m^3$

Where:

Kp_{sed} = solid-water partition coefficient (L/kg)
BD_{solid} = bulk density of the solid phase (kg/m^3) = 2,400 [default]
$Kp_{sed} = K_{oc} \times f_{oc}$
$= 1 \times 0.04$
$= 0.04$ L/kg

Where:

K_{oc} = organic carbon normalised distribution coefficient (L/kg). The K_{oc} for glycerine was calculated from EPISUITE™ using the MCI is 1 L/kg.
F_{oc} = fraction of organic carbon in sediment = 0.04 [default].

PNEC Soil

There are no toxicity data for terrestrial or soil organisms. Therefore, the $PNEC_{soil}$ was calculated using the equilibrium partitioning method. The $PNEC_{soil}$ is 0.24 mg/kg soil dry weight.

The calculations are as follows:

$PNEC_{soil} = (Kp_{soil}/BD_{soil}) \times 1000 \times PNEC_{water}$
$= (0.02/1500) \times 1000 \times 18$

= 0.24 mg/kg

Where:

Kp_{soil} = soil-water partition coefficient (m^3/m^3)

BD_{soil} = bulk density of soil (kg/m^3) = 1,500 [default]

$Kp_{soil} = K_{oc} \times f_{oc}$

= 1 x 0.02

= 0.02 m^3/m^3

Where:

K_{oc} = organic carbon normalised distribution coefficient (L/kg). The K_{oc} for glycerine calculated from EPISUITE™ using the MCI is 1 L/kg.

F_{oc} = fraction of organic carbon in soil = 0.02 [default].

VIII. PERSISTENCE, BIOACCUMULATION AND TOXICITY (PBT) ASSESSMENT

The methodology for the Persistent, Bioaccumulative and Toxic (PBT) substances assessment is based on the Australian and EU REACH Criteria methodology (DEWHA, 2009; ECHA, 2017).

Glycerine is readily biodegradable and thus does not meet the screening criteria for persistence.

No bioconcentration studies are available for glycerine. Based on the measured log K_{ow} for glycerine of -1.75,glycerine does not meet the screening criteria for bioaccumulation.

Glycerine as fatty acid glyceride and as metabolite of fatty acid glycerides is part of (almost) all organisms (ECHA). The chronic NOEC values for glycerine in fish and invertebrates are > 0.1 mg/L. The acute E(L)C50 values for glycerine in fish and invertebrates are >1 mg/L. Thus, glycerine does not meet the screening criteria for toxicity.

Therefore, glycerine is not a PBT substance.

IX. CLASSIFICATION AND LABELLING

A. Classification

Not Classified

B. Labelling

No signal word

A. Pictogram

None.

X. HANDLING AND SAFETY INFORMATION (OCCUPATIONAL LIMITS AND TRANSPORTATION REQUIREMENTS)

A. First Aid

Please refer to the product SDS for additional information and confirmation of the information provided herein.

Eye Contact

In case of contact, immediately flush eyes with plenty of water for at least 15 minutes.

Skin Contact

Wash thoroughly with soap and water.

Inhalation

If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.

Ingestion

Rinse mouth with water and then drink a plenty of water. Get medical attention. Never give anything by mouth to an unconscious person.

B. Fire Fighting Information

Extinguishing Media

Water spray, carbon dioxide, foam, dry chemical.

Specific Exposure Hazards

Keep product and empty container away from heat and sources of ignition. May emit toxic fumes under fire conditions. Depending on conditions, decomposition products may include the following: carbon monoxide, carbon dioxide.

Special Protective Equipment for Firefighters

Wear self-contained breathing apparatus.

C. Accidental Release Measures

Personal Precautions

Use appropriate protective equipment. Handle in accordance with good industrial hygiene and safety practice. Ensure adequate ventilation. Do not breathe vapours, mists, or gas.

Environmental Precautions

Prevent from entering sewers, waterways or low areas.

Steps to be Taken if Material is Released or Spilled

For large amounts: dike spillage and pump off product. For residues: pick up with suitable absorbent material. Dispose of contaminated material as prescribed.

D. Storage And Handling

General Handling

Keep product and empty container away from heat and sources of ignition. Ensure adequate ventilation, especially in confined areas.

Other Handling Precautions

Avoid inhalation of vapor or mist.

Storage

Keep container tightly closed and in a dry and well-ventilated place. Keep in a cool place.

E. Exposure Controls / Personal Protection

Occupational Exposure Standards

The workplace exposure standards for glycerine (mist) in Australia is as follows 10 mg/m^3 (Time-weighted average, TWA).

Engineering Controls

Good general ventilation should be used.

Personal Protection Equipment

Respiratory Protection: Respiratory protection is not required.

Hand Protection: Chemical resistant protective gloves.

Skin Protection: Body protection must be chosen depending on activity and possible exposure.

Eye protection: Safety glasses with side-shields.

Other Precautions: Handle in accordance with good industrial hygiene and safety practice. Wearing of closed work clothing is recommended. Ensure that eyewash stations and safety showers are close to the workstation location.

F. Transport Information

Glycerine is not considered hazardous for purposes of transportation by road or rail. An Australian Dangerous Goods code is not required.

XI. DISPOSAL MANAGMENT

Disposal should be in accordance with all local, state and federal regulations.

XII. REGULATORY STATUS

Australian AICS Inventory: Listed.

XIII. REFERENCES

ADWG. (2011). National Water Quality Management Strategy. Australian Drinking Water Guidelines, Section 6, Australian Government, National Health and Medical Research Council, Natural Resource Management Ministerial Council. Updated January 2022. Available: https://www.nhmrc.gov.au/about-us/publications/australian-drinking-water-guidelines

Anderson, R.C., Harris, P.N., and Chen, K.K. (1950). Toxicological studies on synthetic glycerin. J. Am. Pharm. Assoc. 39: 583-585.

Bringmann, G., and Kuehn, R. (1980). Comparison of the toxicity thresholds of water pollutants to bacteria, algae, and protozoa in the cell multiplication inhibition test. Water. Res. 14: 231-241.

CAS Common Chemistry. CAS, a division of the American Chemical Society, n.d. https://commonchemistry.cas.org/detail?cas_rn=56-81-5 (retrieved 2022-12-12) (CAS RN: 56-81-5). Licensed under the Attribution-Non-commercial 4.0 International License (CC BY-NC 4.0).

Doolittle, D., Lee, D.A., and Lee, C.K. (1988). The genotoxic activity of glycerol in an in vitro test battery. Food Chem. Toxicol. 26: 631-635.

Department of the Environment, Water, Heritage and the Arts [DEWHA]. (2009). Environmental risk assessment guidance manual for industrial chemicals, Department of the Environment, Water, Heritage and the Arts, Commonwealth of Australia. Available: http://www.nepc.gov.au/resource/chemical-risk-assessment-guidance-manuals

Department of the Environment and Energy [DoEE]. (2017). Chemical Risk Assessment Guidance Manual: for chemicals associated with coal seam gas extraction, Guidance manual prepared by Hydrobiology and ToxConsult Pty Ltd for the Department of the Environment and Energy, Commonwealth of Australia, Canberra.

ECHA. ECHA REACH database: http://echa.europa.eu/information-on-chemicals/registered-substances

enHealth Human Risk Assessment [HHRA]. (2012). Environmental Health Risk Assessment, Guidelines for Assessing Human Health Risks from Environmental Hazards. Office of Health Protection of the Australian Government Department of Health. Available: https://www1.health.gov.au/internet/main/publishing.nsf/Content/health-pubhlth-publicat-environ.htm

European Chemicals Agency [ECHA]. (2017). Guidance on Information Requirements and Chemical Safety Assessment, Chapter R11: PBT Assessment, European Chemicals Agency, Helsinki, Finland. Available: https://echa.europa.eu/guidance-documents/guidance-on-information-requirements-and-chemical-safety-assessment

Haworth, S. et al. (1983). Salmonella mutagenicity test results for 250 chemicals. Environ. Mutagen. Suppl. 1: 3-142.

Hine, C.H., Anderson, H.H., Moon, H.D., Dunlap, M.K., and Morse, M.S. (1953). Comparative toxicity of synthetic and natural glycerin. AMA Arch. Ind. Hyg. Occup. Med. 7: 282-291.

Klimisch, H.J., Andreae, M., and Tillmann, U. (1997). A systematic approach for evaluating the quality of experimental and toxicological and ecotoxicological data. Regul. Toxicol. Pharmacol. 25:1-5.

Lehninger, A.L. (1970). Biochemistry. The molecular basis of cell structure and function. Worth Publishers, Inc. NY, NY

OECD (2002). SIDS Initial Assessment Report (SIAR) and IUCLID Data Set on Glycerol (CAS No. 56-81-5), UNEP Publications. Available at: http://www.inchem.org/documents/sids/sids/56815.pdf.

Renne, R. (1992). 2-Week and 13-week inhalation studies of aerosolized glycerol in rats. Inhal. Toxicol. 4: 95-111.

U.S. Environmental Protection Agency [EPA]. (2017). EPISuite™ v. 4.11, United States Environmental Protection Agency, Office of Pollution Prevention and Toxics and Syracuse Research Corporation. Available: https://www.epa.gov/tsca-screening-tools/epi-suitetm-estimation-program-interface.

Weil, C.S., and Scala, R.A. (1971). Study of intra- and interlaboratory variability in the results of rabbit eye and skin irritation tests. Toxicol. Appl. Pharmacol. 19: 276-360.

GUAR GUM

This dossier on guar gum (CAS RN 9000-30-0) presents the most critical studies pertinent to the risk assessment of the substance in its use in coal seam or shale gas extraction activities. This dossier does not represent an exhaustive or critical review of all available data. The information presented in this dossier was obtained from the chemistry database PubChem. Where possible, study quality was evaluated using the Klimisch scoring system (Klimisch et al., 1997).

I. SUBSTANCE IDENTIFICATION

Chemical Name (IUPAC): disodium;[[[5-(6-aminopurin-9-yl)-3-hydroxyoxolan-2-yl]oxy-methoxyphosphoryl]oxy-oxidophosphoryl] hydrogen phosphate

CAS RN: 9000-30-0

Molecular weight: 535.15 g/mol; 200,000 to 300,000 daltons (Glickman, 1969)

Molecular formula: $C_{10}H_{14}N_5Na_2O_{12}P_3$

Synonyms: GU-052, guar flour, guaran, gum guar, slocose

SMILES:: COP(=O)(OC1C(CC(O1)N2C=NC3=C(N=CN=C32)N)O)OP(=O)([O-])OP(=O)(O)[O-].[Na+].[Na+]

II. PHYSICO-CHEMICAL PROPERTIES

Table 1: Overview of the Physico-Chemical Properties of Guar Gum

Property	Value	Klimisch Score	Reference
Physical state at 20°C and 101.3 kPa	Off-white to yellowish-white powder	-	PubChem
Vapour Pressure	Negligible	-	PubChem
Water Solubility	< 1 g/L @ 20°C (insoluble)	-	PubChem

III. ENVIRONMENTAL FATE PROPERTIES

Guar gum is a carbohydrate polymer consisting of D-mannose and D-galactose sugars from the guar plant or cluster bean. As a high molecular weight polysaccharide polymer, guar gum is expected to have a negligible vapour pressure. If released to air, a negligible vapour pressure indicates guar gum will exist solely in the particulate phase in the atmosphere. Particulate-phase guar gum will be removed from the atmosphere by wet and dry deposition. If released to soil, guar gum is expected to have no mobility since it is a polymer that binds strongly with soil particles. Volatilisation from moist soil surfaces is not expected to be an important fate process based upon a negligible Henry's Law constant. Likewise, guar gum is not expected to volatilise from dry soil surfaces based upon its vapour pressure. If released into water, guar gum is expected to adsorb to suspended solids and sediment (PubChem). Half-life data was not available.

Guar gum is expected to readily undergo microbial biodegradation in the environment (on the basis that it is a polysaccharide and expected to be readily biodegradable), and the potential to bioaccumulate in organisms is considered to be low (DoEE, 2017 and USEPA, 2005).

IV. HUMAN HEALTH HAZARD ASSESSMENT

A. Summary

Guar gum exhibits very low acute toxicity by the oral route. It is non-irritating to the skin and minimally irritating to the eyes. Repeated dose toxicity studies in rats showed minimal toxicity from exposure to guar gum in the diet. Guar gum is not genotoxic or carcinogenic. Oral exposure to guar gum did not affect fertility in rats; nor was there any indication of developmental toxicity in either rats or mice.

NICNAS has assessed Guar Gum in an IMAP Tier 1 assessment and concluded that it poses no unreasonable risk to human health[1]

B. Acute Toxicity

The oral LD_{50} in rats was reported to be 7,060 mg/kg (Graham *et al.*, 1981) [Kl. Score = 2].

C. Irritation

Guar gum is non-irritating to the skin and minimally irritating to the eyes (McCarty *et al.*, 1990). Nonetheless, ECHA warns that the substance may cause serious eye irritation.

D. Sensitisation

There were reports of workers sensitised to guar gum in a carpet-manufacturing plant. Immediate skin reactivity to guar gum was observed in 8 out of 162 employees, and 11 of 133 participants had serum IgE antibodies to guar gum. These findings are difficult to interpret since carbohydrates, such as guar gum, are generally not associated with allergenicity (Malo, 1990).

E. Repeated Dose Toxicity

Oral

Male and female Osborne-Mendel rats were given diets containing 0, 1, 2, 4, 7.5, or 15% guar gum for 91 days. The average daily intakes are: 0; 580; 1,187; 2,375; 4,561 and 10,301 mg/kg/day for males; and 0; 691; 1,362; 2,762; 5,770 and 13,433 mg/kg/day for females. There were no deaths during the study. Body weights were significantly decreased in the ≥1% females and the ≥7.5% males; biologically significant changes (>10%) were seen in the 7.5% females and the 15% males. Liver weights were decreased in the ≥1% dietary groups. Kidney weights were decreased in the ≥7.5% dietary groups and were borderline significant in the 4% group. The 15% group males had reduced bone marrow cellularity; although the level was within normal limits, several of the rats were at the lower end of the normal range. The NOAEL for this study is 4% in the diet or 2,762 mg/kg/day based on reduced body weights in the female rats (Graham *et al.*, 1981) [Kl. Score = 2].

Male and female F344 rats and $B6C3F_1$ mice were given diets containing 0; 6,300; 12,500; 25,000; 50,000 or 100,000 ppm guar gum for 13 weeks. Mean body weights were decreased in the 100,000 ppm male rats and in the ≥50,000 ppm female mice. A dose-related decrease in feed consumption was observed for male and female rats; male and female mice were comparable or higher than that of controls. There were no compound-related clinical signs or histopathological effects. The NOAELs

[1] https://www.industrialchemicals.gov.au/chemical-information/search-assessments?assessmentcasnumber=9000-30-0%2C+

for this study are 50,000 and 25,000 ppm for rats and mice, respectively. Using the fraction of body weight that rats and mice consume per day as food (0.05 and 0.13, respectively; USEPA), the NOAELs corresponds to 2,500 mg/kg/day for rats and 3,250 mg/kg/day for mice (NTP, 1982) [Kl. Score = 2].

Male and female F344 rats and B6C3F$_1$ mice were given diets containing 0 ppm, 25,000 ppm or 50,000 ppm guar gum for 103 weeks. Mean body weights of the high-dose females were lower than those of the controls after week 20 for mice and week 40 for rats. No compound-related clinical signs or adverse effects on survival were observed. Feed consumption by dosed rats and mice of either sex was lower than that of controls. There were no non-neoplastic histopathological effects in either rats or mice that were treatment-related. The NOAEL for both rats and mice is 25,000 ppm. Using the fraction of body weight that rats and mice consume per day as food (0.05 and 0.13, respectively; USEPA), the NOAELs correspond to 1,250 mg/kg/day for rats and 3,250 mg/kg/day for mice (NTP, 1982) [Kl. Score = 2].

Inhalation

No studies are available.

Dermal

No studies are available.

F. Genotoxicity

In vitro Studies

Guar gum was not mutagenic to *S. typhimurium* strains TA 97, TA 98, TA 100, TA 102, TA 104, TA 1535, TA 1537, and TA1538 in the presence or absence of metabolic activation (Zeiger *et al.*, 1992) [Kl. Score = 2].

In vivo Studies

Guar gum was inactive in a rat bone marrow cytogenetic assay at doses up to 5,000 mg/kg (Johnson *et al.*, 2015) Kl. Score = 4].

In a rat dominant lethal mutation test, rats were dosed by oral gavage with either a single or multiple doses of up to 5,000 mg/kg guar gum. There was no indication of a mutagenic effect by guar gum (Lee *et al.*, 1983) [Kl. Score = 2].

G. Carcinogenicity

Male and female F344 rats were given diets containing 0 ppm, 25,000 ppm or 50,000 ppm guar gum for 103 weeks in an NTP chronic bioassay. There were increased incidences of adenomas of the pituitary in male rats and pheochromocytomas of the adrenal medulla in female rats that were statistically significant, but these differences were considered to be unrelated to guar gum administration. When pituitary adenomas or carcinomas and when pheochromocytomas or malignant pheochromocytomas were combined, the statistical differences disappeared. NTP concluded that, under conditions of this bioassay, guar gum was not carcinogenic for F344 rats (NTP, 1982) [Kl. Score = 2].

Male and female B6C3F$_1$ mice were given diets containing 0 ppm, 25,000 ppm or 50,000 ppm guar gum for 103 weeks in an NTP chronic bioassay. Hepatocellular carcinomas occurred in treated male

mice at incidences that were significantly lower than that in controls. The combined incidence of male mice with either hepatocellular adenomas or carcinomas was also significantly lower in the high-dose group. NTP concluded that, under conditions of this bioassay, guar gum was not carcinogenic for B6C3F_1 mice (NTP, 1982) [Kl. Score = 2].

H. Reproductive Toxicity

Oral

Male and female Osborne-Mendel rats were fed diets containing 0, 1, 3, 4, 7.5, or 15% guar gum for 13 weeks before mating, during mating and throughout gestation. The daily intakes for the female rats during gestation were 0; 700; 1,400; 2,700; 5,200 or 11,800 mg/kg/day. Fertility was unaffected by treatment. There were slightly fewer corpora lutea and implantations in the 15% dietary group, but implantation efficiency was unaffected. The NOAEL for reproductive toxicity is 5,200 mg/kg/day (Collins *et al.*, 1987) [Kl. Score = 2].

I. Developmental Toxicity

Oral

Male and female Osborne-Mendel rats were fed diets containing 0, 1, 3, 4, 7.5, or 15% guar gum for 13 weeks before mating, during mating and throughout gestation. The daily intake for the female rats during gestation were 0; 700; 1,400; 2,700; 5,200 or 11,800 mg/kg/day. There were no deaths during the study. In the 15% group, the number of viable foetuses per litter were slightly reduced but was not statistically significantly different from controls. The authors indicated that the reduction may have been an effect of the decreased number of corpora lutea because the number of resorptions was unaffected in this treatment group. There was no treatment-related effect on foetal development or sex distribution, and there were no teratogenic effects (Collins *et al.*, 1987) [Kl. Score = 2].

Pregnant female rats were dosed by oral gavage with 0, 9, 42, 200 or 900 mg/kg guar gum on GD 6 to 15. There was no maternal or developmental toxicity at any dose level. The NOAEL for maternal and developmental toxicity is 900 mg/kg/day (FDRL, 1973) [Kl. Score = 2].

Pregnant female CD-1 mice were dosed by oral gavage with 0, 8, 37, 170, or 800 mg/kg guar gum on GD 6 to 15. A significant number of deaths (6 out of 29) occurred in the 800 mg/kg dose group. There were indications of maternal toxicity in the surviving high-dose dams. There was no developmental toxicity at any dose level. The NOAELs for maternal and developmental toxicity are 170 and 800 mg/kg/day, respectively (FDRL, 1973) [Kl. Score = 2].

V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES

The toxicological reference values developed for guar gum follow the methodology discussed in enHealth (2012). The approach used to develop drinking water guidance values is described in the Australian Drinking Water Guidelines (ADWG, 2021).

A. Non-Cancer

Oral

In a two-year NTP chronic bioassay, female rats and mice given 50,000 ppm guar gum in their feed had lower body weights. There were no treatment-related non-neoplastic lesions in either rats or

mice. The NOAEL for this study is 25,000 ppm for rats and mice, which corresponds to 1,250 mg/kg/day for rats and 3,250 mg/kg/day for mice.

The NOAEL of 1,250 mg/kg/day will be used for determining the oral reference dose (RfD) and the drinking water guidance value.

Oral Reference Dose (oral RfD)

Oral RfD = NOAEL / (UF_A x UF_H x UF_L x UF_{Sub} x UF_D)

Where:

UF_A (interspecies variability) = 10
UF_H (intraspecies variability) = 10
UF_L (LOAEL to NOAEL) = 1
UF_{Sub} (subchronic to chronic) = 1
UF_D (database uncertainty) = 1
Oral RfD = 1,250/(10 x 10 x 1 x 1 x 1) = 1,250/100 = <u>13 mg/kg/day</u>

Drinking water guidance value

Drinking water guidance value = (animal dose) x (human weight) x (proportion of intake from water) / (volume of water consumed) x (safety factor)

Using the oral RfD,

Drinking water guidance value = (oral RfD) x (human weight) x (proportion of water consumed) / (volume of water consumed)

Where:

Human weight = 70 kg (ADWG, 2021)
Proportion of water consumed = 10% (ADWG, 2021)
Volume of water consumed = 2L (ADWG, 2021)
Drinking water guidance value = (13 x 70 x 0.1)/2 = <u>46 mg/L</u>

B. Cancer

Guar gum was not carcinogenic to rats or mice in two-year dietary studies. Thus, a cancer reference value was not derived.

VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES

Guar gum does not exhibit the following physico-chemical properties:

- Explosivity
- Flammability
- Oxidising potential

VII. ENVIRONMENTAL HAZARD ASSESSMENT

A. Summary

Guar gum is a polysaccharide polymer. It has low acute toxicity concern for fish but exhibits moderate acute toxicity to invertebrates (*Daphnia*).

B. Aquatic Toxicity

Acute Studies

The 96-hour LC_{50} for *Oncorhynchus mykiss* is 218 mg/L (Biesinger *et al.*, 1976) [Kl. Score = 2].

The 48-hour and 96-hour LC_{50} values for *Daphnia magna* are 42 mg/L and <6.2 mg/L, respectively (Biesinger *et al.*, 1976) [Kl. Score = 2].

Chronic Studies

No studies are available.

C. Terrestrial Toxicity

No studies are available.

D. Calculation of PNEC

The PNEC calculations for guar gum follow the methodology discussed in DEWHA (2009).

PNEC water

Experimental results are available for two trophic levels. The acute LC_{50} values are available for fish (218 mg/L) and *Daphnia* (<6.2 mg/L). No chronic studies are available. On the basis that the data consists of acute studies from two trophic levels, an assessment factor of 1,000 has been applied to the lowest reported LC_{50} value of 6.2 mg/L for *Daphnia*. The $PNEC_{water}$ is 0.006 mg/L.

PNEC sediment

No experimental toxicity data on sediment organisms are available. The K_{ow} and K_{oc} of guar gum cannot be calculated using EPI Suite because the molecular weight of guar gum greatly exceeds the limit of 1,000. Thus, the equilibrium partition method cannot be used to determine a $PNEC_{sediment}$ and the assessment of this compartment will be covered by the aquatic assessment.

PNEC soil

No experimental toxicity data on soil organisms are available. The K_{ow} and K_{oc} of guar gum cannot be calculated using EPI Suite because the molecular weight of guar gum greatly exceeds the limit of 1,000. Thus, the equilibrium partition method cannot be used to determine a $PNEC_{soil}$ and the assessment of this compartment will be covered by the aquatic assessment.

VIII. PERSISTENCE, BIOACCUMULATION AND TOXICITY (PBT) ASSESSMENT

The methodology for the Persistent, Bioaccumulative and Toxic (PBT) substances assessment is based on the Australian and EU Reach Criteria methodology (DEWHA, 2009; ECHA, 2008).

Guar gum is a naturally occurring polysaccharide from the guar plant or cluster bean; it expected to be readily biodegradable. Thus it is not expected to meet the screening criteria for persistence.

The potential to bioaccumulate in organisms is considered to be low. Thus guar gum is not expected to meet the criteria for bioaccumulation.

There are no adequate chronic aquatic toxicity studies available on guar gum. The acute LC_{50} values for guar gum are >1 mg/L in fish and invertebrates. Therefore, guar gum does not meet the screening criteria for toxicity.

The overall conclusion is that guar gum is not a PBT substance.

IX. CLASSIFICATION AND LABELLING

A. Classification

Acute Aquatic Toxicity Category 2

B. Labelling

Warning!

According to the classification provided by companies to ECHA in CLP notifications, this substance causes serious eye irritation.

C. Pictogram



X. HANDLING AND SAFETY INFORMATION (OCCUPATIONAL LIMITS AND TRANSPORTATION REQUIREMENTS)

A. First Aid

Eye Contact

In case of contact, immediately flush eyes with plenty of water for at least 15 minutes.

Skin Contact

Remove contaminated clothing. Wash thoroughly with soap and water.

Inhalation

If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.

Ingestion

Rinse mouth with water and then drink plenty of water. Never give anything by mouth to an unconscious person.

Notes to Physician

May cause asthma-like (reactive airways) symptoms.

B. Fire Fighting Information

Extinguishing Media

Water spray, carbon dioxide, foam, dry chemical.

Specific Exposure Hazards

May emit toxic fumes under fire conditions. Depending on conditions, decomposition products may include the following: carbon monoxide, carbon dioxide.

Special Protective Equipment for Firefighters

Wear self-contained breathing apparatus for fire fighting.

C. Accidental Release Measures

Personal Precautions

Avoid dust formation.

Environmental Precautions

No special environmental precautions required.

Steps to be Taken if Material is Released or Spilled

Sweep up and dispose in suitable, closed containers.

D. Storage And Handling

General Handling

Avoid creating or inhaling dust.

Storage

Keep container tightly closed and in a dry and well-ventilated place. Keep in a cool place.

E. Exposure Controls / Personal Protection

Occupational Exposure Standards

Workplace Australia has not established an occupational exposure standard specifically for guar gum.

Engineering Controls

Ensure adequate ventilation.

Personal Protection Equipment

Respiratory Protection: Respiratory protection is not required.

Hand Protection: Handle with gloves.

Skin Protection: Body protection must be chosen depending on activity and possible exposure.

Eye protection: Safety glasses with side-shields.

Other Precautions: Handle in accordance with good industrial hygiene and safety practice. Eyewash fountains and safety showers must be easily accessible.

F. Transport Information

Guar gum is not considered hazardous for purposes of transportation by road or rail. An Australian Dangerous Goods code is not required.

XI. DISPOSAL MANAGEMENT

Disposal should be in accordance with all local, state and federal regulations.

XII. REGULATORY STATUS

Australian AICS Inventory: Listed.

XIII. REFERENCES

ADWG (2021). National Water Quality Management Strategy. Australian Drinking Water Guidelines, Section 6, Australian Government, National Health and Medical Research Council, Natural Resource Management Ministerial Council.

Biesinger, K.E., Lemke, A.E., Smith, W.E., and Tyo, R.M. (1976). Comparative toxicity of polyelectrolytes to selected aquatic animals. J. Water Pollut. Control Fed. 48: 183-187; cited in U.S. EPA ECOTOX database.

Collins, T.F.X., Welsh, J.J., Black, T.N., Graham, S.L., and O'Donnell, M.W., Jr. (1987). Study of the teratogenic potential of guar gum. Food Chem. Toxicol. 25: 807-814.

Department of the Environment, Water, Heritage and the Arts [DEWHA]. (2009). Environmental risk assessment guidance manual for industrial chemicals, Department of the Environment, Water, Heritage and the Arts, Commonwealth of Australia.

Department of the Environment and Energy [DoEE]. (2017). Chemical Risk Assessment Guidance Manual: for chemicals associated with coal seam gas extraction, Guidance manual prepared by Hydrobiology and ToxConsult Pty Ltd for the Department of the Environment and Energy, Commonwealth of Australia, Canberra.

ECHA. ECHA REACH database: http://echa.europa.eu/information-on-chemicals/registered-substances

enHealth Human Risk Assessment [HHRA]. (2012). Environmental Health Risk Assessment, Guidelines for Assessing Human Health Risks from Environmental Hazards. Office of Health Protection of the Australian Government Department of Health.

European Chemicals Agency [ECHA]. (2008). Guidance on Information Requirements and Chemical Safety Assessment, Chapter R11: PBT Assessment, European Chemicals Agency, Helsinki, Finland.

Food and Drug Research Laboratories, Inc. [FDRL]. (1973). Teratologic evaluation of FDA 71-16 (guar gum) in mice, rats, hamsters, and rabbits. Final report prepared under DHEW contract No. FDA 71-260. Maspeth, NY. NTIS No. PB-223-819/4; cited in CIR (2015).

Glickman M. (1969). Gum technology in the Food Industry, pp. 590, Academic Press, New York; cited in Yoon *et al.* (1998).

Graham, S.L., Arnold, A., Kasza, L., Ruffin, G.E., Jackson, R.C., Watkins, T.L., and Graham, C.H. (1981). Subchronic effects of guar gum in rats. Fd. Cosmet. Toxicol. 19: 287-290.

Johnson, W., Jr., Heldreth, B., Bergfeld, W.F., Belsito, D.V., Hill, R.A., Klaassen, C.D., Liebler, D.C., Marks, J.G., Jr., Shank, R.C., Slaga, T.J., Snyder, P.W., and Andersen, F.A. (2015). Safety assessment of galactomannans as used in cosmetics. Int. J. Toxicol. 34(Suppl. 1): 35S-65S.

Klimisch, H.J., Andreae, M., and Tillmann, U. (1997). A systematic approach for evaluating the quality of experimental and toxicological and ecotoxicological data. Regul. Toxicol. Pharmacol. 25:1-5.

Lee, W.R., Abrahamson, S., Valencia, R., Von Halle, E.S., Wuergler, F.E., and Zimmering, S. (1983). The sex-linked recessive lethal test for mutagenesis in *Drosophila melanogaster*. A report of the U.S. Environmental Protection Agency Gene-Tox Program. Mutat. Res. 123: 183-279.

Malo, J.L., Cartier, A., L'Archevêque, J., Ghezzo, H., Soucy, F., Somers, J., and Dolovich, J. (1990). Prevalence of occupational asthma and immunologic sensitization to guar gum among employees at a carpet-manufacturing plant. J. Allergy Clin. Immunol. 86: 562-569.

McCarty, J.D., Weiner, M., Freeman, C., Aguinaldo, E.R., and Fletcher, M.J. (1990). Primary skin and ocular irritation studies on five food additive plant gums. J. Am. Coll. Toxicol. 1(1): 50-51.

NTP. (1982). NTP Technical Report on the Carcinogenesis Bioassay of Guar Gum (CAS No. 9000-30-0) in F344 Rats and B6C3F_1 Mice (Feed Study), National Toxicology Program, Research Triangle Park, NC.

PubChem. PubChem open chemistry database: https://pubchem.ncbi.nlm.nih.gov

United States Environmental Protection Agency [USEPA]. (2005). Science Assessment for Hydroxypropyl Guar Gum, Lower Risk Pesticide Chemical Focus Group, Office of Prevention, Pesticides and Toxic Substances, US Environmental Protection Agency. Accessed: http://www.epa.gov/opprd001/inerts/hydroxypropyl.pdf

Zeiger, E., Anderson, B., Haworth, S., Lawlor, T., and Mortelmans, K. (1992). Salmonella mutagenicity tests: V. Results from the testing of 311 chemicals. Environ. Mol. Mutagen. 21: 2-141.

HYDROCHLORIC ACID

This dossier on hydrochloric acid presents the most critical studies pertinent to the risk assessment of hydrochloric acid in its use in coal seam or shale gas extraction activities. This dossier does not represent an exhaustive or critical review of all available data. The majority of information presented in this dossier was obtained from OECD-SIDS documents (OECD, 2002a,b) and the ECHA database that provides information on chemicals that have been registered under the EU REACH (ECHA). Where possible, study quality was evaluated using the Klimisch scoring system (Klimisch et al., 1997).

NICNAS has assessed hydrochloric acid in an IMAP Tier 1 assessment and concluded that it poses no unreasonable risk to the environment.

I. SUBSTANCE IDENTIFICATION

Chemical Name (IUPAC): Chlorane

CAS RN: 7647-01-0

Molecular formula: HCl

Molecular weight: 36.46 g/mol

Synonyms: Hydrochloric acid; HCl; chlorane; hydrogen chloride; muriatic acid; chlorohydric acid

SMILES: Cl

II. PHYSICO-CHEMICAL PROPERTIES

Table 1: Overview of the Physico-chemical Properties of Hydrochloric Acid

Property	Value	Klimisch Score	Reference
Physical state at 20°C and 101.3 kPa	Colourless to slightly yellow gas of fuming liquid with pungent, irritating odour.	2	ECHA
Melting Point	-114.22°C	2	ECHA
Boiling Point	-85°C	4	ECHA
Density	1.639 kg/m^3 @ 0°C (gas) 1190 kg/m^3 @ 15°C (liquid)	4	ECHA
Vapour Pressure	4,104 kPa 4,723 kPa @ 25°C	4	ECHA
Partition Coefficient (log K_{ow})	Not applicable	-	-
Water Solubility	Very soluble	4	ECHA
Viscosity	1.7 x 10^{-6} m^2s @ 20°C	1	ECHA

Hydrochloric acid can exist in a gaseous phase at room temperature and pressure. Hydrochloric acid is also very soluble in water and is a strong acid that dissociates completely in water to hydrogen (H^+) and chloride (Cl^-) ions.

III. ENVIRONMENTAL FATE PROPERTIES

Due to its high water solubility, hydrochloric acid will be found predominantly in the aquatic environment where it dissociates completely to hydrogen (H^+) and chloride (Cl^-) ions. Both ions are ubiquitous in the environment (UNEP, 1995).

The addition of hydrochloric acid to an aquatic ecosystem may decrease the pH depending on the buffer capacity of the receiving water. In general, the buffer capacity is regulated by the equilibria between CO_2, HCO_3^- and CO_3^{2-}:

$CO_2 + H_2O \leftrightarrow HCO_3^- + H^+$ ($pKa_1 = 6.35$)

$HCO_3^- \leftrightarrow CO_3^{2-} + H^+$ ($pKa_2 = 10.33$)

A release of hydrochloric acid into the aquatic environment from the use of HCl could potentially increase the chloride concentration and decrease the pH in the aquatic environment. Table 2 shows the amount of hydrochloric acid that would need to be added to bicarbonate solutions to obtain pH values of 6.0 and 4.0. The UNEP (1995) study reported that the 10th percentile, mean and the 90th percentile of bicarbonate concentrations in 77 rivers in North America, South America, Asia, Africa, Europe and Oceania were 20, 106, and 195 mg/L, respectively. The data show that the decrease in pH depends on the buffer capacity (bicarbonate concentration) of the receiving water. The calculated values in Table 2 were confirmed experimentally.

Table 2: Buffer Capacity to Maintain the pH Based on Bicarbonate Concentration from UNEP Monitoring Data (de Groot and van Dijk, 2002; taken from OECD, 2002b)

Initial concentration of HCO_3^-	Final pH	Concentration of HCl required to obtain the final pH value
		Calculated (mg/L)
20 mg/L HCO_3^- (10th percentile 77 rivers)	6.0	8.28
	4.0	11.9
106 mg/L HCO_3^- (mean value of 77 rivers)	6.0	43.9
	4.0	63.2
195 mg/L HCO_3^- (90th percentile 77 rivers)	6.0	80.7
	4.0	116.3

H^+ and Cl^- ions will not adsorb on the particulate matter or surfaces and will not accumulate in living tissues (OECD, 2002a,b).

IV. HUMAN HEALTH HAZARD ASSESSMENT

A. Summary

Hydrochloric acid is a corrosive liquid. Depending on the concentration, aqueous solutions of hydrochloric acid (HCl) are either corrosive, irritating or non-irritating to the skin, eyes and gastrointestinal tract. Vapours from aqueous solutions of HCl can cause respiratory irritation. HCl is not a skin sensitiser. Subchronic inhalation studies show localised irritation to the upper respiratory tract of rats and mice, but no systemic toxicity. No repeated dose toxicity studies have been conducted by the oral route. Positive findings have been reported in some *in vitro* genotoxicity studies, which are considered to be the result of the pH change in the test system. A lifetime inhalation study showed no carcinogenicity in rats exposed to HCl. No adequate reproductive or developmental studies have been conducted on HCl.

B. Acute Toxicity

The oral LD_{50} values in rats were reported to be 238 to 277 mg/kg and 700 mg/kg (OECD, 2002a,b) [Kl. scores = 2 and 4, respectively].

The lethal dose by dermal exposure is > 5,010 mg/kg for rabbits (OECD 2002a,b) [Kl. score = 4].

The LC_{50} values in rats for HCl gas are 40,989 and 4,701 ppm for 5 and 30 minutes, respectively (ECHA) [Kl. score = 2]. The LC_{50} values in rats for HCl aerosol are 31,008 and 5,666 ppm (45.6 and 8.3 mg/L) for 5 and 30 minutes, respectively (ECHA) [Kl. score = 2].

C. Irritation

Application of a 37% aqueous solution of HCl for 1 or 4 hours was corrosive to the skin of rabbits (OECD, 2002a,b) [Kl. score = 2]. Application of 0.5 mL of a 17% solution of aqueous solution of HCl for 4 hours was corrosive to the skin of rabbits (OECD, 2002a,b) [Kl. score = 3]. Moderate skin irritation was observed in rabbits following an application of 0.5 mL of a 3.3% aqueous solution of HCl for five days; no irritation was observed with 0.5 mL of a 1% aqueous solution (OECD, 2002a,b) [Kl. score = 2]. In humans, an aqueous solution of 4% of HCl was slightly irritating, while a 10% solution was sufficiently irritating to be classified as a skin irritant (OECD, 2002a,b).

Instillation of 0.1 mL of a 10% aqueous solution of HCl to the eyes of rabbits resulted in severe eye irritation (ECHA) [Kl. score = 2]. Instillation of 0.1 mL of a 5% solution of HCl produced corneal opacity, iridial lesions, conjunctival redness and chemosis in 3/3 animals at 1 hour and at day one post-instillation. There was no recovery in any animal and the study was terminated on day two (ECHA) [Kl. score = 1].

D. Sensitisation

Hydrochloric acid was not a skin sensitiser in a guinea pig maximisation test (ECHA) [Kl. score = 2].

E. Repeated Dose Toxicity

Oral

No adequate studies were located.

Inhalation

Male and female SD rats and F344 rats were exposed by inhalation to 0, 10, 20, or 50 ppm 6 hours/day, 5 days/week for up to 90 days. Clinical signs were mainly indicative of the irritant/corrosive nature of HCl. Body weights were significantly decreased in the 50 ppm male F344 rats. There were no treatment-related effects on the haematology or clinical chemistry parameters or urinalysis. At study termination, heart, kidney and testes weights were increased in the 100 and/or 50 ppm groups; these changes were considered to be mainly related to the treatment-related effect on body weight. Histopathological examination showed minimal to mild rhinitis in the $\geq$ 20 ppm dose groups of both strains of rats (both sexes). The NOAELs for systemic toxicity and localised irritation (site-of-contact) are 20 and 10 ppm, respectively (ECHA) [Kl. score = 1].

Male and female B6C3F$_1$ mice were exposed by inhalation to 0, 10, 20 or 50 ppm HCl, 6 hours/day, 5 days/week for up to 90 days. Clinical signs were mainly indicative of the irritant/corrosive nature of HCl. Body weights were significantly decreased in the 50 ppm groups. At study termination, absolute liver weights were decreased in the 50 ppm males. Histopathologic examination showed only eosinophilic globules in the nasal epithelium in the 50 ppm animals. The NOAEL for this study is 20 ppm (ECHA) [Kl. score = 1].

Male SD rats were exposed by inhalation to 0 or 10 ppm HCl 6 hours/day, 5 days/week for 128 weeks. Survival and body weights were similar between treated and control groups. There was a higher incidence of hyperplasia of the larynx compared to control, but no serious irritating effects of the nasal epithelium (ECHA) [Kl. score = 2].

Dermal

No studies were located.

F. Genotoxicity

In vitro Studies

Table 3 presents the *in vitro* genotoxicity studies on hydrochloric acid.

Table 3: *In vitro* Genotoxicity Studies on Hydrochloric Acid

Test System	Results*		Klimisch Score	Reference
	-S9	+S9		
Bacterial reverse mutation (*S. typhimurium* and *E. coli* strains)	-	-	2	ECHA
Mammalian cell gene mutation (mouse lymphoma L5178Y cells)	-	+	2	ECHA
Chromosomal aberration (CHO cells)	+	+	2	ECHA
Saccharomyces cerevisiae (mitotic recombination	-	-	2	ECHA
E. coli W3110 (pol A+) and P3078 (pol A-) repair assay	-	-	2	ECHA

* +, positive; -, negative

In the mouse lymphoma assay, the mutant frequency increased as the pH was lowered to 6.5 to 6.0 (from increased HCl) in the presence of metabolic activation. A decrease in pH from the addition of HCl to the medium also resulted in clastogenic effects to CHO cells in the absence or presence of metabolic activation. The positive findings in these two studies are considered to be the result of the pH change in the test media.

In vivo Studies

No adequate studies were located.

G. Carcinogenicity

Oral

No studies were located.

Inhalation

Male SD rats were exposed by inhalation to 0 or 10 ppm HCl 6 hours/day, 5 days/week for 128 weeks. Survival and body weights were similar between treated and control groups. There was a higher incidence of hyperplasia of the larynx compared to control, but no serious irritating effects of the nasal epithelium. There was no increased incidence of tumours in the HCl-treated rats compared to controls (ECHA) [Kl. score = 2].

H. Reproductive Toxicity

No studies were located.

I. Developmental Toxicity

No adequate studies were located.

V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES

Repeated dose, reproductive and developmental toxicity studies by the oral route have not been conducted on hydrochloric acid. These toxicity studies would have questionable usefulness because of the corrosive/irritating nature of hydrochloric acid, which would limit the amount of absorbed HCl. Hydrochloric acid dissociates to hydrogen and chloride ions in bodily fluids, and a significant amount of these ions are already ingested in foods. Furthermore, both ions are present in the body and are highly regulated by homeostatic mechanisms. Thus, an oral toxicological reference and drinking water guidance values were not derived from hydrochloric acid.

The Australian drinking water guideline values for pH (6.5 to 8.5) and chloride (250 ppm, aesthetics) may be applicable (ADWG, 2011).

VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES

Hydrochloric acid does not exhibit the following physico-chemical properties:

- Explosivity
- Flammability
- Oxidising potential

VII. ENVIRONMENTAL HAZARD ASSESSMENT

A. Summary

The hazard of hydrochloric acid for aquatic organisms is caused by the hydrogen ion (H^+). The toxicity values in terms of mg/L are not relevant because of the varying buffering capacity of different test systems and different aquatic ecosystems.

B. Aquatic Toxicity

Acute Studies

The acute aquatic toxicity studies on hydrochloric acid are listed in Table 4.

Table 4: Acute Aquatic Toxicity Studies on Hydrochloric Acid

Test Species	Endpoint	Results	Klimisch Score	Reference
Lepomis macrochirus	96-hour LC_{50}	pH 3.25 – 3.5 (20 mg/L)	2	ECHA; OECD 2002a,b
Daphnia magna	48-hour EC_{50}	pH 4.92 (0.45 mg/L)	1	ECHA
Chlorella vulgaris	72-hour EC_{50} 72-hour EC_{10}	pH 4.7 [growth rate] (0.73 mg/L) PH 4.7 (0.364 mg/L)	1	ECHA

Chronic Studies

No chronic studies are available.

C. Terrestrial Toxicity

No studies are available.

D. Calculation of PNEC

PNEC values were not derived from hydrochloric acid because factors such as the buffer capacity, the natural pH and the fluctuation of the pH are very specific for a certain ecosystem.

VIII. PERSISTENCE, BIOACCUMULATION AND TOXICITY (PBT) ASSESSMENT

The methodology for the Persistent, Bioaccumulative and Toxic (PBT) substances assessment is based on the Australian and EU REACH Criteria methodology (DEWHA, 2009; ECHA, 2008).

Hydrochloric acid is an inorganic salt that dissociates completely to hydrogen and chloride ions in aqueous solutions. Biodegradation is not applicable to these inorganic ions; both hydrogen and chloride ions are also ubiquitous and are present in water, soil and sediment. For the purposes of this PBT assessment, the persistent criteria are not considered applicable to this inorganic salt.

Hydrogen and chloride ions are essential to all living organisms, and their intracellular and extracellular concentrations are actively regulated. Thus, hydrochloric acid is not expected to bioaccumulate.

No chronic toxicity data exist on hydrochloric acid. The acute EC_{50} values are > 1 mg/L in fish, < 1 mg/L for invertebrates and algae. Thus, hydrochloric acid meets the screening criteria for toxicity.

The overall conclusion is that hydrochloric acid is a PBT substance based on toxicity to invertebrates and algae.

IX. CLASSIFICATION AND LABELLING

A. Classification

For HCl concentrations of >25%:

- Metal Corrosive Category 1
- Skin Corrosive 1B
- STOT SE Category 3 [Respiratory irritant]

In addition to the hazard statements corresponding to the GHS classification for corrosive, the following non-GHS hazard statement is to be added to the SDS: AUH071: Corrosive to the Respiratory Tract.

B. Labelling

Danger

According to the classification provided by companies to ECHA in REACH registrations this substance causes severe skin burns and eye damage, is toxic if inhaled, may damage fertility or the unborn child, causes serious eye damage, may cause damage to organs through prolonged or repeated exposure, may be corrosive to metals and may cause respiratory irritation.

C. Pictogram



X. HANDLING AND SAFETY INFORMATION (OCCUPATIONAL LIMITS AND TRANSPORTATION REQUIREMENTS)

A. First Aid

Eye Contact

Immediately flush open eyes with plenty of water for at least 15 minutes. Remove contacts, if present and easy to do. Get medical attention immediately, preferably a physician for an ophthalmologic examination.

Skin Contact

For minor skin contact, avoid spreading material on unaffected skin. Remove and isolate contaminated clothing. Wash the contaminated area of the body with soap and fresh water. Get medical attention immediately.

Inhalation

Move person to fresh air. Administer oxygen if breathing is difficult. Do not use mouth-to-mouth method if victim inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or another proper respiratory medical device. Give artificial respiration if the victim is not breathing. Get medical attention immediately.

Ingestion

Rinse mouth and lips with plenty of water if a person is conscious. Do not induce vomiting. Do not use mouth-to-mouth method if the victim ingested the substance. Obtain medical attention immediately if ingested.

Notes to Physician

Treat as corrosive due to pH of the material. All treatments should be based on observed signs and symptoms of distress in the patient.

B. Fire Fighting Information

Extinguishing Media

Use dry chemical, carbon dioxide, water spray or fog, or foam.

Specific Exposure Hazards

Containers may explode when heated. Emits toxic fumes under fire conditions. Depending on conditions, decomposition products may include the following materials: halogenated compounds, may release dangerous gases (chlorine).

Special Protective Equipment for Firefighters

Structural firefighter's protective clothing provides limited protection in fire situations only; it is not effective in spill situations where direct contact with the substance is possible. Wear chemical protective clothing that is specifically recommended by the manufacturer. It may provide little or no thermal protection. Wear positive pressure self-contained breathing apparatus (SCBA). Move containers from the fire area if you can do it without risk.

C. Accidental Release Measures

Personal Precautions

Ventilate enclosed areas. Do not walk through spilt material. Do not touch damaged containers or spilt material unless wearing appropriate protective clothing. Wear appropriate personal protective equipment, avoid direct contact. Do not breath mist, vapours, or spray. Do not get in eyes, on skin, or on clothing.

Environmental Precautions

Prevent entry into waterways, sewers, basements or confined areas.

Steps to be Taken if Material is Released or Spilt

ELIMINATE all ignition sources (no smoking, flares, sparks or flames in immediate area). As an immediate precautionary measure, isolate spill or leak area for at least 50 meters in all directions. Keep unauthorised personnel away. Stay upwind. Keep out of low areas. Do not get water inside container.

D. Storage and Handling

General Handling

Handle and open container with care. Use only with adequate ventilation. Keep away from heat. Use caution when combining with water. DO NOT add water to corrosive liquid, ALWAYS add corrosive liquid to water while stirring to prevent the release of heat, steam and fumes. Wear appropriate personal protective equipment, avoid direct contact. Do not breath mist, vapours or spray. Do not get in eyes, on skin or on clothing. Do not ingest. Wash thoroughly with soap and water after handling and before eating, drinking or using tobacco.

Storage

Keep contain tightly closed. Store in a cool, dry, well-ventilated place. Keep away from incompatible materials. Keep from direct sunlight. Separate from alkalis. Do not store above 49^{o}C/120^{o}F.

E. Exposure Controls / Personal Protection

Occupational Exposure Standards

The workplace exposure standard for hydrochloric acid in Australia is 5 ppm (7.5 mg/m^3 as a peak limitation, with a sensitisation notation). A peak limitation is defined by Safe Work Australia as a maximum or peak airborne concentration of a substance determined over the shortest analytically practicable period of time which does not exceed 15 minutes.

Engineering Controls

Good general ventilation should be used. Ventilation rates should be matched to conditions. If applicable, use process enclosures, local exhaust ventilation or other engineering controls to maintain airborne levels below recommended exposure limits.

Personal Protection Equipment

Respiratory Protection: If workers are exposed to concentrations above the exposure limit, they must use appropriate, certified respirators. Use a properly fitted, air-purifying or air-fed respirator complying with an approved standard if a risk assessment indicates this is necessary. Respirator selection is based on known or anticipated exposure levels, the hazard of the product and the safe working limits of the selected respirator.

Hand Protection: Chemical-resistant, impervious gloves complying with an approved standard should be worn at all times when handling chemical products if a risk assessment indicates this is necessary. Considering the parameters specified by the glove manufacturer, check during use that the gloves are still retaining their protective properties. It should be noted that the time to breakthrough for

any glove material may be different for different glove manufacturers. In the case of mixtures, consisting of several substances, the protection time of the gloves cannot be accurately estimated.

Skin Protection: Personal protective equipment for the body should be selected based on the task being performed and the risks involved and should be approved by a specialist before handling hydrochloric acid.

Eye Protection: Wear chemical splash goggles and face shield.

Other Precautions: Wash hands, forearms and face thoroughly after handling chemical products; before eating, smoking and using the lavatory; and at the end of the working period. Appropriate techniques should be used to remove potentially contaminated clothing. Wash contaminated clothing before reusing. Ensure that eyewash stations and safety showers are close to the workstation location.

F. Transport Information

Australian Dangerous Goods

UN 1789 (HYDROCHLORIC ACID)

Class: 8

Packing Group: II or III

XI. DISPOSAL MANAGEMENT

Disposal should be in accordance with all local, state and federal regulations.

XII. REGULATORY STATUS

Australian AICS Inventory: Listed.

XIII. REFERENCES

ADWG. (2011). National Water Quality Management Strategy. Australian Drinking Water Guidelines, Section 6, Australian Government, National Health and Medical Research Council, Natural Resource Management Ministerial Council.

de Groot, W.A., and van Dijk, N.R.M. (2002). Addition of hydrochloric acid to a solution with sodium bicarbonate to a fixed pH. Solvay Pharmaceuticals, Study No. A SOL.S.027; cited in OECD 2002a,b.

Department of the Environment, Water, Heritage and the Arts [DEWHA]. (2009). Environmental risk assessment guidance manual for industrial chemicals, Department of the Environment, Water, Heritage and the Arts, Commonwealth of Australia.

ECHA. ECHA REACH database: http://echa.europa.eu/information-on-chemicals/registered-substances

enHealth Human Risk Assessment [HHRA]. (2012). Environmental Health Risk Assessment, Guidelines for Assessing Human Health Risks from Environmental Hazards. Office of Health Protection of the Australian Government Department of Health.

European Chemicals Agency [ECHA]. (2008). Guidance on Information Requirements and Chemical Safety Assessment, Chapter R11: PBT Assessment, European Chemicals Agency, Helsinki, Finland.

Klimisch, H.J., Andreae, M., and Tillmann, U. (1997). A systematic approach for evaluating the quality of experimental and toxicological and ecotoxicological data. Regul. Toxicol. Pharmacol. 25:1-5.

OECD. (2002a). IUCLID Data Set for Hydrogen chloride (CAS No. 7647-01-0), UNEP Publications.

OECD. (2002b). Screening Information Dataset (SIDS) Initial Assessment Report for Hydrogen chloride (CAS No. 7647-01-0), UNEP Publications.

UNEP. (1995). Water quality of world river basins. UNEP Environment Library No. 14, Nairobi, Kenya; cited in OECD, 2002a,b.

HYDROTREATED LIGHT PETROLEUM DISTILLATE

This dossier on hydrotreated light petroleum distillate (CAS RN 64742-47-8) presents the most critical studies pertinent to the risk assessment of this substance in its use in coal seam or shale gas extraction activities. This dossier does not represent an exhaustive or critical review of all available data. The majority of information presented in this dossier was obtained from the ECHA database that provides information on chemicals that have been registered under the EU REACH (ECHA). Where possible, study quality was evaluated using the Klimisch scoring system (Klimisch et al., 1997).

I. SUBSTANCE IDENTIFICATION

Chemical Name (IUPAC): 1,4-bis(propan-2-yl)benzene; 7,7-dimethylhexadecane; octadecane

CAS RN: 64742-47-8

Molecular formula: Not available (UVCB substance)

Molecular weight: Not available (UVCB substance)

Synonyms: Distillates, petroleum, hydrotreated light

SMILES: CC(C)C1=CC=C(C=C1)C(C)C.CCCCCCCCCCCCCCCCCC.CCCCCCCCCC(C)(C)CCCCCC

II. PHYSICO-CHEMICAL PROPERTIES

Hydrotreated light petroleum distillate is a UVCB substance (unknown variable composition or biological substance) containing aliphatic (linear, branched, and/or cyclic paraffins) molecules of carbon and hydrogen. Physical and chemical properties were not available for the UVCB hydrocarbon. As a result, information was obtained from a read-across substance (hydrodesulfurised kerosine). Key physical and chemical properties for the substance are shown in Table 1.

Table 1: Overview of the Physico-Chemical Properties of Hydrodesulfurised Kerosine (CAS RN 64742-81-0)

Property	Value	Klimisch Score	Reference
Physical state at 20°C and 101.3 kPa	Liquid	2	ECHA
Melting Point	-49°C (pour point) @ 101.3 kPa.	2	ECHA
Boiling Point[1]	90 to 320°C @ 101.3 kPa	2	ECHA
Density	770 to 850 kg/m^3 @ 15°C	2	ECHA
Vapour Pressure	<1,000 to 37,000 Pa at 37.8°C	2	ECHA
Partition Coefficient (log K_{ow})	1.99 – 18.02 @ 20°C	2	ECHA
Water Solubility	0.000009 – 0.00645 g/L @ 25 °C	-	OECD
Viscosity	1.1 to 2.5 mm^2/s @ 20°C (kinematic)	2	ECHA
Auto flammability	220 - 250°C (for kerosines)	2	ECHA

[1] CAS numbers in this category indicate a boiling point range of 90-320 deg Celsius.

III. ENVIRONMENTAL FATE PROPERTIES

A. Summary

Representative substances are expected to be readily biodegradable. They are highly insoluble in water and have high adsorption potential. They have a low potential to bioaccumulate.

While sediment and soil are expected to be the main targets for environmental distribution, biodegradation potential is expected to offset sorption. In fact, fugacity modelling suggests that accumulation in sediment is expected to be several orders of magnitude less than 1%, relative to soil, water and air compartments.

B. Partitioning

Based on Henry's Law Constant values > 4.76 x 10^4 Pa-m^3/mol @25 ^oC, members of this group have the potential to volatilise from water or moist soil surfaces. These chemicals are unlikely to degrade by hydrolysis as they lack a functional group that is hydrolytically reactive. However, in the air, category members have the potential to rapidly degrade through indirect photolytic processes (OECD, 2012).

C. Biodegradation

Kerosine's are readily to inherently biodegradable. In the supporting OECD 301 study, naphtha solvents were readily biodegraded in 28 days but not within the 10-day window. The mean of three samples was 61% theoretical biological oxygen demand on Day 28. In a valid OECD 301F supporting study Kerosine Mid-Blend was not considered readily biodegradable in 28 days, with less than 60% degradation on day 28 (58.6%). However, according to USEPA guidance for biodegradability, it is considered inherently biodegradable because significant degradation occurred). Based on this and the known properties of hydrocarbons in the range C9 to C16, kerosines are often considered not readily biodegradable; but as they can be degraded by microorganisms, they are regarded as being inherently biodegradable.

If a chemical is found to be inherently or readily biodegradable, it is categorised as Not Persistent since its half-life is substantially less than 60 days (DoEE, 2017).

D. Environmental Distribution

Standard adsorption/desorption studies are not applicable to petroleum UVCB substances. Mackay Level III modelling indicates that category member constituents partition mostly to the sediment and soil compartments rather than air compartment when an equal emission rate (1000 kg/hr) to the air, water, and soil compartment is assumed. When release occurs only to either the air, or soil compartment, constituents are indicated in the modelling to partition largely to the compartment to which they are released. When released to the water compartment, constituents are indicated by the model to partition to either water or sediment (HPVIS). However, based on the member category low solubility, partitioning to sediment would be expected.

E. Bioaccumulation

No experimental studies are available on the substance. Using BCFBAF in EPISuite™, the estimated BCF of a representative substance is 0.893 L/kg based on the Arnot-Gobas model that includes biotransformation and upper trophic. Thus, bioaccumulation is not expected (ECHA). [Kl. score = 2]

IV. HUMAN HEALTH HAZARD ASSESSMENT

The information presented within this Section was derived in part from read-across substances: hydrodesulfurised kerosine (CAS RN 64742-81-0) and undiluted JP-8 jet fuel (CAS No. 8008-20-6).

A. Summary

The substance has low acute toxicity by the oral and dermal route. It is not irritating to the skin and eyes, but it is a skin sensitiser. Aside from minor changes in body weight, no adverse effects were seen in animals given repeated doses by the oral route. The substance is not genotoxic when tested in both *in vitro* and *in vivo* assays. There is no indication that this substance will cause malformations or have an adverse effect on reproduction and development. This information was derived in part from products of similar structure or composition.

B. Toxicokinetics

The studies of the pharmacokinetics (i.e., absorption, distribution, metabolism and excretion) of kerosine are scarce. There are some *in vitro* and *in vivo* studies available on jet fuels. However, because jet fuel is a complex mixture, these studies use certain constituents of jet fuels as marker compounds to describe the total jet fuel's pharmacokinetics. There are more data available for a number of kerosine constituents, and these can be used as a basis for understanding the pharmacokinetics of kerosine as a whole. There are three ways in which humans are exposed to kerosine: by inhalation; ingestion; and dermal contact. Due to the relatively low volatility of kerosine and jet fuels, dermal exposure can be a more important route of exposure than exposure via inhalation. During many operations involving aircraft fuel tanks there is a significant potential for dermal exposure. Ingestion occurs primarily as a consequence of incidental ingestion.

Groups of five male C3H mice were dosed with a single dermal application of 15 or 60 µL kerosine (30% straight-run hydrotreated and 70% hydrocracked kerosine) spiked with radiolabelled naphthalene or tetradecane, and sacrificed after 96 h exposure (Mobil, 1994). Another group of five male C3H mice were exposed by air to the same compounds and doses in a metabolism cage to determine passive inhalation. The results of the dermal exposure show that 5% of the labelled tetradecane and 15% of the labelled naphthalene were absorbed over 96 h. The inhalation experiments showed that 2.8% of the labelled naphthalene was bioavailable. Comparison of these data with a similar dataset obtained with a 25% concentration of the test compounds diluted in mineral oil, revealed that dilution did not affect the absorption of the test compound.

Four groups of eight male Sprague-Dawley rats were exposed to 1, 4, 8, or 16 mL kerosine through the abdominal skin for 2 h at a skin area of 4, 8, 16 or 64 cm2, respectively (Tsujino et al., 2003). Before, during and after the experiment, blood samples were taken and analysed for trimethylbenzenes and aliphatic hydrocarbons. Trimethylbenzenes were detectable in blood within 5-20 min and showed a dose dependent absorption. High concentrations of aliphatic hydrocarbons were detected in the exposed skin as compared to the blood concentration. The aliphatic hydrocarbon levels were dependent on the amount of kerosine exposed per unit area.

The systemic distribution of kerosine components in the blood and tissues of rats following *in vitro* dermal exposures was investigated, using trimethylbenzenes and aliphatic hydrocarbons (C9-C16) as biomarkers (Tsujinoet al., 2002). The trimethylbenzenes were absorbed through the skin and detected in blood and tissues to a greater extent as compared to the aliphatics. The data indicate that kerosine components are absorbed percutaneously and distributed to the various organs via the blood circulation. Distribution of trimethylbenzenes in blood and tissues following dermal exposure

is (at decreasing concentrations): kidney > blood > liver > adipose > brain > spleen > lung = muscle. Distribution of aliphatics in blood and tissues following dermal exposure is (at decreasing concentrations): blood > adipose > muscle > lung > liver > kidney > spleen > brain.

The inhalation studies demonstrate that the volatile kerosine constituents are well absorbed (31 – 54%) and are distributed mainly in the fat tissue. Aromatics were metabolised at a higher rate than naphthenes, n-alkanes, isoalkanes and 1-alkenes. Dermal application of kerosine or jet fuel generally shows that the aromatics and aliphatics are well absorbed into the skin. Subsequently, the aromatics penetrate the skin at a higher rate than the alkanes. SKINPERM calculations indicate that although skin permeation rates of alkanes, naphthenes and aromatics are more or less comparable, the latency times of alkanes are longer than the latency times of naphthenes and aromatics. After absorption, the kerosine constituents are distributed via the blood circulation to the fat tissue and various organs. Studies with oral exposure to kerosine indicate that gastrointestinal absorption of kerosine is slow and incomplete, resulting in low bioavailability.

C. Acute Toxicity

Kerosines are of low acute toxicity, with an oral LD50 greater than 5,000 mg/kg (rat), a dermal LD50 greater than 2,000 mg/kg (rabbit), and an inhalation LC50 greater than 5.28 mg/L (rat). The most important effects in animals following very high oral doses were slight irritation of the stomach and the gastrointestinal tract. The only adverse effects observed in acute inhalation studies were decreased activity and breathing frequency at very high doses. Dermal application of kerosine did not lead to acute toxic systemic effects. Clinical effects observed were related to dermal irritation rather than to systemic toxicity. The acute toxicity of kerosine is not classified by EU CLP Regulation (EC No. 1272/2008).

Oral

In the key acute oral toxicity study (Klimisch score=1; ARCO, 1992a), groups of fasted (5 per sex), young adult, Sprague Dawley rats were given a single oral dose of undiluted thermocracked kerosine at a dose of 5,000 mg/kg bw and observed for 14 days. There were no treatment related mortalities. All of the study animals exhibited one or more of the following clinical signs: nasal discharge, ocular discharge, abnormal stools, lethargy, stained coat, and alopecia. All animals gained weight during study period. At necropsy, one of the ten animals exhibited visual lesions, the remaining nine showed signs of alopecia in the inguinal and/or perineal regions. The oral LD50 was determined to be greater than 5000 mg/kg in males and females.

In supporting studies conducted on kerosine substances, rats were administered single oral gavage doses of the test substance. The results supported an oral LD50 of > 5,000 mg/kg in males and females.

Inhalation

In the key acute inhalation toxicity study (Klimisch score = 1; API, 1987a), groups of Sprague-Dawley rats, five males and five females, were exposed by inhalation route to straight-run kerosine for 4 hours to their whole body at a single dose of 5.28 mg/L (vapour, analytical). All except one animal had normal growth rates throughout the study. The one exception on day 8 had a body weight less than its starting body weight but by the end of the study normal growth had resumed. All animals exhibited decreased activity during the exposure. Otherwise, there were no treatment-related clinical signs of toxicity. No macroscopic lesions were observed in any animal at post-mortem and no microscopic changes were observed in any lung section examined. The LC50 was greater than 5.28 mg/L.

In supporting studies conducted on kerosine substances, rats were administered single doses of the test substance via inhalation. The LC50s as measured based on mortality and systemic effects do not indicate classification of kerosine as an acute inhalation toxicant. One supporting study on deodorised kerosine showed a lack of systemic effects after repeated exposure to rats (6 hours each day for 4 days) and resulted in an LC50 of > 7.5 mg/L (Carpenter et al., 1976). Another supporting study on deodorised kerosine showed a lack of systemic effects after a single 6-hour exposure to cats and resulted in an LC50 of > 6.4 mg/L (Carpenter et al., 1976).

Dermal

In the key acute dermal toxicity study (Klimisch score=1; ARCO, 1992g), groups of young adult New Zealand White rabbits, five males and five females, were dermally exposed to undiluted thermocracked kerosine for 24 hours to 10% of their body surface area at a dose of 2,000 mg/kg. Animals were then observed for 14 days. There were no mortalities and all animals gained weight during the study. All of the animals exhibited one or more of the following clinical signs during the observation period: dermal irritation (erythema, oedema, eschar, fissuring and/or dried skin) and/or abnormal stools. Apart from skin irritation, there were no other abnormalities noted at necropsy. The dermal LD50 was determined to be greater than 2,000 mg/kg in both males and females.

In supporting studies conducted on kerosine substances, rabbits were administered single dermal doses of the test substance, and results supported a dermal LD50 of > 2,000 mg/kg in males and females.

D. Irritation

Skin

In the key study, young adult rabbits (6 females) were dermally exposed (occlusive coverage) to 0.5 mL of undiluted kerosine/heating oil for 24 hours on both intact and abraded skin sites. Each of the test sites was evaluated for skin responses for 9 days post-exposure and was scored using the Draize scale. The mean erythema score from 24 to 72 hours was 3.46/4 while the mean oedema score from 24 to 72 hours was 2.33/4. While this protocol deviates from current guidelines that state exposure should be semi-occlusive over 4 hours, and to intact skin only, this study is included as key to show the irritating nature of kerosine products.

In another guideline study conducted according to GLP and in accordance with current guidelines, young adult New Zealand White rabbits (3 per sex) were dermally exposed (semi-occlusive coverage) to 0.5 mL of undiluted odourless kerosine, for 4 hours. Animals were observed for seven days after exposure. Irritation was scored based on the Draize method (1959). The mean erythema score from 24 to 72 hours was 0.17/4 while the mean oedema score from 24 to 72 hours was 0/4.

Additional supporting studies are provided on straight run kerosine, odourless kerosine, hydrocracked kerosine, hydrodesulfurised kerosine, Jet Fuel A, Jet Fuel A1, JP-5, and Cherry Point Jet Fuel A. Most of the studies are valid in their methodology, but they differ from the current OECD guidelines in that animals were exposed under occluded conditions for 24 hours instead of semi-occluded conditions for 4 hours. Considering the conditions of the test, results must be interpreted carefully for the purposes of classification and labelling. The mean scores for erythema and oedema have been assessed against the deviations and provided the test would be conducted under standard conditions, the overall weight of evidence indicates that kerosines are irritating to skin. Kerosines are classified as irritating to the skin according to criteria in EU CLP Regulation (EC No. 1272/2008).

Effects on skin irritation/corrosion: irritating

Eyes

Several well-controlled (GLP) animal experiments performed on a variety of kerosines indicate that none of the kerosines and jet fuels tested were more than slightly irritating to the eyes. In addition, a number of short reports on eye irritation studies on JP-5 and JP-8 show no eye irritation whatsoever in rabbits (6 unwashed eyes; 3 washed eyes): all scores 0.0 for up to 7 days (end of the study). None of the hazard assessments of kerosine and jet fuel constituents have resulted in classification for eye irritation.

In the key study selected for primary eye irritation, 0.1mL of undiluted thermocracked kerosine was instilled into the conjunctival sac of the right eye of three female young adult New Zealand White rabbits and observed through 72 hours. Irritation was scored according to the Draize method (1959). There was no evidence of damage to the cornea or iris for all animals over all scoring periods. Mild conjunctivae indicators such as redness, chemosis, and discharge were evident at the one-hour scoring interval, but not at any of the other scoring intervals. Fluorescein staining scores were zero for all study animals over all scoring periods.

The average irritation score was 0.0 for the cornea, iris and conjunctivae.

Based on the evidence, kerosine is not an eye irritant.

E. Sensitisation

In animal assays for skin sensitisation such as the Magnusson-Kligman GPMT and the Buehler assay, kerosines and jet fuels did not trigger a positive response.

In the key dermal sensitisation study (Klimisch score=1; ARCO, 1992q), thermocracked kerosine in mineral oil was tested on male young adult Pig/Hartley guinea pigs using a modified Buehler technique. During the challenge phase, a second exposure of a 1:4 dilution of thermocracked kerosine to induced test animals did not yield higher response grades, severity, or incidence than those associated with the naive challenge control group exposed to thermocracked kerosine. During the challenge phase, exposure of 0.2% DNCB to induction positive control animals elicited significantly higher response grades, severity indices, and incidence over the naive DNCB challenge control group. The vehicle irritation control group was free of dermal irritation during the challenge phase. Therefore, under the conditions of this study, thermocracked kerosine is not considered a delayed contact sensitiser while DNCB induced an appropriate positive response.

Based on test data, there was no evidence of skin sensitisation; therefore, kerosine is not classified for skin sensitisation according to EU CLP Regulation (EC No. 1272/2008)

F. Repeated Dose Toxicity

Oral

In the key oral subchronic study (Klimisch score=1; Mattie et al., 2000), male rats were treated for 70 to 90 days with 0 (1mL of distilled water), 750, 1,500, or 3,000 mg/kg/day of undiluted JP-8 jet fuel, then mated to untreated females (one female at a time). Males were gavaged throughout the cohabitation period and were returned to their individual cage after successful mating. In the second part of the study, female rats were administered the test compound at doses of 0 (1mL of distilled water), 375, 750, or 1,500 mg/kg/day undiluted JP-8 jet fuel for 90-day prior to mating, through

mating, gestation, delivery, and lactation for a total of 21 week. During mating, they were housed with untreated males.

There were no effects on clinical signs or mortality in either sex. Haematology, clinical chemistry, and urinalysis were measured only in females without any effects noted. Body weights in male rats were decreased in a dose-dependent manner and was likely related to nephropathy, which is specific in male rats treated with hydrocarbons, and not relevant for human exposure. In females, body weight was only significantly reduced in the high-dose group. Absolute and relative liver weights were increased in mid- and high-dose females but were not likely biologically significant due to the lack of changes in clinical chemistry or histopathology in the liver. The test compound caused perianal dermatitis (high-dose only) and stomach hyperplasia (mid- and high-dose) in the female rats. There was a dose-related decrease in pup weight that was significant in the 750 mg/kg/day group on postnatal day 4 only and in the 1,500 mg/kg/day group from postnatal day 4 through postnatal day 21 but had recovered by postnatal day 90. There were no treatment-related effects on reproduction or sperm parameters in males. There were no effects on reproduction, gestation, or litter size in females.

The study low observed adverse effect level (LOAEL) for systemic effects is 1,500 mg/kg/day and the no observed adverse effects level (NOAEL) for systemic effects is 750 mg/kg/day, based on reduced body weight in dams and in pups. The LOAEL for adult male rats exposed to JP-8 orally was 750 mg/kg/day due to changes in clinical pathology, body weight, organ weights and the same irritation seen in female rats. The decrease in male rat bodyweight is very likely due to the male rat-specific nephropathy and is therefore not considered for the derivation of the oral NOAEL. The reproduction NOAEL was 3,000 and 1,500 mg/kg/day in males and females, respectively.

Inhalation

In a key subchronic inhalation toxicity study (Klimisch score=1; Mattie et al., 1991), JP-8 jet fuel was administered to 95 male Fisher 344 rats, 75 female Fischer 344 rats, and 100 male and female C57BL/6 mice by dynamic whole body vapour exposure at concentrations of 0, 500 or 1,000 mg/m3(0, 0.5, or 1.0 mg/L) as a vapour for 24 hours per day, 7 days/week for a total of 90 days. The male rats developed hydrocarbon-induced nephropathy at both treatment concentrations. Male rats had decreased body weight and decreased absolute and relative kidney weight at both treatment concentrations. Female rats were unaffected by treatment. In mice, no significant clinical signs of toxicity were noted that differentiated the groups that were treatment-related. The no observed adverse effect concentration (NOAEC) for male rats is difficult to establish, since potential adverse effects may be masked by male rat specific hydrocarbon nephropathy. However, based on the hydrocarbon-induced nephropathy and reduced body weights and increased kidney weights, the lowest observed adverse effects concentration (LOAEC) in male rats is 500 mg/m^3. The LOEC for male mice is also 500 mg/m^3, but it was not treatment related. The NOAEC for female rats and mice is greater than or equal to 1,000 mg/m3. This was the highest dose tested in the study.

In a subacute inhalation toxicity study (Klimisch score = 1; API, 1986), hydrodesulfurised kerosine vapour was administered to 20 Sprague-Dawley rats/sex/concentration by dynamic whole-body exposure at a concentration of 24 mg/m^3 (0.024 mg/L) for 6 hours per day, 5 days/week for 4 weeks. There were no compound related effects in mortality, clinical signs, body weight, haematology, clinical chemistry, organ weights, or gross and histologic pathology. Therefore, the NOAEC is greater than or equal to 24 mg/m^3. This was the highest dose tested in the study.

Dermal

In a key sub-chronic dermal study hydrodesulfurised kerosine was applied at concentrations of 20, 40 or 60% (v/v) at a rate of 1 ml/kg/day to the shorn intrascapular region of groups of 12 individually housed male and female, Sprague-Dawley rats (aged 7-9 weeks). This was equivalent to doses of test material of 165, 330 or 495 mg/kg/day. Dosing was continued for five days a week for 13 weeks. In addition, a group of 12 male and 12 female rats of similar age were administered mineral oil at a dose rate of 1 ml/kg/day; these animals served as vehicle controls. 12 rats/sex/group each in the vehicle controls and high dose group were maintained for a 4-week recovery period. Ingestion of the test material was prevented by using a collar and removal of any residual test or control material from the skin. Animals were observed for clinical signs prior to dosing and 1, 6 and 24 hours after the first dose. Subsequently, observations were made prior to each dose being applied.

Prior to the administration of each dose, the treated skin site was evaluated for dermal irritation using the Draize scoring method. Body weights were recorded prior to the first dose and weekly thereafter. An ophthalmic examination was conducted on each rat prior to application of the first dose and again prior to sacrifice at the end of the study. During the week prior to the first dose, each rat was subjected to a functional observation battery (FOB). The FOB was conducted again 1, 6 and 24 hours after the first dose and at 7 and 14 days. During the study, the FOB, motor activity and startle response testing was conducted on all rats at weeks 4, 8 and 12. At week 14 blood samples were collected from 12 animals/sex/group. Full necropsies were performed at week 14 on 6 rats/sex/group and at week 18 on the recovery rats (vehicle and high dose groups). Each full necropsy included an examination of the external surface of the body and its contents. The remaining six rats of each group were anesthetized with an intraperitoneal injection of Pentothal and transcardially perfused in-situ using 10% neutral-buffered formalin and given a limited necropsy. For these rats, no organs were weighed, and specific tissues were also collected for subsequent microscopic testing.

There was a generally dose-related increase in the incidence and severity of various skin conditions at the treated site. Males seemed to be more sensitive than females as they were affected at all doses, however, the effects indicated very little irritation. Recovery group animals revealed complete recovery in the females and minimal hyperkeratosis in the high dose group males. At necropsy no substance-related observations were made for males in any group. In the females there was a suggestion of a possible treatment-related effect which occurred in 7 rats across all groups and consisted of skin crusts or ulceration at the site of application of test material. Haematological and serum clinical parameters were unaffected by treatment.

All animals survived until scheduled termination. There were no test substance-related effects on survival, clinical observations (apart from skin irritation), neurobehavioral signs or ophthalmological findings. The NOEL for systemic toxicity was >495 mg/kg/day. The LOEL for slight dermal irritation was 165 mg/kg/day, equivalent to ~ 1 mg/cm^2.

G. Genotoxicity

In vitro Gene Mutation in Mammalian Cells

Key in vitro gene mutation studies in mammalian cells were identified. In a study by the American Petroleum Institute (API, 1984b), cultures of mouse lymphoma cells were exposed to hydrodesulfurised kerosine with or without metabolic activation by Aroclor 1254-induced rat liver S9 fraction. Under non-activation conditions the test material induced a good range of toxicities for evaluation (relative growths ranged from 2.8% to 65.3%). None of the assays induced a mutant

frequency that exceeded the minimum criterion (40.8 x 10-6). The test material was not mutagenic under non-activation conditions. In the presence of metabolic activation, a wide range of toxicities was induced (6.1 to 107.9% relative growths). The minimum criterion mutant frequency of 69.0 x 10-6 was not exceeded. The test material was therefore considered non mutagenic under activation conditions. In a study by API (1977) (Klimisch score = 1), mouse lymphoma L5178Y cells were exposed to straight-run kerosine in acetone vehicle at concentrations ranging from 0.04 to 0.065 µL/mL (with metabolic activation) or 0.006 to 0.13 µL/mL (without activation). There was no evidence that straight-run kerosine induced mutant colonies over background levels.

In vitro Cytogenicity in Mammalian Cells

Hydrodesulfurised kerosine was tested in the sister chromatid exchange assay using Chinese hamster ovary cells (API, 1988a). The assay was conducted with Aroclor-induced rat liver S-9 activation system. A small but statistically significant increase in the frequency of sister chromatid exchanges was observed at the high and low concentrations with metabolic activation. These increases appeared to be random and of no biological significance. There were no significant increases observed at any concentration in the absence of metabolic activation. Under the conditions of the study, hydrodesulfurised kerosine is negative in the sister chromatid exchange assay with Chinese hamster ovary cells.

In vivo Cytogenicity

Based on weight of evidence kerosine substances were found to be non-mutagenic through cytogenic investigations.

In six in vivo bone marrow cytogenetic studies in the rat, there were no indications of chromosomal aberrations. Although an in vivo Sister Chromatid Exchange study in the mouse gave positive findings in the male group (but not in the females) the positive findings in the males were associated with signs of toxicity (lethargy and weight loss) at the very high-top dose used in the study (4,000 mg/kg), both on the day of the administration of the kerosine and the day after (when they were sacrificed).

In a rat bone marrow micronucleus assay (API, 1985c, Klimisch score = 1), straight run kerosine (CAS RN 800-20-6) was administered to Sprague Dawley rats. Straight run kerosine was not considered to induce chromosomal aberrations in bone marrow cells of rats. In another bone marrow micronucleus assay (API, 1984b, Klimisch score = 1), hydrodesulfurised kerosine (CAS RN 64742-81-0) was administered to rats. No clinical signs of toxicity were exhibited by the rats, and there was no significant increase in frequency of micronucleated polychromatic erythrocytes in bone marrow as compared to control. In a study by API (1977) (Klimisch score = 1), straight-run kerosine (CAS RN 8008-20-6) was administered to 45 male rats. No significant increase in the frequency of micronucleated polychromatic erythrocytes was observed.

In vivo Gene Mutation

Key in vivo gene mutation studies were identified. In a sperm cell dominant lethal mutation assay (API, 1980b, Klimisch score = 1), Jet Fuel A was administered via inhalation route to male mice at concentrations of 100 or 400 ppm for a 6-hour exposure period, 5 days per week for 8 weeks. Males were mated with females, and the uteri of pregnant females were examined for living and dead implants. Jet Fuel A did not increase the incidence of post-implantation deaths. In another study by API (1973) (Klimisch score = 1), deodorised kerosine was administered subcutaneously to 10 male Swiss-Webster mice in corn oil vehicle or intraperitoneally to 10 Long-Evans rats undiluted at a dose of 1.0 mL/kg. Males were mated with females, and no pattern of decreased pregnancy rate or increased embryo loss was observed in the females.

H. Carcinogenicity

Kerosine is not carcinogenic when animals are exposed via the oral or inhalation route (ECHA).

Male mice were administered dermally 37.5µL of jet fuel A to the shaved backs of 50 mice per dose, twice a week for 2 years or intermittently so that application of the jet fuel was suspended when dermal irritation was noted in 20% of the group and was resumed when irritation resolved in all but 20% of the affected animals. There was a significant increase in tumours at the application site with continuous treatment compared to the control (0% versus 44%), but not with intermittent treatment (0% versus 2%). With continuous treatment, there was a treatment-related increase in dermal tumour incidence compared to controls. However, stopping treatment during dermal irritation nearly eliminated the carcinogenic effect (ECHA) [Kl. Score = 1].

Male and female mice were administered dermally 25 mg of petroleum-derived jet fuel A to the shaved backs of 25 mice, three times a week for 105 weeks. Due to high mortality, jet fuel A application was discontinued during week 62, but surviving animals were observed until study termination. There was a significant increase in tumours at the application site (0%, 26%, and 26% in the controls, JP-4, and jet A groups). The majority of the tumours were squamous cell carcinomas or fibrosarcomas. At the doses tested, there was a treatment-related increase in dermal tumour incidence when compared to controls. The results of the study indicate that there was a treatment-related increase in dermal tumour incidence when compared to controls, therefore it can be concluded that Jet fuel A has a carcinogenic effect on mice at 25 mg dosage (ECHA) [Kl. Score = 1].

Straight-run kerosine (CAS RN 8008-20-6) and hydrodesulfurised kerosine (CAS RN 64742-81-0) were tested in standard 2-year bioassays in mice. The animals, 50 per group, were treated twice weekly with 50 µl straight-run kerosine or with hydrodesulfurised kerosine. It was concluded that both straight-run and hydrodesulfurised kerosine were moderate skin carcinogens (ECHA) [Kl. Score = 2].

In the key carcinogenicity study from NTP, JP-5 navy fuel in acetone was administered to 50 mice dermally at dose levels of 0 (vehicle control), 250, or 500 mg/kg bw/day for up to 103 weeks. There was a significant decrease in survival in females at both treatment doses. Remaining high-dose females were sacrificed at week 90. There was no treatment-related effect on survival in male mice. The LOAEL is 250 mg/kg/day, based on dermatitis and decreased survival in females. No NOAEL can be determined. At the doses tested, there was not a treatment-related increase in tumour incidence when compared to controls (ECHA) [Kl. Score = 1].

The potential influence of skin irritation on tumour development in long-term mouse skin painting studies was investigated as part of the CONCAWE middle distillates programme. The study included straight run hydrotreated kerosine (MD3). The test material was applied to the shorn skin of three groups of 50 male mice for 104 weeks. For the straight run hydrotreated kerosine, skin tumours only developed in the group of animals in which substantial skin irritation occurred during the study. Since no polycyclic aromatic compounds were detected in the straight run kerosine it is concluded that the occurrence of tumours is likely to have been caused by a non-genotoxic mechanism. This conclusion is consistent with reports by others that lighter middle distillates are tumour promotors but not initiators and furthermore that skin irritation plays an important role in skin tumour development. These tumours are probably the consequence of a continuous cycle of cell damage and repair caused by chronic skin irritation. The conclusions gained from this study can be applied to other carcinogenicity studies on kerosines, and they show that tumours are noted in the presence of repeated dermal irritation, and that kerosines lack a genotoxic mechanism of carcinogenicity (ECHA) [Kl. Score = 1].

I. Reproductive Toxicity

There are no specific reproductive toxicity data for the substance but there are data available with ECHA as migrated information which is read-across based on grouping of substances (category approach).

An OECD Guideline 415 One-Generation Reproduction Toxicity study was conducted. This was a reproductive study performed in two parts. In the first part, males were treated for 70 to 90 days with 0 (1mL of distilled water), 750, 1,500, or 3,000 mg/kg/day of undiluted JP-8 jet fuel, then mated to untreated females (one female at a time). In the second part of the study, female rats were administered the test compound at doses of 0 (1mL of distilled water), 375, 750, or 1,500 mg/kg/day undiluted JP-8 jet fuel for 90 -day prior to mating, through mating, gestation, delivery, and lactation for a total of 21 weeks.

There were no changes in clinical signs or mortality in parental animals. Body weights in male rats were decreased in a dose-dependent manner. Terminal body weights were approximately 545 grams, 520 grams, 475 grams, and 315 grams in the control, 750, 1,500, and 3,000 mg/kg/day, respectively. In females, body weight was only significantly reduced in the high-dose group, but the differences were not significant at terminal sacrifice. The body weight in females at 20 weeks (1 week before sacrifice) was approximately 400 grams, 385 grams, 382 grams, and 335 grams in the control, 375, 750, and 1,500 mg/kg/day, respectively. Hematology was not measured in the males and no effects were noted in the females. Clinical chemistry was not measured in the males and no effects were noted in the females. Urinalysis was not measured in the males and no effects were noted in the females. Absolute and relative liver weights were increased in mid- and high-dose females but were not accompanied by any histological findings. The test compound caused perianal dermatitis (high-dose only) and stomach hyperplasia (mid- and high-dose) in the female rats.

There were no treatment-related effects on reproduction or sperm parameters in males. There were no effects on reproduction, gestation, or litter size in females. The lowest NOAEL based on parental body weight was determined to be 750 mg/kg/day.

The F1 generation was not examined for clinical signs though no mention would suggest no significant signs were noted. No mortality was observed. There were no effects on offspring viability. However, there was a dose-related decrease in pup weight that was significant in the 750 mg/kg/day group on postnatal day 4 only and in the 1,500 mg/kg/day group from postnatal day 4 through postnatal day 21. The 1,500 mg/kg/day group recovered by postnatal day 90. The NOAEL based on offspring body weight was determined to be 750 mg/kg/day.

J. Reproductive Toxicity/Developmental Toxicity

In a developmental toxicity study, undiluted JP-8 jet fuel was administered to 30 Sprague-Dawley (Crl:CD) rats/dose by gavage at various volumes to achieve dose levels of 0 (sterile water), 500, 1,000, 1,500, or 2,000 mg/kg bw/day from days 6 through 15 of gestation.

There was a significant decrease in maternal weight gain with doses of 1,000 mg/kg/day or greater. Maternal necropsy weight was significantly different than the control in the 1,500 and 2,000 mg/kg/day groups. There were no apparent clinical signs of toxicity. Reproductive endpoints were not assessed in this study because females were pregnant prior to treatment and did not deliver, so only developmental endpoints can be assessed. Thirteen females (one 1,000 mg/kg/day; three 1,500 mg/kg/day, and nine 2,000 mg/kg/day) were found dead. Although there appears to be a dose-dependent increase in the mortality, necropsy found the cause of death to be related to the

presence of the test compound in the lungs indicating dosing into the lungs instead of the gastrointestinal tract. The maternal LOAEL is 1,000 mg/kg/day, based on reduced body weight gain. The maternal NOAEL is 500 mg/kg/day.

There was a significant decrease in foetal weight in both male and female foetuses dosed with 1,500 and 2,000 mg/kg/day. The test compound did not significantly increase the incidence of malformations or variations compared to the control nor was the sex ratio altered. The developmental LOAEL is 1,500 mg/kg/day, based on reduced foetal weight. The developmental NOAEL is 1,000 mg/kg/day. It can be concluded that the test substance is not toxic to development.

This study received a Klimisch score of 1 and is classified as reliable without restrictions because it was carried out in a method equivalent/similar to OECD TG 414.

V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES

The toxicological reference values developed for the substance follow the methodology discussed in enHealth (2012). The approach used to develop drinking water guidance values is described in the Australian Drinking Water Guidelines (ADWG, 2011).

Non-Cancer

The NOAEL for reduced maternal body weight is 500 mg/kg/day, based on reduced body weight in dams and in pups treated under a repeat dose regimen. The NOAEL from this study will be used for determining the oral Reference dose (RfD) and the drinking water guidance value.

Oral Reference Dose (oral RfD)

Oral RfD = NOAEL / (UF_A x UF_H x UF_L x UF_{Sub} x UF_D)

Where:
UF_A (interspecies variability) = 10
UF_H (intraspecies variability) = 10
UF_L (LOAEL to NOAEL) = 1
UF_{Sub} (subchronic to chronic) = 10
UF_D (database uncertainty) = 1

Oral RfD = 500 /(10 x 10 x 1 x 10 x 1) = 500/1,000 = 0.5 mg/kg-day

Drinking water guidance value

Drinking water guidance value = (animal dose) x (human weight) x (proportion of intake from water) / (volume of water consumed) x (safety factor)

Using the oral RfD,

Drinking water guidance value = (oral RfD) x (human weight) x (proportion of water consumed) / (volume of water consumed)

where:
Human weight = 70 kg (ADWG, 2011)

Proportion of water consumed = 10% (ADWG, 2011)
Volume of water consumed = 2L (ADWG, 2011)

Drinking water guidance value = (0.500 x 70 x 0.1)/2 = 1.8 mg/L

Cancer

There are no carcinogenicity studies on the substance or related hydrocarbons. Thus, a cancer reference value was not derived.

VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES

The substance does not exhibit the following physico-chemical properties:

- Explosivity
- Oxidising potential

The substance is classified as a "Flammable Liquid Category 3"

VII. ENVIRONMENTAL HAZARD ASSESSMENT

A. Summary

The substance is of low acute concern to aquatic organisms.

B. Aquatic Toxicity

Acute Studies

Table 2 lists the results of acute aquatic toxicity studies on hydrotreated light petroleum distillate surrogates.

Table 2: Acute Aquatic Toxicity Studies on Hydrotreated Light Petroleum Distillate Surrogate[2]

Test Species	Endpoint	Results (mg/L)	Klimisch Score	Reference
Oncorhynchus mykiss	96-hour LL_{50}	2-5	1	ECHA
Daphnia magna	48-hour EL_{50}	1.4	1	ECHA
Raphidocelis subcapitata	72-hour EC_{50}	<1-3 (average of 2)	1	ECHA
Selenastrum capricornutum	72-hour EC_{50}	3.7	2	ECHA

Chronic Studies

There are no long-term toxicity studies on fish. A single long-term study on invertebrates is discussed below.

In a 21-day semi-static chronic reproductive toxicity test (OECD 211; KS = 1) on *Daphnia magna*, hydrodesulfurised kerosine was evaluated using water accommodated fraction methodology. The

[2] Hydrodesulfurised Kerosine (CAS RN 64742-81-0)

actual loading rates were 0 (control), 0.08, 0.19, 0.48, 1.2 and 3.0 mg/L. Under the conditions of this test, the 21-day chronic reproductive NOEL for kerosine is 0.48 mg/L. The LOEL is 1.2 mg/L. The EL_{50} based on reproduction is 0.89 mg/L (ECHA).

C. Terrestrial Toxicity

There are no terrestrial toxicity studies for this substance.

D. Calculation of PNEC

The PNEC calculations for hydrotreated light petroleum distillate follow the methodology discussed in DEWHA (2009).

PNEC Water

Experimental results are available from acute tests on three trophic levels. There is one long term study on a single trophic level organism, *D. magna*.

On the basis that the data consists of short-term studies from three trophic levels and a long-term study from one trophic level, an assessment factor of 100 is applied to the 21-day chronic reproductive NOEL for kerosine of 0.48 mg/L. The $PNEC_{aquatic}$ is 0.005 mg/L.

PNEC Sediment

There are no toxicity data for sediment-dwelling organisms. Therefore, the $PNEC_{sed}$ was calculated using the equilibrium partitioning method. The $PNEC_{sed}$ is 0.36 mg/kg sediment wet weight.

The calculations are as follows:

$PNEC_{sed} = (K_{sed\text{-}water}/BD_{sed}) \times 1000 \times PNEC_{water}$
$= (93.4/1280) \times 1000 \times 0.005$
$= 0.36$ mg/kg

Where:
$K_{sed\text{-}water}$ = suspended matter-water partition coefficient (m^3/m^3) [calculated]
BD_{sed} = bulk density of sediment (kg/m^3) = 1,280 [default]

$K_{sed\text{-}water} = 0.8 + [0.2 \times Kp_{sed}/1000 \times BD_{solid}]$
$= 0.8 + [0.2 \times 193/1000 \times 2400]$
$= 93.4\ m^3/m^3$

And:
Kp_{sed} = solid-water partition coefficient (L/kg).[calculated]
BD_{solid} = bulk density of the solid phase (kg/m^3) = 2,400 [default]

$Kp_{sed} = K_{oc} \times f_{oc}$
$= 4818 \times 0.04$
$= 193$ L/kg

Where:
K_{oc} = organic carbon normalized distribution coefficient (L/kg). The K_{oc} for hydrodesulfurised kerosine calculated from EPISUITE™ using the MCI is 4818 L/kg.
F_{oc} = fraction of organic carbon in sediment = 0.04 [default].

PNEC Soil

There are no experimental toxicity testing results available for the substance or its noted surrogates. Therefore, the $PNEC_{soil}$ was calculated using the equilibrium partitioning method. The $PNEC_{soil}$ is 0.32 mg/kg soil dry weight.

The calculations are as follows:

$PNEC_{soil} = (Kp_{soil}/BD_{soil}) \times 1000 \times PNEC_{water}$
$= (96.4/1500) \times 1000 \times 0.005$
$= 0.32$ mg/kg

Where:
Kp_{soil} = soil-water partition coefficient (m3/m3)
BD_{soil} = bulk density of soil (kg/m3) = 1,500 [default]

$Kp_{soil} = K_{oc} \times f_{oc}$
$= 4818 \times 0.02$
$= 96.4\ m^3/m^3$

And:
K_{oc} = organic carbon normalised distribution coefficient (L/kg). The K_{oc} for hydrodesulfurised kerosine calculated from EPISUITE™ using the MCI is 4818 L/kg.
F_{oc} = fraction of organic carbon in soil = 0.02 [default].

VIII. PERSISTENCE, BIOACCUMULATION AND TOXICITY (PBT) ASSESSMENT

The methodology for the Persistent, Bioaccumulative and Toxic (PBT) substances assessment is based on the Australian and EU REACH Criteria methodology (DEWHA, 2009; ECHA, 2017).

The substance or similar compounds are readily biodegradable; thus they do not meet the screening criteria for persistence.

Based on the estimated BCF values, derived from EPISuite estimates (BCF = 3.162 L/kg wet-weight) the substance does not meet the screening criteria for bioaccumulation.

The NOEC values from acute and chronic aquatic toxicity studies on the substance indicate it does not meet the screening criteria for toxicity.

Therefore, hydrotreated light petroleum distillates are not PBT substances.

IX. CLASSIFICATION AND LABELLING

A. Classification

Asp. Tox. 1

B. Labelling

Danger

C. Pictogram



X. HANDLING AND SAFETY INFORMATION (OCCUPATIONAL LIMITS AND TRANSPORTATION REQUIREMENTS)

A. First Aid

Eye Contact

Rinse immediately with plenty of running water. If easy to do, remove contact lenses. Get medical attention if symptoms persist.

Skin Contact

Wash with soap and water. Get medical attention if symptoms occur.

Inhalation

Treat symptomatically. Move to fresh air. Get medical attention if symptoms persist.

Ingestion

In case of ingestion, always assume that aspiration has occurred. Do not induce vomiting. Rinse mouth with water and then drink plenty of water. Never give anything by mouth to an unconscious person. Seek medical attention.

B. Fire Fighting Information

Extinguishing Media

Foam (Specifically trained personnel only)- Water fog (Specifically trained personnel only)- Dry chemical powder- Carbon dioxide- Other inert gases (subject to regulations)- Sand or earth

Specific Exposure Hazards

None known.

Special Protective Equipment for Firefighters

Self-contained breathing apparatus and full protective clothing must be worn in case of fire.

C. Accidental Release Measures

Personal Precautions

Wear appropriate personal protective equipment.

Environmental Precautions

Do not release to open drains or surface water. Not regarded as dangerous to the environment.

Steps to be Taken if Material is Released or Spilled

Collect free product with suitable means. Transfer collected product and other contaminated materials to suitable containers for recycle, recovery or safe disposal. Absorb spill with inert absorbent material, then place in a container for chemical waste.

D. Storage and Handling

General Handling

Ensure that all relevant regulations regarding explosive atmospheres, and handling and storage facilities of flammable products, are followed.

Other Handling Precautions

Wash hands thoroughly after handling.

Storage

Keep containers tightly closed and properly labelled. Protect from the sunlight5.3. Light hydrocarbon vapours can build up in the headspace of containers. These can cause flammability / explosion hazard.

E. Exposure Controls / Personal Protection

Occupational Exposure Standards

Workplace Australia has not established an occupational exposure standard for the substance.

Engineering Controls

Good general ventilation should be used.

Personal Protection Equipment

Respiratory Protection:
Respiratory protection is not required.

Hand Protection:
Minimize skin contact.

Skin Protection:
Body protection must be chosen depending on activity and possible exposure.

Eye protection:
Minimize eye contact.

Other Precautions:
Handle in accordance with good industrial hygiene and safety practice. Eyewash fountains and safety showers must be easily accessible.

F. Transport Information

The substance retains UN 1223 transport code is listed as such within the Australian Dangerous Goods (AUS 2018)

XI. DISPOSAL MANAGEMENT

Disposal should be in accordance with all local, state, and federal regulations.

XII. REGULATORY STATUS

Australian AICS Inventory: Listed.

XIII. REFERENCES

ADWG. (2011). National Water Quality Management Strategy. Australian Drinking Water Guidelines, Section 6, Australian Government, National Health and Medical Research Council, Natural Resource Management Ministerial Council. Updated January 2022. Available: https://www.nhmrc.gov.au/about-us/publications/australian-drinking-water-guidelines

AUS (2018). Australian Code for the Transport of Dangerous Goods by Road & Rail Edition 7.6, 2018. Commonwealth of Australia National Transport Commission, Level 3, 600 Bourke Street MELBOURNE, VIC, 3000.

BASF (2012). GPS Safety Summary: Fatty acids, C8-C16, 2-ethylhexyl ester. Available at: http://www.safety-summaries.basf.com/group/corporate/safety-summaries/en/literature-document:/GPS+Safety+Summaries--Fatty+acids+C8+16+2+ethylhexyl+ester-English.pdf.

Bookstaff, R.C., Stuard, S.B., Ward, S.R., Pesik, P.K., and Henwood, S.M. (2004). The safety of ethyl oleate is supported by a 91-day feeding study in rats. Regul. Toxicol. Pharmacol. 39: 202-213.

Department of the Environment, Water, Heritage and the Arts (DEWHA). (2009). Environmental risk assessment guidance manual for industrial chemicals, Department of the Environment, Water, Heritage and the Arts, Commonwealth of Australia. Available: http://www.nepc.gov.au/resource/chemical-risk-assessment-guidance-manuals

Department of the Environment and Energy (DoEE). (2017). Chemical Risk Assessment Guidance Manual: for chemicals associated with coal seam gas extraction, Guidance manual prepared by Hydrobiology and ToxConsult Pty Ltd for the Department of the Environment and Energy, Commonwealth of Australia, Canberra.

ECHA. ECHA REACH database: http://echa.europa.eu/information-on-chemicals/registered-substances

enHealth Human Risk Assessment (HHRA). (2012). Environmental Health Risk Assessment, Guidelines for Assessing Human Health Risks from Environmental Hazards. Office of Health Protection of the Australian Government Department of Health. Available: https://www1.health.gov.au/internet/main/publishing.nsf/Content/health-pubhlth-publicat-environ.htm

European Chemicals Agency (ECHA). (2017). Guidance on Information Requirements and Chemical Safety Assessment, Chapter R11: PBT Assessment, European Chemicals Agency, Helsinki, Finland. Available: https://echa.europa.eu/guidance-documents/guidance-on-information-requirements-and-chemical-safety-assessment

Klimisch, H.J., Andreae, M., and Tillmann, U. (1997). A systematic approach for evaluating the quality of experimental and toxicological and ecotoxicological data. Regul. Toxicol. Pharmacol. 25:1-5.

OECD (2012). SIDS INITIAL ASSESSMENT PROFILE. C9-C14 Aliphatic [≤2% aromatic] Hydrocarbon Solvents Category. CoCAM 3, 16-18 October 2012.

United States Environmental Protection Agency (USEPA) (2017). EPISuite™ v. 4.11, United States Environmental Protection Agency, Office of Pollution Prevention and Toxics and Syracuse Research Corporation. Available at: https://www.epa.gov/tsca-screening-tools/epi-suitetm-estimation-program-interface.

ISOPROPANOL

This dossier on isopropanol presents the most critical studies pertinent to the risk assessment of isopropanol in its use in coal seam or shale gas extraction activities. It does not represent an exhaustive or critical review of all available data. The majority of information presented in this dossier was obtained from the ECHA database that provides information on chemicals that have been registered under the EU REACH (ECHA). Where possible, study quality was evaluated using the Klimisch scoring system (Klimisch et al., 1997).

I. SUBSTANCE IDENTIFICATION

Chemical Name (IUPAC): Propan-2-ol

CAS RN: 67-63-0

Molecular formula: C_3H_8O

Molecular weight: 60.1 g/mol

Synonyms: Isopropanol, isopropyl alcohol, 2-propanol, *sec*-propyl alcohol, dimethylcarbinol

SMILES: CC(C)O

II. PHYSICO-CHEMICAL PROPERTIES

Table 1: Overview of the Physico-Chemical Properties of Isopropanol

Property	Value	Klimisch Score	Reference
Physical state at 20°C and 101.3 kPa	Colourless liquid	2	ECHA
Melting Point	-88.5°C; -89.5°C[1]	2	ECHA
Boiling Point	82.5°C; 82.3°C @ 101.3 kPa	2	ECHA
Density	800 kg/m^3 @ 20°C	2	ECHA
Vapour Pressure	4,400 Pa @ 20°C; 6,002 Pa @ 25°C	2	ECHA
Partition Coefficient (log K_{ow})	0.05 @ 25°C	2	ECHA
Water Solubility	Miscible	2	ECHA
Viscosity	2.038 mPa s @ 25°C	2	ECHA

III. ENVIRONMENTAL FATE PROPERTIES

A. Summary

Isopropanol is readily biodegradable. It is not expected to bioaccumulate. Isopropanol has a low tendency to bind to soil or sediment.

[1] No information on the atmospheric pressure reported.

B. Partitioning

Isopropanol is miscible in water. Volatilisation from water surfaces or moist soil surfaces is expected to be an important fate process based upon this compound's estimated Henry's Law constant of 0.821 Pa m^3/mole. It is also expected to volatilise from dry soil surfaces based upon its vapour pressure (Pub Chem).

C. Biodegradation

Aerobic biodegradation of isopropanol has been shown to occur rapidly under non-acclimated conditions, based on a result of 49% biodegradation from a 5-day BOD test (Bridie et al., 1979). Additional biodegradation data developed using standardised test methods show that isopropanol is readily biodegradable in both freshwater and saltwater media (72 to 78% biodegradation in 20 days) (Price et al., 1974).

If a chemical is found to be readily biodegradable, it is categorised as Not Persistent since its half-life is substantially less than 60 days (DoEE, 2017).

D. Environmental Distribution

No experimental data are available for isopropanol. Using KOCWIN in EPI Suite™ (USEPA, 2017), the estimated K_{oc} value from log K_{ow} is 3.478 L/kg. The estimated K_{oc} value from the molecular connectivity index (MCI) is 1.53 L/kg.

E. Bioaccumulation

Bioconcentration of isopropanol in aquatic organisms is not expected to occur based on a measured log K_{ow} of 0.05 (ECHA). Based on this estimated value, the substance is expected to have very high mobility in soil. If released to water, based on this value and its water solubility, it is also not expected to adsorb to suspended solids and sediment.

Volatilisation from water surfaces is expected with half-lives for a model river and model lake of 86 hours and 29 days, respectively (PubChem).

IV. HUMAN HEALTH HAZARD ASSESSMENT

A. Summary

The acute toxicity of isopropanol is low by the oral, dermal and inhalation routes. At high exposure levels, isopropanol is irritating to the eyes, nose and throat and may cause transient central nervous system depression. It is not a skin sensitiser, but in some individuals, there may be an allergic contact dermatitis due to cross-sensitisation to other alcohols, such as ethanol. Repeated high exposures cause reversible narcotic effects, consistent with other short-chain alcohols. Isopropanol is not genotoxic. Lifetime inhalation studies in rodents showed no carcinogenic effects. The weight-of-evidence indicates that isopropanol is not a reproductive toxicant. In a two-generation reproductive toxicity study, the male mating index was affected by isopropanol exposure; the significance of this effect is, however, unclear. Developmental toxicity can occur at maternally toxic doses; but it is not a teratogen. Isopropanol also does not affect neurobehavioral development.

B. Acute Toxicity

The acute oral LD_{50} of isopropanol has been reported as 4,700 mg/kg, 5,300 mg/kg, 5,500 mg/kg and 5,400 mg/kg in rats; 4,500 mg/kg in mice; and 5,030 mg/kg, 7,800 mg/kg and 7,900 mg/kg in rabbits (ECHA) [KI Score = 2].

The acute dermal LD_{50} in rabbits has been reported to be 12,900 mg/kg (ECHA) [KI Score = 2].

The acute inhalation 8-hour LC_{50} in rats was 19,000 ppm in females and 22,500 ppm in males (ECHA) [KI Score = 2]. Exposure of rats to 16,000 ppm for 8 hours resulted in four deaths out of six animals (ECHA) [KI Score = 2].

In an acute neurotoxicity study, male and female F344 rats were exposed to 0, 500, 1,500, 5,000 or 10,000 ppm isopropanol for 6 hours. A spectrum of behavioural effects indicative of narcosis, defined as a generalised loss of neuromotor and reflex function, was observed in animals of the 10,000 ppm group and to a lesser extent in the 5,000 ppm animals. Recovery from these effects was observed by 24 hours for the 10,000 ppm animals and by 6 hours for the 5,000 ppm animals. A concentration-dependent decrease in motor activity was observed for the 1,500 ppm males and the 5,000 ppm females. The results show that exposure of rats to isopropanol vapour produces transient, concentration-related narcosis and/or central nervous system sedation. The NOAEL for acute neurotoxicity is 500 ppm (ECHA) [KI Score = 2].

C. Irritation

Isopropanol applied to the intact or abraded skin of rabbits and guinea pigs produced negligible irritation. Liquid isopropanol is moderately irritating to the eyes of rabbits. Isopropanol produced little irritation when tested on the skin of six human subjects (ECHA) [KI Score = 1].

D. Sensitisation

There have been reports of isolated cases of dermal irritation and/or skin sensitisation. Except for three case reports, the positive reactions were observed on patch testing patients with contact dermatitis due to ethanol. These patients also had a positive reaction to ethanol.

E. Repeat Dose Toxicity

Oral

In a drinking water study, rats ingested 0.5 to 10% of isopropanol for 27 weeks and showed decreased body weight gain but no gross or microscopic tissue abnormalities (ECHA) [KI score = 3]. Increased formation of hyaline droplets in the proximal tubules was reported in male rats given 1–4% isopropanol in drinking water for 12 weeks (ECHA) [KI Score = 3].

A two-generation reproductive toxicity study has been conducted in rats given isopropanol by oral gavage. Pre-mating exposures were for at least 10 weeks for both generations. The results from this study are presented in the Reproductive Toxicity section (ECHA) [KI Score = 2].

Inhalation

F344 rats and CD-1 mice (both sexes) were exposed to 0, 100, 500, 1,500 or 5,000 ppm isopropanol for 6 hours/day, 5 days/week for 13 weeks. There were no deaths during the study. During and immediately following exposure to 5,000 ppm, ataxia, narcosis, hypoactivity and a lack of startle

reflex were observed in some rats and mice. Narcosis was not observed in rats during exposure following week 2, suggesting some adaptation to isopropanol. During exposures to 1,500 ppm, narcosis, ataxia, and hypoactivity were observed in some mice, whereas only hypoactivity was observed in rats. Immediately following exposures, ataxia and/or hypoactivity were observed in a few rats or mice exposed to 5,000 ppm. Overall, the 1,500 and 5,000 ppm rats and the 5,000 ppm female mice showed increased body weights and/or body weight gain during the study. Liver weights relative to body weight were observed in rats of both sexes and the 5,000 ppm female mice; however, no corresponding microscopic changes were noted in the liver. Histopathological evaluation showed a slight increase in the size and frequency of hyaline droplets in the kidneys of the isopropanol-exposed rats. Excluding the clinical signs of CNS depression, the NOAEL for this study is 5,000 ppm (ECHA) [Kl Score = 1].

In a subchronic neurotoxicity study, male and F344 rats were exposed by inhalation to 0, 100, 500, 1,500 or 5,000 ppm for 13 weeks. Neurobehavioural evaluations included a functional observation battery (FOB), motor activity and neuropathology. Effects of narcosis were observed in the 5,000 ppm groups only. There were no changes in FOB, but increased motor activity was noted in 5,000 female rats at weeks 9 and 13. Neuropathological examination revealed no exposure-related lesions in the nervous system. The NOAEL for acute effects is 500 ppm, and the NOAEL for subchronic neurotoxicity is 1,500 ppm (ECHA) [Kl Score = 1].

An additional subchronic neurotoxicity study was conducted to clarify the increased motor activity findings. Female F344 rats were exposed to 0 or 5,000 ppm of isopropanol vapour for 6 hours/day, 5 days/week. Half of the animals in each group were exposed for 9 consecutive weeks and the other half for 13 consecutive weeks. After 9 weeks of exposure, the motor activity effect was reversible within 2 days after the last exposure. Subtle differences in the shape of the motor activity versus test session time curve were noted in both the 9-week and the 13-week exposed animals, although it was unclear whether these changes were treatment-related. Complete reversibility of these changes did not occur until 1 and 6 weeks after the last exposure in the 9 and 13 week exposure groups, respectively (ECHA) [Kl Score = 2].

Male and female CD-1 mice were exposed by inhalation to 0, 500, 2,500 or 5,000 ppm isopropanol vapour 6 hours/day, 5 days/week for 18 months. An additional group of mice (all exposure levels) were assigned to a recovery group which were exposed to isopropanol for 12 months and then retained until study termination at 18 months. Survival was similar across all groups. Clinical signs were noted in the 5,000 ppm animals and included hypoactivity, lack of a startle reflex, ataxia, prostration and narcosis. Some of the animals in the 2,500 ppm group also showed hypoactivity, lack of a startle reflex and narcosis. Ataxia was the only exposure-related clinical sign that was noted for the 5,000 ppm animals following exposure. There was a concentration-related increase in body weights and body weight gain in both the 2,500 and 5,000 ppm animals (both sexes). There were no exposure-related changes in the haematological parameters at the 12- and 18-month time points. At study termination, there was a concentration-related increase in liver weights in the females, with the 5,000 ppm females being statistically significant. Nonneoplastic lesions were limited to the testes (males) and the kidney. In the testes, enlargement of the seminal vesicles occurred in the absence of associated inflammatory or degenerative changes. The kidney effects included tubular proteinosis and/or tubular dilatation. The incidence of testicular and kidney effects was not increased in the isopropanol-exposed recovery animals. The NOAEL is 500 ppm (ECHA) [Kl Score = 2].

Male and female Fischer 344 rats were exposed to 0, 500, 2,500 or 5,000 ppm isopropanol vapour 6 hours/day, 5 days/week for 24 months. The mortality rates for all male rats were 82, 83, 91 and 100% for the 0, 500, 2,500 and 5,000 ppm groups, respectively. The corresponding values for the female rats were 54, 48, 55 and 69%. The main cause of death for the 5,000 ppm rats (both sexes),

as well as for much of the mortality of the 2,500 ppm male rats, was chronic progressive nephropathy. Clinical signs were seen in the 5,000 ppm animals and included hypoactivity, lack of a startle reflex and narcosis. Some of the 2,500 ppm animals also showed a lack of a startle reflex. Body weight of the 5,000 ppm animals showed an initial decrease; from Weeks 6-72, body weights and body weight gain were increased. A similar pattern was seen in the 2,500 ppm males. Liver weights were increased in the ≥ 2,500 ppm male at 18 months, in the 2,500 ppm males at 24 months and in the 5,000 ppm females at 24 months. Kidney weights were increased in the 5,000 ppm males at 18 months and in the 5,000 ppm females at 24 months. Isopropanol exposure resulted in impaired kidney function, as indicated by various urine chemistry changes in male (2,500 and 5,000 ppm) and female (5,000 ppm) rats. Animals in these groups also exhibited histopathological effects in the kidneys which appeared to be an exacerbated form of chronic progressive nephropathy. The NOAEL is 500 ppm (ECHA) [Kl Score = 1].

Dermal

No studies are available.

F. Genotoxicity

In vitro Studies

The results of the *in vitro* genotoxicity studies on isopropanol are presented in Table 2.

Table 2: *In vitro* Genotoxicity Studies on Isopropanol

Test System	Results*		Klimisch Score	Reference
	-S9	+S9		
Bacterial reverse mutation (*S. typhimurium* TA98, TA100, TA1535, TA1537)	-	-	2	ECHA
Bacterial reverse mutation (*S. typhimurium* TA97, TA98, TA100, TA102, TA104, TA1535, TA1537, TA1538)	-	-	2	ECHA
Sister Chromatid Exchange (V79 cells)	-	-	2	ECHA
Mammalian cell gene mutation (CHO/HGPRT)	-	-	1	ECHA
Adenovirus (SA7) cell transformation (Syrian hamster embryo cells)	NA	-	2	ECHA

*+, positive; -, negative; NA, not applicable

In vivo Studies

Male and female ICR mice were given a single intraperitoneal injection of 0, 350, 1,173 or 2,500 mg/kg isopropanol. There were no increases in micronuclei in the bone marrow polychromatic erythrocytes at the 24, 48 or 72-hour post-dosing time points at any dose level (ECHA) [Kl Score = 1].

G. Carcinogenicity

Oral

No studies are available.

Inhalation

The carcinogenic potential of isopropanol was evaluated via inhalation using three strains of mice. Male mice were exposed to 7.5 ppm of isopropanol for 3 to 7 hours/day, 5 days/week for 5 to 8 months. Animals were killed at either 8 or 12 months. There was no significant increase in the number of lung tumours observed (ECHA) [KI Score = 3].

Male and female CD-1 mice were exposed by inhalation to 0, 500, 2,500 or 5,000 ppm isopropanol vapour for 6 hours/day, 5 days/week for 18 months. An additional group of mice (all exposure levels) were assigned to a recovery group which were exposed to isopropanol for 12 months and then retained until study termination at 18 months. There was no increased frequency of neoplastic lesions in any of the isopropanol-exposed animals (ECHA) [KI Score = 1].

Male and female Fischer 344 rats were exposed to 0, 500, 2,500 or 5,000 ppm of isopropanol vapour for 6 hours/day, 5 days/week for 24 months. The mortality rates for all male rats were 82, 83, 91 and 100% for the 0, 500, 2,500 and 5,000 ppm groups, respectively. The corresponding values for the female rats were 54, 48, 55 and 69%, respectively. The main cause of death for the 5,000 ppm rats (both sexes), as well as for much of the mortality of the 2,500 ppm male rats, was chronic progressive nephropathy. The only neoplastic lesion noted was increased interstitial (Leydig) cell adenomas in male rats. The frequency of these tumours, although elevated above the control animals, was within the historical control range of the testing facility and within the range reported for control animals from the National Toxicology Program carcinogenicity studies (ECHA) [KI Score = 1].

H. Reproductive Toxicity

In a two-generation reproductive toxicity study, Sprague–Dawley rats were dosed by oral gavage with 0, 100, 500 or 1,000 mg/kg isopropanol. There were seven parental deaths that were considered treatment-related: two high-dose F_0 females, two F_1 high-dose females, one mid-dose F_0 female, and two low-dose F_1 males. Lactation body weight gain was increased in the 500 and 1,000 mg/kg females in both generations, and liver and kidney weights were increased in the 500 and 1,000 mg/kg groups in both sexes. Centrilobular hepatocyte hypertrophy was noted in some 1,000 mg/kg F_1 males. There were some kidney effects in the 500 and 1,000 mg/kg F_0 males and in all treated F_1 male rats. The kidney effects were characterised by an increased number of hyaline droplets in the convoluted proximal tubular cells, epithelial degeneration and hyperplasia, and proteinaceous casts. Increased mortality occurred in the high-dose F_1 offspring during the early postnatal period; no other clinical signs of toxicity were observed in the offspring from either generation. Offspring body weight, however, in the 1,000 mg/kg group was reduced during the early postnatal period. There was significant mortality in the F_1 weanlings (18/70) before the selection of the F_1 adults. A statistically significant reduction was observed in the F_1 male mating index of the 1,000 mg/kg group (73 versus 97% in the controls). There were no other treatment-related effects on reproduction, including fertility and gestational indices, or histopathology of the reproductive organs. A benchmark dose level of 420 mg/kg/day was calculated (lower bound on dose associated with a 5% response rate) for the decrease in the male mating index (ECHA) [KI Score = 1].

In a one-generation reproductive/embryotoxicity study, male and female Wistar rats were given 0, 0.5, 1.0 or 2.0% isopropanol in their drinking water. The calculated intakes for males were 383, 686 and 1,107 mg/kg/day (pre-mating) and 347, 625 and 1,030 mg/kg/day (18 weeks of treatment). The calculated intakes for females were 456, 835 and 1,206 mg/kg/day (premating); 668, 1,330 and 1,902 mg/kg/day (gestation); and 1,053, 1,948 and 2,768 mg/kg/day (postpartum). An immediate, statistically significant dose-dependent decrease occurred in water intake in the male rats. Intake

was reduced ~5-14% (1% group; premating period) and ~30% (2% group; days 7-11 to end of study). Overall mean feed consumption was significantly lower in treated versus control animals. Male body weights (2% only) were reduced throughout the study. Water consumption was initially reduced in the 1% and 2% females, but the 2% group recovered to only ~70% of the control values (premating); it continued to be reduced during the gestation and lactation period. Mean maternal body weights were reduced (all treated groups) at the start of gestation, with partial recovery during the gestation period except for the 2% group. Overall weight gain during gestation in these groups were similar to the controls. Following parturition from PND 4 onward, the 2% dams had significantly lower body weights. There were no infertile males in any group, and no treatment-related effect on female fertility or on length of gestation. The number of pups/litter on GD 1 was reduced in the 2% group; because it was not replicated in the embryotoxicity portion, an increase in pup mortality during parturition or GD 0, followed by cannibalism of the dead pups by the dam was suggested. No macroscopic abnormalities were seen in females; nor was there any treatment-related histopathological changes seen in the reproductive tissue in the 2% parental animals. Absolute kidney weight and relative kidney, liver and spleen weights were increased in the 2% F_0 males; increased absolute liver and kidney weights and relative liver weights in the 2% F_0 females. In the embryotoxicity portion, there was a statistically significant increase in the total number of pre-implantation losses in the 2% animals. Whole body oedema was seen in 40% of the foetuses in 3/8 litters in the 2% group. No macroscopic abnormalities of the viscera of these foetuses were detected, and the incidence of oedema was not related to gender. In the one-generation portion, postnatal pup survival and in the average pup weight (by PND 7) were decreased in the 2% group. F_1 generation animals of both sexes showed increased relative liver weights at all dose levels, and the 2% males had higher relative kidney weights. A slight but significant decrease in absolute brain weight and increase in relative empty cecum weights in both sexes of the 2% F_1 generation group was observed. No treatment-related gross abnormalities were observed in the F_1 generation animals at necropsy. The NOAEL for reproductive toxicity is 2% in drinking water, the highest dose tested (ECHA) [KI Score = 1]. The effects of isopropanol (2.5% in drinking water) on the reproduction and growth of rats were assessed in a multigenerational study. No reproductive toxicity was observed. The NOAEL for reproductive toxicity is 2.5% isopropanol in drinking water (ECHA) [KI Score = 4].

Isopropanol was administered as a 3% solution in drinking water to Wistar rats. Reduced parental body weight gain, food, and water consumption were observed in the treated animals compared with the controls. Fertility, litter size and pup weights at postnatal days 4 and 21 were reduced in treated animals compared with the controls. In the second generation, the isopropanol concentration was reduced to 2%, and there were essentially no effects (ECHA) [KI Score = 4].

I. Developmental Toxicity

Oral Studies

Isopropanol was given at concentrations of 0, 0.5, 1.25 or 2.5% in the drinking water to female Wistar rats on GD 6 to 16. The calculated intakes of isopropanol during GD 6-16 were 596, 1,242 and 1,605 mg/kg/day. There was an immediate reduction in water intake in the 2.5% dose group, and this was statistically significant throughout the treatment period when compared to controls. A smaller reduction in water intake was also seen in the 1.25% females (statistically significant during GD 6-9), with no change in the 0.5% females. Palatability of the drinking water may have been the problem since water intake significantly increased the first day following the end of the treatment period for all dose groups. Feed consumption patterns paralleled the water consumption during and after treatment in the mid- and high-dose groups. Overall, mean body weights of the 2.5% females were lower than the controls from GD 7 to termination. Effects on weight gain in the 0.5% and 1.25% females were limited to a failure to gain weight during the first (0.5%) and second (1.25%) day of treatment. There were no treatment-related effects in post-implantation loss, mean number of

implantation sites or live foetuses. There was a slight dose-dependent decrease in mean litter weight and a significant decrease in mean foetal weight in the 1.25% and 2.5% groups. A statistically significant increase in variations was observed, indicative of a lower degree of ossification in the treated animals. There was a dose-dependent decrease in the number of foetuses with the 4th sacral arch and a dose-dependent increase in the number of foetuses with less than 2 caudal arches. The sternum also showed reduced ossification because there were increased numbers of foetuses with small, absent or incompletely ossified sternebrae. The NOAEL for maternal and developmental toxicity is 596 mg/kg/day (ECHA) [KI Score = 1].

In a rat developmental study, female Sprague–Dawley rats were dosed by oral gavage with either 0, 400, 800 or 1,200 mg/kg of isopropanol during gestational days 6 to 15. Two dams (8%) died at 1,200 mg/kg and one dam (4%) died at 800 mg/kg. At 1,200 mg/kg, maternal body weights were reduced throughout gestation (GS 0-20; 89.9% of control value), associated with reduced gravid uterine weight. There were no other treatment-related effects on the dams. Foetal body weights per litter were also significantly reduced at the 800 and 1,200 mg/kg dose levels, but there were no teratogenic effects. The NOAEL for maternal and developmental toxicity is 400 mg/kg/day, respectively (ECHA) [KI Score = 1]. In a rabbit developmental study, female New Zealand white rabbits were dosed by oral gavage with either 0, 120, 240 or 480 mg/kg of isopropanol during gestational days 6 to 18. At 480 mg/kg, isopropanol was unexpectedly toxic to pregnant female rabbits, resulting in the deaths of four does (26%). Maternal body weights were significantly reduced during treatment (gestational days 6–18) and were associated with reduced maternal food consumption during this period. Profound clinical signs were noted at 480 mg/kg and included flushed and/or warm ears, cyanosis, lethargy and laboured respiration. No adverse maternal effects were noted at 120 or 240 mg/kg. There were no developmental or teratogenic effects at any dose tested. The NOAELs for maternal and developmental toxicity are 240 and 480 mg/kg/day, respectively (ECHA) [KI Score = 1].

Isopropanol was given by oral gavage to Sprague–Dawley rats from gestational days 6 to 21 in doses of 0, 200, 700 or 1,200 mg/kg. The dams were allowed to deliver, litters were culled on postnatal day (PND) 4, pups were weaned on PND 22, and their dams were killed. Weaned pups were assessed for day of testes descent or vaginal opening, motor activity, auditory startle and active avoidance. The pups were killed on PND 68. Some of the pups were taken from each dose group and were perfused in situ for pathological examination of the central nervous system. There were no biologically significant findings in the behavioural tests, no changes in organ weights and no pathological findings of note. Thus, there was no evidence of developmental neurotoxicity from isopropanol exposure (ECHA) [KI Score = 1].

Inhalation Studies

Pregnant female Sprague Dawley rats were exposed to 0, 3,500, 7,000 or 10,000 ppm isopropanol for 7 hours/day during gestational days 1–19. The animals showed unsteady gait and narcotisation during initial exposures in the mid- and high-dose groups; reduced food consumption and reduced weight gain were also noted in both the mid- and high-dose groups. Foetal body weights per litter were reduced in all dose groups. Exposure to 10,000 ppm also resulted in failure of implantation, fully resorbed litters, increased resorptions per litter and increased incidence of cervical ribs. The NOAEL for maternal toxicity is 3,500 ppm. The LOAEL for developmental toxicity is 3,500 ppm; a NOAEL was not established (ECHA) [KI Score = 2].

V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES

The toxicological reference values developed for isopropanol follow the methodology discussed in enHealth (2012). The approach used to develop drinking water guidance values is described in the Australian Drinking Water Guidelines (ADWG, 2021).

A. Non-cancer

Oral

The repeated-dose toxicity studies on isopropanol by the oral route are inadequate for the purposes of risk assessment. There is, however, a well-conducted two-generation reproductive toxicity study, in which rats were dosed by oral gavage up to 1,000 mg/kg/day (Bevan et al., 1995). Allen et al. (1998) calculated a benchmark dose level of 420 mg/kg/day (lower bound on dose associated with a 5% response rate for the decrease in the male mating index). The Point of Departure (POD) of 420 mg/kg/day will be used for determining the oral reference dose (RfD) and the drinking water guidance value.

Oral Reference Dose (oral RfD)

Oral RfD = NOAEL / (UF_A x UF_H x UF_L x UF_{Sub} x UF_D)

Where:

- UF_A (interspecies variability) = 10
- UF_H (intraspecies variability) = 10
- UF_L (LOAEL to NOAEL) = 1
- UF_{Sub} (subchronic to chronic) = 10
- UF_D (database uncertainty) = 1
- Oral RfD = 420/(10 x 10 x 1 x 10 x 1) = 420/1000 = 0.4 mg/kg/day

Drinking water guidance value

Drinking water guidance value = (animal dose) x (human weight) x (proportion of intake from water) / (volume of water consumed) x (safety factor)

Using the oral RfD,

Drinking water guidance value = (oral RfD) x (human weight) x (proportion of water consumed) / (volume of water consumed)

Where:

- Human weight = 70 kg (ADWG, 2021)
- Proportion of water consumed = 10% (ADWG, 2021)
- Volume of water consumed = 2L (ADWG, 2021)
- Drinking water guidance value = (0.4 x 70 x 0.1)/2 = 1.4 mg/L

B. Cancer

Isopropanol was not carcinogenic to rats or mice in chronic inhalation studies. Therefore, a cancer reference value was not derived.

VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES

Isopropanol is a flammable liquid.

Isopropanol does not exhibit the following physico-chemical properties:

- Explosivity
- Oxidising potential

VII. ENVIRONMENTAL EFFECTS SUMMARY

A. Summary

Isopropanol is of low toxicity concern to aquatic organisms.

B. Aquatic Toxicity

Acute Studies

Table 3 lists the results of acute aquatic toxicity studies conducted on isopropanol.

Table 3: Acute Aquatic Toxicity Studies on Isopropanol

Test Species	Endpoint	Results	Klimisch score	Reference
Pimephales promelas	96-hour LC_{50}	9,640 mg/L	2	ECHA
Daphnia magna	24-hour EC_{50}	> 10,000 mg/L	2	ECHA

Chronic Studies

Table 4 lists the results of chronic aquatic toxicity studies on diethanolamine.

Table 4: Chronic Aquatic Toxicity Studies on Isopropanol

Test Species	Endpoint	Results (mg/L)	Klimisch score	Reference
Daphnia magna	16-day NOEC	141 mg/L	4	ECHA
Daphnia magna	21-day NOEC	30 mg/L	4	OECD, 1977a,b
Scenedesmus quadricauda	7-day NOEC	1,800 mg/L	2	ECHA

C. Terrestrial Toxicity

An EC_{50} value of 2,100 mg/L was determined from a lettuce seed germination test (Reynold, 1977) [Kl score = 2].

D. Calculation of PNEC

The PNEC calculations for isopropanol follow the methodology discussed in DEWHA (2009).

PNEC water

Experimental results are available for two trophic levels. Acute $E(L)C_{50}$ values are available for fish (9,640 mg/L) and invertebrates (> 10,000 mg/L). Results from chronic studies are available for

invertebrates (16- and 21-day NOECs for *Daphnia* are 141 and 30 mg/L, respectively). On the basis that the data consists of acute studies from two trophic levels and a chronic study from one trophic level, an assessment factor of 100 has been applied to the lowest reported NOEC of 30 mg/L for invertebrates. The $PNEC_{water}$ is 0.3 mg/L.

PNEC Sediment

There are no toxicity data for sediment-dwelling organisms. Therefore, the $PNEC_{sed}$ was calculated using the equilibrium partitioning method. The $PNEC_{sed}$ is 0.2 mg/kg sediment wet weight.

The calculations are as follows:

$PNEC_{sed} = (K_{sed\text{-}water}/BD_{sed}) \times 1000 \times PNEC_{water}$
$= (0.87/1280) \times 1000 \times 0.3$
$= 0.2$ mg/kg

Where:
$K_{sed\text{-}water}$ = suspended matter-water partition coefficient (m^3/m^3)
BD_{sed} = bulk density of sediment (kg/m^3) = 1,280 [default]
$K_{sed\text{-}water} = 0.8 + [0.2 \times Kp_{sed})1000 \times BD_{solid}]$
$= 0.8 + [0.2 \times 0.14/1000 \times 2400]$
$= 0.87\ m^3/m^3$

Where:
Kp_{sed} = solid-water partition coefficient (L/kg).
BD_{solid} = bulk density of the solid phase (kg/m^3) = 2,400 [default]
$Kp_{sed} = K_{oc} \times f_{oc}$
$= 3.478 \times 0.04$
$= 0.14$ L/kg

Where:
K_{oc} = organic carbon normalised distribution coefficient (L/kg). The K_{oc} for isopropanol calculated from EPI Suite™ using Log K_{ow} is 3.478.
f_{oc} = fraction of organic carbon in sediment = 0.04 [default].

PNEC soil

There are no toxicity data for terrestrial or soil organisms. Therefore, the $PNEC_{soil}$ was calculated using the equilibrium partitioning method. The $PNEC_{soil}$ is 0.014 mg/kg soil dry weight.

The calculations are as follows:

$PNEC_{soil} = (Kp_{soil}/BD_{soil}) \times 1000 \times PNEC_{water}$
$= (0.07/1500) \times 1000 \times 0.3$
$= 0.014$ mg/kg

Where:
Kp_{soil} = soil-water partition coefficient (m^3/m^3)
BD_{soil} = bulk density of soil (kg/m^3) = 1,500 [default]
$Kp_{soil} = K_{oc} \times f_{oc}$
$= 3.478 \times 0.02$
$= 0.07\ m^3/m^3$

Where:

K_{oc} = organic carbon normalised distribution coefficient (L/kg). The K_{oc} for isopropanol calculated from EPI Suite™ using K_{ow} is 3.478 L/kg.

f_{oc} = fraction of organic carbon in soil = 0.02 [default].

VIII. PERSISTENCE, BIOACCUMULATION AND TOXICITY (PBT) ASSESSMENT

The methodology for the Persistent, Bioaccumulative and Toxic (PBT) substances assessment is based on the Australian and EU REACH Criteria methodology (DEWHA, 2009; ECHA, 2008).

Isopropanol is readily biodegradable; thus, it does not meet the screening criteria for persistence.

Based on a measured log K_{ow} of 0.05 and a calculated BCF of 1, isopropanol does not meet the screening criteria for bioaccumulation.

The chronic toxicity data on isopropanol show a NOEC of > 0.1 mg/L. The acute E(L)C_{50} values for isopropanol are > 1 mg/L. Thus, isopropanol does not meet the screening criteria for toxicity.

The overall conclusion is that isopropanol is not a PBT substance.

IX. CLASSIFICATION AND LABELLING

A. Classification

Flammable Liquid Category 2

Eye Irritant Category 2

STOT Single Exposure Category 3 [Narcosis]

B. Labelling

Danger

C. Pictogram



X. SAFETY AND HANDLING

A. First Aid

Eye Contact

Immediately flush open eyes with plenty of water for at least 15 minutes. Remove contacts, if present and easy to do. Get medical attention immediately, preferably a physician for an ophthalmologic examination.

Skin Contact

For minor skin contact, avoid spreading material on unaffected skin. Remove and isolate contaminated clothing. Wash the contaminated area of body with soap and fresh water. Get medical attention. Launder contaminated clothing before reuse.

Inhalation

Move person to fresh air. If respiratory irritation, dizziness, nausea or unconsciousness occurs, seek immediate medical assistance. Give artificial respiration if victim is not breathing. Do not use mouth-to-mouth method if victim inhaled the substance; give artificial respiration with the air of a pocket mask equipped with a one-way valve or other proper respiratory medical device.

Ingestion

Do not induce vomiting. Get medical attention immediately.

Notes to Physician

If ingested, material may be aspirated into the lungs and cause chemical pneumonitis. Treat appropriately.

B. Fire Fighting Information

Extinguishing Media

Use water spray or fog, foam, dry chemical or carbon dioxide. Do not use straight streams of water.

Specific Exposure Hazards

Highly flammable. Vapours are flammable and heavier than air. Vapours may travel across the ground and reach remote ignition sources causing a flashback fire danger. Emits toxic fumes under fire conditions. Depending on conditions, decomposition products may include the following: carbon dioxide, carbon monoxide.

Special Protective Equipment for Firefighters

Wear self-contained breathing apparatus and chemical-protective clothing.

C. Accidental Release Measures

Personal Precautions

Isolate area. Keep unnecessary and unprotected personnel from entering the area. Use personal protective clothing. Ensure adequate ventilation. Wear respiratory protection if ventilation is inadequate. Do not breath mist, vapours or spray. Avoid contact with skin, eyes and clothing. Eliminate all sources of ignition.

Environmental Precautions

Prevent from entering sewers, waterways or low areas.

Steps to be Taken if Material is Released or Spilled

Eliminate all sources of ignition. All equipment used when handling the material must be grounded. A vapour suppressing foam may be used to reduce vapours. Use clean non-sparking tools to collect absorbed material. Pick up with suitable absorbent material and transfer to a container for chemical waste. For large amounts: dike spillage and pump off product into container for chemical waste. Dispose of contaminated material as prescribed.

D. Storage And Handling

General Handling

Prevent exposure to ignition sources (i.e., use non-sparking tools and explosion-proof equipment). Avoid contact with eyes, skin and clothing. Avoid breathing vapour. Wash thoroughly after handling. Keep container closed. Use with adequate ventilation. Use proper bonding and/or ground procedures. However, bonding and grounds may not eliminate the hazard from static accumulation. Peroxides may form upon prolonged storage. Exposure to light, heat or air significantly increases peroxide formation. If evaporated to a residue, the mixture of peroxides residue and material vapour may explode when exposed to heat or shock.

Storage

Keep container tightly closed. Store in a cool, well-ventilated area away from heat and light. Storage containers should be grounded and bonded. Fixed storage containers, transfer containers and associated equipment should be grounded and bonded to prevent accumulation of static charge. See SDS for suitable materials and coatings.

E. Exposure Controls / Personal Protection

Occupational Exposure Standards

The workplace exposure standard for isopropanol in Australia is 400 ppm as an 8-hour TWA and 500 ppm as a 15-min STEL.

Engineering Controls

Good general ventilation should be used. Ventilation rates should be matched to conditions. If applicable, use process enclosures, local exhaust ventilation or other engineering controls to

maintain airborne levels below recommended exposure limits. If exposure limits have not been established, maintain airborne levels to an acceptable level.

Personal Protection Equipment

Respiratory Protection: If workers are exposed to concentrations above the exposure limit, they must use appropriate, certified respirators. If there are no applicable exposure limit requirements or guidelines, use an approved respirator. Selection of air-purifying or positive pressure supplied-air will depend on the specific operation and the potential airborne concentration of the product. For emergency conditions, use an approved positive-pressure self-contained breathing apparatus. The following should be effective types of air-purifying respirators: organic vapour cartridge with a particulate pre-filter.

Hand Protection: Use gloves chemically resistant to this material. Consult the SDS for appropriate glove barrier materials.

Skin Protection: Use protective clothing chemically resistant to the material. Selection of specific items such as face shield, boots, apron or full body suit will depend on the task.

Eye Protection: Use chemical goggles.

Other Precautions: Wash hands, forearms and face thoroughly after handling chemical products; before eating, smoking and using the lavatory; and at the end of the working period. Appropriate techniques should be used to remove potentially contaminated clothing. Wash contaminated clothing before reusing. Ensure that eyewash stations and safety showers are close to the workstation location.

F. Transport Information

UN 1219 (Isopropanol)

Class 3

Packing Group II

XI. DISPOSAL

Disposal should be in accordance with all local, state and federal regulations.

XII. REGULATORY STATUS

Australian AICS Inventory: Listed

XIII. REFERENCES

ADWG. (2021). National Water Quality Management Strategy. Australian Drinking Water Guidelines, Section 6, Australian Government, National Health and Medical Research Council, Natural Resource Management Ministerial Council.

Allen, B; Gentry, R; Shipp, A; Van Landingham, C. (1998). Calculation of benchmark doses reproductive and developmental toxicity observed after exposure to isopropanol. Regul Toxicol Pharmacol 28: 38-44. http://dx.doi.org/10.1006/rtph.1998.1226

Bevan C., Tyler T.R., Gardiner T.H., Kapp Jr. R.W., Andrews L. and Beyer B.K. (1995). Two generation reproductive toxicity study with isopropanol in rats. J. Appl. Toxicol. 15(2):117-123.

Bridie, A.L., Wolff, C.J.M., and Winter, M. (1979). BOD and COD of some petrochemicals. Water Res. 13: 627-630.

Department of the Environment, Water, Heritage and the Arts [DEWHA]. (2009). Environmental risk assessment guidance manual for industrial chemicals, Department of the Environment, Water, Heritage and the Arts, Commonwealth of Australia.

Department of the Environment and Energy [DoEE]. (2017). Chemical Risk Assessment Guidance Manual: for chemicals associated with coal seam gas extraction, Guidance manual prepared by Hydrobiology and ToxConsult Pty Ltd for the Department of the Environment and Energy, Commonwealth of Australia, Canberra.

ECHA. ECHA REACH database: https://echa.europa.eu/information-on-chemicals/registered-substances

enHealth Human Risk Assessment [HHRA]. (2012). Environmental Health Risk Assessment, Guidelines for Assessing Human Health Risks from Environmental Hazards. Office of Health Protection of the Australian Government Department of Health.

European Chemicals Agency [ECHA]. (2008). Guidance on Information Requirements and Chemical Safety Assessment, Chapter R11: PBT Assessment, European Chemicals Agency, Helsinki, Finland.

Klimisch, H.J., Andreae, M., and Tillmann, U. (1997). A systematic approach for evaluating the quality of experimental and toxicological and ecotoxicological data. Regul. Toxicol. Pharmacol. 25:1-5.

OECD. (1997a). IUCLID Data Set for 2-Propanol (CAS No. 67-63-0), UNEP Publications.

OECD. (1997b). Screening Information Dataset (SIDS) Initial Assessment Report for 2-Propanol (CAS No. 67-63-0), UNEP Publications.

Price, K.S., Waggy, G.T., and Conway, R.A. (1974) Brine shrimp bioassay and seawater BOD of petrochemicals. J. Water Pollut. Contr. Fed., 46: 63-77.

PubChem. National Institutes of Health. National Library of Medicine National Center for Biotechnology Information. https://pubchem.ncbi.nlm.nih.gov/

Reynold, T. (1977). An anomalous effect of isopropanol on lettuce germination. Plant Sci. Lett. 15: 25-28.

USEPA. (2017). EPISuite™ v. 4.11, United States Environmental Protection Agency, Office of Pollution Prevention and Toxics and Syracuse Research Corporation. Available at: https://www.epa.gov/tsca-screening-tools/epi-suitetm-estimation-program-interface.

MAGNESIUM SILICATE HYDRATE (TALC)

This dossier on magnesium silicate hydrate (talc) presents the most critical studies pertinent to the risk assessment of this substance in its use in coal seam gas extraction activities. This dossier does not represent an exhaustive or critical review of all available data. The majority of information presented in this dossier was obtained from the ECHA database that provides information on chemicals that have been registered under the EU REACH (ECHA). Where possible, study quality was evaluated using the Klimisch scoring system (Klimisch et al., 1997).

NICNAS has assessed magnesium silicate hydrate (talc) in an IMAP Tier 1 assessment and concluded that it poses no unreasonable risk to the environment

I. SUBSTANCE IDENTIFICATION

Chemical Name (IUPAC): dioxosilane; oxomagnesium; hydrate

CAS RN: 14807-96-6

Molecular formula: $H_2Mg_3O_{12}Si_4$

Molecular weight: 379.27 g/mol

Synonyms: Talcum, oxosilanediol, trimagnesium; dioxido(oxo)silane; hydroxy-oxido-oxosilane, dioxosilane; oxomagnesium; hydrate

II. PHYSICO-CHEMICAL PROPERTIES

Table 1: Overview of the Physico-chemical Properties of Magnesium Silicate Hydrate (Talc)

Property	Value	Klimisch Score	Reference
Physical state at 20°C and 101.3 kPa	White solid odorless powder	2	ECHA
Melting Point	1,500°C @ 101.3 kPa	2	ECHA
Boiling Point	This substance is a solid that melts above 300°C	-	-
Density	2700 kg/m³ @ 20°C	2	ECHA
Vapour Pressure	0 Pa at 25°C	2	ECHA
Partition Coefficient (log K_{ow})	-9.4 @ 25°C	2	ECHA
Water Solubility	0.0001 g/L @ 25°C; insoluble in water	2	ECHA
Flash Point	ND	-	-
Auto flammability	ND	-	-
Viscosity	Not applicable as substance is a solid.	2	ECHA
Dissociation constant	ND because the substance is insoluble in water	-	ECHA

ND – not determined

III. ENVIRONMENTAL FATE PROPERTIES

A. Summary

Magnesium silicate hydrate (talc) is an inorganic substance for which biodegradation is irrelevant. Moreover, it will not bioaccumulate and has a low potential to adsorb to soil.

B. Biodegradation

As an inorganic substance, magnesium silicate hydrate (talc) will not biodegrade. Soil and sediment degradation studies are not considered to be applicable as the test material is essentially insoluble in water and consists of materials which occur naturally in these compartments (ECHA).

C. Environmental Distribution

Magnesium silicate hydrate (talc) is insoluble in water. The log K_{OC} of was estimated to be 1.5027 which is equal to a K_{OC} value of 31.82 L/kg using the KOCWIN v2.00 QSAR method (ECHA). Based on this K_{oc} value, if released to soil, magnesium silicate hydrate (talc) is expected to have a low potential for adsorption. If released into water, the substance has a low potential for adsorption to sediment or suspended solids.

D. Bioaccumulation

There is no potential for bioaccumulation. Due to its inherent chemical-physical properties, such as absence of lipophilicity as well as the capability of the organism to excrete absorbed SiO_2 components, bioaccumulation can be disregarded. Magnesium is widespread in living cells and does not bioconcentrate in aquatic organisms (ECHA).

IV. HUMAN HEALTH HAZARD ASSESSMENT

A. Summary

Talc is a mineral composed of hydrated magnesium silicate. Talc is essentially non-toxic by the oral and dermal routes. Talc is non-irritating to the eyes and skin. There was no toxicity or carcinogenic effects in rats. Talc is not genotoxic. No developmental toxicity was reported in pregnant female rats, mice or rabbits given oral doses of talc.

B. Basic Toxicokinetics

Inhalation

To determine the deposition, distribution and clearance of talc, 44 female Syrian golden hamsters received a single 2-hour nose-only exposure to a neutron-activated talc aerosol and sub-groups of 4 animals were then killed at 11 different intervals from 15 minutes to 132 days after exposure.

The talc tested was a commercial baby powder. Nine unexposed control animals were used; four were killed on the day the test animals were exposed and five were killed on the final day of the study. The aerosol exposure system had 7 tiers of exposure ports, and the talc aerosol was passed through a cyclone elutriator to remove particles that were larger than ~10 µm in diameter; the activity median aerodynamic diameter was 6.4-6.9 µm. The mean aerosol concentration was 40 and 75 µg/L at the 15 to 30 and 60 to 90-minute sampling periods, respectively. In the presentation of the results, the γ-ray counts from the controls were expressed as µg talc equivalent, and the γ-ray counts of the exposed animals were not corrected for control values.

Variations among animals killed at the same time were attributed to variations in aerosol concentration at different tiers. The mean pulmonary talc content in the lungs of test animals at various time intervals was 33.08 µg (15 minutes after exposure), 24.08 µg (100 minutes), 42.70 µg (4 hours), 18.75 µg (21 hours), 21.30 µg (2 days), 21.03 µg (after 4 days), 13.85 µg (after 8 days) and 8.95 µg (after 18 days); the mean for the Day 0 control animals was 1.78 µg. The biological half-life of the talc deposited in the lungs was 7 to 10 days. At the time of termination of the final group, i.e., 132 days, there was no statistically significant difference in the talc burden of the lungs of test (3.70 µg) and control (2.30 µg) animals. The amount of talc in the liver, kidneys and lungs was also determined; the only statistically significant differences compared to controls in any of these organs were found in the liver. There was a decrease at 4 hours compared to day 0 controls, an increase at Day 36 compared to both Day 0 and Day 132 controls, and an increase on Day 68 compared to Day 132 controls.

Analysis of the data using the Kruskal-Wallis test showed that there were no significant differences among the mean talc burden values for the liver, kidneys and ovaries, including the control values, and that there was no significant trend, indicating there was no translocation of talc to these tissues.

As noted, no translocation from the respiratory tract to other tissues was found in this study, and the clearance of talc from the lungs was complete within 4 months after exposure.

Oral

In one study, six female Syrian golden hamsters (outbred Ela:ENG strain) were dosed by gavage with 1 mL neutron-activated talc suspended in physiological saline containing 0.6% (w/w) 1% methyl cellulose, and the animals were killed 24 hours after dosing. The talc used was a commercial baby powder.

Four hamsters were dosed similarly with a non-irradiated talc solution. The neutron-activated talc was exposed to an integrated neutron flux of 7 x 1,016 n/cm^2 30 days prior to dosing. The skinned carcass, gastrointestinal (GI) tract, lungs, liver, kidneys and excreta were analysed for isotopes 60 Co and 46 Sc by gamma-ray spectrometry, and the gamma-ray counts were compared with those of four hamsters that were not dosed with talc.

The γ-ray counts of the tissue and excreta of the dose animals were equivalent to a total of 2.94 mg talc. Based on γ-ray counts, 74.5% of the neutron-activated talc was recovered in the faeces and 23.5% was recovered in the GI tract, while 1.91% was recovered in the skinned carcass, 0.09% in the urine, 0.04% in the kidneys and 0.02% in the liver. The amount found in the urine of the hamsters given irradiated talc was statistically significantly increased compared to the controls. No talc was recovered in the lungs (ECHA) [KI score = 2].

In a second oral study, four LACA female mice were given a single oral dose of 40 mg/kg [3H] talc. Two mice were killed at 6 hours and two at 24 hours after dosing. In the mice killed 6 hours after dosing, 95 and 96% of the radioactivity was recovered in the large intestines and faeces, 9 and 7% was recovered in the small intestines and stomach, and 0.7 and 0% in the urine of each mouse. In the two mice killed 24 hours after dosing, 99 and 101% of the radioactivity was recovered in the large intestines and faeces, 4 and 6% was recovered in the small intestines and stomach, and 1.3 and 1.5% in the urine of each mouse. Less than 0.005% of the radioactivity was found in the carcass of any of the mice (ECHA) [KI score = 2].

In a third oral study, three male Wistar albino rats were given a single oral dose and three rats were given six daily oral doses by gavage of 50 mg/kg body wt [3H] talc. After the last dose, urine and

faeces were collected every 24 hours for 4 days and on Day 10; the rats were then killed. Within 24 hours after administration of the single dose, approximately 75% of the radioactivity was recovered in the faeces and only 1% was recovered in the urine. After 96 hours, a total of 95.8% of the dose was excreted in the faeces and 1.7% in the urine, with a total excretion of 97.5% of the dose. No radioactivity was recovered in the liver or kidneys 10 days after a single dose of talc. On Day 10 in the rats given six daily doses of [3H] talc, there was no radioactivity found in the faeces or livers, and there was a trace of radioactivity (< 0.02%) in the kidneys of these rats (ECHA) [KI score = 2].

C. Acute Toxicity

Oral

A single oral dose of 5,000 mg/kg of talc prepared as an 18.3% (w/v) suspension in saline was administered to 10 male rats. All animals survived, and there were no signs of toxicity. In conclusion, the median lethal dose of Talc (Mg3H2(SiO3)4) after a single oral administration to male rats, observed over a period of 14 days is: LD50 > 5,000 mg/kg body weight (ECHA) [KI Score = 2].

Inhalation

Groups of 5 male and female Wistar rats were treated with magnesium hydroxide as aerosol during 4 hours. No mortality or other relevant adverse effects were observed. An inhalatory LC_{50} (4-hour) value for magnesium hydroxide exceeding 2.1 mg/L was determined, being the maximum feasible concentration that could be tested (ECHA) [KI Score = 2].

Dermal

An OECD Guideline 402 (Acute Dermal Toxicity) was performed. Five males and five female Wistar rats were dermally exposed to a single talc dose of 2,000 mg/kg.

Approximately 24 hours before the test, the fur was removed from the dorsal area of the trunk using an electric clipper. Care was taken to avoid abrading the skin, and only animals with healthy intact skin were used. No less than 10% of the body surface was cleared for the application.

The test item was applied at a single dose, uniformly over an area which was approximately 10% of the total body surface. The test item was held in contact with the skin throughout a 24-hour period. At the end of the exposure period the residual test item was not removed.

Under the conditions of this study, single dermal application of the test item magnesium chloride hexahydrate to rats at a dose of 2,000 mg/kg body weight was associated with no mortality. The dermal LD_{50} was determined to be > 2,000 mg magnesium chloride hexahydrate/kg body weight (ECHA) [KI Score = 2].

Dermal

No studies were available.

D. Irritation

Skin

An *in vitro* skin irritation test was carried out with the reconstituted three-dimensional human skin model EPISKIN-SM™ (Skinethic). This skin model consists of normal (non-cancerous), adult human-

derived epidermal keratinocytes (NHEK) which have been cultured to form a multilayered, highly differentiated model of the human epidermis. The NHEK are cultured on chemically modified, collagen-coated cell culture inserts. A highly differentiated and stratified epidermis model is obtained after a 13-day culture period and is comprised of the main basal, supra basal, spinous and granular layers and a functional stratum corneum.

The test item showed no irritant effects. The mean relative tissue viability (% negative control) was ≥ 50% (112.9%) after 15-minute treatment and 42-hour post incubation. The controls confirmed the validity of the study. The mean OD550 of the three negative control tissues was ≥ 0.6. The mean relative tissue viability (% negative control) of the positive control was ≤ 30% (22.6%). The standard deviation of replicate tissues of all dose groups was ≤ 30% (1.4% - 9.4%). It can be concluded that talc is non-irritating to skin (ECHA) [KI Score = 2].

Eye

An OECD Guideline 405 (Acute Eye Irritation / Corrosion) study was performed using magnesium chloride hexahydrate as a surrogate substance for talc. A dose of 0.1 g of the test item was applied at a single dose in the conjunctival sac of one eye of each test animal after pulling the lower lid away from the eyeball. The lids were then gently held together for about 1 second in order to prevent loss of the material. The untreated contralateral eye served as control. Observations of the eye were made at 1, 24, 48 and 72 hours and 4 to 6 days.

Under the conditions of the study, single ocular instillation of the test item magnesium chloride hexahydrate to rabbits at a dose of 0.1 g produced irritant effects, which were fully reversible. Neither mortalities nor significant clinical signs of toxicity were observed. The test item is deemed to be non-irritating to eyes (ECHA) [KI Score = 2].

E. Sensitisation

No experimental data are available on the Talc ($Mg_3H_2(SiO_3)_4$) powder and silicates; however, there is long experience in humans. Data collected from industrial hygiene surveillance over the last 50 years do not indicate any potential for skin sensitisation. Despite the widespread cosmetic use of talc and special studies in volunteers (BIBRA, 1991) there are no indications of any allergenic effect (ECHA) [KI score = 3].

F. Repeated Dose Toxicity

Oral

A study equivalent or similar to OECD Guideline 452 (Chronic Toxicity Studies) was performed using male and female Wistar rats. Wistar rats (16 male and 16 female) were exposed to talc in feed which resulted in an amount taken up of 100 mg/kg/day. After feeding had been carried out for 101 days, the animals were observed until death and subsequently examined histopathologically.

One of the animals treated with talc showed a leiomyosarcoma of the stomach. Sarcomas, which were not associated with the talc treatment, were found in the uterus of two animals. No chronic pathological effect was associated with oral administration of talc over 5 months. No adverse effects were seen on general toxicity endpoints. Under the condition of this study, for a period of 101 days for male and female rats, the NOAEL of talc in a feeding study was 100 mg/kg/day (ECHA) [KI score = 2].

Inhalation

A study equivalent or similar to OECD Guideline 452 (Chronic Toxicity Studies) was performed using male and female Wistar rats. The Wistar rats (12 male and 12 female) were exposed whole body to aerosolised talc at a mean respirable dust concentration of 10.8 mg/m^3 for 7.5 hours per day, 5 days a week for 6 or 12 months.

Ten days after the end of each exposure period, 6 rats per group were killed; 12 rats per group died and 2 rats per group were unaccounted for. The remaining 4 rats per group were killed one year after the end of the exposure period. Minimal fibrosis was observed. Talc exposure led to distinct fibrosis that was comparable with that after exposure to chrysotile in the parallel group. A lung adenoma was detected in 1 of 24 animals treated with talc. In rats exposed by inhalation to 10.8 mg/m^3 Italian talc (grade 00000; ready milled; mean particle size, 25 µm) for 3 months, minimal fibrosis was observed, the degree of which did not change during the observation period after exposure. Animals that were exposed for 1 year had minimal to slight fibrosis, the degree of which had increased to moderate within 1 year after cessation of exposure.

A no observed adverse effect concentration (NOAEC) of 10.8 mg/m^3 was determined (ECHA) [KI Score = 2].

Dermal

No adequate studies for human health risk assessment are available.

G. Genotoxicity

In Vitro Studies

The *in vitro* genotoxicity studies on talc are presented in Table 2.

Table 2: *In vitro* Genotoxicity Studies on Talc

Test System	Results*		Klimisch Score	Reference
	-S9	+S9		
Mammalian cell gene mutation (rat pleural mesothelial cells (RPMC)).	-*	ND	2	ECHA

*+, positive; -, negative
ND – not determined

Talc did not cause a statistically significant increase in sister chromatid exchanges (SCEs) and was not clastogenic. The test substance is non-mutagenic under the given experimental conditions (ECHA) [KI Score = 2].

In Vivo Studies

A study equivalent or similar to OECD Guideline 478 (Genetic Toxicology: Rodent Dominant Lethal Test) was performed per a rat dominant lethal assay on Sprague Dawley rats. Groups of 10 male rats were dosed by gavage with a single dose or once daily for 5 days with 30, 300, 3,000 or 5,000 mg/kg talc.

There were no dose-response or time trend patterns; talc did not induce dominant lethal mutations in this assay. Therefore, talc was not genotoxic in a rat dominant lethal assay (ECHA) [KI Score = 2].

H. Carcinogenicity

Oral

An OECD Guideline 453 (Combined Chronic Toxicity / Carcinogenicity Studies) was performed. In a feeding study of 16 male and 16 female Wistar rats, talc was added to the diet; this resulted in a dosage rate of 100 mg/kg/day. After feeding had been carried out for 101 days, the animals were observed until death (approximately 614 days) and subsequently examined histopathologically. One of the animals treated with talc showed a leiomyosarcoma of the stomach. Sarcomas, which were not associated with the talc treatment, were found in the uterus of two animals.

However, no differences in tumour incidence were noted between treated animals and 8 male and 8 female control animals fed basal diet throughout (average survival, 641 days).

Inhalation

In a lifetime experiment, three groups of 50 male and 50 female Syrian golden hamsters, 4 weeks of age, were exposed (whole body) by inhalation to an aerosol of talc baby powder that was prepared from Vermont talc by flotation (95% w/w platy talc with trace quantities of magnesite, dolomite, chlorite and rutile) for 3, 30 or 150 minutes per day, 5 days a week for 30 days. The mean aerosol concentration was 37.1 mg/m^3, with a measurable respiratory fraction of 9.8 mg/m^3 and a MMAD of 4.9 µm. A placebo exposed group comprised 25 males and 25 females. Two further groups of hamsters, 7 weeks of age, were exposed to talc aerosol for 30 or 150 minutes per day for 300 days. The mean aerosol concentration was 27.4 mg/m^3, with a measurable respiratory fraction of 8.1 mg/m^3 and a MMAD of 6.0 µm. Another placebo-exposed group comprised 25 males and 25 females. The survivors of the last two talc-exposed groups were killed at the age of 20 months.

No clinical signs of toxicity to talc were observed. The type, incidence and severity of lesions indicated no trend toward a dose-response and no statistically significant differences between exposed and control groups. The incidence of focal alveolar cell hyperplasia (25% in treated groups; 10% in controls) appeared to be affected by treatment, but a two-way weighted analysis showed no significant association. Thus, exposure of hamsters to talc via inhalation did not produce carcinogenic effects (ECHA) [Kl Score = 2].

I. Reproductive Toxicity

An OECD Guideline 416 (Two-Generation Reproduction Toxicity Study) was performed. Groups of 12-15 gravid Dutch-belted female rabbits were dosed orally with 9, 42, 195 or 900 mg/kg bw talc in corn oil on Days 6-18 of gestation. Eight gravid negative controls were given only vehicle and nine gravid positive controls were dosed with 2.5 mg/kg bw of 6-aminonicotinamide on Day 9 of gestation. The dams were killed on Day 29 of gestation. A total of 1/8, 4/15, 2/12, 5/15 and 2/13 dams of the negative control, 9, 42, 195 and 900 mg/kg bw dose groups, respectively, died or aborted before Day 29 of gestation, and the number of live litters for these groups was 6/7, 10/11, 8/10, 10/10 and 7/11, respectively. Details on Results (PO): Administration of up to 900 mg/kg bw talc on Days 6-18 of gestation had no discernible effect on nidation or on maternal survival.

The number of abnormalities did not differ between test and control animals.

Details on Results (F1): Administration of up to 900 mg/kg bw talc on days 6-18 of gestation had no discernible effect on nidation or on foetal survival. The number of abnormalities did not differ between test and control animals.

The NOAEL was considered to be 900 mg/kg bw/day for reproduction toxicity study. A NOAEL of > 900 mg/kg/day was determined for reproduction (ECHA) [KI Score = 2].

J. Developmental Toxicity

A GLP compliant study was performed. Groups of 20-22 gravid albino CD-1 mice and groups of 20-24 gravid Wistar rats were dosed by gavage with 0, 16, 74, 350 or 1,600 mg/kg bw talc as an anhydrous corn oil suspension on days 6-15 of gestation. The mice were killed on Day 17 and the rats on Day 20 of gestation and the number of implantation sites, resorptions sites, and live and dead foetuses, and the live pup body weights were recorded.

Maternal Toxicity: The administration of up to 1,600 mg/kg bw talc in corn oil had no effect on maternal endpoints.

Embryotoxic / Teratogenic Effects: The administration of up to 1,600 mg/kg bw talc in corn oil had no effect on developmental parameters and had no effect on foetal survival.

The NOAEL was considered to be 1,600 mg/kg bw/day for developmental toxicity (ECHA) [KI score = 2].

V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES

The toxicological reference values developed for talc follow the methodology discussed in enHealth (2012). The approach used to develop drinking water guidance values is described in the Australian Drinking Water Guidelines (ADWG, 2021).

A. Non-Cancer

<u>Oral</u>

The NOAEL of 100 mg/kg/day from a chronic feeding study in rats was used to determine the oral RfD and drinking water guidance value.

Oral Reference Dose (oral RfD)

Oral RfD = NOAEL / (UF_A x UF_H x UF_L x UF_{Sub} x UF_D)

Where:

UF_A (interspecies variability) = 10
UF_H (intraspecies variability) = 10
UF_L (LOAEL to NOAEL) = 1
UF_{Sub} (subchronic to chronic) = 1
UF_D (database uncertainty) = 1
Oral RfD = 100/(10 x 10 x 1 x 1 x 1) = 100/100 = 1 mg/kg/day

Drinking water guidance value

Drinking water guidance value = (animal dose) x (human weight) x (proportion of intake from water) / (volume of water consumed) x (safety factor)

Using the oral RfD,

Drinking water guidance value = (oral RfD) x (human weight) x (proportion of water consumed) / (volume of water consumed)

Where:

Human weight = 70 kg (ADWG, 2021)
Proportion of water consumed = 10% (ADWG, 2021)
Volume of water consumed = 2L (ADWG, 2021)
Drinking water guidance value = (1 x 70 x 0.1)/2 = 3.5 mg/L

B. Cancer

The carcinogenicity studies suggest talc is not a carcinogen. Thus, a cancer reference value was not derived.

VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES

Talc does not exhibit the following physico-chemical properties:

- Flammability
- Explosivity
- Oxidising potential

VII. ENVIRONMENTAL HAZARD ASSESSMENT

A. Summary

Talc is of low toxicity concern to aquatic organisms.

B. Aquatic Toxicity

Table 3 lists the results of the acute aquatic toxicity studies on magnesium silicate hydrate (talc).

Table 3: Acute Aquatic Toxicity Studies on Talc

Test Species	Endpoint	Results (mg/L)	Klimisch score	Reference
Fish (species unnamed)	96-hour LC_{50}	89,581 mg/L (QSAR)	2	ECHA
Daphnid	48-hour LC_{50}	36,812 mg/L (QSAR)	2	ECHA
Algae (species unnamed)	96-hour LC_{50}	7,203 mg/L	1	ECHA

Chronic Studies

No data are available. Short term aquatic toxicity tests reported in the literature on fish (LC_{50} *Brachydanio rerio* (Zebra fish) >100,000 mg/L/24 hr; for talc) show this substance is not toxic to aquatic life. On this basis the need for long term aquatic testing is waived (ECHA).

C. Terrestrial Toxicity

No data are available.

D. Calculation of PNEC

PNEC calculations for talc follow the methodology discussed in DEWHA (2009).

PNEC water

Acute experimental results are available for three trophic levels. Acute E(L)C_{50} values are available for fish (89,581 mg/L), *Daphnia* (36,812 mg/L), and algae (7,203 mg/L). By applying an assessment factor of 100 to the lowest E(L)C_{50} value of 7,203 mg/L from the acute studies, the $PNEC_{water}$ for talc is 72 mg/L.

PNEC sediment

There are no toxicity data for sediment-dwelling organisms. Moreover, the low K_{ow} indicates that talc is not expected to partition to sediments. Therefore, a $PNEC_{sed}$ was not calculated.

PNEC soil

There are no toxicity data for terrestrial or soil organisms. Moreover, talc is biodegradable and due to its low K_{ow}, is not expected to partition to soil. Therefore, a $PNEC_{soil}$ was not calculated.

VIII. PERSISTENCE, BIOACCUMULATION AND TOXICITY (PBT) ASSESSMENT

The methodology for the Persistent, Bioaccumulative and Toxic (PBT) substances assessment is based on the Australian and EU REACH Criteria methodology (DEWHA, 2009; ECHA, 2008).

Magnesium silicate hydrate (talc) is an inorganic substance and thus, biodegradation is not relevant. For the purposes of this PBT assessment, the persistent criteria are not considered applicable for this substance.

No data are available on bioaccumulation. However, based on the low log K_{ow}, and the inherent chemical-physical properties of magnesium silicate hydrate (talc), bioaccumulation is not expected. Thus, magnesium silicate hydrate (talc) does not meet the screening criteria for bioaccumulation.

Chronic aquatic toxicity data is not available. The E(L)C_{50} values from the acute aquatic toxicity studies on magnesium silicate hydrate (talc) are > 1 mg/L. Thus, magnesium silicate hydrate (talc) does not meet the criteria for toxicity.

Therefore, magnesium silicate hydrate (talc) is not a PBT substance.

IX. CLASSIFICATION AND LABELLING

A. Classification

H332- Harmful if inhaled.

B. Labelling

Warning

C. Pictogram



X. HANDLING AND SAFETY INFORMATION (OCCUPATIONAL LIMITS AND TRANSPORTATION REQUIREMENTS)

A. First Aid

Eye Contact

Immediately flush open eyes with plenty of water for at least 15 minutes. Remove contacts, if present and easy to do. Get medical attention immediately, preferably a physician for an ophthalmologic examination.

Skin Contact

For minor skin contact, avoid spreading material on unaffected skin. Remove and isolate contaminated clothing. Wash the contaminated area of body with soap and fresh water. Get medical attention. Launder contaminated clothing before reuse.

Inhalation

Move person to fresh air. Administer oxygen if breathing is difficult. Do not use mouth-to-mouth method if victim inhaled the substance; give artificial respiration with the air of a pocket mask equipped with a one-way valve or other proper respiratory medical device. Give artificial respiration if victim is not breathing. Get medical attention immediately.

Ingestion

Do not induce vomiting. Rinse out mouth then drink plenty of water. Get medical attention.

Notes to Physician

All treatments should be based on observed signs and symptoms of distress in the patient.

B. Fire Fighting Information

Extinguishing Media

Use water spray or fog, foam, dry chemical or carbon dioxide.

Specific Exposure Hazards

Magnesium oxide, silicon oxides.

Special Protective Equipment for Firefighters

Wear self-contained breathing apparatus and chemical-protective clothing.

C. Accidental Release Measures

Personal Precautions

Isolate area. Keep unnecessary and unprotected personnel from entering the area. Use personal protective clothing. Ensure adequate ventilation. Wear respiratory protection if ventilation is inadequate. Avoid dust formation. Avoid breathing vapours, mist of gas. Avoid contact with skin, eyes and clothing. Eliminate all sources of ignition.

Environmental Precautions

No specific environmental precautions required.

Steps to be Taken if Material is Released or Spilled

Eliminate all sources of ignition. Pick up with suitable absorbent material and transfer to a container for chemical waste. For large amounts: dike spillage and pump off product into container for chemical waste. Dispose of contaminated material as prescribed.

D. Storage and Handling

General Handling

Keep away from heat, sparks and flame. Avoid contact with eyes, skin and clothing. Avoid breathing vapour. Wash thoroughly after handling. Keep container closed. Use with adequate ventilation.

Storage

Keep container tightly closed. Store away from heat and light. Store in cool place. Keep container tightly closed in a dry and well-ventilated place.

E. Exposure Controls/Personal Protection

Occupational Exposure Standards

Workplace Australia has established an occupational exposure standard for exposure to talc of an 8 hour time weighed average (TWA) exposure limit of 2.5 mg/m^3 (containing no asbestos fibres).

Engineering Controls

Good general ventilation should be used. Ventilation rates should be matched to conditions. If applicable, use process enclosures, local exhaust ventilation or other engineering controls to maintain airborne levels below recommended exposure limits. If exposure limits have not been established, maintain airborne levels to an acceptable level.

Personal Protection Equipment

Respiratory Protection: If workers are exposed to concentrations above the exposure limit, they must use appropriate, certified respirators. If there are no applicable exposure limit requirements or guidelines, use an approved respirator. Selection of air-purifying or positive pressure supplied-air will depend on the specific operation and the potential airborne concentration of the product. For emergency conditions, use an approved positive-pressure self-contained breathing apparatus. The following should be effective types of air-purifying respirators: organic vapour cartridge with a particulate pre-filter.

Hand Protection: Use gloves chemically resistant to this material. Consult the SDS for appropriate glove barrier materials.

Skin Protection: Use protective clothing chemically resistant to this material. Selection of specific items such as face shield, boots, apron or full body suit will depend on the task.

Eye Protection: Use chemical goggles.

Other Precautions: Wash hands, forearms and face thoroughly after handling chemical products, as well as before eating, smoking and using the lavatory and at the end of the working period. Appropriate techniques should be used to remove potentially contaminated clothing. Wash contaminated clothing before reusing. Ensure that eyewash stations and safety showers are close to the workstation location.

F. Transport Information

Talc is not considered hazardous for purposes of transportation by road or rail. An Australian Dangerous Goods code is not required.

XI. DISPOSAL MANAGEMENT

Disposal should be in accordance with all local, state and federal regulations.

XII. REGULATORY STATUS

Australian AICS Inventory: Listed.

XIII. REFERENCES

ADWG. (2011). National Water Quality Management Strategy. Australian Drinking Water Guidelines, Section 6, Australian Government, National Health and Medical Research Council, Natural Resource Management Ministerial Council

BIBRA. (1991). The British Industrial Biological Research Association (BIBRA) Toxicity Profile – Talc. BIBRA, Carshalton, GB.

enHealth Human Risk Assessment [HHRA]. (2012). Environmental Health Risk Assessment, Guidelines for Assessing Human Health Risks from Environmental Hazards. Office of Health Protection of the Australian Government Department of Health.

Department of the Environment, Water, Heritage and the Arts [DEWHA]. (2009). Environmental risk assessment guidance manual for industrial chemicals, Department of the Environment, Water, Heritage and the Arts, Commonwealth of Australia.

European Chemicals Agency [ECHA] (2008). Guidance on Information Requirements and Chemical Safety Assessment, Chapter R11: PBT Assessment, European Chemicals Agency, Helsinki, Finland.

Klimisch, H.J., Andreae, M., and Tillmann, U. (1997). A systematic approach for evaluating the quality of experimental and toxicological and ecotoxicological data. Regul. Toxicol. Pharmacol. 25:1-5.

MANNANASE

This dossier on mannanase presents the most critical studies pertinent to the risk assessment of mannanase in its use in coal seam or shale gas extraction activities. This dossier does not represent an exhaustive or critical review of all available data. The majority of information presented in this dossier was obtained from the ECHA database that provides information on chemicals that have been registered under the EU REACH (ECHA) and a 2005 human and environmental risk assessment (HERA) report for the surrogate chemical α-amylase. Where possible, study quality was evaluated using the Klimisch scoring system (Klimisch et al., 1997).

For the purpose of this dossier, α-amylase (CAS RN 9000-90-2) and cellulase (CAS RN 9012-54-8) enzymes have been reviewed as surrogates for mannanase, where appropriate.

NICNAS has assessed mannanase in an IMAP Tier 1 assessment and concluded that it poses no unreasonable risk to the environment[1]

I. SUBSTANCE IDENTIFICATION

Chemical Name (IUPAC): mannan endo-1,4-beta-mannosidase IUBMB 3.2.1.78

CAS RN: 37288-54-3

Molecular formula: Not applicable, unknown or variable composition complex reaction products and biological material (UVCB)

Molecular weight: Not applicable, UVCB

Synonyms: Mannanase; beta-mannanase; endo-B-1,4-mannanase

SMILES: Not applicable, UVCB

II. PHYSICO-CHEMICAL PROPERTIES

Enzymes and other proteins are polymers built of different combinations of the 20 common amino acids. The sequence and length of the amino acids in the polymer differ between enzymes, and this determines the 3-dimensional structure, the activity and specificity of the enzyme. The physico-chemical characteristics of enzymes are mainly dependent on the amino acids building the enzyme. Since all enzymes are built up of a combination of the same 20 common amino acids, the physical and chemical characteristics will be very similar across different enzymes.

The majority of the physico-chemical characteristics are not relevant for enzymes e.g., boiling point, therefore, only relevant parameters have been determined and are summarised for mannanase in Table 1.

[1] https://www.industrialchemicals.gov.au/chemical-information/search-assessments?assessmentcasnumber=37288-54-3

Table 1: Overview of the Physico-chemical Properties of mannanase

Property	Value	Klimisch Score	Reference
Physical state at 20°C and 101.3 kPa	Not applicable	-	-
Melting Point	Not applicable	-	-
Boiling Point	Not applicable	-	-
Density	1320 -1420 kg/m^3 (relative density 1.37 ± 0.05) @ 20°C	1	ECHA
Vapour Pressure	0.004 Pa @ 25°C	1	ECHA
Partition Coefficient (log K_{ow})	-1.3 @ 20°C	1	ECHA
Water Solubility	125 g/L @ 25°C	1	ECHA
Flash Point	Not applicable	-	-
Auto flammability	Not applicable	-	-
Viscosity	Not applicable	-	-
Henry's Law Constant	Not applicable	-	-

III. ENVIRONMENTAL FATE PROPERTIES

A. Summary

Mannanase is readily biodegradable, it has a low octanol-water partition coefficient, and it is highly soluble in water. Mannanase will not absorb to sediment or soil, and it is not expected to bioaccumulate in aquatic or terrestrial organisms (ECHA).

B. Biodegradation

The biodegradability of mannanase was evaluated in a 28-day modified sturm test as per OECD guideline 301 B (readily biodegradability: CO2 evolution test). Mannanase was introduced to the test system at 20 mg Dissolved Organic Carbon (DOC)/L. Mannanase showed the greater part of biodegradation between Day 2 and 7, increasing from 14.0 to 55.1%. Mannanase reached 38.4% within 5 days and 63.0% biodegradation within 9 days. On Day 28, mannanase achieved a total cumulative biodegradation of 73.7 which indicates that mannanase is readily biodegradable under the conditions of this test (ECHA) [KI. score =1].

In two additional studies, two different amylase enzymes were considered readily biodegradable based on the results of OECD 301E tests. In both tests, there was 99% DOC removal of the enzyme after 28 days. Likewise, mannanase is expected to be readily biodegradable (HERA 2005).

If a chemical is found to be readily biodegradable, it is categorised as Not Persistent since its half-life is substantially less than 60 days (DoEE, 2017).

C. Environmental Distribution

Because all enzymes are built up of the combination of the same 20 common amino acids, the physical and chemical characteristics are very similar for different enzymes, and hence, read-across from other enzymes should be fully applicable. The log octanol water partition coefficient (K_{ow}) value

of mannanase has not been determined but other enzymes have been analysed and the $LogK_{ow}$ from literature studies was found to be between -3.1 to -2.95. Due to the similar nature of enzymes, this value can also be extrapolated to mannanase (ECHA) [KI. Score = 1]. In addition, the organic carbon partition coefficient (K_{oc}) for similar enzyme glucoamylase was measured <= 1.3 L/kg at 20°C (HERA, 2005).

Based on these values and its high water solubility (125 g/L), mannanase has a low potential to adsorb to sediment or soil (ECHA).

D. Bioaccumulation

Mannanase is not expected bioaccumulate because it is highly soluble in water and a low potential to cross biological membranes (ECHA).

IV. HUMAN HEALTH HAZARD ASSESSMENT

A. Summary

Mannanase has low acute toxicity, it is degraded in the gastrointestinal tract, and it is not readily absorbed by in the respiratory tract. Mannanase is not irritating to the skin, or the eye and it is not expected to be a skin sensitiser based on studies using a surrogate chemical. Mannanase is not genotoxic and there are no carcinogenic studies available to determine if this substance is a carcinogen. Mannanase is not a reproductive toxicant. No developmental toxicity studies were available.

B. Metabolism

Toxicokinetic studies performed on enzymes and UVCBs are very limited, but toxicokinetic information can be derived from the structure of enzymes combined with knowledge available for proteins in general since enzymes are proteins with catalytic activity.

Skin absorption of enzymes is at a toxicologically insignificant level. The enzymes are degraded in the gastrointestinal tract and are absorbed at a very low extent through the respiratory tract; therefore, the total bioavailability of enzymes can be concluded to be extremely low. This is further supported by the physico-chemical data. Enzymes have a low octanol water partition coefficient value, which indicates that they have no bioaccumulation potential. Also, they are expected to be readily biodegraded. Systemic exposure following enzyme exposure due to occupational or consumer exposure levels is not expected to be of toxicological significance (ECHA).

Given the relatively low absorption of enzymes, metabolism and distribution are not expected to be a relevant pathway (ECHA).

C. Acute Toxicity

<u>Oral</u>

As per EU Method B.1 (Acute Toxicity Oral), male and female Sprague-Dawley rats were exposed to 3.32 g/kg or 10 ml/kg bw mannanase by oral gavage. The only clinical sign observed was piloerect coats in all the rats within two minutes after the first dose and throughout the remainder of the first treatment day. No adverse clinical signs were observed on the second day and the overall body weight during the study was considered to be normal. There were no post-mortem abnormalities reported in this study. Therefore, the LD_{50} was reported to be >3.32 g/kg bw (ECHA) [KI. score =1].

No deaths were observed when male and female rats were given an aqueous suspension of 0, 4,000, or 10,000 mg/kg ofα-amylase ("salt free" batch PPY 1316, enzyme derived from B.subtilis by oral gavage. The actual enzyme content of this batch was 239 mg active enzyme protein (aep)/g (HERA, 2005).

In another study, male and female rats were given an aqueous suspension of 0 or 5,000mg/kg α-amylase preparation derived from B.licheniformis, the actual enzyme content of the preparation was 60.13 mg aep/g. There were no deaths (HERA, 2005).

Rats were exposed by inhalation to either 1.6 mg/L of a production α-amylase (from B. subtilis) batch ADTA202-204, a mixture of two batches prepared by the standard production process (45.9% of particles <4.7 µm) or 1.08 mg/L of a "salt-free" α-amylase (from B. subtilis) batch PPY1316, prepared from production batch ADTA202-204 by removal of NaCl (33.3% of particles <4.7 µm), for 4 hours. An air-exposed control group was also included. The actual amount of enzyme protein in the test aerosols was 0.114 mg aep/L (production batch) and 0.258 mg aep/L (salt-free batch). There were no deaths occurred (HERA, 2005).

In another study, rats were exposed to 1.6 mg/L α-amylase (from B. subtilis) preparation (highest concentration attainable) derived from a genetically modified strain of B. subtilis for 4 hours. Total organic solids comprised 83.3% of the test substance (active and inactive enzyme as well as other organic material). There were no deaths (HERA, 2005).

Inhalation

Male and female Sprague-Dawley rats were exposed to 0.45 mg mannanase concentrated dry matter/ L by inhalation of aerosol droplets through the nose for four hours. The particle size distribution was 86% respirable with an aerodynamic diameter of < 7 µm. There were no unscheduled deaths or evidence of a toxic response in this study. Therefore, the LC_{50} was reported to be > 0.45 mg/L air (analytical) (ECHA) [KI. score =1].

Dermal

Acute dermal toxicity studies were not conducted for mannanase. Due to the physicochemical and toxicological properties, the potential of absorption through the skin is expected to be very low (ECHA).

D. Irritation

Skin

α-Amylase (from B. subtilis) has a low potential for irritation to the skin and eyes of rabbits (HERA,2005).

In a human repeat insult patch test (HRIPT), although skin irritation did not appear after a single application, irritation was reported in human volunteers receiving nine topical applications of 1, 2.5, 5 or 10% α-amylase (from B. subtilis) in distilled water. The magnitude of responses increased with increasing concentration such that the use of the 10% concentration was discontinued and was replaced for the rest of the study by a 0.5 % α-amylase. The irritation was thought to be due to residual protease activity present in the amylase preparation (HERA, 2005).

The irritation potential of mannanase to the skin was evaluated in an OECD guideline 404 (Acute Dermal Irritation/Corrosion) study. New Zealand white rabbits were exposed to 0.5 ml of mannanase

via semi occlusive dressing for four hours. The rabbits were observed for dermal and systemic reactions at 1, 24, 48, and 72 hours after patch removal. There were no signs of erythema or oedema during the study period. There were no abnormal clinical signs reported, and the body weight changes were determined to be normal. The primary irritation score was reported to be zero which indicates that Mannanase is not irritating to the skin of rabbits (ECHA) [KI. score = 1].

Eye

The irritation potential of mannanase to the eye was evaluated in an OECD guideline 405 (Acute Eye irritation/Corrosion) study. New Zealand white rabbits were exposed to 0.1 mL of mannanase in one eye. Each treated eye was examined for irritation of the cornea, the iris, and the conjunctiva at 1, 24, 48, and 72 hours after exposure to mannanase. The mean cornea opacity score was reported to zero, the mean chemosis score was reported to be zero, and the mean conjunctiva score was reported to be 0.33. All the reported effects were cleared 48-72 hours after treatment. In this study, mannanase was reported to be non-irritating to the eyes of rabbits (ECHA) [KI. score = 1].

E. Sensitisation

Skin

α-Amylase (from B. subtilis) was not a skin sensitiser to guinea pigs in two different studies (HERA, 2005). In a human repeat insult patch test (HRIPT) reported above. There were no significant reactions indicative of skin sensitisation in the challenge phase (HERA, 2005).

Respiratory

There are no studies available.

F. Repeated Dose Toxicity

Oral

A sub-chronic systemic toxicity study (OECD guideline 408-Repeated dose 90-day oral toxicity study) was performed on Wistar rats. Male and female rats were exposed to 128, 425, and 1,277 mg/kg bw/day of mannanase daily by oral gavage for a total of 13 weeks. Mannanase was well-tolerated at all doses and there were no significant findings of toxicological relevance. The NOAEL for this study was established at ≥1, 277 mg/kg bw/day (highest dose tested) (ECHA) [KI. score =1].

In the 13-week dietary study on a cellulase enzyme (cellulase enzymes cleave the β-1,4-glycosidic bonds in cellulose and for the purpose of risk assessment the structure of amylases would be expected to be relatively similar to that of celluloses given the fact that amylases and cellulases are both enzyme families that hydrolyse polysaccharides, although differing in their substrates), there was reduced body weight gain in rats given 3,000 mg/kg/day. No other adverse effects were observed. The NOAEL for this study is 600 mg/kg/day (HERA, 2005)

Rats and dogs have been given amylase enzymes orally for up to 90 days. These studies were not reported in any detail and the actual amount of enzyme in the formulations tested in these studies is unclear. No findings of toxicological significance were observed in either species exposed to any of the α-amylase formulations tested other than “slight” reductions in food consumption at high dietary doses (>5% of the diet) or irritation of the stomach of rats dosed by oral gavage with >3,000 mg/kg/day (HERA, 2005).

Inhalation

There are no studies available.

Dermal

There are no studies available.

G. Genotoxicity

In vitro Studies

The *in vitro* genotoxicity studies on mannanase are presented in Table 2.

Table 2: *In vitro* Genotoxicity Studies on mannanase

Test System	Results*		Klimisch Score	Reference
	-S9	+S9		
Bacterial reverse mutation assay (Salmonella typhimurium strains TA1537, TA98, TA1535, TA100; Escherichia coli WP2uvrA)	-	-	1	ECHA
Mammalian chromosome aberration test (human lymphocytes)	-	-	1	ECHA
Mammalian cell gene mutation test (mouse lymphoma L5178Y cells) **	-	-	1	ECHA
Bacterial reverse mutation assay (S. typhimurium strains TA1535, TA1537, TA98, TA100) ***	-	-	N/A	HERA, 2005
Chromosome aberration assay (human lymphocytes and bone marrow) ****	-	-	N/A	HERA, 2005

*+, positive; -, negative
**α-Amylase
***α-Amylase (from B. subtilis and B. licheniformis
****α-Amylase (from B. licheniformis)

In Vivo Studies

There are no studies available.

H. Carcinogenicity

Oral

There are no studies available.

Inhalation

There are no studies available.

Dermal

There are no studies available.

I. Reproductive Toxicity

Two α-amylases, one derived from B. stearothermophilus and one derived from a genetically modified strain of B. subtilis have been evaluated for effects on fertility in one-generation studies in rats. The diets containing 0, 36 or 72 units of α-amylase/g food. No treatment-related effects on fertility or other findings of toxicological significance were observed for either enzyme (HERA,2005).

J. Developmental Toxicity

Oral

There are no studies available.

Inhalation

There are no studies available.

Dermal

There are no studies available.

V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES

The toxicological reference values developed for mannanase follow the methodology discussed in enHealth (2012). The approach used to develop drinking water guidance values is described in the Australian Drinking Water Guidelines (ADWG, 2011).

A. Non-Cancer

Oral

Proteins are digested into amino acids by gastric juices, digestive enzymes and pancreatic proteolytic enzymes in the lumen of the gastrointestinal tract. As enzymes are simply a class of proteins, enzymes will undergo the same process as any food source based on proteins. Absorption of enzymes in toxicological significant amounts through the gastrointestinal tract is unlikely (ECHA). Therefore, an oral reference value and DWG value was not derived.

B. Cancer

There are no studies available to determine if mannanase is a carcinogen. A cancer reference value was not derived.

VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES

Mannanase does not exhibit the following physico-chemical properties:

- Explosivity
- Flammability
- Oxidising potential

VII. ENVIRONMENTAL HAZARD ASSESSMENT

A. Summary

Mannanase has low acute aquatic toxicity to algae, fish, and invertebrates. There are no chronic studies available, but mannanase is to have low chronic toxicity to ecological receptors given its reported physicochemical properties.

B. Aquatic Toxicity

Acute Studies

Table 3 lists the results of acute aquatic toxicity studies conducted on mannanase.

Table 3: Acute Aquatic Toxicity Studies on mannanase

Test Species	Endpoint	Results (mg aep*/L)	Klimisch Score	Reference
Oncorhynchus mykiss (rainbow trout)	96-hour LC_{50}	>105.8 mg/L (55.5 mg aep)	1	ECHA
Daphnia magna	48-hour $_{EC50}$	>105.8 mg/L (55.5 mg aep)	1	ECHA
Raphidocelis subcapitata (green algae)	72-hour EC_{50}	>105.8 mg/L (55.5 mg aep)	1	ECHA
*Scenedesmus subspicatus***	72-hour EC_{50}	112	-	HERA 2005

*Active enzyme protein (aep)/L
**α-Amylase (Termamyl)

Chronic Studies

An OECD Guideline 201 (Alga, growth inhibition) study was conducted using Raphidocelis subcapitata (green algae) that were exposed to mannanase for 72 hours at 25 °C. The 72 hour NOEC was reported to be 26.5 mg/L (equivalent to 13.9 mg/L active enzyme protein) based on growth rate (ECHA)[KI. score =1].

C. Terrestrial Toxicity

There are no studies available. However, mannanase has a very low vapor pressure (0.004 Pa) and a low K_{ow} (<0). Therefore, exposure to agricultural soil via sludge application as well as via aerial deposition is very low (ECHA).

D. Calculation of PNEC

The PNEC calculations for mannanase follow the methodology discussed in DEWHA (2009).

PNEC Water

Experimental results are available for three trophic levels. Acute $E(L)C_{50}$ values are available for fish (55.5 mg aep /L), *Daphnia* (55.5 mg aep /L), and algae (55.5 mg aep /L). Results from chronic studies are available for algae (13.9 mg aep/L). On the basis that the data consists of short-term results from

three trophic levels and long-term results from one trophic level, an assessment factor of 100 has been applied to the NOEC value of 13.9 mg ep/L for algae. The $PNEC_{water}$ is 0.139 mg/L.

PNEC Sediment

There are no toxicity data for sediment-dwelling organisms. PNEC values for sediment exposure have not been derived because the enzyme is readily biodegradable, highly water soluble and has a very low potential for adsorption to sediments. Exposure of the sediment to toxicologically significant concentrations of the enzyme is thus not expected (ECHA).

PNEC Soil

There are no toxicity data for terrestrial or soil organisms. Therefore, the $PNEC_{soil}$ was calculated using the equilibrium partitioning method. The $PNEC_{soil}$ is 0.002 mg/kg soil dry weight.

The calculations are as follows:

$PNEC_{soil} = (Kp_{soil}/BD_{soil}) \times 1000 \times PNEC_{water}$
$= (0.026/1500) \times 1000 \times 0.139$
$=0.002$ mg/kg

Where:
Kp_{soil}= soil-water partition coefficient (m^3/m^3)
BD_{soil} = bulk density of soil (kg/m^3) = 1,500 [default]
$Kp_{soil} = K_{oc} \times f_{oc}$
$=1.3 \times 0.02$
$=0.026$ m^3/m^3

Where:
K_{oc} = organic carbon normalised distribution coefficient (L/kg). The calculated K_{oc} for similar enzymes to mmannanase is <1.3 L/kg (HERA, 2005)
F_{oc} = fraction of organic carbon in soil = 0.02 [default].

VIII. PERSISTENCE, BIOACCUMULATION AND TOXICITY (PBT) ASSESSMENT

The methodology for the Persistent, Bioaccumulative and Toxic (PBT) substances assessment is based on the Australian and EU REACH Criteria methodology (DEWHA, 2009; ECHA, 2017).

Mannanase is readily biodegradable and thus does not meet the screening criteria for persistence.

The log K_{ow} for mannanase is -1.3. Thus, mannanase does not meet the criteria for bioaccumulation.

The chronic NOEC value for mannanase is >0.1 mg/L. The acute $E(L)C_{50}$ values from the acute aquatic toxicity studies on mannanase are > 1 mg/L. Thus, mannanase does not meet the criteria for toxicity.

The overall conclusion is that mannanase is not a PBT substance.

IX. CLASSIFICATION AND LABELLING

A. Classification

H334: May cause allergy or asthma symptoms or breathing difficulties if inhaled

Respiratory sensitisation-category 1

B. Labelling

Danger

A. Pictogram



X. HANDLING AND SAFETY INFORMATION (OCCUPATIONAL LIMITS AND TRANSPORTATION REQUIREMENTS)

A. First Aid

Please refer to the product SDS for additional information and confirmation of the information provided herein.

Eye Contact

In case of contact, immediately flush eyes with plenty of water for at least 15 minutes.

Skin Contact

Wash thoroughly with soap and water.

Inhalation

If inhaled, remove from area to fresh air. Get medical attention.

Ingestion

Rinse mouth with water and then drink a glass of water. Get medical attention. Never give anything by mouth to an unconscious person.

B. Fire Fighting Information

Extinguishing Media

Water spray, carbon dioxide, foam, dry chemical.

Specific Exposure Hazards

Keep product and empty container away from heat and sources of ignition. May emit toxic fumes under fire conditions. Depending on conditions, decomposition products may include the following: carbon monoxide, carbon dioxide.

Special Protective Equipment for Firefighters

Wear self-contained breathing apparatus.

C. Accidental Release Measures

Personal Precautions

Use appropriate protective equipment. Handle in accordance with good industrial hygiene and safety practice.

Environmental Precautions

Prevent from entering sewers, waterways, or low areas.

Steps to be Taken if Material is Released or Spilled

For large amounts: dike spillage and pump off product. For residues: pick up with suitable absorbent material. Dispose of contaminated material as prescribed.

D. Storage And Handling

General Handling

Keep product and empty container away from heat and sources of ignition. Ensure adequate ventilation, especially in confined areas.

Storage

Keep container tightly closed and in a dry and well-ventilated place. Keep in a cool place.

E. Exposure Controls / Personal Protection

Occupational Exposure Standards

A workplace exposure standard is not available in Australia for mannanase

Engineering Controls

Good general ventilation should be used.

Personal Protection Equipment

Respiratory Protection: Respiratory protection is not required if ventilation is adequate.

Hand Protection: Chemical resistant protective gloves.

Skin Protection: Body protection must be chosen depending on activity and possible exposure.

Eye protection: Safety glasses with side-shields.

Other Precautions: Handle in accordance with good industrial hygiene and safety practice. Wearing of closed work clothing is recommended. Ensure that eyewash stations and safety showers are close to the workstation location.

F. Transport Information

Mannanase is not considered hazardous for purposes of transportation by road or rail. An Australian Dangerous Goods code is not required.

XI. DISPOSAL MANAGMENT

Disposal should be in accordance with all local, state, and federal regulations.

XII. REGULATORY STATUS

Australian AICS Inventory: Listed.

XIII. REFERENCES

ADWG. (2011). National Water Quality Management Strategy. Australian Drinking Water Guidelines, Section 6, Australian Government, National Health and Medical Research Council, Natural Resource Management Ministerial Council. Updated January 2022. Available: https://www.nhmrc.gov.au/about-us/publications/australian-drinking-water-guidelines

Department of the Environment, Water, Heritage and the Arts [DEWHA]. (2009). Environmental risk assessment guidance manual for industrial chemicals, Department of the Environment, Water, Heritage and the Arts, Commonwealth of Australia. Available: http://www.nepc.gov.au/resource/chemical-risk-assessment-guidance-manuals

Department of the Environment and Energy [DoEE]. (2017). Chemical Risk Assessment Guidance Manual: for chemicals associated with coal seam gas extraction, Guidance manual prepared by Hydrobiology and ToxConsult Pty Ltd for the Department of the Environment and Energy, Commonwealth of Australia, Canberra. Available: www.environment.gov.au/water/coal-and-coal-seam-gas/national-assessment-chemicals/consultation-risk-assessment-guidance-manual

ECHA. ECHA REACH database: http://echa.europa.eu/information-on-chemicals/registered-substances

enHealth Human Risk Assessment [HHRA] (2012). Environmental Health Risk Assessment, Guidelines for Assessing Human Health Risks from Environmental Hazards. Office of Health Protection of the Australian Government Department of Health. Available: https://www1.health.gov.au/internet/main/publishing.nsf/Content/health-pubhlth-publicat-environ.htm

European Chemicals Agency [ECHA]. (2017). Guidance on Information Requirements and Chemical Safety Assessment, Chapter R11: PBT Assessment, European Chemicals Agency, Helsinki, Finland. Available: https://echa.europa.eu/guidance-documents/guidance-on-information-requirements-and-chemical-safety-assessment

Human and Environmental Risk Assessment (HERA) on Ingredients of Household Cleaning Products: α-amylase, CAS No. 9000-90-2; Cellulase (β-(1,4)-glucanase), CAS No. 9012-54-8; Lipase, 9001-62-1, 2005. Available: https://www.heraproject.com/files/38-F-Hera_Bridging_document_28.10.05.pdf

Klimisch, H.J., Andreae, M., and Tillmann, U. (1997). A systematic approach for evaluating the quality of experimental and toxicological and ecotoxicological data. Regul. Toxicol. Pharmacol. 25:1-5.

METHANOL

This dossier on methanol presents the most critical studies pertinent to the risk assessment of methanol in its use in coal seam or shale gas extraction activities. It does not represent an exhaustive or critical review of all available data. The information presented in this dossier was obtained primarily from the OECD-SIDS documents on methanol (OECD, 2004a,b), and the ECHA database that provides information on chemicals that have been registered under the EU REACH (ECHA). Where possible, study quality was evaluated using the Klimisch scoring system (Klimisch et al., 1997).

NICNAS has assessed methanol in an IMAP Tier 1 assessment and concluded that it poses no unreasonable risk to the environment

I. SUBSTANCE IDENTIFICATION

Chemical Name (IUPAC): Methanol

CAS RN: 67-56-1

Molecular formula: CH_4O

Molecular weight: 32.04 g/mol

Synonyms: Methyl alcohol, carbinol, wood spirits, wood alcohol, methylol, wood, columbian spirits, colonial spirit, columbian spirit, methyl hydroxide, monohydroxymethane, pyroxylic spirit, wood naphtha.

SMILES: CO

II. PHYSICO-CHEMICAL PROPERTIES

Table 1: Physico-Chemical Properties of Methanol

Property	Value	Klimisch score	Reference
Physical state at 20°C and 101.3 kPa	Colourless liquid	2	ECHA
Melting Point	-97.8°C @ 101.3 kPa	2	ECHA
Boiling Point	64.7°C @ 101.3 kPa	2	ECHA
Density	790 kg/m^3@ 20 °C	2	ECHA
Vapour Pressure	16927 Pa @ 25 °C	2	ECHA
Partition Coefficient (log P_{ow})	-0.77	2	ECHA
Water Solubility	>1,000 g/L [miscible]	2	ECHA
Flash Point	9.7°C	2	ECHA
Auto flammability	455°C @ 101.3 kPa	2	ECHA
Viscosity	0.544 – 0.59 mPa s (dynamic)	2	ECHA
Henry's Law Constant	0.461 Pa m^3/mol @ 20 °C	2	ECHA

Methanol is a highly flammable liquid.

III. ENVIRONMENTAL FATE PROPERTIES

A. Summary

Methanol is readily biodegradable. It has a low adsorptive capacity to soils and is unlikely to bioaccumulate.

B. Biodegradation

Methanol is readily biodegradable. In a closed bottle test using seawater, there was 84% and 95% degradation after 10 and 20 days, respectively (Price et al., 1974; ECHA). [Kl. score = 2]

In a soil test using [^{14}C]-methanol, there was 53.4% degradation under aerobic conditions after 5 days, as measured by CO_2 evolution; and 46.3% degradation under anaerobic conditions after 5 days, as measured by CO_2 evolution (Scheunert et al., 1987; ECHA). [Kl. score = 2]

If a chemical is found to be readily biodegradable, it is categorised as Not Persistent since its half-life is substantially less than 60 days (DoEE, 2017).

C. Environmental Distribution

The adsorption of methanol was investigated in three different soil types at 6°C (Lokke, 1984; ECHA). There was slight adsorption with the sandy soils tested (percentage organic matter of 0.09% and 0.1% in the samples) and with the clay soil (percentage organic matter was 0.22%). Methanol solutions of concentrations of 0.1, 1.0, 9 and 90 mg/L were used in one-hour exposure adsorption studies; the K_{oc} values were between 0.13 and 0.61 for all soil types and at all concentrations.

Based upon these K_{oc} values, if released to soil, methanol is expected to have very high mobility. If released into water, due to its high water solubility and low K_{oc}, methanol is not expected to adsorb to suspended solids and sediment in water.

D. Bioaccumulation

The BCF of methanol in *Cyprinus carpio* was determined to be 1.0 (Gluth et al. 1985); in *Leuciscus idus*, the BCF was < 10 (Hansch and Leo, 1985; Freitag et al. 1985). Therefore, the potential for bioaccumulation is low.

IV. HUMAN HEALTH HAZARD ASSESSMENT

A. Summary

Methanol has low acute oral, dermal and inhalation toxicity in experimental animals but moderate to high acute oral and dermal toxicity in humans. Methanol is metabolised to formate, which is considered to be the ultimate toxicant in acute methanol intoxication in humans. Acute methanol toxicity in humans is characterised by CNS depression, followed by acidosis and ocular injury. Methanol is not irritating to the skin, but it is slightly irritating to the eyes. It is not a skin sensitiser. Repeated exposures by the oral and inhalation routes have not resulted in any systemic toxicity to rodents. In primates, adverse health effects on brain, kidney and heart were observed in chronic inhalation studies. Methanol is not genotoxic or carcinogenic. Conflicting results have been obtained concerning the effect of methanol on reproductive and developmental toxicity in experimental animals. However, it is not considered to have reproductive or developmental toxicity in humans.

B. Toxicokinetics and Metabolism

Several reviews on the metabolism and pharmacokinetics of methanol are available (Kavet and Nauss, 1990; Liesivuori and Savolainen, 1991; Tephly, 1991; IPCS, 1997; OECD, 2004a, b). Methanol is first oxidised to formaldehyde. This initial metabolic step involves different enzymes in rats than in primates and humans, although the rates are similar. A catalase–peroxidase system is primarily responsible for the initial step in rats, whereas alcohol dehydrogenase plays a major role in humans and monkeys. Methanol oxidation can also occur via hepatic microsomal oxidation involving the cytochrome P450 system.

Formaldehyde is converted to formic acid, which is converted to formate and a hydrogen ion. Conversion to formic acid is a two-step process, the second step is irreversible. In the first reaction, formaldehyde combines with reduced glutathione (GSH) to form S-formylglutathione. This is mediated by an NAD-dependent formaldehyde dehydrogenase. In the second reaction, thiolase catalyses the hydrolysis of S-formylglutathione to form formic acid and GSH. A folate-dependent pathway in the liver is responsible for formate metabolism in both rats and primates. Formate first forms a complex with tetrahydrofolate (THF) that is sequentially converted to 10-formyl-THF (by formyl-THF synthetase) and then to CO_2 (by formyl-THF dehydrogenase). THF is derived from folic acid in the diet and is also regenerated in the folate pathway. Although the folate pathway metabolises formate in both rats and monkeys, rats use the pathway more efficiently.

The dermal uptake rate of liquid methanol applied to the forearm of human volunteers was 11.5 mg/cm^2/hr (Dutkiewicz et al., 1980). The dermal flux for methanol in human skin (epidermis) *in vitro* is 8.29 mg/cm^2/hr (Schueplein and Blank, 1971). When 12 human volunteers immersed one hand into a vessel containing neat methanol for up to 16 minutes, the maximum methanol concentration in blood reached 1.9 ± 1.0 hr after exposure. Delivery rates from the skin into blood lagged exposure by 0.5 hours, and methanol continued to enter the blood for 4 hours following exposure. The average derived dermal absorption rate absorption rate was 8.1 $\pm$ 3.7 mg/cm^2/hr. The authors calculated that the maximum concentration of methanol in blood following immersion of one hand in methanol for approximately 20 minutes is comparable to that reached following inhalation exposures to 200 ppm methanol (Batterman and Franzblau, 1997).

C. Acute Toxicity

The acute oral LD_{50} for rats range from 6,200 to 13,000 mg/kg (Kimura et al., 1971; Welch and Slocum, 1943; Deichman and Mergard, 1948; Smyth et al., 1941). The acute dermal LD_{50} for rabbits was reported to be 20 mL/kg (Rowe and McCollister, 1982). The inhalation 4- and 6-hour LC_{50} values in rats are 128.2 and 87.5 mg/L, respectively (BASF, 1980a,b). Sublethal doses, however, produce CNS effects and ocular injury that may result in blindness. This effect has been seen in primates, but not in rodents, and has been attributed to the differences in blood levels of the metabolite, formic acid.

Methanol is metabolised to formate, which is considered to be the ultimate toxicant in acute methanol intoxication in humans. Acute methanol toxicity in humans is characterised by CNS depression, followed by acidosis and ocular injury. Generally, transient CNS effects appear above methanol levels of 200 mg/L and serious ocular symptoms appear above 500 mg/L (OECD, 2004a). This blood concentration can transiently be achieved in an adult person (70 kg) by ingestion of 0.4 mL methanol/kg (approximately 0.32 mg/kg). The minimal acute methanol dose to humans that can result in death is considered to be 300 to 1,000 mg/kg by ingestion, and fatalities have occurred in untreated patients with initial methanol blood levels in the range of 1,500-2,000 mg/L (OECD,

2004a). However, such high blood methanol levels able to cause death are not likely to be achieved through inhalation exposure.

D. Irritation

Methanol is not irritating to the skin of rabbits (BASF, 1975), but it is slightly irritating to the eyes of rabbits (BASF, 1975).

E. Sensitisation

Methanol was not considered a skin sensitiser to guinea pigs (BASF, 1979).

F. Repeated Dose Toxicity

Oral

Male and female Sprague–Dawley rats were dosed by oral gavage with 0, 100, 500 or 2,500 mg/kg of methanol for 90 days. There were no differences in body weight gain and food consumption between treated and control animals. Brain weights were decreased in both sexes in the 2,500 mg/kg dose group. Elevated serum glutamic pyruvate transaminase and alkaline phosphatase were noted in the 2,500 mg/kg dose group, but there were no adverse treatment-related effects in the gross pathology and histopathological evaluation. The NOAEL is 500 mg/kg/day (USEPA, 1986).

Sprague-Dawley rats were given in their drinking water 0, 500, 5,000 or 20,000 ppm methanol for 104 weeks, and then the animals were maintained until natural death. The study was conducted by the Ramazzini Foundation which uses its testing guideline for carcinogenicity studies and not an internationally accepted guideline. Treatment with methanol did not decrease survival. However, there was considerable early mortality; by 18 months, 30% of the male controls had died. In females, there were no differences in survival between controls and treated groups. There was still more early mortality in the females than expected, but it was less pronounced than the males. There was no obvious effect of methanol exposure on water consumption. The 20,000 ppm males and females weighed more than the controls (up to 14% and 7%, respectively) throughout the study. The 5,000 ppm females also weighed more (4%) than the controls at 24 months, but not at earlier time points. There were no body weight differences between the remaining treatment groups and the controls. The calculated methanol doses based on water intake were: 0, 55, 542 and 1,840 mg/kg/day for males; and 0, 67, 630 and 2,250 mg/kg/day for females. Nearly all rats in all dose groups had some pathology in the lung. The finding of lung pathology was consistent regardless of the age at death (not an old age response). The lung pathology included inflammation, dysplasia or tumours. Lung pathology was present in 70-100% of the first 10% of deaths in each group, including controls (70, 80, 80, 100% in males; and 90, 90, 100, 100% in females at 0, 500, 5,000 and 20,000 ppm, respectively). The degree of inflammation in the lungs is difficult to assess because no other lung information was recorded for the rats when a neoplasm in the lung was recorded (Soffritti et al., 2002; Cruzan, 2009; USEPA, 2013a) [Kl. score = 3].

Inhalation

Cynomolgus monkeys or Sprague–Dawley rats were exposed by inhalation to 0, 500, 2,000 or 5,000 ppm (0, 660, 2,620 or 6,552 mg/m^3) methanol for 6 h/day, 5 days/week for 4 weeks. There was no mortality and no clinical signs of toxicity among the monkeys, but there were a few signs of eye and nose irritation in the rats. No differences were seen between treated and control groups in body weight gain and organ weights, with the exception being decreased absolute adrenal weight in the 5,000 ppm female monkeys and increased relative spleen weights in the 2,000 ppm female rats.

These changes were not considered by the authors to be of biological significance. There were no treatment-related effects on the ophthalmoscopy, gross pathology or histopathology. The NOAEL for this study is 5,000 ppm (6,552 mg/m^3) (Andrews et al., 1987) [Kl. score = 4].

Groups of four male rats were exposed by inhalation to 0, 200, 2,000 or 10,000 ppm (0, 262, 2,621 or 13,104 mg/m^3) methanol for 6 hours/day, 5 days/week for 1, 2, 4 or 6 weeks. Additional groups of animals were exposed for 6 weeks followed by a 6-week recovery period. Evaluation of a number of parameters including lung weights, surfactant levels and enzyme activities did not reveal any adverse effects on the lung. No histopathological examinations were performed (White et al. 1983) [Kl score = 2].

Male and female F344 rats were exposed by inhalation to 0, 10, 100 or 1,000 ppm methanol 19.5 hours/day, 7 days/week for 104 weeks. The average methanol doses were: 0, 3.7, 37 and 369 mg/kg/day in males; and 0, 5.9, 60 and 599 mg/kg/day for females. There were no treatment-related clinical signs and no effect on survival or food consumption. Lower body weights were seen in the 1,000 ppm females beginning around Day 259, but after Day 574, there was no difference from controls. Body weights in males were similar across all groups. There were no treatment-related effects on urinalysis, hematology or clinical biochemistry. Nor were there any treatment-related effects on organ weights or gross lesions. Histopathologic examination showed no statistically significant differences between treated and control animals (NEDO, 1985a) [Kl score = 2].

Male and female B6C3F1 mice were exposed by inhalation to 0, 10, 100 or 1,000 ppm methanol 19.5 hours/day, 7 days/week for 78 weeks. The average methanol doses were: 0, 9.8, 95 and 947 mg/kg/day in males; and 0, 8.1, 106 and 1,071 mg/kg/day for females. There were no treatment-related clinical signs and no effect on survival or body weight. Food consumption was decreased slightly between months 7 and 12 in the 1,000 ppm females. Urinalysis, hematology and clinical biochemistry were similar across all groups. No differences were seen in organ weights, gross lesions or histopathology between treated and control mice (NEDO, 1985b) [Kl score = 2].

Dermal

No studies were identified.

G. Genotoxicity

In Vitro Studies

Methanol was not mutagenic to *Salmonella* strains TA97, TA98, TA100, TA1535, TA1537 and TA1538 in *in vitro* bacterial mutation assays with or without metabolic activation (De Flora et al., 1984a,b; Florin et al., 1980; Gocke et al.,1981). Equivocal results were obtained with *Salmonella* strain TA102 in the presence of metabolic activation (De Flora et al., 1984b). Methanol was not mutagenic in a DNA-repair test using various strains of *Escherichia coli* WP2 (De Flora et al., 1984a) and in a forward mutation assay using *Schizosaccharomyces pombe* (Abbondandolo et al., 1980).

Methanol did not induce micronuclei in Chinese hamster lung V79 cells in vitro (Lasne et al., 1984). Methanol was mutagenic in the mouse lymphoma assay in the presence of metabolic activation (McGregor et al., 1985), but it was not mutagenic in a Basc test or in a Drosophila, sex-linked, recessive lethal mutation assay (Gocke et al., 1981). Treatment of primary cultures of Syrian golden hamster embryo cells with methanol did not lead to cell transformation (Heidelberger et al., 1983).

In Vivo Studies

Male C57BL/6J mice were exposed by inhalation to 0, 800 or 4,000 ppm methanol, 6 hours/day for five days. There were no increased frequencies of micronuclei in blood cells; sister chromatid exchanges, chromosomal aberrations, or micronuclei in lung cells; or synaptosomal complex damage in spermatocytes (Campbell et al., 1991).

Normal or folate-deficient mice were given four daily intraperitoneal injections of up to 2,500 mg/kg of methanol. There was no increase in micronucleated erythrocytes in the treated mice compared to the controls (O'Loughlin et al., 1992).

Male and female NMRI mice were given a single intraperitoneal injection of 0, 1,920, 3,200 or 4,480 mg/kg methanol. There was no increase in micronuclei observed in the bone marrow at any dose level (Gocke et al., 1981).

H. Carcinogenicity

The carcinogenicity studies conducted on methanol were reviewed by Cruzan (2009) and by the USEPA (2013a).

Oral

Male and female SD rats were given in their drinking water 0, 500, 5,000 or 20,000 ppm methanol for 104 weeks. This study was conducted by the Ramazzini Foundation, which uses a unique methodology and not the standardised international testing guidelines. There was excessive early mortality, and lung pathology (inflammation, dysplasia, or tumours) was present in 87 to 94% of those dying anytime during the study. An increase in lympho-immunoblastic lymphomas was reported (Soffritti et al., 2002; Cruzan, 2009; USEPA, 2013a) [KI score = 3].

Inhalation

Male and female F344 rats were exposed by inhalation to 0, 10, 100 or 1,000 ppm methanol 19.5 hours/day, 7 days/week for 104 weeks. The average methanol doses were: 0, 3.7, 37 and 369 mg/kg/day in males; and 0, 5.9, 60 and 599 mg/kg/day for females. There was no increase in tumours in the methanol-exposed rats and mice (NEDO, 1985a) [KI score = 2].

Male and female B6C3F1 mice were exposed by inhalation to 0, 10, 100 or 1,000 ppm methanol 19.5 hours/day, 7 days/week for 78 weeks. The average methanol doses were: 0, 9.8, 95 and 947 mg/kg/day in males; and 0, 8.1, 106 and 1,071 mg/kg/day for females. There was no increase in tumours in the methanol-exposed mice (NEDO, 1985b) [KI score = 2].

I. Reproductive and Developmental Toxicity

Based on the data available, methanol is not considered to have reproductive or developmental toxicity in humans (NICNAS, 2013).

The reproductive and developmental toxicity studies were reviewed by the NTP Centre for Evaluation of Risks to Human Reproduction (NTP-CERHR, 2003). Conflicting results have been obtained concerning the effect of methanol on testicular hormones in rats; nevertheless, methanol does not appear to be a male reproductive toxicant. The primate data indicates that methanol is unlikely to be a reproductive hazard in females. Methanol causes developmental effects at very high

exposure levels in both rats (≥ 10,000 ppm) and mice (≥ 2,000 ppm); there is also some evidence that it is a developmental neurotoxicant in rodents, but not in primates.

Blood methanol concentrations associated with serious teratogenic effects and reproductive toxicity are in the range associated with formate accumulation, which is likely to result in metabolic acidosis, and visual and clinical effects in humans (NTP-CERHR, 2003). Other effects (such as subtle, not yet definitive neurological effects observed in primates) may be exhibited at lower inhalation doses and lower methanol blood levels (OECD, 2004).

The limited data available in humans do not show an association of reproductive and developmental toxicity with methanol (NTP-CERHR, 2003). Based on the studies reviewed by the NTP (2003), it concluded that there is evidence to suggest that women with low folate levels may be more susceptible to the adverse developmental effects of methanol, but more information is necessary to clarify this issue (NICNAS, 2013).

V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES

The toxicological reference values developed for methanol follow the methodology discussed in enHealth (2012). The approach used to develop drinking water guidance values is described in the Australian Drinking Water Guidelines (ADWG, 2021).

A. Non-Cancer

Oral

USEPA has derived an oral reference dose (RfD) by using exposure-response data from candidate principal inhalation studies of mice (Rogers et al., 1993) and rats (NEDO, 1987) and route-to-route extrapolation with the aid of the USEPA physiologically based pharmacokinetic (PBPK) model. The decision to use inhalation rather than oral study data is due to limitations in the database of oral studies, including the limited reporting of noncancer findings in the subchronic and chronic oral studies of rats, the determination that developmental effects are the most sensitive effects of methanol exposure. The RfD of 2 mg/kg/day was estimated from the Rogers et al. (1993) study for extra cervical rib incidence in mice (USEPA, 2013a). This RfD will be used for determining the drinking water guidance value.

Drinking water guidance value

Drinking water guidance value = (animal dose) x (human weight) x (proportion of intake from water) / (volume of water consumed) x (safety factor)

Using the oral RfD: Drinking water guidance value = (oral RfD) x (human weight) x (proportion of water consumed) / (volume of water consumed)

Where:

Human weight = 70 kg (ADWG, 2021)
Proportion of water consumed = 10% (ADWG, 2021)
Volume of water consumed = 2 L (ADWG, 2021)
Drinking water guidance value = (2 x 70 x 0.1)/2 = 7 mg/L

B. Cancer

Methanol was not carcinogenic to rats or mice in chronic inhalation studies. Increased tumours from methanol in drinking water were reported by Soffritti et al. (2002); however, there are methodological problems with this study and questions have been raised about the validity of the results. No cancer reference value was derived.

VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES

Methanol is a highly flammable liquid.

Methanol does not exhibit the following physico-chemical properties:

- Explosivity
- Oxidising potential

VII. ENVIRONMENTAL HAZARD ASSESSMENT

A. Summary

Methanol exhibits a low toxicity concern for aquatic organisms, terrestrial invertebrates and plants.

B. Aquatic Toxicity

Acute Studies

Table 2 lists the results of acute aquatic toxicity studies conducted on methanol.

Table 2: Acute Aquatic Toxicity Studies on Methanol

Test Species	Endpoint	Results (mg/L)	Klimisch score	Reference
Bluegill	96-hour LC_{50}	15,400	1	Poirer et al. 1986
Salmo gairdneri	96-hour LC_{50}	20,100	1	Call et al., 1983
Pimphales promelas	96-hour LC_{50}	28,100	1	Call et al., 1983
Daphnia magna	96-hour EC_{50}	18,260	2	Dom et al., 2012; ECHA
Daphnia magna	48-hour EC_{50}	>10,000	2	Kuehn et al., 1989
Selenastrum capricornutum	96-hour EC_{50}	~22,000	2	Cho et al., 2008; ECHA
Chlorella pyrenoidosa	10 to 14-day EC_{50}	28,400	2	Stratton and Smith, 1988

Chronic Studies

No adequate chronic studies were identified. Reported studies were either invalid or their reliability was questionable. Methanol belongs to the category of organic chemicals exerting toxicity for aquatic organisms with a non-specific mode of action. The acute and chronic toxicity may be estimated for such kind of chemicals using QSAR methods. The ECOSAR model (version 1.11, US EPA, July 2012) predicts for methanol a chronic toxicity value of about 450 mg/L (equivalent to a NOEC) for *Pimephales promelas* and a value of 208 mg/L for *Daphnia magna* (REACH) [Kl. score = 1].

C. Terrestrial Toxicity

The terrestrial toxicity studies on methanol are listed in **Table 3**.

Table 3: Terrestrial Toxicity Studies on Methanol

Test Species (Method)	Endpoint	Results (mg/kg soil dw)	Klimisch score	Reference
Earthworm *Eisenia fetida* (OECD 222)	35-day EC_{50} 63-day EC_{50}	17,199 26,646	2	ECHA
Folsomia candida (OECD 232)	28-day EC_{25} 28-day NOEC* (reproduction)	2,842 1,000	1	ECHA
Hordeum vulgare (OECD 208)	14-day EC_{50} 14-day NOEC* (seedling emergence)	15,492 12,000	1	ECHA
	14-day EC_{25} 14-day NOEC* (shoot dry mass)	2,538 1,555		
	14-day EC_{25} 14-day NOEC* (root dry mass)	2,823 2,592		
	14-day EC_{25} 14-day NOEC* (shoot length)	4,885 2,592		
	14-day EC_{25} 14-day NOEC* (root length)	5,752 4,320		

* Since only EC_{25} values were available from the test results, NOECs were derived graphically from the representing treatment means.

D. Calculation of PNEC

The PNEC calculations for methanol follow the methodology discussed in DEWHA (2009).

PNEC Water

Experimental results are available for three trophic levels. Acute $E(L)C_{50}$ values are available for fish (15,400 mg/L), *Daphnia* (> 10,000 mg/L) and algae (22,000 mg/L). There are no well-conducted long-term studies on methanol. Therefore, an assessment of 1,000 has been applied to the lowest reported effect concentration of 10,000 mg/L for *Daphnia*. The $PNEC_{water}$ is 10 mg/L.

PNEC Sediment

There are no adequate toxicity studies on sediment-dwelling organisms. Therefore, the $PNEC_{sed}$ was calculated using the equilibrium partitioning method. The $PNEC_{sed}$ is 6.3 mg/kg wet weight.

The calculations are as follows:

$PNEC_{sed} = (K_{sed\text{-}water}/BD_{sed}) \times 1000 \times PNEC_{water}$
$= (0.81/1280) \times 1000 \times 10$
$= 6.3$ mg/kg

Where:
$K_{sed\text{-}water}$ = suspended matter-water partition coefficient (m^3/m^3)
BD_{sed} = bulk density of sediment (kg/m^3) = 1,280 [default]
$K_{sed\text{-}water} = 0.8 + [0.2 \times Kp_{sed}/1000 \times BD_{soilid}]$
$= 0.8 + [0.2 \times 0.02/1000 \times 2400]$
$= 0.81\ m^3/m^3$

Where:
Kp_{sed} = solid-water partition coefficient (L/kg).
BD_{solid} = bulk density of the solid phase (kg/m^3) = 2,400 [default]
$Kp_{sed} = K_{oc} \times f_{oc}$
$= 0.61 \times 0.04$
$= 0.02$ L/kg

Where:
K_{oc} = organic carbon normalised distribution coefficient (L/kg). The K_{oc} for methanol is 0.61 L/kg.
f_{oc} = fraction of organic carbon suspended sediment = 0.04 [default].

PNEC Soil

Experimental results from chronic studies are available for three trophic levels. The lowest NOEC is 1,000 mg/kg soil dry weight for the arthropod *Folsomia candida*. On the basis that the data consists of long-term results from three trophic levels, an assessment factor of 10 has been applied to the lowest reported long-term NOEC of 1,000 mg/kg soil dry weight. The $PNEC_{soil}$ is 100 mg/kg soil dry weight.

VIII. PERSISTENCE, BIOACCUMULATION AND TOXICITY (PBT) ASSESSMENT

The methodology for the Persistent, Bioaccumulative and Toxic (PBT) substances assessment is based on the Australian and EU REACH Criteria methodology (DEWHA, 2009 and ECHA, 2008).

Methanol is readily biodegradable and thus it does not meet the screening criteria for persistence.

Based on an experimental BCF of < 10 in fish, methanol does not meet the criteria for bioaccumulation.

There are no adequate chronic toxicity studies on methanol. Predicted toxicity based on QSAR methods indicates chronic values > 0.1 mg/L for fish and invertebrates. The acute EC_{50} values of methanol in fish, invertebrates and algae is >1 mg/L; thus, it does not meet the screening criteria for toxicity.

The overall conclusion is that methanol is not a PBT substance.

IX. CLASSIFICATION AND LABELLING

A. Classification

Flammable Liquid Category 2

Acute Toxicity Category 3 [Oral]

Acute Toxicity Category 3 [dermal]

Acute Toxicity Category 3 [inhalation]

STOT SE Category 1 [optic nerve, central nervous system]

In the EU, there are concentration limits for the STOT SE classification of methanol. This may or may not apply to GHS classifications for Australian SDS.

Concentration range (%):

>10	STOT SE Category 1
>3 and <10	STOT SE Category 2

B. Labelling

Danger

C. Pictograms



The health hazard pictogram is omitted if the STOT SE classification for methanol does not apply (i.e., concentration of methanol is below the concentration limits).

X. HANDLING AND SAFETY INFORMATION (OCCUPATIONAL LIMITS AND TRANSPORTATION REQUIREMENTS)

Note: Methanol is used in the drilling mud product ALDACIDE® G ANTIMICROBIAL at a concentration of 0.1% to 1%. The safety and handling of methanol at this concentration in ALDACIDE® G ANTIMICROBIAL will be provided in the dossier on glutaraldehyde, the major constituent of ALDACIDE® G ANTIMICROBIAL.

A. Occupational Exposure Standards

The workplace exposure standard for methanol in Australia is 200 ppm (262 mg/m^3) as an 8-hour TWA and 250 ppm (328 mg/m^3) as a 15-minute STEL. There is also a skin notation indicating that absorption through the skin may be a significant source of exposure.

B. Transport Information

Methanol is used in drilling mud product ALDACIDE® G ANTIMICROBIAL at a concentration of 0.1 to 1%. The transportation information for ALDACIDE® G ANTIMICROBIAL will be provided in the dossier on glutaraldehyde, the major constituent of ALDACIDE® G ANTIMICROBIAL.

XI. DISPOSAL MANAGEMENT

Disposal should be in accordance with all local, state and federal regulations.

XII. REGULATORY STATUS

Australian AICS Inventory: Listed.

XIII. REFERENCES

Abbondandolo, A. et al. (1980). Mutat. Res. 79: 141 – 150.

ADWG. (2021). National Water Quality Management Strategy. Australian Drinking Water Guidelines, Section 6, Australian Government, National Health and Medical Research Council, Natural Resource Management Ministerial Council.

Andrews, L.S., Clary, J.J., Terrill, J.B., and Bolte, H.F. (1987). Subchronic inhalation toxicity of methanol. J. Toxicol. Environ. Health 20: 117-124.

BASF AG. (1975). Unpublished data, (XXIV 436), 03 July 1975; cited in OECD-SIDS SIAR on Methanol.

BASF AG. (1979). Unpublished data, (78/333), 11 April / 11 July 1979; cited in OECD-S SIDS SIAR on Methanol.

BASF AG. (1980a). Unpublished report, (80/158), 07 Aug. 1980; cited in OECD-SIDS SIAR on Methanol.

BASF AG. (1980b). Unpublished report, (80/158), 20 Nov. 1980; cited in OECD-SIDS SIAR on Methanol.

Batterman, S.A., and Franzblau, A. (1997). Time-resolved cutaneous absorption and permeation rates of methanol in human volunteers. Int. Arch. Occup. Environ. Health 70: 341-351.

Call, D.J., L.T. Brooke, N. Ahmad, J.E. Richter. (1983). Toxicity and metabolism studies with EPA priority pollutants and related chemicals in freshwater organisms, EPA-600/3-83-095, PB83-263665.

Campbell, J.A., Howard, D.R., Backer, L.C., Allen, J.W. (1991). Evidence that methanol does not induce chromosome damage in mice. Mutat. Res. 260 : 257-264.

Cho, C. W., Y-C. Jeon, T.P.T. Pham, K. Vijayaraghaven, Y-S. Yun. (2008). The ecotoxicity of ionic liquids and traditional organic solvents on microalga Selenastrum capricornutum. Ecotoxicol. Environ. Saf. 71: 166-171.

Cruzan, G. (2009). Assessment of the cancer potential of methanol. Crit. Rev. Toxicol. 39: 347-363.

Department of the Environment and Energy [DoEE]. (2017). Chemical Risk Assessment Guidance Manual: for chemicals associated with coal seam gas extraction, Guidance manual prepared by Hydrobiology and ToxConsult Pty Ltd for the Department of the Environment and Energy, Commonwealth of Australia, Canberra.

Department of the Environment, Water, Heritage and the Arts [DEWHA]. (2009). Environmental risk assessment guidance manual for industrial chemicals, Department of the Environment, Water, Heritage and the Arts, Commonwealth of Australia.

Deichman, W.B., and Mergard, E.G. (1948). J. Ind. Hyg. Toxicol. 30: 373 – 378.

Dom, N., M. Penninck, D. Knapen, R. Blust. (2012). Discrepancies in the acute versus chronic toxicity of compounds with a designated narcotic mechanism. Chemosphere 87: 742-749.

Dutkiewicz, B., Korczalik, H., and Karwacki, W. (1980). Int. Arch. Occup. Environ. Health 47: 47: 81-88.

ECHA. ECHA REACH database: http://echa.europa.eu/information-on-chemicals/registered-substances

enHealth Human Risk Assessment (HHRA). (2012). Environmental Health RiskAssessment, Guidelines for Assessing Human Health Risks from Environmental Hazards. Office of Health Protection of the Australian Government Department of Health.

European Chemicals Agency (ECHA). (2008). Guidance on Information Requirements and Chemical Safety Assessment, Chapter R11: PBT Assessment, European Chemicals Agency, Helsinki, Finland.

De Flora, S., Zanacchi, A., Camoirano, A., Bennicelli, C. and Badolati, G.S. (1984a). Mutat. Res. 133(3) : 161 – 198.

De Flora, S., Zanacchi, A., Camoirano, A., Bennicelli, C. and Badolati, G.S. (1984b). Mutat. Res. 134 : 159 – 165.

Florin, I., Rutberg, L., Curvall, M. and Enzell, C.R (1980). Toxicol. 18 : 219 – 232.

Freitag, D., Lay, P. and Korte, F. (1985). Environmental Hazard Profile of Organic Chemicals: An experimental method for the assessment of the behaviour of organic chemicals in the ecosphere by means of simple laboratory tests with 14C labelled chemicals. Chemosphere, 14: 1589-1616.

Gluth, G., D. Freitag, W. Hanke, F. Korte. (1985). Accumulation of pollutants in fish. Comp. Biochem. Physiol., 81C: 273 – 277.

Gocke, E., M.-T. King, K. Eckhardt, D. Wild. (1981). Mutagenicity of cosmetic ingredients licensed by the European Communities. Mutat. Res. 90: 91 – 109.

Hansch, C. and Leo, A.J. (1985). Medchem. Project Issue No.26, Claremont CA, Pomona College.

Heidelberger, C. Freeman A., Pienta R.J., Sivak A., Bertram J.S., Casto B.C., Dunkel V., Francis M.W., Kakunaga T., Little J.B., Schechtman L.M. (1983). Mutat. Res. 114 : 283 – 385.

IPCS. (1997). Environmental Health Criteria on Methanol 196, WHO, Geneva.

Kavet , R., and Nauss, K.M. (1990). The toxicity of inhaled methanol vapors. CRC Crit. Rev. Toxicol. 20: 21 – 50.

Kimura, E.T., Ebert, D.M., and Dodge, P.W. (1971). Toxicol. Appl. Pharmacol. 19: 699 – 703.

Klimisch, H.J., Andreae, M., and Tillmann, U. (1997). A systematic approach for evaluating the quality of experimental and toxicological and ecotoxicological data. Regul. Toxicol. Pharmacol. 25:1-5.

Kuehn, R., et al. (1989). Water Research, 23: 495-499.

Lasne, C., et al. (1984.) Mutat. Res. 130: 273 – 282.

Liesivuori, J., and Savolainen, H. (1991). Pharmacol. Toxicol. 69: 157 – 163.

Lokke, H. (1984). Leaching of ethylene glycol and ethanol in subsoils. Water, Air, and Soil Pollution 22: 373-387.

McGregor, D.B et al. (1985). Environ. Mutagen. 7(Suppl. 3), A10.

NEDO. (1985a). 24-month inhalation carcinogenicity study on methanol in Fischer 344 rats (test no.: 5A-268), Report dated September 30, 1985, 10 volumes. Mitsubishi Kasei Institute for Toxicological and Environmental Sciences, Tokyo.

NEDO. (1985b). 18-month inhalation carcinogenicity study on methanol in B6C3F1 mice (test no.: 4A-223), Report dated March 30, 1985, 9 volumes. Mitsubishi Kasei Institute for Toxicological and Environmental Sciences, Tokyo.

NEDO. (1987). Toxicological research of methanol as a fuel for power station: summary report on tests with monkeys, rats and mice. Tokyo, Japan.

NICNAS. (2013). IMAP Single Assessment Report for Methanol: Human Health Tier II Assessment. May 17, 2013. Available at: https://www.industrialchemicals.gov.au/sites/default/files/Methanol_Human%20health%20tier%20II%20assessment.pdf

NTP-CERHR. (2003). NTP-CERHR Monograph on the Potential Human Reproductive and Developmental Effects of Methanol, Center for the Evaluation of Risks to Human Reproduction, National Toxicology Program, U.S. Department of Health and Human Services, NIH Publication, No. 03-4478.

OECD. (2004a). IUCLID Data Set for Methanol (CAS No. 67-56-1). Available at: http://webnet.oecd.org/Hpv/UI/SIDS_Details.aspx?id=39B5D34A-2F5D-4D53-B000-E497B3A3EE89

OECD. (2004b). Screening Information Dataset (SIDS) Initial Assessment Report for Methanol (CAS No. 67-56-1). Available at: http://webnet.oecd.org/Hpv/UI/SIDS_Details.aspx?id=39B5D34A-2F5D-4D53-B000-E497B3A3EE89

O'Loughlin, K. et al. (1992). Environ. Mutagen Soc. 47 (Abstr.).

Poirer S.H., Knuth, L.M., Anderson-Buchou, C.D,. et al. (1986). Comparative toxicity of methanol and N,N-dimethylformamide to freshwater fish. Bull. Environ. Contam. Toxicol., 37: 615-621.

Price, K.S., G.T. Waggy, R.A. Conway. (1974). Brine shrimp bioassay and seawater BOD of petrochemicals. J. Water Pollution Control Fed. 46: 63-77.

Rogers, JM; Mole, ML; Chernoff, N; Barbee, BD; Turner, CI; Logsdon, TR; Kavlock, RJ. (1993). The developmental toxicity of inhaled methanol in the CD-1 mouse, with quantitative dose-response modeling for estimation of benchmark doses. Teratology 47: 175-188. http://dx.doi.org/10.1002/tera.1420470302.

Rowe, K., and McCollister, S.B. (1982). In: Patty's Industrial Hygiene and Toxicology, 3rd rev. ed. (G. D. Clayton and F. E. Clayton, eds.), pp. 4527-4708, Wiley, New York.

Scheunert, I., D. Vockel, J. Schmitzer, F. Korte. (1987). Biomineralization rates of 14C-labelled organic chemicals in aerobic and anaerobic suspended soil. Chemosphere 16: 1031-1041.

Schuelplein, R.J., and Blank, I.H. (1971). Physiol. Rev. 51: 702-747.

Smyth, H.F., Seaton, J., and Fisher, L. (1941). J. Ind. Hyg. Toxicol. 23: 259 – 268.

Soffritti, M., Belpoggi, F., Cevolani, D., Guarino, M., Padovani, M., and Maltoni, C. (2002). Results of long-term experimental studies on the carcinogenicity of methyl alcohol and ethyl alcohol in rats. In: M.A. Mehlman (Ed.), Carcinogenesis bioassays and protecting public health: commemorating the lifework of Cesare Maltoni and colleagues, pp. 46-69, Bologna, Italy: Ann. N.Y. Acad. Sci.

Stratton, G.W., and Smith, T.M. (1988). Interaction of organic solvents with the green alga Chlorella pyrenoidosa, Bull. Environ. Contam. Toxicol., 40: 736-742.

Tephly, T.R. (1991). The toxicity of methanol. Life Sci. 48: 1031 – 1041.

USEPA. (1986). Rat Oral Subchronic Study on Methanol, U.S. Environmental Protection Agency, Washington, DC. Cited in the U.S. Integrated Risk Information System (IRIS) database for methanol (https://www.epa.gov/iris).

USEPA. (2013a). Toxicological Review of Methanol (Noncancer) (CAS No. 67-56-1) in Support of Summary Information on the Integrated Risk Information System (IRIS). EPA/635/R-11/00FA U.S. Environmental Protection Agency, Washington, DC. Available at: https://cfpub.epa.gov/ncea/iris/iris_documents/documents/toxreviews/0305tr.pdf

USEPA. (2013b). Integrated Risk Information System (IRIS) Chemical Assessment Summary: Methanol (CASRN 67-56-1). Available at: https://cfpub.epa.gov/ncea/iris/iris_documents/documents/subst/0305_summary.pdf

Welch, H., and Slocum, G.G. (1943). J. Lab. Chem. Med. 28: 1440.

White, L.R., Marthinsen, A.B.L., Ricchard, R.J., Eik-Nes, K.B., and Nilsen, O.G. (1983). Biochemical and cytological studies of rat lung after inhalation of methanol vapor. Toxicol. Lett. 17: 1-5.

POLYACRYLAMIDE

This dossier on polyacrylamide presents the most critical studies pertinent to the risk assessment of polyacrylamide in its use in coal seam or shale gas extraction activities. This dossier does not represent an exhaustive or critical review of all available data. The majority of information presented in this dossier was obtained the Cosmetic Ingredient Review on polyacrylamide (CIR, 2005) and from the book titled Ecological Assessment of Polymers, Strategies for Product Stewardship and Regulatory Programs (Lyons and Vasconellos, 1997). Where possible, study quality was evaluated using the Klimisch scoring system (Klimisch et al., 1997).

NICNAS has assessed polyacrylamide in an IMAP Tier 1 assessment and concluded that it is a polymer that poses no unreasonable risk to the environment[1]

I. SUBSTANCE IDENTIFICATION

Chemical Name (IUPAC): Copolymer of polyacrylamide (poly(2-propenamide)] and polyacrylate [poly(2-propenoic acid)]

CAS RN: 9003-05-8

Molecular formula: $(C_3H_5NO)_x$- and $(C_3H_3O_2)_x$-

Molecular weight: 1,000,000 to >50,000,000 g/mol for polyacrylamide copolymers used as flocculants (Lyons and Vasconcellos, 1997)

Synonyms: Polyacrylamide, anionic polyacrylamide, Copolymer of polyacrylamide (poly(2-propenamide)] and polyacrylate [poly(2-propenoic acid)]

SMILES: not applicable (polymer)

II. PHYSICO-CHEMICAL PROPERTIES

Polyacrylamide polymers can exist in cationic, anionic or non-ionic forms, depending on their ionic charge. The non-ionic form of polyacrylamide is generated from the basic polymerisation of acrylamide. Polyacrylamide polymer can then be formed from the hydrolysis of the acrylamide homopolymer either simultaneously during the polymerisation process or as a subsequent step (Zheng et al., 2013). Polyacrylamide polymer can also be formed from the copolymerisation of acrylamide and acrylic acid (Lyons and Vasconellos, 1997; Zheng et al., 2013).

[1] https://www.industrialchemicals.gov.au/chemical-information/search-assessments?assessmentcasnumber=9003-05-8++

III. ENVIRONMENTAL FATE PROPERTIES

A. Summary

There are no studies on the environmental fate of polyacrylamide available. As a high-molecular-weight, water-soluble polymer, it is not expected to biodegrade or bioaccumulate (Lyons and Vasconcellos, 1997). The environmental fate of polyacrylamide will be determined primarily by adsorption (Lyons and Vasconcellos, 1997).

The polyanions in this group are expected to partition onto natural colloids in surface waters and in soil and are not expected to undergo long-range transport in the environment (DoEE, 2017).

IV. HUMAN HEALTH HAZARD ASSESSMENT

A. Summary

Polyacrylamide is not bioavailable when ingested. It is essentially non-toxic by the oral route, and it is not irritating to the skin or eyes. Lifetime dietary studies in rats showed no toxicity or carcinogenic effects. There were no indications of reproductive or developmental toxicity in rats given polyacrylamide in their feed over several generations.

B. Metabolism

Female rats were dosed by oral gavage with 140 mg/kg bw/day [^{14}C]-anionic polyacrylamide (molecular weight of 3,000,000). No radioactivity was observed in any of the animals. After 25 hours, the sum of the radioactivity recovered in the feces was 95.13% of the administered dose, and the gastrointestinal tract and contents accounted for 1.64% of the dose. The urine contained activity representing 0.82% of the dose and carbon dioxide in the expired air was 0.07%. Liver and kidney tissue contained about 0.05%. (McCollister et al., 1965).

C. Acute Toxicity

Oral

No deaths were observed in rats given either nonionic or anionic polyacrylamide at oral doses up to 4,000 mg/kg. The oral LD_{50} is >4,000 mg/kg bw/day (McCollister et al., 1965).

Inhalation

There are no studies available.

Dermal

There are no studies available.

D. Irritation

Application of a 5% solution of polyacrylamide to the skin of rabbits was “well tolerated” (CIR, 2005). Polyacrylamide is non-irritating to slightly irritating to the eyes (CIR, 2005).

E. Sensitisation

There are no studies are available.

F. Repeated Dose Toxicity

Oral

Male and female rats were given in their diet 0, 5, or 10% anionic polyacrylamide (molecular weight of 3,000,000) for two years. The animals in the 10% dose group showed significant retardation of growth. At the end of the study, there was a slight statistically significant increase in kidney weights in the 10% males and in the ≥5% females. Gross and microscopic examination of the tissues from the ≥5% groups at 12 months showed some slight diffuse cloudy swelling, areas of focal necrosis and mild replacement fibrosis in the liver. At 18 and 24 months, all the animals showed tissue changes indicate of old age. These changes involved the small arterioles of the heart, kidney, spleen, pancreas, and to a lesser degree, the liver. All groups of animals were affected including the controls, but the degree of severity was somewhat increased in the ≥5% animals. The authors of the study suggested that the effects seen in the ≥5% dietary groups are attributed indirectly to the large, hydrophilic, non-nutritive bulkiness of the polymer in the gastrointestinal tract. For instance, reduced caloric intake may be partially responsible for the growth retardation; there may also have been interference of the absorption of dietary nutrients. Moreover, the [C^{14}]polymer bioavailability studies no gastrointestinal absorption. The NOAEL for this study is 10% in the diet (McCollister et al., 1965).

Inhalation

There are no studies available.

Dermal

There are no studies available.

G. Genotoxicity

There are no *in vitro* or *in vivo* studies available for polyacrylamide.

H. Carcinogenicity

Oral

Male and female rats were fed 0, 5, or 10% anionic polyacrylamide (molecular weight of 3,000,000) in their diet for two years. The tumour incidences were similar between the treated and control animals (McCollister et al., 1965).

Inhalation

There are no studies available.

Dermal

There are no studies available.

I. Reproductive Toxicity and Developmental Toxicity

In an abstract, it was reported that rats fed up to 2,000 ppm polyacrylamide in a three-generation reproductive toxicity study showed no reproductive, developmental, or parental toxicity (CIR, 2005).

V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES

The toxicological reference values developed for polyacrylamide follow the methodology discussed in enHealth (2012). The approach used to develop drinking water guidance values is described in the Australian Drinking Water Guidelines (ADWG, 2011).

A. Non-Cancer

Oral

No adverse effects were reported in rats fed anionic polyacrylamide in their diet at doses up to 10% for two years (McCollister et al., 1965). Using 0.05 as the fraction of body weight that is consumed per day as food for the rat, the NOAEL for this study is 5,000 mg/kg bw/day-day. The NOAEL of 5,000 mg/kg bw/day-day will be used for determining the oral reference dose (RfD) and the drinking water guidance value.

Oral Reference Dose (oral RfD)

Oral RfD = NOAEL / (UF_A x UF_H x UF_L x UF_{Sub} x UF_D)

Where:
UF_A (interspecies variability) = 10
UF_H (intraspecies variability) = 10
UF_L (LOAEL to NOAEL) = 1
UF_{Sub} (subchronic to chronic) = 1
UF_D (database uncertainty) = 1

Oral RfD = 5,000/(10 x 10 x 1 x 1 x 1) = 5000/100 = 50 mg/kg bw/day

Drinking water guidance value

Drinking water guidance value = (animal dose) x (human weight) x (proportion of intake from water) / (volume of water consumed) x (safety factor)

Using the oral RfD,

Drinking water guidance value = (oral RfD) x (human weight) x (proportion of water consumed) / (volume of water consumed)

where:
Human weight = 70 kg (ADWG, 2011)
Proportion of water consumed = 10% (ADWG, 2011)
Volume of water consumed = 2L (ADWG, 2011)

Drinking water guidance value = (50 x 70 x 0.1)/2 = 175 mg/L

B. Cancer

Polyacrylamide was not carcinogenic to rats when given in a two-year dietary study; thus, a cancer reference value was not derived.

VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES

Polyacrylamide does not exhibit the following physico-chemical properties:

- Explosivity
- Flammability
- Oxidising potential

VII. ENVIRONMENTAL HAZARD ASSESSMENT

A. Summary

Anionic polyacrylamide has a low acute toxicity concern to aquatic organisms.

B. Aquatic Toxicity

Acute Studies

Table 1 lists the results of acute aquatic toxicity studies on the powder form of anionic polyacrylamides. The data were reported in a table as LC_{50} values with no details on the individual studies.

Table 1: Acute Aquatic Toxicity Studies on Polyacrylamide in powder form*

Test Species	Ionic charge	Results (mg/L)	Klimisch score	Reference
Fathead minnow	-31	LC_{50}: 810	-	Betz laboratories, Inc. (1995)
Rainbow trout	-31	LC_{50}: >100	-	Betz laboratories, Inc (1995)
Bluegill sunfish	-31	LC_{50}: >300	-	Betz laboratories, Inc (1995)
Rainbow trout	-22	LC_{50}: >100	-	Betz laboratories, Inc (1995)
Bluegill sunfish	-22	LC_{50}: >300	-	Betz laboratories, Inc (1995)
Rainbow trout	-12	LC_{50}: >100	-	Betz laboratories, Inc (1995)
Bluegill sunfish	-12	LC_{50}: >300	-	Betz laboratories, Inc (1995)
Daphnia magna	-39	LC_{50}: 470	-	Betz laboratories, Inc (1995)

*Acrylic acid-acrylamide copolymers with molecular weights of >1,000,000.

Chronic Studies

There are no studies available.

C. Terrestrial Toxicity

There are no studies available.

D. Calculation of PNEC

The PNEC calculations for polyacrylamide follow the methodology discussed in DEWHA (2009).

PNEC Water

Experimental results are available for two trophic levels. Acute E(L)C_{50} values are available for fish (>100 mg/L) and *Daphnia* (470 mg/L). On the basis that the data consists of only short-term results from two trophic levels, an assessment factor of 1,000 has been applied to the lowest reported E(L)C_{50} value of >100 mg/L for fish. The $PNEC_{aquatic}$ is 0.1 mg/L.

PNEC Sediment

There are no toxicity data for sediment-dwelling organisms. The K_{ow} and K_{oc} have not been experimentally derived for anionic polyacrylamide; these values cannot be estimated using QSAR models because of the high molecular weight of anionic polyacrylamide. Thus, the equilibrium partitioning method cannot be used to calculate the $PNEC_{sed}$.

PNEC Soil

There are no toxicity data for soil-dwelling organisms. The K_{ow} and K_{oc} have not been experimentally derived for anionic polyacrylamide; these values cannot be estimated using QSAR models because of the high molecular weight of anionic polyacrylamide. Thus, the equilibrium partitioning method cannot be used to calculate the $PNEC_{soil}$.

VIII. PERSISTENCE, BIOACCUMULATION AND TOXICITY (PBT) ASSESSMENT

The methodology for the Persistent, Bioaccumulative and Toxic (PBT) substances assessment is based on the Australian and EU REACH Criteria methodology (DEWHA, 2009; ECHA, 2017).

Polyacrylamide is a large molecular weight, water-soluble polymer. It is not expected to be readily biodegradable; thus, it meets the screening criteria for persistence.

Pharmacokinetic studies showed that polyacrylamide was not bioavailable to rats when ingested; this is most likely due to its large size (high molecular weight) and presumed resistance to breakdown in the gastrointestinal tract. Polyacrylamide is thus not expected to be bioavailable to aquatic or terrestrial organisms. It is not expected to meet the criteria for bioaccumulation.

There are no chronic aquatic toxicity data available for polyacrylamide. The acute E(L)C_{50} values from the acute aquatic toxicity studies on polyacrylamide are > 1 mg/L. Thus, polyacrylamide does not meet the criteria for toxicity.

The overall conclusion is that polyacrylamide is not a PBT substance.

IX. CLASSIFICATION AND LABELLING

A. Classification

Polyacrylamide is not classified.

B. Labelling

None

A. Pictogram

None

X. HANDLING AND SAFETY INFORMATION (OCCUPATIONAL LIMITS AND TRANSPORTATION REQUIREMENTS)

A. First Aid

Please refer to the product SDS for additional information and confirmation of the information provided herein.

Eye Contact

In case of contact, immediately flush eyes with plenty of water for at least 15 minutes.

Skin Contact

Wash thoroughly with soap and water.

Inhalation

If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.

Ingestion

Rinse mouth with water and then drink a glass of water. Get medical attention. Never give anything by mouth to an unconscious person.

B. Fire Fighting Information

Extinguishing Media

Water spray, carbon dioxide, foam, dry chemical.

Specific Exposure Hazards

Keep product and empty container away from heat and sources of ignition. May emit toxic fumes under fire conditions. Depending on conditions, decomposition products may include the following: carbon monoxide, carbon dioxide.

Special Protective Equipment for Firefighters

Wear self-contained breathing apparatus.

C. Accidental Release Measures

Personal Precautions

Use appropriate protective equipment. Avoid dust formation. Ensure adequate ventilation. Do not breathe dust. Handle in accordance with good industrial hygiene and safety practice.

Environmental Precautions

Prevent from entering sewers, waterways, or low areas.

Steps to be Taken if Material is Released or Spilled

For large amounts: dike spillage and pump off product. For residues: pick up with suitable absorbent material. Dispose of contaminated material as prescribed.

D. Storage And Handling

General Handling

Keep product and empty container away from heat and sources of ignition. Ensure adequate ventilation, especially in confined areas.

Storage

Keep container tightly closed and in a dry and well-ventilated place. Keep in a cool place.

E. Exposure Controls / Personal Protection

Occupational Exposure Standards

The workplace Australia has not established an occupational exposure standard for polyacrylamide.

Engineering Controls

Good general ventilation should be used.

Personal Protection Equipment

Respiratory Protection: Respiratory protection is not required.

Hand Protection: Chemical resistant protective gloves.

Skin Protection: Body protection must be chosen depending on activity and possible exposure.

Eye protection: Safety glasses with side-shields.

Other Precautions: Handle in accordance with good industrial hygiene and safety practice. Wearing of closed work clothing is recommended. Ensure that eyewash stations and safety showers are close to the workstation location.

F. Transport Information

Polyacrylamide is not considered hazardous for purposes of transportation by road or rail. An Australian Dangerous Goods code is not required.

XI. DISPOSAL MANAGMENT

Disposal should be in accordance with all local, state, and federal regulations.

XII. REGULATORY STATUS

Australian AICS Inventory: Listed.

XIII. REFERENCES

ADWG. (2011). National Water Quality Management Strategy. Australian Drinking Water Guidelines, Section 6, Australian Government, National Health and Medical Research Council, Natural Resource Management Ministerial Council. Updated January 2022. Available: https://www.nhmrc.gov.au/about-us/publications/australian-drinking-water-guidelines

Betz Laboratories, Inc. (1991). Betz Handbook of Industrial Water Conditioning, 9th Ed., Trevose, PA; cited in Lyons and Vasconcellos (1997).

Cosmetic Ingredient Review [CIR] (2005). Amended final report on the safety assessment of polyacrylamide and acrylamide residues in cosmetics. Int. J. Toxicol. 24 (Suppl 2): 21-50.

Department of the Environment, Water, Heritage and the Arts [DEWHA]. (2009). Environmental risk assessment guidance manual for industrial chemicals, Department of the Environment, Water, Heritage and the Arts, Commonwealth of Australia. Available: http://www.nepc.gov.au/resource/chemical-risk-assessment-guidance-manuals

Department of the Environment and Energy [DoEE]. (2017). Chemical Risk Assessment Guidance Manual: for chemicals associated with coal seam gas extraction, Guidance manual prepared by Hydrobiology and ToxConsult Pty Ltd for the Department of the Environment and Energy, Commonwealth of Australia, Canberra.

ECHA. ECHA REACH database: http://echa.europa.eu/information-on-chemicals/registered-substances

enHealth Human Risk Assessment [HHRA]. (2012). Environmental Health Risk Assessment, Guidelines for Assessing Human Health Risks from Environmental Hazards. Office of Health Protection of the Australian Government Department of Health. Available: https://www1.health.gov.au/internet/main/publishing.nsf/Content/health-pubhlth-publicat-environ.htm

European Chemicals Agency [ECHA]. (2017). Guidance on Information Requirements and Chemical Safety Assessment, Chapter R11: PBT Assessment, European Chemicals Agency, Helsinki, Finland. Available: https://echa.europa.eu/guidance-documents/guidance-on-information-requirements-and-chemical-safety-assessment

Klimisch, H.J., Andreae, M., and Tillmann, U. (1997). A systematic approach for evaluating the quality of experimental and toxicological and ecotoxicological data. Regul. Toxicol. Pharmacol. 25:1-5.

Lyons, L.A., and Vasconcellos, S.R. (1997). Water treatment polymers. In: Ecological Assessment of Polymers. Strategies for Product Stewardship and Regulatory Programs (Hamilton, J.D. and R. Sutcliffe, Eds.), pp. 113-145, Wiley.

McCollister, D.D., Hake, C.L., Sadek, S.E., and Rowe, V.K. (1965). Toxicologic investigations of polyacrylamides. Toxicol. Appl. Pharmacol. 7: 639-651.

Ovivo Australia (2014). Safety Data Sheet (SDS) for EnviroFloc 4017. Prepared by Chemwatch, 34-4761, version No: 2.1.1.1, issue date: 16/02/2014.

Zheng, H., Ma, J., Ji, F., Tang, X., Chen, W., Zhu, J., Liao, Y., and Tan, M. (2013). Synthesis and application of anionic polyacrylamide in water treatment. Asian J. Chem. 25(13): 7071-7074.

POLYOXYETHYLENE NONYLPHENOL ETHER, [NONYLPHENOL, ETHOXYLATED] (CAS NO. 9016-45-9)
POLYOXYETHYLENE GLYCOL TRIMETHYLNONYL ETHER (CAS NO. 127087-87-0)
NONOXYNOL-9 (CAS NO. 26571-11-9)

This group contains polyoxyethylene nonylphenol ether (also referred to as nonylphenol, ethoxylated or NPE), and similar NPEs polyoxyethylene glycol trimethylnonyl ether (also referred to as branched p-nonylphenol ethoxylate) and nonoxynol-9. Information provided in this dossier is based on the group.

This dossier on NPE, branched p-nonylphenol ethoxylate and nonoxynol-9 presents the most critical studies pertinent to the risk assessment of these substances in their use in coal seam or shale gas extraction activities. This dossier does not represent an exhaustive or critical review of all available data. The majority of information presented in this dossier was obtained from the NICNAS environmental and human health tier II assessments for the NPE group (NICNAS, 2018 and 2019) and from the ECHA database that provides information on chemicals that have been registered under the EU REACH (ECHA). Where possible, study quality was evaluated using the Klimisch scoring system (Klimisch et al., 1997).

I. SUBSTANCE IDENTIFICATION

Chemical Name (IUPAC): 26-(Nonylphenoxy)-3,6,9,12,15,18,21, octaoxahexacosan-1-ol

CAS RN: 26571-11-9

Molecular formula:C_{33}-H_6O-$O_1$0

Molecular weight: 616.827 g/mol

Synonyms: Nonoxynol-9; 3,6,9,12,15,18,21,24-Octaoxahexacosan-1-ol, 26-(nonylphenoxy)-; Nonaethylene glycol mono (nonylphenyl) ether; nonaethylene glycol nonylphenyl ether; nonylphenol octa(oxyethylene) ethanol

SMILES: CCCCCCCCCC1=CC=C(C=C1)OCCOCCOCCOCCOCCOCCOCCOCCOCCO;

Chemical Name (IUPAC): 2-(4-nonylphenoxy)ethanol

CAS RN: 127087-87-0

Molecular formula: $C_{17}H_{28}O_2$

Molecular weight: 264.4 g/mol

Synonyms: Polyoxyethylene glycol trimethylnonyl ether; Poly(oxy-1,2-ethanediyl), .alpha.-(4-nonylphenyl)-.omega.-hydroxy-branched; 2-(p-Nonylphenoxy)ethanol

SMILES: CCCCCCCCCC1=CC=C(C=C1)OCCO;

Chemical Name (IUPAC): Poly(oxy-1,2-ethanediyl), .alpha.-(nonylphenyl)-.omega.-hydroxy-

CAS RN: 9016-45-9

Molecular formula: $C_{39}H_{72}O_{13}$ (can vary based on length of ethoxy ether chain)

Molecular weight: 748.98 g/mol (can vary based on length of ethoxy ether chain)

Synonyms: polyoxyethylene nonylphenol ether; nonylphenol, ethoxylated; nonylphenol ethoxylate; 2-[2-(4-Nonylphenoxy)ethoxy]ethanol; ethoxylated nonylphenol

SMILES: CC(C)CC(C)CC(C)c1ccc(OCCOCCOCCOCCOCCOCCOCCOCCOCCOCCOCCOCCOCCO)cc1

II. PHYSICO-CHEMICAL PROPERTIES

NPE is a non-ionic surfactant used as a detergent, emulsifier, wetting agent, or defoaming agents. The general formula of NPEs is C15H24(C2H4O) n; where 'n' is the number of ethylene oxide (EO) units attached to the phenol ring, and can vary from 1–120. The NPEs differ by the length of the EO chain, which also contributes to different physicochemical properties and the degree of toxicity (NICNAS, 2019).

Key physical and chemical properties for a representative nonylphenol ether (NPE) are shown in Table 1.

Table 1: Overview of the Physico-chemical Properties of Nonylphenol, Ethoxylated

Property	Value	Klimisch Score	Reference
Physical state at 20°C and 101.3 kPa	Liquid	2	ECHA
Melting Point	>42-<44°C (pressure not provided)	2	ECHA
Boiling Point	>295-<320°C (pressure not provided)	2	ECHA
Density	1050 kg/m3@ 50°C	2	ECHA
Vapour Pressure	140 Pa @ 25°C	2	ECHA
Partition Coefficient (log K_{ow})	3.70 @ 25°C	2	ECHA
Water Solubility	153 g/L @ 20°C	2	ECHA
Flash Point	Not available	-	ECHA
Auto flammability	383°C @ 101.7 kPa	2	ECHA
Viscosity	Not available	-	ECHA
Henry's Law Constant	Not available	-	ECHA

III. ENVIRONMENTAL FATE PROPERTIES

A. Summary

NPE is readily biodegradable, and it is not expected to bioaccumulate. It has a low potential to adsorb to soil or sediment.

B. Biodegradation

NPE is readily biodegradable. There was 96% degradation of NPEs after 30 days, indicating substantial primary biodegradation. The biodegradation process generated degradants nonylphenol mono- and di-ethoxylates, nonylphenoxy acetate and nonylphenol mono-ethoxyacetate, some of which remained at the end of 30 days (ECHA). [Kl. Score = 2].

These degradants are expected to be ultimately biodegraded in the environment (NICNAS, 2018).

If a chemical is found to be readily biodegradable, it is categorised as Not Persistent since its half-life is substantially less than 60 days (DoEE, 2017).

C. Environmental Distribution

No sediment or soil partitioning data were found. Long chain nonylphenol ethoxylates are expected to remain in water as they have high water solubility and low volatility. Thus, it is expected that NPE has a low potential for adsorption to soil or sediment. Water soluble degradation products, nonylphenol ethoxyacetates, are also expected to remain in water (NICNAS, 2018).

D. Bioaccumulation

NPEs are surfactants and most surfactants tend to be retained on epithelial surfaces, rather than cross cellular membranes and bioaccumulate (de Oude, 1992; McWilliams and Payne, 2001). Hence, bioaccumulation for most classes of surfactants is generally below the level for concern (McWilliams and Payne, 2001). As a result, NPE is expected to have low bioaccumulation potential in aquatic organisms. The BCF in the fish Cyprinus carprio of nonylphenol ethoxylates was reported to be <0.2 L/kg at 2 mg/L and <1.4 L/kg at 0.2 mg/L (NICNAS, 2018).

IV. HUMAN HEALTH HAZARD ASSESSMENT

A. Summary

Most of the human and animal data available were from studies conducted using NPEs with 1–50 EO units. The NPEs metabolise in the body and biodegrade in the environment to nonylphenols (NPs). Therefore, toxicity of NPs was considered acceptable to derive the toxicity of the ethoxylates when there were no hazard data available on specific systemic endpoints. It is noted that compared with NPEs, NPs are more toxic (NICNAS, 2019).

NPEs exhibits low to moderate oral acute toxicity and low dermal toxicity. Skin irritation studies in rabbits with some NPEs have shown moderate to severe irritation. It is not a skin sensitiser. The available studies with various NPEs indicate that the level of eye irritation generally increases with decreasing EO chain length. No dermal or inhalation repeat dose studies were available but oral repeat does studies do not suggest that NPEs cause serious damage to health. The substance is not genotoxic or carcinogenic. Based on the available data and considering the routes of exposure relevant for humans (excluding spermicide use), a conclusion on the reproductive and developmental toxicity of NPEs cannot be derived. However, NPs are classified for reproductive and developmental toxicity based on animal data.

B. Acute Toxicity

Oral

The acute oral toxicity of NPEs could range from low to moderate. The toxicity of NPEs is considered to increase with decreasing EO units (or chain length) (Health Canada, 2002). For NPE the oral LD50 was reported to be 1310 mg/kg bw in rats (HSDB). However, the CAS RN for NPE applies to many NPEs containing 1–120 EO units. The following LD50s were reported for NPEs of various EO chain lengths (NICNAS, 2019):

- 3500–4500 mg/kg bw in rats for NPEs with EO units 2, 5, 7 or 9;
- 2000–4290 mg/kg bw in mice, guinea pigs and rabbits for an NPE with 9 EO units;
- 1300 mg/kg bw in rats for an NPE with 10 EO units; and
- other NPEs with 30 EO units were reported as 'relatively harmless' in rats but no LD_{50}s were determined.

Reported signs of toxicity included diarrhoea, tremors, prostration and narcosis. Necropsy revealed congested lungs, gastrointestinal system, and kidneys (CIR, 1983 as cited in NICNAS, 2019).

Inhalation

The limited data available are not sufficient to derive a conclusion on the acute inhalation toxicity of the chemicals.

In an acute inhalation study, male rats were exposed (whole body) to undiluted or 1 % NPEs (with 4, 7 or 9 EO units) for either four or eight hours and observed for 14 days. The exposure concentrations were not reported. No toxic effects were observed (CIR, 1983 as cited in NICNAS, 2019).

In a 4-hour acute inhalation study, Sprague Dawley (SD) rats were exposed (whole body) to aerosolised detergent (containing NPE as the principal component) at concentrations of 0.50, 0.90 or 1.41 mg/L. Sub-lethal effects included eye and respiratory 4rritation, hypoactivity, laboured and audible breathing, unkempt fur, and distended abdomens. At two weeks post-exposure, the animals showed body weight loss or decreased weight gain, and perinasal encrustation. The LC_{50} was reported as 1.60 g/m3 (CalEPA, 2010 as cited in NICNAS, 2019).

Dermal

Based on the limited data available, the chemicals are expected to have low acute dermal toxicity. The dermal LD_{50} for NPE was reported to be 2000 mg/kg bw in rabbits (NICNAS, 2019).

C. Irritation

Skin

Skin irritation studies in rabbits with some NPEs have shown moderate to severe irritation. The degree of irritation changes with the number of EO units (NICNAS, 2019).

In a skin irritation study in New Zealand White (NZW) rabbits, 11 NPEs (with EO units 2, 4, 6, 7, 9, 10, 12, 13, 15, 30 or 40) were tested undiluted by applying occlusive patches of 0.01–0.50 mL. The NPEs with EO chains ≤6 caused moderate to severe irritation (CIR, 2015 as cited in NICNAS, 2019).

Severe skin irritation effects were observed in animals tested with NPEs containing five or six EO units. In a skin irritation study, an NPE containing six EO units (NPE-6) was applied (occlusively, 0.5 mL) to the clipped intact and abraded skin of six rabbits. The effects (erythema and oedema) were scored at 24 and 72 hours after application. The chemical was classified as severely irritating to the skin of rabbits, with a primary irritation index (PII) of 3.0. A PII of 6.6 was reported in another skin irritation study with NPE-6 (animal species and experimental details not stated) (CIR, 1999 as cited in NICNAS, 2019).

However, NPEs with an EO) chain of > 30 are slightly irritation or non-irritating (Talmage, 1994).

Eye

The available studies with various NPEs indicate that the level of irritation generally increases with decreasing EO chain length (NICNAS, 2019).

In a study conducted according to the Draize method, an NPE with six EO units caused severe eye irritation in rabbits. The average scores obtained on days one and seven post-exposure were 28.8 and 16.0, respectively (maximum score=110) (CIR, 1999 as cited in NICNAS, 2019).

In studies involving the instillation of 0.1 mL of an undiluted NPE solution to the eyes of rabbits, NPEs with chains of 2 to 15 were moderately to severely irritating. NPEs with EO chains of >30 were non-irritating (ECHA) [Kl. Score = 2].

D. Sensitisation

Based on the available data, NPEs and their anionic surfactant derivatives are generally not considered to have skin sensitisation potential.

In a guinea pig maximisation test, five albino guinea pigs were exposed intradermally to NPE containing six EO units (NPE-6) at concentrations of 0, 1.7, 3.0, 9.0 or 27 % (w/w) during the induction phase. After seven days, undiluted NPE-6 was applied topically, and the site occluded for 48 hours. The application site was later challenged topically with 2.7 % NPE-6. No dermal responses were observed after 48 hours following the challenge (ECHA) [Kl. Score = 2].

E. Repeated Dose Toxicity

Oral

In several 90-day repeated dose oral toxicity studies (individual test protocols), NPEs containing 4, 6, 15, 20, 30 or 40 EO units were orally administered to rats in the diet at 40–5000 mg/kg bw/day (0.01–1% of the diet). Growth retardation due to poor palatability of the diets was observed with NPEs containing 4, 6, 15 and 20 EO units at > 200 mg/kg bw/day. Increased absolute and relative liver weights were observed when animals were administered NPE-4 or NPE-6 at 200 mg/kg bw/day, but no histopathological changes were observed. No effects were observed in rats that ingested NPE-30. Slight hepatic necrosis and centrilobular granular degeneration were observed in rats administered NPE-40 at a 3 % dietary concentration (~700 mg/kg bw/day) (CIR, 1983; Danish EPA, 2000 as cited in NICNAS, 2019).

In 2-year repeated dose oral toxicity studies, NPE-4 and NPE-9 were administered to rats at doses of ~400–1000 mg/kg bw/day. In rats, reduced body weights and enlarged livers were observed at doses > 1000 mg/kg bw/day. The authors concluded that these NPEs had low chronic toxicity (CIR, 1983 as cited in NICNAS, 2019).

In another study using NPE-9 in rats, enlarged livers were accompanied by cloudy swelling and reduced polysaccharides at the 250 mg/kg bw/day dose, and focal hepatic cell necrosis at the 1250 mg/kg bw/day dose (Danish EPA, 2000 as cited in NICNAS, 2019).

In repeated dose oral toxicity study, mice were administered NPE-10 in the diet at doses of 0, 500, 1500 or 4500 ppm (0, 81.5, 254 or 873 mg/kg bw/day) for 104 weeks. At the highest dose, decreased body weight gain, decreased absolute liver and kidney weights, and increased relative brain, liver and kidney weights were observed. No other significant effects attributed to the chemical were observed (CIR, 2015 as cited in NICNAS, 2019). The no observed adverse effect level (NOAEL) for NPE-10 was determined as 254 mg/kg bw/day.

Inhalation

No data are available.

Dermal

No data are available.

F. Genotoxicity

Based on the available in vitro genotoxicity data, NPEs are not considered to be genotoxic. NPEs with EO chains of 9 and 30 were not mutagenic to S. typhimurium strains TA 1535, TA 1537, TA 98, and TA 100 in the absence or presence of metabolic activation (ECHA) [Kl. Score = 2].

No *in vivo* genotoxicity data are available for NPEs.

G. Carcinogenicity

Based on the available data, NPEs are not considered to be carcinogenic.

In a carcinogenicity study, female mice (n = 50/dose) were administered NPE-10 (NPE with 10 EO units) in the diet at doses of 0, 500, 1500 or 4500 ppm (0, 81.5, 254 or 873 mg/kg bw/day) for 104 weeks. No increase in the incidence of neoplastic or non-neoplastic lesions was observed at any dose level. The authors concluded that NPE-10 was not carcinogenic (CIR, 2015 as cited in NICNAS, 2019).

In another carcinogenicity study, rats were administered NPE-9 (NPE with 9 EO units) intravaginally at doses of 0, 6.7 or 33.6 mg/kg bw/day, 3 times a week for 24 months. The administered doses were equivalent to 4 or 20 times the clinical dose, respectively. No significant differences (including masses or mortalities) compared with controls were observed. Positive observations (details not available) in the experimental groups at necropsy were considered to be related to ageing. The authors concluded that NPE-9 was 'neither toxic nor carcinogenic in this lifetime exposure study, even at a dose that was 20 times that recommended for humans' for use as a spermicide (CIR, 1999 as cited in NICNAS, 2019).

In 2-year carcinogenicity studies, NPE-4 and NPE-9 were administered orally to rats at doses of 200 and 140 mg/kg bw/day. No increase in the frequency of tumours was reported (Danish EPA, 2000 as cited in NICNAS, 2019).

H. Reproductive Toxicity

Studies are available only for NPE-9, NPE-10, NPE-30. No data are available for the other chemicals in this group.

The chemical NPE-9 is a known spermicide and the studies available using NPE-9 have reported reproductive toxicity effects in rats from doses of 50 mg/kg bw/day, when administered intravaginally. However, oral studies in rats with NPE-9 showed reproductive and developmental effects only at a dose of 250 mg/kg bw/day. Based on the available data and considering the routes of exposure relevant for humans (excluding spermicide use), a conclusion on the reproductive and developmental toxicity of NPEs cannot be derived. However, NPs are classified for reproductive and developmental toxicity based on animal data (NICNAS, 2019).

In an in vivo sperm abnormality assay, male mice (n = 5/sex/dose) were injected intraperitoneally with NPE-9 in distilled water at doses of 0, 20, 40, 50 or 60 mg/kg bw/day for five days. No increase in the frequency of morphologically abnormal sperm was observed compared with controls (CIR, 1999 as cited in NICNAS, 2019).

In a reproductive toxicity study to evaluate embryotoxicity of NPE-9, nulliparous female Wistar rats were intravaginally administered the chemical at 5 mg/100 g bw (50 mg/kg bw) on gestation days (GD) three or seven. Ulcerative vaginitis and perivaginal oedema were observed in the dams, but were reversible by GD 15. Significant differences in the mean number of normal implantation sites and the number of resorption sites were observed in dams (NICNAS, 2019).

In another study, pregnant Wistar rats were intravaginally administered NPE-9 at 25 mg/kg bw/day on GD 1–10. Increased incidences of nonpregnancies and resorptions were observed in dams administered the chemical on GD 3–6, and a significantly reduced number of live foetuses in dams was observed when the chemical was administered on GD 4, 5, and 9. The chemical NPE-9 was reported to be embryolethal and foetocidal, but not teratogenic when administered intravaginally (CIR, 2015 as cited in NICNAS, 2019).

In an oral developmental toxicity study, female rats were administered NPE-9 at doses up to 500 mg/kg bw/day on GD 6–15. The no observed effect level (NOEL) was determined as 50 mg/kg bw/day based on reproductive and developmental effects (increased pre-implantation losses, skeletal anomalies in the litters) observed at doses > 250 mg/kg bw/day. The same authors conducted a dermal study in female mated rats with NPE-9 at doses of 50 or 500 mg/kg bw/day. No treatment-related effects on the skeletal or soft tissues were observed. However, an increased incidence of extra ribs was observed at 50 mg/kg bw/day (CIR, 1999 as cited in NICNAS, 2019).

In a developmental toxicity study, female mice were administered oral gavage doses of NPE-10 at 600 mg/kg bw/day on GD 6–13. No developmental toxicity effects were observed (CIR, 1999). Repeated subcutaneous administration of NPE-10 in female rats (from birth to day 21 after the birth of F1 offspring) at up to 80 mg/kg bw/day did not cause teratogenic effects. However, the treatment affected the growth of the offspring, e.g., decreased body weight or tendency to decrease body weight from day seven after birth (CIR, 2015 as cited in NICNAS, 2019).

Studies with NPE-30 have shown no treatment-related effects in female rats at oral doses up to 1000 mg/kg bw/day on GD 6–15 (HSDB as cited in NICNAS, 2019).

I. Developmental Toxicity

In an oral developmental toxicity study, female rats were administered NPE-9 at doses up to 500 mg/kg bw/day on GD 6–15. The NOEL was determined as 50 mg/kg bw/day based on reproductive and developmental effects (increased pre-implantation losses, skeletal anomalies in the litters) observed at doses $\geq$ 250 mg/kg bw/day. The same authors conducted a dermal study in female mated rats with NPE-9 at doses of 50 or 500 mg/kg bw/day. No treatment-related effects on the skeletal or soft tissues were observed. However, an increased incidence of extra ribs was observed at 50 mg/kg bw/day (CIR, 1999 as cited in NICNAS, 2019).

In a developmental toxicity study, female mice were administered oral gavage doses of NPE-10 at 600 mg/kg bw/day on GD 6–13. No developmental toxicity effects were observed (CIR, 1999 as cited in NICNAS, 2019). Repeated subcutaneous administration of NPE-10 in female rats (from birth to day 21 after the birth of F1 offspring) at up to 80 mg/kg bw/day did not cause teratogenic effects. However, the treatment affected the growth of the offspring, e.g., decreased body weight or tendency to decrease body weight from day seven after birth (CIR, 2015 as cited in NICNAS, 2019).

Studies with NPE-30 have shown no treatment-related effects in female rats at oral doses up to 1000 mg/kg bw/day on GD 6–15 (HSDB as cited in NICNAS, 2019).

The metabolites, NP and OP, have measured oestrogenic activity. Assessment of NP suggested that developmental effects may derive from antiandrogenic activity (NICNAS, 2019).

V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES

The toxicological reference values developed for NPE follow the methodology discussed in enHealth (2012). The approach used to develop drinking water guidance values is described in the Australian Drinking Water Guidelines (ADWG, 2011).

A. Non-Cancer

Oral

A two-year dietary study has been conducted in mice with NPE-10. At the highest dose, decreased body weight gain, decreased absolute liver and kidney weights, and increased relative brain, liver and kidney weights were observed. The NOAEL was determined as 254 mg/kg bw/day. The NOAEL from this repeat dose study will be used to derive an oral reference dose (RfD) and drinking water guideline value. This NOAEL was selected rather than NOELs reported for NPE-9 in reproductive/developmental toxicity studies as the conclusion on the reproductive and developmental toxicity of NPEs could not be derived.

Oral Reference Dose (oral RfD)

Oral RfD = NOAEL / (UF_A x UF_H x UF_L x UF_{Sub} x UF_D)

Where:

- UF_A (interspecies variability) = 10
- UF_H (intraspecies variability) = 10
- UF_L (LOAEL to NOAEL) = 1
- UF_{Sub} (subchronic to chronic) = 1
- UF_D (database uncertainty) = 1

Oral RfD = 254/ (10 x 10 x 1 x 1 x 1) = 254/100 = 2.54 mg/kg/day

Drinking water guidance value

Drinking water guidance value = (animal dose) x (human weight) x (proportion of intake from water) / (volume of water consumed) x (safety factor)

Using the oral RfD,

Drinking water guidance value = (oral RfD) x (human weight) x (proportion of water consumed) / (volume of water consumed)

Where:

Human weight = 70 kg (ADWG, 2011)
Proportion of water consumed = 10% (ADWG, 2011)
Volume of water consumed = 2L (ADWG, 2011)
Drinking water guidance value = (2.54 x 70 x 0.1)/2 = 8.9 mg/L

B. Cancer

Based on the available data, NPEs are not considered to be carcinogenic. Thus, a cancer reference value was not derived.

VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES

NPE does not exhibit the following physico-chemical properties:

- Explosivity
- Flammability
- Oxidising potential

VII. ENVIRONMENTAL HAZARD ASSESSMENT

A. Summary

NPEs are of moderate toxicity concern to aquatic receptors.

B. Aquatic Toxicity

Acute Studies

Table 2 lists the results of acute aquatic toxicity studies on NPEs. NPEs rapidly degrade to more recalcitrant and toxic common degradants, some of which possess estrogenic activity. As a result, data for nonylphenol monoethoxylate (CAS RN 27986-36-3), which is a common degradant of the chemicals in this group and the most toxic member of the group, are also presented.

Table 2 lists the results of acute aquatic toxicity studies conducted on for a representative nonylphenol ether (NPE).

Table 2: Acute Aquatic Toxicity Studies on NPE

Test Species	Endpoint	Results (mg/L)	Klimisch score	Reference
Pimephales promelas (Fathead minnow0	95-hr LC_{50}	0.128*	-	NICNAS, 2018
Lepomis macrochirus (Bluegill)	96-hr LC_{50}	1.3	-	NICNAS, 2018
Ceriodaphnia dubia (Water flea)	48-hr EC_{50}	0.328*	-	NICNAS, 2019
Daphnia magna	48-hr LC_{50}	1.8	2	ECHA
Pseudokirchneriella subcapitata	48-hr EC_{50}	20-50	2	ECHA

* data for nonylphenol monoethoxylate (CAS RN 27986-36-3)

Chronic Studies

Based on chronic toxicity studies from degradant nonylphenol monoethoxylate (CAS RN 27986-36-3), the 21-day NOEC for Oncorhynchus mykiss (Rainbow trout) is 0.048 mg/L and the 7-day NOEC for Ceriodaphnia dubia is 0.285 mg/L.

The 6-d NOEC for NPE from a chronic study on invertebrates (Daphnia Magna) is 1.0 mg/L. The 96-hr NOEC from an algal (Pseudokirchneriella subcapitata) is 8 mg/L while a 120-hr (5-d) EC_{50} of 37.4 mg/L was determined for green algae (Scenedesmus Opoliensis) (NICNAS, 2018).

Both NPs and short-chain NPEs have been reported to have endocrine activity and cause toxic effects in the reproductive systems of organisms, with NPEs having less activity than NPs (NICNAS, 2018).

C. Sediment Toxicity

The 48-hr LC_{50} to the Gallery worm (Capitella capitata) is 3.26 mg/L (NICNAS).

D. Terrestrial Toxicity

No terrestrial toxicity data was identified for NPE.

E. Calculation of PNEC

The PNEC calculations for NPE follow the methodology discussed in DEWHA (2009).

PNEC Water

Experimental results are available for three trophic levels. Using data from the more toxic degradant, acute E(L)C50 values are available for fish (0.218mg/L), and invertebrates (0.328 mg/L). Results are also available from chronic studies on two trophic levels, with NOEC values for fish (0.048 mg/L) and invertebrates (0.285 mg/L). On the basis that the data consists of short-term results from two trophic levels and long-term results from two trophic levels, an assessment factor of 50 has been applied to the lowest reported NOEC value of 0.048 mg/L for fish. The $PNEC_{water}$ is 0.00096 mg/L.

Acute E(L)C_{50} values are available for fish (22,810 mg/L), *Daphnia* (>100 mg/L), and algae (10,940 mg/L). NOEC values from long-term studies are available for fish (15,380 mg/L), invertebrates (8,590 mg/L) and algae (10,000 mg/L). On the basis that the data consists of short-term and long-term results from three trophic levels, an assessment factor of 10 has been applied to the lowest reported E(L)C_{50} value of 100 mg/L for fish. The E(L)C_{50} value is used because the value for fish is lower than the NOEC values for all three trophic levels. The $PNEC_{aquatic}$ is 10 mg/L.

PNEC Sediment

There are limited toxicity data for sediment-dwelling organisms. In addition, no sediment or soil partitioning data were found. Thus, the equilibrium partitioning method cannot be used to calculate the $PNEC_{sediment}$. Based on its properties, NPE is not expected to significantly adsorb to sediment and is subject to rapid degradation. Some of the degradants are highly toxic to aquatic organisms. Therefore, the assessment of this compartment will be covered by the aquatic assessment.

PNEC Soil

There are no toxicity data for terrestrial or soil organisms. In addition, no sediment or soil partitioning data were found. Thus, the equilibrium partitioning method cannot be used to calculate the $PNEC_{soil}$. Based on its properties, NPE is not expected to significantly adsorb to soil and is subject to rapid degradation. Some of the degradants are highly toxic to aquatic organisms. Therefore, the assessment of this compartment will be covered by the aquatic assessment.

VIII. PERSISTENCE, BIOACCUMULATION AND TOXICITY (PBT) ASSESSMENT

The methodology for the Persistent, Bioaccumulative and Toxic (PBT) substances assessment is based on the Australian and EU REACH Criteria methodology (DEWHA, 2009; ECHA, 2017).

NPEs are readily biodegradable and thus do not meet the screening criteria for persistence.

The measured BCF values in fish for NPEs are <1.4 L/Kg; thus, NPEs do not meet the screening criteria for bioaccumulation.

The NOEC values from chronic aquatic toxicity studies are > 0.1 mg/L for NPE. The acute E(L)C50 values for NPE are > 1 mg/L. Thus, NPE does not meet the criteria for toxicity.

The overall conclusion is that NPEs are not PBT substances.

IX. CLASSIFICATION AND LABELLING

A. Classification

H315: Skin irritation-category 2
H302: Acute toxicity (ingestion)-category 4
H319: Eye irritation-category 2A

B. Labelling

Warning

A. Pictogram



X. HANDLING AND SAFETY INFORMATION (OCCUPATIONAL LIMITS AND TRANSPORTATION REQUIREMENTS)

A. First Aid

Please refer to the product SDS for additional information and confirmation of the information provided herein.

Eye Contact

In case of contact, immediately flush eyes with plenty of water for at least 20 to 30 minutes. IMMEDIATELY transport the victim after flushing eyes to a hospital even if no symptoms (such as redness or irritation) develop.

Skin Contact

IMMEDIATELY flood affected skin with water while removing and isolating all contaminated clothing. Wash thoroughly with soap and water.

Inhalation

IMMEDIATELY leave the contaminated area; take deep breaths of fresh air. If symptoms (such as wheezing, coughing, shortness of breath, or burning in the mouth, throat, or chest) develop, call a physician, and be prepared to transport the victim to a hospital.

Ingestion

Rinse mouth with water and then drink plenty of water and IMMEDIATELY call a hospital or poison control centre. Never give anything by mouth to an unconscious person. DO NOT INDUCE VOMITTING.

B. Fire Fighting Information

Extinguishing Media

Water spray, carbon dioxide, foam, dry chemical.

Specific Exposure Hazards

Keep product and empty container away from heat and sources of ignition. May emit toxic fumes under fire conditions. Depending on conditions, decomposition products may include the following: carbon monoxide, carbon dioxide.

Special Protective Equipment for Firefighters

Wear self-contained breathing apparatus.

C. Accidental Release Measures

Personal Precautions

Use appropriate protective equipment. Handle in accordance with good industrial hygiene and safety practice.

Environmental Precautions

Prevent from entering sewers, waterways or low areas.

Steps to be Taken if Material is Released or Spilled

For large amounts: dike spillage and pump off product. For residues: pick up with suitable absorbent material. Dispose of contaminated material as prescribed.

D. Storage And Handling

General Handling

Keep product and empty container away from heat and sources of ignition. Ensure adequate ventilation, especially in confined areas.

Storage

Keep container tightly closed and in a dry and well-ventilated place. Keep in a cool place.

E. Exposure Controls / Personal Protection

Occupational Exposure Standards

The workplace Australia exposure standards have not been established for NPE.

Engineering Controls

Good general ventilation should be used.

Personal Protection Equipment

Respiratory Protection: Respiratory protection is not required.

Hand Protection: Chemical resistant protective gloves.

Skin Protection: Body protection must be chosen depending on activity and possible exposure.

Eye protection: Safety glasses with side-shields.

Other Precautions: Handle in accordance with good industrial hygiene and safety practice. Wearing of closed work clothing is recommended. Ensure that eyewash stations and safety showers are close to the workstation location.

F. Transport Information

NPEs are considered Australian Dangerous Goods Class 9 for purposes of transportation by road or rail.

XI. DISPOSAL MANAGMENT

Disposal should be in accordance with all local, state and federal regulations.

XII. REGULATORY STATUS

Australian AICS Inventory: Listed.

XIII. REFERENCES

ADWG. (2011). National Water Quality Management Strategy. Australian Drinking Water Guidelines, Section 6, Australian Government, National Health and Medical Research Council, Natural Resource Management Ministerial Council. Updated January 2022. Available: https://www.nhmrc.gov.au/about-us/publications/australian-drinking-water-guidelines

Department of the Environment, Water, Heritage and the Arts [DEWHA]. (2009). Environmental risk assessment guidance manual for industrial chemicals, Department of the Environment, Water, Heritage and the Arts, Commonwealth of Australia. Available: http://www.nepc.gov.au/resource/chemical-risk-assessment-guidance-manuals

Department of the Environment and Energy [DoEE]. (2017). Chemical Risk Assessment Guidance Manual: for chemicals associated with coal seam gas extraction, Guidance manual prepared by Hydrobiology and ToxConsult Pty Ltd for the Department of the Environment and Energy, Commonwealth of Australia, Canberra.

ECHA. ECHA REACH database: http://echa.europa.eu/information-on-chemicals/registered-substances

enHealth Human Risk Assessment [HHRA]. (2012). Environmental Health Risk Assessment, Guidelines for Assessing Human Health Risks from Environmental Hazards. Office of Health Protection of the Australian Government Department of Health. Available: https://www1.health.gov.au/internet/main/publishing.nsf/Content/health-pubhlth-publicat-environ.htm

European Chemicals Agency [ECHA]. (2017). Guidance on Information Requirements and Chemical Safety Assessment, Chapter R11: PBT Assessment, European Chemicals Agency, Helsinki, Finland. Available: https://echa.europa.eu/guidance-documents/guidance-on-information-requirements-and-chemical-safety-assessment

Hayashi, S., Saito, S., Kim, J.-H., Nishimura, O., and Sudo, R. (2005). Aerobic biodegradation behavior of nonylphenol polyethoxylates and their metabolites in the presence of organic matter. Environ. Sci. Technol. 39: 5625-5633.

Klimisch, H.J., Andreae, M., and Tillmann, U. (1997). A systematic approach for evaluating the quality of experimental and toxicological and ecotoxicological data. Regul. Toxicol. Pharmacol. 25:1-5.

Lu, J., Yillang, H., Jun, W., and Qiang, J. (2009). Aerobic and anaerobic biodegradation of nonylphenol ethoxylates in estuary sediment of Yangtze River, China. Environ. Geology.

National Industrial Chemicals Notification and Assessment Scheme (NICNAS). (2019). Human Health Tier II Assessment of Nonylphenol Ethoxylates and Related Compounds. National Industrial Chemicals Notification and Assessment Scheme, Sydney, Australia. Available at: https://www.industrialchemicals.gov.au/sites/default/files/Nonylphenol%20and%20octylphenol%20ethoxylates%20and%20related%20compounds_Human%20health%20tier%20II%20assessment.pdf.

NICNAS. (2018). Nonylphenol ethoxylates and their sulfate and phosphate esters: Environment tier II assessment. National Industrial Chemicals Notification and Assessment Scheme, Sydney, Australia. Available at: https://www.industrialchemicals.gov.au/sites/default/files/Nonylphenol%20ethoxylates%20and%20their%20sulfate%20and%20phosphate%20esters_%20Environment%20tier%20II%20assessment.pdf

National Institute of Technology and Evaluation (NITE). (2014). Japan Chemicals Collaborative Knowledge Database. National Institute of Technology and Evaluation. Tokyo, Japan. Accessed 19 March 2014 at http:/www.safe.nite.go.ip.

Talmage, S.S. (1994). Environmental and Human Safety of Major Surfactants – Alcohol Ethoxylates and Alkylphenol Ethoxylates, pp. 35, The Soap and Detergent Association, Lewis Publishers, Boca Raton, Florida

U.S. Environmental Protection Agency [EPA]. (2017). EPISuite™ v. 4.11, United States Environmental Protection Agency, Office of Pollution Prevention and Toxics and Syracuse Research Corporation. Available: https://www.epa.gov/tsca-screening-tools/epi-suitetm-estimation-program-interface.

Ying, G.-G., Williams, B., and Kookana, R. (2002). Environmental fate of alkylphenols and alkylphenol ethoxylates. – a review. Environment Int. 32: 417-431.

POTASSIUM HYDROXIDE

This dossier on potassium hydroxide (CAS RN 1310-58-3) presents the most critical studies pertinent to the risk assessment of potassium hydroxide in its use in coal seam or shale gas extraction activities. It does not represent an exhaustive or critical review of all available data. The information presented in this dossier was obtained from the OECD-SIDS documents on potassium hydroxide (OECD, 2002) and the ECHA database that provides information on chemicals that have been registered under the EU REACH (ECHA). Where possible, study quality was evaluated using the Klimisch scoring system (Klimisch et al., 1997).

NICNAS has assessed potassium hydroxide in an IMAP Tier 1 assessment and concluded that it poses no unreasonable risk to the environment.

I. SUBSTANCE IDENTIFICATION

Chemical Name (IUPAC): Potassium hydroxide

CAS RN: 1310-58-3

Molecular formula: KOH

Molecular weight: 56.1 g/mol

Synonyms: Potassium hydroxide; caustic potash; potash lye; potassium hydrate

SMILES: [OH-].[K+]

II. PHYSICO-CHEMICAL PROPERTIES

Key physical and chemical properties for the substance are shown in Table 1.

Table 1: Overview of the Physico-Chemical Properties of Potassium Hydroxide

Property	Value	Klimisch score	Reference
Physical state at 20°C and 101.3 kPa	White, crystalline solid	2	ECHA
Melting Point	406°C (pressure not provided) 250°C	2	ECHA
Boiling Point	1,327°C @ 1013 hPa	2	ECHA
Density	2044 kg/m^3 @ 20°C	2	ECHA
Partition Coefficient (log K_{ow})	Not applicable	-	-
Water Solubility	Very soluble	2	ECHA

Potassium hydroxide is a strong alkaline substance that dissociates completely in water to potassium (K^+) and hydroxyl (OH^-) ions.

III. ENVIRONMENTAL FATE PROPERTIES

Potassium hydroxide will be found predominantly in the aquatic environment where it dissociates completely to potassium (K^+) and hydroxyl (OH^-) ions as a result of its high water solubility and low vapour pressure. Both ions are ubiquitous in the environment (UNEP, 1995).

Potassium is an essential nutrient involved in fluid and electrolyte balance and is required for normal cellular function. The hazard of potassium hydroxide for aquatic organisms is caused by the hydroxyl ion (OH-), which has the potential to increase the pH of the aquatic environment, depending on the buffering capacity of the receiving water. In general, the buffer capacity is regulated by the equilibria between CO_2, HCO_3^- and CO_3^{2-}:

$CO_2 + H_2O \leftrightarrow HCO_3^- + H^+$ ($pKa_1 = 6.35$)
$HCO_3^- \leftrightarrow CO_3^{2-} + H^+$ ($pKa_2 = 10.33$)

A release of potassium hydroxide into the aquatic environment from the use of KOH could potentially increase the potassium concentration and the pH in the aquatic environment. Table 2 shows the concentration of potassium hydroxide needed to increase the pH to values of 9.0, 10.0, 11.0 and 12.0.

Table 2: Potassium Hydroxide Concentration (mg/L) Needed to Increase pH to a Value of 9 (OECD, 2002)

Buffer capacity	Concentration of KOH (mg/L)
0 mg/L HCO_3 (distilled water)	0.56
20 mg/L HCO_3 (10^{th} percentile of 77 rivers)	0.86
106 mg/L HCO_3^- (mean value of 77 rivers)	4.51
195 mg/L HCO_3^- (90^{th} percentile of 77 rivers)	8.30

K^+ and OH^- ions will not adsorb on the particulate matter or surfaces and will not accumulate in living tissues (OECD, 2002).

IV. HUMAN HEALTH HAZARD ASSESSMENT

A. Summary

Limited toxicity data exist for potassium hydroxide. Depending on the concentration, solutions of potassium hydroxide are corrosive, irritating, or non-irritating. These solutions cause direct effects to the skin, eyes, respiratory tract, and gastrointestinal tract. Vapours from aqueous solutions of potassium hydroxide can cause respiratory irritation. Potassium hydroxide is not a skin sensitiser. There are no repeated dose, reproductive, and developmental toxicity studies on potassium hydroxide.

B. Metabolism

Potassium hydroxide dissociates completely in aqueous solutions to potassium (K^+) and hydroxide (OH-) ions. Potassium is an essential nutrient involved in fluid and electrolyte balance and is required for normal cellular function (OECD, 2002).

C. Acute Toxicity

Oral

The oral LD50 values in rats for potassium hydroxide have been reported to be 365 milligrams per kilogram (mg/kg) (Johnson et al., 1975; ECHA) and 273 mg/kg (Bruce, 1987; ECHA). [Kl. scores = 2].

Inhalation

No acute inhalation studies are available.

Dermal

No acute dermal toxicity studies are available

D. Irritation

Skin

Application of 0.5 millilitres (mL) of a 5% solution of potassium hydroxide to the skin of rabbits for 4 hours under semi-occlusive conditions was moderately irritating, with a primary dermal irritation indices (PII) score of 4.8 (OECD, 2002). A 10% solution was severely irritating (Nixon et al., 1990; OECD, 2002) [Kl. score = 2]. Application of 0.1 mL of a 5% solution of potassium hydroxide to the skin of rabbits for 24 hours under semi-occlusive conditions was mildly irritating to intact skin (Johnson *et al.*, 1975; OECD, 2002) [Kl. score = 2].

Eye

Instillation of 0.1 mL of a 5% potassium hydroxide solution into the eyes of rabbits for 5 minutes was extremely irritating to corrosive; a 1% KOH solution for 5 minutes or 24 hours was considered irritating; 0.5% potassium hydroxide solution for 24 hours was marginally irritating; and 0.1% potassium hydroxide solution for 24 hours was negative (Johnson et al., 1975; OECD, 2002) [Kl. score = 2].

E. Sensitisation

Potassium hydroxide was not a skin sensitiser in a guinea pig sensitisation test (Johnson et al., 1975; OECD, 2002) [Kl. score = 2]

F. Repeated Dose Toxicity

No studies are available

G. Genotoxicity

In Vitro Studies

Potassium hydroxide was not mutagenic to *S. typhimurium* strains TA 97 and TA 102 in the absence or presence of metabolic activation (ECHA). [Kl. score = 2]

In Vivo Studies

No studies are available.

H. Carcinogenicity

Oral

No studies are available.

Inhalation

No studies are available.

I. Reproductive Toxicity

No reliable studies have been conducted that address female fertility or reproductive toxicity by a relevant route of exposure.

J. Developmental Toxicity

No studies are available.

V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES

The toxicological reference values developed for potassium hydroxide follow the methodology discussed in enHealth (2012). The approach used to develop drinking water guidance values is described in the Australian Drinking Water Guidelines (ADWG, 2011).

A. Non-Cancer

There are no repeated dose, reproductive, and developmental toxicity studies available on potassium hydroxide. Potassium hydroxide dissociates to potassium and hydroxide ions in bodily fluids, and a significant amount of these ions are already ingested in foods. Furthermore, both ions are present in the body and are highly regulated by homeostatic mechanisms. Thus, a toxicological reference value was not derived for potassium hydroxide.

The Australian drinking water guideline value for pH is 6.5 to 8.5 (ADWG, 2011).

B. Cancer

There are no carcinogenicity studies on potassium hydroxide. Thus, a cancer reference value was not derived.

VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES

Potassium hydroxide does not exhibit the following physico-chemical properties:

- Explosivity
- Flammability
- Oxidising potential

VII. ENVIRONMENTAL HAZARD ASSESSMENT

A. Aquatic Toxicity

As noted in(OECD, 2002) toxicity tests with potassium hydroxide depend on the buffer capacity of the test medium. Thus, the pH change could influence the speciation of other chemicals and therefore increase and/or decrease the toxicity.

There are no guideline studies on potassium hydroxide; the studies summarised below have Klimisch scores of 3 or 4. Studies on sodium hydroxide (NaOH) have also been included, given its similarity to potassium hydroxide (KOH).

Acute Fish

KOH: The 96-hour LC_{50} to *Gambusia affinis* (mosquito fish) is 80 milligrams per litre (mg/L). At 56 mg/L, no mortality was observed.

NaOH: The 24-hour LC_{50} to *Carassius auratus* (goldfish) is 160 mg/L. At 100 mg/L, which was equivalent to a pH of 9.8, no mortality was observed. The 48-hour LC_{50} to *Leuciscus idus melanotus*, is 189 mg/L. The 96-hour LC_{50} of *Gambusia affinis* (mosquitofish) is 125 mg/L. At 84 mg/L, no effects on the fish were observed. The pH was 9 at 100 mg/L.

Acute Invertebrate

KOH: No studies are available.

NaOH: The 48-hour LC_{50} is 40 mg/L for *Ceriodaphnia cf. dubia*. The toxicity threshold concentration of NaOH for *Daphnia magna* was reported to range from 40 to 240 mg/L.

Acute Algae

No studies are available.

Chronic Toxicity

No studies are available.

B. Terrestrial Toxicity

No studies are available.

VIII. CALCULATION OF PNEC

Based on the available data it is not considered useful to derive a PNEC for potassium hydroxide (OECD, 2002) as:

- The natural pH of aquatic ecosystems can vary significantly between aquatic ecosystems;
- The sensitivity of the aquatic ecosystems to a change of the pH can vary significantly between aquatic ecosystems; and
- The change in pH due to an anthropogenic potassium hydroxide addition is influenced significantly by the buffer capacity of the receiving water.

Based on the information above, PNEC values for water, sediment, and soil were not derived for potassium hydroxide.

IX. PERSISTENCE, BIOACCUMULATION AND TOXICITY (PBT) ASSESSMENT

The methodology for the Persistent, Bioaccumulative and Toxic (PBT) substances assessment is based on the Australian and EU REACH Criteria methodology (DEWHA, 2009; ECHA, 2017).

Potassium hydroxide is an inorganic salt that dissociates completely to potassium and hydroxide ions in aqueous solutions. Biodegradation is not applicable to these inorganic ions; both potassium and hydroxide ions are also ubiquitous and are present in most water, soil and sediment. For the purposes of this PBT assessment, the persistent criteria are not considered applicable to this inorganic salt.

Potassium and hydroxide ions are essential to all living organisms, and their intracellular and extracellular concentrations are actively regulated. Thus, potassium hydroxide is not expected to bioaccumulate.

No chronic toxicity data exist on potassium hydroxide; however, the acute LC_{50} values are >1 mg/L in fish, invertebrates and algae. Thus, potassium hydroxide does not meet the screening criteria for toxicity.

The overall conclusion is that potassium hydroxide is not a PBT substance.

X. CLASSIFICATION AND LABELLING

A. Classification

Acute toxicity – category 4
Skin corrosion – category 1A

H302 (Harmful if swallowed)
H314 (Causes severe skin burns and eye damage)

B. Labelling

Danger

C. Pictogram



XI. HANDLING AND SAFETY INFORMATION (OCCUPATIONAL LIMITS AND TRANSPORTATION REQUIREMENTS)

A. First Aid

Eye Contact

In case of contact, immediately flush eyes with plenty of water for 15 minutes.

Skin Contact

IMMEDIATELY flood affected skin with water while removing and isolating all contaminated clothing. Wash thoroughly with soap and water.

Ingestion

Rinse mouth with water and then drink plenty of water and IMMEDIATELY call a hospital or poison control centre. Never give anything by mouth to an unconscious person. DO NOT INDUCE VOMITTING.

Inhalation

IMMEDIATELY leave the contaminated area; take deep breaths of fresh air. If symptoms (such as wheezing, coughing, shortness of breath, or burning in the mouth, throat, or chest) develop, seek medical attention.

B. Fire Fighting Information

Extinguishing Media

Water spray, carbon dioxide, foam, dry chemical.

Specific Exposure Hazards

Keep product and empty container away from heat and sources of ignition. May form explosive mixtures with strong acids. May emit toxic fumes under fire conditions including halogenated compounds, metal oxides/oxides, potassium monoxide.

Special Protective Equipment for Firefighters

Wear self-contained breathing apparatus and chemical-protective clothing.

C. Accidental Release Measures

Personal Precautions

Use appropriate protective equipment and avoid direct contact.

Environmental Precautions

Prevent from entering sewers, waterways, or low areas.

Steps to be Taken if Material is Released or Spilled

Soak up with inert absorbent material.

D. Storage And Handling

General Handling

Keep product and empty container away from heat and sources of ignition. Ensure adequate ventilation, especially in confined areas.

Storage

Keep container tightly closed and in a dry and well-ventilated place. Keep in a cool place.

E. Exposure Controls / Personal Protection

Occupational Exposure Standards

The workplace exposure standard for potassium hydroxide in Australia is 2 mg/m^3 as a peak limitation, with a sensitisation notation. A peak limitation is defined by Safe Work Australia as a maximum or peak airborne concentration of a substance determined over the shortest analytically practicable period of time which does not exceed 15 minutes.

Engineering Controls

Good general ventilation should be used.

Personal Protection Equipment

Respiratory Protection: Respiratory protection is required. Use a mask or approved air purifying respirator.

Hand Protection: Chemical resistant protective gloves.

Skin Protection: Body protection must be chosen depending on activity and possible exposure.

Eye protection: Safety glasses with side-shields.

Other Precautions: Handle in accordance with good industrial hygiene and safety practice. Wearing of closed work clothing is recommended. Ensure that eyewash stations and safety showers are close to the workstation location.

F. Transport Information

Potassium hydroxide is considered Australian Dangerous Goods Class 8 for purposes of transportation by road or rail. Packing Group II or III

XII. DISPOSAL MANAGEMENT

Disposal should be in accordance with all local, state and federal regulations.

XIII. REGULATORY STATUS

Australian AICS Inventory: Listed.

XIV. REFERENCES

ADWG. (2011). National Water Quality Management Strategy. Australian Drinking Water Guidelines, Section 6, Australian Government, National Health and Medical Research Council, Natural Resource Management Ministerial Council. Updated January 2022. Available: https://www.nhmrc.gov.au/about-us/publications/australian-drinking-water-guidelines

Bruce, R.D., (1987), A Confirmatory study of the up- and down- method for acute oral toxicity testing. *Fundamental and Applied Toxicology*, 8(1):97-100.

Department of the Environment, Water, Heritage and the Arts (DEWHA). (2009). Environmental risk assessment guidance manual for industrial chemicals, Department of the Environment, Water, Heritage and the Arts, Commonwealth of Australia. Available: http://www.nepc.gov.au/resource/chemical-risk-assessment-guidance-manuals

ECHA. ECHA REACH database: http://echa.europa.eu/information-on-chemicals/registered-substances

enHealth Human Risk Assessment (HHRA). (2012). Environmental Health Risk Assessment, Guidelines for Assessing Human Health Risks from Environmental Hazards. Office of Health Protection of the Australian Government Department of Health. Available: https://www1.health.gov.au/internet/main/publishing.nsf/Content/health-pubhlth-publicat-environ.htm

European Chemicals Agency (ECHA). (2017). Guidance on Information Requirements and Chemical Safety Assessment, Chapter R11: PBT Assessment, European Chemicals Agency, Helsinki, Finland. Available: https://echa.europa.eu/guidance-documents/guidance-on-information-requirements-and-chemical-safety-assessment

Johnson, G.T, Lewis, T.R. and Wagner, W.D. (1975). Acute Toxicity of caesium and rubidium compounds. *Toxicology and Applied Pharmacology*, 32(2): 239-245.

Klimisch, H.J., Andreae, M., and Tillmann, U. (1997). A systematic approach for evaluating the quality of experimental and toxicological and ecotoxicological data. Regulatory Toxicology and Pharmacology 25:1-5.

Nixon, G.A., Bannan, E.A., Gaynor, T.W., Johnston, D.H. and Griffith, J.F. (1990), Evalustion of modified methods for determining skin irritation. *Regulatory Toxicology and Pharmacology*. 12:127-136

OECD. (2002). OECD-SIDS documents for Potassium hydroxide (CAS No. 1310-58-3), UNEP Publications. Available at: https://hpvchemicals.oecd.org/UI/handler.axd?id=0cd7a76e-c7bc-4545-b26e-b2c4dbfb9ef9

UNEP. (1995). Water quality of world river basins. UNEP Environment Library No. 14, Nairobi, Kenya; cited in OECD, 2002a,b.

POTASSIUM PERSULFATE

This dossier on potassium persulfate presents the most critical studies pertinent to the risk assessment of potassium persulfate in its use in coal seam or shale gas extraction activities. This dossier does not represent an exhaustive or critical review of all available data. The majority of information presented in this dossier was obtained from the ECHA database that provides information on chemicals that have been registered under the EU REACH (ECHA). Where possible, study quality was evaluated using the Klimisch scoring system (Klimisch et al., 1997).

NICNAS has assessed potassium persulfate in an IMAP Tier 1 assessment and considers it to be of low concern[1] .

I. SUBSTANCE IDENTIFICATION

Chemical Name (IUPAC): dipotassium peroxodisulphate

CAS RN: 7727-21-1

Molecular formula: $H_2O_8S_2.2K$

Molecular weight: 270.33 g/mol

Synonyms: potassium persulfate; dipotassium peroxydisulfate; Anthion; Peroxydisulfuric acid ([(HO)S(O)2]2O2), potassium salt (1:2); Peroxydisulfuric acid ([(HO)S(O)2]2O2), dipotassium salt

SMILES: [K+].[K+].[O-]S(=O)(=O)OOS([O-])(=O)=O

II. PHYSICO-CHEMICAL PROPERTIES

Table 1: Overview of the Physico-chemical Properties of Potassium persulfate

Property	Value	Klimisch Score	Reference
Physical state at 20°C and 101.3 kPa	Inorganic, odourless, white, crystalline white solid	1	ECHA
Melting Point	Decomposes at 100 °C @ 100.8 kPa	1	ECHA
Boiling Point	Decomposes at 100 °C @ 100.8 kPa	1	ECHA
Density	1390 kg/m^3@ 20°C	1	ECHA
Vapour Pressure	0 Pa @ 25°C*	2	ECHA
Partition Coefficient (log K_{ow})	Not applicable (inorganic substance)	-	ECHA
Water Solubility	52.77 g/L @ 20°C	1	ECHA
Flash Point	Not available because this substance is a solid	-	ECHA
Auto flammability	>600°C** (substance is not expected to be auto flammable)	1	ECHA

[1] https://www.industrialchemicals.gov.au/chemical-information/search-assessments?assessmentcasnumber=7727-21-1

Property	Value	Klimisch Score	Reference
Viscosity	Not available because this substance is a solid	-	ECHA
Henry's Law Constant	Not available because this substance is readily oxidisable in water	-	ECHA

*Inorganic chemicals are outside of the EPIWIN (v.4.0) domain so no experimental determination for vapor pressure was carried out for this substance

**This value was determined using read across for a similar substance (diammonium persulfate, CAS RN 7727-54-0)

III. ENVIRONMENTAL FATE PROPERTIES

Potassium persulfate is known to dissociate completely to the potassium cation (K^{2+}) and persulfate anion ($S_2O_8^{2-}$) when dissolved in water. The persulfate anion, independent of the cation, undergoes further decomposition in normal water or acid conditions which readily oxidizes water to oxygen thus producing sulphate and hydrogen ions. All persulfate decomposition products are ubiquitous to the environment (ECHA).Biodegradation is not applicable to inorganic compounds.

Potassium persulfate has a low potential for bioaccumulation. Persulfates are very soluble in water and are not expected to bioaccumulate in soil or aqueous solutions. (ECHA).

IV. HUMAN HEALTH HAZARD ASSESSMENT

A. Summary

Potassium persulfate is unlikely to become bioavailable in the body regardless of the exposure route. Potassium persulfate has moderate acute oral toxicity, and it has low acute dermal and inhalation toxicity. This substance was reported to be irritating to the skin and slightly irritating to the eyes. Potassium persulfate is a moderate-strong skin sensitiser in animals and humans. There is evidence from occupational studies that potassium persulfate may be a respiratory sensitiser. Potassium persulfate has low systemic toxicity. Potassium persulfate is not genotoxic or carcinogenic. Potassium persulfate is not a reproductive or developmental toxicant.

B. Metabolism

Potassium persulfate will hydrolyse upon contact with water, and it will degrade to eventually form corresponding cations (potassium) and persulfate anions. The persulfate anion, independent of the cation, undergoes further decomposition upon contact with water to form sulfate species. Given these properties, potassium persulfate is unlikely to become bioavailable neither by inhalation, ingestion, or dermal contact. In addition to this, all of potassium persulfate degradation products are physiologically essential to organisms. Therefore, bioaccumulation of potassium persulfate is unlikely in view of its rapid degradation and its high-water solubility (ECHA) [KI. score =1].

The persulfate ion is poorly absorbed from the gastro-intestinal tract, especially when administered in large doses, such that the capacity of specialised transport processes for this ion in the intestines is exceeded. No data were available on the distribution of the persulfate salts in the body. Based on the *in vitro* chemistry of persulfates, the persulfate anion is expected to decompose under *in vivo* conditions to form hydrogen peroxide and sulfate ions. Hydrogen peroxide is rapidly metabolised to oxygen and water by catalase and peroxidase enzymes in mammalian tissues and there is practically no potential for bioaccumulation (OECD, 2005). Sulfate ions are required by the body for the synthesis of sulfur-containing macromolecules. Physiological studies have demonstrated that

sodium, potassium, and ammonium ions are mainly excreted in the urine. Inorganic sulfate is also eliminated from the body, almost entirely by renal excretion (i.e., without biotransformation) (NICNAS, 2020).

C. Acute Toxicity

Oral

Potassium persulfate was tested for acute oral toxicity in male rats in who were administered Dipotassium persulfate by oral gavage as a suspension in corn oil in doses of 2500 mg/kg bw, 1000 mg/kg bw, and 500 mg/kg bw. The acute LD50 value for dipotassium persulfate was determined to be 1130 mg/kg bw. (ECHA)[KI. score =2].

An OECD Guideline 401 (Acute Oral Toxicity) study was conducted using 10 male and 10 female Sprague-Dawley rats exposed to 215, 464, 562, 681, 825, 1,000, 1,210 and 1470 mg/kg disodium peroxodisulphate (CAS RN 7775-27-1) via oral gavage. The rats were observed for four weeks following exposure to disodium peroxodisulphate (CAS RN 7775-27-1). No animal died in the lowest dose group (215 mg/kg bw), two rats (one male and one female rat) died in the intermediate dose group (681 mg/kg bw) and all rats died in the highest dose group (1470 mg/kg bw). Death occurred within 60 minutes until 6 days after application. Surviving animals had recovered after 48 hours after application. Clinical signs included sedation, dyspnoea, diarrhoea, muscular hypotension, reduced feed intake and face-down position. LD_{50}-values of 930 mg/kg bw (males) and 920 mg/kg bw (females) were determined after a 14 days observation period and corresponding LD_0 values of 464 mg/kg in male rats and 562 mg/kg in female rats were revealed (ECHA)[KI. score =2].

The acute oral median lethal dose (LD_{50}) values for the three persulfate salts (in rats) were reported as 495-820 mg/kg bw for ammonium persulfate (Smyth et al, 1969; FMC, 2001), 895-930 mg/kg bw for sodium persulfate (Degussa AG, 1979; as cited in NICNAS 2020) and 1130 mg/kg bw for potassium persulfate (FMC, 1979a as cited in NICNAS 2020). Clinical signs for all persulfates were ocular and oral discharge, irregular breathing, and loss of muscle control (NICNAS, 2020).

Inhalation

Male rats were exposed to 42.9 mg/L of potassium persulfate for one hour. None of the seven test animals died during the 14 days observation period. Thus, the LC_{50} and LC_0 values for inhalation toxicity for dipotassium persulfate were estimated to be greater than >42.9 mg/L and 42.9 mg/L, respectively (ECHA)[KI. score =2].

An EPA OPP 81-3 (Acute inhalation study) was conducted using male and female Sprague Dawley rats exposed to diammonium peroxodisulphate (CAS RN 7727-54-0) via whole body inhalation of dust for 240 minutes. The acute LC_{50} and LC_0 for the 4-hour whole body exposure were greater than >2.95 mg/L and >2.95 mg/L, respectively. The administered concentration was considered the maximum attainable concentration (ECHA) [KI. score =1].

Acute inhalation studies with ammonium, sodium and potassium persulfates performed according to OECD guidelines in rats, indicated median lethal concentration (LC_{50}) values of greater than the maximum attainable concentrations, 2.95 mg/L, 5.1 mg/L and 42.9 mg/L, respectively. Following exposure to high concentrations of persulfates, animals exhibited dyspnoea, respiratory distress and increased nasal, ocular, and oral secretion (FMC 1987, FMC, 1979b; FMC 1995; as cited in NICNAS, 2020).

Dermal

10,000 mg/kg bw of disodium peroxodisulphate (CAS RN 7775-27-1) was administered to male rabbits via a single dermal application. None of the four test animals died during the 14 days observation period. Based on the obtained results, LD_{50} and LD_0 values of >10,000 mg/kg bw and 10,000 mg/kg bw, respectively, were determined (ECHA)[KI. score =2].

As per an EPA OPP 81-2 (Acute dermal toxicity) study, male and female Sprague-Dawley rats were exposed to 2,000 mg/kg bw of diammonium peroxodisulphate (CAS RN 7727-54-0) via occulusive dressing for 24 hours. In this study, the acute LD_{50} and LD_0 values were > 2,000 mg/kg bw and 2,000 mg/kg bw, respectively, in both male and female rats. Under the conditions of this study, diammonium persulfate was considered as non-toxic to both male and female rats when topically applied (ECHA)[KI. score=1].

The acute dermal LD_{50} was >2000 mg/kg bw (rats) for ammonium persulfate (FMC, 1991b), and >10,000 mg/kg bw (rabbits) for sodium and potassium persulfates (FMC, 1979c). Ocular and nasal discharge and slight irritation were reported in animals dermally exposed to high levels of persulfates (FMC, 1979b; as cited in NICNAS, 2020).

D. Irritation

Skin

An OECD Guideline 404 (Acute dermal irritation/corrosion) study was conducted using three Albino-White Russian rabbits exposed to Diammonium persulfate (CAS RN 7727-54-0) via occlusive dressing for four hours. Diammonium persulfate showed formation of severe non-reversible erythema and slight oedema. Based on these results diammonium persulfate was considered irritating to the skin (ECHA)[KI. score =2].

The dermal irritation potential of ammonium persulfate was determined (according to OECD Test Guideline TG404) using six male and female New Zealand White rabbits (CTFA, 1994). No irritation was noted within 72 hours following application. In another study, ammonium persulfate, 0.5 g moistened with 0.1 mL of water was applied under an occlusive patch to the intact and abraded skin of three white Russian rabbits for 4 hours (BGChemie, 1994). Slight oedema, which disappeared within 24 hours, was observed on intact skin, while moderate to severe erythema, moderate oedema, and scab formation were observed at the abraded sites. Ammonium persulfate was considered non-irritating to intact skin. Three brief study reports submitted by industry on sodium persulfate showed at most a slight skin irritant potential in rabbits (FMC, 1979d; FMC, 1980; as cited in NICNAS, 2020).

Standard patch tests have shown 5 % ammonium persulfate to be irritating to human skin (Calnan & Shuster, 1963; Cronin, 1980; as cited in NICNAS, 2020), although a separate study found 1/20 people exhibited an equivocal response when tested with 5 % to 10 % persulfate (Forck, 1968; as cited in NICNAS, 2020). Application of 17.5 % solution of the persulfate salts under an occlusive wrap for four hours was found to cause irritation in 8/46 subjects (Jordan, 1998 cited in CIR, 2001; as cited in NICNAS, 2020).

Eye

An OECD Guideline 405 (Acute Eye Irritation/Corrosion) study was conducted using Albino rabbits exposed to 0.1 mL of diammonium peroxodisulphate (CAS RN 7727-54-0). Conjunctival redness,

obvious swelling with partial eversion of lids plus hypersecretion were observed (in one animal, one hour after application. 72 hours after application full recovery was observed. The irritating index was determined to be 10.5. Under the conditions of this study diammonium persulfate was considered to be slightly irritating to eyes. No systemic-toxic effects were observed, and the general state of the animals was good throughout the study period. (ECHA) [KI. score =1].

In one eye irritation study, ammonium persulfate (0.1 g) was instilled into the conjunctival sacs of the eyes of three white Russian rabbits (BG Chemie, 1996; as cited in NICNAS, 2020). Severe diffused reddening and swelling with hyper-secretion were noticed, and subsided within 72 hours, although clouding of the cornea was still present at this time. Ammonium persulfate was considered slightly irritating to the eye. No irritation scores were available (NICNAS, 2020).

In another study conducted according to the OECD TG 405 (details not available), ammonium persulfate was instilled in the eyes of nine New Zealand White rabbits. The eyes of six animals were not rinsed whereas the eyes of three animals were rinsed 30 seconds after instillation (CTFA 1994; as cited in NICNAS, 2020). Ammonium persulfate caused slight to mild conjunctivitis and iritis in the unrinsed eyes and was considered minimally irritating to these eyes. Ammonium persulfate was practically non-irritating to rinsed eyes. No irritation scores were available (NICNAS, 2020).

In a single unpublished study, sodium persulfate was instilled into the eyes of 8 rabbits. Eye irritation was scored by the Draize method at 24, 48 and 72 h. Slight conjunctivitis was noted at 48 h (FMC, 1979c; as cited in NICNAS, 2020).

E. Sensitisation

Skin

An OECD Guideline 406 (Skin sensitisation) study was conducted using male and female Pirbright white guinea pigs exposed to 0.1% diammonium peroxodisulphate (CAS RN 7727-54-0) via the intradermal route of exposure. After challenge, erythema and oedema were observed in 16 of 20 guinea pigs in the test group, compare to only 3 control animals that revealed slight erythema. All animals remained healthy and gained weight during the study. Under the conditions of this study, the test material diammonium persulfate was considered sensitising to the skin of Guinea pigs (ECHA) [KI. score =2].

There was evidence of delayed contact hypersensitivity in two maximisation tests (OECD TG 406) using ammonium and sodium persulfate in guinea pigs. All test animals reacted positively following challenge by intradermal injection of 0.1 % ammonium persulfate and 80 % of animals were positive following dermal challenge with 1 % ammonium persulfate 14 days later. The corresponding figures for sodium persulfate were 90 % positive for test animals positive following an (non-standard) intracutaneous challenge and 60 % of the test animals were positive following topical challenge (CIR, 2001; BIBRA International, 1997; as cited in NICNAS, 2020).

Sodium persulfate was not sensitising when applied to the skin of guinea pigs in an unpublished Buehler Test, conducted to guideline standards (FMC, 1990b). In a murine local lymph node assay (LLNA), investigators concluded that both ammonium and sodium persulfate were moderate to strong sensitisers with EC3 values (amount of chemical required to elicit a stimulation index of 3) calculated to be 1.9 % and 0.9 % respectively (Cruz et al., 2009 cited in HSDB; as cited in NICNAS, 2020).

Many patch-test studies in human volunteers gave positive response to sodium and ammonium persulfates (Fisher et al., 1976; Pepys et al, 1976; as cited in NICNAS, 2020).

There are strong indications that ammonium, sodium, and potassium persulfate are linked to a variety of skin complaints indicative of sensitisation in occupationally exposed human subjects. In general, persulfates are associated with immediate and delayed contact hypersensitivity, contact urticaria, eczema, dermatoses, and rashes (White et al., 1982; as cited in NICNAS, 2020).

The persulfates caused both delayed-type and immediate skin reactions. These reactions include irritant dermatitis, allergic eczematous dermatitis, localised contact urticaria, generalised urticaria, rhinitis, asthma, and syncope. The most common causes of allergic dermatitis in hairdressers are the active ingredients in hair dyes, and ammonium persulfate has been identified as a frequent allergen. Several occupational case studies document these types of reactions, but no incidence data were available (CIR, 2001; as cited in NICNAS, 2020).

Respiratory

Occupational asthma, rhinitis, bronchitis, and decreased lung function has been widely reported in hairdressers from bleaching powders and industrial workers exposed to persulfate salts. Several occupational studies have been reviewed in CIR (2001; as cited in NICNAS, 2020).

F. Repeated Dose Toxicity

Oral

An OECD Guideline 408 (Repeated Dose 90-Day Oral Toxicity Study in Rodents) subchronic study was conducted using male and female Charles River CR strain rats exposed to 0; 22; 91; 200 mg/kg bw/day disodium persulfate. Observations included body weight, food consumption, blood and urine parameters. Further ophthalmologic examinations and gross and microscopic examinations were carried out. All animals survived the study. Significant differences were seen among the groups in body weights and food consumption. No significant differences were seen among groups in Haematological blood chemical, and urine analytical parameters, and organ weight and body weight ratios. Organ weights, organ-to-body weight ratios and type and frequency of grossly observable lesions seen during necropsy were comparable among the four groups. Intestinal changes were noted in rats which received 3000 ppm of sodium persulfate for 13 weeks. These changes were seen more frequently among females than males. The former received 50 percent more test material than the latter on a dose per body weight basis. No significant changes were seen among the controls or the groups which received 300 ppm, or 1000 ppm in the diet for eight weeks, followed by 5000 ppm in the diet for the remainder of the study. No other microscopic changes were noted on comparison among these three groups. LOAEL and NOAEL values of 200 and 91 mg/kg bw /day (3000 and 1000 ppm), respectively were determined. (ECHA)[KI. score =2].

An OECD Guideline 407 (Repeated Dose 28-day oral toxicity) sub-chronic study was conducted using male Weanling CR-CD albino rats exposed to 0, 12.62, 41.15, and 131.50 mg/kg bw/day (0, 100, 316, and 1000 ppm) potassium persulfate in their feed for 28 days. All test animals showed normal body weight gain and survived the study period. No significant pathology was observed. The NOAEL was determined to be 131.5 mg/kg bw/day (ECHA)[KI. score =2].

The persulfates have low repeat dose toxicity. A 28-day repeated dose oral (dietary) toxicity studies were conducted in rats with all three persulfate salts. The oral doses for the three salts were 0, 100, 316, 1000 ppm (equivalent to 0, 12.6, 41.2, 131.5 mg/kg bw/day for the potassium salt). Tests were performed in male rats only. The NOAEL for sodium and potassium salts were 137 and 131.5 mg /kg

bw/day, respectively (the highest doses tested), while the NOAEL for ammonium persulfate was 41 mg/kg bw/day, based on decreased relative adrenal weight at the highest dose (FMC, 1979a; FMC, 1979b; FMC1979c; as cited in NICNAS, 2020).

Another oral (dietary) subchronic toxicity study using sodium persulfate was conducted in rats. Rats (20/sex/group; strain not provided) were fed rodent chow containing 0, 300, 1000 or 3000 ppm sodium persulfate (0, 23, 100 or 225 mg/kg bw/day) for 90 days. On day 48 of the study, the concentration of the group receiving 1000 ppm was increased to 5000 ppm for the remainder of the study. At the two high dose levels body weight was decreased during the last 6 weeks of treatment (FMC 1979e; as cited in NICNAS, 2020).

There were no treatment-related effects on urinalysis, clinical chemistry, or haematology parameters. Pathological findings were limited to the 3000 ppm group only and consisted of necrosis and atrophy of the gastrointestinal tract epithelial lining. The absence of the gastrointestinal lesions in the group receiving 1000 ppm for 8 weeks, followed by 5000 ppm for 5 weeks, indicates that the lesions are related both to concentration in diet (dose) and length of exposure. There were no treatment related pathological findings in reproductive organs or any other organ system or tissue. A lowest observed adverse effect level (LOAEL) of 3000 ppm (200-250 mg/kg bw/day) was established in this study (CIR, 2001; as cited in NICNAS, 2020)

Inhalation

No inhalation studies were available for potassium persulfate. However, studies were available for other persulfates.

A sub chronic inhalation study was conducted using male and female Sprague-Dawley rats exposed to 0, 5.0, 10.3, and 25 mg/m^3 ammonium persulfate (CAS RN 7727-54-0) via whole body inhalation of dust for 6 hours per day (5 days per week) for 13 weeks There were no exposure-related deaths during the study. Increased respiration rates were noted in both males and females in the 25 mg/m³ group, and in a few animals in the 10.3 mg/m³ group. The incidence of these clinical signs decreased to zero during the first weeks of the recovery period. Body weights for both males and females in the 25 mg/m³ group were significantly depressed during most of the exposure period compared to the control group. By the end of the recovery period, body weights for the exposed animals were similar to the control group values. Lung weights were elevated in the 25 mg/m³ group after 13 wk of exposure but were similar to controls at 6 wk post exposure. Irritation of the trachea and bronchi/bronchioles was noted microscopically after 13 weeks of exposure to 25 mg/m³. These lesions had recovered by 6 wk post exposure. Based on these results, the no-observed-adverse-effect concentration (NOAEC) was 10.3 mg/m³, while the no-observed-effect concentration (NOEC) for exposure of rats to a dust aerosol of ammonium persulfate was 5.0 mg/m³(ECHA) [KI. score =1].

A well conducted 90-day inhalation study using ammonium persulfate gave evidence of inflammation of the airways, reduced body weight gain, rales, increased respiratory rate and increased lung weights (FMC 1998; NICNAS, 2020). In the study, rats (10/sex/group, rat strain not specified) were exposed in whole body chambers to dust aerosol concentrations of 0, 5, 10 or 25 mg/m^3 ammonium persulfate, 6 hours/day, 5 days/week for 13 weeks. Additional groups of 5 animals/sex/group were exposed for 13 weeks followed by a 6-week or 13-week recovery periods. Rales and increased respiratory rates were noted in high dose males and females during the study, and sporadically in the mid-dose group. At 25 mg/m^3, inflammation of the trachea and bronchi/bronchioles, decreased body weights and increased lung weights were found after 13 weeks. These lesions had reversed to normal by the end of the 6-week recovery period. The no

observed adverse effect concentration (NOAEC) in this study was determined to be 10.3 mg/m^3 (NICNAS, 2020).

Pulmonary function tests conducted on employees of a persulfate production facility indicated no adverse effects on pulmonary function at workplace exposure levels, measured at 0.5 mg/m^3 (FMC, 1992; as cited in NICNAS, 2020). Follow-up of these same employees indicated that exposure at 0.5 mg/m^3 had no long-term effects on pulmonary function (Greaves, 1997; as cited in NICNAS, 2020).

Dermal

There are no studies available.

G. Genotoxicity

In vitro Studies

The *in vitro* genotoxicity studies on potassium persulfate are presented in Table 2.

Table 2: *In vitro* Genotoxicity Studies on Potassium Persulfate

Test System	Results*		Klimisch Score	Reference
	-S9	+S9		
Bacterial reverse mutation assay (E. coli WP2 uvr A)	-	-	1	ECHA
Salmonella typhimurium (TA 1538, TA 1535, TA 1537, TA 98, TA 100) **	-	-	2	ECHA
Unscheduled DNA synthesis (rat liver hepatocytes) **	-	-	2	ECHA
Bacterial reverse mutation assay (Salmonella typhimurium TA 1538, TA 1535, TA 1537, TA98, TA 100)	-	-	2	ECHA
DNA damage and repair study (rat liver hepatocytes)	-	-	2	ECHA

*+, positive; -, negative
**Disodium peroxodisulphate (CAS RN 7775-27-1)

In vivo Studies

An OECD Guideline 474 (Mammalian Erythrocytes Micronucleus) test was conducted using male and female ICR mice exposed to 85, 169, 338 mg/kg of disodium peroxodisulphate (CAS RN 7775-27-1) via intraperitoneal exposure. No significant increases in micronucleated polychromatic erythrocytes were observed at 24, 48 or 72 hours after dose administration in males or females. The results of the assay indicated that under the conditions described disodium persulfate did not induce a significant increase in micronucleated polychromatic erythrocytes in male or female ICR mice. Disodium persulfate was concluded to be negative in the mouse micronucleus assay. Thus, disodium persulfate was considered to be not clastogenic (ECHA) [KI. score =2].

An *in vivo/in vitro* unscheduled DNA synthesis test was conducted using male Fischer 344 rats exposed to 41, 164, and 820 mg/kg bw/day disodium peroxodisulphate (CAS RN 7775-27-1) via oral gavage for 2-18 hours. The results of the *in vivo*/*in vitro* UDS assay indicated that under the test

conditions, the test substance did not cause a significant increase in the mean net nuclear grain counts (i.e., an increase of at least 5 counts over the vehicle control) in hepatocytes isolated from treated animals (a negative result). Therefore, disodium persulfate was considered not mutagenic (ECHA)[KI. score =2].

Sodium persulfate was negative in two in vivo genotoxicity studies. Doses of sodium persulfate up to 338 mg/kg injected into mice intraperitoneally did not increase the incidence of micronuclei in bone marrow polychromatic erythrocytes (FMC, 1990c; as cited in NICNAS). Sodium persulfate was found to be non-genotoxic when tested up to 820 mg/kg in an in vivo unscheduled DNA synthesis test in rats (FMC, 1991c; as cited in NICNAS).

H. Carcinogenicity

Oral

There are no studies available.

Inhalation

There are no studies available.

Dermal

An OECD Guideline 451 (Carcinogenicity) study was conducted using female Sencar mice exposed to 200 mg/mL to potassium persulfate twice weekly via dermal exposure (shaved dorsum) for 52 weeks. There was no significant difference observed between the treated group and the control group. Based on the obtained results potassium persulfate was considered neither a tumour promoter nor a carcinogen when applied to the skin (ECHA) [KI. score =2].

In a non-guideline study, female SENCAR mice were exposed dermally twice weekly to 0.2 mL of a 200 mg/mL solution of ammonium persulfate for 51 weeks. The investigators concluded that ammonium persulfate is neither a tumour promoter nor a complete carcinogen when applied to the skin (Kurokawa et al., 1984; as cited in NICNAS, 2020).

I. Reproductive Toxicity

Diammonium peroxodisulphate (APS) was examined for its possible prenatal developmental toxicity in accordance with subacute OECD guideline 414 study. Groups of 26 sperm-positive female Han: Wistar rats were treated with APS by oral administration daily at three dose levels of 10, 30 and 100 mg/kg bw/day respectively from day 5 up to and including day 19 post coitum. A control group of 26 sperm positive females was included and the animals were given the vehicle water. There were no test item related adverse effects on the foetal- and placental weight. There were no test item related external malformations and variations found. The visceral malformations were not attributed to the treatment. The skeletal malformations were found in three foetuses with a statistical significance. However, the incidence was low and the type of alterations less severe and partially different. There was no dose related increase seen in external and skeletal variations. Based on these observations the NOAELs were determined as follows: NOAEL (maternal toxicity): 30 mg/kg bw/day, NOAEL (developmental toxicity): 100 mg/kg bw/day, NOAEL (teratogenicity): 100 mg/kg bw/day (high dose) (ECHA)[KI. score =1].

Diammonium persulfate was tested for oral reproductive/developmental toxicity in a screening test with rats according to OECD guideline 421.The purpose of this study was to obtain initial information

on the possible effects of the test item on reproduction and development when administered orally in the diet to Crl:CD (SD)IGS BR rats at doses of 40, 100 and 250 mg/kg bw/day compared to control animals (plain diet only). There were no treatment-related clinical signs of toxicity observed in F0 parents of either sex or in F1 pups at any treatment level. Remarkable clinical signs in the F0 parents and F1 pups were not attributed to treatment with diammonium persulfate, as they occurred sporadically, were of short duration, and did not demonstrate a dose response. No significant changes were observed in male and female reproductive performance such as gonadal function, mating behaviour, conception, pregnancy, parturition and in development of the F1 offspring from conception to day 4 postpartum. In conclusion, under the conditions of this study, the NOAEL for male and female toxicity, the NOAEL for male and female fertility performance and the NOAEL for F1 viability and development was ≥250 mg/kg/day (ECHA) [KI. score =1].

A one-generation reproductive toxicity study was conducted using male and female rats exposed to 50, 100, 180, or 200 potassium persulfate in their diet. There were no effects on reproductive performance following exposure to the test substance. The NOAEL for systemic toxicity and female reproductive performance was reported to be 50 mg/kg bw/day. The NOAEL for male reproductive performance was reported to be 180 mg/kg bw/day (ECHA)[KI.score=1].

J. Developmental Toxicity

Oral

Diammonium peroxodisulphate (APS) was examined for its possible prenatal developmental toxicity. Groups of 25 (low and mid dose) and 26 (high dose) inseminated New Zealand White rabbits were treated with Diammonium peroxodisulphate (APS) by oral (gavage) administration daily at three dose levels of 10, 30 and 100 mg/kg bw/day respectively from day 6 up to and including day 27 post insemination. A control group of 25 inseminated females was included and the animals were given the vehicle water. There was no test item related mortality, moribund state or abortion observed. In total, on gestation day 28 there were 22, 23, 21 and 20 evaluated litters in the control, 10, 30 and 100 mg/kg bw/day group respectively. There were no test item related clinical signs and pathological macroscopic findings observed. Treatment with the test item at 100 mg/kg bw/day induced maternal toxicity manifest as an initial weight loss and subsequent reduction in body weight gain (77% between GD 6-28). Corrected body weight and corrected body weight gain clearly reflected the effect at 100 mg/kg bw/day. The reduction in body weight correlated with a reduction in food consumption, observed from the start of the treatment. Treatment with the test item at 30 mg/kg bw/day did not induce maternal toxicity. Variations in weight gain were not statistically significant during the study. Variations in the food consumption were not statistically significant at 30 mg/kg bw/day except for GD 18-21. This did not result in statistically lower body weight gain. There was no effect of 10 mg/kg bw/day on maternal body weight or food consumption. There was evidence of an increase in early embryonic death/post-implantation loss/total intrauterine mortality and a slightly lower mean number of viable foetuses (without a statistical significance) in the 100 mg/kg bw/day dose group. This outcome was considered to be related to the severity of the maternal toxicity induced. Significantly lower foetal weight and crown-rump length were observed in the 100 mg/kg bw/day dose group. These smaller foetuses showed evidence of delayed ossification (e.g., larger or slightly larger anterior fontanelle, reduced or asymmetric ossification of the bones of the digits (including pollex) or small hole in xiphoid cartilage. These effects were considered to be a consequence of the maternal toxicity induced. There was no evidence of treatment-related malformation at 100 mg/kg bw/day. There was no effect of treatment at 10 or 30 mg/kg bw/day on foetal growth or development. The severity of the maternal toxicity at 100 mg/kg bw/day was considered to impact foetal viability and growth and to slightly delay ossification. This dose of Diammonium peroxodisulphate (APS) did not induce foetal malformation. The NOAEL for developmental toxicity is 30 mg/kg bw/day (ECHA)[KI. score=1].

A developmental toxicity study was conducted using Wistar rats exposed to 10, 30, 100 mg//kg bw/day potassium persulfate via oral gavage. There were no treatment related effects observed in this study. The NOAEL for maternal toxicity was reported to be 30 mg/kg bw/day. The NOAEL for developmental toxicity was reported to be 100 mg/kg bw/day (ECHA) [KI. score =1].

A developmental toxicity study was conducted using New Zealand white rabbits exposed to 10,30,100 mg/kg bw/day potassium persulfate via oral gavage. The NOAEL for maternal toxicity was reported to be 30 mg/kg bw/day based on body weight gain (ECHA)[KI. score =1].

In a well conducted fertility/developmental study (OECD 421), groups of rats (Crl:CD (SD)IGS BR, 12/sex/group) were administered ammonium persulfate in the diet at doses of 0, 40, 100 and 250 mg/kg bw/day (Weaver, 2004). Animals (both sexes) were dosed two weeks prior to and during mating. Females were administered the substance following mating, throughout gestation and until lactation day 4. In the parental generation group, there were no treatment related clinical signs, effects on body and organ weights or gross lesions. There were no significant adverse effects on the gonads and progression of spermatogenesis, although a non-significant decrease in pregnancy rates was reported at = 100 mg /kg bw/day. On this basis, it was concluded that the NOAEL for fertility indices and reproductive performance was the top dose of 250 mg /kg bw/day. There were no treatment-related clinical signs, mortality or necropsy findings among pups (live birth and viability indices were similar across all groups). There was a slight transient depression in mean pup body weight; however, it was not considered adverse. The developmental toxicity NOAEL determined was the highest dose of 250 mg /kg bw/day (Weaver, 2004; as cited in NICNAS, 2020).

Inhalation

There are no studies available.

Dermal

There are no studies available.

V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES

The toxicological reference values developed for potassium persulfate follow the methodology discussed in enHealth (2012). The approach used to develop drinking water guidance values is described in the Australian Drinking Water Guidelines (ADWG, 2011).

A. Non-Cancer

Oral

An OECD Guideline 408 (Repeated Dose 90-Day Oral Toxicity Study in Rodents) sub chronic study was conducted using male and female Charles River CR strain rats exposed to 0; 22; 91; 200 mg/kg bw/day disodium persulfate. All animals survived the study. Significant differences were seen among the groups in body weights and food consumption. No significant differences were seen among groups in Haematological blood chemical, and urine analytical parameters, and organ weight and body weight ratios. Organ weights, organ-to-body weight ratios and type and frequency of grossly observable lesions seen during necropsy were comparable among the four groups. LOAEL and NOAEL values of 200 and 91 mg/kg bw /day (3000 and 1000 ppm), respectively were determined (ECHA)[KI. score =2].

A NOAEL of 91 mg/kg bw/day for repeated dose toxicity will be used for determining the oral reference dose (RfD) and the drinking water guidance value.

Oral Reference Dose (oral RfD)

Oral RfD = NOAEL / (UF_A x UF_H x UF_L x UF_{Sub} x UF_D)

Where:

UF_A (interspecies variability) = 10
UF_H (intraspecies variability) = 10
UF_L (LOAEL to NOAEL) = 1
UF_{Sub} (subchronic to chronic) = 10
UF_D (database uncertainty) = 1
Oral RfD = 91/(1 x 10 x 1 x 1 x 1) = 91/1000 = 0.091mg/kg/day

Drinking water guidance value

Drinking water guidance value = (animal dose) x (human weight) x (proportion of intake from water) / (volume of water consumed) x (safety factor)

Using the oral RfD,

Drinking water guidance value = (oral RfD) x (human weight) x (proportion of water consumed) / (volume of water consumed)

Where:

Human weight = 70 kg (ADWG, 2011)
Proportion of water consumed = 10% (ADWG, 2011)
Volume of water consumed = 2L (ADWG, 2011)
Drinking water guidance value = (0.091 x 70 x 0.1)/2 = 0.32 mg/L

Potassium persulfate readily dissociates in aqueous media to the potassium (K^{2+}) and persulfate ($S_2O_8^{2-}$) ions. The persulfate anion, independent of the cation, undergoes further decomposition in normal water or acid conditions which readily oxidizes water to oxygen thus producing sulphate and hydrogen ions. Therefore, the Australian drinking water guideline values for sulphate (250 mg/L) may also apply to potassium persulfate.

B. Cancer

There is limited data available and there is no evidence of carcinogenicity for any persulfate salt including potassium persulfate.

VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES

Potassium persulfate does exhibit the following physico-chemical properties:

- Explosivity
- Flammability

It is considered an oxidiser (ECHA).

VII. ENVIRONMENTAL HAZARD ASSESSMENT

A. Summary

Potassium persulfate are of low toxicity concern to aquatic receptors.

B. Aquatic Toxicity

Acute Studies

Table 3 lists the results of acute aquatic toxicity studies conducted on potassium persulfate.

Table 3: Acute Aquatic Toxicity Studies on Potassium Persulfate

Test Species	Endpoint	Results (mg/L)	Klimisch Score	Reference
Oncorhynchus mykiss (Rainbow trout)	96-h LC_{50}	76.3 (mortality)*	1	ECHA
Oncorhynchus mykiss (Rainbow trout)	96-h LC_{50}	163 (mortality)*	1	ECHA
Oncorhynchus mykiss (Rainbow trout)	96-h LC_{50}	76.3 (mortality)**	1	ECHA
Daphnia magna	48-h EC_{50}	120 (mobility)*	1	ECHA
Daphnia magna	48-h EC_{50}	120 (mobility)**	1	ECHA
Phaeodactylum tricornutum	72-EC_{50}	320 (growth rate reduction) *	1	ECHA

*Disodium peroxodisulphate (CAS RN 7775-54-0)
** Dipotassium peroxodisulphate (CAS RN 7727-21-1)

Chronic Studies

Table 4 lists the results of chronic aquatic toxicity studies conducted on potassium persulfate.

Table 4: Chronic Aquatic Toxicity Studies on Potassium persulfate

Test Species	Endpoint	Results (mg/L)	Klimisch Score	Reference
Daphnia magna	21-d NOEC	20.8 (reproduction)*	1	ECHA
Daphnia magna	21-d NOEC	20.8* (reproduction)**	1	ECHA
Phaeodactylum tricornutum	72-h NOEC	32 (cell growth inhibition and growth rate reduction) *	1	ECHA

*Diammonium peroxodisulphate (CAS RN 7727-54-0)
**Dipotassium peroxodisulphate (CAS RN 7727-21-1)

C. Terrestrial Toxicity

There are no studies available. Persulfates are not expected to be distributed into the terrestrial compartment and consequently not to cause toxicity to terrestrial organisms and plants (ECHA).

D. Calculation of PNEC

The PNEC calculations for Potassium persulfate follow the methodology discussed in DEWHA (2009).

PNEC Water

Experimental results are available for three trophic levels. Acute E(L)C_{50} values are available for fish (76.3 mg/L), *Daphnia* (120 mg/L), and algae (320 mg/L). NOEC values from long-term studies are available for invertebrates (20.8 mg/L) and algae (32 mg/L). On the basis that the data consists of short-term results for three tropic levels and long-term results from two trophic levels, an assessment factor of 50 has been applied to the lowest reported E(L)C_{50} value of 20.8 mg/L for invertebrates. The $PNEC_{water}$ is 0.416 mg/L.

PNEC Sediment

There are limited toxicity data for sediment-dwelling organisms. K_{ow} and K_{oc} parameters do not readily apply to inorganics, such as potassium persulfate. Thus, the equilibrium partitioning method cannot be used to calculate the $PNEC_{sediment}$. Based on its properties, no adsorption of potassium persulfate to sediment is expected and the assessment of this compartment will be covered by the aquatic assessment.

PNEC Soil

There are no toxicity data for terrestrial or soil organisms K_{ow} and K_{oc} parameters do not readily apply to inorganics, such as potassium persulfate. Thus, the equilibrium partitioning method cannot be used to calculate the $PNEC_{soil}$. Based on its properties, no adsorption of potassium persulfate to soil is expected. In addition, persulfates are not expected to be distributed into the terrestrial compartment and consequently not to cause toxicity to terrestrial organisms and plants.

VIII. PERSISTENCE, BIOACCUMULATION AND TOXICITY (PBT) ASSESSMENT

The methodology for the Persistent, Bioaccumulative and Toxic (PBT) substances assessment is based on the Australian and EU REACH Criteria methodology (DEWHA, 2009; ECHA, 2017).

Potassium persulfate is an inorganic compound that dissociates completely to ionic species. Biodegradation is not applicable to these compounds. For the purposes of this PBT assessment, the persistent criterion is not considered applicable to potassium persulfate or its dissociated compounds.

Persulfates are very soluble in water and are not expected to bioaccumulate in soil or aqueous solutions. Thus, potassium persulfate does not meet the criteria for bioaccumulation.

The NOECs from the chronic aquatic toxicity studies on potassium persulfate and read-across compounds are > 0.1 mg/L. The acute E(L)C_{50} values from the acute aquatic toxicity studies on potassium persulfate and read-across compounds are > 1 mg/L. Thus, potassium persulfate does not meet the criteria for toxicity.

The overall conclusion is that potassium persulfate is not a PBT substance.

IX. CLASSIFICATION AND LABELLING

A. Classification

H302 (Harmful if swallowed)
H315 (Causes skin irritation)
H319 (Causes serious eye irritation)
H334 (May cause allergy or asthma symptoms or breathing difficulties if inhaled)
H317 (May cause an allergic skin reaction)
H335 (May cause respiratory irritation)
H272 (May intensify fire, oxidizer)

B. Labelling

Danger

A. Pictogram



X. HANDLING AND SAFETY INFORMATION (OCCUPATIONAL LIMITS AND TRANSPORTATION REQUIREMENTS)

A. First Aid

Please refer to the product SDS for additional information and confirmation of the information provided herein.

Eye Contact

In case of contact, immediately flush eyes with plenty of water for at least 15 minutes.

Skin Contact

Wash thoroughly with soap and water.

Inhalation

If inhaled, remove from area to fresh air. Get medical attention.

Ingestion

Rinse mouth with water and then drink a glass of water. Get medical attention. Never give anything by mouth to an unconscious person.

B. Fire Fighting Information

Extinguishing Media

Water spray, carbon dioxide, foam, dry chemical.

Specific Exposure Hazards

Keep product and empty container away from heat and sources of ignition. May emit toxic fumes under fire conditions. Depending on conditions, decomposition products may include the following: carbon monoxide, carbon dioxide.

Special Protective Equipment for Firefighters

Wear self-contained breathing apparatus.

C. Accidental Release Measures

Personal Precautions

Use appropriate protective equipment. Handle in accordance with good industrial hygiene and safety practice.

Environmental Precautions

Prevent from entering sewers, waterways or low areas.

Steps to be Taken if Material is Released or Spilled

For large amounts: dike spillage and pump off product. For residues: pick up with suitable absorbent material. Dispose of contaminated material as prescribed.

D. Storage And Handling

General Handling

Keep product and empty container away from heat and sources of ignition. Ensure adequate ventilation, especially in confined areas.

Storage

Keep container tightly closed and in a dry and well-ventilated place. Keep in a cool place.

E. Exposure Controls / Personal Protection

Occupational Exposure Standards

The workplace exposure standards for potassium persulfate in Australia is as follows: 0.1 mg/m^3 (peak limitation, time-weighted average).

Engineering Controls

Good general ventilation should be used.

Personal Protection Equipment

Respiratory Protection: Respiratory protection is not required.

Hand Protection: Chemical resistant protective gloves.

Skin Protection: Body protection must be chosen depending on activity and possible exposure.

Eye protection: Safety glasses with side-shields.

Other Precautions: Handle in accordance with good industrial hygiene and safety practice. Wearing of closed work clothing is recommended. Ensure that eyewash stations and safety showers are close to the workstation location.

F. Transport Information

Potassium persulfate is considered hazardous for purposes of transportation by road or rail. An Australian Dangerous Goods code is not required.

XI. DISPOSAL MANAGMENT

Disposal should be in accordance with all local, state and federal regulations.

XII. REGULATORY STATUS

Australian AICS Inventory: Listed.

XIII. REFERENCES

ADWG. (2011). National Water Quality Management Strategy. Australian Drinking Water Guidelines, Section 6, Australian Government, National Health and Medical Research Council, Natural Resource Management Ministerial Council. Updated January 2022. Available: https://www.nhmrc.gov.au/about-us/publications/australian-drinking-water-guidelines

CAS Common Chemistry. CAS, a division of the American Chemical Society, n.d. https://commonchemistry.cas.org/detail?cas_rn=7727-21-1 (retrieved 2022-12-13) (CAS RN: 7727-21-1). Licensed under the Attribution-Non-commercial 4.0 International License (CC BY-NC 4.0).

Department of the Environment, Water, Heritage and the Arts [DEWHA]. (2009). Environmental risk assessment guidance manual for industrial chemicals, Department of the Environment, Water, Heritage and the Arts, Commonwealth of Australia. Available: http://www.nepc.gov.au/resource/chemical-risk-assessment-guidance-manuals

Department of the Environment and Energy [DoEE]. (2017). Chemical Risk Assessment Guidance Manual: for chemicals associated with coal seam gas extraction, Guidance manual prepared by Hydrobiology and ToxConsult Pty Ltd for the Department of the Environment and Energy, Commonwealth of Australia, Canberra.

ECHA. ECHA REACH database: http://echa.europa.eu/information-on-chemicals/registered-substances

enHealth Human Risk Assessment [HHRA]. (2012). Environmental Health Risk Assessment, Guidelines for Assessing Human Health Risks from Environmental Hazards. Office of Health Protection of the Australian Government Department of Health. Available: https://www1.health.gov.au/internet/main/publishing.nsf/Content/health-pubhlth-publicat-environ.htm

European Chemicals Agency [ECHA]. (2017). Guidance on Information Requirements and Chemical Safety Assessment, Chapter R11: PBT Assessment, European Chemicals Agency, Helsinki, Finland. Available: https://echa.europa.eu/guidance-documents/guidance-on-information-requirements-and-chemical-safety-assessment

Klimisch, H.J., Andreae, M., and Tillmann, U. (1997). A systematic approach for evaluating the quality of experimental and toxicological and ecotoxicological data. Regul. Toxicol. Pharmacol. 25:1-5.

NICNAS. Australian Industrial Chemicals Introduction Scheme. Persulfates: Human health tier II assessment. Available at: https://www.industrialchemicals.gov.au/sites/default/files/Persulfates_Human%20health%20tier%20II%20assessment.pdf

POTASSIUM SORBATE

This dossier on potassium sorbate presents the most critical studies pertinent to the risk assessment of potassium sorbate in its use in coal seam or shale gas extraction activities. This dossier does not represent an exhaustive or critical review of all available data. The majority of information presented in this dossier was obtained from the ECHA database that provides information on chemicals that have been registered under the EU REACH (ECHA). Where possible, study quality was evaluated using the Klimisch scoring system (Klimisch et al., 1997).

NICNAS has assessed potassium sorbate in an IMAP Tier 1 assessment and concluded that it poses no unreasonable risk to the environment.[1]

I. SUBSTANCE IDENTIFICATION

Chemical Name (IUPAC): potassium (E, E)-hexa-2,4-dienoate

CAS RN:24634-61-5

Molecular formula: $C_6H_8O_2.K$

Molecular weight: 150.22 g/mol

Synonyms: potassium sorbate, potassium (E, E)-hexa-2,4-dienoate

SMILES: CC=CC=CC(=O) [O-]. [K+]

II. PHYSICO-CHEMICAL PROPERTIES

Table 1: Overview of the Physico-chemical Properties of Potassium Sorbate

Property	Value	Klimisch Score	Reference
Physical state at 20oC and 101.3 kPa	Organic, crystalline, white, odorless powder	1	ECHA
Melting Point	This chemical decomposes at temperatures ≥ 205 °C	1	ECHA
Boiling Point	≥ 205°C @ 101.3 kPa	1	ECHA
Density	1.36 (relative density) @ 23.5°C	1	ECHA
Vapour Pressure	< 0 Pa* @ 20°C	1	ECHA
Partition Coefficient (log K_{ow})	1.32 (@ pH 2.5) and -1.72 (@pH 6.5) @ 20°C	1	ECHA
Water Solubility	≥1.95-≤ 543 g/L @ 20°C	1	ECHA
Flash Point	Not applicable	-	-
Auto flammability	178°C	1	ECHA
Viscosity	≥ 17.4-≤ 19.3 mPa s @ 20°C	1	ECHA

[1] https://www.industrialchemicals.gov.au/chemical-information/search-assessments?assessmentcasnumber=24634-61-5+

Property	Value	Klimisch Score	Reference
Henry's Law Constant	2.77 x 10^{-9} Pa m^3/mol @ 20°C	1	ECHA

*Calculated based on conservative estimates using the Antoine equation

III. ENVIRONMENTAL FATE PROPERTIES

A. Summary

Potassium sorbate is soluble in water, it is readily biodegradable, and it is expected to have negligible bioaccumulation potential. Potassium sorbate is expected to be mobile in soil and it has a high potential to leach into groundwater. However, potassium sorbate is not expected to volatize from water.

B. Biodegradation

In an OECD Guideline 301 D (Ready Biodegradability: Closed Bottle) test on sorbic acid, degradation was 74.9% after 28 days. Thus, potassium sorbate is expected to be readily biodegradable (ECHA) [KI. score =1]. If a chemical is found to be readily biodegradable, it is categorised as Not Persistent since its half-life is substantially less than 60 days (DoEE, 2017).

C. Environmental Distribution

In an OECD Guide 121 (Estimation of the adsorption coefficient K_{oc} on soil and on sewage sludge using high performance liquid chromatography), the estimated log K_{oc} value for sorbic acid was reported to be -1.82 L/Kg at pH 6.0 and 20 °C. The K_{oc} value was reported to be 0.015 L/Kg at 20°C which suggests that potassium sorbate has high mobility in soil, and it has a high potential to leach into groundwater (ECHA) [KI. score =1].

D. Bioaccumulation

A bioconcentration factor (BCF) was estimated for sorbic acid based on its physio-chemical properties. The formula log BCF_{fish} =0.85 x logP_{ow}-0.7 was used to estimate the BCF value for sorbic acid. The BCF value for sorbic acid at pH 2.5 was reported to be 2.6. The BCF value for sorbic acid at pH 6.5 was reported to be 0.007. These values suggest that sorbic acid/potassium sorbate has negligible bioaccumulation potential (ECHA) [KI. score =1].

IV. HUMAN HEALTH HAZARD ASSESSMENT

A. Summary

Potassium sorbate has low acute oral, inhalation, and dermal toxicity. Potassium sorbate is not a skin irritant, and it is not a skin sensitizer. Potassium sorbate is moderately irritating to the eye of rabbits. Potassium sorbate is not expected to be genotoxic despite mixed findings reported in the *in vitro* studies. This substance is not expected to be carcinogenic nor is there any of evidence that potassium sorbate elicits reproductive toxicity or developmental toxicity.

B. Metabolism

In an EU method B.36 (Toxicokinetic) study 40 and 3000 mg/kg bw/day of 1-14 C radiolabelled surrogate sorbic acid was given to female mice by oral gavage. The mice were observed for four days

following exposure to sorbic acid. Within four days ~80% of the administered dose of sorbic acid was expired as radioactive carbon dioxide, only 2.6-5.4% of sorbic acid was excreted in the urine, and less than 1% was excreted in the faeces. In the urine, 0.7% of the administered dose was recovered as unchanged sorbic acid and 0.2-0.6% was recovered as muconic acid. In this study, the major metabolic pathway for sorbic acid was reported to be oxidation to CO_2 and water. The extrapolation from sorbic acid to potassium sorbate or vice versa is considered not to be restricted in any way, since the determinant of potential toxicity is on the "sorbate" anion (ECHA) [KI. score =2].

In an EU method B. 36 (Toxicokinetic) study 61, 130, 160, 261,287, 277, 500, 587, 825, 888, and 1213 mg/kg bw/day of 1-14 C radiolabelled sorbic acid was given to female Sprague-Dawley rats by oral gavage. The rats were observed for four to twenty hours after treatment. The total recovery of radioactivity was 100% in the low and high dose groups of mice. The major route of metabolism for sorbic acid was via expired CO2 with 85% of the administered dose being recovered as CO2 within 4-10 hours after administration (ECHA) [KI. score =2].

Potassium sorbate is expected to be metabolize rapidly and completely in the gastrointestinal tract (ECHA).

C. Acute Toxicity

Oral

Male and female Sherman rats were fed 0.2 g/ml of sorbic acid and they were observed for 14 days. The reported LD_{50} of 10,500 mg/kg bw/day (ECHA) [KI. score = 2].

Male and female Wistar rats were given 0, 3.8, 5.1, 6.9, 9.3, 12.5, and 16.9 g/kg of sorbic acid by oral gavage and they were observed for seven days. The LD_{50} in males was reported to be 12,500 mg/kg bw and the reported LD_{50} in females was reported to be 9,600 mg/kg bw/day (ECHA) [KI. score = 2].

Inhalation

No reliable inhalation studies available.

Dermal

An OECD guideline 402 (Acute dermal toxicity) test was conducted using male and female Sprague-Dawley rats exposed to sorbic acid via semi occlusive dressing. The LD_{50} was reported to be > 2000 mg/kg bw/day (ECHA) [KI. score =1].

D. Irritation

Skin

An OECD guideline 404 (Acute dermal irritation/corrosion) test was conducted using New Zealand White rabbits exposed to potassium sorbate by semi occlusive dressing. One rabbit had slight erythema and oedema and another rabbit had well defined erythema and oedema one hour after exposure to potassium sorbate. After 24 hours, the individual scores for erythema and oedema in all the rabbits was reported to be zero. Only one rabbits had dry skin 72 hours after exposure to potassium sorbate. The max score for erythema and oedema was reported to be 4 after 24, 48, and 72 hours. Potassium sorbate was reported to be non-irritating to the skin of rabbits (ECHA) [KI. score =1].

Eye

An OECD guideline 405 (Acute Eye irritation/corrosion) test was conducted using New Zealand White rabbits. Approximately 100 mg of potassium sorbate was instilled into the eyes of the rabbits and the other eye was used as a control. The rabbits were observed for 21 days at observation timepoints of 1, 24, 48, 72 hours and day 7, day 14, and day 21. The mean chemosis score was reported to be 2.11, the mean conjunctivae score was reported to be 1.66, and the mean iris score was reported to be 0.44, and the mean cornea opacity score was reported to be 0.44. The rabbits experienced discoloration, swelling and haemorrhage of the conjunctivae after exposure to potassium sorbate. All the observed effects were found to be fully reversible within 7- 21days. Potassium sorbate was reported to moderately irritating to the eyes of rabbits (ECHA) [KI. score =1].

E. Sensitisation

A guinea pig maximization test was conducted according to EU method B.6 (Skin sensitization) using male and female Pirbright-Hartley guinea pigs. There was no evidence of a positive reaction after intradermal injection of 0.1 or 1% sorbic acid. Based on this study sorbic acid is not expected to be sensitizing to the skin of guinea pigs (ECHA) [KI. score =2].

F. Repeated Dose Toxicity

Oral

An OECD guideline 407 (28-day repeated dose toxicity study in rodents) test was conducted using male and female Sprague-Dawley rats exposed to 0, 25,000, 50,000, and 100,000 ppm of sorbic acid in their feed for 28 days. There were no overt clinical signs of toxicity, no mortalities, no treatment related effects on food consumption, nor were there any changes in neurotoxicological measurements in this study. A NOAEL (males and females) of 100,000 ppm was reported in this study. A NOAEL of 9200 mg/kg bw/day was reported for male rats and a NOAEL of 8600 mg/kg bw/day was reported for female rats (ECHA) [KI. score = 1].

An OECD guideline 408 (90-day repeat dose oral toxicity study in rodents) test was conducted using male and female Sprague-Dawley rats exposed to 25,000, 50,000, and 100,000 ppm of sorbic acid in their feed for 90-92 days. There were no overt clinical signs of toxicity, no mortalities, no-treatment related effects on food consumption, and no ophthalmologic findings observed in this study. A NOAEL (males and females) of 100,000 was reported for this study. A NOAEL of 6800 mg/kg bw/day was reported for male rats and a NOAEL of 7200 mg/kg bw/day was reported for female rats (ECHA) [KI. score = 1].

A EU method B.27 (90-day oral repeated dose sub chronic toxicity test in rodents) study was conducted using male and female half cocker, mixed cocker + terrier dogs exposed to 0 and 400,000 ppm of sorbic acid in their feed for 88-91 days. There were no specific abnormalities reported upon gross and histopathological examination of the tissues and evaluation of haematological parameters. A NOAEL of > 40,000 ppm was reported for this study (ECHA) [KI. score = 2].

A chronic toxicity and carcinogenicity study was conducted using male and female Wistar rats exposed to concentrations of 1.5 or 10% sorbic acid in their feed for two years. In the high dose group, a decrease in body weight gain and a decrease of body weight value was observed. However, as the difference from the control was small, this was associated with some reduction in food intake. Food consumption and compound intake showed no consistent differences between treated and control rats, although there were some statistically significant decreases. Haematology examination showed a statistically significant reduction in the total leucocyte count in high dose females at week

27 (individual data not presented in the publication) and a statistically significant increase in the total red blood cells count in the low dose female group at week 52. As no similar changes were found in the males, these findings were determined to be incidental. Clinical chemistry analysis showed no relevant effect data. The high dose males showed a statistically significant increase of urea when compared to the control group. This was related to the normal ageing changes in the rat kidney. The urinary volume of the high dose females showed a slight statistically significant increase at week 13 and 52 when compared to the control. The absolute and relative organ weight of the thyroid in the high dose male group was increased. The animals with increased thyroid showed some signs of advanced renal changes. It is concluded that the heavier thyroids do not represent an effect of sorbic acid on the thyroid but rather an indirect effect of renal damage on the parathyroid. In the relative organ weight analysis, the liver was statistically significantly increased in the high dose male and female group. As demonstrated by the histopathological examination these effects are not definitely hepatotoxic. The kidneys, small intestine and gonads of the high dose females showed a statistically significant increase when compared to the control. In the microscopic pathology the liver of the high dose females showed an increase in focal fatty change, a statistically significantly decreased incidence of bile-duct hyperplasia and a statistically significantly increased incidence of focal necrosis. The fatty change could have resulted from an increased intake of fatty acids. The focal necrosis may have been an indication of an incidental infection, probably of viral origin. In high dose males a statistically significantly decreased incidence of increased extramedullary haematopoiesis in spleen and a decrease of haemosiderin deposition in spleen was observed. Dietary levels up to 10 % sorbic acid caused no carcinogenic effect. Thus, the study failed to detect carcinogenic potential of sorbic acid. A NOAEL of 750 mg/kg bw/day/day and a LOAEL of 5,000 mg/kg/day was reported for this study (ECHA) [KI. score = 2].

A chronic oral toxicity and carcinogenicity study was conducted using male and female ASH/CS1 mice exposed to concentrations of1400, 7000, and 14, 000 mg/kg bw/day bw sorbic acid in their feed for 80 weeks. There were no adverse effects on mortality or the incidence of histological lesions including tumours. The mice that were exposed to 10% sorbic acid experienced a decrease in body weight when compared to control mice. The mice exposed to 5% and 10% sorbic acid had increased kidney weights and increased relative liver weights A NOEL of 1400 mg/kg bw/day was reported for this study (ECHA) [KI. score = 2].

Inhalation

There are no studies available.

Dermal

There are no studies available.

G. Genotoxicity

In vitro Studies

The *in vitro* genotoxicity studies on potassium sorbate are presented in Table 2.

Table 2: *In vitro* Genotoxicity Studies on Potassium Sorbate

Test System	Results*		Klimisch Score	Reference
	-S9	+S9		
Bacteria Reverse Mutation Assay (Salmonella typhimurium TA 1535, TA 1537, TA98, and TA 100)	-	-	2	ECHA
Bacteria Reverse Mutation Assay (Salmonella typhimurium TA97a and TA102)	-	-	2	ECHA
In vitro mammalian chromosome aberration test (Chinese hamsters lung fibroblasts or CHL cells)	+	-	2	ECHA
Mammalian cell gene mutation assay (Chinese hamster ovary or CHO cells)	-	-	2	ECHA
DNA damage and repair assay, unscheduled DNA synthesis in mammalian cells (human cell line A 549 American type culture collection no. CCL 185) *	-	-	2	ECHA

*+, positive; -, negative
*sorbic acid

In Vivo Studies

An OECD guideline 474 (mammalian erythrocyte micronucleus test) study was conducted using male and female NMRI mice exposed to 0, 500, 1500, or 5000 mg/kg bw/day of sorbic acid by oral gavage for 72 hours. The mice were observed after 24 hours, 48 hours, and 72 hours post treatment. There were no increases in the number of micro nucleated polychromatic erythrocytes and micro-nucleated normo-chromatic erythrocytes at any of the observation time points. Sorbic acid was reported to be non-genotoxic under the condition of this test (ECHA) [KI. Score =2].

The genotoxic potential of sorbic acid was evaluated in a sister chromatid exchange assay using male and female NMRI mice exposed to 500, 1500, and 5000 mg/kg bw/day of sorbic acid for 24 hours. The mice were observed 24 hours post treatment. Sorbic acid did not induce any sister chromatid exchanges in bone marrow cells at any of the dose levels evaluated. Sorbic acid was non genotoxic under the conditions of this test (ECHA) [KI. Score =2].

H. Carcinogenicity

Oral

A chronic oral toxicity and carcinogenicity study was conducted using male and female ASH/CS1 mice exposed to concentrations of 0,1,5 or 10%, sorbic acid in their feed for 80 weeks. There were no adverse effects on mortality or the incidence of histological lesions including tumours. The mice that were exposed to 10% sorbic acid experienced a decrease in body weight when compared to control mice. Compared with the control this decrease was statistically significant in high dose females. The lower weight was considered to represent only a mildly unfavourable response, since only the mice treated with the highest level of test substance weighed significantly less. Haematology examination showed a statistically significant reduction in the haemoglobin concentration of treated male mice after 13 weeks of administration, for medium dose males also

after 26 weeks and a statistically significant decrease of red blood cells (RBC) for low dose males after 26 weeks. As there were no parallel reductions in the other erythrocyte measurements and the differences were confined to one sex, this incidence did not appear to be treatment related. The higher values for the relative weights of brain, spleen, stomach and small intestine were seen in the absence of any significant differences in the absolute weights and with no indication of any histological change. The increased values for relative heart weights in females are anomalous as there were no comparable changes in the males. It is possible that the increased value at the highest level may reflect the lower body weight. In addition to this, the weight of the hearts in the female controls was slightly less than expected for mice of this size. The increase of relative liver weights cannot be attributed to differences in body weight since some higher values were found in the absolute weights despite the lower body weights. This increase is a reflection of an increase in metabolic demand rather than a toxic effect of Sorbic acid. The increased relative kidney weight does not represent any marked toxic effect of Sorbic acid, as the histological examination found significantly fewer incidences of lesions in the kidney in treated mice than in the control. In the kidneys a statistically significant reduction of perivascular lymphocytes occurred in the treated male and female groups compared to the controls. Also, the kidneys of the treated female groups showed degenerative changes, the low dose group with a statistically significant increase. Early degenerative changes in the liver occurred more frequently in the control than in the treated males. High dose females showed more incidence of early degenerative change in liver than the control. Hyperplastic nodules and amyloids in liver and spleen occurred once in a female mouse administered the 10 % dose. Treated females showed a reduction of follicular cysts in the ovary, with a statistically significant decrease in the medium dose group compared to the control. Chronic inflammation in the lung was found in treated as well as in control females. Most of the types of tumours encountered occurred with a similar or higher frequency in control than in treated mice. One case of a malignant squamous skin epithelioma, although found in a high dose female mouse was a singular observation among 264 treated animals and cannot be construed as a carcinogenic effect since such tumours are known to occur spontaneously. The single mammary adenocarcinoma in a high dose female mouse represents an incidence, which lies in the overall incidence range recorded in females of the same strain of mice at the end of other studies in these laboratories. The squamous-cell carcinoma of the stomach in a low dose male mouse is not considered as an indication for a carcinogenic effect. Overall, dietary levels up to 10 % of sorbic acid for 80 weeks caused no carcinogenic effects in mice. A NOEL of 1400 mg/kg bw/day and a LOAEL of 3750 mg/kg bw/day was reported for this study (ECHA) [KI.score =2].

A chronic toxicity and carcinogenicity study was conducted using male and female Wistar rats exposed to concentrations of 1.5 or 10% sorbic acid in their feed for two years. In the high dose group, a decrease in body weight gain and a decrease of body weight value was observed. However, as the difference from the control was small, this was associated with some reduction in food intake. Food consumption and compound intake showed no consistent differences between treated and control rats, although there were some statistically significant decreases. Haematology examination showed a statistically significant reduction in the total leucocyte count in high dose females at week 27 (individual data not presented in the publication) and a statistically significant increase in the total red blood cells count in the low dose female group at week 52. As no similar changes were found in the males, these findings were determined to be incidental. Clinical chemistry analysis showed no relevant effect data. The high dose males showed a statistically significant increase of urea when compared to the control group. This was related to the normal ageing changes in the rat kidney. The urinary volume of the high dose females showed a slight statistically significant increase at week 13 and 52 when compared to the control. The absolute and relative organ weight of the thyroid in the high dose male group was increased. The animals with increased thyroid showed some signs of advanced renal changes. It is concluded that the heavier thyroids do not represent an effect of sorbic acid on the thyroid but rather an indirect effect of renal damage on the parathyroid. In the

relative organ weight analysis, the liver was statistically significantly increased in the high dose male and female group. As demonstrated by the histopathological examination these effects are not definitely hepatotoxic. The kidneys, small intestine and gonads of the high dose females showed a statistically significant increase when compared to the control. In the microscopic pathology the liver of the high dose females showed an increase in focal fatty change, a statistically significantly decreased incidence of bile-duct hyperplasia and a statistically significantly increased incidence of focal necrosis. The fatty change could have resulted from an increased intake of fatty acids. The focal necrosis may have been an indication of an incidental infection, probably of viral origin. In high dose males a statistically significantly decreased incidence of increased extramedullary haematopoiesis in spleen and a decrease of haemosiderin deposition in spleen was observed. Dietary levels up to 10 % sorbic acid caused no carcinogenic effect. Thus, the study failed to detect carcinogenic potential of sorbic acid. A NOAEL of 750 mg/kg bw/day and a LOAEL of 5,000 mg/kg bw/day was reported for this study (ECHA) [KI. score =2].

Inhalation

There are no studies available.

Dermal

There are no studies available.

I. Reproductive Toxicity

An OECD guideline 416 (two generation reproductive toxicity study) test was conducted using male and female Crj: CD (SD) rats exposed to 0, 300, 1000, or 3000 mg/kg bw/day of sorbic acid by oral gavage. The NOAEL for male and female animals of the P-generation was established at 3000 mg/kg bw/day . The statistically significant reduction of food intake for F0 and F1 dams at 1000 and 3000 mg/kg bw/day , in the presence of caloric substitution by sorbic acid was considered to be the cause of reduced body weight development and slight developmental disturbances (morphological landmarks, learning and memory) of the F1/F2 offspring of the mid and high dose group during lactation. The reason for this effect remains unknown, however nutritional deficiencies in the pups masked by caloric overcompensation in lactating females might be an explanation. The NOAEL concerning effects on development of the conceptus and the offspring (F1-generation) through sexual maturity was established at 1000 mg/kg bw/day . Unscheduled deaths and clinical signs in F1 weanlings selected for mating (observed for 5 juveniles at 3000 mg/kg bw/day and one juvenile at 1000 mg/kg bw/day) during early pre-mating period is not uncommon in oral (gavage) reproduction toxicity studies. When administering excessive dose levels to juveniles as in this case, intolerance to oral gavage treatment often is a more important aspect rather than toxic effects induced by sorbic acid itself - findings that would not be necessarily seen in a corresponding dietary (feeding) study. Hence, these deaths may also be considered as incidental and not treatment related, and therefore are of no toxicological relevance (ECHA) [KI. score = 1]

J. Developmental Toxicity

Oral

An EU method B.31 (Prenatal Developmental Toxicity study) test was conducted using Wistar rats exposed to 3.4-340.0 mg/kg bw/day of potassium sorbate by oral gavage on day 6-16 of mating. The administration of up to 340 mg/kg bw/day of potassium sorbate had no clearly discernible effect on nidation or on maternal or foetal survival. The number of abnormalities seen in either soft or skeletal tissues of the test groups did not differ from the number occurring spontaneously in the

sham-treated controls. A LOAEL and NOAEL of 340 mg/kg bw/day was reported for maternal toxic effects. A LOAEL and NOAEL of 340 mg/kg bw/day was reported for embryotoxic and teratogenic effects (ECHA) [KI. score = 2].

An OECD guideline 414 (prenatal developmental toxicity study) test was conducted using Himalayan rabbits exposed to 10 mL/kg bw/day of sorbic acid by oral gavage from day 6-29 of gestation. There were no teratogenic properties observed up to a dose level of 1000 mg/kg bw/day . There were no treatment-related maternal or developmental effects were observed at 300 mg/kg bw/day . Maternal findings in the mid dose group included increased respiratory rate following administration, decreased body weight gain and rough surface of the spleen. Maternal findings in high dose females included increased respiratory rate following administration, death, abortion, decreased body weight and body weight gain, marked decrease in food consumption and pathological findings upon necropsy (rough surface and reduced size of the spleen). Statistically significant reductions in mean foetal and placental weights and the viability of the foetuses were observed at the mid and high dose levels. At 1000 mg/kg bw/day , marginal statistically significantly increased incidences of unclassified macroscopic variations (abdominal distension caused by an inflated gastric tract) and skeletal variations (less than 7 lumber vertebral bodies ossified) occurred. Abdominal distension was noted in two dams where all foetuses were affected and was regarded as not related to sorbic acid exposure. At the high dose level, causing severe maternal toxicity, increased post-implantation loss, severely reduced viability of foetuses, increased incidences of malrotation of fore paws, domed head, accessory 13th ribs, skeletal retardations according to Dawson and soft tissue variations of the head according to Wilson were recorded. However, it did not appear justified to draw any valid conclusion on teratogenic properties at the highest dose level of this study. Slight or severe maternal toxicity observed at the mid and high dose level, respectively, and severely reduced food consumption at both dose levels indicated malnutrition. This normally results in inadequate intake of calcium and micronutrients like trace elements and vitamins, which are required for normal development of the foetuses. The malnutrition resulted in premature death of dams, retarded development of the foetuses and reduced viability of foetuses in the highest dose group. As a reason, it was considered that sorbic acid was administered over the test period by single gastric intubations per day. Necropsy revealed gastric lesions in all deceased animals. Since sorbic acid is known to have irritant properties, such lesions are probably attributable to administration of a large quantity of the irritant test article by gastric intubation. Furthermore, it cannot be excluded that administration of large quantities of an antimicrobial substance resulted in disturbance of the intestinal microflora which, in turn, would result in deficiencies in nutrients, in particular for the rabbit species. It should, in contrast, be noted that in feeding studies for rodents and dogs (with human-like intestinal function), high doses of sorbic acid are well tolerated, which supports these conclusions. The LOAEL for maternal effects was reported to be 1000 mg/kg bw/day and the NOAEL for maternal effects was reported to be 300 mg/kg bw/day . A LOAEL of 1000 mg/kg bw/day was reported for embryotoxic or teratogenic effects and a NOAEL of 300 mg/kg bw/day was reported for embryotoxic or teratogenic effects (ECHA) [KI. score = 1].

Inhalation

There are no studies available.

Dermal

There are no studies available.

V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES

The toxicological reference values developed for potassium sorbate follow the methodology discussed in enHealth (2012). The approach used to develop drinking water guidance values is described in the Australian Drinking Water Guidelines (ADWG, 2011).

A. Non-Cancer

Oral

A prenatal developmental toxicity study provided the basis for the NOAEL of 300 mg/kg bw/day bw/day reported in rabbits. The NOAEL of 300 mg/kg bw/day will be used for determining the oral reference dose (RfD) and the drinking water guidance value.

Oral Reference Dose (oral RfD)

Oral RfD = NOAEL / (UF_A x UF_H x UF_L x UF_{Sub} x UF_D)

Where:

UF_A (interspecies variability) = 10
UF_H (intraspecies variability) = 10
UF_L (LOAEL to NOAEL) = 1
UF_{Sub} (subchronic to chronic) = 10
UF_D (database uncertainty) = 1
Oral RfD = 300/ (1 x 10 x 1 x 1 x 1) = 300/1000 = 0.30 mg/kg bw/day

Drinking water guidance value

Drinking water guidance value = (animal dose) x (human weight) x (proportion of intake from water) / (volume of water consumed) x (safety factor)

Using the oral RfD,

Drinking water guidance value = (oral RfD) x (human weight) x (proportion of water consumed) / (volume of water consumed)

Where:

Human weight = 70 kg (ADWG, 2011)
Proportion of water consumed = 10% (ADWG, 2011)
Volume of water consumed = 2L (ADWG, 2011)
Drinking water guidance value = (0.30 x 70 x 0.1)/2 = 1.05 mg/L

B. Cancer

There is no evidence that potassium sorbate is carcinogenic. Thus, a cancer reference value was not derived.

VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES

Potassium sorbate does not exhibit the following physico-chemical properties:

- Explosivity

- Flammability
- Oxidising potential

VII. ENVIRONMENTAL HAZARD ASSESSMENT

A. Summary

Potassium sorbate has low toxicity to aquatic organisms.

B. Aquatic Toxicity

Acute Studies

Table 3 lists the results of acute aquatic toxicity studies conducted on potassium sorbate.

Table 3: Acute Aquatic Toxicity Studies on Potassium Sorbate

Test Species	Endpoint	Results (mg/L)	Klimisch score	Reference
Danio rerio	96-hour LC_{50}	>500 (mortality)	1	ECHA
Oncorhynchus mykiss	96-hour LC_{50}	>1,000 (mortality)	1	ECHA
Danio rerio	96-hour LC_{50}	1,250 (mortality)	2	ECHA
Daphnia magna	48-hour EC_{50}	982 (mobility)	1	ECHA
Daphnia magna	48-hour EC_{50}	750 (mobility)	2	ECHA
Desmodesmus subspicatus	48-hour EC_{50}	480 (growth rate)	3	ECHA

Chronic Studies

Table 4 lists the results of chronic aquatic toxicity studies conducted on sorbic acid.

Table 4: Chronic Aquatic Toxicity Studies on Sorbic Acid

Test Species	Endpoint	Results (mg/L)	Klimisch score	Reference
*Desmodesmus subspicatus**	72-hour NOEC	8.46	3	ECHA
Daphnia magna	21-day NOEC	50	1	ECHA

C. Terrestrial Toxicity

An OECD guideline 207 (Earthworm, Acute Toxicity) test was conducted using *Eisenia fetida* exposed to sorbic acid in their soil for 14 days. Sorbic acid did not cause any adverse effects on mortality or body weight. The 14-day LC_{50} was reported to be 675 mg/kg soil dw and the 14-day NOEC was reported to be 455 mg/kg soil dw. However, these endpoint values were recalculated and the resulting 14-day LC_{50} was reported to be 864 mg/kg soil dry weight and the 14-day NOEC was reported to be 582 mg/kg soil dry weight (ECHA) [KI. score=1].

Guideline ISO 22030 (2005) was used to evaluate the toxicity of potassium sorbate to terrestrial plants Brassica rapa and Avena sativa for 44 days using natural soil. The 31-day NOEC for Brassica

rapa was reported to be ≥ 100 mg/kg soil dw. The 39-day NOEC for Avena sativa was reported to be ≥ 100 mg/kg soil dw (ECHA) [KI. score =1].

D. Calculation of PNEC

The PNEC calculations for potassium sorbate follow the methodology discussed in DEWHA (2009).

PNEC Water

Experimental results are available for three trophic levels. Acute E(L)C_{50} values are available for fish (>500 mg/L), *Daphnia* (750 mg/L), and algae (480 mg/L). NOEC values from long-term studies are available for invertebrates (50 mg/L) and algae (8.46 mg/L). On the basis that the data consists of short-term results from three tropic levels and long-term results from two trophic levels, an assessment factor of 50 has been applied to the lowest reported NOEC value of 8.46 mg/L for algae. The NOEC value is used because the value for algae is lower than the NOEC values for both trophic levels. The $PNEC_{water}$ is 0.169mg/L.

PNEC Sediment

There are no toxicity data for sediment-dwelling organisms. Therefore, the $PNEC_{sed}$ was calculated using the equilibrium partitioning method. The $PNEC_{sed}$ is 0.106 mg/kg sediment wet weight.

The calculations are as follows:

$PNEC_{sed} = (K_{sed\text{-}water}/BD_{sed}) \times 1000 \times PNEC_{water}$
$= (0.8/1280) \times 1000 \times 0.169$
$= 0.106$ mg/kg

Where:
$K_{sed\text{-}water}$ = suspended matter-water partition coefficient (m^3/m^3)
BD_{sed} = bulk density of sediment (kg/m^3) = 1,280 [default]
$K_{sed\text{-}water} = 0.8 + [(0.2 \times Kp_{sed})/1000 \times BD_{solid}]$
$= 0.8 + [(0.2 \times 0.0006/1000 \times 2400]$
$= 0.8\ m^3/m^3$

Where:
Kp_{sed} = solid-water partition coefficient (L/kg)
BD_{solid} = bulk density of the solid phase (kg/m^3) = 2,400 [default]
$Kp_{sed} = K_{oc} \times f_{oc}$
$= 0.015 \times 0.04$
$= 0.0006$ L/kg

Where:
K_{oc} = organic carbon normalised distribution coefficient (L/kg). The K_{oc} for potassium sorbate was estimated to be 0.015 L/Kg using an OECD Guide 121 (Estimation of the adsorption coefficient K_{oc} on soil and on sewage sludge using high performance/ liquid chromatography) test (ECHA)[KI. score =1].
F_{oc} = fraction of organic carbon in sediment = 0.04 [default].

PNEC Soil

There are only two toxicity studies using terrestrial receptors or soil organisms. The NOEC for earthworms is 582 mg/kg soil dw and the NOEC for plants is ≥ 100 mg/kg soil dw. Given the limited data for the soil compartment, an assessment factor of 100 was applied to derive the $PNEC_{soil}$ value of 1 mg/kg soil dry weight.

VIII. PERSISTENCE, BIOACCUMULATION AND TOXICITY (PBT) ASSESSMENT

The methodology for the Persistent, Bioaccumulative and Toxic (PBT) substances assessment is based on the Australian and EU REACH Criteria methodology (DEWHA, 2009; ECHA, 2017).

Potassium sorbate is readily biodegradable and thus does not meet the screening criteria for persistence.

The measured BCF in fish is 0.007 at pH 6.5. Thus, potassium sorbate does not meet the criteria for bioaccumulation.

The NOECs from the chronic aquatic toxicity studies on potassium sorbate are > 0.1 mg/L. The acute $E(L)C_{50}$ values from the acute aquatic toxicity studies on potassium sorbate are > 1 mg/L. Thus, potassium sorbate does not meet the criteria for toxicity.

The overall conclusion is that potassium sorbate is not a PBT substance.

IX. CLASSIFICATION AND LABELLING

A. Classification

H319: Causes serious eye irritation (Eye irritation-category 2)

B. Labelling

Warning

A. Pictogram



X. HANDLING AND SAFETY INFORMATION (OCCUPATIONAL LIMITS AND TRANSPORTATION REQUIREMENTS)

A. First Aid

Please refer to the product SDS for additional information and confirmation of the information provided herein.

Eye Contact

In case of contact, immediately flush eyes with plenty of water for at least 15 minutes.

Skin Contact

Wash thoroughly with soap and water.

Inhalation

If inhaled, remove from area to fresh air. Get medical attention.

Ingestion

Rinse mouth with water and then drink a glass of water. Get medical attention. Never give anything by mouth to an unconscious person.

B. Fire Fighting Information

Extinguishing Media

Water spray, carbon dioxide, foam, dry chemical.

Specific Exposure Hazards

Keep product and empty container away from heat and sources of ignition. May emit toxic fumes under fire conditions. Depending on conditions, decomposition products may include the following: carbon monoxide, carbon dioxide.

Special Protective Equipment for Firefighters

Wear self-contained breathing apparatus.

C. Accidental Release Measures

Personal Precautions

Use appropriate protective equipment. Handle in accordance with good industrial hygiene and safety practice.

Environmental Precautions

Prevent from entering sewers, waterways, or low areas.

Steps to be Taken if Material is Released or Spilled

For large amounts: dike spillage and pump off product. For residues: pick up with suitable absorbent material. Dispose of contaminated material as prescribed.

D. Storage And Handling

General Handling

Keep product and empty container away from heat and sources of ignition. Ensure adequate ventilation, especially in confined areas.

Storage

Keep container tightly closed and in a dry and well-ventilated place. Keep in a cool place.

E. Exposure Controls / Personal Protection

Occupational Exposure Standards

There are no workplace exposure standards for potassium sorbate in Australia.

Engineering Controls

Good general ventilation should be used.

Personal Protection Equipment

Respiratory Protection: Respiratory protection is not required.

Hand Protection: Chemical resistant protective gloves.

Skin Protection: Body protection must be chosen depending on activity and possible exposure.

Eye protection: Safety glasses with side-shields.

Other Precautions: Handle in accordance with good industrial hygiene and safety practice. Wearing of closed work clothing is recommended. Ensure that eyewash stations and safety showers are close to the workstation location.

F. Transport Information

Potassium sorbate is not considered hazardous for purposes of transportation by road or rail. An Australian Dangerous Goods code is not required.

XI. DISPOSAL MANAGMENT

Disposal should be in accordance with all local, state, and federal regulations.

XII. REGULATORY STATUS

Australian AICS Inventory: Listed.

XIII. REFERENCES

ADWG. (2011). National Water Quality Management Strategy. Australian Drinking Water Guidelines, Section 6, Australian Government, National Health and Medical Research Council, Natural Resource Management Ministerial Council. Updated January 2022. Available: https://www.nhmrc.gov.au/about-us/publications/australian-drinking-water-guidelines

Department of the Environment, Water, Heritage and the Arts [DEWHA]. (2009). Environmental risk assessment guidance manual for industrial chemicals, Department of the Environment, Water, Heritage and the Arts, Commonwealth of Australia. Available: http://www.nepc.gov.au/resource/chemical-risk-assessment-guidance-manuals

Department of the Environment and Energy [DoEE]. (2017). Chemical Risk Assessment Guidance Manual: for chemicals associated with coal seam gas extraction, Guidance manual prepared by Hydrobiology and ToxConsult Pty Ltd for the Department of the Environment and Energy, Commonwealth of Australia, Canberra. Available at: www.environment.gov.au/water/coal-and-coal-seam-gas/national-assessment-chemicals/consultation-risk-assessment-guidance-manual

ECHA. ECHA REACH database: http://echa.europa.eu/information-on-chemicals/registered-substances

enHealth Human Risk Assessment [HHRA]. (2012). Environmental Health Risk Assessment, Guidelines for Assessing Human Health Risks from Environmental Hazards. Office of Health Protection of the Australian Government Department of Health. Available: https://www1.health.gov.au/internet/main/publishing.nsf/Content/health-pubhlth-publicat-environ.htm

European Chemicals Agency [ECHA]. (2017). Guidance on Information Requirements and Chemical Safety Assessment, Chapter R11: PBT Assessment, European Chemicals Agency, Helsinki, Finland. Available: https://echa.europa.eu/guidance-documents/guidance-on-information-requirements-and-chemical-safety-assessment

Klimisch, H.J., Andreae, M., and Tillmann, U. (1997). A systematic approach for evaluating the quality of experimental and toxicological and ecotoxicological data. Regul. Toxicol. Pharmacol. 25:1-5.

QUATERNARY AMMONIUM COMPOUNDS, BIS (HYDROGENATED TALLOW ALKYL), DIMETHYL, SALTS WITH BENTONITE

This dossier is for quaternary ammonium compounds, bis (hydrogenated tallow alkyl), dimethyl, salts with bentonite (CAS RN 68953-58-2). For the purposes of this dossier, this substance will be referred to as dialkyl chain quaternary ammonium compound [2M(2Alk)] bentonite.

This dossier presents the most critical studies pertinent to the risk assessment of 2M(2Alk) bentonite in its use in coal seam or shale gas extraction activities. This dossier does not represent an exhaustive or critical review of all available data. The majority of information presented in this dossier was obtained from the OECD-SIDS Initial Assessment Profile on the Organoclays Category (OECD, 2007). Where possible, study quality was evaluated using the Klimisch scoring system (Klimisch et al., 1997).

I. SUBSTANCE IDENTIFICATION

Chemical Name (IUPAC): quaternary ammonium compounds, bis (hydrogenated tallow alkyl), dimethyl, salts with bentonite

CAS RN: 68953-58-2

Molecular formula: Unspecified

Molecular weight: Unspecified. Substance is a UVCB.

Synonyms: Quaternium-18 Bentonite; dialkyl chain quaternary ammonium compound [2M(2Alk)] bentonite; bis (hydrogenated tallow alkyl) dimethylammonium bentonite

SMILES: Not applicable. Substance is a UVCB.

II. PHYSICO-CHEMICAL PROPERTIES

2M(2Alk) bentonite is one of a group of organoclays composed of quaternary ammonium compounds (cations) that have the following general formula:

N+R1, R2, R3, R4

Where R1, R2, R3, and R4 are substitutions on the N (nitrogen atom) of the quaternary compound (salt) as follows:

- Methyl – 1 or 2 substitutions
- Benzyl – 0 or 1 substitutions
- Alkyl (C14-22) – 1, 2 or 3 substitutions

The organoclays discussed in this dossier are hydrogenated tallowalkonium bentonites and are the product of the reaction of hydrogenated tallowalkonium chloride and bentonite. Bentonite is a widely distributed natural material consisting predominantly of the clay montmorillonite, a smectite clay. Bentonite is formed of highly colloidal and plastic clays and is produced by in-situ devitrification of volcanic ash (CIR, 2016).

Organoclays, such as 2M(2Alk) bentonite, are free flowing solid powders that are essentially insoluble in water, in organic solvents and in lipids. They are not volatile under ambient conditions. The organoclays do not melt or boil, although some degradation may occur when subjected to extreme heat at about 180^0C to 600°C. The densities range from 1,400 to 1,800 kg/m^3 (temperature not provided) (OECD, 2007).

III. ENVIRONMENTAL FATE PROPERTIES

A. Summary

The clay component of 2M(2Alk) bentonite is not biodegradable, and the organic component is not readily biodegradable. Bioaccumulation is not expected due to the insolubile nature of 2M(2Alk) bentonite. Quaternary ammonium ions are tightly held to the clay, resulting in organoclay compounds ("salts") that are very hydrophobic in nature (OECD, 2007).

B. Biodegradation

No biodegradation studies were located for 2M(2Alk) bentonite. Biodegradation studies are available for quaternary ammonium compounds, benzylbis (hydrogenated tallow alkyl)methyl, chlorides, compounds with bentonite [also referred to as B(2Alk)M bentonite].

In three separate OECD TG 306 biodegradation tests using B(2Alk)M bentonite, biodegradation ranged from 4.7 to 33.4% in 28 days (OECD, 2007). Based on these data as well as the structural and chemical properties of these compounds, it is assumed that other organoclay category members will also show limited biodegradation. It should be noted that biodegradation relates only to the organic component of the organoclays (i.e., the alkyl quaternary ammonium salts).

C. Environmental Distribution

Quaternary ammonium ions are tightly held to the clay, resulting in organoclay compounds ("salts") that are very hydrophobic in nature (OECD, 2007).

D. Bioaccumulation

Bioaccumulation is not expected due to the insolubility of 2M(2Alk) bentonite (OECD, 2007).

IV. HUMAN HEALTH HAZARD ASSESSMENT

A. Summary

2M(2Alk) bentonite has low acute toxicity and is excreted rapidly. This substance is not irritating nor is it a skin sensitiser.

No systemic effects were observed in repeat dose oral or dermal toxicity studies. It is not genotoxic, carcinogenic, nor is it a reproductive or developmental toxicant.

B. Metabolism

2M(2Alk) bentonite are not expected to be absorbed following oral (gavage) and it will be excreted rapidly via faeces with negligible elimination from the urine and bile. There is no evidence of any tissue retention or systemic uptake of this substance. This substance is not expected to be respirable based on the particle size nor is it is expected to be absorbed through the skin.

C. Acute Toxicity

Acute toxicity studies demonstrate a low order of toxicity with an inhalation 4-hr LC_{50}S and an oral gavage LD_{50}S greater than 5.0 milligrams per litre (mg/L) and 5,000 milligrams per kilogram body weight (mg/kg/bw) respectively.

The oral LD_{50} for 2M(2Alk) bentonite is >8,000 mg/kg in rats (CIR, 1982) [Kl. score = 4]. The inhalation LC_{50} for 2M(2Alk) bentonite is >5.7 mg/L in rats for a 4-hr. 22-min. exposure. There were no mortalities, and the particle size was $\geq$ 10 micrometre (μm), 30% $\leq$ μm (CIR, 2016) [Kl. score = 4].

No acute dermal toxicity studies are available.

D. Irritation

2M(2Alk) bentonite is not irritating to the skin. Eye irritation is generally minimal in human and moderate in animals.

Application of 0.5 g. 2M(2Alk) bentonite to the skin of rabbits for 6 hours/day for five consecutive days, followed by 10 days of rest and then five more days of exposure, did not result in any signs of irritation (CIR, 1982) [Kl. score = 4].

Instillation of 0.1 mL of a 10% suspension of 2M(2Alk) bentonite in physiological saline produced no signs of irritation (CIR, 1982) [Kl. score = 4].

E. Sensitisation

2M(2Alk) bentonite was not considered a skin sensitiser when tested in a guinea pig sensitisation test (CIR, 1982) [Kl. score = 4].

F. Repeated Dose Toxicity

Oral

Rats were fed diets containing 0, 1%, 5%, or 25% 2M(2Alk) bentonite for 12 weeks. There was a depression of growth rate at the 25% test substance dose level, being somewhat more marked in males. There were no treatment-related effects seen in the hematology parameters, organ weights, gross pathology, or histopathology. Assuming 1% in the diet translated to about 500-1,000 mg/kg-bw/day, the no observed adverse effect level (NOAEL) (25% in the diet) was determined to be approximately 12,500 to 25,000 mg/kg-bw/day, the highest dose tested (OECD, 2007). [Kl. Score = 4].

Inhalation

No studies available.

Dermal

Rabbits were administered to the skin under occlusive conditions 0.5 g 2M(2Alk) bentonite for 6 hours/day for 90 days. There was no evidence of local or systemic toxicity (CIR, 1982) [Kl. score = 4].

G. Genotoxicity

In vitro Studies

The *in vitro* genotoxicity studies on 2M(2Alk) bentonite are presented in Table 1.

Table 1: *In vitro* Genotoxicity Studies on 2M(2Alk) bentonite

Test System	Results*		Klimisch Score	Reference
	-S9	+S9		
Mouse lymphoma cells	-	-	-	OECD SIDS 2007
Bacterial reverse mutation assay	-	-	-	OECD SIDS 2007

*+, positive; -, negative

In vivo Studies

No studies are available for 2M(2Alk) bentonite. However, this substance is not expected to be mutagenic based on read across to B(Alk)2M bentonite (OECD, 2007).

H. Carcinogenicity

There are no data regarding the carcinogenicity of 2M(2Alk) bentonite. However, the impurity, respirable crystalline silica which may be present at 0.1-5% is considered a known human carcinogen (Group 1 according to IARC) (OECD, 2007).

I. Reproductive Toxicity

2M(2Alk) bentonite is not expected to be a reproductive toxicant based on results from a one-generation reproduction study using another organoclay substance [B(2Alk)M hectorite] at dose levels of 0, 50, 225, and 1,000 mg/kg bw/day in rats. There were no treatment-related effects on adults or litters at any dose level. The parental and F1 offspring NOAEL was 1,000 mg/kg bw/d, the highest dose tested (OECD, 2007).

J. Developmental Toxicity

2M(2Alk) bentonite is not expected to be a developmental toxicant based on results from a one-generation reproduction/developmental toxicity study using another organoclay substance [B(2Alk)M hectorite] at dose levels of 0, 50, 225, and 1,000 mg/kg bw/day in rats. There were no treatment-related effects on litters at any dose level. The only statistically significant effect was a reduction in group mean litter weight from day 7 to 21 of lactation caused by a slightly reduced group mean litter size at 1,000 mg/kg bw/d. This effect was not considered to be of toxicological significance. There were no effects on mean individual offspring weights. There were no toxicologically significant findings for all parameters evaluated; the NOAEL was 1,000 mg/kg bw/d, the highest dose tested (OECD, 2007).

V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKIN WATER GUIDANCE VALUES

The toxicological reference values developed for 2M(2Alk) bentonite follow the methodology discussed in enHealth (2012). The approach used to develop drinking water guidance values is described in the Australian Drinking Water Guidelines (ADWG, 2011).

A. Non-Cancer

2M(2Alk) bentonite has been tested in a rat 12-week dietary study. The NOAEL was 12,500 mg/kg bw/day, the highest dose tested. This NOAEL will be used for determining the oral reference dose (RfD) and the drinking water guidance value.

Oral Reference Dose (oral RfD)

Oral RfD = NOAEL / (UF_A x UF_H x UF_L x UF_{Sub} x UF_D)

Where:

UF_A (interspecies variability) = 10
UF_H (intraspecies variability) = 10
UF_L (LOAEL to NOAEL) = 1
UF_{Sub} (subchronic to chronic) = 3
UF_D (database uncertainty) = 1
Oral RfD = 12500/(10 x 10 x 1 x 3 x 10) = 12500/300 = 41.67 mg/kg/day

Drinking water guidance value

Drinking water guidance value = (animal dose) x (human weight) x (proportion of intake from water) / (volume of water consumed) x (safety factor)

Using the oral RfD,

Drinking water guidance value = (oral RfD) x (human weight) x (proportion of water consumed) / (volume of water consumed)

Where:

Human weight = 70 kg (ADWG, 2011)
Proportion of water consumed = 10% (ADWG, 2011)
Volume of water consumed = 2L (ADWG, 2011)
Drinking water guidance value = (41.67 x 70 x 0.1)/2 = 146 mg/L

B. Cancer

There are no carcinogenicity studies on 2M(2Alk) bentonite. Thus, a cancer reference value was not derived.

VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES

2M(2Alk) bentonite does not exhibit the following physico-chemical properties:

- Explosivity
- Flammability
- Oxidising potential

VII. ENVIRONMENTAL HAZARD ASSESSMENT

A. Summary

2M(2Alk) bentonite displays low acute aquatic toxicity.

B(Alk)2M bentonite has low acute toxicity to fish and invertebrates, with likely low acute toxicity to algae. A chronic *Daphnia* study conducted on an organoclay similar to B(Alk)2M bentonite suggests that these compounds may have moderate chronic toxicity concerns for aquatic organisms. However, the toxicity observed in the study has been due, in part, to the physical effects of the organoclay test material. B(Alk)2M bentonite is virtually non-toxic to terrestrial organisms.

B. Aquatic Toxicity

Acute Studies

Table 2 lists the results of acute aquatic toxicity studies conducted on 2M(2Alk) bentonite and similar organoclays.

Table 2: Acute Aquatic Toxicity Studies on 2M(2Alk) bentonite and Similar Organoclays

Test Species	Endpoint	Results (mg/L)	Klimisch Score	Reference
Freshwater rainbow trout	96-hour LC_{50}	>ca. 500**	4	OECD SIDS, 2007
Daphnia magna	48-hour EC_{50}	>100	4	OECD SIDS, 2007
Daphnia magna	96-hour EC_{50}	300 **	4	OECD SIDS, 2007
Daphnia magna	48-hour EC_{50}	<500**	4	OECD SIDS, 2007
Skeletonema costatum	72-hour EC_{50}	23.8** (growth rate)	4	OECD SIDS, 2007
Skeletonema costatum	72-hour EC_{50}	82.3 (growth rate)	4	OECD SIDS, 2007
Skeletonema costatum	72-hour EC_{50}	>1,000** (growth rate)	4	OECD SIDS, 2007
Scenedesmus subspicatus	72-hour EC_{50}	>100 (growth rate)***	4	OECD SIDS, 2007

*Only one concentration was used
** Test material was B(2Alk)M bentonite (CAS No. 68153-30-0)
*** Test material was B(2Alk)M hectorite (CAS RN 121888-67-3).

Chronic Studies

No chronic studies are available on 2M(2Alk) bentonite. The 21-day no observed effect concentration (NOEC) in a *Daphnia* reproduction test on B(2Alk)M hectorite was 3.2 mg/L (OECD, 2007). The mortality of *Daphnia* seen at the LOEC of 32 mg/L was considered to be due, in part, to physical effects of the test material.

The 72-hour NOEC in a *Scenedesmus subspicatus* OECD TG201 toxicity test on B(2Alk)M hectorite was 100 mg/L, based on growth rate (OECD, 2007).

C. Terrestrial Toxicity

The 14-day NOEC of another organoclay substance [B(Alk)2M bentonite] to earthworms is 1,000 mg/kg. Since 1,000 mg/kg is the limit dose, it is assumed that the LC_{50} is >1,000 mg/kg (OECD, 2007).

Terrestrial plant toxicity are available for B(2Alk)M hectorite (CAS No. 12188-67-3). The EC_{50} values of B(2Alk)M hectorite for the emergence and early growth stages of wheat and radish seedlings (*Tritium aestivum* and *Raphanus sativus*, respectively) are >100 mg/kg; the NOEC are 100 mg/kg, the

highest dose tested (OECD, 2007). The LC_{50} of B(2Alk)M hectorite was 9 mg/kg for the emergence and early growth stages of cress seedling (*Lepidum sativum*); the LOEC was 1 mg/kg, and a NOEC was not established (OECD, 2007).

D. Calculation of PNEC

The PNEC calculations for 2M(2Alk) bentonite follow the methodology discussed in DEWHA (2009).

PNEC Water

Experimental results are available for three trophic levels. Acute $E(L)C_{50}$ values are available for fish (500 mg/L), invertebrates (100 mg/L), and algae (100 mg/L). Chronic NOEC values are available for invertebrates (3.2 mg/L) and algae (100 mg/L). On the basis that the data consists of short-term results from three trophic levels and long-term results from two trophic levels, an assessment factor of 50 has been applied to the lowest reported $E(L)C_{50}$ value of 3.2 mg/L for invertebrates (daphnia). The $PNEC_{aquatic}$ is 0.064 mg/L.

PNEC Sediment

No experimental toxicity data on sediment organisms are available. The K_{ow} of 2M(2Alk) bentonite cannot be calculated because it is essentially insoluble in water. Thus, the equilibrium partition method cannot be used to determine a $PNEC_{sediment}$.

PNEC Soil

No experimental toxicity data on terrestrial or soil organisms are available for 2M(2Alk) bentonite. Experimental results are available for two trophic levels for other organoclay substances in the group. An acute LC_{50} value is available for earthworms (>1,000 mg/kg). Results from the long-term studies are only available for terrestrial plants, which give widely divergent results. On the basis that the data consist of one short-term result from one trophic level, an assessment factor of 1,000 has been applied to the acute LC_{50} value of 1,000 mg/kg for earthworms. The $PNEC_{soil}$ is 1.0 mg/kg soil dry weight.

VIII. PERSISTENCE, BIOACCUMULATION AND TOXICITY (PBT) ASSESSMENT

The methodology for the Persistent, Bioaccumulative and Toxic (PBT) substances assessment is based on the Australian and EU REACH Criteria methodology (DEWHA, 2009; ECHA, 2017).

2M(2Alk) bentonite is not readily biodegradable and thus does not meet the screening criteria for persistence.

2M(2Alk) bentonite is insoluble in water and is not bioavailable. Thus, it is not expected to meet the screening criteria for bioaccumulation.

There are no chronic aquatic toxicity studies available on 2M(2Alk) bentonite; however, the NOEC from a chronic *Daphnia* study on a similar organoclay is >0.1 mg/L. The acute EC_{50} values for 2M(2Alk) bentonite and similar organoclays are >1 mg/L in fish, invertebrates and algae. Thus, it does not meet the criteria for toxicity.

The overall conclusion is that 2M(2Alk) bentonite is not a PBT substance.

IX. CLASSIFICATION AND LABELLING

A. Classification

Not Classified

B. Labelling

None

C. Pictogram

None

X. HANDLING AND SAFETY INFORMATION (OCCUPATIONAL LIMITS AND TRANSPORTATION REQUIREMENTS)

A. First Aid

Eye Contact

In case of contact, immediately flush eyes with plenty of water for at least 15 minutes.

Skin Contact

Wash thoroughly with soap and water.

Inhalation

If inhaled, remove from area to fresh air. Get medical attention.

Ingestion

Rinse mouth with water and then drink a glass of water. Get medical attention. Never give anything by mouth to an unconscious person.

B. Fire Fighting Information

Extinguishing Media

Water spray, carbon dioxide, foam, dry chemical.

Specific Exposure Hazards

Keep product and empty container away from heat and sources of ignition. May emit toxic fumes under fire conditions. Depending on conditions, decomposition products may include the following: carbon monoxide, carbon dioxide.

Special Protective Equipment for Firefighters

Wear self-contained breathing apparatus.

C. Accidental Release Measures

Personal Precautions

Use appropriate protective equipment. Handle in accordance with good industrial hygiene and safety practice.

Environmental Precautions

Prevent from entering sewers, waterways or low areas.

Steps to be Taken if Material is Released or Spilled

For large amounts: dike spillage and pump off product. For residues: pick up with suitable absorbent material. Dispose of contaminated material as prescribed.

D. Storage And Handling

General Handling

Keep product and empty container away from heat and sources of ignition. Ensure adequate ventilation, especially in confined areas.

Storage

Keep container tightly closed and in a dry and well-ventilated place. Keep in a cool place.

E. Exposure Controls / Personal Protection

Occupational Exposure Standards

Workplace Australia has not established a value for this substance.

Engineering Controls

Good general ventilation should be used.

Personal Protection Equipment

Respiratory Protection: Respiratory protection is not required.

Hand Protection: Chemical resistant protective gloves.

Skin Protection: Body protection must be chosen depending on activity and possible exposure.

Eye protection: Safety glasses with side-shields.

Other Precautions: Handle in accordance with good industrial hygiene and safety practice. Wearing of closed work clothing is recommended. Ensure that eyewash stations and safety showers are close to the workstation location.

F. Transport Information

2M(2Alk) bentonite is not considered hazardous for purposes of transportation by road or rail. An Australian Dangerous Goods code is not required.

XI. DISPOSAL MANAGEMENT

Disposal should be in accordance with all local, state and federal regulations.

XII. REGULATORY STATUS

Australian AICS Inventory: Listed.

XIII. REFERENCES

Australian Drinking Water Guidelines (ADWG). (2011). National Water Quality Management Strategy. Australian Drinking Water Guidelines, Section 6, Australian Government, National Health and Medical Research Council, Natural Resource Management Ministerial Council. Updated January 2022. Available: https://www.nhmrc.gov.au/about-us/publications/australian-drinking-water-guidelines

Cosmetic Ingredient Review (CIR). (1982). Final report on the safety assessment of quaternium-18, quaternium-18 hectorite and quaternium-18 bentonite. Intl. J. Toxicol. 1(2): 71-83.

CIR. (2016). Safety assessment of alkonium clays as used in cosmetics. Available at: http://online.personalcarecouncil.org/ctfa-static/online/lists/cir-pdfs/FR698.pdf.

Department of the Environment, Water, Heritage and the Arts (DEWHA). (2009). Environmental risk assessment guidance manual for industrial chemicals, Department of the Environment, Water, Heritage and the Arts, Commonwealth of Australia. Available: http://www.nepc.gov.au/resource/chemical-risk-assessment-guidance-manuals

enHealth Human Risk Assessment (HHRA). (2012). Environmental Health Risk Assessment, Guidelines for Assessing Human Health Risks from Environmental Hazards. Office of Health Protection of the Australian Government Department of Health. Available: https://www1.health.gov.au/internet/main/publishing.nsf/Content/health-pubhlth-publicat-environ.htm

European Chemicals Agency (ECHA). (2017). Guidance on Information Requirements and Chemical Safety Assessment, Chapter R11: PBT Assessment, European Chemicals Agency, Helsinki, Finland. Available: https://echa.europa.eu/guidance-documents/guidance-on-information-requirements-and-chemical-safety-assessment ECHA. ECHA REACH database: http://echa.europa.eu/information-on-chemicals/registered-substances

Klimisch, H.J., Andreae, M., and Tillmann, U. (1997). A systematic approach for evaluating the quality of experimental and toxicological and ecotoxicological data. Regul. Toxicol, Pharmacol. 25:1-5.

OECD (2007). SIDS Initial Assessment Profile on Organoclays Category. Available at: http://webnet.oecd.org/hpv/ui/handler.axd?id=b8b51b84-081c-444c-bb95-fb7f41c859c1.

SODIUM (C14-16) OLEFIN SULFONATE

This dossier on sodium (C14-16) olefin sulfonate (CAS RN 68439-57-6) presents the most critical studies pertinent to the risk assessment of the substance in its use in coal seam gas extraction activities. This dossier does not represent an exhaustive or critical review of all available data. The majority of information presented in this dossier was obtained from the ECHA database that provides information on chemicals that have been registered under the EU REACH (ECHA). Where possible, study quality was evaluated using the Klimisch scoring system (Klimisch et al., 1997).

I. SUBSTANCE IDENTIFICATION

Chemical Name (IUPAC): Sulfonic acids, C14-16 alkane hydroxy and C14-16-alkene, sodium salts

CAS RN: 68439-57-6

Molecular formula: C(4+2n)H(9+4n)SO4Na C(4+2n)H(7+4n)SO4Na n = 5-6

Molecular weight: 298.42 – 344.49 g/mol (Substance is a UVCB)

Synonyms: Sodium C14-16 olefin sulfonate; sodium C14-16-alkane hydroxy and C14-16-olefin sulfonates; alkenes, C14-16 alpha-, sulfonated, sodium salts; sodium tetradecenesulfonate; sodium α-olefin sulfonate sodium (C14-16) olefin sulfonate

Smiles: CCCCCCCCCCCC=CCS(=O)(=O)[O-].[Na+]

II. PHYSICO-CHEMICAL PROPERTIES

Sodium (C14-16) olefin sulfonate is an anionic surfactant. It is a mixture of long chain sulfonate salts prepared by sulfonation of C14-16 alpha olefins. Key physical and chemical properties for the substance are shown in Table 1.

Table 1: Overview of the Physico-Chemical Properties of Sodium (C14-16) Olefin Sulfonate

Property	Value	Klimisch Score	Reference
Physical state at 20°C and 101.3 kPa	Solid white powder	-	ECHA
Melting Point	≥240 °C @ 101.3 kPa		ECHA
Boiling Point	Not applicable		ECHA
Density	1054 kg/m^3 @ 20°C		ECHA
Vapour Pressure	≤5.87 x 10^{-6} Pa @ 25°C	-	ECHA
Partition Coefficient (log K_{ow})	-1.3 @ 20°C	-	ECHA
Water Solubility	292 g/L @ 20°C		ECHA
Flash Point	Not applicable as substance is solid	-	ECHA
Auto flammability	372.9°C @ 101.3 kPa	-	ECHA
Viscosity	Not applicable as substance is solid	-	ECHA

III. ENVIRONMENTAL FATE PROPERTIES

A. Summary

Sodium (C14-16) olefin sulfonate is readily biodegradable. It is not expected to bioaccumulate. It has a low potential to adsorb to soil or sediment.

B. Biodegradation

Sodium (C14-16) olefin sulfonate is readily biodegradable. Several biodegradation tests are available for alpha olefin sulfonates. The key study investigates the biodegradation of sulfonic acids, C14-16 (even numbered)-alkane hydroxy and C14-16 (even numbered)-alkene, sodium salts in a modified Sturm test according to OECD guideline 301B using domestic activated sludge as inoculum. After 28 days the test substance was degraded by 80 % (ECHA) [Kl. Score = 2]. Hence, the test substance is readily biodegradable according to OECD criteria (ECHA).

If a chemical is found to be readily biodegradable, it is categorised as Not Persistent since its half-life is substantially less than 60 days (DoEE, 2017).

C. Environmental Distribution

No experimental data are available for sodium (C14-C16) olefin sulfonate. It was determined that an adsorption / desorption test was not required because the test substance decomposes rapidly (ECHA). Using KOCWIN in EPISUITE™ (EPA, 2019), the estimated K_{oc} value for sodium (C14-C16) olefin sulfonate is 1.607 (if the experimental log $K_{ow}$of -1.3 is entered into the program) (ECHA) [Kl. Score = 2]. However, one should keep in mind that surfactancy (the fact that surfactants tend to stay in the boundary layer between the phases) and dissociation is not considered in the EPISUITE™ estimations. Therefore, calculated K_{oc} values should be used with caution (ECHA).

If released to soil, based on this K_{oc} value, the substance is expected to have very high mobility. If released to water, based on the K_{oc} value and its water solubility, the substance is not expected to adsorb to suspended solids and sediment.

D. Bioaccumulation

Sodium (C14-16) olefin sulfonate has a low potential for bioaccumulation as indicative of a log K_{ow} of -1.3 (ECHA).

A bioconcentration test with aquatic organisms is not available for the test substance. Based on the experimental log K_{ow} of -1.3, the test substance has a low bioaccumulation potential. This assumption is confirmed by the SIDS Initial Assessment Report for Alkyl Sulfates, Alkane Sulfonates, Alpha-Olefin Sulfonates (SIAM 25) (OECD, 2007). The document summarizes the data for the category consisting of the mentioned groups and concluded that the bioconcentration tendency for α-olefin sulfonates (AOS) is low (BCF < 100) for chain lengths up to C16 and due to similar chemistry and physical properties, bioaccumulation potential of AOS is expected to be similar to that of the Alkyl Sulfates. Hence, bioconcentration factors for AOS are expected to be like those of the Alkyl Sulfates. Experimental data from a fish study (Wakabayashi et al., 1980) show that the BCF of Alkyl Sulfates in aquatic species is < 100. Both BCF and depuration time (the latter at least for 12 and 14 carbons in the alkyl chain) indicate that the substances are not bioaccumulative up to 16 carbons in the alkyl chain (SIDS, 2007).

IV. HUMAN HEALTH HAZARD ASSESSMENT

A. Summary

Sodium (C14-16) olefin sulfonate exhibits low acute toxicity by the oral, inhalation and dermal routes. Sodium (C14-16) olefin sulfonate is irritating to the skin (≥5%) and serious irritation to the eyes (≥1%). Sodium (C14-16) olefin sulfonate was not a skin sensitiser. No systemic effects were observed in chronic repeated dose toxicity studies up to 259 mg/kg/day. The substance was not genotoxic in *in vitro* and *in vivo* models and is not carcinogenic. It is not a reproductive or developmental toxicant.

B. Acute Toxicity

Oral

In an OECD 401 (Acute Oral Toxicity) study, an LD_{50} of 2079 mg/kg was established for sodium (14-16) olefin sulfonate (ECHA). [KI score = 1].

Inhalation

In an OECD 403 (Acute Inhalation Toxicity) study, an LD_{50} >52 mg/L was established for sodium (14-16) olefin sulfonate (ECHA). [KI score = 2].

Dermal

In an OECD 402 (Acute Dermal Toxicity) study, an LD_{50} of 6300 mg/kg was established for sodium (14-16) olefin sulfonate (ECHA). [KI score = 2].

C. Irritation

Skin

An OECD Guideline 404 (Acute Dermal Irritation / Corrosion) was conducted to determine the skin irritation potential of sodium (C14-16) olefin sulfonate using New Zealand White rabbits. sodium (C14-16) olefin sulfonate was irritating following semi-occlusive exposure for 4 hr at 95% and following occlusive exposure for 24 hr at 5%. (ECHA) [KI score = 2].

Eye

An OECD Guideline 405 (Acute Eye Irritation / Corrosion) was conducted to determine the eye irritation potential of sodium (C14-16) olefin sulfonate using New Zealand White rabbits. Sodium (C14-16) olefin sulfonate was irritating at concentrations ≥5%. (ECHA) [KI score = 1].

D. Sensitisation

An OECD Guideline 406 (Skin Sensitisation) study (i.e., Buehler test) was performed on Pirbright-Hartley guinea pigs. Sodium (C14-16) olefin sulfonate did not induce skin sensitisation in this study (ECHA) [Kl score = 1].

E. Repeated Dose Toxicity

Oral

A chronic oral toxicity study in rodents was performed using male and female rats. Sodium (C14-16) olefin sulfonate was administered orally via feed for 104 weeks at a dose of 0, 39, 96, 195 mg/kg/day for males and 0, 57, 132, 259 mg/kg/day for females. A no observed adverse effect level (NOAEL) of 259 mg/kg/day was established based on the absence of effects at all doses up to 259 mg/kg/day. (ECHA) [KI score = 2].

Inhalation

No data were available.

Dermal

An OECD Guideline 411 study (Subchronic Dermal Toxicity: 90-Day study) was performed using rabbits. Sodium (C14-16) olefin sulfonate was administered in accordance with the OECD Guideline 411. At necroscopy, hematology, organ weights and organ to body weight data were all normal. Skin irritation was rated to mild to moderate as there was non-suppurative dermatitis, parakeratosis and hyperkeratosis observed. One of the animals had a firm, swollen salivary gland which upon microscopic examination exhibited inflammation and hyperplastic changes. The NOAEL was determined to be 35.7 mg/kg/day. (ECHA) [KI score = 1].

F. Genotoxicity

In vitro Studies

The results of the *in vitro* genotoxicity studies on sodium (C14-16) olefin sulfonate are presented in Table 2.

Table 2: *In vitro* Genotoxicity Studies on Copper (II) Sulfate

Test System[1]	Results*		Klimisch Score	Reference
	-S9	+S9		
OECD Guideline 471 (Bacterial Reverse Mutation Assay) Salmonella typhimurium strains TA98, TA100, TA1535, TA1537, TA102	-	-	1	ECHA

*+, positive; -, negative.

In vivo Studies

In an In Vivo Mammalian Germ Cell study was performed using CD-1 mice exposed intramuscularly to sodium (C14-16) olefin sulfonate (5,000 mg/kg). The injected bacteria or yeast cells were recovered and investigated. Sodium (C14-16) olefin sulfonate was not mutagenic in bacteria and yeast when metabolized by mice. (ECHA) [KI score = 4].

G. Carcinogenicity

A chronic oral toxicity study in rodents was performed using male and female rats. Sodium (C14-16) olefin sulfonate was administered orally via feed for 104 weeks at a dose of 0, 39, 96, 195 mg/kg/day

for males and 0, 57, 132, 259 mg/kg/day for females. The NOAEL for the test substance for carcinogenic effects was determined to be 259 mg/kg bw/day for the oral and 157.5 mg/kg bw/day for the dermal route. Sulfonic acids, C14-16 (even numbered)-alkane hydroxy and C14-16 (even numbered)-alkene, sodium salts does not have to be classified for carcinogenicity according to the criteria of EU Directive 67/548/EEC or Regulation (EC) No 1272/2008. (ECHA) [KI score = 2].

H. Reproductive Toxicity

Swiss albino male mice were fed with SLS either at 1 % (corresponds to 1000 mg/kg bw/day) for two weeks, or with 0.1% for six weeks (corresponds to 100 mg/kg bw/day). The study concluded that SLS has no adverse effects on fertility when administered at concentrations sufficient to cause a significant reduction in body weight (parental toxicity). A NOAEL of 1,000 mg/kg bw/day (in males) for fertility was reported for the study (NICNAS).

I. Developmental Toxicity

Sodium (C14-16) olefin sulfonate was analysed in accordance with OECD Guideline 414: Prenatal Developmental Toxicity Study. Pregnant CD-1 mice were exposed to sodium (C14-16) olefin sulfonate via oral gavage (0, 0.2, 2, 300, 600 mg/kg/day from gestational day 6 through 15. Embryotoxic effects have been observed from 300 mg/kg bw/d on. However, as these observations were accompanied by marked maternal toxicity (even maternal death at the highest dose level of 600 mg/kg bw/d) and were not significantly different from historic controls at 300 mg/kg bw/d, they were considered secondary to the toxicity of the test substance on the dam and are therefore insufficient for a classification as embryotoxic. The test item induced embryotoxic effects only in the presence of maternal toxicity. These effects were therefore considered to be secondary to maternal toxicity. (ECHA). [Kl. Score = 2].

V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES

The toxicological reference values developed for sodium (C14-16) olefin sulfonate follow the methodology discussed in enHealth (2012). The approach used to develop drinking water guidance values is described in the Australian Drinking Water Guidelines (ADWG, 2011).

A. Non-Cancer

A two-year dietary study in rats has been conducted on sodium (C14-16) olefin sulfonate. A NOAEL of 259 mg/kg/day was established based on the absence of effects at all doses up to the highest dose tested. The NOAEL of 259 mg/kg/day will be used for determining the oral reference dose (RfD) and the drinking water guidance value.

Oral Reference Dose (oral RfD)

Oral RfD = NOAEL / (UF_A x UF_H x UF_L x UF_{Sub} x UF_D)

Where:

UF_A (interspecies variability) = 1
UF_H (intraspecies variability) = 10
UF_L (LOAEL to NOAEL) = 1
UF_{Sub} (subchronic to chronic) = 1
UF_D (database uncertainty) = 1
Oral RfD = 259/(1 x 10 x 1 x 1 x 1) = 259/10 = <u>25.9 mg/kg/day</u>

Drinking water guidance value

Drinking water guidance value = (animal dose) x (human weight) x (proportion of intake from water) / (volume of water consumed) x (safety factor)

Using the oral RfD,

Drinking water guidance value = (oral RfD) x (human weight) x (proportion of water consumed) / (volume of water consumed)

Where:
Human weight = 70 kg (ADWG, 2011)
Proportion of water consumed = 10% (ADWG, 2011)
Volume of water consumed = 2L (ADWG, 2011)

Drinking water guidance value = (25.9 x 70 x 0.1)/2 = 90.65 mg/L

B. Cancer

Sodium (C14-16) olefin sulfonate is not considered a carcinogen. Thus, a cancer reference value will not be calculated for this substance.

VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES

Sodium (C14-16) olefin sulfonate does not exhibit the following physico-chemical properties:

- Explosivity
- Flammability
- Oxidising potential

VII. ENVIRONMENTAL HAZARD ASSESSMENT

A. Summary

Sodium (C14-16) olefin sulfonate has moderate toxicity to aquatic organisms and low toxicity to terrestrial organisms.

B. Aquatic Toxicity

Acute Studies

Table 3 lists the results of acute aquatic toxicity studies conducted on sodium (C14-16) olefin sulfonate.

Table 3: Acute Aquatic Toxicity Studies on Sodium (C14-16) olefin sulfonate

Test Species	Endpoint	Results (mg/L)	Klimisch Score	Reference
Danio rerio (Zebra Fish)	96-hr LC_{50}	4.2	1	ECHA
Ceriodaphnia dubia	48-hr EC_{50}	4.53	2	ECHA
Skeletonema costatum	72-hr EC_{50}	5.2	1	ECHA

Chronic Studies

Long-term aquatic toxicity test of sodium (C14-16) olefin sulfonate was conducted in invertebrates. The chronic toxicity to Daphnia magna (OECD 211) was studied with a 21-d reproduction test in a semistatic system. The test solution was renewed 3 times per week. The 21-day no observed effect concentration (NOEC) was determined to be 6.3 mg/L for the tested substance at 38.5% sodium (C14-16) olefin sulfonate and 2.42 mg/L at 100% for reproduction and survival of the adult test animals (ECHA) [Kl. Score = 1].

A long-term fish study was deemed not necessary based on short-term fish study and the above long-term invertebrate results (ECHA).

C. Terrestrial Toxicity

Based on the available data, no toxicity of sodium (C14-16) olefin sulfonate to terrestrial organisms is expected. Additionally, the substance is not expected to remain in the terrestrial environment, due to ready biodegradability and low adsorption potential, reducing the potential for chronic exposure (ECHA).

D. Calculation of PNEC

The PNEC calculations for sodium (C14-16) olefin sulfonate follow the methodology discussed in DEWHA (2009).

PNEC Water

Experimental results are available for three trophic levels. Acute E(L)C_{50} values are available for fish (4.20 mg/L), invertebrates (4.53 mg/L) and algae (5.20 mg/L). Results from a chronic study is available for invertebrates (6.3 mg/L). On the basis that the data consists of short-term studies for three trophic levels and long-term results studies for two trophic levels, an assessment factor of 50 has been applied to the lowest reported NOEC of 4.20 mg/L for fish. The $PNEC_{water}$ is 0.08 mg/L.

PNEC Sediment

There are no toxicity data for sediment-dwelling organisms. Therefore, the $PNEC_{sed}$ was calculated using the equilibrium partitioning method. The $PNEC_{sed}$ is 0.05 mg/kg sediment wet weight.

The calculations are as follows:

$PNEC_{sed} = (K_{sed\text{-}water}/BD_{sed}) \times 1{,}000 \times PNEC_{water}$

$= (0.83/1{,}280) \times 1{,}000 \times 0.08$

$= 0.05$ mg/kg

Where:

$K_{sed\text{-}water}$ = suspended matter-water partition coefficient (cubic metre per cubic metre [m^3/m^3])

BD_{sed} = bulk density of sediment (kg/m^3) = 1,280 [default]

$K_{sed\text{-}water} = 0.8 + [(0.2 \times Kp_{sed})/1{,}000 \times BD_{solid}]$

$= 0.8 + [(0.2 \times 0.064/1{,}000 \times 2{,}400]$

$= 0.83$ m^3/m^3

Where:

Kp_{sed} = solid-water partition coefficient (L/kg).

BD_{solid} = bulk density of the solid phase (kg/m^3) = 2,400 [default]

$Kp_{sed} = K_{oc} \times f_{oc}$
= 1.607 x 0.04
= 0.064 L/kg

Where:
K_{oc} = organic carbon normalized distribution coefficient (L/kg). The K_{oc} for sodium (C14-C16) olefin sulfonate calculated from EPISUITE™ 1.607 L/kg .
F_{oc} = fraction of organic carbon in sediment = 0.04 [default].

PNEC Soil

There is no toxicity data for terrestrial or soil organisms. Therefore, the $PNEC_{soil}$ was calculated using the equilibrium partitioning method. The $PNEC_{soil}$ is 0.002 mg/kg soil dry weight.

The calculations are as follows:
$PNEC_{soil} = (Kp_{soil}/BD_{soil}) \times 1000 \times PNEC_{water}$
= (0.03/1500) x 1000 x 0.08
= 0.002 mg/kg

Where:
Kp_{soil} = soil-water partition coefficient (m^3/m^3)
BD_{soil} = bulk density of soil (kg/m^3) = 1,500 [default]
$Kp_{soil} = K_{oc} \times f_{oc}$
= 1.607 x 0.02
= 0.03 m^3/m^3

Where:
K_{oc} = organic carbon normalised distribution coefficient (L/kg). The K_{oc} for sodium (C14-C16) olefin sulfonate calculated from EPISUITE™ is 1.607 L/kg .
F_{oc} = fraction of organic carbon in soil = 0.02 [default].

VIII. PERSISTENCE, BIOACCUMULATION AND TOXICITY (PBT) ASSESSMENT

The methodology for the Persistent, Bioaccumulative and Toxic (PBT) substances assessment is based on the Australian and EU REACH Criteria methodology (DEWHA, 2009; ECHA, 2017).

Sodium (C14-16) olefin sulfonate is readily biodegradable and thus does not meet the screening criteria for persistence.

Based on a measured log K_{ow} of -1.3, sodium (C14-16) olefin sulfonate does not meet the screening criteria for bioaccumulation.

The lowest chronic NOEC for sodium (C14-16) olefin sulfonate is >0.1 mg/L. The acute $E(L)C_{50}$ values are >1 mg/L. Thus, sodium (C14-16) olefin sulfonate does not meet the screening criteria for toxicity.

The overall conclusion is that sodium (C14-16) olefin sulfonate is not a PBT substance.

IX. CLASSIFICATION AND LABELLING

A. Classification

Irritation-Eye category 1:H318: Causes serious eye damage.

Irritation-Skin category 2: H315: Causes skin irritation.

B. Labelling

Danger! According to the classification provided by companies to ECHA in REACH registrations this substance causes serious eye damage and causes skin irritation.

C. Pictogram



X. HANDLING AND SAFETY INFORMATION (OCCUPATIONAL LIMITS AND TRANSPORTATION REQUIREMENTS)

A. First Aid

Please refer to the product SDS for additional information and confirmation of the information provided herein.

Eye Contact

Immediately flush open eyes with plenty of water for at least 15 minutes. Remove contacts, if present and easy to do. Get medical attention immediately, preferably a physician for an ophthalmologic examination.

Skin Contact

For minor skin contact, avoid spreading material on unaffected skin. Remove and isolate contaminated clothing. Wash the contaminated area of body with soap and fresh water. Get medical attention. Launder contaminated clothing before reuse.

Inhalation

Move person to fresh air. Administer oxygen if breathing is difficult. Do not use mouth-to-mouth method if victim inhaled the substance; give artificial respiration with the air of a pocket mask equipped with a one-way valve or other proper respiratory medical device. Give artificial respiration if victim is not breathing. Get medical attention immediately.

Ingestion

Do not induce vomiting. Get medical attention immediately.

B. Fire Fighting Information

Extinguishing Media

Use water spray or fog, foam, dry chemical or carbon dioxide.

Specific Exposure Hazards

Emits toxic fumes under fire conditions. Depending on conditions, decomposition products may include the following: carbon dioxide, carbon monoxide.

Special Protective Equipment for Firefighters

Wear self-contained breathing apparatus and chemical-protective clothing.

C. Accidental Release Measures

Personal Precautions

Isolate area. Keep unnecessary and unprotected personnel from entering the area. Use personal protective clothing. Ensure adequate ventilation. Wear respiratory protection if ventilation is inadequate. Do not breath mist, vapours or spray. Avoid contact with skin, eyes and clothing. Eliminate all sources of ignition.

Environmental Precautions

Prevent from entering sewers, waterways or low areas.

Steps to be Taken if Material is Released or Spilled

Eliminate all sources of ignition. Pick up with suitable absorbent material and transfer to a container for chemical waste. For large amounts: dike spillage and pump off product into container for chemical waste. Dispose of contaminated material as prescribed.

D. Storage And Handling

General Handling

Keep away from heat, sparks and flame. Avoid contact with eyes, skin and clothing. Avoid breathing vapour. Wash thoroughly after handling. Keep container closed. Use with adequate ventilation.

Storage

Keep container tightly closed. Store away from heat and light.

E. Exposure Controls / Personal Protection

Occupational Exposure Standards

Workplace Australia has not established an occupational exposure standard for sodium (C14-16) olefin sulfonate.

Engineering Controls

Good general ventilation should be used. Ventilation rates should be matched to conditions. If applicable, use process enclosures, local exhaust ventilation, or other engineering controls to maintain airborne levels below recommended exposure limits. If exposure limits have not been established, maintain airborne levels to an acceptable level.

Personal Protection Equipment

Respiratory Protection: If workers are exposed to concentrations above the exposure limit, they must use appropriate, certified respirators. If there are no applicable exposure limit requirements or guidelines, use an approved respirator. Selection of air-purifying or positive pressure supplied-air will depend on the specific operation and the potential airborne concentration of the product. For emergency conditions, use an approved positive-pressure self-contained breathing apparatus. The following should be effective types of air-purifying respirators: organic vapour cartridge with a particulate pre-filter.

Hand Protection: Use gloves chemically resistant to this material. Consult the SDS for appropriate glove barrier materials.

Skin Protection: Use protective clothing chemically resistant to the material. Selection of specific items such as face shield, boots, apron or full body suit will depend on the task.

Eye Protection: Use chemical goggles.

Other Precautions: Wash hands, forearms and face thoroughly after handling chemical products; before eating, smoking, and using the lavatory; and at the end of the working period. Appropriate techniques should be used to remove potentially contaminated clothing. Wash contaminated clothing before reusing. Ensure that eyewash stations and safety showers are close to the workstation location.

F. Transport Information

Sodium (C14-16) olefin sulfonate is not considered hazardous for purposes of transportation by road or rail. An Australian Dangerous Goods code is not required.

XI. DISPOSAL MANAGEMENT

Disposal should be in accordance with all local, state and federal regulations.

XII. REGULATORY STATUS

Australian AICS Inventory: Listed.

XIII. REFERENCES

ADWG. (2011). National Water Quality Management Strategy. Australian Drinking Water Guidelines, Section 6, Australian Government, National Health and Medical Research Council, Natural Resource Management Ministerial Council. Updated January 2022. Available: https://www.nhmrc.gov.au/about-us/publications/australian-drinking-water-guidelines

Department of the Environment, Water, Heritage and the Arts [DEWHA]. (2009). Environmental risk assessment guidance manual for industrial chemicals, Department of the Environment, Water, Heritage and the Arts, Commonwealth of Australia. Available: http://www.nepc.gov.au/resource/chemical-risk-assessment-guidance-manuals

Department of the Environment and Energy [DoEE]. (2017). Chemical Risk Assessment Guidance Manual: for chemicals associated with coal seam gas extraction, Guidance manual prepared by Hydrobiology and ToxConsult Pty Ltd for the Department of the Environment and Energy, Commonwealth of Australia, Canberra.

ECHA. ECHA REACH database: http://echa.europa.eu/information-on-chemicals/registered-substances

enHealth Human Risk Assessment [HHRA]. (2012). Environmental Health Risk Assessment, Guidelines for Assessing Human Health Risks from Environmental Hazards. Office of Health Protection of the Australian Government Department of Health. Available: https://www1.health.gov.au/internet/main/publishing.nsf/Content/health-pubhlth-publicat-environ.htm

European Chemicals Agency [ECHA]. (2017). Guidance on Information Requirements and Chemical Safety Assessment, Chapter R11: PBT Assessment, European Chemicals Agency, Helsinki, Finland. Available: https://echa.europa.eu/guidance-documents/guidance-on-information-requirements-and-chemical-safety-assessment

Klimisch, H.J., Andreae, M., and Tillmann, U. (1997). A systematic approach for evaluating the quality of experimental and toxicological and ecotoxicological data. Regul. Toxicol. Pharmacol. 25:1-5.

OECD. (2007) Screening Information Data Sets (SIDS).Initial assessment profile: Alkyl sulfates, alkane sulfonates and alpha-olefin sulfonates. SIDS Initial Assessment Meeting (SIAM) 25.

National Industrial Chemicals Notification and Assessment Scheme (NICNAS). Inventory Multi-tiered Assessment and Prioritisation (IMAP) Human Health Tier II Assessment for sodium, ammonium and potassium lauryl sulfate (CAS Nos 151- 21-3, 2235-54-3, 4706-78-9).

U.S. Environmental Protection Agency [EPA]. (2017). EPISuite™ v. 4.11, United States Environmental Protection Agency, Office of Pollution Prevention and Toxics and Syracuse Research Corporation. Available: https://www.epa.gov/tsca-screening-tools/epi-suitetm-estimation-program-interface.

Wakabayashi M, Kikuchi M, Kojima H. Yoshida T. (1980). Effect of alkyl chain on the uptake, distribution, and excretion of 35S-labelled alkyl sulfates in carp. Eco-tox Environ Safety. 4(2): 195-206.

SODIUM BENZOATE

This dossier on sodium benzoate presents the most critical studies pertinent to the risk assessment of sodium benzoate in its use in coal seam or shale gas extraction activities. This dossier does not represent an exhaustive or critical review of all available data. The majority of information presented in this dossier was obtained from the ECHA database that provides information on chemicals that have been registered under the EU REACH (ECHA). Where possible, study quality was evaluated using the Klimisch scoring system (Klimisch et al., 1997).

NICNAS has assessed sodium benzoate in an IMAP Tier 1 assessment and concluded that it poses no unreasonable risk to the environment.[1]

I. SUBSTANCE IDENTIFICATION

Chemical Name (IUPAC): Sodium benzoate

CAS RN: 532-32-1

Molecular formula: $C_7H_6O_2.Na$

Molecular weight: 144.105 g/mol

Synonyms: benzoate, sodium, benzoic acid, sodium salt,

SMILES: [Na+].[O-]C(=O)C1=CC=CC=C1

II. PHYSICO-CHEMICAL PROPERTIES

Table 1: Overview of the Physico-Chemical Properties of Sodium Benzoate

Property	Value	Klimisch Score	Reference
Physical state at 20oC and 101.3 kPa	White, odorless granules or crystalline powder with a sweet astringent taste	2	ECHA
Melting Point	436°C @ 101.3 kPa	1	ECHA
Boiling Point	Decomposes at 450-475°C without boiling point	1	ECHA
Density	1500 kg/m3@ 20°C	1	ECHA
Vapour Pressure	0 Pa @ 20°C	2	ECHA
Partition Coefficient (log K_{ow})	1.88 (temperature not reported) *	2	ECHA
Water Solubility	556 g/L @ 20°C	2	ECHA
Flash Point	Not applicable	2	ECHA
Auto flammability	Not applicable	2	ECHA
Viscosity	Not applicable	2	ECHA
Dissociation constant (pKa)	4.03 @ 20°C *	2	ECHA

*Based on read across from benzoic acid

[1] https://www.industrialchemicals.gov.au/chemical-information/search-assessments?assessmentcasnumber=532-32-1+

III. ENVIRONMENTAL FATE PROPERTIES

A. Summary

Sodium benzoate is water soluble, readily biodegradable, and it is not expected to bioaccumulate.

B. Biodegradation

A biotic degradation CO_2 evolution study reported that there was slightly lower degradation (75% of ThOD) recorded over 30 days in a closed bottle test. This study showed that there was 85-92% degradation for sodium benzoate even though there is no information on the 10-day window. It can be concluded that sodium benzoate is readily biodegradable (ECHA) [Kl. score = 2].

In an OECD guideline 301 CO_2 evolution test, degradation ranged from 85 to 94% after 28 days (ECHA) [Kl. score = 2].

The biodegradability of sodium benzoate was evaluated in using an ECETOC (1988) method. Concentrations of 50, 60, and mg/L of sodium benzoate were used, and the fermentation periods were 28-61 days. The biodegradation of sodium benzoate was reported to be 50-97% over a period of 60 days (ECHA) [KI. score = 2].

If a chemical is found to be readily biodegradable, it is categorised as Not Persistent since its half-life is substantially less than 60 days (DoEE, 2017).

C. Environmental Distribution

A quantitative structure activity relationship model (EPISUITE v4.11 KOCWIN 2017 program) was used to estimate the soil adsorption coefficient (K_{oc}) for sodium benzoate at or above 0.1 % w/w). The K_{oc} was predicted to be 7.033 L/kg at neutral pH (ECHA)[KI. score =2).

D. Bioaccumulation

There are no bioconcentration studies available for sodium benzoate. Sodium benzoate is not expected to bioaccumulate based on a log K_{ow} of 1.88 based on read across from benzoic acid (ECHA) [Kl. score = 2].

IV. HUMAN HEALTH HAZARD ASSESSMENT

A. Summary

Sodium benzoate is the sodium salt of benzoic acid, and it is completely metabolized to benzoic acid and ultimately hippuric acid in the body. Sodium benzoate is absorbed rapidly, and it is rapidly excreted as hippuric acid through urine. This substance is not acutely toxic through any route of exposure (i.e., oral, inhalation, dermal). Sodium benzoate is slightly irritating to the eye of rabbits and non-irritating to the skin of rabbits. This substance is not a skin sensitizer. It has low repeated oral, dermal, and inhalation toxicity. Sodium benzoate is not genotoxic or carcinogenic and does not induce reproductive or developmental toxicity.

B. Metabolism

Sodium benzoate is metabolized to benzoic acid and ultimately hippuric acid by conjugation with glycine. Sodium benzoate is not expected to accumulate in the body. Sodium benzoate and its metabolites are excreted through urine (ECHA) [KI. score =2].

Upon oral ingestion sodium benzoate is rapidly absorbed (100%, assumed). Dermal absorption is less effective and is inversely proportional to the administered dose (14-43%). There are no update data available regarding the inhalation route of exposure (ECHA) [KI. score = 2].

C. Acute Toxicity

Oral

In an acute oral toxicity study, sodium benzoate was given to male and female Sherman rats through their feed. The rats were observed for 14 days after dosing. The acute oral LD_{50} was reported to be 3,450 mg/kg bw (ECHA) [KI. score = 2].

In an acute oral toxicity study, 5000 mg/kg of sodium benzoate was given to male rats. The rats were observed for 10 days post treatment. No mortality or abnormal gross pathology findings were reported in this study. The acute oral LD_{50} was reported to be > 5000 mg/kg (ECHA) [KI. score = 2].

Inhalation

In an acute inhalation toxicity study, male and female Spartan rats were given 12,200 mg/m^3 of benzoic acid dust through whole body inhalation for four hours. The rats were observed for 14 days after treatment. There were no deaths following a single inhalation dose of 12,200 mg/m^3 of benzoic acid dust. Increased motor activity and slight erythema was observed during the four-hour exposure period. The rats appeared to be normal after 24 hours and after the 14-day observation period. The LC_{50} was reported to be >12,200 mg/m^3 air (ECHA) [KI. score = 2].

Dermal

In an acute dermal toxicity study, male and female New Zealand white rabbits were exposed to 2000 mg/kg of benzoic acid via semi occlusive dressing for 24 hours. The rabbits were observed for 14 days following exposure to benzoic acid. The LD50 was reported to be > 2,000 mg/kg bw (ECHA) [KI. score = 2].

D. Irritation

Skin

In an OECD guideline 404 (acute dermal irritation/corrosion) study, New Zealand White rabbits were exposed 0.5 grams of sodium benzoate via semi occlusive dressing (test are of skin =100 cm^2) for four hours. The rabbits were observed for 1,24,48, and 72 hours after treatment. One of the rabbits had slight erythema but it was resolved within 24 hours after exposure. A primary irritation index (PII) score of zero (max score for erythema = 1 and max score for oedema =0) was reported for sodium benzoate in this study. Sodium benzoate is reported to be non-irritating to the skin of rabbits (ECHA) [KI. score = 1].

Eye

An OECD guideline 405 (Acute eye irritation/corrosion) test was conducted using female New Zealand white rabbits exposed to ± 60 mg of sodium benzoate (instilled into one eye) for 24 hours. The rabbits were observed for 1,24,48,72 hours and 7-14 days following treatment. The mean cornea opacity score was reported to be 0, the mean iris score was reported to be 0, the mean conjunctivae score was reported to be 2.44, and the mean chemosis score was reported to be 0.67. All of these effects were determined to be fully reversible after 14 days. Sodium benzoate was reported to be slightly irritating to the eye (ECHA) [KI. score = 1].

E. Sensitisation

An OECD guideline 429 (Skin sensitisation: Local Lymph Node Assay) was conducted using female CBA mice exposed to 5,10, and 20% benzoic acid. The stimulation index (SI) values for each administered dose (5, 10, 20%) of benzoic acid were reported to be 0.8, 0.9, and 0.8 respectively. Based on this data, benzoic acid is not a skin sensitizer to female mice (ECHA) [KI. score =2].

An OECD guideline 429 (Skin sensitisation: Local Lymph Node Assay) was conducted using female CBA mice exposed to 5,10, and 20% sodium benzoate. The stimulation index (SI) values for each administered dose (5, 10, 20%) of benzoic acid were reported to be 0.8, 0.9, and 0.8 respectively. Based on this data, sodium benzoate is not a skin sensitizer to female mice (ECHA) [KI. score =2].

F. Repeated Dose Toxicity

Oral

A chronic oral repeated dose toxicity study was conducted using male and female Fischer 344 rats exposed to a daily dose of 1 or 2% sodium benzoate in their feed for 18-24 months. There were no adverse clinical signs identified in this study. The difference in average body weight and mortality rates between the treated and control groups were negligible. A variety of tumors occurred in the test animals and the controls rats for each sex. However, there was no evidence of carcinogenicity in the reported in the rats exposed to sodium benzoate. A NOAEL of 1,000 mg/kg bw/day was reported for this study (ECHA) [KI. score =2].

Inhalation

An OECD guideline 412 (28-day sub-acute inhalation toxicity) study was conducted using male and female Sprague-Dawley rats exposed to 25, 250, or 1,200 mg/m^3 of benzoic acid dust by whole body inhalation exposure for 28 days (6 hours per day for 5 days per week for four consecutive weeks). A mean equivalent aerodynamic diameter of 4.7 µm was defined for this study. All of the test concentrations induced local effects which consisted of nasal redness, nasal discharge, pulmonary fibrosis, and inflammatory cell infiltrates in the lungs. There were no systemic effects reported in the animals exposed to 25 mg/m^3 of benzoic acid. The female rats exposed to 250 mg/m^3 of benzoic acid developed a slight decrease in absolute kidney weight and their body weights were slightly (not statistically significant) lower than the control rats. The rats exposed to 1,200 mg/m^3 of benzoic acid developed a decrease in body weight and a decrease in liver, kidney, and lung weights. There were no histopathological findings except for the lungs. A NOEC of ≤ 25 mg/m^3 air was reported for local effects and a NOAEL of 250 mg/m3 was reported for systemic effects (ECHA) [KI. score = 1].

Dermal

An EPA OPP 82-2 (Repeated dose dermal toxicity-21/28 days) study was conducted using male and female New Zealand White rabbits exposed to 100, 500, and 2500 mg/kg of benzoic acid for six hours (once a day, 5 days per week, for three consecutive weeks). Slight dermal irritation was reported for one rabbit exposed to 2500 mg/kg of benzoic acid. There was no compound related systemic effects reported in this study. Thus, a NOAEL of > 2,500 was reported for this study (ECHA) [KI. score = 1].

An EPA OPP 82-2 (Repeated dose dermal toxicity-21/28 days) study was conducted using male and female New Zealand White rabbits exposed to 100, 500, and 2500 mg/kg of sodium benzoate for six hours (once a day, 5 days per week, for three consecutive weeks). Slight dermal irritation was reported for one rabbit exposed to 2500 mg/kg of sodium benzoate. There was no compound related systemic effects reported in this study. Thus, a NOAEL of > 2,500 was reported for this study (ECHA) [KI. score = 1].

G. Genotoxicity

In vitro Studies

The *in vitro* genotoxicity studies on sodium benzoate are presented in Table 2.

Table 2: *In vitro* Genotoxicity Studies on Sodium Benzoate

Test System	Results*		Klimisch Score	Reference
	-S9	+S9		
OECD guideline 471 (Bacterial Reverse Mutation Assay) -Salmonella typhimurium TA 1535, TA 1537, TA 98, TA100, TA 1538, and E. coli WP2	-	-	2	ECHA
In vitro chromosome aberration study (human embryonic lung cultures)	-	-	2	ECHA

*+, positive; -, negative

In vivo Studies

An OECD guideline 475 (Mammalian Bone Marrow Chromosome Aberration Test) was conducted using male Sprague-Dawley rats exposed to 50, 500, and 5,000 mg/kg of sodium benzoate for 96 hours. The rats were euthanized 6 hours, 24 hours, and 48 hours after treatment. Sodium benzoate did not product a significant increase in the number of aberrations in bone marrow metaphase chromosomes in rats. Thus, sodium benzoate is reported to be non-genotoxic in this study (ECHA) [KI. score = 2].

H. Carcinogenicity

Oral

Male and female Fischer 344 rats were given 1 or 2% of sodium benzoate in their feed for 18-24 months. There were no adverse clinical signs associated with exposure to sodium benzoate when compared to control rats. The differences in average body weight and mortality rates between treated and control groups were negligible. A variety of tumours were identified in the test and

control rats for each sex. However, the number of tumours in the treated and control mice were not statistically significant. A NOAEL of >1,000 mg/kg bw/day was reported and there was no evidence of carcinogenicity reported in this study (ECHA) [KI. score = 2].

Male and female Swiss mice were exposed to 2% sodium benzoate in their drinking water from five weeks of age through death. Consumption of sodium benzoate did not cause any detectable tumorigenic effects in the treated mice. A NOAEL of >4,000 mg/kg bw/day was reported in this study (ECHA) [KI. score = 2].

Inhalation

There are no studies available.

Dermal

There are no studies available.

I. Reproductive Toxicity

An OECD guideline 416 (two-generation toxicity) study was conducted using rats exposed to 0,0.5, or 1% benzoic acid in their feed for 11-12 weeks prior to mating and through four generations. There were no adverse effects on reproductive parameters including fertility measures, delayed sexual maturity, total number of pups born, pup survival, onset of reproductive senescence or litter size. In addition to this, organ weights and histopathologic findings were similar for all dose groups. There was an unexplained statistically significant increase in the lifespan of rats in the 0.5% dose group (i.e., a higher percentage of the rats lived longer). There were no dose-related adverse effects on either reproductive or developmental parameters over four generations. Thus, benzoic acid is not a reproductive or developmental toxicant. A NOEL was not established in this study (ECHA) [KI. score = 2].

J. Developmental Toxicity

Oral

An OECD guideline 414 (prenatal developmental toxicity) study was conducted using Wistar rats exposed to 0,699, 965,1,306, or 1,874, mg/kg bw/day (0,1,2, 4, 8 %) of sodium benzoate through their feed throughout the entire gestation period, delivery, and weaning period. The rats were euthanized on gestation day 20. Maternal feed consumption values in the 4% and 8% groups were decreased 58% and 87%, respectively, when compared to the control group and resulted in body weight loses in both treatment groups during the entire gestation period. The study authors considered these to reflect a palatability issue with the test diet rather than a consequence of the toxicity of sodium benzoate. No developmental toxicity was observed in the maternal or foetal animals exposed to up to 2% sodium benzoate. The number of abnormalities observed in either soft or skeletal tissues of the foetuses and weanlings in the 1% and 2% dose groups did not differ significantly from the control group. The NOEL for this study was reported to be 965 mg/kg bw/day (2%) (ECHA)[KI. score = 2].

In a developmental toxicity study, pregnant Wistar rats were administered 0, 1.75, 8.0, 38.0, or 175.0 mg/kg sodium benzoate by oral gavage once daily on gestation days (GD) 6 through 15 while positive control animals received 250 mg/kg aspirin. On GD 20, all surviving dams were subjected to Caesarean section under anaesthesia, and the numbers of corpora lutea, implantation sites, resorptions sites, and live and dead foetuses were recorded. Under conditions of this study, no dose-

related adverse effects were observed in the dams or foetuses in any of the groups receiving up to 175.0 mg/kg sodium benzoate during gestation days 6 through 15. The NOEL for maternal toxicity and developmental toxicity was reported to be > 175 mg/kg bw/day (ECHA) [KI. score = 2].

In a developmental toxicity study, pregnant Dutch-belted female rabbits were administered 0, 2.5, 12.0, 54.0, or 250.0 mg/kg sodium benzoate by oral gavage once daily on gestation days (GD) 6 through 18. On GD 29, all surviving does were subjected to Caesarean section under anaesthesia, and the numbers of corpora lutea, implantation sites, resorptions sites, and live and dead foetuses were recorded. Under conditions of this study, no dose-related adverse effects were observed in the does or foetuses in any of the sodium benzoate-treated groups. The NOEL for developmental toxicity was reported to be 250 mg/kg bw/day and the NOEL for maternal toxicity was reported to be >250 mg/kg bw/day (ECHA) [KI. score = 2].

Inhalation

There are no studies available.

Dermal

There are no studies available.

V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES

A chronic oral repeated dose toxicity study was conducted using male and female Fischer 344 rats exposed to a daily dose of 1 or 2% sodium benzoate in their feed for 18-24 months. There was no evidence of carcinogenicity in the reported in the rats exposed to sodium benzoate. A NOAEL of 1,000 mg/kg bw/day was reported for this study (ECHA) [KI. score =2].

Oral Reference Dose (oral RfD)

Oral RfD = NOAEL / (UF_A x UF_H x UF_L x UF_{Sub} x UF_D)

Where:

UF_A (interspecies variability) = 10
UF_H (intraspecies variability) = 10
UF_L (LOAEL to NOAEL) = 1
UF_{Sub} (subchronic to chronic) = 1
UF_D (database uncertainty) = 1
Oral RfD = 1000/(10 x 10 x 1 x 1 x 1) = 1000/100 = 10 mg/kg bw/day

Drinking water guidance value

Drinking water guidance value = (animal dose) x (human weight) x (proportion of intake from water) / (volume of water consumed) x (safety factor)

Using the oral RfD,

Drinking water guidance value = (oral RfD) x (human weight) x (proportion of water consumed) / (volume of water consumed)

Where:

Human weight = 70 kg (ADWG, 2011)
Proportion of water consumed = 10% (ADWG, 2011)
Volume of water consumed = 2L (ADWG, 2011)
Drinking water guidance value = (10 x 70 x 0.1)/2 = 35 mg/L

B. Cancer

There is no evidence that sodium benzoate is carcinogenic. Thus, a value for cancer was not derived.

VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES

Sodium benzoate does not exhibit the following physico-chemical properties:

- Explosivity
- Flammability
- Oxidising potential

VII. ENVIRONMENTAL HAZARD ASSESSMENT

A. Summary

The sodium benzoate is of low toxicological concern to environmental receptors.

B. Aquatic Toxicity

Acute Studies

Table 3 lists the results of acute aquatic toxicity studies conducted on sodium benzoate.

Table 3: Acute Aquatic Toxicity Studies on Sodium Benzoate

Test Species	Endpoint	Results (mg/L)	Klimisch Score	Reference
Pimephales promelas	96-hour LC_{50}	484 (mortality)	2	ECHA
Pimephales promelas	96-hour LC_{50}	>100 (mortality)	2	ECHA
Daphnia magna	96-hour LC_{50}	>100 (mortality)	2	ECHA
Raphidocelis subcapitata (formerly known as *Pseudokirchneriella subcapitata*)	72-hour EC_{50}	>30.5 (growth rate)	1	ECHA

Chronic Studies

Table 4 lists the results of chronic aquatic toxicity studies conducted on sodium benzoate.

Table 4: Chronic Aquatic Toxicity Studies on Sodium Benzoate

Test Species	Endpoint	Results (mg/L)	Klimisch score	Reference
Raphidocelis subcapitata	72-hour EC_{10}	6.5 (growth rate)	1	ECHA
Danio rerio	144-hour NOEC	10	2	ECHA

C. Terrestrial Toxicity

There are no studies available.

D. Calculation of PNEC

The PNEC calculations for sodium benzoate follow the methodology discussed in DEWHA (2009).

PNEC Water

Experimental results are available for three trophic levels. Acute E(L)C_{50} values are available for fish (>100 mg/L), *Daphnia* (>100 mg/L), and algae (>30.5 mg/L). NOEC values from long-term studies are available for fish (10 mg/L) and algae (6.5 mg/L). On the basis that the data consists of short-term results from three trophic levels and long-term results from two trophic levels, an assessment factor of 10 has been applied to the lowest reported NOEC value of 6.5 mg/L for fish. The NOEC value is used because the value for algae is lower than the NOEC values for the other trophic level. The $PNEC_{water}$ is 0.65 mg/L.

PNEC Sediment

There are no toxicity data for sediment-dwelling organisms. Therefore, the $PNEC_{sed}$ was calculated using the equilibrium partitioning method. The $PNEC_{sed}$ is 0.475 mg/kg sediment wet weight.

The calculations are as follows:

$PNEC_{sed} = (K_{sed\text{-}water}/BD_{sed}) \times 1000 \times PNEC_{water}$
$= (1.11/1280) \times 1000 \times 0.65$
$= 0.475$ mg/kg

Where:

$K_{sed\text{-}water}$ = suspended matter-water partition coefficient (m^3/m^3)
BD_{sed} = bulk density of sediment (kg/m^3) = 1,280 [default]
$K_{sed\text{-}water} = 0.8 + [(0.2 \times Kp_{sed})/1000 \times BD_{solid}]$
$= 0.8 + [(0.2 \times 0.66/1000 \times 2400]$
$= 0.935\ m^3/m^3$

Where:

Kp_{sed} = solid-water partition coefficient (L/kg)
BD_{solid} = bulk density of the solid phase (kg/m^3) = 2,400 [default]
$Kp_{sed} = K_{oc} \times f_{oc}$
$= 7.03 \times 0.04$
$= 0.28$ L/kg

Where:

K_{oc} = organic carbon normalised distribution coefficient (L/kg). The K_{oc} for sodium benzoate calculated from EPISUITE™ using QSAR is 7.03 L/kg.
F_{oc} = fraction of organic carbon in sediment = 0.04 [default].

PNEC Soil

There are no toxicity data for terrestrial or soil organisms. Therefore, the $PNEC_{soil}$ was calculated using the equilibrium partitioning method. The $PNEC_{soil}$ is 0.06 mg/kg soil dry weight.

The calculations are as follows:

$PNEC_{soil} = (Kp_{soil}/BD_{soil}) \times 1000 \times PNEC_{water}$
$= (0.33/1500) \times 1000 \times 10$
$=0.06$ mg/kg

Where:
Kp_{soil} = soil-water partition coefficient (m^3/m^3)
BD_{soil} = bulk density of soil (kg/m^3) = 1,500 [default]
$Kp_{soil} = K_{oc} \times f_{oc}$
$= 7.03 \times 0.02$
$= 0.14\ m^3/m^3$

Where:
K_{oc} = organic carbon normalised distribution coefficient (L/kg). The K_{oc} for sodium benzoate calculated from EPISUITE™ using the QSAR is 7.03 L/kg.
F_{oc} = fraction of organic carbon in soil = 0.02 [default].

VIII. PERSISTENCE, BIOACCUMULATION AND TOXICITY (PBT) ASSESSMENT

The methodology for the Persistent, Bioaccumulative and Toxic (PBT) substances assessment is based on the Australian and EU REACH Criteria methodology (DEWHA, 2009; ECHA, 2017).

Sodium benzoate is readily biodegradable and thus does not meet the screening criteria for persistence.

There are no bioconcentration studies available for sodium benzoate. The measure log K_{ow} for benzoic acid is reported to be 1.88. Therefore, sodium benzoate does not meet the screening criteria for bioaccumulation.

The NOEC and EC_{10} values from the chronic aquatic toxicity studies on sodium benzoate are > 0.1 mg/L. The acute $E(L)C_{50}$ values from the acute aquatic toxicity studies on sodium benzoate are > 1 mg/L. Thus, sodium benzoate does not meet the criteria for toxicity.

The overall conclusion is that sodium benzoate is not a PBT substance.

IX. CLASSIFICATION AND LABELLING

A. Classification

H319: Causes serious eye irritation

B. Labelling

Warning

A. Pictogram



X. HANDLING AND SAFETY INFORMATION (OCCUPATIONAL LIMITS AND TRANSPORTATION REQUIREMENTS)

A. First Aid

Please refer to the product SDS for additional information and confirmation of the information provided herein.

Eye Contact

In case of contact, immediately flush eyes with plenty of water for at least 15 minutes.

Skin Contact

Wash thoroughly with soap and water.

Inhalation

If inhaled, remove from area to fresh air. Get medical attention.

Ingestion

Rinse mouth with water and then drink a glass of water. Get medical attention. Never give anything by mouth to an unconscious person.

B. Fire Fighting Information

Extinguishing Media

Water spray, carbon dioxide, foam, dry chemical.

Specific Exposure Hazards

Keep product and empty container away from heat and sources of ignition. May emit toxic fumes under fire conditions. Depending on conditions, decomposition products may include the following: carbon monoxide, carbon dioxide.

Special Protective Equipment for Firefighters

Wear self-contained breathing apparatus.

C. Accidental Release Measures

Personal Precautions

Use appropriate protective equipment. Handle in accordance with good industrial hygiene and safety practice.

Environmental Precautions

Prevent from entering sewers, waterways, or low areas.

Steps to be Taken if Material is Released or Spilled

For large amounts: dike spillage and pump off product. For residues: pick up with suitable absorbent material. Dispose of contaminated material as prescribed.

D. Storage And Handling

General Handling

Keep product and empty container away from heat and sources of ignition. Ensure adequate ventilation, especially in confined areas.

Storage

Keep container tightly closed and in a dry and well-ventilated place. Keep in a cool place.

E. Exposure Controls / Personal Protection

Occupational Exposure Standards

There are no workplace exposure standards for sodium benzoate in Australia.

Engineering Controls

Good general ventilation should be used.

Personal Protection Equipment

Respiratory Protection: Respiratory protection is not required.

Hand Protection: Chemical resistant protective gloves.

Skin Protection: Body protection must be chosen depending on activity and possible exposure.

Eye protection: Safety glasses with side-shields.

Other Precautions: Handle in accordance with good industrial hygiene and safety practice. Wearing of closed work clothing is recommended. Ensure that eyewash stations and safety showers are close to the workstation location.

F. Transport Information

Sodium benzoate is not considered hazardous for purposes of transportation by road or rail. An Australian Dangerous Goods code is not required.

XI. DISPOSAL MANAGMENT

Disposal should be in accordance with all local, state, and federal regulations.

XII. REGULATORY STATUS

Australian AICS Inventory: Listed.

XIII. REFERENCES

ADWG. (2011). National Water Quality Management Strategy. Australian Drinking Water Guidelines, Section 6, Australian Government, National Health and Medical Research Council, Natural Resource Management Ministerial Council. Updated January 2022. Available: https://www.nhmrc.gov.au/about-us/publications/australian-drinking-water-guidelines

Department of the Environment, Water, Heritage and the Arts [DEWHA]. (2009). Environmental risk assessment guidance manual for industrial chemicals, Department of the Environment, Water, Heritage and the Arts, Commonwealth of Australia. Available: http://www.nepc.gov.au/resource/chemical-risk-assessment-guidance-manuals

Department of the Environment and Energy [DoEE]. (2017). Chemical Risk Assessment Guidance Manual: for chemicals associated with coal seam gas extraction, Guidance manual prepared by Hydrobiology and ToxConsult Pty Ltd for the Department of the Environment and Energy, Commonwealth of Australia, Canberra. Available: www.environment.gov.au/water/coal-and-coal-seam-gas/national-assessment-chemicals/consultation-risk-assessment-guidance-manual

ECHA. ECHA REACH database: http://echa.europa.eu/information-on-chemicals/registered-substances

enHealth Human Risk Assessment [HHRA]. (2012). Environmental Health Risk Assessment, Guidelines for Assessing Human Health Risks from Environmental Hazards. Office of Health Protection of the Australian Government Department of Health. Available: https://www1.health.gov.au/internet/main/publishing.nsf/Content/health-pubhlth-publicat-environ.htm

European Chemicals Agency [ECHA]. (2017). Guidance on Information Requirements and Chemical Safety Assessment, Chapter R11: PBT Assessment, European Chemicals Agency, Helsinki, Finland. Available: https://echa.europa.eu/guidance-documents/guidance-on-information-requirements-and-chemical-safety-assessment

Klimisch, H.J., Andreae, M., and Tillmann, U. (1997). A systematic approach for evaluating the quality of experimental and toxicological and ecotoxicological data. Regul. Toxicol. Pharmacol. 25:1-5.

U.S. Environmental Protection Agency [EPA]. (2017). EPISuite™ v. 4.11, United States Environmental Protection Agency, Office of Pollution Prevention and Toxics and Syracuse Research Corporation. Available: https://www.epa.gov/tsca-screening-tools/epi-suitetm-estimation-program-interface.

SODIUM BISULFITE

This dossier on sodium bisulfite presents the most critical studies pertinent to the risk assessment of sodium bisulfite in its use in coal seam or shale gas extraction activities. This dossier does not represent an exhaustive or critical review of all available data. The majority of information presented in this dossier was obtained from the ECHA database that provides information on chemicals that have been registered under the EU REACH (ECHA). Where possible, study quality was evaluated using the Klimisch scoring system (Klimisch et al., 1997).

NICNAS has assessed sodium bisulfite in an IMAP Tier 1 assessment and considers it an inorganic substance comprising ions of low ecological concern[1] .

I. SUBSTANCE IDENTIFICATION

Chemical Name (IUPAC): Sodium hydrogen sulfite

CAS RN: 7631-90-5

Molecular formula: $NaHSO_3$

Molecular weight: 104.06 g/mol

Synonyms: sodium bisulfite; sodium acid sulfite; sulfurous acid, monosodium salt; sodium bisulphite

SMILES: H-O3-S. Na

II. PHYSICO-CHEMICAL PROPERTIES

Table 1: Overview of the Physico-chemical Properties of Sodium Bisulfite

Property	Value	Klimisch Score	Reference
Physical state at 20°C and 101.3 kPa	White, crystalline, solid	-	PubChem
Melting Point	104 °C , Decomposes	-	Pubchem
Boiling Point	Decomposes	-	Pubchem
Density	1348 kg/m^3@ 20°C	1	ECHA
Vapour Pressure	Not applicable	-	-
Partition Coefficient (log K_{ow})	Not applicable (inorganic substance)	-	-
Water Solubility	724 g/L @ 20°C	2	ECHA
Flash Point	Not available	-	-
Auto flammability	Not available	-	-
Viscosity	3.64 mPa s @ 20°C	-	PubChem
Henry's Law Constant	Not applicable	-	-

[1] https://services.industrialchemicals.gov.au/assessment-detail/?id=96e2433e-f36b-1410-8e4e-00f1fcf8411a

Sodium bisulfite is a weak acid with a pK_a of 6.97. Its conjugate base is the sulfite ion (SO_3^{2-}).

$NaHSO_3 \leftrightarrow Na^+ + HSO_3^-$

$HSO_3^- \leftrightarrow H^+ + SO_3^{2-}$

At neutral pH, a mixture of 50% sulfite (SO_3^{2-}) and 50% bisulfite (HSO_3^{2-}) is present.

In surface waters, sulfite is oxidised to sulfate either catalytically by air oxygen or by microbial action (OECD, 2008). The presence of cations like iron, copper or manganese in the environment accelerates the oxidation rate significantly.

Dissociation of sodium bisulfite in aqueous solutions can also liberate sulfur dioxide (SO_2), which is a gas.

III. ENVIRONMENTAL FATE PROPERTIES

At environmental pHs, sodium bisulfite dissociates in water to form sodium (Na^+) ions, bisulfite ions (HSO_3^-), sulfite (SO_2^{3-}) ions, and sulfur dioxide (SO_2) which is a gas.

Sodium bisulfite is not expected to bioaccumulate in the environment because of its dissociation to ionic species and a gas. Furthermore, sulfite will oxidise to sulfate, which is ubiquitous in the environment.

Sodium bisulfite and its dissociated species are expected to have a low potential to adsorb to soil and sediment.

IV. HUMAN HEALTH HAZARD ASSESSMENT

A. Summary

Limited toxicity data are available on sodium bisulfite; therefore, structural analogues have been used to read across to sodium bisulfite. Sodium bisulfite has low acute toxicity by the oral, inhalation, and dermal routes. Sodium bisulfite is minimally irritating to the skin and slightly irritating to the eyes. It is not a skin sensitiser. No systemic toxicity was seen in rats when given read across substance sodium metabisulfite in their diet over a lifetime. There were, however, indications of stomach lesions as a result of localized irritation from the ingestion of sodium metabisulfite. Sodium bisulfite is not expected to be genotoxic or carcinogenic. No reproductive or developmental toxicity was observed in any of the animal studies on sodium bisulfite or its structural analogues.

B. Acute Toxicity

<u>Oral</u>

No acute toxicity studies are available for sodium bisulfite.

The oral LD_{50} value in rats for sodium sulfite is 2,610 mg/kg (ECHA) [Kl. score = 2]. The oral LD_{50} values in rats for sodium metabisulfite are 1,420 mg/kg (males), 1,630 mg/kg (females), and 1,540 mg/kg (combined sexes) (ECHA) [Kl. score = 2].

Inhalation

The 4-hour inhalation LC_{50} in rats for sodium sulfite is >5.5 mg/L (ECHA)[Kl. score = 2]

Dermal

The dermal LD_{50} in rats for sodium sulfite is >2,000 mg/kg (ECHA)[Kl. score = 2]

C. Irritation

There are no studies are available for sodium bisulfite.

Application of 0.5 mL of sodium sulfite to the skin of rabbits for 4 hours under occlusive conditions was minimally irritating. The mean of the 24, 48, and 72 scores were: 0.5 for erythema and 0.0 for oedema (ECHA). [Kl. score = 2]

Instillation of 0.1 mL of sodium sulfite (with 0.5% cobalt sulfate) into the eyes of rabbits produced slight irritation. The mean of the 24-, 48- and 72-hour scores are as follows: 0.5 for conjunctival redness; 0.5 for conjunctival chemosis; 0.0 for corneal lesions; and 0.0 for iridial lesions (ECHA)[Kl. score = 2]

D. Sensitisation

Sodium bisulfite was not considered a skin sensitiser in a mouse local lymph node assay (ECHA)[K. score = 1].

E. Repeated Dose Toxicity

Oral

There are no studies available for sodium bisulfite.

A study is available on sodium metabisulfite. Sodium metabisulfite dissociates in water to form sodium (Na^+) ions, disulfite ($S_2O_5^{2-}$) ions, and sulfur dioxide (SO_2). The disulfite ions can form bisulfite (HSO_3^-) and sulfite ions (SO_2^{3-}); at neutral pH, a mixture of 50% sulfite (SO_3^{2-}) and 50% bisulfite (HSO_3^{2-}) is present.

Male and female Wistar rats were fed in their diet 0, 0.125, 0.25, 0.5, 1.0, or 2.0% sodium metabisulfite for up to two years and over three generations. The diet was enriched with thiamine to prevent thiamine deficiency as a result of sulfite-induced destruction of this vitamin. During storage up to the time of consumption, the losses of sulfite from the feed containing sodium metabisulfite at levels of 0.125, 0.25, 0.5, 1.0, and 2.0% averaged 22, 14,12, 8, and 4.5%, respectively, while the decrease in thiamine was 2.7, 1.7, 8.3, 14.5, and 15.4%, respectively. Addition of thiamine to the diet prevented thiamine deficiency in rats at all dose levels based on measurements of thiamine levels in the urine and liver. The general condition of the rats was good during the first 72 weeks in the F0 generation, as well as the other two generations. After 72 weeks, there was a rapid increase in mortality in all groups. Survival in the treated groups were generally higher than the controls, except for the 2% F1 males; no deaths occurred in the 2% F2 females. A marginal reduction in body weight gain was observed in the 2% dose group (both sexes) in the F1 and F2 generations. Feed consumption was similar between treated and control groups. There were no changes in hematology and clinical chemistry parameters and urinalysis that were considered toxicologically significant. The >1% dietary groups had occult blood in their feces. Relative kidney weights were

increased in the 2% F2 females, but there were no pathological changes noted in the kidneys from this group. Hyperplastic changes in the fore- and glandular stomachs were noted in the >1% groups in all three generations. Some slight alterations were also noted in stomachs of the 0.5% F2 rats. The NOAEL for systemic toxicity is 1.91% in the diet. This was estimated to be 955 mg/kg bw/day based on a rat body weight of 400 g and a daily feed intake of 20 g. The histopathologic effects on the stomach and the occult blood in faeces are considered to be the result of localized irritation (a site-of-contact effect) from the ingestion of sodium metabisulfite. Because there was no evidence of systemic toxicity following chronic treatment, the NOAEL for systemic effects can be expected to be above the highest dose of 2% sodium metabisulfite which corresponds to 955 mg/kg bw/day of $Na_2S_2O_5$ or 1045 mg/kg bw/day of sodium hydrogensulfite (Til et al., 1972; as cited in ECHA). [Kl. score = 2]

Inhalation

There are no studies available.

Dermal

There are no studies available.

F. Genotoxicity

In vitro Studies

There are no *in vitro* genotoxicity studies were located for sodium bisulfite. Table 2 presents the findings from *in vitro* genotoxicity studies conducted on structural analogues of sodium bisulfite.

Table 2: *In vitro* Genotoxicity Studies on Structural Analogues to Sodium Bisulfite

Test System	Test Substance	Results*		Klimisch Score	Reference
		-S9	+S9		
Bacterial reverse mutation (*S. typhimurium* strains)	Sodium metabisulfite	-	-	2	ECHA
Bacterial reverse mutation (*S. typhimurium* strains)	Potassium metabisulfite	-	-	2	ECHA
Bacterial reverse mutation (*S. typhimurium* strains)	Potassium metabisulfite	-	-	2	ECHA
Bacterial reverse mutation (*S. typhimurium* and *E. coli* strains)	Sodium metabisulfite	-	-	2	ECHA
Mammalian cell gene mutation (mouse lymphoma L5178Y cells)	Sodium metabisulfite	-	-	2	ECHA
Chromosomal aberration (human lymphocytes)	Sodium metabisulfite	-	-	1	ECHA

*+, positive; -, negative

In vivo Studies

Sodium bisulfite did not show a mutagenic response in a rat dominant lethal assay when given in feed at doses of 0, 4.5, 15, or 45 mg/kg/day (ECHA). [Kl. score = 2].

Sodium sulfite was not genotoxic in a bone marrow micronucleus test in rats. Male NMRI rats were given a single subcutaneous injection of 0, 250, 500, or 1,000 mg/kg sodium sulfite (ECHA). [Kl. score = 1].

G. Carcinogenicity

Oral

There are no studies are available for sodium bisulfite.

Male and female Wistar rats were fed in their diet 0, 0.125, 0.25, 0.5, 1.0, or 2.0% sodium metabisulfite for up to two years and over three generations. There was no increased incidence of tumours in the treated groups compared to the controls (Til et al., 1972; as cited in ECHA). [Kl. score = 2].

Male and female ICR/JCL mice were given in their drinking water 0, 1, or 2% potassium metabisulfite for two years. There was no increased incidence of tumours in the treated groups compared to the controls (Tanaka et al., 1979; as cited in ECHA) [Kl. score = 2].

Inhalation

There are no studies available.

Dermal

There are no studies available.

H. Reproductive Toxicity

There are no studies are available for sodium bisulfite.

Male and female Wistar rats were fed in their diet 0, 0.125, 0.25, 0.5, 1.0, or 2.0% sodium metabisulfite for up to two years and over three generations. The diet was enriched with thiamine to prevent thiamine deficiency as a result of sulfite-induced destruction of this vitamin. During storage up to the time of consumption, the losses of sulfite from the feed containing sodium metabisulfite at levels of 0.125, 0.25, 0.5, 1.0, and 2.0% averaged 22, 14,12, 8, and 4.5%, respectively, while the decrease in thiamine was 2.7, 1.7, 8.3, 14.5, and 15.4%, respectively. Addition of thiamine to the diet prevented thiamine deficiency in rats at all dose levels based on measurements of thiamine levels in the urine and liver. The effects other than reproductive and developmental toxicity are discussed above in the Repeated Dose Toxicity section. There were no treatment-related effects on female fertility, the number of young per litter, or birth weight or mortality of the offspring. The number of F2a pups was significantly reduced in the >0.5% groups during the first breeding cycle, but there was no dose-response, and the reduction did not occur during the second breeding cycle. Slight growth retardation was observed in the F1 and F2 generation rats both before and after weaning. The NOAEL for reproductive toxicity is 1.91% in the diet. This was estimated to be 955 mg/kg bw/day based on a rat body weight of 400 g and a daily feed intake of 20 g (Til et al., 1972; as cited in ECHA) [Kl. score = 2].

Male and female rats were given sodium metabisulfite in their drinking water for up to 2.5 years and in three successive generations. The doses were 375 and 750 ppm as sulfur dioxide (SO_2). There was no evidence of systemic toxicity in either dose group. The number of offspring of either the F1 and F2 generation and the proportion surviving to the end of lactation were similar between treated and

control groups. The NOAEL for reproductive toxicity is 750 ppm (as SO2) in drinking water. Assuming an average rat body weight of 400 g and a daily water intake of 28 mL, 750 ppm (as SO_2) corresponds to 53 mg/kg bw/day sodium metabisulfite (Lockett and Natoff, 1960; as cited in ECHA) [Kl. score = 2].

I. Developmental Toxicity

Oral

Pregnant female Wistar rats were dosed by oral gavage with up to 110 mg/kg-day sodium bisulfite during GD 6-15. There was no maternal or developmental toxicity. The NOAEL for maternal and developmental toxicity for this study is 110 mg/kg bw/day (ECHA) [Kl. score = 2].

Pregnant female CD-1 mice were dosed by oral gavage with up to 150 mg/kg-day sodium bisulfite during GD 6-15. There was no maternal or developmental toxicity. The NOAEL for maternal and developmental toxicity for this study is 150 mg/kg bw/day (ECHA) [Kl. score = 2].

Pregnant female Dutch-belted were dosed by oral gavage with up to 100 mg/kg-day sodium bisulfite during GD 6-18. There was no maternal or developmental toxicity. The NOAEL for maternal and developmental toxicity for this study is 100 mg/kg bw/day (ECHA) [Kl. score = 2].

Inhalation

There are no studies available.

Dermal

There are no studies available.

V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES

The toxicological reference values developed for sodium bisulfite follow the methodology discussed in enHealth (2012). The approach used to develop drinking water guidance values is described in the Australian Drinking Water Guidelines (ADWG, 2011).

A. Non-Cancer

Oral

No repeated dose toxicity studies have been conducted on sodium bisulfite. In a study conducted on sodium metabisulfite, there was no evidence of systemic toxicity in rats fed up to 2% for two years (Til et al., 1972; as cited in ECHA). The NOAEL for this study is 2% or 955 mg/kg bw/day Na_2S2O5 or 1,045 mg/kg bw/day sodium bisulfite. The NOAEL of 1,045 mg/kg bw/day will be used for determining the oral reference dose (RfD) and the drinking water guidance value for sodium bisulfite.

Oral Reference Dose (oral RfD)

Oral RfD = NOAEL / (UF_A x UF_H x UF_L x UF_{Sub} x UF_D)

Where:

UF_A (interspecies variability) = 10
UF_H (intraspecies variability) = 10

UF_L (LOAEL to NOAEL) = 1
UF_{Sub} (subchronic to chronic) = 10
UF_D (database uncertainty) = 1
Oral RfD = 1045/(10 x 10 x 1 x 10 x 1) = 1045/1000 = 1.045 mg/kg/day

Drinking water guidance value

Drinking water guidance value = (animal dose) x (human weight) x (proportion of intake from water) / (volume of water consumed) x (safety factor)

Using the oral RfD,

Drinking water guidance value = (oral RfD) x (human weight) x (proportion of water consumed) / (volume of water consumed)

Where:
Human weight = 70 kg (ADWG, 2011)
Proportion of water consumed = 10% (ADWG, 2011)
Volume of water consumed = 2L (ADWG, 2011)
Drinking water guidance value = (1.045 x 70 x 0.1)/2 = 3.66 mg/L

B. Cancer

There are no carcinogenicity studies for sodium bisulfite. No carcinogenic effects were reported for sodium metabisulfite in rat and mouse chronic studies. The available data on long-term oral exposure of experimental animals to sodium and potassium metabisulphite allow an evaluation of the carcinogenic risks of sulphite compounds for humans exposed via the oral route. There was no indication that metabisulphite had any carcinogenic effect itself (ECHA), therefore a cancer reference value was not derived.

VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES

Sodium bisulfite does not exhibit the following physico-chemical properties:

- Explosivity
- Flammability
- Oxidising potential

VII. ENVIRONMENTAL HAZARD ASSESSMENT

A. Summary

No aquatic toxicity studies have been conducted on sodium bisulfite. Other inorganic sulfite compounds show low to moderate toxicity concern to aquatic organisms.

B. Aquatic Toxicity

Acute Studies

No acute aquatic studies are available on sodium bisulfite; however, studies are available on other inorganic sulfite compounds. The studies on these inorganic sulfite compounds can be used to read across to sodium bisulfite since sulfite ions are formed in water upon dissociation of sodium

bisulfite. Table 3 lists the results of acute aquatic toxicity studies on the structural analogues of sodium bisulfite.

Table 3 lists the results of acute aquatic toxicity studies conducted on the structural analogues of sodium bisulfite.

Table 3: Acute Aquatic Toxicity Studies on the structural analogues of sodium bisulfite

Test Species	Test Substance	Endpoint	Results (mg/L)	Klimisch score	Reference
Oncorhynchus mykiss(Salmo gairdneri)	Disodium disulphite	96-hour LC_{50}	147-215 (177.8*)	2	ECHA
Leuciscus idus	Potassium sulphite	96-hour LC_{50}	>220-460 (316*)	2	ECHA
Leuciscus idus	Disodium sulfite	96-hour LC_{50}	316	2	ECHA
Oncorhynchus mykiss	Diammonium thiosulfate	96-hour LC_{50}	770	1	ECHA
Lepomis macrochirus	Diammonium thiosulfate	96-hour LC_{50}	510	1	ECHA
Brachydanio rerio	Potassium metabisulfite	96-hour LC_{50}	464-1,000 (681.2*)	1	ECHA
Daphnia magna	Sodium disulphite	48-hour EC_{50}	88.8	2	ECHA
Daphnia magna	Sodium dithionite	48-hour EC_{50}	98.31	2	ECHA
Daphnia magna	Diammonium thiosulfate	48-hour EC_{50}	230	1	ECHA
S. subspicatus	Sodium disulfite	96-hour EC_{50} 72-hour EC_{10}	43.9 (36.8**) 33.3	2	ECHA
Desmodesmus subspicatus (S. subpicatus)	Disodium disulphite	72-hour EC_{50}	43.8	2	ECHA
Scenedesmus brasiliensis	Disodium sulfite	96-hour EC_{50}	37.8	2	ECHA
Desmodesmus subspicatus (S. subspicatus)	Disodium dithionite	72-hour EC_{50}	206.2 (189**)	2	ECHA
Raphidocelis subcapitata	Ammonium thiosulfate	72-hour EC_{50}	>100	1	ECHA

*Geometric mean.
** sulfite ion (SO_3^{2-})

Chronic Studies

No chronic studies are available on sodium bisulfite; however, studies are available on sodium sulfite.

Table 4 lists the results of chronic aquatic toxicity studies conducted on sodium sulfite.

Table 4: Chronic Aquatic Toxicity Studies on Structural Analogues of Sodium Sulfite (CAS No. 7757-83-7)

Test Species	Test substance	Endpoint	Results (mg/L)	Klimisch score	Reference
Danio rerio	Sodium sulfite	34-day NOEC	≥316 (200.5*)	1	ECHA
Daphnia magna	Disodium disulphite	21-day NOEC	>10	2	ECHA
Dophnia magna	Sodium dithionite	21-day NOEC	>10	1	ECHA
Desmodesmus subspicatus	Disodium disulphite	72-hour EC_{10}	33.3 (28*)	2	ECHA
Scenedesmus brasiliensis	Sodium sulphite	96-hour NOEC	37.8	2	ECHA
Desmodesmus subspicatus	Disodium dithionite	72-hour EC_{10}	81.7 (75*)	2	ECHA
Raphidocelis subcapitata	Ammonium thiosulfate	72-hour NOEC	≥100	1	ECHA

*sulfite ion (SO_3^{2-})

C. Terrestrial Toxicity

There are no studies available.

D. Calculation of PNEC

The PNEC calculations for sodium bisulfite follow the methodology discussed in DEWHA (2009).

PNEC Water

There are no studies available for sodium bisulfite. However, the results from studies conducted on other inorganic sulphite compounds can be used to read across to sodium bisulfite. Hence, experimental acute and chronic results are available for three trophic levels. Acute E(L)C50 values are available for fish (177.8 mg/L for sodium pyrosulfite), invertebrates (88.8 mg/L for sodium sulfite), and algae (36.8 mg/L for sulfite ion)). Results from chronic studies on sodium sulfite or other inorganic sulphite compounds are also available for all three trophic levels. NOEC or EC_{10} values from long-term studies are available for fish (200.5 mg/L for sulfite ion), invertebrates (>10 mg/L), and algae (28 mg/L, for sulfite ion) , with the lowest NOEC being >10 mg/L for invertebrates. Using the molecular weights of sodium sulfite (126 g/mol) and sodium bisulfite (104.1 g/mol, the NOEC of 10 mg/L for sodium sulfite is converted to 8.3 mg/L. On the basis that the data consist of short-term and long-term results from three trophic levels, an assessment factor of 10 has been applied to the lowest reported NOEC of 8.3 mg/L for invertebrates. The $PNEC_{water}$ is 0.8 mg/L.

PNEC Sediment

No experimental toxicity data on sediment organisms are available. Sodium bisulfite dissociates completely in water with its environmental distribution is dominated by its high water solubility. K_{ow} and K_{oc} parameters do not readily apply to inorganics, such as sodium bisulfite. Thus, the equilibrium

partitioning method cannot be used to calculate the $PNEC_{sed}$. Based on its properties, no adsorption of sodium bisulfite to sediment is to be expected, and the assessment of this compartment will be covered by the aquatic assessment.

PNEC Soil

No experimental toxicity data on soil organisms are available. Sodium bisulfite dissociates completely in water with its environmental distribution is dominated by its high water solubility. K_{ow} and K_{oc} parameters do not readily apply to inorganics, such as sodium bisulfite. Thus, the equilibrium partitioning method cannot be used to calculate the $PNEC_{soil}$. Based on its properties, no adsorption of sodium bisulfite to soil is to be expected, and the assessment of this compartment will be covered by the aquatic assessment.

VIII. PERSISTENCE, BIOACCUMULATION AND TOXICITY (PBT) ASSESSMENT

The methodology for the Persistent, Bioaccumulative and Toxic (PBT) substances assessment is based on the Australian and EU REACH Criteria methodology (DEWHA, 2009; ECHA, 2017).

Sodium bisulfite is an inorganic compound that dissociates completely to ionic species and sulfur dioxide gas. Biodegradation is not applicable to these compounds. For the purposes of this PBT assessment, the persistent criterion is not considered applicable to sodium bisulfite or its dissociated compounds.

Sodium bisulfite is not expected to bioaccumulate because its dissociated species are inorganic ions and a gas.

There are no aquatic toxicity data on sodium bisulfite. The lowest NOEC from chronic aquatic toxicity studies on sodium sulfite, a structural analogue of sodium bisulfite, is >0.1 mg/L. Thus, sodium bisulfite is not expected to meet the criteria for toxicity.

The overall conclusion is that sodium bisulfite is not a PBT substance.

IX. CLASSIFICATION AND LABELLING

A. Classification

H302-Acute Toxicity category 4: Harmful if swallowed

H318-Eye damage-category 1: Causes serious eye damage

B. Labelling

Danger

A. Pictogram



X. HANDLING AND SAFETY INFORMATION (OCCUPATIONAL LIMITS AND TRANSPORTATION REQUIREMENTS)

A. First Aid

Please refer to the product SDS for additional information and confirmation of the information provided herein.

Eye Contact

In case of contact, immediately flush eyes with plenty of water for at least 15 minutes.

Skin Contact

Wash thoroughly with soap and water.

Inhalation

If inhaled, remove from area to fresh air. Get medical attention.

Ingestion

Rinse mouth with water and then drink a glass of water. Get medical attention. Never give anything by mouth to an unconscious person.

B. Fire Fighting Information

Extinguishing Media

Water spray, carbon dioxide, foam, dry chemical.

Specific Exposure Hazards

Keep product and empty container away from heat and sources of ignition. May emit toxic fumes under fire conditions. Depending on conditions, decomposition products may include the following: carbon monoxide, carbon dioxide.

Special Protective Equipment for Firefighters

Wear self-contained breathing apparatus.

C. Accidental Release Measures

Personal Precautions

Use appropriate protective equipment. Handle in accordance with good industrial hygiene and safety practice.

Environmental Precautions

Prevent from entering sewers, waterways or low areas.

Steps to be Taken if Material is Released or Spilled

For large amounts: dike spillage and pump off product. For residues: pick up with suitable absorbent material. Dispose of contaminated material as prescribed.

D. Storage And Handling

General Handling

Keep product and empty container away from heat and sources of ignition. Ensure adequate ventilation, especially in confined areas.

Storage

Keep container tightly closed and in a dry and well-ventilated place. Keep in a cool place.

E. Exposure Controls / Personal Protection

Occupational Exposure Standards

The workplace exposure standards for sodium bisulphite in Australia is as follows: 5 mg/m^3 (Time weighted average, TWA).

Engineering Controls

Good general ventilation should be used.

Personal Protection Equipment

Respiratory Protection: Respiratory protection is not required.

Hand Protection: Chemical resistant protective gloves.

Skin Protection: Body protection must be chosen depending on activity and possible exposure.

Eye protection: Safety glasses with side-shields.

Other Precautions: Handle in accordance with good industrial hygiene and safety practice. Wearing of closed work clothing is recommended. Ensure that eyewash stations and safety showers are close to the workstation location.

F. Transport Information

Sodium bisulfite is not considered hazardous for purposes of transportation by road or rail. An Australian Dangerous Goods code is not required.

XI. DISPOSAL MANAGMENT

Disposal should be in accordance with all local, state and federal regulations.

XII. REGULATORY STATUS

Australian AICS Inventory: Listed.

XIII. REFERENCES

ADWG. (2011). National Water Quality Management Strategy. Australian Drinking Water Guidelines, Section 6, Australian Government, National Health and Medical Research Council, Natural Resource Management Ministerial Council. Updated January 2022. Available: https://www.nhmrc.gov.au/about-us/publications/australian-drinking-water-guidelines

de Giovanni-Donnelly, R. (1985). The mutagenicity of sodium bisulfite on based-substitution strains of S. typhimurium. Teratogen. Carcinogen. Mutagen. 5: 195-203.

Department of the Environment, Water, Heritage and the Arts [DEWHA]. (2009). Environmental risk assessment guidance manual for industrial chemicals, Department of the Environment, Water, Heritage and the Arts, Commonwealth of Australia. Available: http://www.nepc.gov.au/resource/chemical-risk-assessment-guidance-manuals

ECHA. ECHA REACH database: http://echa.europa.eu/information-on-chemicals/registered-substances

enHealth Human Risk Assessment [HHRA]. (2012). Environmental Health Risk Assessment, Guidelines for Assessing Human Health Risks from Environmental Hazards. Office of Health Protection of the Australian Government Department of Health. Available: https://www1.health.gov.au/internet/main/publishing.nsf/Content/health-pubhlth-publicat-environ.htm

European Chemicals Agency [ECHA]. (2017). Guidance on Information Requirements and Chemical Safety Assessment, Chapter R11: PBT Assessment, European Chemicals Agency, Helsinki, Finland. Available: https://echa.europa.eu/guidance-documents/guidance-on-information-requirements-and-chemical-safety-assessment

HSDB. Hazardous Substance Database: https://toxnet.nlm.nih.gov/newtoxnet/hsdb.htm

Ishidate, M., Sofumi, T., Yoshikawa, K., Hayashi, M., Nohmi, T., Sawada, M., and Mastuoka, A. (1984). Primary mutagenicity screening of food additives currently used in Japan. Fd. Chem. Toxicol. 22: 623-636.

Klimisch, H.J., Andreae, M., and Tillmann, U. (1997). A systematic approach for evaluating the quality of experimental and toxicological and ecotoxicological data. Regul. Toxicol. Pharmacol. 25:1-5.

OECD (2001). OECDS-SIDS: Disodium disulphite (CAS No. 7657-4). UNEP Publications. Available at: http://www.inchem.org/documents/sids/sids/DISODIUM.pdf.

OECD (2008). Screening Information Dataset (SIDS) Initial Assessment Report for Sodium Sulfite (CAS No. 7757-83-7). Available at: https://hpvchemicals.oecd.org/UI/SIDS_Details.aspx?id=AF456240-42B5-4118-8E97-4FE480D85FB9.

Lockett, M.F., and Natoff, I.L. (1960). A study of the toxicity of sulfite. 1. J. Pharm. Pharmacol. 12: 488-496.

Pagano, D.A., and Zeiger, E. (1987). Condition affecting the mutagenicity of sodium bisulfite in S. typhimurium. Mutat. Res. 179: 159-166.

Pagano, D.A., Zeiger, E., and Stack, A. (1990). Autooxidation and mutagenicity of sodium bisulfite. Mutat. Res. 228: 89-96.

Renner, H.W., and Wever, J. (1983). Attempts to induce cytogenetic effects with sulphite in sulphite oxidase-deficient Chinese hamsters and mice. Fd. Chem. Toxicol. 21: 123-127.

Tanaka, T., Fujii, M., Mori, H., and Hirono, I. (1979) Carcinogenicity test of potassium metabisulfite in mice. Ecotoxicol. Environ. Safety 3: 451-453.

Til, H.P., Feron, V.P., de Groot, A.P. (1972). The toxicity of sulphite. I. Long-term feeding and multigeneration studies in rats. Fd. Cosmet. Toxicol. 10: 291-310.

SODIUM BROMATE

This dossier on sodium bromate presents the most critical studies pertinent to the risk assessment of sodium bromate in its use in coal seam or shale gas extraction activities. This dossier does not represent an exhaustive or critical review of all available data. The majority of information presented in this dossier was obtained from the ECHA database that provides information on chemicals that have been registered under the EU REACH (ECHA), the 2020 National Industrial Chemical Notification and Assessment Scheme Inventory [NICNAS] human health tier II assessment for bromates, and the 1994 cosmetic ingredient review (CIR) for sodium bromate and potassium bromate. Where possible, study quality was evaluated using the Klimisch scoring system (Klimisch et al., 1997).

I. SUBSTANCE IDENTIFICATION

Chemical Name (IUPAC): Sodium bromate

CAS RN:7789-38-0

Molecular formula: $NaBrO_3$ or $BrNaO_3$

Molecular weight: 150.89 g/mol

Synonyms: bromic acid sodium salt

SMILES: [O-]Br(=O) =O. [Na+]

II. PHYSICO-CHEMICAL PROPERTIES

Table 1: Overview of the Physico-chemical Properties of Sodium Bromate

Property	Value	Klimisch Score	Reference
Physical state at 20°C and 101.3 kPa	White, odorless, crystalline powder	2	ECHA
Melting Point	381°C (pressure not indicated)	2	ECHA
Boiling Point	Not applicable, substance is a solid which melts above 300 °C	-	-
Density	3339 kg/m^3 @ 20°C	2	ECHA
Vapour Pressure	Not applicable	-	-
Partition Coefficient (log K_{ow})	Not applicable (inorganic substance)	-	-
Water Solubility	364 g/L @ 20°C	2	ECHA
Flash Point	Not applicable	-	-
Auto flammability	Not applicable	-	-
Viscosity	Not applicable	-	-
Henry's Law Constant	Not applicable	-	-

Sodium bromate is the sodium salt of bromic acid that is highly soluble in water. Sodium bromate is formed by passing bromine through a solution of sodium carbonate and it can also be created by

oxidation of bromine with chlorine to sodium hydroxide (CIR 1994). It dissociates to form sodium (Na+) and bromate (BrO_3^-) ions. It has strong oxidizing properties, and it reacts vigorously with organic matter and is reduced to bromide. (ECHA).

III. ENVIRONMENTAL FATE PROPERTIES

Sodium bromate dissociates in aqueous media to form sodium (Na+) and bromate (BrO_3^-) ions. Biodegradation is not applicable to inorganic compounds. Sodium bromate is not expected to bioaccumulate in the environment because of its dissociation to ionic species. Sodium bromate is not expected to adsorb to soil or sediment because of its high water solubility of 364 g/L (ECHA).

IV. HUMAN HEALTH HAZARD ASSESSMENT

A. Summary

Sodium bromate is reduced in the body to bromide and it is ultimately excreted in the urine and feces. Sodium bromate has high acute oral toxicity in rats and it is expected to be irritating to the eyes and the skin. Sodium bromate is a mild skin sensitiser. Sodium bromate is genotoxic and the bromate moiety is possibly carcinogenic . It is not a reproductive or developmental toxicant.

B. Metabolism

Sodium bromate is rapidly absorbed from the gastrointestinal tract and it remains largely unchanged. It is then distributed throughout the body where it will appear in the plasma, urine, and unchanged in other tissues as bromide. Sodium bromate is reduced to bromide in several body tissues, most likely by glutathione (GSH) or other sulfhydryl-containing compounds. Sodium bromate is mostly excreted in the urine as either bromate or bromide and it can also be excreted in the faeces (ECHA) [KI. score =2].

Sodium bromate will dissociate in water and the bromate ion is rapidly absorbed from the gastrointestinal tract. Bromine has been detected in the adipose tissue of mice following long-term treatment with bromate (NICNAS, 2020).

C. Acute Toxicity

An acute oral toxicity study in rats was reported for sodium bromate. An oral LD_{50} value of 301 mg/kg bw was reported for this study (ECHA) [KI. score =4].

Several cases of acute bromate toxicity have been reported in humans following accidental or intentional ingestion of permanent hair wave neutralising solution. These products usually contain either 2 % potassium bromate, or 10 % sodium bromate. Bromate intoxication leads to gastrointestinal symptoms (abdominal pain, nausea, vomiting, diarrhoea), central nervous system depression, renal failure, and hearing loss. Although these effects are usually reversible, death from renal failure may ensue if medical intervention is not successful. Hearing loss is usually irreversible (NICNAS, 2020).

D. Irritation

<u>Skin</u>

There are no adequate studies available to evaluate the skin irritancy potential of sodium bromate. However, sodium bromate is reported to have skin irritating properties (ECHA) [KI. score =4].

An *in vitro* study was conducted according to Organisation for Economic Co-operation and Development (OECD) Test Guideline (TG) 431, using a human skin model. The study consisted of a topical exposure of potassium bromate to a human reconstructed model followed by a cell viability test. Potassium bromate was not considered to possess a corrosive potential (NICNAS,2020).

Eye

There are no adequate studies available to evaluate the eye irritancy potential of sodium bromate. However, sodium bromate is reported to have eye irritating properties (ECHA) [KI. score =4].

An eye irritation study was conducted according to OECD TG 437: Bovine Corneal Opacity and Permeability Test Method for Identifying Ocular Corrosives and Severe Irritants. In this test, the damage is assessed by quantitative measurements of changes in corneal opacity and permeability with an opacitometer and a visible light spectrophotometer, respectively. Potassium bromate caused weak opacity but no permeability of the cornea compared with the results of the negative control group. The chemical was considered to be a mild eye irritant (NICNAS, 2020).

E. Sensitisation

There are no adequate studies available to evaluate if sodium bromate is a skin sensitiser.

The Buehler method (No. 406 Skin sensitization Buehler Test, Method B6) study was used to evaluate the sensitisation potential of sodium bromate in guinea pigs. An undiluted dose of 0.5 ml of sodium bromate was applied to the flank of four guinea pigs using occlusive dressing for six hours and the treated site was scored at 24 and 48 hours post treatment. Two of the guinea pigs who received the undiluted dose of sodium bromate developed mild irritation after 24 hours, one guinea pig did not have any observable effects, and the fourth guinea pig also developed mild irritation that ultimately resolved after 48 hours. Next, a 75% dilution of sodium bromate was used and resulted in a mild irritant reaction after 48 hours. Based on these results in guinea pigs, sodium bromate was reported to be a mild sensitizer (CIR, 1994).

A skin sensitisation study conducted according to OECD TG 429 (local lymph node assay—LLNA), potassium bromate (CAS No. 7758-01-2) at 1.25 %, 2.5 %, and 7.5 % (w/v) concentration was applied topically at the dorsum of each ear of female CBA mice once daily on three consecutive days. A further group of mice was treated with the positive control item and a control group of mice was also treated with the vehicle only. Stimulation Indices (S.I.) of 0.90, 0.53, and 0.64 were determined with the test item at concentrations of 1.25, 2.5, and 7.5 % (w/v), respectively. The EC3 value could not be calculated since none of the tested concentrations induced an S.I. of greater than three. Potassium bromate was not considered to be a skin sensitiser (NICNAS, 2020).

F. Repeated Dose Toxicity

Oral

Several repeated dose oral toxicity studies in animals indicate that the kidney is the major target organ of bromate associated toxicity, leading to carcinogenicity. Specific non-cancer effects included degenerative, necrotic, nephropathic, and regenerative changes in the kidney (NICNAS, 2020).

A 13-week (sub-chronic) oral drinking water repeated dose toxicity study was performed using male and female F344 rats exposed to 0, 150, 300, 600, 1,250, 5,000, and 10,000 ppm potassium bromate. All the rats in the 1,250-ppm group died within seven weeks. The observed signs of toxicity included a significant reduction in body weight gain in the male rats treated with the 600, 1,250, 5,000, and

10,000 ppm potassium bromate There was also a significant increase the following serum parameter: glutamate oxaloacetate transaminase, glutamate pyruvate transaminase, lactate dehydrogenase, alkaline phosphatase, blood urea nitrogen [BUN], Na+, and cholinesterase. There was also a decrease in serum potassium levels in both sexes of rats treated with 600 ppm of potassium bromate. Droplets of various sizes and regenerative changes in the renal tubules were also observed in rats exposed to potassium bromate. Ultimately, a LOAEL of ≤ 63 mg/kg bw/day was established for this study (ECHA) [KI. score =2]. A NOAEL of 300 mg/L was determined (NICNAS, 2020).

A 15-month oral drinking water repeated dose toxicity study was performed using male Wistar rats exposed to 0.04% potassium bromate. All the rats exposed to potassium bromate experienced a reduction in body weight. Histological examination of the kidneys of each rat at 7-11 weeks revealed karyopknotic foci (a necrotic change characterized by shrinking of the nucleus and condensation of the chromatin) in the tubules of the inner medulla. There was also in an increase in the blood urea nitrogen (BUN) levels and marked structural abnormalities of the cortical tubules in the rats exposed to potassium bromate after 15 months. A NOAEL was not established for this study, but a LOAEL of 30 mg/kg bw/day was established based on a decrease in body weight and the reported renal effects (ECHA) [KI. score =2].

An 18-month chronic toxicity study was conducted using five groups of Wistar rats (60 male and 60 females in each group) that were fed 1) 0 (control); 2) 50 ppm potassium bromate; 3) 75 ppm potassium bromate; 4) 50 ppm potassium bromate with 30 ppm ascorbic acid and 50 ppm benzoyl peroxide; 5) 50 ppm potassium bromate with 30 ppm ascorbic acid and 50 ppm benzoyl peroxide and 15 ppm chlorine dioxide bread base diets. The cumulative mortality of the treatment groups and the mean body weights of the rats were not altered significantly, for majority of the treatment groups, when compared to the rats in the control group. However, the male rats exposed to 50 ppm potassium bromate had significantly increased body weights between week 12 and 72 of treatment when compared to the control group (CIR, 1994).

In a chronic toxicity/carcinogenicity study, potassium bromate was administered at 0, 250, and 500 ppm concentrations to F344 rats (53/sex/group) for 110 weeks. Daily intake of potassium bromate was equivalent to 12.5 and 27.5 mg/kg bw/day in males and 12.5 and 25.5 mg/kg bw/day in females, respectively. As the growth of males in the high dose group was severely inhibited, the concentration in this group was reduced to 400 ppm at week 60. Body weight gain was significantly reduced in high-dose males, but not in the other treated groups. Survival was reduced in high-dose males by about week 60 and in low-dose males by about week 100. No effect on survival was observed in treated female rats. A variety of non-cancer effects were reported, including degenerative, necrotic, and regenerative changes in renal tubules; formation of hyaline droplets; thickening of transitional epithelium of the renal pelvis; papillary hyperplasia; and papillary growth. It was noted that the lesions were more extensive in degree and distribution in treated rats compared with controls, especially males. However, in the absence of information on the incidence of these lesions or on the statistical significance of these findings, a NOAEL for non-cancer effects could not be determined (NICNAS, 2020).

In another chronic study, potassium bromate was administered to male F344 rats and male B6C3F1 mice in drinking water at concentrations of 0, 0.02, 0.1, 0.2, and 0.4 g/L and 0, 0.08, 0.4, and 0.8 g/L, respectively, for 100 weeks. The doses were equal to 0, 1.5, 7.9, 16.9, and 37.5 mg/kg bw/day and 0, 9.1, 42.4, and 77.8 mg/kg bw/day, respectively, for rats and mice. In male rats, a statistically significant decrease in the mean body weight and survival was noted at the termination of the study at 0.4 g/L. The decrease in survival and body weight was attributed to an excessive mesothelioma burden. The effects on survival and body weight in rats indicate that the maximum tolerated dose

(MTD) was reached in this study. A significant dose-dependent increase in the incidence of urothelial hyperplasia was noted in rats in the 0.1 g/L and higher dose groups. Foci of mineralisation of the renal papilla and eosinophilic droplets in the proximal tubule epithelium were also noted, without any information on dose levels. There were no other treatment-related non-neoplastic effects observed in any other tissue examined. Based on kidney effects in male rats, a NOAEL of 0.02 g/L (20 ppm; 1.5 mg/kg bw/day) was determined (NICNAS, 2020).

These results also indicate that male B6C3F1 mice are potentially less sensitive to the effects of bromate exposure than rats. Bromate in drinking water had no effect on the body weights and survival of male mice. There was no increased incidence of non-neoplastic lesion in any tissue examined. Therefore, the highest tested dose of 0.8 g/L (77.8 mg/kg bw/day) is a NOAEL for male mice (NICNAS, 2020).

Inhalation

There are no studies available.

Dermal

There are no studies available.

G. Genotoxicity

In vitro Studies

The *in vitro* genotoxicity studies on sodium bromate and potassium bromate are presented in Table 2.

Table 2: *In vitro* Genotoxicity Studies on Sodium Bromate and Potassium Bromate

Test System	Results*		Klimisch Score	Reference
	-S9	+S9		
Bacterial Reverse Mutation Assay (S. typhimurium TA 97, TA98, TA 100, TA 102)	-	-	2	ECHA
Chromosome aberration (Chinese hamster fibroblast cells) *	+	-	-	CIR, 1994
Ames assay (Salmonella typhimurium TA92, TA94, TA98, TA1535, and TA1537)*	-	-	-	CIR, 1994
Ames assay (Salmonella typhimurium TA97, TA98, TA100, TA1535, and TA1537)*	+	+		NICNAS, 2020
Ames assay (Salmonella typhimurium TA100, TA102, TA104)*	-	+	-	CIR, 1994
Bacterial Reverse Mutation Assay (Escherichia coli WP2try$^-$ and WP2try$^-$ his$^-$)*	-	-	-	CIR, 1994
Rec mutagenic assay (Bacillus subtilis)*	-	-	-	CIR, 1994

*+, positive; -, negative
*Potassium bromate

Induction of oxidative DNA modifications in isolated perfused kidneys or calf thymus DNA was not observed after potassium bromate administration. Dose-dependent increases in the number of aberrant metaphase cells in rat bone marrow cells were reported in all treated animals as acute cytogenetic effects of potassium bromate (NICNAS,2020).

In assays using V79 Chinese hamster ovary cells, potassium bromate increased the frequency of cells with micronuclei, the number of chromosomal aberrations and the number of DNA strand breaks and induced gene mutations at the HPRT locus. Many chromosome aberrations observed were chromatid breaks and chromatid exchanges. Significantly increased levels of 8-oxodeoxyguanosine were also detected (Health Canada, 2010; ECHA). The result of a chromosomal aberration assay (Chinese hamster fibroblasts) using potassium bromate indicated a dose-related increase in the frequency of exchange-type aberrations (including gaps) (NICNAS,2020).

Potassium bromate induced deoxyribonucleic acid (DNA) damage in cultured mammalian cells and primary human thyroid, white blood and kidney cells as measured by the in vitro comet assay; micronuclei in cultured mammalian cells and primary human lymphocytes and kidney cells; chromosomal aberrations, DNA repair, sister chromatid exchange, and DNA modifications (increased oxidation of DNA) in mammalian cell lines, primary human cultured cells and cell-free systems; and weak chromosomal aberration induction in cultured mammalian cells (NICNAS,2020).

In Vivo Studies

An OECD guideline 474 (Mammalian Erythrocyte Micronucleus) test was performed in male and female mice (genetically modified: Tg.AC hemizygous, p53 haploinsufficient; n=15 per sex per dose) exposed to a daily dose 0, 64, 128, 256 mg/kg bw/day of sodium bromate via dermal exposure for 26 weeks. Sodium bromate induced a dose response statistically significant increase in the frequency of micronucleated erythrocytes in all of the treated mice which indicates that sodium bromate is mutagenic in this study. There were also significant increases in the percentage of polychromatic erythrocytes among total erythrocytes in the male mice exposed to sodium bromate (ECHA) [KI. score = 1].

An OECD guideline 474 (Mammalian Erythrocyte Micronucleus) test was performed in male and female mice (genetically modified: Tg.AC hemizygous; n=15 per sex per dose) exposed to a daily dose 0, 80, 400, 800 mg/L of sodium bromate in their drinking water for 26 weeks. Sodium bromate induced a dose response statistically significant increase in the frequency of micronucleated erythrocytes in all of the treated mice which indicates that sodium bromate is mutagenic in this study. There were also significant increases in the percentage of polychromatic erythrocytes among total erythrocytes in the male and female mice exposed to sodium bromate (ECHA) [KI. score = 1].

An OECD guideline 474 (Mammalian Erythrocyte Micronucleus) test was performed in male and female mice (p53 haploinsufficient; n=15 per sex/dose) exposed to a daily dose of 0, 80, 400, and 800 mg/L of sodium bromate in their drinking water for 27 weeks. Sodium bromate induced a, dose response, statistically significant increase in the frequency of micronucleated erythrocytes in all of the treated mice which indicates that sodium bromate is mutagenic in this study (ECHA) [KI. score =1].

However, in the carcinogenicity study reported in this publication, sodium bromate, did not show evidence of any carcinogenic activity. Thus, in an overall assessment of the entire data set, it is not possible to conclude on the classification for genotoxicity of sodium bromate (inconclusive).

Potassium bromate induced micronuclei *in vivo* in multiple organs in rats and mice: micronucleated reticulocytes in CD-1 mice following intraperitoneal (IP) injection; peripheral blood cell micronuclei (micronuclei reticulocytes) in male F344 rats following IP injection; micronuclei in femoral bone marrow cells of mice following intraperitoneal injections; and micronucleated polychromatic erythrocytes in two strains of mice following gavage administration (NICNAS, 2020).

Potassium bromate was negative with respect to *in vivo* genotoxicity assays: induction of micronuclei was not observed in spermatids, and no induction of DNA damage was observed in the lung, spleen or bone marrow of mice (NICNAS,2020).

H. Carcinogenicity

Considering that potassium bromate and sodium bromate will produce similar effects through bromate ions, an International Agency for Research on Cancer (IARC) classification of “probably carcinogenic to humans” has been recommended for sodium bromate. This is based on sufficient evidence of carcinogenicity in animal studies for potassium bromate and no data in humans. This is supported by the classification of 'bromate moiety' as a carcinogen by other regulatory agencies. The US EPA has also classified the bromate moiety as a 'probable human carcinogen based on no evidence in humans, but adequate evidence of carcinogenicity in male and female rats' (Group B2 carcinogen) under previous guidelines and as a 'likely human carcinogen by the oral route of exposure, insufficient data for evaluation by the inhalation route' under current guidelines. The World Health Organization (WHO) evaluated the bromate moiety under the WHO Guidelines for Drinking-water Quality and stated that 'the weight of evidence from rat bioassays clearly indicates that bromate has the potential to be a human carcinogen' (NICNAS,2020).

<u>Oral</u>

In a 27-week NTP carcinogenicity study, sodium bromate was administered to genetically modified male and female mice (953 deficient and Tg.AC hemizygous) in water at dose levels of 0, 80, 400 and 800 mg/L. The mice in the 800 mg/L group developed a decrease body weight. There were no increases in tumour incidence nor was there evidence of carcinogenicity in this study (ECHA) [KI.score =1].

In a 43-week NTP carcinogenicity study, sodium bromate was administered to genetically modified male and female mice (p53 deficient and Tg. AC mice) in water at dose levels of 0, 80, 400 and 800 mg/L. The mice in the 800 mg/L group developed a decrease body weight. There were no increases in tumour incidence nor was there evidence of carcinogenicity in this study (ECHA) [KI.score =1].

In a 111-week study in F344 rats (53 male and 53 female) were fed 250 or 500 ppm potassium bromate. All the animals survived the 111-week treatment, but the first renal cell neoplasm was found in a male rat exposed to 500 ppm of potassium bromate during week 14 of treatment. The animals treated with 500 ppm potassium bromate had a decrease in body weight so the concentration of potassium bromate was reduced to 400 ppm at week 60. Neoplasms were identified in the kidneys, testis, peritoneum, thyroid, pituitary, mammary glands, and the spleen in both the treated and control rats. Renal cell neoplasms developed in 0% (control), 56% (250ppm), and 80% (500 ppm) of female rats, and 6% (control), 60% (250 ppm), and 88% (500 ppm) of the male rats. The male rats that survived beyond week 14 and the female rats that survived beyond week 58 were included in the effective number of rats. In the treated rats, the other neoplasms found in the kidneys included two transitional cell carcinomas and one angiosarcoma. One liposarcoma was found in a control rat. More than 80% of the renal cell neoplasms were diagnosed as carcinomas. The mean survival time (88.1 ± 18.1 weeks) was the shortest in male rats fed 500 ppm potassium

bromate in their diet. The mean survival times for the other treated groups were 101-104 weeks. The survival of the controls in week 104 for the female rats was 66% compared with 77.4% for the male rats. Under the conditions of this bioassay, potassium bromate was reported to be carcinogenic and induced renal cell carcinomas in high incidences in a dose-response relationship in both male and female F344 rats (CIR, 1994).

A two-stage, 26-week carcinogenesis study was conducted in F344 rats (128 males) who received 500 or 1000 ppm of potassium bromate in their diet. N-ethyl-N-hydroxyethylnitrosamine (EHEN) was used as an initiator. Ten out of 20 rats developed renal tumours in the 500 ppm EHEN dose group (plus potassium bromate in drinking water) after 24 weeks. Four of the 23 rats who received EHEN, for only two weeks, developed renal cell tumours. Although, potassium bromate induced cancer at two years in other studies, none of the rats who received potassium bromate for 24 weeks developed cancer. The authors concluded that potassium bromate can be classified as a carcinogen that has both initiating and enhancing activities in the kidneys of rats. The initiating activity was not observed in a 104-week study, in which F344 rats (6 weeks old) were given an intragastrical dose of potassium bromate followed by being maintained on a diet containing 4000 ppm sodium barbital as a promoting agent (CIR, 1994).

In another study, male F344 rats (180 male) were divided into twelve groups followed by 500 ppm of EHEN in their drinking water or distilled water for two weeks followed by potassium bromate, potassium bromide, or distilled water for the next 24 weeks. The male rats in groups 1-9 were given EHEN at 500 ppm three times per week for two weeks at the initiation stage. The male rats in groups of 1-6 were given potassium bromate in their drinking water at concentrations of 15, 30, 60, 125, 250, or 500 ppm for 24 weeks. The male rats in groups of 7 and 8 were given potassium bromate for 24 weeks at concentrations of 350 and 1,750 ppm. The rats in group 9 were given distilled water initiation with EHEN. The male rats in group 10-12 were given distilled water for the first two weeks followed by 500 ppm potassium bromate, 1,750 potassium bromide, or distilled water for 24 weeks. The number of dysplastic hepatic foci per cm_2 were significantly increased in a dose-related manner from 15-500 ppm of potassium bromate in their drinking water. The number of renal cell neoplasms per cm^2 were significantly higher in the 500-ppm group. The incidence of dysplastic hepatic foci and renal cell neoplasms did not significantly increase with increasing levels of potassium bromate in the drinking water. The threshold concentration of potassium bromate in the drinking water of the rats, for the enhancement of renal carcinogenesis, was between 15 and 30 ppm. There was no evidence of renal carcinogenesis observed with exposure to potassium bromate in this study (CIR, 1994).

Twenty male Syrian golden hamsters, a species that rarely develop spontaneous renal neoplasms, were administered 125, 250, 500, or 2,000 ppm potassium bromate in their drinking for 89 weeks. There were no apparent differences in the survival time between the control and the treated groups. There was a significant difference in the body weight gain between the control and the high-dose groups. The authors concluded that although the incidence of renal cell tumours in the test group was not statistically significant, the fact that these tumours were not seen in the controls suggests that potassium bromate has the potential to produce tumours in Syrian golden hamsters (CIR, 1994).

Dose response studies were used to evaluate the potential for potassium bromate to induce carcinogenesis in 149 male F344 rats. The rats were given potassium bromate in their drinking water at concentrations of 15, 30, 60, 125, 250, or 500 ppm for a period of 104 weeks. Potassium bromate was dissolved in distilled water at a concentration of one percent as a stock solution refrigerated at 4 ^{o}C and diluted twice weekly before use. Renal cell carcinomas were identified in three of the twenty rats that were exposed to potassium bromate. The combined incidences of renal cell adenocarcinomas and adenomas were significantly increased in rats treated with doses of 125, 250, or 500 pm potassium bromate. Mesotheliomas of the peritoneum were observed in rats fed doses >

300 ppm potassium bromate and the rate was significantly increased in the 500-ppm group. The incidence of interstitial cell adenomas of the testis was very high in both the potassium bromate treated rats and the control rats. Papillomas of the urinary bladder were identified in the rats given water containing 15 or 250 ppm potassium bromate. In this study, renal carcinomas were observed in 20 (15%) of the rats exposed to 500 potassium bromate (CIR, 1994).

Male and female Theiller mice were fed diets containing 79% breadcrumbs made from flour treated with 75 (Group I), 50 (Group II), and 0 mg (Group III) mg/kg of potassium bromate for 80 weeks. Of groups I, II, III, 53, 46, and 35 male mice and 52, 54, and 53 female mice respectively underwent necropsy for detailed histopathological examination. There were no carcinogenic effects produced in mice that were fed bread made from flour that had been treated with potassium bromate before baking (CIR, 1994). A similar feeding studying using male (60) and female (60) Wistar rats was conducted and no carcinogenic effects were produced in any of the treated rats when they were maintained on the treated-bread diet for 104 weeks (CIR, 1994).

Based on these animal feeding studies, IARC classified potassium bromate as an animal carcinogen and a possible carcinogen to humans (given the lack of adequate data). The IARC working group indicated that ionic compounds such as potassium bromate are poorly absorbed through the skin and there is negative data for skin application studies using potassium bromate (CIR, 1994).

Inhalation

There are no studies available.

Dermal

In a 26-week NTP carcinogenicity study, solutions containing sodium bromate were also applied to the backs of male and female Tg.AC mice at dose levels of 0, 64, 128, or 256 mg/kg. The mice in the 256 mg/kg group had a decrease in body weight. There were no increases in tumour incidence nor was there evidence of carcinogenicity in this study (ECHA) [KI. score =1].

In a 39-week NTP carcinogenicity study, solutions containing sodium bromate were also applied to the backs of male and female Tg.AC mice at dose levels of 0, 64, 128, or 256 mg/kg. The mice in the 256 mg/kg group had a decrease in body weight. There were no increases in tumour incidence nor was there evidence of carcinogenicity in this study (ECHA) [KI. score =1].

I. Reproductive Toxicity

Male and female rats were exposed to sodium bromate in a reproductive toxicity study. Sodium bromate did not induce any adverse signs of general toxicity at any dose levels (a maximum tolerated dose was not achieved in this study). Reproductive function in female rats was not adversely impacted and there were no treatment related gross or microscopic changes in the kidney, liver, spleen, testis, or epididymis. Treated male rats in the 250-ppm dose group developed a statistically significant decrease (18%) in epididymal sperm density. However, all other endpoints in the male rats were comparable to controls. A NOAEL of 80 ppm (7.7 mg/kg bw/day) and a LOAEL of 250 ppm (22 mg/kg bw/day) was established for sodium bromate based on changes in sperm density in male rats. (ECHA) [KI. score =2].

J. Developmental Toxicity

Oral

In a multigeneration, continuous-breeding paradigm, sodium bromate was administered to male and female Sprague-Dawley (SD) rats in drinking water at concentrations of 0, 30, 100, and 300 mg/L. The chemical produced general toxicity in male and female SD rats at 100 and 300 mg/L as noted by chronic progressive nephropathy and hyaline droplets in males and renal cell proliferative changes in females. Even though the chemical produced a 16 % decrease in sperm density in the F0 generation, the chemical is not considered a reproductive toxicant as no treatment-related changes were observed in the reproductive litter parameters. Although the sperm density was also decreased by 8 % in the F1 generation, the change was not statistically significant (NICNAS,2020).

Inhalation

There are no studies available.

Dermal

There are no studies available.

V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES

The toxicological reference values developed for sodium bromate follow the methodology discussed in enHealth (2012). The approach used to develop drinking water guidance values is described in the Australian Drinking Water Guidelines (ADWG, 2011).

A. Non-Cancer

Oral

An oral reference dose was not derived for sodium bromate. Sodium bromate will dissociate in water to form sodium (Na+) and bromate (BrO_3^-) ions.

The Australian drinking water guideline (DWG) value for bromate is 0.02 mg/L based on health considerations. Drinking water that contains 2-10% bromate can cause toxic effects including nausea, abdominal pain, diarrhea, central nervous system depression, and pulmonary oedema which are mostly reversible. However, irreversible effects include kidney failure and deafness (ADWG, 2011).

There is also an Australian drinking water guideline value of 180 mg/L for sodium based on aesthetic considerations (taste). Excessive sodium intake can severely aggravate chronic congestive heart failure (ADWG, 2011).

B. Cancer

There is no evidence that sodium bromate is carcinogenic. However, the bromate moiety is classified as a possible carcinogen by regulatory agencies. There are animal studies that suggest that potassium bromate (surrogate chemical for sodium bromate) is a possible carcinogen to humans (CIR 1994, ECHA, NICNAS,2020).Therefore, under considerations of the classification from the structural analogue potassium bromate, sodium bromate is also suspected to be a carcinogen

(ECHA). However, a cancer reference value was not derived. As described above, an Australian DWG value is available for bromate.

VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES

Sodium bromate is not combustible but enhances combustion of other substances. It is a strong oxidizer. The substance gives off irritating or toxic fumes (or gases) in a fire. Further, there is a risk of fire and explosion on contact with combustible substances or reducing agents (PubChem).

VII. ENVIRONMENTAL HAZARD ASSESSMENT

A. Summary

There are limited environmental studies evaluating the ecotoxicological effects of sodium bromate. Based on read across using surrogate chemical potassium bromate, sodium bromate is of low acute and chronic toxicity concern to aquatic organisms.

B. Aquatic Toxicity

Acute Studies

Table 3 lists the results of acute aquatic toxicity studies conducted on potassium bromate.

Table 3: Acute Aquatic Toxicity Studies on Potassium Bromate

Test Species	Endpoint	Results (mg/L)	Klimisch Score	Reference
*Morone saxatillis (striped bass)**	96-hour-LC_{50}	30.8	2	ECHA
*Morone saxatillis (striped bass)***	48-hour LC_{50}	605.0	2	ECHA
Leiostomus xanthurus	24-hour-LC_{50}	698.0	2	ECHA
Daphnia magna	48-hour EC_{50}	>100	1	ECHA
Desmodesmus subpicatus	72-hour EC_{50}	>100	1	ECHA

*Newly hatched
**four-day old

Chronic Studies

Table 4 lists the results of chronic aquatic toxicity studies conducted on potassium bromate

Table 4: Chronic Aquatic Toxicity Studies on Potassium Bromate

Test Species	Endpoint	Results (mg/L)	Klimisch Score	Reference
Morone saxatillis (striped bass)	10-day LC_{50}	92.6	2	ECHA
Leiostomus xanthurus	10-day LC_{50}	278.6	2	ECHA
Desmodesmus subspicatus	72-hour NOEC	31.6	1	ECHA

C. Terrestrial Toxicity

There are no studies available.

D. Calculation of PNEC

The PNEC calculations for sodium bromate follow the methodology discussed in DEWHA (2009).

PNEC Water

Experimental results are available for three trophic level. Acute E(L)C_{50} values are available for fish (30.8 mg/L), invertebrates (>100), and algae (>100). Chronic LC_{50} values from long-term studies are available for two tropic levels including fish (92.6 mg/L) and algae (31.6). On the basis that the data consists of short-term results from three trophic levels and long-term results from two trophic levels, an assessment factor of 100 has been applied to the lowest reported E(L)C_{50} value of 30.8 mg/L for fish. The E(L)C_{50} value is used because the value for acute toxicity value fish is lower than the chronic values for this trophic level. The $PNEC_{water}$ is 0.308 mg/L.

PNEC Sediment

No experimental toxicity data on sediment organisms are available. Sodium bromate's environmental distribution is dominated by its high-water solubility. K_{oc} parameter do not readily apply to inorganics, such as sodium bromate. Thus, the equilibrium partitioning method cannot be used to calculate the $PNEC_{sediment}$. Based on its properties, no adsorption of sodium bromate to sediment is to be expected, and the assessment of this compartment will be covered by the aquatic assessment.

PNEC Soil

No experimental toxicity data on terrestrial organisms are available. The environmental distribution of sodium bromate is dominated by its water solubility. Sorption of sodium bromate should probably be regarded as a reversible situation, i.e., the substance is not tightly nor permanently bound. K_{oc} parameters do not readily apply to inorganics, such as sodium bromate. Thus, the equilibrium partitioning method cannot be used to calculate the $PNEC_{soil}$. Based on its properties, sodium bromate is not expected to significantly adsorb to soil, and the assessment of this compartment will be covered by the aquatic assessment.

VIII. PERSISTENCE, BIOACCUMULATION AND TOXICITY (PBT) ASSESSMENT

The methodology for the Persistent, Bioaccumulative and Toxic (PBT) substances assessment is based on the Australian and EU REACH Criteria methodology (DEWHA, 2009; ECHA, 2017).

Sodium bromate is an inorganic salt that will dissociate to sodium and bromate ions. Biodegradation is not applicable to this inorganic chemical. For the purpose of this PBT assessment, the persistent criteria are not considered applicable to this inorganic salt.

Sodium bromate is not expected to bioaccumulate because its dissociated species are inorganic ions. Thus, the substance does not meet the criteria for bioaccumulation.

There are no aquatic toxicity data on sodium bromate. The lowest NOEC from chronic aquatic toxicity studies on potassium bromate, a structural analogue, are >0.1 mg/L. The acute E(L)C_{50} values

from the acute aquatic toxicity studies on potassium bromate are > 1 mg/L. Thus, sodium bromate does not meet the criteria for toxicity.

The overall conclusion is that sodium bromate is not a PBT substance.

IX. CLASSIFICATION AND LABELLING

A. Classification

H272: May intensify fire; oxidiser

H302: Harmful if swallowed

H315: Causes skin irritation

H319: Causes serious eye irritation

H335: May cause respiratory irritation.

H351: Suspected of causing cancer

Acute toxicity-category 3

Carcinogenicity-category 1B

B. Labelling

Danger

A. Pictogram



X. HANDLING AND SAFETY INFORMATION (OCCUPATIONAL LIMITS AND TRANSPORTATION REQUIREMENTS)

A. First Aid

Please refer to the product SDS for additional information and confirmation of the information provided herein.

Eye Contact

In case of contact, immediately flush eyes with plenty of water for at least 15 minutes.

Skin Contact

Wash thoroughly with soap and water.

Inhalation

If inhaled, remove from area to fresh air. Get medical attention.

Ingestion

Rinse mouth with water and then drink a glass of water. Get medical attention. Never give anything by mouth to an unconscious person.

B. Fire Fighting Information

Extinguishing Media

Water spray, carbon dioxide, foam, dry chemical.

Specific Exposure Hazards

Keep product and empty container away from heat and sources of ignition. May emit toxic fumes under fire conditions. Depending on conditions, decomposition products may include the following: carbon monoxide, carbon dioxide.

Special Protective Equipment for Firefighters

Wear self-contained breathing apparatus.

C. Accidental Release Measures

Personal Precautions

Use personal protective clothing. Avoid dust formation. Ensure adequate ventilation. Do not breathe dust. Wear respiratory protection if ventilation is inadequate. Avoid contact with skin, eye, and clothing.

Environmental Precautions

Prevent from entering sewers, waterways, or low areas.

Steps to be Taken if Material is Released or Spilled

For large amounts: dike spillage and pump off product. For residues: pick up with suitable absorbent material. Dispose of contaminated material as prescribed.

D. Storage And Handling

General Handling

Keep product and empty container away from heat and sources of ignition. Ensure adequate ventilation, especially in confined areas.

Good general ventilation should be used. Ventilation rates should be matched to conditions. If applicable, use process enclosures, local exhaust ventilation, or other engineering controls to maintain airborne levels below recommended exposure limits

Storage

Keep container tightly closed and in a dry and well-ventilated place. Keep in a cool place.

E. Exposure Controls / Personal Protection

Occupational Exposure Standards

There are no workplace exposure standards established for sodium bromate in Australia.

Engineering Controls

Good general ventilation should be used.

Personal Protection Equipment

Respiratory Protection: Use respiratory protection when airborne concentrations are expected to be high.

Hand Protection: Chemical resistant protective gloves.

Skin Protection: Body protection must be chosen depending on activity and possible exposure.

Eye protection: Safety glasses with side-shields.

Other Precautions: Handle in accordance with good industrial hygiene and safety practice. Wearing of closed work clothing is recommended. Ensure that eyewash stations and safety showers are close to the workstation location.

F. Transport Information

The transport classification of sodium bromate is UN1494 class 51 II 02 (ECHA) [KI. score =2].

UN 1494

Class: 5.1

Packaging Group: II

XI. DISPOSAL MANAGMENT

Disposal should be in accordance with all local, state, and federal regulations.

XII. REGULATORY STATUS

Australian AICS Inventory: Listed.

XIII. REFERENCES

ADWG. (2011). National Water Quality Management Strategy. Australian Drinking Water Guidelines, Section 6, Australian Government, National Health and Medical Research Council, Natural Resource Management Ministerial Council. Updated January 2022. Available: https://www.nhmrc.gov.au/about-us/publications/australian-drinking-water-guidelines

Cosmetic ingredient review (CIR). Final Report on the safety assessment of sodium bromate and potassium bromate. Available at: Final Report on the Safety Assessment of Sodium Bromate and Potassium Bromate (sagepub.com)

Department of the Environment, Water, Heritage and the Arts [DEWHA]. (2009). Environmental risk assessment guidance manual for industrial chemicals, Department of the Environment, Water, Heritage and the Arts, Commonwealth of Australia. Available: http://www.nepc.gov.au/resource/chemical-risk-assessment-guidance-manuals

Department of the Environment and Energy [DoEE]. (2017). Chemical Risk Assessment Guidance Manual: for chemicals associated with coal seam gas extraction, Guidance manual prepared by Hydrobiology and ToxConsult Pty Ltd for the Department of the Environment and Energy, Commonwealth of Australia, Canberra. Available: www.environment.gov.au/water/coal-and-coal-seam-gas/national-assessment-chemicals/consultation-risk-assessment-guidance-manual

ECHA. ECHA REACH database: http://echa.europa.eu/information-on-chemicals/registered-substances

enHealth Human Risk Assessment [HHRA]. (2012). Environmental Health Risk Assessment, Guidelines for Assessing Human Health Risks from Environmental Hazards. Office of Health Protection of the Australian Government Department of Health. Available: https://www1.health.gov.au/internet/main/publishing.nsf/Content/health-pubhlth-publicat-environ.htm

European Chemicals Agency [ECHA]. (2017). Guidance on Information Requirements and Chemical Safety Assessment, Chapter R11: PBT Assessment, European Chemicals Agency, Helsinki, Finland. Available: https://echa.europa.eu/guidance-documents/guidance-on-information-requirements-and-chemical-safety-assessment

Klimisch, H.J., Andreae, M., and Tillmann, U. (1997). A systematic approach for evaluating the quality of experimental and toxicological and ecotoxicological data. Regul. Toxicol. Pharmacol. 25:1-5.

National Industrial Chemical Notification and Assessment Scheme Inventory [NICNAS] Multi-tiered Assessment and Prioritisation (IMAP) framework (2020). Available at: Bromates_Human health tier II assessment.pdf (industrialchemicals.gov.au)

SODIUM ERYTHORBATE

This dossier on sodium erythorbate presents the most critical studies pertinent to the risk assessment of sodium erythorbate in its use in coal seam or shale gas extraction activities. This dossier does not represent an exhaustive or critical review of all available data. The majority of information presented in this dossier was obtained from the ECHA database that provides information on chemicals that have been registered under the EU REACH (ECHA). Where possible, study quality was evaluated using the Klimisch scoring system (Klimisch et al., 1997).

I. SUBSTANCE IDENTIFICATION

Chemical Name (IUPAC): sodium;(2R)-2-[(1R)-1,2-dihydroxyethyl]-4-hydroxy-5-oxo-2H-furan-3-olate

CAS RN: 6381-77-7

Molecular formula: $C_6H_7NaO_6$

Molecular weight: 198.11 g/mol

Synonyms: D-araboascorbic acid, erythorbic acid, erythroascorbic acid, isoascorbic acid, isoascorbic acid, disodium salt, isoascorbic acid, monosodium salt, isoascorbic acid, sodium salt, 2,3-didehydro-3-O-sodio-D-erythro-hexono-1,4-lactone.

SMILES: C(C(C1C(=C(C(=O)O1)O)[O-])O)O.[Na+]

II. PHYSICO-CHEMICAL PROPERTIES

Table 1: Overview of the Physico-chemical Properties of Sodium Erythorbate

Property	Value	Klimisch Score	Reference
Physical state at 20°C and 101.3 kPa	Crystalline, odourless solid	2	ECHA
Melting Point	>160°C (decomposes at 180°C) @ 101.3 kPa	2	ECHA
Boiling Point	-	-	-
Density	1702 kg/m^3 @ 20°C	2	ECHA
Vapor Pressure	0 Pa at 25°C	2	ECHA
Partition Coefficient (log K_{ow})	-3.29 (estimated) @ 25°C	2	ECHA
Water Solubility	146 g/L at 20°C	1	ECHA
Flash Point[a]	Study scientifically not necessary	-	ECHA
Auto flammability[a]	Study scientifically not necessary	-	ECHA
Flammablility[a]	Non-flammable	2	ECHA
Viscosity	As solid, study scientifically not necessary	-	ECHA
Henry's Law Constant	Not available	-	-

a - The substance has no pyrophoric properties and does not liberate flammable gases on contact with water. It is not highly flammable solid derived from preliminary screening test result of flammable solids.

III. ENVIRONMENTAL FATE PROPERTIES

A. Summary

Sodium erythorbate is highly soluble in water and it has a low potential to bind to soil or sediment. It is ultimately biodegradable. Sodium erythorbate is not expected to bioaccumulate.

B. Biodegradation

In an OECD 301E compliant test, the degradation after the 28-day plateau was not yet visible in the degradation curve. The DOC elimination was 56% after 28 days. Thus, the substance can't be considered as readily degradable. However, under strict test conditions, the substance appears to be ultimately biodegradable (under the subclassification of inherent biodegradability) (ECHA) [Kl. score = 2].

If a chemical is found to be readily or inherently biodegradable, it is categorized as Not Persistent since its half-life is substantially less than 60 days.

C. Environmental Distribution

No experimental data are available for sodium erythorbate. Based on its log K_{ow} and high-water solubility values, if released to the soil, sodium erythorbate is expected to have a low potential for adsorption and a high potential for mobility. If released to water, it is likely to remain in water and it is not expected to adsorb to sediment.

D. Bioaccumulation

There are no bioaccumulation studies available for sodium erythorbate. The bioconcentration factor (BCF) was estimated to be 0.8933 based on the Arnot-Gobas method (for the upper trophic level) (USEPA, 2020). Based on the estimated BCF and the low log K_{ow} value of – 3.29, bioaccumulation is not expected.

IV. HUMAN HEALTH HAZARD ASSESSMENT

A. Summary

Sodium erythorbate is absorbed orally and dermally. However, the acute toxicity of sodium erythorbate is low by oral and dermal routes of exposure. Sodium erythorbate is not irritating to the eyes or the skin and it is not a skin sensitizer. Sodium erythorbate is not genotoxic or carcinogenic. There is no evidence to suggest that sodium erythorbate elicits reproductive toxicity or developmental toxicity.

B. Pharmacokinetics/Metabolism

<u>Absorption - Oral</u>

In accordance with the ECHA Guidance on Information Requirements and Chemical Safety Assessment, Chapter R.7C Section R.7.12 (Endpoint Specific Guidance; ECHA, 2008), the physico-chemical properties can provide an insight into the potential behaviour of 2,3-didehydro-3-O-sodio-D-erythro-hexono-1,4-lactone in the body.

The molecular weight (199.12 g/mol) and water solubility of 146 g/L at 20°C are favourable for oral absorption of 2,3-didehydro-3-O-sodio-D-erythro-hexono-1,4-lactone. The log P of -3.29 (estimated) suggests that 2,3-didehydro-3-O-sodio-D-erythro-hexono-1,4-lactone is considerably hydrophilic and is not in the favourable range for passive diffusion (log P: -1 to 4) or absorption via the lymphatic system (log >5). As 2,3-didehydro-3-O-sodio-D-erythro-hexono-1,4-lactone is very hydrophilic and the molecular weight is <200 g/mol, it may pass through aqueous pore, be carried through the epithelial barrier by the bulk passage of water, or an active transport mechanism may be involved (ECHA).

Absorption – Dermal

The molecular weight of 199.12 g/mol is above the range for favourable dermal absorption (<100 g/mol). The water solubility of 149 g/L at 20°C and poor lipophilicity (log P of -3.29, estimated) indicate that 2,3-didehydro-3-O-sodio-D-erythro-hexono-1,4-lactone is likely to be too hydrophilic to cross the stratum corneum, therefore dermal absorption is likely to be low (ECHA).

Absorption – Inhalation

The particle size distribution report for 2,3-didehydro-3-O-sodio-D-erythro-hexono-1,4-lactone indicates ranges from 4.365 µm - 1096.478 µm. The % of particles available in the inhalable fractions of air (<100 µm) is likely to be negligible. Based on the molecular weight (199.12 g/mol), water solubility (149 g/L) and particle size, 2,3-didehydro-3-O-sodio-D-erythro-hexono-1,4-lactone may readily diffuse/dissolve into the mucus lining of the respiratory tract. As it is very hydrophilic (log P: -3.29) it may be absorbed through aqueous pores (molecular weight <200 g/mol) or be retained in the mucus and transported out of the respiratory tract. Therefore, there is potential for absorption via the inhalation route (ECHA).

Distribution/Metabolism/Excretion

The molecular weight (199.12 g/mol) and water solubility (149 g/L at 20°C) of 2,3-didehydro-3-O-sodio-D-erythro-hexono-1,4-lactone are favourable for wide distribution, but the very low log P (-3.29, estimated) indicates it is not likely to accumulate in fat during intermittent exposure (ECHA).

In a dietary study, 3-didehydro-3-O-sodio-D-erythro-hexono-1,4-lactone was administered to Male F344 rats (five per group) at dose levels of 5% for 22 weeks. The rats eliminated totals of 203.3 ± 33.2 mg/100 mL erythorbic acid and 9.0 ± 5.1 mg/100 mL dehydroerythorbic acid during the study. Ascorbic acid and dehydroascorbic acid were not detected. Urine pH was 6.98 ±0.31, which was significantly different from that of rats given basal diet alone (6.31 ± 0.18; $p < 0.05$). Urine osmolarity also differed significantly from controls; osmolarity was 1378 ± 277 mOsmol/kg H20 in rats given Sodium Erythorbate and 1756 ± 200 mOsmol/kg H20 in rats of the control group. Crystals were detected in urine of rats given basal diet and sodium erythorbate or basal diet alone. This study indicated that erythorbic acid is the major metabolite and dehydroerythorbic acid is the minor metabolite of 3-didehydro-3-O-sodio-D-erythro-hexono-1,4-lactone and it is expected to be excreted in the urine (ECHA).

Based upon the molecular weight of 199.12 g/mol and water solubility of 149 g/L at 20°C, it is likely that 2,3-didehydro-3-O-sodio-D-erythro-hexono-1,4-lactone is excreted mainly in the urine (ECHA).

C. Acute Toxicity

Oral

Ten fasted albino rats were administered 5,000 mg/kg of sodium erythorbate in a 50% aqueous suspension. Clinical observations were noted at 3, 5, and 24 hrs. post-dosing using an unspecified standard acute toxicity test. The treated rats had soft, pasty stools within 3 hours of dosing, followed in 2 hours by marked diarrhea that persisted for 24 hrs. The LD_{50} was determined to be > 5,000 mg/kg bw (ECHA) [Kl. score=2].

Inhalation

There are no inhalation toxicity studies available.

Dermal

Sodium erythorbate (2,000 mg/kg) was applied to the intact and abraded skin of six rabbits. Each test site was moistened with physiological saline just prior to dosing. After application of the test material, the exposure area was covered with a double layer of surgical gauze and a piece of rubber dam (occlusive dressing). The trunk of each rabbit was wrapped in a stockinette, which was secured to the body with tape. The dressings were removed after 24 hours, and the amount of residual sample and signs of localized irritation were noted. The exposure area was cleaned by thorough wiping, and the rabbits were observed for signs of toxicity for signs of toxicity for 48 hours, 72 hours, and 14 days.

The behaviour, body weight gain, and consumption of feed and water were normal for all of the animals, and no signs of toxicity were observed. No erythema, oedema, or other signs of dermal irritation were observed at five of six test sites. One rabbit (abraded skin) had slight (1+) erythema at 24 hours that cleared by 48 hours.

The dermal LD_{50} was determined to be > 2000 mg/kg bw (ECHA)[Kl. score=2].

D. Irritation

Skin

Sodium erythorbate powder (2,000 mg/kg) was applied to the intact and abraded skin of six albino rabbits. Each test site was moistened with physiological saline just prior to dosing. After application of the test material, the exposure area was covered with a double layer of surgical gauze and a piece of rubber dam. The trunk of each rabbit was wrapped in a stockinette, which was secured to the body with tape. The dressings were removed after 24 hours, and the amount of residual sample and signs of localized irritation were noted. The exposure area was cleaned by thorough wiping, and the rabbits were observed for signs of toxicity for 48 hours, 72 hours, and 14 days.

No erythema, oedema, or other signs of dermal irritation were observed at five of six test sites. One rabbit (abraded skin) had slight erythema at 24 hours that cleared by 48 hours. In this study, sodium erythorbate is not a dermal irritant (ECHA) [Kl. score=2].

Eye

Sodium erythorbate powder (100 mg) was instilled into the conjunctival sac of albino rabbits (10 male and 2 female). The eyes of half of the treated rabbits were rinsed after 5 seconds and the

rabbits were observed for two days. The reactions were compared between rinsed and unrinsed eyes and the following irritation parameters were noted: iris, conjunctival redness. The reactions were comparable in rinsed and unrinsed eyes and were slight and transient in nature.

One hour after dosing, two of six unrinsed eyes had congestion of the iris, but the iris reacted normally to light. Varying degrees of redness were observed in the lids of all unrinsed eyes. Slight redness of the nictitating membrane or palpebral conjunctiva at the medial canthus was observed in two unrinsed eyes.

At one hour, 1+ iritis was observed in one rinsed eye. Five of six rinsed eyes had slight redness that was limited to only the nictitating membrane in three cases. At 24 hours, all eyes were normal, with the exception of one that had slight reddening of the conjunctiva at the medial canthus. All eyes, rinsed and unrinsed, were normal at 48 hours.

The mean ocular irritation scores after 48 hours (2 days) were 0.33/110 (unrinsed eyes) and 0.17/110 (rinsed eyes). Therefore, in this study, sodium erythorbate is not an eye irritant (ECHA) [Kl. score=2].

E. Sensitisation

An OECD Guideline 429 (Skin Sensitization: Local Lymph Node Assay) was performed.

In the dermal sensitisation study with sodium erythorbate (5, 10, 25% w/w in propylene glycol), young adult female CBA/Ca (CBA/CaOlaHsd) mice (4/group) were tested using the local lymph node assay (LLNA). The reliability of the test system was confirmed by the most recent positive control assay (Phenylacetaldehyde [>90%] in propylene glycol; January 2013).

There was no mortality and all animals appeared normal throughout the study. There were no statistically significant differences observed between any treatment groups with respect to body weight. Treatment with sodium erythorbate at 5, 10, or 25% (w/w) resulted in stimulation indices (SI) of 1.13, 0.91, and 1.29 respectively.

In this study, sodium erythorbate is not a potential skin sensitiser (ECHA) [Kl. score=1].

F. Combined Repeated Dose and Carcinogenicity Evaluation

<u>Oral</u>

A combined repeated dose and carcinogenicity study was conducted (Inai et. al. 1989; as cited in ECHA) [KI. score = 2].

In a preliminary test male and female B6C3F1 mice (10 per sex per group) were given drinking water containing 0.625%, 1.25%, 2.5%, 5.0%, or 10% sodium erythrobate for 10 weeks. Water and feed were available ad libitum. The untreated control group consisted of 20 male and 20 female mice. Mortality, bodyweight gain, gross pathology, and histopathology were noted (ECHA).

In the main test, sodium erythorbate was administered in drinking water to male B6C3F1 mice at concentrations of 1.25% and 2.5%. Female mice received 2.5% and 5% (maximum tolerated dose [MTD]). Each group contained 50 mice. Treatment continued for 96 weeks; the study was terminated at week 110. Feed and water were available ad libitum. Mortality, body weight, organ weights and neoplastic histopathology were noted.

In the preliminary study, six male mice and one female mouse of the 10% dosing group had died by the end of week 1. In male mice given 5.0% sodium erythrobate, the average weekly body weight gain was slightly less than 90% that of the control female mice. Body weight gain was increased in female mice given sodium erythrobate at a concentration of 5.0%, compared to that of control mice. No significant changes were observed in the visceral organs of untreated mice or mice given the dose less than or equal to the MTD of sodium erythrobate. Mice given doses greater than the MTD had marked atrophy of both hepatocytes and splenic lymphoid follicles, as well as hydropic degeneration of the renal tubular epithelium. The MTD of sodium erythrobate in drinking water was 2.5% (25,000 mg/L) for male mice (2,400 mg/kg-day)[1] and 5.0% (50,000 mg/L) for female mice (2456 mg/kg -day)[1], respectively.

In the main study, the average body weights of the treated mice were similar to controls. Of the male mice (without tumours) that survived beyond week 43, dose-dependent reductions in the heart and brain weights were observed. The weights of the heart, lungs, kidneys, and brain of female mice (without tumours) were significantly different between the high dose group and the control group. At the doses tested, there was not a treatment-related increase in tumour incidence when compared to controls. Overall, tumour incidence, time to death with tumours, and the distribution of tumours in treated mice did not differ significantly from mice of the control group. The data from the main study indicates that sodium erythrobate is not a carcinogen under the conditions of the study (ECHA) [Kl Score=2].

For the purposes of this dossier, the MTD of 2,400 mg/kg-day for male mice was considered the NOAEL.

In a repeated dose and carcinogenicity study, sodium erythorbate was administered to 10 Fischer 344/DuCrj rats/sex/dose in water at dose levels of 0, 0.625, 1.25, 2.5, 5 and 10% for 13 weeks (preliminary study) and then to 52 male/50 female Fischer 344/DuCrj rats in water at dose levels of 1.25 and 2.5% for 104 weeks (main study) (ECHA)[KI. score =2].

In the preliminary study, all the rats given the 10% solution refused to drink and died in 2 to 5 weeks. Three males and one female out of the 10 given the 5% solution died during the first 4 days. All the rats given the 2.5% and lower concentrations survived to the end of 13 weeks. The 2.5% solution suppressed body weight gains by 12% in males and by 6% in females as compared with nontreated controls.

In the main study, body weight gain was normal in low dose group rats and was reduced by 8.5% for males and 15.5% for females at weeks 88 and 85, respectively in rats given 2.5% sodium erythorbate. At the doses tested, there was not a treatment related increase in tumour incidence when compared to controls. The pattern of occurrence of the various types of tumours was similar among the groups. A NOAEL was not established for this study (ECHA)[KI. score =2].

Spontaneous testicular interstitial-cell tumours, endometrial stromal polyps, mammary fibroadenomas, adrenal pheochromocytomas, and other endocrine tumours in control rats showed a pattern of incidence similar to that of earlier reports by others. The incidence of leukemias in female controls, however, was higher at 37.8% than in prior studies by others, (9.9%, 11.0% and 21.9%). The authors had no specific explanation for the difference (ECHA)[KI. score =2].

[1] NTP 2009. Converted using mean mouse water ingestion rates and body weights at 53-101 week old animals Tables J3 and J from NTP 2009. NTP TECHNICAL REPORT ON THE TOXICOLOGY AND CARCINOGENESIS STUDIES OF BROMOCHLOROACETIC ACID (CAS NO. 5589-96-8) IN F344/N RATS AND B6C3F1 MICE (DRINKING WATER STUDIES) NATIONAL TOXICOLOGY PROGRAM Research Triangle Park, NC 27709 NTP TR 549 NIH Publication No. 09-5890

Inhalation

There are no repeat dose inhalation data available.

Dermal

There are no repeat dose dermal data available.

G. Genotoxicity

In vitro Studies

Table 2 presents the results of the *in vitro* genotoxicity studies on sodium erythorbate.

Table 2: *In vitro* Genotoxicity Studies on sodium erythorbate

Test System	Results*		Klimisch Score	Reference
	-S9	+S9		
Chromosomal aberration Chinese hamster lung (CHL))	-	-	2	Matsuoka et al 1979. Andersen 1999. (as cited in ECHA).
Bacterial Reverse Mutation Assay (S. typhimurium TA 1535, TA 1537, TA 98, TA 100, TA 92, and TA 94)	-	-	2	ECHA

*+, positive; -, negative; NA, not applicable

In vivo Studies

A chromosome aberration (rodent dominant lethal assay) was performed (Jorgenson et. al. 1978; as cited in ECHA). Proven breeder male rats were distributed into groups of 10 each. Treatments were by oral gavage as a single dose and with 5 consecutive daily doses; 3 dosage levels were used for each regimen. Untreated reference controls and positive controls receiving a single intraperitoneal injection of triethylenemelamine were used with each compound studied. Following treatment, each single-dose male was mated to two adult females weekly for 8 weeks; each multiple-dosed male was mated to two adult females weekly for 7 weeks.

The positive control induced the appropriate mutagenic response. No consistent responses occurred to suggest that sodium erythorbate was not mutagenic to the rat by the dominant lethal procedure (ECHA) [Kl. score = 2].

Male and female mice were treated with two dose levels of sodium erythorbate for seven weeks in a chromosome aberration (mouse heritable translocation assay). The positive control (triethylenemelamine) induced the appropriate response (positive translocations). Cytogenetic examinations were made on meiotic cells from the males considered as the presumptive positives following two successive breeding. All the breeding data were evaluated and correlated with the cytogenetic examinations. There were no positive reciprocal translocations observed in the control and sodium erythorbate treated groups. Sodium erythorbate did not induce heritable translocation heterozygosity.

H. Carcinogenicity

See combined repeated dose and carcinogenicity study above (Section F).

I. Reproductive Toxicity

There are no specific reproductive toxicity studies have been conducted on sodium erythorbate by any route of exposure.

J. Developmental Toxicity

Oral

An OECD Guideline 414 (Prenatal Developmental Toxicity) study was performed in Wistar rats. (Andersen 1999; as cited in ECHA) [KI. score =2]. The female rats were mated with young adult males and observation of the vaginal sperm plug was considered Day 0 of gestation. (One male was not permitted to impregnate more than one female per group). Pregnant females were dosed orally in a water carrier via oral gavage at doses of 9.0, 41.8, 194.0, or 900.0 mg/kg bw/day of sodium erythorbate on days 6-15 of gestation. All dams were subjected to caesarean section on day 20.

The number of animals for each dosage group were as follows.

- Positive control: 22 animals
- 0, 900 mg/kg bw/day: 24 animals
- 9, 41.8 mg/kg bw/day: 20 animals
- 194 mg/kg bw/day: 21 animals

Maternal Effects: No statistically significant differences were observed in number of pregnancies, corpus lutea, implantation rates, live births, resorptions, dams with >1 site resorbed, dams with all sites resorbed, % partial resorptions, complete resorptions, number live foetuses (average/dam) between treated and control groups. The NOAEL for maternal effects was determined to be 900 mg/kg bw/day (ECHA) [KI. score =2].

Foetal Effects: No statistically significant differences in average foetus weight or number of live foetuses examined at term in rats of the negative control group or in rats given sodium erythorbate. No gross, skeletal or soft tissue morphological abnormalities were observed in rats of the negative control group or in rats given sodium erythorbate. The NOAEL for developmental effects was determined to be 900 mg/kg bw/day (ECHA) [KI. score= 2].

In a developmental toxicity study, sodium erythorbate was administered to CD-1 mice by oral gavage at dose levels of 0, 10.3, 47.8, 221.9, 1030 mg/kg bw/day from day 6-15 of gestation. All of the dams were subjected to caesarean section on gestation day 17). There were no deaths or premature deliveries recorded in this study. The highest dose tested (1030 mg/kg bw/day) did not produce any discernible effects on maternal or foetal survival. Therefore, the NOAEL for maternal toxicity was determined to be 1030 mg/kg bw/day.

One pup of a dam from the positive control group developed exophthalmos, encephalomeningocele, and gastroschisis. A cleft palate was also observed in one of the pups from the group treated with 1030 mg/kg bw/day of sodium erythorbate. The number of abnormalities observed in either soft or skeletal tissues of the mice treated with sodium erythorbate did not differ from the number of spontaneously occurring abnormalities in the sham treated controls. Therefore, the NOAEL for developmental toxicity was determined to be 1030 mg/kg bw/day (ECHA) [KI. score= 2].

V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES

The toxicological reference values developed for sodium erythorbate follow the methodology discussed in enHealth (2012). The approach used to develop drinking water guidance values is described in the Australian Drinking Water Guidelines (ADWG, 2011).

A. Non-Cancer

Oral

A prenatal developmental toxicity study discussed in Section J provided the basis for the NOAEL of 900 mg/kg bw/day in rats. The NOAEL of 900 mg/kg bw/day will be used for determining the oral reference dose (RfD) and the drinking water guidance value.

Oral Reference Dose (oral RfD)

Oral RfD = NOAEL / (UF_A x UF_H x UF_L x UF_{Sub} x UF_D)

Where:
UF_A (interspecies variability) = 10
UF_H (intraspecies variability) = 10
UF_L (LOAEL to NOAEL) = 1
UF_{Sub} (subchronic to chronic) = 10
UF_D (database uncertainty) = 1

Oral RfD = 900/1000 = 0.9 mg/kg-day

Drinking water guidance value

Drinking water guidance value = (animal dose) x (human weight) x (proportion of intake from water) / (volume of water consumed) x (safety factor)

Using the oral RfD,
Drinking water guidance value = (oral RfD) x (human weight) x (proportion of water consumed) / (volume of water consumed)

Where:
Human weight = 70 kg (ADWG, 2011)
Proportion of water consumed = 10% (ADWG, 2011)
Volume of water consumed = 2L (ADWG, 2011)

Drinking water guidance value = (0.9 x 70 x 0.1)/2 = 3.15 mg/L

B. Cancer

Sodium erythorbate was not carcinogenic to mice in a combined repeated dose and carcinogenicity study (Inai et. al 1989; as cited in ECHA). Thus, a cancer reference value for sodium erythorbate was not derived.

VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES

Sodium erythorbate does not exhibit the following physico-chemical properties:

- Explosivity
- Flammability
- Oxidising potential

VII. ENVIRONMENTAL HAZARD ASSESSMENT

A. Summary

Sodium erythorbate exhibits low acute toxicity to aquatic organisms.

B. Aquatic Toxicity

Acute Studies

Table 3 lists the results of acute aquatic toxicity studies on sodium erythorbate.

Table 3: Acute Aquatic Toxicity Studies on Sodium erythorbate

Test Species	Endpoint	Results (mg/L)	Klimisch Score	Reference
Oncorhynchus mykiss	96-h LC_{50}	>100	1	ECHA
Daphnia magna	48-h EC_{50}	>100	1	ECHA
Raphidocelis subcapitata	72-h EC_{50}	>160	1	ECHA

Chronic Studies

There are no chronic aquatic toxicity studies for fish and invertebrates. However, there is a 72-hour NOEC value of 20 mg/L reported for *Raphidocelis subcapitata* (previous names: *Pseudokirchneriella subcapitata, Selenastrum capricornutum*). (ECHA) [Kl. score = 1].

C. Terrestrial Toxicity

There are no terrestrial toxicity data available for sodium erythorbate.

D. Calculation of PNEC

The PNEC calculations for sodium erythorbate follow the methodology discussed in DEWHA (2009).

PNEC Water

Experimental results are available for three trophic levels. Acute E (L)C_{50} values are available for fish (>100 mg/L), Daphnia (>100 mg/L), and algae (>160 mg/L) . A chronic NOEC value is also available for algae (20 mg/L). On the basis that the data consists of short-term results from three trophic levels and long-term results from one trophic level, an assessment factor of 100 has been applied to the NOEC of 20 mg/L for algae. The $PNEC_{water}$ is 0.2 mg/L.

PNEC Sediment

There are no toxicity data for sediment-dwelling organisms. Moreover, the substance is not expected to substantially partition to sediments. Nonetheless, a $PNEC_{sed}$ was calculated using the equilibrium partitioning method. The $PNEC_{sed}$ is 0.16 mg/kg sediment wet weight.

The calculations are as follows:

$PNEC_{sed} = (K_{sed\text{-}water}/BD_{sed}) \times 1000 \times PNEC_{water}$
$= 0.922/1280 \times 1000 \times 0.2$
$= 0.155$ mg/kg

Where:
$K_{sed\text{-}water}$ = suspended matter-water partition coefficient (m^3/m^3)
BD_{sed} = bulk density of sediment (kg/m^3) = 1,280 [default]

$K_{sed\text{-}water} = 0.8 + [(0.2 \times Kp_{sed})/1000 \times BD_{solid}]$
$= 0.8 + [(0.2 \times 0.4/1000 \times 2400]$
$= 0.992\ m^3/m^3$

Where:
Kp_{sed} = solid-water partition coefficient (L/kg).
BD_{solid} = bulk density of the solid phase (kg/m^3) = 2,400 [default]

$Kp_{sed} = K_{oc} \times f_{oc}$
$= 10 \times 0.04$
$= 0.4$ L/kg

Where:
K_{oc} = organic carbon normalized distribution coefficient (L/kg). The K_{oc} was calculated using EPISUITE via the molecular connectivity index (MCI) method to be 10 L/kg (USEPA, 2020).
f_{oc} = fraction of organic carbon in sediment = 0.04 [default].

PNEC Soil

There are no toxicity data for terrestrial or soil organisms. Therefore, the $PNEC_{soil}$ was calculated using the equilibrium partitioning method. The $PNEC_{soil}$ is 0.027 mg/kg soil dry weight.

The calculations are as follows:

$PNEC_{soil} = (Kp_{soil}/BD_{soil}) \times 1000 \times PNEC_{water}$
$= (0.2/1500) \times 1000 \times 0.2$
$= 0.0267$ mg/kg soil dry weight

Where:
Kp_{soil} = soil-water partition coefficient (m^3/m^3)
BD_{soil} = bulk density of soil (kg/m^3) = 1,500 [default]

$Kp_{soil} = K_{oc} \times f_{oc}$
$= 10 \times 0.02$

= 0.2 m^3/m^3

Where:
K_{oc} = organic carbon normalised distribution coefficient (L/kg). The K_{oc} was calculated using EPISUITE via the MCI method to be 10 L/kg (USEPA, 2020).
f_{oc} = fraction of organic carbon in soil = 0.02 [default].

VIII. PERSISTENCE, BIOACCUMULATION AND TOXICITY (PBT) ASSESSMENT

The methodology for the Persistent, Bioaccumulative and Toxic (PBT) substances assessment is based on the Australian and EU REACH Criteria methodology (DEWHA, 2009; ECHA, 2017).

Sodium erythorbate is ultimately biodegradable; thus, it does not meet the screening criteria for persistence.

Based on a log K_{ow} value of – 3.29, sodium erythorbate does not meet the criteria for bioaccumulation.

The lowest chronic NOEC value for sodium erythorbate is >0.1 mg/L. The $E(L)C_{50}$ values from acute aquatic toxicity studies on sodium erythorbate are >1 mg/L. Thus, this substance does not meet the screening criteria for toxicity.

Therefore, sodium erythorbate is not a PBT substance.

IX. CLASSIFICATION AND LABELLING

A. Classification

Not classified

B. Labelling

No label

C. Pictogram

None

X. HANDLING AND SAFETY INFORMATION (OCCUPATIONAL LIMITS AND TRANSPORTATION REQUIREMENTS)

A. First Aid

Eye Contact

Immediately flush open eyes with plenty of water for at least 15 minutes. Remove contacts, if present and easy to do. Get medical attention immediately, preferably a physician for an ophthalmologic examination.

Skin Contact

Remove contaminated clothing. Wash thoroughly with soap and water.

Inhalation

If inhaled, remove from area to fresh air. Give artificial respiration if victim is not breathing. Get medical attention.

Ingestion

Rinse mouth with water and then drink plenty of water. Get medical attention. Never give anything by mouth to an unconscious person.

B. Fire Fighting Information

Extinguishing Media

Water spray, carbon dioxide, foam, dry chemical.

Specific Exposure Hazards

Keep product and empty container away from heat and sources of ignition. May emit toxic fumes under fire conditions. Depending on conditions, decomposition products may include the following: nitrogen oxides, carbon monoxide, carbon dioxide.

Special Protective Equipment for Firefighters

Wear self-contained breathing apparatus and chemical-protective clothing.

C. Accidental Release Measures

Personal Precautions

Use appropriate protective equipment. Handle in accordance with good industrial hygiene and safety practice. Avoid contact with skin, eyes, and clothing.

Environmental Precautions

Prevent from entering sewers, waterways, or low areas.

Steps to be Taken if Material is Released or Spilled

For large amounts: dike spillage and pump off product. For residues: pick up with suitable absorbent material. Dispose of contaminated material as prescribed.

D. Storage and Handling

General Handling

Keep product and empty container away from heat and sources of ignition. Ensure adequate ventilation, especially in confined areas.

Storage

Keep container tightly closed and in a dry and well-ventilated place. Keep in a cool place.

E. Exposure Controls / Personal Protection

Occupational Exposure Standards

Workplace Australia has not established an occupational exposure standard for sodium erythorbate.

Engineering Controls

Good general ventilation should be used.

Personal Protection Equipment

Respiratory Protection:

Use respiratory protection in case of vapor or aerosol release.

Hand Protection:
Chemical resistant protective gloves.

Skin Protection:

Body protection must be chosen depending on activity and possible exposure.

Eye protection:
Safety glasses with side-shields.

Other Precautions:
Handle in accordance with good industrial hygiene and safety practice. Wearing of closed work clothing is recommended. Ensure that eyewash stations and safety showers are close to the workstation location.

F. Transport Information

Sodium erythorbate is not considered hazardous for purposes of transportation by road or rail. An Australian Dangerous Goods code is not required.

XI. DISPOSAL MANAGEMENT

Disposal should be in accordance with all local, state, and federal regulations.

XII. REGULATORY STATUS

Australian AICS Inventory: Listed.

XIII. REFERENCES

ADWG. (2011). National Water Quality Management Strategy. Australian Drinking Water Guidelines, Section 6, Australian Government, National Health and Medical Research Council, Natural Resource Management Ministerial Council. Updated January 2022. Available: https://www.nhmrc.gov.au/about-us/publications/australian-drinking-water-guidelines

Andersen, F. Alan. Cosmetic Ingredient Expert Review Panel. (1999). Final Report on the Safety Assessment of Ascorbyl Palmitate, Ascorbyl Dipalmitate, Ascorbyl Stearate, Erythorbic Acid, and sodium Erythorbate. Journal of Toxicology 1999 18 (suppl. 3): 1-26

Department of the Environment, Water, Heritage and the Arts [DEWHA]. (2009). Environmental risk assessment guidance manual for industrial chemicals, Department of the Environment, Water, Heritage and the Arts, Commonwealth of Australia. Available: http://www.nepc.gov.au/resource/chemical-risk-assessment-guidance-manuals

Department of the Environment and Energy (DoEE). (2017). Chemical Risk Assessment Guidance Manual: for chemicals associated with coal seam gas extraction, Guidance manual prepared by Hydrobiology and ToxConsult Pty Ltd for the Department of the Environment and Energy, Commonwealth of Australia, Canberra. Available: www.environment.gov.au/water/coal-and-coal-seam-gas/national-assessment-chemicals/consultation-risk-assessment-guidance-manual

ECHA. ECHA REACH database: http://echa.europa.eu/information-on-chemicals/registered-substances

ECHA. (2017). Guidance on Information Requirements and Chemical Safety Assessment, Chapter R11: PBT Assessment, European Chemicals Agency, Helsinki, Finland. Available: https://echa.europa.eu/guidance-documents/guidance-on-information-requirements-and-chemical-safety-assessment

ECHA (2008). Guidance on Information Requirements and Chemical Safety Assessment, Chapter R.7C Section R.7.12 Endpoint Specific Guidance, European Chemicals agency, Helsinki, Finland.

enHealth Human Risk Assessment [HHRA] (2012). Environmental Health Risk Assessment, Guidelines for Assessing Human Health Risks from Environmental Hazards. Office of Health Protection of the Australian Government Department of Health. Available: https://www1.health.gov.au/internet/main/publishing.nsf/Content/health-pubhlth-publicat-environ.htm

Inai K, Akamizu H, Eto R, Nishida T, Ohe K, Kobuke T, Nambu S, Matsuki K, Tokuoka S. (1989). Tumorigenicity study of sodium erythorbate administered orally to mice. Hiroshima J Med Sci. Sep;38(3):135-9.

Jorgenson, T. A., C. J. Rushbrook, G. W. Newell, and S. Green. (1978). Study of the mutagenic potential of three GRAS chemicals in mice by the heritable translocation test. Mutat. Res. 53:125.

Klimisch, H.J., Andreae, M., and Tillmann, U. (1997). A systematic approach for evaluating the quality of experimental and toxicological and ecotoxicological data. Regul. Toxicol. Pharmacol. 25:1-5.

Matsuoka, A., M. Hayashi, and M. Ishidate, Jr. (1979). Chromosomal aberration tests on 29 chemicals combined with S9 mix in vitro. Mutat. Res. 66:277- 290

USEPA 2020. Estimation Programs Interface Suite™ for Microsoft® Windows, v 4.11. United States Environmental Protection Agency, Washington, DC, USA.

SODIUM GLUCONATE

This dossier on sodium gluconate presents the most critical studies pertinent to the risk assessment of this substance in its use in coal seam and shale gas extraction activities. This dossier does not represent an exhaustive or critical review of all available data. The majority of information presented in this dossier was obtained from Organization for Economic Cooperation and Development Screening Information Dataset (OECD SIDS) (OECD, 2004). Where possible, study quality was evaluated using the Klimisch scoring system (Klimisch et al., 1997).

NICNAS has assessed sodium gluconate in an IMAP Tier 1 assessment and concluded that it poses no unreasonable risk to the environment.

I. SUBSTANCE IDENTIFICATION

Chemical Name (IUPAC): Sodium D-gluconate

CAS RN: 527-07-1

Molecular formula: $C_6H_{11}NaO_7$

Molecular weight: 218.14 g/mol

Synonyms: Sodium gluconate; Sodium D-gluconate 527-07-1; D-Gluconic acid, monosodium salt;D-Gluconic acid sodium salt

SMILES: C(C(C(C(C(C(=O)[O-])O)O)O)O)O.[Na+]

II. PHYSICO-CHEMICAL PROPERTIES

Key physical and chemical properties for the substance are shown in Table 1.

Table 1: Overview of the Physico-Chemical Properties of Sodium Gluconate

Property	Value	Klimisch Score	Reference
Physical state at 20°C and 101.3 kPa	Dry, white, crystalline powder	-	PubChem
Melting Point	205-209 °C (pressure not provided)	-	OECD, 2004
Boiling Point	613.1 °C (pressure not provided)	-	OECD, 2004
Density	1790 kg/m^3 @ 20 °C	-	PubChem
Vapor Pressure	Negligible @ 25 °C	-	OECD, 2004
Partition Coefficient (log K_{ow})	-5.99	-	OECD, 2004
Water Solubility	590 g/L @ 25 °C	-	OECD, 2004
Dissociation constant (pKa)	3.70	-	OECD, 2004

Sodium gluconate is the sodium salt of gluconic acid. Gluconic acid is a naturally occurring weak acid and its dissociation in water is expected to be complete. Sodium gluconate is a chelator that forms stable complexes with various ions and ultimately prevents these ions from engaging in chemical reactions. Gluconates are naturally occurring substances that freely dissociate to the gluconate anion and its respective cations. Gluconate is used as a chelating agent in many cleaning products, industrial applications, and foodstuffs.

III. ENVIRONMENTAL FATE PROPERTIES

A. Summary

Sodium gluconate is readily biodegradable. It is not expected to bioaccumulate, and it has low potential to adsorb to sediment and soil.

B. Partitioning

Sodium gluconate is highly soluble in water. Volatilisation from water or moist soil surfaces is not expected to be an important fate process based upon its water solubility and that it is a salt. It is not expected to volatilise from dry soil surfaces based upon its estimated negligible vapour pressure.

C. Biodegradation

Sodium gluconate is readily biodegradable under both aerobic and anaerobic conditions. In an aerobic closed bottle test of sodium gluconate, the biodegradation was 89% expressed as the Theoretical Oxygen Demand after 28 days; while under anaerobic conditions, 100% of sodium gluconate was determined as degraded after 35 days. These data demonstrate that gluconates are readily biodegradable both under aerobic and anaerobic test conditions (OECD, 2004).

If a chemical is found to be readily biodegradable, it is categorised as Not Persistent since its half-life is substantially less than 60 days (DoEE, 2017).

D. Environmental Distribution

No experimental data are available for sodium gluconate. Using KOCWIN in EPISuite™ (USEPA, 2018), the estimated K_{oc} value from log K_{ow} is 0.0001046 litres per kilogram (L/kg). The estimated K_{oc} value from the molecular connectivity index (MCI) is 10 L/kg. Based on these values, sodium gluconate has a low potential for adsorption to soil and sediment and is expected to have very high mobility in soil.

E. Bioaccumulation

Based on a log K_{ow} value of -5.99, sodium gluconate has a very low potential for bioaccumulation. This is further supported by metabolic in vivo studies showing that gluconate is readily catabolized or utilized for glucose synthesis (OECD, 2004).

IV. HUMAN HEALTH HAZARD ASSESSMENT

A. Summary

Gluconic acid, the anion of sodium gluconate, is a normal metabolic product of glucose metabolism in mammals. It exhibits low acute toxicity by the oral route. No irritation or skin sensitisation studies

are available. However, it is not expected to be a skin sensitiser. None of the repeated dose toxicity studies showed any significant toxicological effects. Sodium gluconate is not genotoxic.

B. Metabolism

Gluconic acid, the anion of sodium gluconate, is a normal metabolic product of glucose metabolism in mammals. Orally administered gluconate is absorbed rapidly in mammals, A major part is excreted in the urine and the remainder is metabolized (OECD, 2004)

C. Acute toxicity

Oral

Data on acute oral toxicity for sodium gluconate in rat (Mochizuki, M, Bozo Research Center 1995) (doses: 500, 1000, 2000 milligrams per kilogram [mg/kg]) and dog (Okamoto M., 1995) (doses: 1000 and 2000 mg/kg) fed by gavage showed no death at any dose, hence the minimum lethal dose was estimated > 2000 mg/kg for both species.

Inhalation

No acute studies are available.

Dermal

No acute studies are available.

D. Irritation

No studies are available. It is not considered a skin or eye irritant based on studies conducted on similar substance gluconic acid (OECD, 2004).

E. Sensitisation

No studies are available.

F. Repeat Dose Toxicity

Oral

A 28-day study was conducted by feeding rats by gavage with sodium gluconate at doses of 0, 500, 1,000, 2,000 mg/kg body weight in water at a volume of 1 millilitre (mL)/ 100 grams (g) bw. No death or clinical signs of abnormality were observed in any of the groups. Histopathological examination showed a thickening of the limiting ridge of the stomach in 5 out of 12 males at 2,000 mg/kg bw per day dose. No toxic changes associated with the test article were detected. As the limiting ridge is a tissue specific to rodents, this lesion is not toxicologically relevant for humans. Other lesions occurred incidentally and were not treatment related. The NOAEL was estimated to be 1,000 mg/kg bw/day for males and 2000 mg/kg bw/day for females (Mochizuki, M, Bozo Research Centre, 1995).

Another 28-day toxicity study in rats fed with a diet containing up to 5% w/w sodium gluconate (max. 4,100 mg/kg bw for males and 4,400 mg/kg bw for females) was conducted using a control group receiving equivalent concentration of sodium in the form of NaCl to differentiate the potential effects of high doses of sodium intake. No deaths occurred during the study period. No revisions in the general condition, body weight, or food and water intake were observed in the animals over the

study period. No changes were observed in the investigated ophthalmologic tests, urinalysis, hematology, and blood chemistry over the study period. In addition, histopathological examination indicated no adverse effects as a result of the treatment regime. Statistically significant differences in some urinary parameters reported in animals receiving 2.5 or 5% sodium gluconate were comparable to those observed in the NaCl control group and were interpreted as related to the high sodium concentration of the diet.

The authors concluded that the no observed adverse effect level (NOAEL) was 5% (equal to 4100 mg/kg bw per day). However, the Joint Food and Agriculture Organization (FAO)/World Health Organization (WHO) Expert Committee on Food Additives (JECFA) who evaluated this report has concluded that the study was not suitable for identifying a NOAEL because of the small group sizes and the positive findings in the qualitative analysis, even if they have acknowledged that the effects shown in the qualitative urine analyses were related to the high sodium intake (Mochizuki, M. Bozo Research Center, 1997, cited in OECD SIDS, 2004). Nonetheless, this study demonstrates the lack of effects of the gluconate anion even in large doses as the urinary effects were attributed to the high sodium intake and was therefore considered as critical for this endpoint.

None of the repeated dose toxicity studies of any duration (4 weeks, 6 months, or 24 months) showed any significant toxicological effects of gluconates. Potential side effects were attributed to high doses of cation intake, evidenced by results from assays designed for the gluconate anion effect specifically. The NOAEL of sodium gluconate determined from the 28 days studies on rats was equal to 1,000 mg/kg bw for males and 2,000 mg/kg bw for females. On the basis of these data and considering that gluconates are used as food additives permitted in the EU following the Quantum Satis principle (no maximum level specified), further chronic toxicity tests are considered unnecessary (SIDS OECD, 2004).

Inhalation

No adequate or reliable studies are available

Dermal

No adequate or reliable studies are available

G. Genotoxicity

Two *in vitro* studies on bacteria indicated negative results for gene mutation by sodium gluconate with and without metabolic activation (OECD, 2004). The bone marrow of mice exposed orally to sodium gluconate as either a single dose or repeated dose over four consecutive days was examined for evidence of chromosomal aberrations (OECD, 2004). The results from both the single and repeated dose exposures indicated sodium gluconate did not induce chromosomal aberrations and was considered non-genotoxic. These negative results provide sufficient information to indicate low concern for genotoxicity by sodium gluconate.

H. Carcinogenicity

Oral

No studies are available

Inhalation

No studies are available

I. Reproductive Toxicity

No studies are available

J. Developmental Toxicity

No studies are available.

V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES

The toxicological reference values developed for sodium gluconate follow the methodology discussed in enHealth (2012). The approach used to develop drinking water guidance values is described in the Australian Drinking Water Guidelines (ADWG, 2011).

A. Non-Cancer

Toxicological reference values were not derived. Sodium gluconate dissociates in water to sodium and gluconate ions.

The Australian drinking water guideline value for sodium is 180 mg/L based on aesthetics (ADWG, 2011).

B. Cancer

There are no carcinogenicity studies on sodium gluconate. Thus, a cancer reference value was not derived.

VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES

Sodium gluconate does not exhibit the following physico-chemical properties:

- Explosivity
- Flammability
- Oxidising potential

VII. ENVIRONMENTAL HAZARD ASSESSMENT

A. Summary

Sodium gluconate has low toxicity to aquatic and terrestrial organisms.

B. Aquatic Toxicity

Acute Studies

Table 3 presents the results of acute aquatic toxicity studies conducted on sodium gluconate.

Table 3: Acute Aquatic Toxicity Studies on Sodium Gluconate

Test Species	Endpoint	Results (mg/L)	Klimisch Score	Reference
*Oryzias latipes (*Fish, freshwater)	96-hr LC_{50}	>100	-	OECD, 2004
Daphnids magna (Crustacea)	48-hr EC_{50}	>1000	-	OECD, 2004
Selenastrum capricornutum (Algae)	72-hr E_rC_{50}	>1000	-	OECD, 2004

Chronic Studies

Table 4 presents the results of chronic aquatic toxicity studies conducted on sodium gluconate.

Table 4: Chronic Aquatic Toxicity Studies on Sodium Gluconate

Test Species	Endpoint	Results (mg/L)	Klimisch Score	Reference
Selenastrum capricornutum (Algae)	72-hr NOEC	560	-	OECD, 2004

C. Terrestrial Toxicity

No terrestrial toxicity data for gluconates are available. However, the demonstrated biodegradability and the low intrinsic toxicity of gluconates that was observed for aquatic organisms, data on animal toxicokinetic and metabolism (cfr. human toxicology) and their role in mammalian carbohydrate metabolism may also predict a low effect on terrestrial organisms. Therefore, no terrestrial toxicity studies would be required (OECD, 2004).

D. Calculation of PNEC

The PNEC calculations for sodium gluconate follow the methodology discussed in DEWHA (2009).

PNEC Water

Experimental results are available for three trophic levels. Acute $E(L)C_{50}$ values are available for fish (100 mg/L), invertebrates (1,000 mg/L) and for algae (1,000 mg/L). Chronic NOECs are available for algae (560 mg/L). On the basis that the data consists of results from short-term studies from three trophic levels ang long-term studies from one trophic level, an assessment factor of 100 has been applied to the chronic NOEC value of 560 mg/L for algae. The $PNEC_{water}$ is 5.6 mg/L.

PNEC Sediment

No reliable experimental toxicity data on sediment organisms are available. Sodium gluconate dissociates in water with its environmental distribution is dominated by its high water solubility. K_{ow} and K_{oc} parameters do not readily apply to inorganics, such as sodium gluconate. Thus, the equilibrium partitioning method cannot be used to calculate the $PNEC_{sediment}$. Based on its properties, no adsorption of sodium gluconate to sediment is to be expected, and the assessment of this compartment will be covered by the aquatic assessment.

PNEC Soil

No reliable experimental toxicity data on terrestrial organisms are available. The environmental distribution of sodium gluconate is dominated by its water solubility. Sorption of sodium gluconate should probably be regarded as a reversible situation (i.e., the substance is not tightly nor permanently bound). K_{ow} and K_{oc} parameters do not readily apply to inorganics, such as sodium gluconate. Thus, the equilibrium partitioning method cannot be used to calculate the $PNEC_{soil}$. Based on its properties, sodium gluconate is not expected to significantly adsorb to soil, and the assessment of this compartment will be covered by the aquatic assessment.

VIII. PERSISTENCE, BIOACCUMULATION AND TOXICITY (PBT) ASSESSMENT

The methodology for the Persistent, Bioaccumulative and Toxic (PBT) substances assessment is based on the Australian and EU REACH Criteria methodology (DEWHA, 2009; ECHA, 2017).

Sodium gluconate is readily biodegradable; thus, it does not meet the screening criteria for persistence.

The estimated log K_{ow} for sodium gluconate is -5.99. Thus, sodium gluconate does not meet the criteria for bioaccumulation.

The chronic toxicity data on sodium gluconate has NOEC values > 0.1 mg/L.The acute $E(L)C_{50}$ values are >1 mg/L. Thus, sodium gluconate does not meet the screening criteria for toxicity.

Therefore, sodium gluconate is not a PBT substance.

IX. CLASSIFICATION AND LABELLING

A. Classification

Not classified.

B. Labelling

No signal words.

C. Pictogram

None

X. HANDLING AND SAFETY INFORMATION (OCCUPATIONAL LIMITS AND TRANSPORTATION REQUIREMENTS)

A. First Aid

Eye Contact

Immediately flush eyes with plenty of water for at least 15 minutes. Remove contacts, if present and easy to do. If symptoms persist, seek medical attention.

Skin Contact

Wash with soap and water.

Inhalation

If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.

Ingestion

Do not induce vomiting. Rinse mouth with water and then drink a small amount of water. Get medical attention. Never give anything by mouth to an unconscious person.

B. Fire Fighting Information

Extinguishing Media

Water spray, carbon dioxide, foam, dry chemical.

Specific Exposure Hazards

May emit toxic fumes under fire conditions. Depending on conditions, decomposition products may include the following: sodium oxides.

Special Protective Equipment for Firefighters

Wear self-contained breathing apparatus and chemical-protective clothing.

C. Accidental Release Measures

Personal Precautions

Use appropriate protective equipment. Avoid creating and breathing dust.

Environmental Precautions

Prevent from entering sewers, waterways or low areas.

Steps to be Taken if Material is Released or Spilled

Scoop and remove.

D. Storage And Handling

General Handling

Avoid creating or inhaling dust.

Storage

Keep container tightly closed and in a dry and well-ventilated place. Keep in a cool place.

E. Exposure Controls / Personal Protection

Occupational Exposure Standards

Workplace Australia has not established an occupational standard for sodium gluconate.

Engineering Controls

Use in a well-ventilated area.

Personal Protection Equipment

Respiratory Protection: Respiratory protection is not required.

Hand Protection: Chemical resistant protective gloves.

Skin Protection: Body protection must be chosen depending on activity and possible exposure.

Eye Protection: Safety glasses with side-shields.

Other Precautions: Handle in accordance with good industrial hygiene and safety practice. Eyewash fountains and safety showers must be easily accessible.

F. Transport Information

Sodium gluconate is not considered hazardous for purposes of transportation by road or rail. An Australian Dangerous Goods Code is not required.

XI. DISPOSAL MANAGEMENT

Disposal should be in accordance with all local, state and federal regulations.

XII. REGULATORY STATUS

Australian AICS Inventory: Listed.

XIII. REFERENCES

ADWG. (2011). National Water Quality Management Strategy. Australian Drinking Water Guidelines, Section 6, Australian Government, National Health and Medical Research Council, Natural Resource Management Ministerial Council. Updated January 2022. Available: https://www.nhmrc.gov.au/about-us/publications/australian-drinking-water-guidelines

Department of the Environment, Water, Heritage and the Arts (DEWHA). (2009). Environmental risk assessment guidance manual for industrial chemicals, Department of the Environment, Water, Heritage and the Arts, Commonwealth of Australia. Available: http://www.nepc.gov.au/resource/chemical-risk-assessment-guidance-manuals

Department of the Environment and Energy (DoEE). (2017). Chemical Risk Assessment Guidance Manual: for chemicals associated with coal seam gas extraction, Guidance manual prepared by Hydrobiology and ToxConsult Pty Ltd for the Department of the Environment and Energy, Commonwealth of Australia, Canberra.

enHealth Human Risk Assessment (HHRA). (2012). Environmental Health Risk Assessment, Guidelines for Assessing Human Health Risks from Environmental Hazards. Office of Health Protection of the Australian Government Department of Health. Available: https://www1.health.gov.au/internet/main/publishing.nsf/Content/health-pubhlth-publicat-environ.htm

European Chemicals Agency (ECHA). (2017). Guidance on Information Requirements and Chemical Safety Assessment, Chapter R11: PBT Assessment, European Chemicals Agency, Helsinki, Finland. Available: https://echa.europa.eu/guidance-documents/guidance-on-information-requirements-and-chemical-safety-assessment

ECHA. ECHA REACH database: http://echa.europa.eu/information-on-chemicals/registered-substances

Klimisch, H.J., Andreae, M., and Tillmann, U. (1997). A systematic approach for evaluating the quality of experimental and toxicological and ecotoxicological data. Regul. Toxicol. Pharmacol.

Mochizuki, M, 1995a. Bozo Research Center. 25:1-5.

Mochizuki, M. 1997. Bozo Research Center.

Organization for Economic Cooperation and Development Screening Information Dataset (OECD SIDS) (2004). Gluconic Acid and Its Derivatives. Available online: https://hpvchemicals.oecd.org/UI/handler.axd?id=b94cc5f7-de5c-4417-b6c2-f1eb4ffcdb72

PubChem. National Institutes of Health. National Library of Medicine National Center for Biotechnology Information. https://pubchem.ncbi.nlm.nih.gov/

United States Environmental Protection Agency (USEPA). 2018. EPISuite™ v. 4.11, United States Environmental Protection Agency, Office of Pollution Prevention and Toxics and Syracuse Research Corporation. Available at: https://www.epa.gov/tsca-screening-tools/epi-suitetm-estimation-program-interface.

SODIUM POLYACRYLATE (CAS NO. 9003-04-7)
2-PROPENOIC ACID, HOMOPOLYMER, AMMONIUM SALT (CAS NO. 9003-03-6)

This group contains a sodium salt and ammonium salt of polyacrylic acid homopolymers. They are expected to have similar environmental concerns and have consequently been assessed as a group. Information provided in this dossier is based on sodium polyacrylate (CAS No. 9003-04-7).

This dossier on sodium polyacrylate and similar polymers presents the most critical studies pertinent to the risk assessment of these polymers in their use in coal seam or shale gas extraction activities. This dossier does not represent an exhaustive or critical review of all available data. The majority of information presented in this dossier was obtained from the ECHA database that provides information on chemicals that have been registered under the EU REACH (ECHA). Where possible, study quality was evaluated using the Klimisch scoring system (Klimisch et al., 1997).

NICNAS has assessed sodium polyacrylate in an IMAP Tier 1 assessment and considers it a polymer of low concern[1] .

I. SUBSTANCE IDENTIFICATION

Chemical Name (IUPAC): 1-Propenoic acid, homopolymer, sodium salt

CAS RN: 9003-04-7

Molecular formula: $(C_3H_4O_2)$ x-.x-Na

Molecular weight: 94.0447 g/mol (monomer); Variable (polymer)

Synonyms: 2-Propenoic acid, homopolymer, sodium salt; polyacrylic acid, sodium salt, sodium polyacrylate; acrylic acid, polymers, sodium salt; poly (acrylic acid), sodium salt; polyacrylate sodium salt

SMILES: Not available

Chemical Name (IUPAC): 2-Propenoic acid, homopolymer, ammonium salt

CAS RN: 9003-03-6

Molecular formula: $(C_3\text{-}H_4\text{-}O_2)$x-.x-$H_3$-N

Molecular weight: 89.0933 g/mol (monomer); Variable (polymer)

Synonyms: 2-Propenoic acid, homopolymer, ammonium salt;2-Propenoic acid, homopolymer, sodium salt; ammonium polyacrylate; poly(acrylic acid),ammonium salt; ammonium acrylate

SMILES: Not available; C=CC(=O)[O-].[Na]

[1] https://www.nicnas.gov.au/chemical-information/imap-assessments/how-chemicals-are-assessed/Low-concern-polymers.

II. PHYSICO-CHEMICAL PROPERTIES

Sodium polyacrylates are polymers that range in molecular weight (MW) from 1,000 to 78,000 g/mol (HERA, 2014). The sodium polyacrylates mostly used in detergents have a typical molecular weight of approximately 4,500 g/mol (HERA, 2014). For sodium polyacrylate (MW 4,500), the melting point is >150oC, where it decomposes; and the water solubility is >400 g/L (HERA, 2014).

III. ENVIRONMENTAL FATE PROPERTIES

A. Summary

Sodium polyacrylates are not readily biodegradable. Due to their high molecular weights, sodium polyacrylates are not expected to bioaccumulate. In addition, these water-soluble polymers can form insoluble calcium salts in natural waters, suggesting that bioaccumulation is unlikely.

B. Partitioning

Abiotic degradation mechanisms like photolytic and hydrolytic processes do not significantly influence the environmental fate of sodium polyacrylates (HERA, 2014).

C. Biodegradation

Sodium polyacrylates are not readily biodegradable but are partly accessible to ultimate biodegradation particularly under long incubation conditions. Sodium polyacrylates with MW of <2,000 g/mol are partly biodegradable under the conditions of soil and sediment inoculation. Test results with activated sludge inoculum indicate different elimination degrees, apparently due to adsorption and precipitation processes. The removal degrees of different sodium polyacrylates show no clear relationship between elimination extent and molecular weight (HERA, 2014).

If a chemical is found to be readily biodegradable, it is categorised as Not Persistent since its half-life is substantially less than 60 days (DoEE, 2017).

D. Environmental Distribution

Adsorption onto solids and precipitation are the principal mechanisms of abiotic elimination for this type of polymer, the degree of elimination differs and is strongly influenced by test concentration and water hardness (HERA, 2014).

E. Bioaccumulation

No experimental studies are available on sodium polyacrylates. Estimated bioconcentration factors based on octanol-water coefficients are not appropriate since the molecular weights of these polymers are higher than the molecular weight range for the QSAR models. Due to their high molecular weights, sodium polyacrylates are not expected to bioaccumulate. In addition, these water-soluble polymers can form insoluble calcium salts in natural waters, suggesting that bioaccumulation is unlikely (HERA, 2014).

IV. HUMAN HEALTH HAZARD ASSESSMENT

A. Summary

The acute toxicity of sodium polyacrylates are very low by the oral and dermal routes. These polymers are not irritating to the skin and eyes; nor are they skin sensitisers. No systemic toxicity was observed in rats given high oral doses of a sodium polyacrylate for four weeks; pulmonary irritation was seen in rats that inhaled an aerosol or dust of a sodium polyacrylate for 13 weeks, but there was no systemic toxicity. No developmental toxicity was seen in rats when given high oral doses of sodium polyacrylates. Sodium polyacrylates are not genotoxic or mutagenic.

B. Acute Toxicity

Oral

Acute oral toxicity studies have been conducted in rats on sodium polyacrylates with molecular weights (MW) of 1,000 to 78,000. The oral LD50 values are >5,000 or >10,000 mg/kg (the highest doses tested), except for one study on a 3,500 MW sodium polyacrylate, which was reported to be >1,000 mg/kg (the attainable limit dose of a 10% aqueous solution) (HERA, 2014). [Kl. scores = 2].

Inhalation

There are no acute inhalation studies available.

Dermal

The dermal LD50 values in rabbits for sodium polyacrylates with MW of 1,000 or 4,500 are >5,000 mg/kg (HERA, 2014). [Kl. scores = 2].

C. Irritation

According to (HERA, 2014) sodium polyacrylates with MW of 1,000 to 78,000 are not irritating to the skin or eyes [Kl. scores = 2]. However, as per ECHA current classification, the substance 2-Propenoic acid, homopolymer, sodium is considered a skin and eye irritant. Thus, this classification will be retained for purposes of this dossier.

D. Sensitisation

Sodium polyacrylates with MW of 4,500 or 78,000 were not dermal sensitisers in the guinea pig maximisation test (HERA, 2014). [Kl. scores = 2 and 4, respectively].

E. Repeated Dose Toxicity

Oral

Male rats were fed diets containing 0 or 2.5% sodium polyacrylate (MW 2,500) for four weeks. Body weight, body weight gain, and appearance of the animals were similar between treated and control animals. In the fourth week of the study, a small, but significant, decrease in total weight of bone minerals was detected and confirmed by radiographic and histological examination. There was a significant reduction in the concentration of magnesium in the bones and plasma of the treated animals. Calcium loss was slight and not statistically significant. Urinary excretion of sodium and phosphorus was markedly increased, calcium only slightly increased. The authors of the study

interpreted the finding as a metabolic imbalance rather than systemic toxicity. Sodium excretion could have been increased by the high intake of the sodium-neutralised test substance. The NOAEL for the study was considered to be 2.5% sodium polyacrylate in the diet, which was estimated to be 1,136 mg/kg-day (HERA, 2014). [Kl. score = 2].

Inhalation

Male and female rats were exposed by inhalation to 0, 0.2, 1.0, or 5.0 mg/m3 sodium polyacrylate (MW 4,500) as an aerosol for 6 hours/day, 5 days/week for 13 weeks. Additional groups of animals were exposed for 13 weeks followed by a 91-day recovery period. There were no treatment-related effects on body weights, organ weights, feed and water consumption, clinical observations, and blood chemistry. In the histopathologic examination, the lungs of the mid- and high-dose animals showed signs of mild pulmonary irritation increases in polymorphonuclear granulocytes or alveolar macrophages, pneumocyte hyperplasia, alveolar wall thickening and focal alveolitis. The lung effects were reversible and were not seen in the recovery group animals. The NOEC for systemic effects in this study was considered to be 5 mg/m3, and the NOEC for localised irritation is 0.2 mg/m3 (HERA, 2014). [Kl. score = 2].

Dermal

There are no studies available.

F. Genotoxicity

In vitro Studies

The results of the *in vitro* studies on sodium polyacrylates are presented below in Table 1. All the studies show that sodium polyacrylates are not mutagenic or genotoxic.

The *in vitro* genotoxicity studies on sodium polyacrylates are presented in Table 1.

Table 1: *In vitro* Genotoxicity Studies on Sodium Polyacrylates (HERA, 2014)

Mean MW	Test System	Results*	Klimisch Score	Reference
2,000	Bacterial reverse mutation	-	2	HERA (2014)
2,000	Mouse lymphoma	-	2	HERA (2014)
2,000	Unscheduled DNA synthesis	-	2	HERA (2014)
4,500	Bacterial reverse mutation	-	2	HERA (2014)
4,500	Mouse lymphoma	-	2	HERA (2014)
4,500	Unscheduled DNA synthesis	-	2	HERA (2014)
4,500	Cytogenetic (CHO cells)	-	2	HERA (2014)
4,500	Bacterial reverse mutation	-	2	HERA (2014)
4,500	Mammalian cell gene mutation	-	2	HERA (2014)
4,500	Unscheduled DNA synthesis	-	2	HERA (2014)

*+, positive; -, negative

In vivo Studies

There was no increase in micronuclei in polychromatic erythrocytes from the bone marrow of mice given a single oral gavage dose of 13,850 mg/kg sodium polyacrylate with a MW of 2,000 (HERA, 2014).

G. Carcinogenicity

Oral

There are no studies available.

Inhalation

There are no studies available.

Dermal

There are no studies available.

H. Reproductive Toxicity

There are no studies available.

I. Developmental Toxicity

Oral

Pregnant female rats were dosed by oral gavage with 0, 500, 1,000, or 3,000 mg/kg sodium polyacrylate (MW 4,500) on GD 6 to 15. At 3,000 mg/kg, the dams had soft or liquid stools during the treatment period. There was no maternal or developmental toxicity observed in this study. The NOAEL for maternal and developmental toxicity is 3,000 mg/kg-day (HERA, 2014). [Kl. score = 2]

Pregnant female rats were dosed by oral gavage with 0, 125, 375, or 1,125 mg/kg sodium polyacrylate (MW 90,000 as a 77.5% aq. solution) during GD 6 to 13. Some of the dams were sacrificed on GD 13 and the remaining on GD 19. One mid-dose dam and 6 high-dose dams died during the study; of these, three of the high-dose deaths were treatment-related and the remaining were considered the result of gavage errors. There was a transient decrease in feed consumption in the high-dose dams during GD 7-9, but not other indications of maternal toxicity. There was no developmental toxicity. The NOAELs for maternal and developmental toxicity are 375 and 1,125 mg/kg-day (HERA, 2014). [Kl. score = 2]

Inhalation

There are no studies available.

Dermal

There are no studies available.

V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES

The toxicological reference values developed for sodium polyacrylate follow the methodology discussed in enHealth (2012). The approach used to develop drinking water guidance values is described in the Australian Drinking Water Guidelines (ADWG, 2011).

A. Non-Cancer

Oral

A 4-week dietary study showed no systemic toxicity in rats given 2.5% sodium polyacrylate (MW 2,500) in their feed. The estimated dose is 1,136 mg/kg-day. Two pre-natal developmental toxicity studies showed no effects at the highest dose tested: 3,000 and 1,125 mg/kg-day for sodium polyacrylates with MW of 4,500 and 90,000, respectively. The NOAEL of 1,136 mg/kg-day from the 4-week dietary study will be used for determining the oral Reference dose (RfD) and the drinking water guidance value.

Oral Reference Dose (oral RfD)

Oral RfD = NOAEL / (UF_A x UF_H x UF_L x UF_{Sub} x UF_D)

Where:

UF_A (interspecies variability) = 10
UF_H (intraspecies variability) = 10
UF_L (LOAEL to NOAEL) = 1
UF_{Sub} (subchronic to chronic) = 10
UF_D (database uncertainty) = 1
Oral RfD = 1,136/ (1 x 10 x 1 x 1 x 1) = 1,136/1,000 = 1.1 mg/kg/day

Drinking water guidance value

Drinking water guidance value = (animal dose) x (human weight) x (proportion of intake from water) / (volume of water consumed) x (safety factor)

Using the oral RfD,

Drinking water guidance value = (oral RfD) x (human weight) x (proportion of water consumed) / (volume of water consumed)

Where:

Human weight = 70 kg (ADWG, 2011)
Proportion of water consumed = 10% (ADWG, 2011)
Volume of water consumed = 2L (ADWG, 2011)
Drinking water guidance value = (1.1 x 70 x 0.1)/2 = 3.85 mg/L

B. Cancer

No carcinogenicity studies have been conducted on sodium polyacrylates. Therefore, a cancer reference value was not derived.

VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES

Sodium polyacrylates does not exhibit the following physico-chemical properties:

- Explosivity
- Flammability
- Oxidising potential

VII. ENVIRONMENTAL HAZARD ASSESSMENT

A. Summary

Sodium polyacrylates are a low toxicity concern for aquatic organisms, terrestrial invertebrates, and plants.

B. Aquatic Toxicity

Acute Studies

Table 2 lists the results of acute aquatic toxicity studies conducted on sodium polyacrylates.

Table 2: Acute Aquatic Toxicity Studies on Sodium Polyacrylates

Mean MW	Test Species	Endpoint	Results (mg/L)	Klimisch Score	Reference
1,000	*Brachydanio rerio*	96-hour LC_{50}	>200	1	HERA, 2014
1,000	*Salmo gairdneri*	96-hour LC_{50}	>1,000	1	HERA, 2014
1,200	*Leuciscus idus*	96-hour LC_{50}	>500	1	HERA, 2014
2,000	*Brachydanio rerio*	96-hour LC_{50}	>200	1	HERA, 2014
2,500	*Leuciscus idus*	96-hour LC_{50}	>500	1	HERA, 2014
4,500	*Lepomis macrochirus*	96-hour LC_{50}	>1,000	1	HERA, 2014
4,500	*Lepomis macrochirus*	96-hour LC_{50}	>1,000	1	HERA, 2014
8,000	*Leuciscus idus*	96-hour LC_{50}	>500	1	HERA, 2014
10,000	*Lepomis macrochirus*	96-hour LC_{50}	>1,000	1	HERA, 2014
15,000	*Leuciscus idus*	96-hour LC_{50}	>10,000	1	HERA, 2014
78,000	*Brachydanio rerio*	96-hour LC_{50}	>400	2	HERA, 2014
1,000	*Daphnia magna*	48-hour EC_{50}	>200	1	HERA, 2014
1,000	*Daphnia magna*	48-hour EC_{50}	>1,000	1	HERA, 2014
2,000	*Daphnia magna*	48-hour EC_{50}	>200	1	HERA, 2014
4,500	*Daphnia magna*	48-hour EC_{50}	>200	1	HERA, 2014
4,500	*Daphnia magna*	48-hour EC_{50}	>1,000	1	HERA, 2014
78,000	*Daphnia magna*	24-hour EC_{50}	276	2	HERA, 2014

Mean MW	Test Species	Endpoint	Results (mg/L)	Klimisch Score	Reference
8,000	*Selenastrum capricornutum*	72-hour EC_{50}	40	1	HERA, 2014
78,000	*Scenedesmus subspicatus*	96-hour EC_{50}	44	2	HERA, 2014

Chronic Studies

Table 3 lists the results of chronic aquatic toxicity studies conducted on sodium polyacrylates.

Table 3: Chronic Aquatic Toxicity Studies on Sodium Polyacrylates (HERA, 2014)

Mean MW	Test Species	Endpoint	Results (mg/L)	Klimisch score	Reference
4,500	*Pimephales promelas*	32-day NOEC	56	2	HERA, 2014
4,500	*Brachydanio rerio*	28-day NOEC	>450	1	HERA, 2014
78,000	*Brachydanio rerio*	14-day NOEC	>400	2	HERA, 2014
4,500	*Daphnia magna*	21-day NOEC	450	1	HERA, 2014
4,500	*Daphnia magna*	21-day NOEC	58	1	HERA, 2014
4,500	*Daphnia magna*	21-day NOEC	12	2	HERA, 2014
78,000	*Daphnia magna*	21-day NOEC	100	2	HERA, 2014
4,500	*Scenedesmus subspicatus*	96-hour NOEC	180	2	HERA, 2014
78,000	*Scenedesmus subspicatus*	96-hour NOEC	32.8	2	HERA, 2014

There is considerable variability in the chronic aquatic toxicity results for Daphnia magna for sodium polyacrylates with the same molecular weight of 4,500. This was discussed in HERA (2014) and was explained by the solubility of sodium polyacrylates in water. In distilled water, the solubility of sodium polyacrylates with the molecular weight of 4,500 is >400 mg/L; however, under test conditions water solubility will decrease due to the presence of Ca++ and Mg++ (as measured by water hardness). In a study by BASF (reviewed in HERA, 2014), the water solubility of sodium polyacrylate (MW 4,500) was determined with radiolabelled compounds in a test system with a calcium concentration of 70 mg/L, which corresponds to the mean water hardness to the media used in an OECD TG 202 test. Under these conditions, the water solubility of sodium polyacrylate was 1.3 mg/L after 24 hours. So, one explanation for the variability of the chronic Daphnia studies may be due to differences in water hardness.

C. Toxicity to Sediment Organisms

The 96-hour EC0 to Chironomus riparius (larvae) is >4,500 mg/kg sediment dry weight (HERA, 2014).

D. Terrestrial Toxicity

Table 4 lists the results of terrestrial toxicity studies on sodium polyacrylates polymers.

Table 4: Terrestrial Toxicity Studies on Sodium Polyacrylates (HERA, 2014)

Mean MW	Test Species	Endpoint	Results (mg/L)	Klimisch Score	Reference
4,500	*Eisenia foetida foetida*	14-day EC_0	1,000	1	HERA, 2014
78,000	*Eisenia foetida andrei*	14-day EC_0	1,000	2	HERA, 2014
78,000	*Brassica rapa*	21-day NOEC	1,000	2	HERA, 2014
4,500	Nitrogen transformation*	28-day EC_{10}	>2,500	1	HERA, 2014
4,500	Carbon transformation*	28-day EC_{10}	>2,500	1	HERA, 2014

*Soil organisms

E. Calculation of PNEC

The PNEC calculations for sodium polyacrylate follow the methodology discussed in DEWHA (2009).

PNEC Water

Experimental results are available for three trophic levels. Acute E(L)C_{50} values are available for fish (>200mg/L), *Daphnia* (>200 mg/L), and algae (40 mg/L). NOEC values from long-term studies are available for fish (56 mg/L), invertebrates (12 mg/L) and algae (32.8 mg/L). On the basis that the data consists of short-term and long-term results from three trophic levels, an assessment factor of 10 has been applied to the lowest reported NOEC value of 12 mg/L for invertebrates. The E(L)C_{50} value is used because the value for fish is lower than the NOEC values for all three trophic levels. The $PNEC_{water}$ is 1.2 mg/L.

PNEC Sediment

Experimental results are available for one trophic level. There were no visual signs of toxicity to Chironomus riparius (larvae) at the highest concentration tested (>4,500 mg/kg sediment dry weight) (HERA) 2014). The EC_0 is considered to be above 4,500 mg/kg and an assessment factor cannot apply. Thus, the equilibrium partitioning method will be used to determine the $PNEC_{sed}$. The HERA (2014) risk assessment calculated a $PNEC_{sed}$ of 130 mg/kg sediment wet weight using the default of 0.05 as the weight fraction of organic carbon in sediment according to the EU Technical Guidance Document (TGD) (EU 2003).

PNEC Soil

Experimental results are available for three trophic levels. An acute LC_{50} value is available for earthworms (1,000 mg/kg soil dry weight). A 21-day NOEC for Brassica rapa was reported to be 1,000 mg/kg soil dry weight. Results from two long-term studies are available for soil microorganisms, with the NOECs for nitrogen and carbon transformation being >2,500 mg/kg soil dry weight. On the basis that the data consists of short-term tests, as well as one long-term test from

one trophic level, an assessment factor of 100 has been applied to the lowest reported long-term NOEC of >2,500 mg/kg soil dry weight. The $PNEC_{soil}$ is 25 mg/kg soil dry weight.

VIII. PERSISTENCE, BIOACCUMULATION AND TOXICITY (PBT) ASSESSMENT

The methodology for the Persistent, Bioaccumulative and Toxic (PBT) substances assessment is based on the Australian and EU REACH Criteria methodology (DEWHA, 2009; ECHA, 2017).

Sodium polyacrylates are not readily biodegradable, thus does not meet the screening criteria for persistence.

The sodium polyacrylates are expected to have high molecular weights and are not expected to be bioavailable. Thus, these polymers do not meet the criteria for bioaccumulation.

Chronic NOECs for fish, daphnia and algae are available for sodium polyacrylates, and the NOEC values are >0.1 mg/L. Thus, sodium polyacrylates do not meet the screening criteria for toxicity.

The overall conclusion is that sodium polyacrylates are not PBT substances.

IX. CLASSIFICATION AND LABELLING

A. Classification

Aquatic Acute Toxicity Category 3

B. Labelling

Warning

According to the classification provided by companies to ECHA in CLP notifications this substance causes serious eye irritation and causes skin irritation.

A. Pictogram



X. HANDLING AND SAFETY INFORMATION (OCCUPATIONAL LIMITS AND TRANSPORTATION REQUIREMENTS)

A. First Aid

Please refer to the product SDS for additional information and confirmation of the information provided herein.

<u>Eye Contact</u>

In case of contact, immediately flush eyes with plenty of water for at least 15 minutes.

Skin Contact

Wash thoroughly with soap and water.

Inhalation

If inhaled, remove from area to fresh air. Get medical attention.

Ingestion

Rinse mouth with water and then drink a glass of water. Get medical attention. Never give anything by mouth to an unconscious person.

B. Fire Fighting Information

Extinguishing Media

Water spray, carbon dioxide, foam, dry chemical.

Specific Exposure Hazards

Keep product and empty container away from heat and sources of ignition. May emit toxic fumes under fire conditions. Depending on conditions, decomposition products may include the following: carbon monoxide, carbon dioxide.

Special Protective Equipment for Firefighters

Wear self-contained breathing apparatus.

C. Accidental Release Measures

Personal Precautions

Use appropriate protective equipment. Handle in accordance with good industrial hygiene and safety practice.

Environmental Precautions

Prevent from entering sewers, waterways or low areas.

Steps to be Taken if Material is Released or Spilled

For large amounts: dike spillage and pump off product. For residues: pick up with suitable absorbent material. Dispose of contaminated material as prescribed.

D. Storage And Handling

General Handling

Keep product and empty container away from heat and sources of ignition. Ensure adequate ventilation, especially in confined areas.

Storage

Keep container tightly closed and in a dry and well-ventilated place. Keep in a cool place.

E. Exposure Controls / Personal Protection

Occupational Exposure Standards

The are no workplace exposure standards for sodium polyacrylates in Australia.

Engineering Controls

Good general ventilation should be used.

Personal Protection Equipment

Respiratory Protection: Respiratory protection is not required.

Hand Protection: Chemical resistant protective gloves.

Skin Protection: Body protection must be chosen depending on activity and possible exposure.

Eye protection: Safety glasses with side-shields.

Other Precautions: Handle in accordance with good industrial hygiene and safety practice. Wearing of closed work clothing is recommended. Ensure that eyewash stations and safety showers are close to the workstation location.

F. Transport Information

Sodium polyacrylate is not considered hazardous for purposes of transportation by road or rail. An Australian Dangerous Goods code is not required.

XI. DISPOSAL MANAGMENT

Disposal should be in accordance with all local, state and federal regulations.

XII. REGULATORY STATUS

Australian AICS Inventory: Listed.

XIII. REFERENCES

ADWG. (2011). National Water Quality Management Strategy. Australian Drinking Water Guidelines, Section 6, Australian Government, National Health and Medical Research Council, Natural Resource Management Ministerial Council. Updated January 2022. Available: https://www.nhmrc.gov.au/about-us/publications/australian-drinking-water-guidelines

Department of the Environment, Water, Heritage and the Arts [DEWHA]. (2009). Environmental risk assessment guidance manual for industrial chemicals, Department of the Environment, Water, Heritage and the Arts, Commonwealth of Australia. Available: http://www.nepc.gov.au/resource/chemical-risk-assessment-guidance-manuals

Department of the Environment and Energy [DoEE]. (2017). Chemical Risk Assessment Guidance Manual: for chemicals associated with coal seam gas extraction, Guidance manual prepared by Hydrobiology and ToxConsult Pty Ltd for the Department of the Environment and Energy, Commonwealth of Australia, Canberra.

ECHA. ECHA REACH database: http://echa.europa.eu/information-on-chemicals/registered-substances

enHealth Human Risk Assessment [HHRA]. (2012). Environmental Health Risk Assessment, Guidelines for Assessing Human Health Risks from Environmental Hazards. Office of Health Protection of the Australian Government Department of Health. Available: https://www1.health.gov.au/internet/main/publishing.nsf/Content/health-pubhlth-publicat-environ.htm

European Chemicals Agency [ECHA]. (2017). Guidance on Information Requirements and Chemical Safety Assessment, Chapter R11: PBT Assessment, European Chemicals Agency, Helsinki, Finland. Available: https://echa.europa.eu/guidance-documents/guidance-on-information-requirements-and-chemical-safety-assessment

HERA (2014). Human & Environmental Risk Assessment (HERA) on ingredients of European household cleaning products. Polycarboxylates used in detergents (Part I): Polyacrylic acid homopolymers and their sodium salts (CAS 9003-04-7). (http://www.heraproject.com/files/HERA_P-AA_final_v3_23012014.pdf)

Klimisch, H.J., Andreae, M., and Tillmann, U. (1997). A systematic approach for evaluating the quality of experimental and toxicological and ecotoxicological data. Regul. Toxicol. Pharmacol. 25:1-5.

SODIUM SULPHATE

This dossier on sodium sulphate presents the most critical studies pertinent to the risk assessment of sulphate in its use in coal seam gas extraction activities. This dossier does not represent an exhaustive or critical review of all available data. The majority of information presented in this dossier was obtained the OECD-SIDS documents on sodium sulphate (OECD, 2005a,b), and from the ECHA database that provides information on chemicals that have been registered under the EU REACH (ECHA). Where possible, study quality was evaluated using the Klimisch scoring system (Klimisch et al., 1997).

NICNAS has assessed sodium sulphate in an IMAP Tier 1 assessment and concluded that it poses no unreasonable risk to the environment.

I. SUBSTANCE IDENTIFICATION

Chemical Name (IUPAC): Disodium sulphate

CAS RN: 7757-82-6

Molecular formula: Na_2SO_4

Molecular weight: 142.04 g/mol

Synonyms: Sodium sulphate; disodium sulphate; sodium bisulphate; sulphuric acid, disodium salt

SMILES: [O-]S(=O)(=O)[O-].[Na+].[Na+]

II. PHYSICO-CHEMICAL PROPERTIES

Table 1: Overview of the Physico-chemical Properties of Sodium Sulphate

Property	Value	Klimisch score	Reference
Physical state at 20°C and 101.3 kPa	White crystalline solid	2	ECHA
Melting Point	ca. 884°C (pressure not reported)	2	ECHA
Density	2700 kg/m^3 @ 20°C	2	ECHA
Partition Coefficient (Log K_{ow})	-4.38 (temperature not provided)	2	ECHA
Water Solubility	445.5 g/L @ 20°C	1	ECHA
Auto flammability	Not auto flammable	1	ECHA

III. ENVIRONMENTAL FATE SUMMARY

Sodium sulphate dissociates in aqueous media to sodium (Na^+) and sulphate (SO_4^{2-}) ions. Biodegradation is not applicable to inorganic compounds. Sodium sulphate is not expected to bioaccumulate; it will dissociate to ions that are ubiquitous in the environment. Sodium sulphate is not expected to adsorb to soil or sediment because of its dissociation properties and high water solubility.

IV. HUMAN HEALTH HAZARD ASSESSMENT

A. Summary

Sodium sulphate exhibits low acute toxicity by the oral and inhalation routes. It is not irritating to the skin and eyes; and it is not a skin sensitiser. In a reproductive and developmental toxicity screening study, there was no indication of any toxicity in rats given oral doses as high as 1,000 mg/kg/day. Sodium sulphate is not genotoxic.

B. Acute Toxicity

Oral

The oral LD_{50} in rats is > 2,000 mg/kg (ECHA) [KI score = 1].

Human data indicate a very low acute toxicity of sodium sulphate. High oral doses of sodium sulphate, from 300 mg/kg up to 20 grams for an adult, are well tolerated, except from (intentionally) causing severe diarrhea (OECD, 2005a,b).

Inhalation

The 4-hour inhalation LC_{50} for an aerosol of sodium sulphate is > 2.4 mg/L, which was the highest technically feasible aerosol concentration. The mass median aerodynamic diameters (MMAD) were 2.65 to 2.71 µm (ECHA) [KI score = 1].

Dermal

There is no data on acute dermal toxicity.

C. Irritation

Application of 0.5 g sodium sulphate (in PEG 400) to the skin of rabbits for 4 hours was not irritating (ECHA) [KI score = 1].

Instillation of 90 mg sodium sulphate to the eyes of rabbits was not irritating (ECHA) [KI score = 1].

D. Sensitisation

Sodium sulphate was not considered a skin sensitiser in a mouse local lymph node assay (ECHA) [KI score = 1].

E. Repeated Dose Toxicity

Oral

In a reproductive and developmental toxicity screening (OECD 421) study, male and female Wistar rats were dosed by oral gavage with 0, 100, 300 or 1,000 mg/kg sodium sulphate for a total of 4 weeks for males and 7 weeks for females. There was no evidence of toxicity at any dose level. The NOAEL for systemic toxicity is 1,000 mg/kg/day, the highest dose tested.

Inhalation

No studies are available.

Dermal

No studies are available.

F. Genotoxicity

In Vitro Studies

The *in vitro* genotoxicity studies on sodium sulphate are presented in Table 2.

Table 2: *In vitro* Genotoxicity Studies on Sodium Sulphate

Test System	Results*		Klimisch Score	Reference
	-S9	+S9		
Bacterial reverse mutation (S. typhimurium and E. coli strains)	-	-	1	ECHA
Mammalian cell gene mutation (mouse lymphoma L5178Y cells)	-	-	1	ECHA
Chromosomal aberration (Chinese hamster lung fibroblasts)	-	-	1	ECHA

*+, positive; -, negative

In Vivo Studies

No studies are available.

G. Carcinogenicity

No valid studies are available.

H. Reproductive/Developmental Toxicity

A reproductive and developmental toxicity screening (OECD 421) study has been conducted on sodium sulphate. Male and female Wistar rats were dosed by oral gavage with 0, 100, 300 or 1,000 mg/kg sodium sulphate. There were no deaths during the study and no clinical signs of reproductive or developmental toxicity at any dose level. Body weights, body weight gain and feed consumption were similar across all groups. The NOAEL for systemic, reproductive and developmental toxicity is 1,000 mg/kg/day, the highest dose tested (ECHA) [Kl score = 1].

V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES

Toxicological reference values were not derived. Sodium sulphate dissociates in water to sodium and sulphate ions.

The Australian drinking water guideline value for sodium is 180 mg/L based on aesthetics (ADWG, 2021).

The Australian drinking water guideline value for sulphate is 500 mg/L based on health. Concentrations of > 500 mg/L can have purgative effects. There is also an Australian drinking water guideline value for sulphate of 250 mg/L based on aesthetics; it is the taste threshold (ADWG, 2021).

A. Cancer

There are no valid carcinogenicity studies on sodium sulphate. Thus, a cancer reference value was not derived.

VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES

Sodium sulphate does not exhibit the following physico-chemical properties:

- Explosivity
- Flammability
- Oxidising potential

VII. ENVIRONMENTAL HAZARD ASSESSMENT

A. Summary

Sodium sulphate is of low acute concern to aquatic life.

B. Aquatic Toxicity

Acute Studies

Table 3 lists the results of acute aquatic toxicity studies conducted on sodium sulphate.

Table 3: Acute Aquatic Toxicity Studies on Sodium Sulphate

Test Species	Endpoint	Results (mg/L)	Klimisch score	Reference
Pimephales promelas	96-hour LC_{50}	7,960	2	Mount et al. (1997)
Daphnia magna	48-hour EC_{50}	4,736*	2	Davies and Hall (2007)

* Standard test conditions: 100 mg $CaCO_3$/L and Ca:Mg ratio of 0.7.

Chronic Studies

The 7-day LOEC from a *Ceriodapnia dubia* reproduction study, in which the test media contained varying degrees of water hardness, was 1,329 mg/L. The NOEC was extrapolated to be approximately 1,109 mg/L (Soucek, 2007).

C. Sediment Toxicity

The lowest 96-hour LC_{50} value to *Hyalella azteca* in a series of studies involving different hardnesses of water was 757 mg/L (Soucek and Kennedy, 2005). In another study with *Hyalella azteca*, the lowest 96-hour LC_{50} value (in water with the lowest hardness) was 841 mg/L (Davies and Hall, 2007). The lowest 96-hour LC_{50} value to *Chironomus tentans* in a series of studies involving different hardnesses of water was 20,899 mg/L (Soucek and Kennedy, 2005).

D. Terrestrial Toxicity

No adequate studies were located.

E. Calculation of PNEC

The PNEC calculations for sodium sulphate follow the methodology discussed in DEWHA (2009).

PNEC water

Experimental results are available for two trophic levels. Acute E(L)C50 values are available for fish (7,960 mg/L) and *Daphnia* (4,736 mg/L). The NOEC from a chronic study on invertebrates was 1,109 mg/L. On the basis that the data consists of results from short-term studies from two trophic levels and a single long-term study, an assessment factor of 100 has been applied to the chronic NOEC value of 1,109 mg/L for invertebrates. The $PNEC_{water}$ is 11 mg/L.

PNEC sediment

No reliable experimental toxicity data on sediment organisms are available. Sodium sulphate dissociates completely in water with its environmental distribution is dominated by its high water solubility. K_{ow} and K_{oc} parameters do not readily apply to inorganics, such as sodium sulphate. Thus, the equilibrium partitioning method cannot be used to calculate the $PNEC_{sediment}$. Based on its properties, no adsorption of sodium sulphate to sediment is to be expected, and the assessment of this compartment will be covered by the aquatic assessment.

PNEC soil

No reliable experimental toxicity data on terrestrial organisms are available. The environmental distribution of sodium sulphate is dominated by its water solubility. Sorption of sodium sulphate should probably be regarded as a reversible situation, i.e., the substance is not tightly nor permanently bound. K_{ow} and K_{oc} parameters do not readily apply to inorganics, such as sodium sulphate. Thus, the equilibrium partitioning method cannot be used to calculate the $PNEC_{soil}$. Based on its properties, sodium sulphate is not expected to significantly adsorb to soil, and the assessment of this compartment will be covered by the aquatic assessment.

VIII. PERSISTENCE, BIOACCUMULATION AND TOXICITY (PBT) ASSESSMENT

The methodology for the Persistent, Bioaccumulative and Toxic (PBT) substances assessment is based on the Australian and EU REACH Criteria methodology (DEWHA, 2009; ECHA, 2008).

Sodium sulphate is an inorganic salt that dissociates completely to sodium and sulphate ions in aqueous solutions. Biodegradation is not applicable to these inorganic ions; both sodium and sulphate ions are also ubiquitous and are present in most water, soil and sediment. For the purposes of this PBT assessment, the persistent criteria are not considered applicable to sodium sulphate or its dissociated ions.

Sodium and sulphate ions are essential to all living organisms and their intracellular and extracellular concentrations are actively regulated. Thus, sodium sulphate is not expected to bioaccumulate.

The NOEC from a chronic toxicity study with *Ceriodaphnoa rerio* is > 0.1 mg/L. The acute $E(L)C_{50}$ values for fish and *Daphnia* are > 1 mg/L. Thus, sodium sulphate does not meet the criteria for toxicity.

Therefore, sodium sulphate is not a PBT substance.

IX. CLASSIFICATION AND LABELLING

A. Classification

Not classified.

B. Labelling

No signal words.

C. Pictogram

None

X. SAFETY AND HANDLING

A. First Aid

Eye Contact

Immediately flush eyes with plenty of water for at least 15 minutes. Remove contacts, if present and easy to do. If symptoms persist, seek medical attention.

Skin Contact

Wash with soap and water.

Inhalation

If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.

Ingestion

Do not induce vomiting. Rinse mouth with water and then drink a small amount of water. Get medical attention. Never give anything by mouth to an unconscious person.

B. Fire Fighting Information

Extinguishing Media

Water spray, carbon dioxide, foam, dry chemical.

Specific Exposure Hazards

May emit toxic fumes under fire conditions. Depending on conditions, decomposition products may include the following: sodium and sulfur oxides.

Special Protective Equipment for Firefighters

Wear self-contained breathing apparatus and chemical-protective clothing.

C. Accidental Release Measures

Personal Precautions

Use appropriate protective equipment. Avoid creating and breathing dust.

Environmental Precautions

Prevent from entering sewers, waterways or low areas.

Steps to be Taken if Material is Released or Spilled

Scoop and remove.

D. Storage And Handling

General Handling

Avoid creating or inhaling dust.

Storage

Keep container tightly closed and in a dry and well-ventilated place. Keep in a cool place.

E. Exposure Controls / Personal Protection

Occupational Exposure Standards

Workplace Australia has not established an occupational standard for sodium sulphate.

Engineering Controls

Use in a well-ventilated area.

Personal Protection Equipment

Respiratory Protection: Respiratory protection is not required.

Hand Protection: Chemical resistant protective gloves.

Skin Protection: Body protection must be chosen depending on activity and possible exposure.

Eye Protection: Safety glasses with side-shields.

Other Precautions: Handle in accordance with good industrial hygiene and safety practice. Eyewash fountains and safety showers must be easily accessible.

F. Transport Information

Sodium sulphate is not considered hazardous for purposes of transportation by road or rail. An Australian Dangerous Goods Code is not required.

XI. DISPOSAL MANAGEMENT

Disposal should be in accordance with all local, state and federal regulations.

XII. REGULATORY STATUS

Australian AICS Inventory: Listed.

XIII. REFERENCES

ADWG. (2021). National Water Quality Management Strategy. Australian Drinking Water Guidelines, Section 6, Australian Government, National Health and Medical Research Council, Natural Resource Management Ministerial Council.

Davies, T.D. and Hall, K.J. (2007). Importance of calcium in modifying the acute toxicity of sodium sulphate to hyalella Azteca and Daphnia magna. Environ. Toxicol. Chem. 26: 1243-1247.

Department of the Environment, Water, Heritage and the Arts [DEWHA]. (2009). Environmental risk assessment guidance manual for industrial chemicals, Department of the Environment, Water, Heritage and the Arts, Commonwealth of Australia.

ECHA. ECHA REACH database: http://echa.europa.eu/information-on-chemicals/registered-substances

European Chemicals Agency [ECHA]. (2008). Guidance on Information Requirements and Chemical Safety Assessment, Chapter R11: PBT Assessment, European Chemicals Agency, Helsinki, Finland.

Klimisch, H.J., Andreae, M., and Tillmann, U. (1997). A systematic approach for evaluating the quality of experimental and toxicological and ecotoxicological data. Regul. Toxicol. Pharmacol. 25:1-5.

Mount, D.R., Gulley, D.D., Hockett, J.R., Garrison, T.D., and Evans, J.M. (1997). Statistical models to predict the toxicity of major ions to Ceriodaphnia dubia, Daphnia magna and Pimephales promelas (Fathead minnows). Environ. Toxicol. Chem. 16: 2009-2019.

OECD. (2005a). Screening Information Dataset (SIDS) Initial Assessment Report for Sodium sulphate (CAS No. 7757-82-6), UNEP Publications.

OECD. (2005b). IUCLID Data Set for Sodium sulphate (CAS No. 7757-82-6), UNEP Publications.

Soucek, D.J. (2007). Comparison of hardness and chloride regulated acute effects of sodium sulphate on two freshwater crustaceans. Environ. Toxicol. Chem. 26: 773-779.

Soucek, D.J., and Kennedy, A.J. (2005). Effects of hardness, chloride, and acclimation on the acute toxicity of sulphate to freshwater invertebrates. Environ. Toxicol. Chem. 24: 1204-1210.

SODIUM SULPHITE

This dossier on sodium sulphite presents the most critical studies pertinent to the risk assessment of sodium sulphite in its use in coal seam or shale gas extraction activities. This dossier does not represent an exhaustive or critical review of all available data. The information presented in this dossier was obtained primarily from the ECHA database that provides information on chemicals that have been registered under the EU REACH (ECHA). Where possible, study quality was evaluated using the Klimisch scoring system (Klimisch et al., 1997).

NICNAS has assessed sodium sulfite in an IMAP Tier 1 assessment and concluded that it poses no unreasonable risk to the environment[1]

I. SUBSTANCE IDENTIFICATION

Chemical Name (IUPAC): Disodium sulphate

CAS RN: 7757-83-7

Molecular formula: Na_2SO_3

Molecular weight: 126.04 g/mol

Synonyms: Sodium sulphite, disodium sulphite, sodium bisulphite anhydrous, sodium sulfite

SMILES: [O-]S(=O)[O-].[Na+].[Na+]

II. PHYSICO-CHEMICAL PROPERTIES

Table 1: Overview of the Physico-Chemical Properties of Sodium Sulphite

Property	Value	Klimisch Score	Reference
Physical state at 20°C and 101.3 kPa	White, hexagonal, crystalline solid	2	ECHA
Melting Point	911°C (pressure not provided)	2	ECHA
Boiling Point	No data	-	-
Density	2630 kg/m^3 @ 20°C	2	ECHA
Vapor Pressure	Not applicable	-	-
Partition Coefficient (log K_{ow})	Not applicable	-	-
Water Solubility	307 g/L @ 25°C	2	ECHA
Flash Point			
Auto flammability	Not applicable	-	-
Viscosity	Not applicable	-	-

[1] https://www.industrialchemicals.gov.au/chemical-information/search-assessments?assessmentcasnumber=7757-83-7+

Property	Value	Klimisch Score	Reference
Henry's Law Constant	Not applicable	-	-

Sodium sulphite readily dissociates in aqueous media to the sodium (Na^+) and sulphite (SO_3^{2-}) ions. At neutral pH, a mixture of 50% sulphite (SO_3^{2-}) and 50% bisulphite (HSO_3^{2-}) is present.

In surface waters, sulphite is oxidized to sulfate either catalytically by air oxygen or by microbial action. The presence of cations like iron, copper or manganese in the environment accelerates the oxidation rate significantly.

III. ENVIRONMENTAL FATE PROPERTIES

At environmental pHs, sodium sulphite dissociates in water to form sodium (Na^+) ions, sulphite (SO_2^{3-}) ions, and bisulphite ions (HSO_3^-). In acidic solutions, sulfur dioxide (SO_2) gas may be formed.

Sodium sulphite is not expected to bioaccumulate in the environment because of the resulting strong anionic nature of the substance, as well as its rapid oxidative transformation to sulphates under physiological and environmental circumstances. Due to its anionic nature, any quantitatively relevant adsorption onto soil, or sediments, or suspended matter for sodium sulfite as well as its dissociation products is not to be expected. Furthermore, sulphite will oxidize to sulfate, which is ubiquitous in the environment (ECHA).

IV. HUMAN HEALTH HAZARD ASSESSMENT

A. Summary

Sodium sulphite has low acute toxicity by the oral, inhalation and dermal routes. It is not irritating to the skin or eyes; it is not a skin sensitiser. No systemic toxicity was seen in rats when given sodium metabisulphite (which dissociates to the sulphite ion) in their diet over a lifetime. There were, however, indications of stomach lesions as a result of localized irritation from the ingestion of sodium metabisulphite. Genetic toxicity studies were negative. Lifetime oral feeding studies on sodium metabisulphite in rats and mice showed no evidence of carcinogenicity. No reproductive or developmental toxicity was observed in any of the animal studies on sodium metabisulphite.

B. Pharmacokinetics and Metabolism

Sodium sulphite is rapidly absorbed from the gastro-intestinal tract. Sulfate is the main metabolite formed by the action of sulphite oxidase in many tissues. Tissue accumulation of sulphite-derived S is highest in stomach, skin and hair, intestine, and kidney. Excretion is rapid, mainly in the urine (OECD, 2008).

C. Acute Toxicity

The oral LD_{50} of sodium sulphite in male and female Sprague-Dawley rats is 2,610 mg/kg bw (ECHA) [KI. score = 2].

The 4-hour inhalation LC_{50} in male and female Sprague-Dawley rats by nose/head-only dust/aerosol exposure to sodium sulphite is >5.5 mg/L. The mass median aerodynamic diameter (MMAD) was 3.0 μm, with 90.7% of the dust being respirable (ECHA) [Kl. score = 2].

The acute dermal LD_{50} in male and female Wistar rats exposed to disodium sulfate via semi occlusive dressing is >2,000 mg/kg bw (ECHA) [Kl. score = 1].

D. Irritation

Application of 0.5 g disodium sulfate to the skin of Vienna white rabbits for 4 hours under occlusive conditions was non-irritating. The mean erythema score was 0.5 and the mean oedema score was 0. In addition to this, oedema and erythema was not observed at the 8th day reading (ECHA) [Kl. score = 2].

Instillation of 162 mg disodium sulfate (equivalent to 0.1 mL bulk volume) into the eyes of Vienna white rabbits was not irritating. The mean of the 24, 48, and, 72-hour scores were: 0.00 for corneal lesions; 0.00 for iridial lesions; 0.9 for conjunctival redness; and 0.5 for chemosis (ECHA) [Kl. score = 2].

E. Sensitisation

Sodium sulfite was not considered to be a skin sensitiser at concentrations of 10%, 25%, and 50% w/w in a mouse local lymph node assay (ECHA) [Kl. score = 1].

F. Repeated Dose Toxicity

<u>Oral</u>

There are no studies available on sodium sulphite.

Male and female Wistar rats were given in their diet 0, 0.125, 0.25, 0.5, 1.0, or 2.0% sodium metabisulphite for up to two years and over three generations. The diet was enriched with thiamine to prevent thiamine deficiency as a result of sulphite-induced destruction of this vitamin. During storage up to the time of consumption, the losses of sulphite from the feed containing sodium metabisulphite at levels of 0.125, 0.25, 0.5, 1.0, and 2.0% averaged 22, 14,12, 8, and 4.5%, respectively, while the decrease in thiamine was 2.7, 1.7, 8.3, 14.5, and 15.4%, respectively. Addition of thiamine to the diet prevented thiamine deficiency in rats at all dose levels based on measurements of thiamine levels in the urine and liver. The general condition of the rats was good during the first 72 weeks in the F_0 generation, as well as the other two generations. After 72 weeks, there was a rapid increase in mortality in all groups. Survival in the treated groups were generally higher than the controls, except for the 2% F_1 males; no deaths occurred in the 2% F_2 females. A marginal reduction in body weight gain was observed in the 2% dose group (both sexes) in the F_1 and F_2 generations. Feed consumption was similar between treated and control groups. There were no changes in hematology and clinical chemistry parameters and urinalysis that were considered toxicologically significant. The $\geq$1% dietary groups had occult blood in their feces. Relative kidney weights were increased in the 2% F_2 females, but there were no pathological changes noted in the kidneys from this group. Hyperplastic changes in the fore- and glandular stomachs were noted in the $\geq$1% groups in all three generations. Some slight alterations were also noted in stomachs of the 0.5% F_2 rats. The NOAEL for systemic toxicity is 1.91% in the diet. This was estimated to be >955 mg/kg bw/day based on a rat body weight of 400 g and a daily feed intake of 20 g. The histopathologic

effects on the stomach and the occult blood in faeces are considered to be the result of localized irritation (a site-of-contact effect) from the ingestion of sodium metabisulphite (Til et al., 1972 as cited in ECHA). [Kl. score = 2]

Inhalation

There are no adequate studies are available.

Dermal

There are no studies available.

G. Genotoxicity

In vitro Studies

The in vitro genotoxicity studies conducted on sodium sulphite and sodium metasulphite are presented in Table 2.

Table 2: *In vitro* Genotoxicity Studies on Sodium Sulphite and Sodium Metabisulphite

Test System	Results*		Klimisch Score	Reference
	-S9	+S9		
Bacterial reverse mutation (*S. typhimurium* strains)	-	-	2	ECHA
Mammalian cell gene mutation (mouse lymphoma L5178Y cells)**	-	-	1	ECHA
Bacterial reverse mutation (S. typhimurium strains) ***	-	-	2	ECHA

*+, positive; -, negative
**Sodium metasulphite
***sodium disulphite

In Vivo Studies

Male Sprague-Dawley rats were fed in their diet 0, 4.5, 15, or 45 mg/kg-day sodium bisulfite Sodium bisulfite was negative in a rodent dominant lethal mutation assay. The dominant lethal test did not produce any consistent responses that would suggest that sodium bisulfite is mutagenic to Sprague-Dawley rats (ECHA) [KI. score =2].

Male NMRI mice were given a single subcutaneous dose of disodium sulfate at the following concentrations: 0, 250, 500, or 1,000 mg/kg in a chromosome aberration assay. There were no increases in chromosomal aberrations in the bone marrow cells of treated rats compared to the those in the control animals. Under the experimental conditions, disodium sulfate did not induce any chromosome-damaging (clastogenic) effects nor were there any indications of impairment of chromosome distribution during mitosis (aneugenic activity) in bone marrow cells *in vivo* (ECHA) [Kl. score = 1].

H. Carcinogenicity

Oral

There are no carcinogenicity studies available sodium sulphite.

Male and female Wistar rats were fed in their diet 0, 0.125, 0.25, 0.5, 1.0, or 2.0% sodium metabisulphite for up to two years and over three generations. There was no increased incidence of tumours in the treated groups compared to the controls and there was no evidence of carcinogenic activity (Til et al., 1972; as cited in ECHA). [Kl. score = 2]

Male and female ICR/JCL mice were given 0, 1, or 2% potassium metabisulphite continuously in their drinking water for 24 months (2 years). There were no increased incidences of tumours in the treated mice compared to controls and there was no evidence for carcinogenicity (Taneka et al., 1994; as cited in ECHA) [Kl. score = 2].

Male and female Wistar rats were continuously exposed to sodium metabisulfite in their diet/feed for 56 days (short-term study) and up to 24 months (long-term study) at the following concentrations: 0.125%, 0.25%, 0.5%, 1.0%, and 2.0%. Sodium metabisulfite induced hyperplastic changes in the forestomach at dietary levels of 0.5% and higher. The NOAEL for local toxicity was determined to be 0.25% (corrected to 0.215% based on analytical verifications). The lesions induced by sodium metabisulfite in the glandular stomach consisted of microerosions, necrosis of epithelial cells, cellular infiltrations, and atypical glandular hyperplasia. However, upon microscopic examination there was no evidence for the formation of tumour (ECHA) [KI. score = 2].

Male and female rats were exposed to 750 ppm and 275 ppm of sodium metabisulphite via their drinking water for up to 2.5 years (over 3 generations). The incidence of tumours was unaffected by the addition of sodium metabisulphite to rats drinking water and sodium metabisulphite was proven to be non-toxic (ECHA) [KI. score = 2].

Male Fischer 344/DuCrj were exposed to potassium sulfite and potassium metabisulfite via a single dose oral gavage at the following concentrations: 0.45, 0.89, 1.34 g/kg bw (potassium sulfite) and 0.5,0.8,1.1, and 1.4 g/kg bw (potassium metabisulfite). The results from this study suggest that potassium sulfite and potassium metabisulfite may have tumour promoting activities in glandular stomach carcinogenesis (ECHA) [KI. score = 2].

Male Wistar rats were exposed to 1% potassium metabisulfite via their drinking water for up to 40 weeks. The findings from this study suggest that potassium metabisulfite could be considered to exert tumour promoting activity in the rat glandular stomach (ECHA) [KI. score = 2].

Inhalation

There were no adequate studies available.

I. Reproductive Toxicity

Male and female Wistar rats were continuously fed in their diet 0, 0.125, 0.25, 0.5, 1.0, or 2.0% sodium metabisulphite for up to two years and over three generations. The diet was enriched with thiamine to prevent thiamine deficiency as a result of sulphite-induced destruction of this vitamin. During storage up to the time of consumption, the losses of sulphite from the feed containing sodium metabisulphite at levels of 0.125, 0.25, 0.5, 1.0, and 2.0% averaged 22, 14,12, 8, and 4.5%, respectively, while the decrease in thiamine was 2.7, 1.7, 8.3, 14.5, and 15.4%, respectively. Addition of thiamine to the diet prevented thiamine deficiency in rats at all dose levels based on measurements of thiamine levels in the urine and liver. The effects other than reproductive and developmental toxicity are discussed above in the Repeated Dose Toxicity section. There were no treatment-related effects on female fertility, the number of young per litter, or birth weight or mortality of the offspring. The number of F_{2a} pups was significantly reduced in the $\geq$0.5% groups during the first breeding cycle, but there was no dose-response, and the reduction did not occur during the second breeding cycle. Slight growth retardation was observed in the F_1 and F_2 generation rats both before and after weaning. The NOAEL for reproductive toxicity is 1.91% in the diet. This was estimated to be >955 mg/kg bw/day based on a rat body weight of 400 g and a daily feed intake of 20 g (Til et al., 1972; as cited in ECHA). [Kl. score = 2]

Male and female rats were given sodium metabisulphite in their drinking water for up to 2.5 years and in three successive generations. The doses were 375 and 750 ppm as sulfur dioxide (SO_2). There was no evidence of systemic toxicity in either dose group. The number of offspring of either the F_1 and F_2 generation and the proportion surviving to the end of lactation were similar between treated and control groups. The NOAEL for reproductive toxicity is 750 ppm (as SO_2) in drinking water. Assuming an average rat body weight of 400 g and a daily water intake of 28 mL, 750 ppm (as SO_2) corresponds to 53 mg/kg bw/day sodium metabisulphite (Lockett and Natoff, 1960; as cited in ECHA). [Kl. score = 2]

J. Developmental Toxicity

Pregnant female Wistar rats were fed in the diet 0, 0.32, 0.63, 1.25, 2.5, or 5% sodium sulfite heptahydrate($Na_2SO_3 \bullet 7H_2O$) during GD 8 to 20. Maternal body weight gain and feed consumption were reduced in the 5% dose group. There was some evidence of reduced body weight gain in all treated groups, but there was no dose-response relationship, and these effects were not observed in the live birth component of the study. The live birth component showed no treatment-related changes in the pups at three weeks after birth. There was no evidence of teratogenicity. The NOAELs for maternal and developmental toxicity are 2.5% and 5% in the diet, respectively. The calculated daily doses are approximately 850 and 1,450 mg/kg-day, respectively (ECHA). [Kl. score = 2]

Dutch rabbits were exposed to 1.23, 5.71, 26.5, and 123 mg/kg bw of sodium metabisulfite daily via oral gavage from gestation day 6-18 until gestation day 29. The highest tested dose of 123 mg/kg bw/day of sodium metabisulfite did not produce any clearly discernible effects on maternal or foetal survival. The number of abnormalities seen in either soft or skeletal tissues of the test groups did not differ from the number occurring spontaneously in the sham treated controls. The NOAEL for maternal and developmental toxicity is expected to be above the highest dose of 123 mg/kg bw/day sodium metabisulfite in this study (ECHA) [KI. score = 2].

Wistar rats were fed 0.1%, 1.0% and 10% potassium metabisulfite from gestation days 7-14 up to day 20 of gestation (two-thirds of animals) or until week 15 after birth (one third of animals). Exposure to 10%

potassium metabisulfite caused a slight decrease in the postnatal survival rate of the offspring (most likely due to maternal malnutrition) and a reduction in maternal body weight gain during pregnancy and food intake. There was no evidence of teratogenesis of the foetuses in this study. There were several types of skeletal variations as well as delayed ossification in some treatment groups, but these findings were not significantly different from the control group. There were no adverse effects on the pre and postnatal development of the offspring in the rats exposed to 0.1% and 1.0% potassium metabisulfite. The findings from this study helped to conclude that potassium metabisulfite does not have teratogenic effects in rats. The NOAEL for maternal and fetotoxicity in this study was established at the 1.0% dose level (1,320 mg/kg bw/day or 766 mg/kg bw/day SO2 equivalents) (ECHA) [KI. score = 2].

Wistar rats were administered 1.55, 7.19, 33.4, and 155 mg/kg bw potassium metabisulfite daily via oral gavage from day 6 to 15 of gestation until day 20 of gestation. The highest dose tested (155 mg/kg bw) did not induce any discernible effects on maternal or foetal survival. The NOAEL for maternal and developmental toxicity is expected to be above the 155 mg/kg bw/day (ECHA) [KI. score = 2].

CD-1 mice were exposed to 1.25, 5.47, 26.9, and 125 mg/kg bw potassium metabisulfite daily via oral gavage from day 6 to 15 of gestation until day 17 of gestation. The highest dose tested did not cause any discernible effects on maternal or foetal survival. The NOAEL for maternal and developmental toxicity is expected to be above 125 mg/kg bw/day (ECHA) [KI. score = 2].

V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES

The toxicological reference values developed for sodium sulphite follow the methodology discussed in enHealth (2012). The approach used to develop drinking water guidance values is described in the Australian Drinking Water Guidelines (ADWG, 2011).

A. Non-Cancer

Oral

Local effects in the stomach were the most predominant finding of repeated dose toxicity. The NOAEL for local chronic effects in the study described by Til et al. (1972) reported in ECHA is represented by the dose of 0.25% metabisulfite. The corrected dose level corresponded to a dose of 108 mg/kg bw/day $Na_2S_2O_5$. All observed effects (occurrence of occult blood in faeces and changes in gastric morphology) were detected at higher dose levels at and above 0.5% in the diet (220 mg/kg bw/day Na_2S2O_5). There was no evidence of systemic toxicity following chronic treatment with sodium metabisulfite. Therefore, the NOAEL for systemic effects can be expected above the highest dose of 2% metabisulfite in the diet corresponding to 955 mg/kg bw/day of $Na_2S_2O_5$. The NOAEL of 955 mg/kg bw/day from this study will be used for determining the oral reference dose (RfD) and the drinking water guidance value.

Oral Reference Dose (oral RfD)

Oral RfD = NOAEL / (UF_A x UF_H x UF_L x UF_{Sub} x UF_D)

Where:
UF_A (interspecies variability) = 10
UF_H (intraspecies variability) = 10

UF_L (LOAEL to NOAEL) = 1
UF_{Sub} (subchronic to chronic) = 1
UF_D (database uncertainty) = 1

Oral RfD = 955/(10 x 10 x 1 x 1 x 1) = 955/100 = 9.55 mg/kg bw/day

Drinking water guidance value

Drinking water guidance value = (animal dose) x (human weight) x (proportion of intake from water) / (volume of water consumed) x (safety factor)

Using the oral RfD,
Drinking water guidance value = (oral RfD) x (human weight) x (proportion of water consumed) / (volume of water consumed)

where:
Human weight = 70 kg (ADWG, 2011)
Proportion of water consumed = 10% (ADWG, 2011)
Volume of water consumed = 2L (ADWG, 2011)

Drinking water guidance value = (9.55 x 70 x 0.1)/2 = 33.4 mg/L

Sodium sulphite readily dissociates in aqueous media to the sodium (Na^+) and sulphite (SO_3^{2-}) ions. The Australian drinking water guideline values for sodium (180 mg/L) and sulphate (250 mg/L) may also apply to sodium sulphite.

B. Cancer

No carcinogenic effects were reported for sodium metabisulphite in rat and mouse chronic studies. Thus, a cancer reference value for sodium sulphite was not derived.

VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES

Sodium sulphite does not exhibit the following physico-chemical properties:

- Explosivity
- Flammability
- Oxidizing potential

VII. ENVIRONMENTAL HAZARD ASSESSMENT

A. Summary

Sodium sulphite is low toxicity to aquatic life.

B. Aquatic Toxicity

Acute Studies

Table 3 lists the results of acute aquatic toxicity studies conducted on sodium sulphite and sodium disulphite.

Table 3: Acute Aquatic Toxicity Studies on Sodium Sulphite and Sodium Disulphite

Test Species	Endpoint	Results (mg/L)	Klimisch Score	Reference
Leuciscus idus (Golden orfe)	96-hr LC_{50}	316	2	ECHA
Daphnia magna	48-hr EC_{50}	89* (59)	2	ECHA
Desmodesmus subspicatus	72-hr EC_{50}	43.8* (29)	2	ECHA

*Test substance: sodium disulphite

Chronic Studies

Table 4 lists the results of chronic aquatic toxicity studies conducted on sodium sulphite and sodium disulphite.

Table 4: Chronic Aquatic Toxicity Studies on Sodium Sulphite and Sodium Disulphite

Test Species	Endpoint	Results (mg/L)	Klimisch Score	Reference
Zebrafish	34-d NOEC	>316	1	ECHA
Daphnia magna	21-d NOEC	>10* (6.6)	1	ECHA
Desmodesmus subspicatus	EC_{10}	33.3* (22)	2	ECHA

*Test substance: sodium disulphite; adjusted concentration for sodium sulphite in parentheses.

C. Terrestrial Toxicity

No data are available.

D. Calculation of PNEC

The PNEC calculations for sodium sulphite follow the methodology discussed in DEWHA (2009).

The PNEC calculations for sodium metabisulphite follow the methodology discussed in DEWHA (2009).

PNEC Water

Experimental results are available for three trophic levels. Acute $E(L)C_{50}$ values are available for fish (316 mg/L), *Daphnia* (59 mg/L), and algae (29 mg/L). Results from chronic studies are also available for all three trophic levels, with the lowest NOEC or EC_{10} being 6.6 mg/L for invertebrates. On the basis that the data consists of short-term and long-term results from three trophic levels, an assessment factor of 10 has been applied to the lowest reported NOEC of 6.6 mg/L for invertebrates. The $PNEC_{water}$ is 0.7 mg/L.

PNEC Sediment

No experimental toxicity data on sediment organisms are available. Sodium sulphite dissociates completely in water with its environmental distribution is dominated by its high water solubility. K_{ow} and K_{oc} parameters do not readily apply to inorganics, such as sodium sulphite. Thus, the equilibrium partitioning method cannot be used to calculate the $PNEC_{sed}$. Based on its properties, no adsorption of sodium sulphite to sediment is to be expected, and the assessment of this compartment will be covered by the aquatic assessment.

PNEC Soil

No experimental toxicity data on soil organisms are available. Sodium sulphite dissociates completely in water with its environmental distribution is dominated by its high-water solubility. K_{ow} and K_{oc} parameters do not readily apply to inorganics, such as sodium sulphite. Thus, the equilibrium partitioning method cannot be used to calculate the $PNEC_{soil}$. Based on its properties, no adsorption of sodium sulphite to soil is to be expected, and the assessment of this compartment will be covered by the aquatic assessment.

VIII. PERSISTENCE, BIOACCUMULATION AND TOXICITY (PBT) ASSESSMENT

The methodology for the Persistent, Bioaccumulative and Toxic (PBT) substances assessment is based on the Australian and EU Reach Criteria methodology (DEWHA, 2009; ECHA, 2008).

Sodium sulphite is an inorganic compound that dissociates completely to sodium ions, sulphite and bisulphite ions, and sulfur dioxide in aqueous solutions. Biodegradation is not applicable to these compounds. For the purposes of this PBT assessment, the persistent criteria are not considered applicable to sodium sulphite or its dissociated compounds.

Bioaccumulation is not to be expected because of the resulting strong anionic nature of the substance, as well as its rapid oxidative transformation to sulphates under physiological and environmental circumstances. Thus, sodium sulphite does not meet the screening criteria for bioaccumulation.

The NOEC or EC_{10} values from chronic aquatic toxicity studies on sodium sulphite is >0.1 mg/L. Thus, sodium sulphite does not meet the criteria for toxicity.

Therefore, sodium sulphite is not a PBT substance.

IX. CLASSIFICATION AND LABELLING

A. Classification

H302: Harmful if swallowed
H314: Causes severe skin burns and eye damage
H315: Causes skin irritation
H319: Causes serious eye irritation
Acute toxicity-category 4
Eye damage- category 1

B. Labelling

Danger

C. Pictogram



X. HANDLING AND SAFETY INFORMATION (OCCUPATIONAL LIMITS AND TRANSPORTATION REQUIREMENTS)

A. First Aid

Eye Contact

Immediately flush open eyes with plenty of water for at least 15 minutes. Remove contacts, if present and easy to do. Get medical attention immediately, preferably a physician for an ophthalmologic examination.

Skin Contact

Wash thoroughly with soap and water.

Inhalation

If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.

Ingestion

Rinse mouth with water and then drink plenty of water. Never give anything by mouth to an unconscious person. If symptoms develop, seek medical advice.

B. Fire Fighting Information

Extinguishing Media

Water spray, carbon dioxide, foam, dry chemical.

Specific Exposure Hazards

When contacted by water, sodium metabisulphite releases sulfur dioxide (SO_2), a poisonous gas. In the case of fire, the following may be liberated: Sulfur oxides and sulfur dioxide.

Special Protective Equipment for Firefighters

Wear self-contained breathing apparatus.

C. Accidental Release Measures

Personal Precautions

Use appropriate protective equipment.

Environmental Precautions

Prevent from entering sewers, waterways, or low areas. When contacted by water, sodium metabisulphite releases sulfur dioxide (SO_2), a poisonous gas.

Steps to be Taken if Material is Released or Spilled

Scoop up and remove.

D. Storage And Handling

General Handling

When sodium metabisulphite gets wet or moist, it liberates sulfur dioxide (SO_2), a poisonous gas. Use proper protective equipment and exposure controls to prevent exposure to this toxic gas.

Other Handling Precautions

Avoid eye and skin contact. Avoid creating or inhaling dust. Keep away from acids and oxidizing agents.

Storage

Keep container tightly closed and in a dry and well-ventilated place. Keep in a cool place.

E. Exposure Controls / Personal Protection

Occupational Exposure Standards

A workplace exposure standard is not available in Australia for sodium sulphite. However, the workplace exposure standards for sodium metabisulphite (disulphite) and sodium bisulphite in Australia is 5 mg/m^3 as an 8-hr TWA.

Engineering Controls

None

Personal Protection Equipment

Respiratory Protection:
Respiratory protection is not required.

Hand Protection:
Chemical resistant protective gloves.

Skin Protection:
Body protection must be chosen depending on activity and possible exposure.

Eye protection:
Safety glasses with side-shields.

Other Precautions:
Handle in accordance with good industrial hygiene and safety practice. Eyewash fountains and safety showers must be easily accessible.

F. Transport Information

Sodium sulphite is not considered hazardous for purposes of transportation by road or rail. An Australian Dangerous Goods code is not required.

XI. DISPOSAL MANAGEMENT

Disposal should be in accordance with all local, state, and federal regulations.

XII. REGULATORY STATUS

Australian AICS Inventory: Listed.

XIII. REFERENCES

ADWG. (2011). National Water Quality Management Strategy. Australian Drinking Water Guidelines, Section 6, Australian Government, National Health and Medical Research Council, Natural Resource Management Ministerial Council. Updated January 2022. Available: https://www.nhmrc.gov.au/about-us/publications/australian-drinking-water-guidelines

Department of the Environment, Water, Heritage and the Arts [DEWHA]. (2009). Environmental risk assessment guidance manual for industrial chemicals, Department of the Environment, Water, Heritage and the Arts, Commonwealth of Australia. Available: http://www.nepc.gov.au/resource/chemical-risk-assessment-guidance-manuals

ECHA. ECHA REACH database: http://echa.europa.eu/information-on-chemicals/registered-substances

enHealth Human Risk Assessment [HHRA] (2012). Environmental Health Risk Assessment, Guidelines for Assessing Human Health Risks from Environmental Hazards. Office of Health Protection of the Australian Government Department of Health. Available: https://www1.health.gov.au/internet/main/publishing.nsf/Content/health-pubhlth-publicat-environ.htm

European Chemicals Agency [ECHA]. (2017). Guidance on Information Requirements and Chemical Safety Assessment, Chapter R11: PBT Assessment, European Chemicals Agency, Helsinki, Finland. Available: https://echa.europa.eu/guidance-documents/guidance-on-information-requirements-and-chemical-safety-assessment

Klimisch, H.J., Andreae, M., and Tillmann, U. (1997). A systematic approach for evaluating the quality of experimental and toxicological and ecotoxicological data. Regul. Toxicol. Pharmacol. 25:1-5.

OECD (2008). Screening Information Dataset (SIDS) Initial Assessment Report for Sodium Sulphite (CAS No. 7757-83-7). Available at: https://hpvchemicals.oecd.org/UI/SIDS_Details.aspx?id=AF456240-42B5-4118-8E97-4FE480D85FB9.

Tanaka, T., Fujii, M., Mori, H., and Hirono, I. (1979) Carcinogenicity test of potassium metabisulphite in mice. Ecotoxicol. Environ. Safety 3: 451-453.

Til, H.P., Feron, V.P., de Groot, A.P. (1972). The toxicity of sulphite. I. Long-term feeding and multigeneration studies in rats. Fd. Cosmet. Toxicol. 10: 291-310.

SODIUM THIOSULPHATE

This dossier on sodium thiosulphate presents the most critical studies pertinent to the risk assessment of sodium thiosulphate in its use in coal seam or shale gas extraction activities. This dossier does not represent an exhaustive or critical review of all available data. The information presented in this dossier was obtained from the ECHA database that provides information on chemicals that have been registered under the EU REACH (ECHA). Where possible, study quality was evaluated using the Klimisch scoring system (Klimisch et al., 1997).

NICNAS has assessed sodium thiosulphate in an IMAP Tier 1 assessment and concluded that it poses no unreasonable risk to the environment[1].

I. SUBSTANCE IDENTIFICATION

Chemical Name (IUPAC): Disodium sulfanidesulphonate

CAS RN: 7772-98-7

Molecular formula: $Na_2S_2O_3$

Molecular weight: 158.1 g/mol

Synonyms: Sodium thiosulphate; disodium sulphanidesulphonate; sodium thiosulphate; thiosulfuric acid, disodium salt; disodium sulphurothioate

SMILES: [O-]S(=O)(=S)[O-].[Na+].[Na+]

II. Physico-Chemical Properties

Table 1: Overview of the Physico-Chemical Properties of Sodium Thiosulphate

Property	Value	Klimisch Score	Reference
Physical state at 20°C and 101.3 kPa	Colourless crystalline solid	2	ECHA
Melting point	<500°C (decomposition occurs) (pressure not indicated)	1	ECHA
Boiling Point	Not available	-	-
Density	1690 kg/m^3 @ 20°C	2	ECHA
Vapor Pressure	Not applicable	-	-
Partition Coefficient (log Kow)	Not applicable	-	-
Water solubility	764 g/L @ 25°C	2	ECHA
Flash Point	Not applicable	-	-
Auto flammability	Not applicable	-	-
Viscosity	Not applicable	-	-

[1]https://www.industrialchemicals.gov.au/chemical-information/search-assessments?assessmentcasnumber=7772-98-7++

Property	Value	Klimisch Score	Reference
Henry's Law Constant	Not applicable	-	-

III. ENVIRONMENTAL FATE PROPERTIES

Sodium thiosulphate dissociates in aqueous media to sodium (Na^+) and thiosulphate ($S_2O_3^{2-}$) ions. The thiosulphate anion is stable in neutral or alkaline media, but not in acidic media (EPA, 2007). In aqueous media, thiosulphate irreversibly disproportionates to sulphide and sulphate (EPA, 2007).

Biodegradation is not applicable to inorganic compounds. Sodium thiosulphate is not expected to bioaccumulate; it will dissociate to ions that are ubiquitous in the environment. Sodium thiosulphate is not expected to adsorb to soil or sediment because of its dissociation properties and high water solubility.

IV. HUMAN HEALTH HAZARD ASSESSMENT

A. Summary

Sodium thiosulphate is of low acute and chronic toxicity via oral dosing. It is not an eye or skin irritant nor does it illicit skin sensitisation effects. The substance does not exhibit genotoxicity, mutagenicity, carcinogenicity, reproductive or developmental toxicity.

B. Acute Toxicity

There are no acute toxicity studies available for sodium thiosulphate.

The oral LD_{50} of potassium thiosulphate in rats is >2,500 mg/kg (ECHA) [Kl. score = 2]. The oral LD_{50} of calcium thiosulphate in rats is >2,000 mg/kg (ECHA) [Kl. score = 1].

The inhalation 4-hr LC_{50} of potassium thiosulphate in rats is >2.6 mg/L aerosol, whole body. (ECHA) [Kl. score = 1]. The mass median aerodynamic diameter was 2.1 µm (ECHA) [KI. score =1].

The inhalation 4-hr LC_{50} for sodium sulphite in rats is >5.5 mg/L dust/aerosol test, nose/head only (ECHA) [KI. Score =2]. The mass median aerodynamic diameter was 2.7µm (ECHA) [KI. score =2].

The dermal LD_{50} of potassium thiosulphate in rabbits is >2000 mg/kg bw. The dermal LD_{50} of ammonium thiosulphate in rabbits is >2000 mg/kg bw (ECHA) [KI. score =2].

C. Irritation

No reliable skin irritation studies are available for sodium thiosulphate or other thiosulphate salts.

Sodium sulphite in the amount of 0.5 grams was administered to Vienna white rabbits via occlusive dressing for four hours. The rabbits were observed for 8 days with readings at 30-60 minutes after application of test material and 24 hours, 48 hours, and 8 days after the start of application. The mean score for after application of the test substance was 0.33 for erythema and 0 for oedema. On the 8th day of observation, there was no evidence of erythema or oedema, which suggests that all the observed effects were fully reversible (ECHA) [KI. score =2].

Instillation of 0.1 mL or 75 mg of ammonium thiosulphate into the left eyes of rabbits was determined to be non-irritating. The mean of the 1,24-, 48-, and 72-hour scores were: 0.00 for corneal opacity; 0.00 for iridial lesions; 0.56 for conjunctival redness; and 0.11 for chemosis (ECHA) [Kl. score = 2]. All signs of eye irritation in all of the treated animals were cleared by the 72-hour observation period (ECHA) [KI. score =2].

D. Sensitisation

Ammonium thiosulphate was not considered to be a skin sensitiser to mice based on reported findings from a mouse local lymph node assay (ECHA) [Kl. score = 1]. Treatment with concentrations of 10%, 25% or 50% ammonium thiosulphate did not induce a stimulation index for lymph node cell count above 1.4 and lymph node weight was not increased. In addition to this, there were no signs of local or systemic intolerance and the animal body weight was not impacted by exposure to ammonium thiosulphate (ECHA) [KI. score =1].

E. Repeated Dose Toxicity

Oral

No studies are available on the thiosulphate salts. Under acidic conditions, thiosulphates will disproportionate in aqueous mediate to form polythionic acids and bisulphite (HSO_3^-) ions plus sulfur dioxide gas (SO_2) (ECHA). A 2-year three-generation rat study on sodium metabisulfite will be used to read-across to sodium thiosulphate because sodium metabisulfite dissociates in water to form sodium (Na^+) ions, disulphite ($S_2O_5^{2-}$) ions, and sulfur dioxide (SO_2). The disulfite ions can form bisulphite (HSO_3^-) and sulfite ions (SO_2^{3-}) in varying proportions dependent on the pH of the solution (OECD, 2001).

Male and female Wistar rats were fed in their diet 0, 0.125, 0.25, 0.5, 1.0, or 2.0% sodium metabisulfite in a thiamine-containing diet (50 ppm) for up to two years and over three generations. The diet was enriched with thiamine to prevent thiamine deficiency as a result of the sulphite-induced destruction of this vitamin. During storage up to the time of consumption, the losses of sulphite from the feed containing sodium metabisulfite at levels of 0.125, 0.25, 0.5, 1.0, and 2.0% averaged 22, 14,12, 8, and 4.5%, respectively, while the decrease in thiamine was 2.7, 1.7, 8.3, 14.5, and 15.4%, respectively. The addition of thiamine to the diet prevented thiamine deficiency in rats at all dose levels based on measurements of thiamine levels in the urine and liver. The general condition of the rats were good during the first 72 weeks of the F0 generation, as well as the other two generations. After 72 weeks, there was a rapid increase in mortality in all groups. Survival in the treated groups was higher than the controls, except for the 2% F_1 males; no deaths occurred in the 2% F_2 females. A marginal reduction in body weight gain was observed in the 2% dose group (both sexes) in the F_1 and F_2 generations. Feed consumption was similar was between treated and control groups. There were no changes in haematology and clinical chemistry parameters and urinalysis that were considered toxicologically significant. The $\geq$1% dietary groups had occult blood in their feces. Relative kidney weights were increased in the 2% F_2 females, but there were no pathological changes noted in the kidneys from this group. Hyperplastic changes in the fore- and glandular stomachs were noted in the $\geq$1% groups in all three generations. Some slight alterations were also noted in stomachs of the 0.5% F_2 rats. Based on the occurrence of occult blood in faeces and changes in gastric morphology at dose levels of 0.5% or more, the NOAEL for local chronic toxicity in this study is represented by the dose of 0.25% metabisulfite (0.215% accounting for the loss of metabisulfite). The corrected dose level corresponds to a dose of 108 mg/kg bw/day of sodium thiosulphate. The NOAEL for systemic toxicity is 1.91% in the diet. This was estimated to be >955 mg/kg-day (1589 mg/kg bw/day sodium thiosulphate) based on a rat body weight of 400 g and a

daily feed intake of 20 g. The histopathologic effects on the stomach and the occult blood in feces are considered to be the result of localised irritation (a site-of-contact effect) from the ingestion of sodium metabisulfite (Til et al., 1972; as cited in ECHA). [Kl. score = 2]

Inhalation

There are no adequate studies available to determine a NOAEC for sodium thiosulphate.

Dermal

No studies are available given the fact that there is no evidence for significant absorption through the skin

F. Genotoxicity

In vitro Studies

No studies are available on sodium thiosulphate. The *in vitro* genotoxicity studies on ammonium thiosulphate are presented below in Table 2.

Table 2: *In vitro* Genotoxicity Studies on Ammonium Thiosulphate

Test System	Results*		Klimisch Score	Reference
	-S9	+S9		
OECD Guideline 471 Bacterial reverse mutation (*S. typhimurium* and *E. coli* strains)	-	-	1	ECHA
OECD Guideline 476 (*In Vitro* Mammalian Cell Gene Mutation Test)	-	-	1	ECHA
OECD Guideline 473 *In Vitro* Mammalian Chromosomal aberration Test (Chinese hamster ovary cells)	-	-	1	ECHA

*+, positive; -, negative

In vivo Studies

No studies are available.

G. Carcinogenicity

Oral

No studies are available on the thiosulphate salts. Under acidic conditions, thiosulphates will disproportionate in aqueous mediate to form polythionic acids and bisulphite (HSO_3^-) ions plus sulfur dioxide gas (SO_2) (ECHA). A 2-year three-generation rat study on sodium metabisulfite will be used to read-across to sodium thiosulphate because sodium metabisulfite dissociates in water to form sodium (Na^+) ions, disulphite ($S_2O_5^{2-}$) ions, and sulfur dioxide (SO_2). The disulfite ions can form bisulphite (HSO_3^-) and sulfite ions (SO_2^{3-}) in varying proportions dependent on the pH of the solution (OECD, 2001).

Male and female Wistar rats were fed in their diet 0, 0.125, 0.25, 0.5, 1.0, or 2.0% sodium metabisulfite for up to two years and over three generations. There was no increased incidence of tumours in the treated groups compared to the controls (Til et al., 1972 as cited in ECHA). [Kl. score = 2].

Male and female ICR/JCL mice were given in their drinking water 0, 1, or 2% potassium metabisulfite for two years. There was no increased incidence of tumours in the treated groups compared to the controls (Tanaka et al., 1994 as cited in ECHA). [Kl. score = 2].

Male and female Wistar rats were continuously fed in their diet 0%, 0.5%,1%, 2%, 4%, 6%, and 8% sodium metabisulphite for 10-56 days. Microscopic examinations gave no evidence of the formation of tumours (ECHA) [KI. score =2].

Male and female rats were exposed to 375 and 750 ppm sodium metabisulphite continuously via their drinking water for 2.5 years/over 3 generations. The incidence of tumours was unaffected by the addition of disodium disulphate (ECHA) [KI. Score =2].

Male Fischer 344/DuCrj rats were exposed to potassium sulphite or potassium metabisulfite via oral gavage (single dose). The results from this study indicate that potassium sulphite and potassium metabisulfite may have tumour promoting activity in glandular stomach carcinogenesis (ECHA) [KI. score =2].

Male Wistar rats were exposed to 1% potassium metabisulfite continuously via their drinking water for up to 40 weeks. It was concluded that potassium metabisulfite could be considered to exert tumour promoting activity in the rat glandular stomach (ECHA) [KI. score =2].

Inhalation

Male Sprague-Dawley rats were exposed to 10 and 30 ppm sulfur dioxide via whole body inhalation (gas) for 6 hours per day for 5 days per week for a total of 21 weeks/ 101 exposure days. There were no adverse effects reported from sulfur dioxide exposure (ECHA) [KI. score =2].

H. Reproductive Toxicity

No studies are available on the thiosulphate salts. Under acidic conditions, thiosulphates will disproportionate in aqueous mediate to form polythionic acids and bisulphite (HSO_3^-) ions plus sulfur dioxide gas (SO_2) (ECHA). A 2-year three-generation rat study on sodium metabisulfite will be used to read-across to sodium thiosulphate because sodium metabisulfite dissociates in water to form sodium (Na^+) ions, disulfate ($S_2O_5^{2-}$) ions, and sulfur dioxide (SO_2). The disulfite ions can form bisulfited (HSO_3^-) and sulfite ions (SO_2^{3-}) in varying proportions dependent on the pH of the solution (OECD, 2001).

Male and female Wistar rats were fed in their diet 0, 0.125, 0.25, 0.5, 1.0, or 2.0% sodium metabisulfite for up to two years and over three generations. The diet was enriched with thiamine to prevent thiamine deficiency as a result of the sulfite-induced destruction of this vitamin. During storage up to the time of consumption, the losses of sulfite from the feed containing sodium metabisulfite at levels of 0.125, 0.25, 0.5, 1.0, and 2.0% averaged 22, 14,12, 8, and 4.5%, respectively, while the decrease in thiamine was 2.7, 1.7, 8.3, 14.5, and 15.4%, respectively. The addition of thiamine to the diet prevented thiamine deficiency in rats at all dose levels based on measurements of thiamine levels in the urine and liver. The effects other than reproductive and developmental toxicity are discussed above in the Repeated Dose Toxicity section. There were no

treatment-related effects on female fertility, the number of young per litter, or birth weight or mortality of the offspring. The number of F_{2a} pups was significantly reduced in the ≥0.5% groups during the first breeding cycle, but there was no dose-response, and the reduction did not occur during the second breeding cycle. Slight growth retardation was observed in the F_1 and F_2 generation rats both before and after weaning. The NOAEL for reproductive toxicity is 1.91% in the diet. This was estimated to be 955 mg/kg-day (640 mg sulfur dioxide/kg bw/day) based on a rat body weight of 400 g and a daily feed intake of 20 g (Til et al., 1972 as cited in ECHA). [Kl. score = 2]

Male and female rats were given sodium metabisulfite in their drinking water for up to 2.5 years and three successive generations. The doses were 375 and 750 ppm as sulfur dioxide (SO2). There was no evidence of systemic toxicity in either dose group. The number of offspring of either the F1 and F2 generation and the proportion surviving to the end of lactation were similar between treated and control groups. The NOAEL for reproductive toxicity is 750 ppm (as SO2) in drinking water. Assuming an average rat body weight of 400 g and a daily water intake of 28 mL, 750 ppm (as SO2) corresponds to 53 mg/kg-day sodium metabisulfite (Lockett, 1960 as cited in ECHA). [Kl. score = 2]

I. Developmental Toxicity

Pregnant female Wistar rats were dosed by oral gavage with 0, 4, 19, 86, or 400 mg/kg sodium thiosulphate on GD 6 to 15. There was no maternal or developmental toxicity. The NOAEL for maternal and developmental toxicity is 400 mg/kg-day, the highest dose tested (ECHA) [Kl. score = 2].

Pregnant female CD-1 mice were dosed by oral gavage with 0, 5.5, 25.5, 118, or 555 mg/kg sodium thiosulphate on GD 6 to 15. There was no maternal or developmental toxicity. The NOAEL for maternal and developmental toxicity is 555 mg/kg-day, the highest dose tested (ECHA) [Kl. score = 2].

Pregnant female Dutch-belted rabbits were dosed by oral gavage with 0, 2.5, 5.8, 27, 125.4, or 580 mg/kg sodium thiosulphate on GD 6 to 18. There was no maternal or developmental toxicity. The NOAEL for maternal and developmental toxicity is 580 mg/kg-day, the highest dose tested (ECHA) [Kl. score = 2].

Pregnant female golden hamsters were dosed by oral gavage with 4.0, 19.0, 86.0, and 400 mg/kg bw sodium thiosulphate from gestation day 6 until gestation day 14. The NOAEL for maternal and developmental toxicity is 400 mg/kg-day, the highest dose tested (ECHA) [Kl. score = 2].

V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES

A. Non-Cancer

Oral

Sodium thiosulphate dissociates in aqueous media to sodium (Na^+) and thiosulphate ($S_2O_3^{2-}$) ions. In addition, NICNAS does not consider sodium thiosulphate to pose an unreasonable risk to the health of workers and public health on the basis of the Tier I IMAP assessment.[2] Therefore, an oral reference dose and drinking water guidance value was not derived for sodium thiosulphate.

[2] https://www.nicnas.gov.au/chemical-information/imap-assessments/imap-assessments/human-health-assessments#cas-A_7772-98-7.

The Australian drinking water guideline values for sodium (180 mg/L) and sulphate (250 mg/L) may apply to sodium thiosulphate.

B. Cancer

Sodium or potassium metasulphite were not carcinogenic to rodents in two-year dietary studies. Thus, a cancer reference value was not derived for sodium thiosulphate.

VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES

Sodium thiosulphate does not exhibit the following physico-chemical properties:

- Explosivity
- Flammability
- Oxidizing potential

VII. ENVIRONMENTAL HAZARD ASSESSMENT

A. Summary

The substance does not appear to exhibit significant acute aquatic toxicity. No data are available for chronic toxicity studies.

B. Aquatic Toxicity

Acute Studies

No data are available on sodium thiosulphate. Table 3 lists the results of acute aquatic toxicity studies conducted on ammonium thiosulphate (CAS No. 7783-18-8).

Table 3: Acute Aquatic Toxicity Studies on Ammonium Thiosulphate[1]

Test Species	Endpoint	Results (mg/L)	Klimisch Score	Reference
Lepomis macrochirus	96-hr LC_{50}	510	1	ECHA
Salmo gairdneri	96-hr LC_{50}	770 (583)	1	ECHA
Daphnia magna	48-hr EC_{50}	230 (174)	1	ECHA
Pseudokirchneriella subcapitata	72-hr EC_{50}	>100 (>75.7)	1	ECHA

1 Where provided in ECHA, value in parenthetical is expressed as thiosulphate.

Chronic Studies

No studies were identified for sodium thiosulphate or ammonium thiosulphate. However, reliable chronic toxicity data were available for sodium sulphite (CAS No. 7757-83-7) and sodium disulphite (CAS No. 7757-74-6). **Table 4** lists the results of chronic aquatic toxicity studies conducted on sodium sulphite and sodium disulphite.

Table 4: Chronic Aquatic Toxicity Studies on Sodium Sulphite and Sodium Disulphite

Test Species	Endpoint	Results (mg/L)[1]	Klimisch Score	Reference
Danio rerio (zebrafish)	34-d NOEC	>316 (140.6)	1	ECHA
Daphnia magna	21-d NOEC	>10 (>8)	2	ECHA
Pseudokirchneriella subcapitata	EC_{10}	>75.7	2	ECHA

1 Value in parenthetical indicates data translated to sodium thiosulphate, assuming that all S is converted to sulphite when thiosulphate oxidizes

C. Terrestrial Toxicity

No terrestrial toxicity data are available for this substance.

D. Calculation of PNEC

The PNEC calculations for sodium thiosulphate follow the methodology discussed in DEWHA (2009).

PNEC Water

Experimental results are available on ammonium thiosulphate for three trophic levels. Acute $E(L)C_{50}$ values are available for fish (583 mg/L), Daphnia (174 mg/L), and algae (>75.7 mg/L). NOEC values from long-term studies are available for fish (140.6 mg/L), invertebrates (>8 mg/L), and algae (>75.7 mg/L). On the basis that the data consists of short-term and long-term results from three trophic levels, an assessment factor of 10 has been applied to the lowest reported NOEC value of 8 mg/L for invertebrates. The $PNEC_{water}$ for sodium thiosulphate is 0.8 mg/L.

PNEC Sediment

No experimental toxicity data on sediment organisms are available. Sodium thiosulphate dissociates completely in water with its environmental distribution is dominated by its high water solubility. K_{ow} and K_{oc} parameters do not readily apply to inorganics, such as sodium thiosulphate. Thus, the equilibrium partitioning method cannot be used to calculate the $PNEC_{sediment}$. Based on its properties, no adsorption of sodium thiosulphate to sediment is to be expected, and the assessment of this compartment will be covered by the aquatic assessment.

PNEC Soil

No reliable experimental toxicity data on terrestrial organisms are available. The environmental distribution of sodium thiosulphate is dominated by its water solubility. Sorption of sodium thiosulphate should probably be regarded as a reversible situation, i.e., the substance is not tightly nor permanently bound. K_{ow} and K_{oc} parameters do not readily apply to inorganics, such as sodium thiosulphate. Thus, the equilibrium partitioning method cannot be used to calculate the $PNEC_{soil}$. Based on its properties, sodium thiosulphate is not expected to significantly adsorb to soil, and the assessment of this compartment will be covered by the aquatic assessment.

VIII. PERSISTENCE, BIOACCUMULATION AND TOXICITY (PBT) ASSESSMENT

The methodology for the Persistent, Bioaccumulative and Toxic (PBT) substances assessment is based on the Australian and EU Reach Criteria methodology (DEWHA, 2009; ECHA, 2008).

Sodium thiosulphate is an organic salt that dissociates completely to sodium, sulphide, and sulphate ions in aqueous solutions. Biodegradation is not applicable to these inorganic ions; these ionic species are also ubiquitous and are present in most water, soil and sediment. For the purposes of this PBT assessment, the persistent criteria are not considered applicable to sodium thiosulphate or its dissociated ions.

Sodium thiosulphate dissociates to ionic species. The sulphide ion can be oxidized by bacteria to sulphate. The sodium and sulphate ions are essential to all living organisms and their intracellular and extracellular concentrations are actively regulated. Thus, sodium thiosulphate is not expected to bioaccumulate.

There are no chronic toxicity studies on sodium thiosulphate. However, the NOEC or EC10 values from chronic aquatic toxicity studies on read-across sodium sulphite are >0.1 mg/L. The acute $EC(L)_{50}$ values on read-across ammonium thiosulphate are >1 mg/L in fish, invertebrates and algae. Thus, sodium thiosulphate does not meet the screening criteria for toxicity.

The overall conclusion is that sodium thiosulphate is not a PBT substance.

IX. CLASSIFICATION AND LABELLING

A. Classification

H315: Causes skin irritation
H319: Causes serious eye irritation
H335: May cause respiratory irritation

B. Labelling

Warning

C. Pictogram



X. HANDLING AND SAFETY (OCCUPATIONAL LIMITS AND TRANSPORTATION REQUIREMENTS)

A. First Aid

Eye Contact

In the case of contact, immediately flush eyes with plenty of water for at least 15 minutes. If symptoms persist, seek medical advice.

Skin Contact

Wash thoroughly with soap and water.

Inhalation

If inhaled, remove from area to fresh air.

Ingestion

Rinse mouth with water and then drink plenty of water. Do not induce vomiting. Never give anything by mouth to an unconscious person. Seek medical attention.

B. Fire Fighting Information

Extinguishing Media

Water spray or fog, carbon dioxide, dry powder.

Specific Exposure Hazards

Burning produces harmful and toxic fumes.

Special Protective Equipment for Firefighters

Wear a self-contained breathing apparatus.

C. Accidental Release Measures

Personal Precautions

No special precautions are necessary. Ensure adequate ventilation.

Environmental Precautions

Do not discharge into drains, sewers, or waterways.

Steps to be Taken if Material is Released or Spilt

For large amounts: dike spillage and pump off the product. For residues: pick up with suitable absorbent material. Dispose of contaminated material as prescribed.

D. Storage And Handling

General Handling

Handle in accordance with good industrial hygiene and safety practice.

Other Handling Precautions

Protect against fire and explosion: prevent electrostatic charge; sources of ignition should be kept well clear, and fire extinguishers should be kept handy.

Storage

Keep container tightly closed and dry. Protect against heat. Store below 25^{o}C.

E. Exposure Controls / Personal Protection

Occupational Exposure Standards

Occupational exposure standards for the low molecular weight PEGs have not been established.

Engineering Controls

Provide local exhaust ventilation to control vapours and mists.

Personal Protection Equipment

Respiratory Protection: Respiratory protection in case of vapours/aerosol release. Wear a certified organic vapour/particulate respirator.

Hand Protection: Chemical resistant protective gloves.

Skin Protection: Body protection must be chosen depending on activity and possible exposure.

Eye protection: Body protection must be chosen depending on activity and possible exposure. Safety glasses with side-shields.

Other Precautions: Wash hands, forearms, and face thoroughly after handling chemical products, before eating, smoking, and using the lavatory and at the end of the working period. Appropriate techniques should be used to remove potentially contaminated clothing. Wash contaminated clothing before reusing. Ensure that eyewash stations and safety showers are close to the workstation location.

F. Exposure Controls / Personal Protection

Occupational Exposure Standards

Workplace Australia has not established an occupational exposure standard for sodium thiosulphate.

Engineering Controls

Provide local exhaust ventilation to control vapours and mists.

Personal Protection Equipment

Respiratory Protection: Respiratory protection in case of vapours/aerosol release. Wear a certified organic vapour/particulate respirator.

Hand Protection: Chemical resistant protective gloves.

Skin Protection: Body protection must be chosen depending on activity and possible exposure.

Eye protection: Body protection must be chosen depending on activity and possible exposure. Safety glasses with side-shields.

Other Precautions: Wash hands, forearms, and face thoroughly after handling chemical products, before eating, smoking, and using the lavatory and at the end of the working period. Appropriate techniques should be used to remove potentially contaminated clothing. Wash contaminated clothing before reusing. Ensure that eyewash stations and safety showers are close to the workstation location.

G. Transport Information

Sodium thiosulphate is not considered hazardous for purposes of transportation by road or rail. An Australian Dangerous Goods code is not required.

XI. DISPOSAL MANAGEMENT

Disposal should be in accordance with all local, state, and federal regulations.

XII. REGULATORY STATUS

Australian AICS Inventory: Listed.

XIII. REFERENCES

ADWG. (2011). National Water Quality Management Strategy. Australian Drinking Water Guidelines, Section 6, Australian Government, National Health and Medical Research Council, Natural Resource Management Ministerial Council. Updated January 2022. Available: https://www.nhmrc.gov.au/about-us/publications/australian-drinking-water-guidelines

Department of the Environment, Water, Heritage and the Arts [DEWHA]. (2009). Environmental risk assessment guidance manual for industrial chemicals, Department of the Environment, Water, Heritage and the Arts, Commonwealth of Australia. Available: http://www.nepc.gov.au/resource/chemical-risk-assessment-guidance-manuals

ECHA. ECHA REACH database: http://echa.europa.eu/information-on-chemicals/registered-substances

enHealth Human Risk Assessment [HHRA] (2012). Environmental Health Risk Assessment, Guidelines for Assessing Human Health Risks from Environmental Hazards. Office of Health Protection of the Australian Government Department of Health. Available: https://www1.health.gov.au/internet/main/publishing.nsf/Content/health-pubhlth-publicat-environ.htm

European Chemicals Agency [ECHA]. (2017). Guidance on Information Requirements and Chemical Safety Assessment, Chapter R11: PBT Assessment, European Chemicals Agency, Helsinki, Finland. Available: https://echa.europa.eu/guidance-documents/guidance-on-information-requirements-and-chemical-safety-assessment

Klimisch, H.J., Andreae, M., and Tillmann, U. (1997). A systematic approach for evaluating the quality of experimental and toxicological and ecotoxicological data. Regul. Toxicol. Pharmacol. 25:1-5.

Lockett, M.F., and Natoff, I.L. (1960). A study of the toxicity of sulfite. 1. J. Pharm. Pharmacol. 12: 488-496.

OECD (2001). OECDS-SIDS: Disodium disulphite (CAS No. 7657-4). UNEP Publications. Available at: http://www.inchem.org/documents/sids/sids/DISODIUM.pdf

Tanaka, T., Fujii, M., Mori, H., and Hirono, I. (1979) Carcinogenicity test of potassium metabisulfite in mice. Ecotoxicol. Environ. Safety 3: 451-453.

Til, H.P., Feron, V.P., de Groot, A.P. (1972). The toxicity of sulphite. I. Long-term feeding and multigeneration studies in rats. Fd. Cosmet. Toxicol. 10: 291-310.

U.S. EPA [EPA] (2007). Reregistration Elibility Decision (RED) for Ammonium Thiosulphate, Office of Prevention, Pesticides and Toxic Substances, EPA 738-R-07-001, December 20, 2007.

ETHOXYLATED TALLOW ALKYL AMINE

This dossier on tallow alkyl amines ethoxylated presents the most critical studies pertinent to the risk assessment of glutaraldehyde in its use in coal seam or shale gas extraction activities. There is no sufficient data available for this particular substance. This dossier does not represent an exhaustive or critical review of all available data. The majority of information presented in this dossier was obtained from the National Industrial Chemicals Notification and Assessment Scheme (NICNAS, 1994) and the ECHA database that provides information on chemicals that have been registered under the European Union (EU) REACH (ECHA). Where possible, study quality was evaluated using the Klimisch scoring system (Klimisch et al., 1997).

For the purpose of this dossier, fatty acids tall oil ethoxylated (CAS RN 61791-00-2), fatty acids, tall oil, ethoxylated (EO 5) (CAS No. 9004-96-0), or fatty acids, tall-oil, 2-hydroxyethyl esters (CAS RN 97281-31-7) has been reviewed as surrogate chemicals for ethoxylated tallow alkyl amine, where appropriate.

I. SUBSTANCE IDENTIFICATION

Chemical Name (IUPAC): Tallow alkyl amines ethoxylated

CAS RN: 61791-26-2

Molecular formula: Not applicable. This substance is a UVCB.

Molecular weight: Not applicable. This substance is a UVCB.

Synonyms: Ethoxylated tallow alkyl amine; amines, tallow alkyl, ethoxylated; Polyoxyethylene, tallow amine; Primary tallow amine, ethylene oxide adduct

SMILES: Not applicable. This substance is a UVCB.

II. PHYSICO-CHEMICAL PROPERTIES

There are no physical or chemical data for tallow alkyl amines ethoxylated. The data presented below are abstracted from data on a similar substance, fatty acids tall oil ethoxylated (CAS RN 61791-00-2).

Table 1: Physico-Chemical Properties of Tallow Alkyl Amines Ethoxylated[1]

Property	Value	Klimisch Score	Reference
Physical state at 20°C and 101.3 kPa	Liquid.	1	ECHA
Melting point	≥-85 ≤ -5°C @ 101.3 kPa	1	ECHA
Boiling point	Not available. During the heating process the test item began to change its state at approximately 172 °C from liquid to highly viscous. This indicates a thermally caused change of the test item.	1	ECHA

Property	Value	Klimisch Score	Reference
Density	0.958 (relative density) @ 20°C	1	ECHA
Vapour pressure	The vapour pressure could not be determined.	1	ECHA
Partition coefficient (log K_{ow})	5.94 @ 25 °C	1	ECHA
Water solubility	The test item can be mixed with water up to a ratio of 3:7 (m (test item): :m (water). It is not possible to determine a concrete value for the water solubility	1	ECHA
Flash point	Flash point @102.2 kPa 138 °C	1	ECHA
Auto flammability	377 °C @103.1 kPa	1	ECHA
Viscosity	58.0 mPa*s at 20 °C	1	ECHA

[1] = data from fatty acids tall-oil ethoxylated (CAS RN 61791-00-2)

III. ENVIRONMENTAL FATE PROPERTIES

A. Summary

Tallow alkyl amines ethoxylated are expected to biodegrade and show some degree of sorption to sediments and soils. They are not expected to bioaccumulate.

B. Biodegradation

Data on the ready biodegradability of tallow alkyl amines ethoxylated (EO > 1 < 2.5) (CAS 61791-00-2) are not available. Therefore, data on the ready biodegradability of the structurally related analogue substance fatty acids, tall oil, ethoxylated (EO 5) (CAS No. 9004-96-0) is used as read across substance.

This read-across is justified because both, target, and source substance, are structurally identical (ethoxylated oleic acid) except for the fact that the source substance is slightly higher ethoxylated (5 EO) than the target substance (1-2.5EO). This difference might lead to a slightly lower water solubility of the target substance; however, since the solubility of both substances is rather high and not limiting the bio accessibility of the substances to aquatic microorganisms this is not considered to influence the identical biodegradation behaviour of both substances. Both substances share the same functional groups and the same mode of action (baseline toxicity caused by the long lipophilic fatty acid chain). Thus, biotransformation can with very high certainty assumed to be identical.

The biodegradation of fatty acids, tall oil, ethoxylated (EO 5) (CAS No. 9004-96-0) was evaluated test in accordance with OECD Guideline 301 B (Ready Biodegradability: CO_2 Evolution Test), under GLP conditions. Domestic, non-adapted activated sludge was exposed to fatty acids, tall oil, ethoxylated (EO 5) (CAS No. 9004-96-0) for 28 days at 22°C, and biodegradation was measured by CO_2 consumption. After 28 days, fatty acids, tall oil, ethoxylated (EO 5) (CAS No. 9004-96-0) reached a biodegradation of 90 - 100 %. Based on the results for the read-across substance, fatty acids, tall-oil, ethoxylated (EO > 1 < 2.5) (CAS 61791-00-2) is considered to be readily biodegradable (ECHA) [KI. score = 1].

If a chemical is found to be readily biodegradable, it is categorised as Not Persistent since its half-life is substantially less than 60 days (DoEE, 2017).

C. Environmental Distribution

One study investigating the adsorption/desorption behaviour of fatty acids, tall-oil, ethoxylated (CAS RN 61791-00-2) is available. The study was performed according to GLP and OECD guideline 121 (Estimation of Adsorption Coefficient K_{oc} on Soil and on Sewage Sludge using high performance liquid Chromatography or HPLC). Six different peaks were observed with log K_{oc} values ranging from < 1.8 to > 5.63. The two main components (> 85%) show log K_{oc} values > 4. (ECHA) [KI.score =1]. Based on these values and its limited water solubility, fatty acids, tall-oil, ethoxylated will be slightly to hardly mobile in soil as adsorption to soil is expected.

D. Bioaccumulation

Fatty acids, tall-oil, 2-hydroxyethyl esters (CAS RN 97281-31-7) consists of components with log K_{ow} values in the range of 5 to > 10 (KOWWIN v1.68) indicating a potential for bioaccumulation. But due to rapid environmental biodegradation, metabolization via enzymatic hydrolysis (monoesters and diesters) as well as steric hindrance of crossing biological membranes (high molecular weight of diesters) a relevant uptake and bioaccumulation in aquatic organisms is not expected. This is supported by low bioconcentration factor (BCF values of < 100 litres per kilogram of water weight (L/kg ww) (BCFBAF v3.01, Arnot-Gobas, including biotransformation, upper trophic) calculated for different components of the UVCB (mono- and diester EO1 to EO5).

Thus, taking all information into account, fatty acids, tall-oil, 2-hydroxyethyl esters (CAS RN 97281-31-7) is not considered to be bioaccumulative.

IV. HUMAN HEALTH HAZARD ASSESSMENT

A. Summary

Tallow alkyl amines ethoxylated are not acutely toxic. The substance is not expected to be irritating to the eyes or the skin, but it is expected to be a skin sensitiser. Tallow alkyl amines ethoxylated are not genotoxic, mutagenic, or carcinogenic. There is no evidence that tallow alkyl amines ethoxylated cause reproductive or developmental toxicity.

B. Toxicokinetics

There are no data available for tallow alkyl amines ethoxylated.

C. Acute Toxicity

In an acute oral toxicity study performed similar to OECD guideline 401, three groups of Gassner rats consisting of 10 animals/sex/dose were treated by single gavage application with an aqueous solution of fatty acids tall oil ethoxylated (CAS RN 61791-00-2) (10,000, 8,000, 6,400 milligrams per kilogram of body weight [mg/kg bw]). The animals were observed for mortality and for clinical symptoms of toxicity over a period of 7 days. At the end of the observation period, the surviving animals were sacrificed for the purpose of necropsy. No mortality was observed for any of the tested concentrations. At all doses mastication, irregular breathing, redness of the eyes and closed eyes were seen immediately after dosing. The next morning mastication and irregular breathing was observed. On the following days, no clinical sings were observed. Pathological examination revealed hydrometra in 3 animals exposed to 10000 mg/kg bw, 2 animals exposed to 8000 mg/kg bw, and 3

animals exposed to 6,400 mg/kg bw. Based on the results obtained under the test conditions of this study, the acute oral LD_{50} was determined to be > 10,000 mg/kg bw.

In another acute oral toxicity study of similar design four groups of rats consisting of 5 animals/sex/dose were treated by single gavage application with an aqueous solution of fatty acids tall oil ethoxylated (CAS RN 61791-00-2) (200, 6,400, 3,200, 1,600microlitres per kilogram [µL/kg]). The animals were observed for mortality and for clinical symptoms of toxicity. At the end of the observation period, the surviving animals were sacrificed for the purpose of necropsy. No mortality occurred at the tested concentrations. At all doses on the day of the experiment, restless behaviour was observed after application. The animals had slightly accelerated breathing as well as ruffled fur. Four days after the application all animals were without clinical signs. In this study no pathological changes in the organs were observed. One animal showed bronchitis and bronchiectasis on both sides. The LD_{50} was reported to be > 6.4 ml/kg bw (ECHA) [KI. score = 2].

In an additional study a limit test was performed using male and female Wistar rats were treated by single oral administration 2,000 milligrams per kilogram (mg/kg) of fatty acids tall oil ethoxylated (CAS RN 61791-00-2) (2 animals/sex/dose). During the observation period of 14 days, no clinical symptoms of toxicity or mortality were observed. The LD_{50} was reported to be >2,000 mg/kg (ECHA) [KI. score =2].

Inhalation

Based on the inhalation studies, no conclusion on LC_{50} can be drawn, because the tested concentrations of fatty acids tall oil ethoxylated (CAS RN 61791-00-2) are too low in relation to the classification criteria (ECHA)[KI. score =2].

Dermal

There are no data to evaluate dermal toxicity of tallow alkyl amines ethoxylated .

D. Irritation

Skin

By using the currently available methods a single *in vitro* assay is not sufficient to cover the full range of skin irritating/corrosion potential. Therefore, two *in vitro* assays were part of an *in vitro* skin irritation and corrosion test strategy (BASF 2017): The Skin Corrosion Test (SCT) and Skin Irritation Test (SIT). However, the results derived with SIT (performed in a GLP compliant study according to OECD 431, OECD 439, EU method B.40 BIS. And EU method B.46) alone were sufficient for a final assessment. Therefore, further testing in SCT was waived.

The potential of fatty acids tall oil ethoxylated (CAS RN 61791-00-2) to cause dermal irritation was assessed by a single topical application of 30 microlitres (µL) of the undiluted test substance to a reconstructed three-dimensional human epidermis model (EpiDerm™). The irritation test was performed with three EpiDerm™ tissues which were incubated with the test substance for 1 hour followed by a 42-hour post-incubation period. Tissue destruction was determined by measuring the metabolic activity of the tissue after exposure/post-incubation by using a colorimetric test. The reduction of mitochondrial dehydrogenase activity measured by reduced formazan production after incubation with a tetrazolium salt (MTT) was chosen as endpoint. The formazan production of the epidermal tissues treated with the test substance is compared to that of negative control tissues. The quotient of the values indicates the relative tissue viability.

The following results were obtained in the EpiDerm™ skin irritation test: 1) The test substance is able to directly reduce MTT. Therefore, an additional MTT reduction control KC (freeze-killed control tissues) was introduced. 2) The final mean viability of the tissues treated with the fatty acids tall oil ethoxylated (CAS RN 61791-00-2) determined after an exposure period of 1 hour with an about 42-hour post-incubation was 100.7%.

Based on the results observed and by applying the evaluation criteria, it was concluded that the fatty acids tall oil ethoxylated (CAS RN 61791-00-2) does not show a skin irritation potential in the EpiDerm™ *in vitro* skin irritation and corrosion test strategy under the test conditions chosen (ECHA) [KI. score = 1].

In a supporting skin irritation test two Vienna white rabbits were treated with fatty acids tall oil ethoxylated (CAS RN 61791-00-2) for 1, 5, 15 min and 20 hours under occlusive conditions (BASF 1971). An application site of 2.5 x 2.5 cm was covered with the liquid test substance. After the application time (1, 5, 15 min and 20 hours) the skin was washed with Lutrol (50%). The animals were observed for 8 days, and skin changes were recorded daily. The report describes findings after 24 hours and at the end of the observation period (8 days). After 20 hours exposure to the test-substance one animals showed slight erythema after 24 hours (Draize score 2). The observed redness was resolved by the end of the observation period, but a slight scaling was still present. The other animal exposed for 20 hours showed only some questionable erythema effect after 24 hours (score 1) which was fully reversible within 72 hours. No other effects were noted in the animals exposed for 20 hours. Of the animals exposed for shorter periods (1, 5 or 15 minutes) only one animal exposed for 15 minutes showed some questionable erythema which was fully reversible (ECHA) [KI. score =2].

In another similar performed skin irritation test showed stronger effects. The Vienna white rabbits were exposed to fatty acids tall oil ethoxylated (CAS RN 61791-00-2) for 20 hours showed strong to very strong erythema across the whole exposed area. After 8 days the redness in one animal was decreased to slight and had disappeared in the other. However, strong scaling was observed in both animals. In addition to the erythema a slight swelling was seen at 24 hours which also had disappeared after 8 days. The animals exposed for 15 minutes showed questionable erythema which was fully reversible. No ulcers, bleeding, or bloody scabs were observed. Animals exposed for shorter period did not show any signs of irritation. The OECD guideline 404 (Acute Dermal Irritation/Corrosion) states a typical exposure duration of 4 hour under open or semi-occlusive conditions. Therefore, the test employing 20 hours exposure under occlusive conditions is considered a worst-case situation (ECHA) [KI. score = 2].

Severe skin irritating effects were only seen in one of the studies, however, considering the worst-case conditions these effects are questionable. In contrast, the *in vitro* guideline study fatty acids tall oil ethoxylated (CAS RN 61791-00-2) was considered not to be skin irritant, which is supported by the other *in vivo* study (ECHA)

Based on these data, fatty acids tall oil ethoxylated (CAS RN 61791-00-2) is not considered a skin irritant.

<u>Eye</u>

The eye irritating potential of fatty acids tall oil ethoxylated (CAS RN 61791-00-2) was tested *in vitro*. By using the methods currently available a single *in vitro* assay is not sufficient to cover the full range of eye irritating potential. Therefore, two *in vitro* assays were part of this *in vitro* eye irritation test strategy: The Bovine Corneal Opacity and Permeability Test (BCOP Test) and EpiOcular Eye Irritation

Test. However, in the current case the results derived with the EpiOcular test alone (which was applied conforming GLP and in accordance with OECD 492) were sufficient for a final assessment. Therefore, further testing in BCOP was waived.

The potential of the fatty acids tall oil ethoxylated (CAS RN 61791-00-2) to cause ocular irritation was assessed by a single topical application of 50 µL undiluted fatty acids tall oil ethoxylated (CAS RN 61791-00-2) to a reconstructed three-dimensional, human cornea model (EpiOcular™). Two EpiOcular™ tissues were incubated with the test substance for 30 minutes followed by a 2-hour post-incubation period. Tissue destruction was determined by measuring the metabolic activity of the tissue after exposure/post-incubation by using a colorimetric test. The reduction of mitochondrial dehydrogenase activity measured by reduced formazan production after incubation with MTT was chosen as endpoint. The formazan production of the epidermal tissues treated with the test substance is compared to that of negative control tissues. The ratio of the values indicates the relative tissue viability. The following results were obtained in the EpiOcular™ eye irritation assay: 1) Fatty acids tall oil ethoxylated (CAS RN 61791-00-2) is able to directly reduce MTT. Therefore, an additional MTT reduction control (freeze-killed control tissues (KC)) was introduced. 2) The final mean viability of the tissues treated with the test substance was 109.3% (ECHA) [KI. score =1].

Based on the results observed in the EpiOcular Test alone and by applying the evaluation criteria, it was concluded that fatty acids tall oil ethoxylated (CAS RN 61791-00-2) does not show an eye irritation potential in the *in vitro* eye irritation test strategy under the test conditions chosen (ECHA).

In a supporting eye irritation test (BASF 1971) 50 µL of fatty acids tall oil ethoxylated (CAS RN 61791-00-2) was applied to the conjunctival sac of one eye in of two Vienna white rabbits. The adjacent eye served as saline-control. The animals were observed after 1 and 24 hours on the day of treatment and up to 8 days afterwards. The eyes were not washed out after 24 hours as specified in OECD Guideline 405. One hour after application of fatty acids tall oil ethoxylated (CAS RN 61791-00-2) slight redness of the conjunctivae was observed in both animals. After 24 hours one animal still showed slight redness of the conjunctivae while the effects in the other animal were completely reversed. After 8 days both animals were without eye irritating effects (ECHA) [KI. score =2].

In another supporting eye irritation test (BASF 1966) of the same design and exposure regime similar results were obtained. One hour after application of fatty acids tall oil ethoxylated (CAS RN 61791-00-2) slight redness of the conjunctivae was observed in both animals. After 24 hours no eye irritation effects were observed until the end of the observation period. Based on these results, the test substance is considered to be not irritating to the eyes (ECHA) [KI. score =2].

E. Sensitisation

Fatty acids tall oil ethoxylated (CAS RN 61791-00-2) is not considered to be a sensitiser based on results obtained via the Buehler test.

Local Lymph Node Assay (LLNA)

The skin sensitising potential of fatty acids tall oil ethoxylated (CAS RN 61791-00-2) was assessed using the radioactive Murine Local Lymph Node Assay in a GLP compliant study according to OECD no. 429, Commission Regulation (EC) No 440/2008 Part B, and EPA OPPTS 870.2600. The assay simulates the induction phase for skin sensitisation in mice. It determines the response of the auricular lymph nodes on repeated application of the test substance to the dorsal skin of the ears. Groups of 5 female CBA/J mice each were treated with 3%, 10% and 30% w/w preparations of the

test substance in methyl ethyl ketone (MEK) or with the vehicle alone. The high concentration was selected based on the presence of ear irritation in a pretest using a 60% preparation. The study used 3 test groups and 1 control group. Each test animal was applied with 25 µL per ear of the respective test-substance preparation to the dorsum of both ears for three consecutive days. The control group was treated with 25 µL per ear of the vehicle alone. Three days after the last application the mice were injected intravenously with 20 µCi of 3H-thymidine in 250 µL of sterile saline into a tail vein. About 5 hours after the 3H-thymidine injection, the mice were sacrificed, and the auricular lymph nodes were removed. The weights of each animal's pooled lymph nodes were determined. Thereafter lymph nodes were pooled group wise and further evaluated by measuring their cellular content and 3H-thymidine incorporation into the lymph node cells (indicators of cell proliferation). Moreover, a defined area with a diameter of 0.8 cm was punched out of the apical part of each ear and for each test group the weight of the pooled punches was determined in order to obtain an indication of possible skin irritation. The stimulation indices (fold of change as compared to the vehicle control) for cell count, 3H-thymidine incorporation, lymph node weight and ear weight were determined. No signs of systemic toxicity were noticed. When applied as 3%, 10% and 30% preparations in MEK, the test substance did not induce a biologically relevant response (no increase to 1.5-fold or above of control value = stimulation index (SI) ≥ 1.5) in the auricular lymph node cell counts. There was no relevant increase in lymph node weights as well. Concomitantly, the increase of 3H-thymidine incorporation into the cells was not biologically relevant (no increase above the cut off stimulation index of 3) at this concentration. The 30% test-substance preparation caused a minimal increase in ear weights as indication of ear skin irritation. Thus, it is concluded that fatty acids tall oil ethoxylated (CAS RN 61791-00-2) does not show a skin sensitising effect in the Murine Local Lymph Node Assay under the test conditions chosen (ECHA) [KI. score=1].

Buehler test

The dermal sensitising potential of fatty acids tall oil ethoxylated (CAS RN 61791-00-2) was investigated according to one of the methods recommended in the OECD Guideline No. 406, "Skin Sensitisation", 1992 and the EEC Guideline "EEC 92/69 part B6", 1992. The test used was the Buehler test.

The experiment was performed on 30 guinea pigs divided into a test group of 20 animals, and a control group of 10 animals. The study included an induction and a challenge phase. The animals in the test group were induced with the test article and the animals in the control group were induced with sterile distilled water. The induction procedure included a closed patch topical application for 6 hours once a week for 3 weeks.

The challenge procedure included a closed patch topical treatment of the test article on the flank 4 weeks after the first induction. All animals were challenged for 6 hours. The skin reactions were evaluated 24 and 48 hours after termination of the challenge application. The undiluted fatty acids tall oil ethoxylated (CAS RN 61791-00-2) was used for the inductions as well as for the challenge application.

Slight erythema was observed in 8 and 6 animals after 24 and 48 hours, respectively. However, slight erythema was considered a marginal skin change due to other factors than skin sensitisation. After 24 hours a moderate erythema was seen in 1 animal and after 48 hours a moderate erythema was seen in 5 animals. Based on these results, fatty acids tall oil ethoxylated (CAS RN 61791-00-2) is considered to be sensitising to the skin in the Buehler test (ECHA) [KI. score =1].

F. Repeated Dose Toxicity

Oral

An OECD Guideline 422 (Combined Repeated Dose Toxicity Study with the Reproduction / Developmental Toxicity Screening Test) was performed in 2015. The rat is the preferred animal species for reproduction studies according to the various test guidelines and the Wistar strain was selected. This Wistar rat strain (Crl:WI[Han]) was selected since extensive historical control data were available for this strain.

Male and female Wistar rats were dosed with fatty acids tall oil ethoxylated (CAS RN 61791-00-2) by oral gavage with 0, 100, 300, 1000 milligrams per kilogram per day (mg/kg/day). The duration of treatment covered a 2-week premating period and mating in both sexes (mating pairs were from the same test group) as well as entire gestation and lactation period in females up to one day prior to the day of schedule sacrifice of the animals (a total of 28 days).

No clinical effects were observed, no mortality was observed, and body weight changes were not significantly different from controls. There were no treatment related changes in food consumption during the entire study. Water consumption was not affected. There were no haematological effects nor effects on clinical biochemistry parameters. An assessment of functional observation battery indicated no effects no test substance related deviations relative to motor activity were noted. Organ weights were not affected by exposure to the substance at any dose level. Gross pathological and histopathological findings did not indicate any adverse effects.

The no observed adverse effect level (NOAEL) for general systemic toxicity was determined to be 1,000 milligram per kilogram body weight per day (mg/kg bw/day) (ECHA) [KI. score =1].

Inhalation

There are no studies are available.

Dermal

There are no studies are available.

G. Genotoxicity

In vitro Studies

The key *in vitro* genotoxicity studies are presented in Table 2.

Table 2: *In vitro* Genotoxicity Studies on Fatty Acids Tall Oil Ethoxylated (CAS RN 61791-00-2)

Test System	Results*		Klimisch Score	Reference
	-S9	+S9		
Bacterial reverse mutation (*S. typhimurium* TA98, TA100, TA1535, TA1537 and E.coli WP2))	-	-	1	ECHA
Mammalian cell gene mutation (Chinese hamster lung fibroblasts (V 79) cells	-	-	1	ECHA

Test System	Results*		Klimisch Score	Reference
	-S9	+S9		
In vitro mammalian cell micronucleus test (human lymphocytes)	-	-	1	ECHA

*+, positive; -, negative

In vivo Studies

There are no studies were available.

H. Carcinogenicity

There are no studies are available.

I. Reproductive Toxicity

The reproductive toxicity potential of fatty acids tall oil ethoxylated (CAS RN 61791-00-2) was evaluated in a combined repeated dose toxicity study with a reproductive/developmental toxicity screening test (OECD 422). Male and female Wistar rat strain (Crl:WI[Han]) rats were given oral gavage doses of 0, 100, 300, or 1,000 mg/kg-day. There was no indication of reproductive toxicity or any effects on tested endocrine system related parameters (T4 and TSH levels) at any dose level. The NOAEL for reproductive toxicity is 1,000 mg/kg bw/day, the highest dose tested (ECHA) [Kl. score = 1].

J. Developmental Toxicity

The developmental toxicity potential of fatty acids tall oil ethoxylated (CAS RN 61791-00-2) was evaluated in a combined repeated dose toxicity study with a reproductive/developmental toxicity screening test (OECD 422). Male and female Wistar rat strain (Crl:WI[Han]) SD rats were given oral gavage doses of 0, 100, 300, or 1,000 mg/kg bw/day. There was no indication of teratogenic toxicity at any dose level. The NOAEL for developmental toxicity (systemic toxicity and fertility) is 1,000 mg/kg-day, the highest dose tested (ECHA) [Kl. score = 1].

V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES

The toxicological reference values developed for tallow alkyl amines ethoxylated follow the methodology discussed in enHealth (2012). The approach used to develop drinking water guidance values is described in the Australian Drinking Water Guidelines (ADWG, 2011).

A. Non-Cancer

Oral

Under the conditions of a Combined Repeated Dose Toxicity Study with the Reproduction/Developmental Toxicity Screening Test, the oral administration by gavage of fatty acids tall oil ethoxylated (CAS RN 61791-00-2) to Wistar rats revealed no adverse signs of toxicity in male and female animals at a dose level of 1,000 mg/kg bw/day. Thus, the NOAEL for general systemic toxicity was 1,000 mg/kg bw/day, the highest dose tested, for male and female Wistar rats. The NOAEL of 1,000 mg/kg bw/day will be used for determining the oral reference dose (RfD) and the drinking water guidance value.

Oral Reference Dose (oral RfD)

Oral RfD = NOAEL / (UF_A x UF_H x UF_L x UF_{Sub} x UF_D)

Where:
UF_A (interspecies variability) = 10
UF_H (intraspecies variability) = 10
UF_L (LOAEL to NOAEL) = 1
UF_{Sub} (subchronic to chronic) = 3
UF_D (database uncertainty) = 1

Oral RfD = 1,000/(10 x 10 x 1 x 3 x 1) = 1,000/300 = 3.33 mg/kg-day

Drinking water guidance value
Drinking water guidance value = (animal dose) x (human weight) x (proportion of intake from water) / (volume of water consumed) x (safety factor)

Using the oral RfD,
Drinking water guidance value = (oral RfD) x (human weight) x (proportion of water consumed) / (volume of water consumed)

where:
Human weight = 70 kg (ADWG, 2011)
Proportion of water consumed = 10% (ADWG, 2011)
Volume of water consumed = 2L (ADWG, 2011)

Drinking water guidance value = (3.33 x 70 x 0.1)/2 = 11.65 mg/L

B. Cancer

There are no carcinogenicity studies are available for tallow alkyl amines ethoxylated. Thus, a cancer reference value was not derived for tallow alkyl amines ethoxylated.

VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES

The ethoxylated tallow alkyl amine does not exhibit the following physico-chemical properties:

- Explosivity
- Flammability
- Oxidising potential

VII. ENVIRONMENTAL HAZARD ASSESSMENT

A. Summary

Tallow alkyl amines ethoxylated are of low aquatic toxicity concern based on data from analogous substances.

B. Aquatic Toxicity

Table 3 lists the results of acute aquatic toxicity studies on of tallow alkyl amines ethoxylated.

Table 3: Acute Aquatic Toxicity Studies Tallow Alkyl Amines Ethoxylated *

Test Substance	Test Species	Endpoint	Results (mg/L) [WAF]	Kl. score
fatty acids, tall-oil, ethoxylated	*Danio rerio*	96-h LL_{50}	>100 (mortality)	1
fatty acids, tall-oil, ethoxylated	*Daphnia magna*	48-h EL_{50}	12.41 (mobility)	1
fatty acids, tall-oil, ethoxylated	*Pseudokirchnerella subcapitata*	72-h EL_{50}	39.7 (growth rate)	1

* Based on acute aquatic toxicity studies on fatty acids, tall-oil, ethoxylated (CAS RN 61791-00-2)
LL_{50} – median lethal loading rate
EL_{50} – median effective loading rate
The statistical methods used to determine LL_{50} and EL_{50} values are the same as those used to determine LC_{50}, EC_{50} and NOEC values.

All studies used the water accommodated fractions (WAFs) of the test substance.

Chronic Studies

Long-term toxicity data with fatty acids, tall-oil, ethoxylated (CAS RN 61791-00-2) are only available for algae. The algal test revealed the substance to be of low toxicity to algae (72h-EL_{10} = 7.08 mg/L) (ECHA) [Kl. score = 1].

C. Terrestrial Toxicity

There are no studies are available.

D. Calculation of Predicted No Effect Concentrations (PNECs)

The PNEC calculations for the substance follow the methodology discussed in DEWHA (2009).

PNEC Water

Experimental results are available for three trophic levels. Acute E (L)L_{50} values are available for fish (>100 mg/L), invertebrates (12.41 mg/L), and algae (39.7 mg/L). Chronic EL_{10} values are available for algae (7.08 mg/L). On the basis that the data consists of short-term studies from three trophic levels and chronic studies from one trophic level, an assessment factor of 100 has been applied to the lowest reported chronic value (E(L)L_{10} value of 7.08 mg/L for algae. The derived $PNEC_{water}$ for the substance is 0.071 mg/L.

PNEC Sediment

There are no toxicity data for sediment-dwelling organisms. Therefore, the $PNEC_{sed}$ was calculated using the equilibrium partitioning method. The $PNEC_{sed}$ is 3.6 mg/kg sediment wet weight.

The calculations are as follows:
$PNEC_{sed} = (K_{sed\text{-}water}/BD_{sed}) \times 1000 \times PNEC_{water}$
$= (65/1280) \times 1000 \times 0.71$
$= 3.61$ mg/kg

Where:
$K_{sed\text{-}water}$ = suspended matter-water partition coefficient (m^3/m^3)
BD_{sed} = bulk density of sediment (kg/m^3) = 1,280 [default]

$K_{sed\text{-}water} = 0.8 + [(0.2 \times Kp_{sed})/1000 \times BD_{solid}]$
$= 0.8 + [(0.2 \times 133/1000 \times 2400]$
$= 65\ m^3/m^3$

Where:
Kp_{sed} = solid-water partition coefficient (L/kg).
BD_{solid} = bulk density of the solid phase (kg/m^3) = 2,400 [default]

$Kp_{sed} = K_{oc} \times f_{oc}$
$= 3321 \times 0.04$
$= 133$ L/kg

Where:
K_{oc} = organic carbon normalised distribution coefficient (L/kg). The K_{oc} for read-across substance (CAS RN 61791-00-2) calculated from EPISUITE™ using the MCI method is 3321 L/kg .
F_{oc} = fraction of organic carbon in sediment = 0.04 [default].

PNEC Soil

There are no toxicity data for terrestrial or soil organisms. Therefore, the $PNEC_{soil}$ was calculated using the equilibrium partitioning method. The $PNEC_{soil}$ is 3.14 mg/kg soil dry weight.

The calculations are as follows:
$PNEC_{soil} = (Kp_{soil}/BD_{soil}) \times 1000 \times PNEC_{water}$
$=(66/1500) \times 1000 \times 0.071$
$= = 3.14$ mg/kg

Where:
Kp_{soil} = soil-water partition coefficient (m^3/m^3)
BD_{soil} = bulk density of soil (kg/m^3) = 1,500 [default]

$Kp_{soil} = K_{oc} \times f_{oc}$
$= 3321 \times 0.02$
$= 66.42\ m^3/m^3$

Where:
K_{oc} = organic carbon normalised distribution coefficient (L/kg). The K_{oc} for the read-across substance (CAS RN 61791-00-2) calculated from EPISUITE™ using the MCI method is 3321 L/kg.
F_{oc} = fraction of organic carbon in soil = 0.02 [default].

VIII. PERSISTENCE, BIOACCUMULATION AND TOXICITY (PBT) ASSESSMENT

The methodology for the Persistent, Bioaccumulative and Toxic (PBT) substances assessment is based on the Australian and EU Reach Criteria methodology (DEWHA, 2009; ECHA, 2008).

Tallow alkyl amines ethoxylated was noted to be readily biodegradable. Thus, the substance is not expected to meet the screening criteria for persistence.

Modelling of a representative structure indicates tallow alkyl amines ethoxylated does not have the potential to bioaccumulate. Thus, it does not meet the screening criteria for bioaccumulation.

Tallow alkyl amines ethoxylated did not exhibit substantial acute toxicity to fish, invertebrates, or algae. Thus, tallow alkyl amines ethoxylated is not expected to meet the screening criteria for toxicity.

The overall conclusion is that ethoxylated tallow alkyl amine is not a PBT substance.

IX. CLASSIFICATION AND LABELLING

A. Classification

H315-Skin Irrit. 2

H319-Eye Irrit. 2

H317-Skin Sens. 1B

B. Labelling

Warning

C. Pictograms



X. HANDLING AND SAFETY INFORMATION (OCCUPATIONAL LIMITS AND TRANSPORTATION REQUIREMENTS)

A. First Aid

Eye Contact

Immediately flush open eyes with plenty of water for at least 15 minutes. Remove contacts, if present and easy to do. If irritation occurs, get medical attention.

Skin Contact

Wash the contaminated area of with soap and water. Remove and isolate contaminated clothing. Launder contaminated clothing before reuse.

Inhalation

Move person to fresh air. If respiratory irritation, dizziness, nausea, or unconsciousness occurs, seek immediate medical assistance. Give artificial respiration if victim is not breathing.

Ingestion

Do not induce vomiting. Get medical attention immediately.

Notes to Physician

If ingested, material may be aspirated into the lungs and may cause chemical pneumonitis. Treat appropriately.

B. Fire Fighting Information

Extinguishing Media

Use water spray or fog, foam, dry chemical or carbon dioxide. Do not use straight streams of water.

Specific Exposure Hazards

May emit toxic fumes under fire conditions. Depending on conditions, decomposition products may include the following: carbon monoxide, carbon oxides.

Special Protective Equipment for Firefighters

Wear self-contained breathing apparatus and chemical-protective clothing.

C. Accidental Release Measures

Personal Precautions

Isolate area. Keep unnecessary and unprotected personnel from entering the area. Use personal protective clothing. Ensure adequate ventilation. Wear respiratory protection if ventilation is inadequate. Do not breath mist, vapours or spray Avoid contact with skin, eye, and clothing.

Environmental Precautions

Prevent from entering sewers, waterways, or low areas.

Steps to be Taken if Material is Released or Spilled

Pick up with non-combustible absorbent material and transfer to a container for chemical waste. For large amounts: dike spillage and pump off product into container for chemical waste. Dispose of contaminated material as prescribed.

D. Storage And Handling

General Handling

Avoid breathing vapour or aerosol. Keep away from open flames, hot surfaces and sources of ignition. Provide sufficient ventilation in work area.

Storage

Keep container tightly closed and in a dry, well-ventilated place.

E. Exposure Controls / Personal Protection

Occupational Exposure Standards

Workplace Australia has not established an occupational exposure standard for ethoxylated tallow alkyl amine.

Engineering Controls

Use adequate ventilation to control air-borne concentrations.

Personal Protection Equipment

Respiratory Protection: If workers are exposed to concentrations at a level that is not adequate to protect work health, they must use appropriate, certified respirators. The following type of respirator should be considered for this material: particulate, dust or mists. For high airborne concentrations, use an approved supplied-air respirator, operated in positive pressure mode.

Hand Protection: Use gloves chemically resistant to this material. Consult the safety data sheet for appropriate glove barrier materials.

Skin Protection: Use protective clothing chemically resistant to this material. Selection of specific items such as face shield, boots, apron, or full body suit will depend on the task.

Eye protection: Use chemical goggles.

Other Precautions: Wash hands, forearms, and face thoroughly after handling chemical products, before eating, smoking, and using the lavatory and at the end of the working period. Appropriate techniques should be used to remove potentially contaminated clothing. Wash contaminated clothing before reusing. Ensure that eyewash stations and safety showers are close to the workstation location.

F. Transport Information

Ethoxylated tallow alkyl amine) is not considered hazardous for purposes of transportation by road or rail. An Australian Dangerous Goods code is not required.

UN 1993

Class: 3

Packaging Group: II

XI. DISPOSAL MANAGEMENT

Disposal should be in accordance with all local, state, and federal regulations.

XII. REGULATORY STATUS

Australian AICS Inventory: Listed.

XIII. REFERENCES

ADWG. (2011). National Water Quality Management Strategy. Australian Drinking Water Guidelines, Section 6, Australian Government, National Health and Medical Research Council, Natural Resource Management Ministerial Council. Updated January 2022. Available: https://www.nhmrc.gov.au/about-us/publications/australian-drinking-water-guidelinesDepartment of the Environment, Water, Heritage and the Arts [DEWHA]. (2009). Environmental risk assessment guidance manual for industrial chemicals, Department of the Environment, Water, Heritage and the Arts, Commonwealth of Australia. Available: http://www.nepc.gov.au/resource/chemical-risk-assessment-guidance-manuals

ECHA. ECHA REACH database: http://echa.europa.eu/information-on-chemicals/registered-substances

enHealth Human Risk Assessment [HHRA] (2012). Environmental Health Risk Assessment, Guidelines for Assessing Human Health Risks from Environmental Hazards. Office of Health Protection of the Australian Government Department of Health. Available: https://www1.health.gov.au/internet/main/publishing.nsf/Content/health-pubhlth-publicat-environ.htm

European Chemicals Agency [ECHA]. (2017). Guidance on Information Requirements and Chemical Safety Assessment, Chapter R11: PBT Assessment, European Chemicals Agency, Helsinki, Finland. Available: https://echa.europa.eu/guidance-documents/guidance-on-information-requirements-and-chemical-safety-assessment

Klimisch, H.J., Andreae, M., and Tillmann, U. (1997). A systematic approach for evaluating the quality of experimental and toxicological and ecotoxicological data. Regul. Toxicol. Pharmacol. 25:1-5.

NICNAS (1994). National Industrial Chemicals Notification and Assessment Scheme (NICNAS), AGPS, Canberra, Australia.

Appendix D Safety Data Sheets

SAFETY DATA SHEET

Revision date: 02-Dec-2021

Revision Number 1

1. IDENTIFICATION OF THE MATERIAL AND SUPPLIER

Product identifier

Product Name CF550KCB

Product Code(s) 000000069045

Other means of identification

Synonyms Manufactured exclusively for Condor Energy Services by Fusion Technologies (Australia) Pty Ltd

Recommended use of the chemical and restrictions on use

Recommended use Friction reducer.

Uses advised against No information available.

Supplier
Fusion Technologies Australia Pty Ltd
ABN: 50 636 538 960
Street Address: 7 Noble Street
Bridgeman Downs QLD 4035
Australia

Telephone number: +61 (0)460 047 656
Website: www.fusiontechinc.net

Emergency telephone number

Emergency telephone number **1800 033 111 (ALL HOURS)**

Please ensure you refer to the limitations of this Safety Data Sheet as set out in the "Other Information" section at the end of this Data Sheet.

2. HAZARDS IDENTIFICATION

GHS Classification

Classified as a hazardous chemical in accordance with the criteria of Safe Work Australia - Globally Harmonized System (GHS).

Not classified as dangerous goods in accordance with the Australian Code for the Transport of Dangerous Goods by Road and Rail (ADG)

Flammable liquids	Category 4
Acute toxicity - Oral	Category 4

SIGNAL WORD
Warning

Label elements

Exclamation mark



Hazard statements
H227 - Combustible liquid
H302 - Harmful if swallowed

Precautionary Statements - Prevention
Keep away from heat, hot surfaces, sparks, open flames and other ignition sources. No smoking
Wear protective gloves / protective clothing / eye protection / face protection
Wash hands and face thoroughly after handling
Do not eat, drink or smoke when using this product
Precautionary Statements - Response
IF exposed: Get medical advice/attention if you feel unwell
IF SWALLOWED: Call a POISON CENTER or doctor/physician if you feel unwell
Rinse mouth
In case of fire: Use extinguishing media as outlined in Section 5 of this Safety Data Sheet to extinguish.
Precautionary Statements - Storage
Store in a well-ventilated place
Precautionary Statements - Disposal
Dispose of contents/container in accordance with local, regional, national, and international regulations as applicable

Other hazards which do not result in classification

General Hazards Repeated exposure may cause skin dryness or cracking

Poisons Schedule (SUSMP) 5

3. COMPOSITION/INFORMATION ON INGREDIENTS

Chemical name	CAS No.	Weight-%
Polyacrylamide	9003-05-8	30-60%
Aliphatic hydrocarbons	-	30-60%
Glycol ether derivative	-	<5%
Organophillic silicate	-	<5%

4. FIRST AID MEASURES

Description of first aid measures

Emergency telephone number Poisons Information Center, Australia: 13 11 26
Poisons Information Center, New Zealand: 0800 764 766

Inhalation Remove to fresh air and keep at rest in a position comfortable for breathing. If exposed or concerned: Get medical advice/attention.

Eye contact In case of eye contact, remove contact lens and rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. If symptoms persist, call a physician.

Skin contact Wash off immediately with soap and plenty of water. If skin irritation persists, call a physician. Take off contaminated clothing and wash before reuse.

Ingestion Rinse mouth. Drink 1 or 2 glasses of water. Get medical attention.

Most important symptoms and effects, both acute and delayed

Symptoms No information available.

Indication of any immediate medical attention and special treatment needed

Note to physicians Treat symptomatically. Material swells on contact with water.

5. FIRE FIGHTING MEASURES

Suitable Extinguishing Media

Suitable Extinguishing Media Use extinguishing measures that are appropriate to local circumstances and the surrounding environment. Dry chemical, CO2, sand, earth, water spray or regular foam.

Unsuitable extinguishing media High volume water jet.

Specific hazards arising from the chemical

Specific hazards arising from the chemical Extremely slippery when spilled. Combustible liquid.

Hazardous combustion products Carbon oxides. Nitrogen oxides.

Special protective actions for fire-fighters

Special protective equipment for fire-fighters Firefighters should wear self-contained breathing apparatus and full firefighting turnout gear. Use personal protection equipment.

6. ACCIDENTAL RELEASE MEASURES

Personal precautions, protective equipment and emergency procedures

Personal precautions Ensure adequate ventilation. Remove all sources of ignition. Special danger of slipping by leaking/spilling product.

For emergency responders Use personal protection recommended in Section 8.

Environmental precautions

Environmental precautions See Section 12 for additional Ecological Information.

Methods and material for containment and cleaning up

Methods for containment Prevent further leakage or spillage if safe to do so. Dike far ahead of spill to collect runoff water. Contain and collect spillage with non-combustible absorbent material, (e.g. sand, earth, diatomaceous earth, vermiculite) and place in container for disposal according to

local / national regulations (see Section 13).

Methods for cleaning up Collect in properly labelled drums or other suitable containers, with loose fitting lids. Use clean non-sparking tools to collect absorbed material. Prevent product from entering drains. After cleaning, flush away traces with water and detergent.

7. HANDLING AND STORAGE

Precautions for safe handling

Advice on safe handling Handle in accordance with good industrial hygiene and safety practice. Keep away from heat, hot surfaces, sparks, open flames and other ignition sources. No smoking. Use grounding and bonding connection when transferring this material to prevent static discharge, fire or explosion.

General hygiene considerations Avoid contact with skin, eyes, and clothing.

Conditions for safe storage, including any incompatibilities

Storage Conditions Keep containers tightly closed in a dry, cool and well-ventilated place.

Incompatible materials Strong oxidizing agents.

Poisons Schedule (SUSMP) 5

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Control parameters

Exposure Limits No value assigned for this specific material by Safe Work Australia. However, supplier recommended Workplace Exposure Standard(s) for constituent(s):

Chemical name	Australia	ACGIH TLV
Aliphatic hydrocarbons		TWA: 200 mg/m³, Sk (as total hydrocarbon vapour)

As published by Safe Work Australia Workplace Exposure Standards for Airborne Contaminants.

TWA - The time-weighted average airborne concentration of a particular substance when calculated over an eight-hour working day, for a five-day working week.

`Sk' (skin) Notice - absorption through the skin may be a significant source of exposure. The exposure standard is invalidated if such contact should occur.

These Workplace Exposure Standards are guides to be used in the control of occupational health hazards. All atmospheric contamination should be kept to as low a level as is workable. These workplace exposure standards should not be used as fine dividing lines between safe and dangerous concentrations of chemicals. They are not a measure of relative toxicity.

Appropriate engineering controls

Engineering controls Apply technical measures to comply with the occupational exposure limits.

If in the handling and application of this material, safe exposure levels could be exceeded, the use of engineering controls such as local exhaust ventilation must be considered and

the results documented. If achieving safe exposure levels does not require engineering controls, then a detailed and documented risk assessment using the relevant Personal Protective Equipment (PPE) (refer to PPE section below) as a basis must be carried out to determine the minimum PPE requirements.

Individual protection measures, such as personal protective equipment

The selection of PPE is dependent on a detailed risk assessment. The risk assessment should consider the work situation, the physical form of the chemical, the handling methods, and environmental factors.

OVERALLS, SAFETY SHOES, CHEMICAL GOGGLES, GLOVES.



Eye/face protection	Wear safety glasses with side shields (or goggles).
Skin and body protection	Wear suitable protective clothing.
Hand protection	Impervious gloves.
Respiratory protection	No protective equipment is needed under normal use conditions. If exposure limits are exceeded or irritation is experienced, ventilation and evacuation may be required. If determined by a risk assessment an inhalation risk exists, wear an organic vapour respirator meeting the requirements of AS/NZS 1715 and AS/NZS 1716.
Environmental exposure controls	Local authorities should be advised if significant spillages cannot be contained.

9. PHYSICAL AND CHEMICAL PROPERTIES

Information on basic physical and chemical properties

Physical state	Liquid
Appearance	Slurry
Color	Light brown
Odor	Hydrocarbon
Odor threshold	No information available.

Property	**Values**	**Remarks • Method**
pH	6.0 - 8.0	None known
pH (as aqueous solution)	No data available	None known
Melting point / freezing point	-5°C	None known
Boiling point / boiling range	No data available	None known
Flash point	75.5°C	Pensky-Martens Closed Cup (PMCC)
Evaporation rate	No data available	None known
Flammability (solid, gas)	No data available	None known
Flammability Limit in Air		None known
Upper flammability or explosive limits	No data available	
Lower flammability or explosive limits	No data available	
Vapor pressure	No data available	None known
Vapor density	No data available	None known
Relative density	1.1	None known
Water solubility	Dispersible	None known
Solubility(ies)	No data available	None known

Partition coefficient	No data available	None known
Autoignition temperature	No data available	None known
Decomposition temperature	No data available	None known
Kinematic viscosity	No data available	None known
Dynamic viscosity	No data available	None known

Other information

10. STABILITY AND REACTIVITY

Reactivity

Reactivity No information available.

Chemical stability

Stability Stable under normal conditions.

Explosion data

Sensitivity to mechanical impact None.

Sensitivity to static discharge None.

Possibility of hazardous reactions

Possibility of hazardous reactions None under normal processing.

Conditions to avoid

Conditions to avoid Heat, flames and sparks.

Incompatible materials

Incompatible materials Strong oxidizing agents.

Hazardous decomposition products

Hazardous decomposition products Carbon oxides. Nitrogen oxides. Ammonia.

11. TOXICOLOGICAL INFORMATION

Acute toxicity

Information on likely routes of exposure

Product Information No adverse health effects expected if the chemical is handled in accordance with this Safety Data Sheet and the chemical label. Symptoms or effects that may arise if the chemical is mishandled and overexposure occurs are:

Inhalation May cause central nervous system depression with nausea, headache, dizziness, vomiting, and incoordination.

Eye contact May cause irritation.

Skin contact May cause irritation. Repeated exposure may cause skin dryness or cracking.

Ingestion Ingestion may cause gastrointestinal irritation, nausea, vomiting and diarrhoea. Product swells when exposed to moisture and may cause choking if large quantities are involved.

Symptoms No information available.

Numerical measures of toxicity - Product Information
No information available.

Numerical measures of toxicity - Component Information

Component Information

Chemical name	Oral LD50	Dermal LD50	Inhalation LC50
Polyacrylamide	> 1 g/kg (Rat)	-	-
Aliphatic hydrocarbons	> 5000 mg/kg (Rat)	> 2000 mg/kg (Rabbit)	-
Glycol ether derivative	= 1310 mg/kg (Rat)	-	-

See section 16 for terms and abbreviations

Delayed and immediate effects as well as chronic effects from short and long-term exposure

Skin corrosion/irritation May cause skin irritation. Classification based on data available for ingredients.

Serious eye damage/eye irritation May cause slight irritation. Classification based on data available for ingredients.

Respiratory or skin sensitization No information available.

Germ cell mutagenicity No information available.

Carcinogenicity The table below indicates whether each agency has listed any ingredient as a carcinogen.

Chemical name	Australia
Organophillic silicate -	Carc. 1A

Reproductive toxicity No information available.

STOT - single exposure No information available.

STOT - repeated exposure No information available.

Aspiration hazard No information available.

12. ECOLOGICAL INFORMATION

Ecotoxicity

Ecotoxicity The environmental impact of this product has not been fully investigated.

Persistence and degradability

Persistence and degradability For the major component: Expected to be biodegradable.

Bioaccumulative potential

Bioaccumulation No information available.

Mobility

Mobility in soil No information available.

Other adverse effects

13. DISPOSAL CONSIDERATIONS

Waste treatment methods

Waste from residues/unused products Dispose of in accordance with local regulations. Dispose of waste in accordance with environmental legislation.

Contaminated packaging Dispose of contents/containers in accordance with local regulations.

14. TRANSPORT INFORMATION

ADG
Not classified as Dangerous Goods by the criteria of the Australian Dangerous Goods Code (ADG Code) for transport by Road and Rail; NON-DANGEROUS GOODS.

IATA
Not classified as Dangerous Goods by the criteria of the International Air Transport Association (IATA) Dangerous Goods Regulations for transport by air; NON-DANGEROUS GOODS.

IMDG
Not classified as Dangerous Goods by the criteria of the International Maritime Dangerous Goods Code (IMDG Code) for transport by sea; NON-DANGEROUS GOODS.

15. REGULATORY INFORMATION

Safety, health and environmental regulations/legislation specific for the substance or mixture

National regulations

Australia
Classified as a hazardous chemical in accordance with the criteria of Safe Work Australia - Globally Harmonized System (GHS).

Not classified as dangerous goods in accordance with the Australian Code for the Transport of Dangerous Goods by Road and Rail (ADG)

See section 8 for national exposure control parameters

Poisons Schedule (SUSMP) 5

International Inventories

AIIC	All the constituents of this material are listed on the Australian Inventory of Industrial Chemicals.
NZIoC	All the constituents of this material are listed on the New Zealand Inventory of Chemicals.

Legend:
- Australian Inventory of Industrial Chemicals

International Regulations

The Montreal Protocol on Substances that Deplete the Ozone Layer Not applicable

The Stockholm Convention on Persistent Organic Pollutants Not applicable

The Rotterdam Convention Not applicable

16. OTHER INFORMATION

Supplier Safety Data Sheet

Reason(s) For Issue: First Issue Primary SDS

Issuing Date: 02-Dec-2021

This Safety Data Sheet has been prepared by Ixom Operations Pty Ltd (Toxicology and SDS Services).

Revision Note:
The symbol (*) in the margin of this SDS indicates that this line has been revised.

Key or legend to abbreviations and acronyms used in the safety data sheet

Legend Section 8: EXPOSURE CONTROLS/PERSONAL PROTECTION

TWA	TWA (time-weighted average)	STEL	STEL (Short Term Exposure Limit)
Ceiling	Maximum limit value	*	Skin designation
C	Carcinogen		

Key literature references and sources for data used to compile the SDS

EPA (Environmental Protection Agency)
Acute Exposure Guideline Level(s) (AEGL(s))
U.S. Environmental Protection Agency Federal Insecticide, Fungicide, and Rodenticide Act
U.S. Environmental Protection Agency High Production Volume Chemicals
Food Research Journal
Hazardous Substance Database
International Uniform Chemical Information Database (IUCLID)
Japan GHS Classification
Australian Industrial Chemicals Introduction Scheme (AICIS)
NIOSH (National Institute for Occupational Safety and Health)
National Library of Medicine's ChemID Plus (NLM CIP)
National Library of Medicine's PubMed database (NLM PUBMED)
National Toxicology Program (NTP)
New Zealand's Chemical Classification and Information Database (CCID)
Organization for Economic Co-operation and Development Environment, Health, and Safety Publications
Organization for Economic Co-operation and Development High Production Volume Chemicals Program
Organization for Economic Co-operation and Development Screening Information Data Set
RTECS (Registry of Toxic Effects of Chemical Substances)
World Health Organization

Disclaimer

This SDS summarises to our best knowledge at the date of issue, the chemical health and safety hazards of the material and general guidance on how to safely handle the material in the workplace. Since The Supplier cannot anticipate or control the conditions under which the product may be used, each user must, prior to usage, assess and control the risks arising from its use of the material.

If clarification or further information is needed, the user should contact their Supplier representative or The Supplier at the contact details on page 1.

The Supplier's responsibility for the material as sold is subject to the terms and conditions of sale, a copy of which is

available upon request.

End of Safety Data Sheet

SAFETY DATA SHEET

Revision date: 12-Nov-2021

Revision Number 1

1. IDENTIFICATION OF THE MATERIAL AND SUPPLIER

Product identifier

Product Name CF10GGC

Product Code(s) 000000069033

Other means of identification

Synonyms Manufactured by Condor Energy Services Ltd

Recommended use of the chemical and restrictions on use

Recommended use Completion fluid.

Uses advised against No information available.

Supplier
Condor Energy Services Ltd
ABN: 35 153 250 670
Brisbane Head Office: Level 11, 333 Ann Street
Brisbane QLD 4000
Australia

Telephone number: 07 3999 9044
Website: www.CondorEnergy.com.au

Emergency telephone number

Emergency telephone number **1800 033 111 (ALL HOURS)**

Please ensure you refer to the limitations of this Safety Data Sheet as set out in the "Other Information" section at the end of this Data Sheet.

2. HAZARDS IDENTIFICATION

GHS Classification

Classified as a hazardous chemical in accordance with the criteria of Safe Work Australia - Globally Harmonized System (GHS).

Not classified as dangerous goods in accordance with the Australian Code for the Transport of Dangerous Goods by Road and Rail (ADG)

Flammable liquids	Category 4

Acute toxicity - Oral	Category 4
Skin corrosion/irritation	Category 2
Serious eye damage/eye irritation	Category 2A

SIGNAL WORD
Warning

Label elements

Exclamation mark



Hazard statements
H227 - Combustible liquid
H302 - Harmful if swallowed
H315 - Causes skin irritation
H319 - Causes serious eye irritation

Precautionary Statements - Prevention
Keep away from heat, hot surfaces, sparks, open flames and other ignition sources. No smoking
Wear protective gloves / protective clothing / eye protection / face protection
Wash hands and face thoroughly after handling
Do not eat, drink or smoke when using this product
IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing
If eye irritation persists: Get medical advice/attention
IF ON SKIN: Wash with plenty of soap and water
If skin irritation occurs: Get medical advice/attention
Take off immediately all contaminated clothing and wash it before reuse
IF SWALLOWED: Call a POISON CENTER or doctor/physician if you feel unwell
Rinse mouth
In case of fire: Use extinguishing media as outlined in Section 5 of this Safety Data Sheet to extinguish.
Precautionary Statements - Storage
Store in a well-ventilated place
Precautionary Statements - Disposal
Dispose of contents/container in accordance with local, regional, national, and international regulations as applicable

Other hazards which do not result in classification
May be harmful in contact with skin
May be harmful if swallowed and enters airways
Combustible liquid

Poisons Schedule (SUSMP) 5

3. COMPOSITION/INFORMATION ON INGREDIENTS

Chemical name	CAS No.	Weight-%
Guar gum	9000-30-0	30-60%
Aliphatic hydrocarbons	-	30-60%
Glycol ether derivative	-	< 10%
Organophillic silicate	-	< 5%

4. FIRST AID MEASURES

Description of first aid measures

Emergency telephone number	Poisons Information Center, Australia: 13 11 26 Poisons Information Center, New Zealand: 0800 764 766
Inhalation	Remove to fresh air and keep at rest in a position comfortable for breathing. If exposed or concerned: Get medical advice/attention.
Eye contact	In case of eye contact, remove contact lens and rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. If symptoms persist, call a physician.
Skin contact	Wash off immediately with soap and plenty of water. If skin irritation persists, call a physician. Take off contaminated clothing and wash before reuse.
Ingestion	Rinse mouth. Drink 1 or 2 glasses of water. Get medical attention.

Most important symptoms and effects, both acute and delayed

Symptoms	No information available.

Indication of any immediate medical attention and special treatment needed

Note to physicians	Treat symptomatically.

5. FIRE FIGHTING MEASURES

Suitable Extinguishing Media

Suitable Extinguishing Media	Use extinguishing measures that are appropriate to local circumstances and the surrounding environment. Dry chemical, CO2, sand, earth, water spray or regular foam.
Unsuitable extinguishing media	High volume water jet.

Specific hazards arising from the chemical

Specific hazards arising from the chemical	Extremely slippery when spilled. Combustible liquid.
Hazardous combustion products	Carbon oxides.

Special protective actions for fire-fighters

Special protective equipment for fire-fighters	Firefighters should wear self-contained breathing apparatus and full firefighting turnout gear. Use personal protection equipment.

6. ACCIDENTAL RELEASE MEASURES

Personal precautions, protective equipment and emergency procedures

Personal precautions	Ensure adequate ventilation. Remove all sources of ignition. Special danger of slipping by leaking/spilling product.
For emergency responders	Use personal protection recommended in Section 8.

Environmental precautions

Environmental precautions See Section 12 for additional Ecological Information.

Methods and material for containment and cleaning up

Methods for containment Contain and collect spillage with non-combustible absorbent material, (e.g. sand, earth, diatomaceous earth, vermiculite) and place in container for disposal according to local / national regulations (see Section 13).

Methods for cleaning up After cleaning, flush away traces with water and detergent. Collect in properly labelled drums or other suitable containers, with loose fitting lids. Use clean non-sparking tools to collect absorbed material.

7. HANDLING AND STORAGE

Precautions for safe handling

Advice on safe handling Handle in accordance with good industrial hygiene and safety practice. Avoid contact with skin, eyes, and clothing. Keep away from heat, hot surfaces, sparks, open flames and other ignition sources. No smoking. Use grounding and bonding connection when transferring this material to prevent static discharge, fire or explosion.

Conditions for safe storage, including any incompatibilities

Storage Conditions Keep containers tightly closed in a dry, cool and well-ventilated place.

Incompatible materials Strong oxidizing agents.

Poisons Schedule (SUSMP) 5

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Control parameters

Exposure Limits No value assigned for this specific material by Safe Work Australia. However, supplier recommended Workplace Exposure Standard(s) for constituent(s):

Chemical name	Australia	ACGIH TLV
Aliphatic hydrocarbons		TWA: 200 mg/m³, Sk (as total hydrocarbon vapour)

As published by Safe Work Australia Workplace Exposure Standards for Airborne Contaminants.

TWA - The time-weighted average airborne concentration of a particular substance when calculated over an eight-hour working day, for a five-day working week.

`Sk' (skin) Notice - absorption through the skin may be a significant source of exposure. The exposure standard is invalidated if such contact should occur.

These Workplace Exposure Standards are guides to be used in the control of occupational health hazards. All atmospheric contamination should be kept to as low a level as is workable. These workplace exposure standards should not be used as fine dividing lines between safe and dangerous concentrations of chemicals. They are not a measure of relative toxicity.

Appropriate engineering controls

Engineering controls Apply technical measures to comply with the occupational exposure limits.

If in the handling and application of this material, safe exposure levels could be exceeded, the use of engineering controls such as local exhaust ventilation must be considered and the results documented. If achieving safe exposure levels does not require engineering controls, then a detailed and documented risk assessment using the relevant Personal Protective Equipment (PPE) (refer to PPE section below) as a basis must be carried out to determine the minimum PPE requirements.

Individual protection measures, such as personal protective equipment

The selection of PPE is dependent on a detailed risk assessment. The risk assessment should consider the work situation, the physical form of the chemical, the handling methods, and environmental factors.

OVERALLS, SAFETY SHOES, CHEMICAL GOGGLES, GLOVES.



Eye/face protection Wear safety glasses with side shields (or goggles).

Skin and body protection Wear suitable protective clothing.

Hand protection Impervious gloves.

Respiratory protection No protective equipment is needed under normal use conditions. If exposure limits are exceeded or irritation is experienced, ventilation and evacuation may be required. If determined by a risk assessment an inhalation risk exists, wear an organic vapour respirator meeting the requirements of AS/NZS 1715 and AS/NZS 1716.

Environmental exposure controls Local authorities should be advised if significant spillages cannot be contained.

9. PHYSICAL AND CHEMICAL PROPERTIES

Information on basic physical and chemical properties

Physical state	Liquid
Appearance	Slurry
Color	Light brown
Odor	Mild Hydrocarbon
Odor threshold	No information available.

Property	**Values**	**Remarks • Method**
pH	No data available	None known
pH (as aqueous solution)	No data available	None known
Melting point / freezing point	No data available	None known
Boiling point / boiling range	No data available	None known
Flash point	76.7°C	Pensky-Martens Closed Cup (PMCC)
Evaporation rate	No data available	None known
Flammability (solid, gas)	No data available	None known
Flammability Limit in Air		None known
Upper flammability or explosive limits	No data available	
Lower flammability or explosive	No data available	

limits		
Vapor pressure	No data available	None known
Vapor density	No data available	None known
Relative density	1.02 - 1.09	
Water solubility	Emulsifiable	
Solubility(ies)	No data available	None known
Partition coefficient	No data available	None known
Autoignition temperature	No data available	None known
Decomposition temperature	No data available	None known
Kinematic viscosity	28 mm2/s	
Dynamic viscosity	No data available	None known

Other information

10. STABILITY AND REACTIVITY

Reactivity

Reactivity No information available.

Chemical stability

Stability Stable under normal conditions.

Explosion data

Sensitivity to mechanical impact None.

Sensitivity to static discharge None.

Possibility of hazardous reactions

Possibility of hazardous reactions None under normal processing.

Conditions to avoid

Conditions to avoid Heat, flames and sparks.

Incompatible materials

Incompatible materials Strong oxidizing agents.

Hazardous decomposition products

Hazardous decomposition products None known based on information supplied.

11. TOXICOLOGICAL INFORMATION

Acute toxicity

Information on likely routes of exposure

Product Information No adverse health effects expected if the chemical is handled in accordance with this Safety Data Sheet and the chemical label. Symptoms or effects that may arise if the chemical is mishandled and overexposure occurs are:

Inhalation May cause central nervous system depression with nausea, headache, dizziness, vomiting, and incoordination.

Eye contact Causes serious eye irritation.

Skin contact Causes skin irritation. Repeated exposure may cause skin dryness or cracking. Repeated or prolonged skin contact may cause allergic reactions with susceptible persons.

Ingestion Ingestion may cause gastrointestinal irritation, nausea, vomiting and diarrhoea.

Symptoms No information available.

Numerical measures of toxicity - Product Information

The following values are calculated based on chapter 3.1 of the GHS document

ATEmix (oral) 4,967.20
ATEmix (dermal) 4,448.90

Component Information

Chemical name	Oral LD50	Dermal LD50	Inhalation LC50
Guar gum	= 6770 mg/kg (Rat)	-	-
Aliphatic hydrocarbons	> 5000 mg/kg (Rat)	> 2000 mg/kg (Rabbit)	-
Glycol ether derivative	= 1310 mg/kg (Rat)	-	-

See section 16 for terms and abbreviations

Delayed and immediate effects as well as chronic effects from short and long-term exposure

Skin corrosion/irritation Irritating to skin. Classification based on data available for ingredients.

Serious eye damage/eye irritation Causes serious eye irritation. Classification based on data available for ingredients.

Respiratory or skin sensitization No information available.

Germ cell mutagenicity No information available.

Carcinogenicity The table below indicates whether each agency has listed any ingredient as a carcinogen.

Chemical name	Australia
Organophillic silicate -	Carc. 1A

Reproductive toxicity No information available.

STOT - single exposure No information available.

STOT - repeated exposure No information available.

Aspiration hazard No information available.

12. ECOLOGICAL INFORMATION

Ecotoxicity

Ecotoxicity The environmental impact of this product has not been fully investigated.

Persistence and degradability

Persistence and degradability For the major component: Biodegradable.

Bioaccumulative potential

Bioaccumulation No information available.

Mobility

Mobility in soil No information available.

Other adverse effects

13. DISPOSAL CONSIDERATIONS

Waste treatment methods

Waste from residues/unused products Dispose of in accordance with local regulations. Dispose of waste in accordance with environmental legislation.

Contaminated packaging Dispose of contents/containers in accordance with local regulations.

14. TRANSPORT INFORMATION

ADG
Not classified as Dangerous Goods by the criteria of the Australian Dangerous Goods Code (ADG Code) for transport by Road and Rail; NON-DANGEROUS GOODS.

IATA
Not classified as Dangerous Goods by the criteria of the International Air Transport Association (IATA) Dangerous Goods Regulations for transport by air; NON-DANGEROUS GOODS. Not regulated

IMDG
Not classified as Dangerous Goods by the criteria of the International Maritime Dangerous Goods Code (IMDG Code) for transport by sea; NON-DANGEROUS GOODS. Not regulated

15. REGULATORY INFORMATION

Safety, health and environmental regulations/legislation specific for the substance or mixture

National regulations

Australia
Classified as a hazardous chemical in accordance with the criteria of Safe Work Australia - Globally Harmonized System (GHS).

Not classified as dangerous goods in accordance with the Australian Code for the Transport of Dangerous Goods by Road and Rail (ADG)

See section 8 for national exposure control parameters

Poisons Schedule (SUSMP) 5

International Inventories

AIIC	All the constituents of this material are listed on the Australian Inventory of Industrial Chemicals.
NZIoC	All the constituents of this material are listed on the New Zealand Inventory of Chemicals.

Legend:
- Australian Inventory of Industrial Chemicals

International Regulations

The Montreal Protocol on Substances that Deplete the Ozone Layer Not applicable

The Stockholm Convention on Persistent Organic Pollutants Not applicable

The Rotterdam Convention Not applicable

16. OTHER INFORMATION

Supplier Safety Data Sheet

Reason(s) For Issue: First Issue Primary SDS

Issuing Date: 11-Nov-2021

This Safety Data Sheet has been prepared by Ixom Operations Pty Ltd (Toxicology and SDS Services).

Revision Note:
The symbol (*) in the margin of this SDS indicates that this line has been revised.

Key or legend to abbreviations and acronyms used in the safety data sheet

Legend Section 8: EXPOSURE CONTROLS/PERSONAL PROTECTION

TWA	TWA (time-weighted average)	STEL	STEL (Short Term Exposure Limit)
Ceiling	Maximum limit value	*	Skin designation
C	Carcinogen		

Key literature references and sources for data used to compile the SDS

EPA (Environmental Protection Agency)
Acute Exposure Guideline Level(s) (AEGL(s))
U.S. Environmental Protection Agency Federal Insecticide, Fungicide, and Rodenticide Act
U.S. Environmental Protection Agency High Production Volume Chemicals
Food Research Journal
Hazardous Substance Database
International Uniform Chemical Information Database (IUCLID)
Japan GHS Classification
Australian Industrial Chemicals Introduction Scheme (AICIS)
NIOSH (National Institute for Occupational Safety and Health)
National Library of Medicine's ChemID Plus (NLM CIP)
National Library of Medicine's PubMed database (NLM PUBMED)
National Toxicology Program (NTP)
New Zealand's Chemical Classification and Information Database (CCID)
Organization for Economic Co-operation and Development Environment, Health, and Safety Publications
Organization for Economic Co-operation and Development High Production Volume Chemicals Program
Organization for Economic Co-operation and Development Screening Information Data Set
RTECS (Registry of Toxic Effects of Chemical Substances)
World Health Organization

Disclaimer
The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the

date of its publication. The information given is designed only as a guidance for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text

End of Safety Data Sheet

SAFETY DATA SHEET

Revision date: 30-Nov-2021

Revision Number 1

1. IDENTIFICATION OF THE MATERIAL AND SUPPLIER

Product identifier

Product Name CF150FBS

Product Code(s) 000000069041

Other means of identification

Synonyms Manufactured exclusively for Condor Energy Services by Fusion Technologies (Australia) Pty Ltd

Recommended use of the chemical and restrictions on use

Recommended use Hydraulic fracturing additive.

Uses advised against No information available.

Supplier
Fusion Technologies Australia Pty Ltd
ABN: 50 636 538 960
Street Address: 7 Noble Street
Bridgeman Downs QLD 4035
Australia

Telephone number: +61 (0)460 047 656
Website: www.fusiontechinc.net

Emergency telephone number

Emergency telephone number **1800 033 111 (ALL HOURS)**

Please ensure you refer to the limitations of this Safety Data Sheet as set out in the "Other Information" section at the end of this Data Sheet.

2. HAZARDS IDENTIFICATION

GHS Classification

Classified as a hazardous chemical in accordance with the criteria of Safe Work Australia - Globally Harmonized System (GHS).

Not classified as dangerous goods in accordance with the Australian Code for the Transport of Dangerous Goods by Road and Rail (ADG)

Acute toxicity - Oral	Category 4
Skin corrosion/irritation	Category 2
Serious eye damage/eye irritation	Category 1
Specific target organ toxicity (single exposure)	Category 3
Specific target organ toxicity (repeated exposure)	Category 2
Acute aquatic toxicity	Category 2
Chronic aquatic toxicity	Category 3

SIGNAL WORD
Warning

Label elements

Corrosion
Health hazard
Exclamation mark



Hazard statements
H302 - Harmful if swallowed
H315 - Causes skin irritation
H318 - Causes serious eye damage
H371 - May cause damage to kidneys if swallowed
H373 - May cause damage to organs through prolonged or repeated exposure if swallowed
H401 - Toxic to aquatic life
H412 - Harmful to aquatic life with long lasting effects

Precautionary Statements - Prevention
Wash face, hands and any exposed skin thoroughly after handling
Do not eat, drink or smoke when using this product
Wear protective gloves/eye protection/face protection
Do not breathe mist, vapours, spray.
Avoid release to the environment
Precautionary Statements - Response
IF exposed or concerned: Call a POISON CENTER or doctor if you feel unwell
IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing
Immediately call a POISON CENTER or doctor
IF ON SKIN: Wash with plenty of soap and water
If skin irritation occurs: Get medical advice/attention
Take off contaminated clothing and wash it before reuse
IF SWALLOWED: Call a POISON CENTER or doctor/physician if you feel unwell
Rinse mouth
Precautionary Statements - Storage
No storage statements
Precautionary Statements - Disposal
Dispose of contents/container in accordance with local, regional, national, and international regulations as applicable

Other hazards which do not result in classification
Poisons Schedule (SUSMP) 6

3. COMPOSITION/INFORMATION ON INGREDIENTS

Chemical name	CAS No.	Weight-%
Ethylene glycol	107-21-1	10-30%

Nonionic surfactant	-	10-30%
Anionic surfactant	-	10-30%
Non-hazardous ingredients	Proprietary	Balance

4. FIRST AID MEASURES

Description of first aid measures

General advice If swallowed, seek medical advice immediately and show this container or label.

Emergency telephone number Poisons Information Center, Australia: 13 11 26
Poisons Information Center, New Zealand: 0800 764 766

Inhalation Remove to fresh air and keep at rest in a position comfortable for breathing. Call a physician if symptoms occur.

Eye contact Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. Keep eye wide open while rinsing. Remove contact lenses, if present and easy to do. Continue rinsing. Get immediate medical advice/attention.

Skin contact Wash off immediately with soap and plenty of water. Get medical attention if irritation develops and persists. Take off contaminated clothing and wash before reuse.

Ingestion Rinse mouth immediately and drink plenty of water. Get medical attention. Do NOT induce vomiting.

Self-protection of the first aider Avoid breathing vapors or mists. Avoid contact with skin, eyes, and clothing. See section 8 for more information.

Most important symptoms and effects, both acute and delayed

Symptoms No information available.

Indication of any immediate medical attention and special treatment needed

Note to physicians Treat symptomatically.

5. FIRE FIGHTING MEASURES

Suitable Extinguishing Media

Suitable Extinguishing Media Dry chemical, CO2, alcohol-resistant foam or water spray.

Unsuitable extinguishing media Do not use a solid water stream as it may scatter and spread fire.

Specific hazards arising from the chemical

Specific hazards arising from the chemical No information available.

Hazardous combustion products Carbon oxides. Oxides of sulfur.

Special protective actions for fire-fighters

Special protective equipment for fire-fighters Firefighters should wear self-contained breathing apparatus and full firefighting turnout gear. Use personal protection equipment.

6. ACCIDENTAL RELEASE MEASURES

Personal precautions, protective equipment and emergency procedures

Personal precautions Ensure adequate ventilation. Avoid breathing vapors or mists. Avoid contact with skin, eyes, and clothing. Do not touch or walk through spilled material. Extremely slippery when spilled.

For emergency responders Use personal protection recommended in Section 8.

Environmental precautions

Environmental precautions Keep out of drains, sewers, ditches and waterways. Local authorities should be advised if significant spillages cannot be contained.

Methods and material for containment and cleaning up

Methods for containment Prevent further leakage or spillage if safe to do so. Dike to collect large liquid spills. Contain and collect spillage with non-combustible absorbent material, (e.g. sand, earth, diatomaceous earth, vermiculite) and place in container for disposal according to local / national regulations (see Section 13).

Methods for cleaning up Avoid breathing dust or spray mist. Soak up with inert absorbent material (e.g. sand, silica gel, acid binder, universal binder, sawdust). Collect in properly labelled drums or other suitable containers, with loose fitting lids. After cleaning, flush away traces with water and detergent.

7. HANDLING AND STORAGE

Precautions for safe handling

Advice on safe handling Handle in accordance with good industrial hygiene and safety practice. Solutions extremely slippery when spilled.

General hygiene considerations Avoid breathing vapors or mists. Avoid contact with skin, eyes, and clothing. Do not eat, drink or smoke when using this product. Wear suitable gloves and eye/face protection. Remove and wash contaminated clothing and gloves, including the inside, before re-use.

Conditions for safe storage, including any incompatibilities

Storage Conditions Keep containers tightly closed in a dry, cool and well-ventilated place.

Incompatible materials Strong oxidizing agents.

Poisons Schedule (SUSMP) 6

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Control parameters

Exposure Limits No value assigned for this specific material by Safe Work Australia. However, Workplace Exposure Standard(s) for constituent(s):

Ethylene glycol (vapour): 8hr TWA = 52 mg/m^3 (20 ppm), 15 min STEL = 104 mg/m^3 (40 ppm), Sk

As published by Safe Work Australia Workplace Exposure Standards for Airborne Contaminants.

TWA - The time-weighted average airborne concentration of a particular substance when calculated over an eight-hour working day, for a five-day working week.

STEL (Short Term Exposure Limit) - the airborne concentration of a particular substance calculated as a time-weighted average over 15 minutes, which should not be exceeded at any time during a normal eight hour work day. According to current knowledge this concentration should neither impair the health of, nor cause undue discomfort to, nearly all workers.

`Sk' (skin) Notice - absorption through the skin may be a significant source of exposure. The exposure standard is invalidated if such contact should occur.

These Workplace Exposure Standards are guides to be used in the control of occupational health hazards. All atmospheric contamination should be kept to as low a level as is workable. These workplace exposure standards should not be used as fine dividing lines between safe and dangerous concentrations of chemicals. They are not a measure of relative toxicity.

Appropriate engineering controls

Engineering controls Apply technical measures to comply with the occupational exposure limits.

If in the handling and application of this material, safe exposure levels could be exceeded, the use of engineering controls such as local exhaust ventilation must be considered and the results documented. If achieving safe exposure levels does not require engineering controls, then a detailed and documented risk assessment using the relevant Personal Protective Equipment (PPE) (refer to PPE section below) as a basis must be carried out to determine the minimum PPE requirements.

Individual protection measures, such as personal protective equipment

The selection of PPE is dependent on a detailed risk assessment. The risk assessment should consider the work situation, the physical form of the chemical, the handling methods, and environmental factors.

OVERALLS, SAFETY SHOES, SAFETY GLASSES, GLOVES.



Eye/face protection Wear safety glasses with side shields (or goggles).

Skin and body protection Wear suitable protective clothing. Long sleeved clothing. Protective shoes or boots.

Hand protection Wear suitable gloves.

Respiratory protection No protective equipment is needed under normal use conditions. If exposure limits are exceeded or irritation is experienced, ventilation and evacuation may be required. If determined by a risk assessment an inhalation risk exists, wear a suitable mist respirator meeting the requirements of AS/NZS 1715 and AS/NZS 1716.

Environmental exposure controls Do not allow into any sewer, on the ground or into any body of water. Local authorities should be advised if significant spillages cannot be contained.

9. PHYSICAL AND CHEMICAL PROPERTIES

Information on basic physical and chemical properties

Physical state Liquid

Appearance	Clear
Color	Pale Yellow
Odor	Slight Ester
Odor threshold	No information available.

Property	Values	Remarks • Method
pH	7.0 - 8.5	None known
pH (as aqueous solution)	No data available	None known
Melting point / freezing point	-10°C	None known
Boiling point / boiling range	>100°C	None known
Flash point	No data available	None known
Evaporation rate	No data available	None known
Flammability (solid, gas)	No data available	None known
Flammability Limit in Air		None known
Upper flammability or explosive limits	No data available	
Lower flammability or explosive limits	No data available	
Vapor pressure	No data available	None known
Vapor density	No data available	None known
Relative density	0.99 - 1.01	None known
Water solubility	Soluble in water	None known
Solubility(ies)	Soluble in ethanol	None known
Partition coefficient	No data available	None known
Autoignition temperature	No data available	None known
Decomposition temperature	No data available	None known
Kinematic viscosity	No data available	None known
Dynamic viscosity	No data available	None known

Other information

10. STABILITY AND REACTIVITY

Reactivity

Reactivity No information available.

Chemical stability

Stability Stable under normal conditions.

Explosion data

Sensitivity to mechanical impact None.

Sensitivity to static discharge None.

Possibility of hazardous reactions

Possibility of hazardous reactions None under normal processing.

Conditions to avoid

Conditions to avoid Keep away from open flames, hot surfaces and sources of ignition.

Incompatible materials

Incompatible materials Strong oxidizing agents.

Hazardous decomposition products

Hazardous decomposition products Carbon oxides. Oxides of sulfur.

11. TOXICOLOGICAL INFORMATION

Acute toxicity

Information on likely routes of exposure

Product Information No adverse health effects expected if the chemical is handled in accordance with this Safety Data Sheet and the chemical label. Symptoms or effects that may arise if the chemical is mishandled and overexposure occurs are:

Inhalation Inhalation of vapors in high concentration may cause irritation of respiratory system.

Eye contact Causes serious eye damage.

Skin contact Causes skin irritation.

Ingestion Ingestion may cause gastrointestinal irritation, nausea, vomiting and diarrhoea. Harmful if swallowed. May cause adverse kidney effects.

Symptoms No information available.

Numerical measures of toxicity - Product Information
No information available.

Component Information

Chemical name	Oral LD50	Dermal LD50	Inhalation LC50
Ethylene glycol	= 1700 mg/kg (Rat)	= 10600 mg/kg (Rat) = 9530 µL/kg (Rabbit)	-

See section 16 for terms and abbreviations

Delayed and immediate effects as well as chronic effects from short and long-term exposure

Skin corrosion/irritation Causes skin irritation. Classification based on data available for ingredients.

Serious eye damage/eye irritation Causes serious eye damage. Classification based on data available for ingredients.

Respiratory or skin sensitization No information available.

Germ cell mutagenicity No information available.

Carcinogenicity No information available.

Reproductive toxicity No information available.

STOT - single exposure Causes damage to organs if swallowed.

STOT - repeated exposure Causes damage to organs through prolonged or repeated exposure if swallowed.

Aspiration hazard No information available.

12. ECOLOGICAL INFORMATION

Ecotoxicity

Ecotoxicity Harmful to aquatic organisms, may cause long-term adverse effects in the aquatic environment.

Chemical name	Algae/aquatic plants	Fish	Toxicity to microorganisms	Crustacea
Ethylene glycol	EC50: 6500 - 13000mg/L (96h, Pseudokirchneriella subcapitata)	LC50: =41000mg/L (96h, Oncorhynchus mykiss) LC50: 14 - 18mL/L (96h, Oncorhynchus mykiss) LC50: =27540mg/L (96h, Lepomis macrochirus) LC50: =40761mg/L (96h, Oncorhynchus mykiss) LC50: 40000 - 60000mg/L (96h, Pimephales promelas) LC50: =16000mg/L (96h, Poecilia reticulata)	-	EC50: =46300mg/L (48h, Daphnia magna)

Persistence and degradability

Persistence and degradability Expected to be biodegradable.

Bioaccumulative potential

Bioaccumulation Bioaccumulation is not expected.

Chemical name	Partition coefficient
Ethylene glycol	-1.93

Mobility

Mobility in soil No information available.

Other adverse effects

13. DISPOSAL CONSIDERATIONS

Waste treatment methods

Waste from residues/unused products Dispose of in accordance with local regulations. Dispose of waste in accordance with environmental legislation.

Contaminated packaging Dispose of in accordance with federal, state and local regulations.

14. TRANSPORT INFORMATION

ADG
Not classified as Dangerous Goods by the criteria of the Australian Dangerous Goods Code (ADG Code) for transport by Road and Rail; NON-DANGEROUS GOODS.

IATA
Not classified as Dangerous Goods by the criteria of the International Air Transport Association (IATA) Dangerous Goods Regulations for transport by air; NON-DANGEROUS GOODS.

IMDG
Not regulated Not classified as Dangerous Goods by the criteria of the International Maritime Dangerous Goods Code (IMDG Code) for transport by sea; NON-DANGEROUS GOODS.

15. REGULATORY INFORMATION

Safety, health and environmental regulations/legislation specific for the substance or mixture

National regulations

Australia
Classified as a hazardous chemical in accordance with the criteria of Safe Work Australia - Globally Harmonized System (GHS).

Not classified as dangerous goods in accordance with the Australian Code for the Transport of Dangerous Goods by Road and Rail (ADG)

See section 8 for national exposure control parameters

Poisons Schedule (SUSMP) 6

Chemical name	National pollutant inventory
Ethylene glycol - 107-21-1	10 tonne/yr Threshold category 1

International Inventories

AIIC	All the constituents of this material are listed on the Australian Inventory of Industrial Chemicals.
NZIoC	All the constituents of this material are listed on the New Zealand Inventory of Chemicals.

Legend:
- Australian Inventory of Industrial Chemicals

International Regulations

The Montreal Protocol on Substances that Deplete the Ozone Layer Not applicable

The Stockholm Convention on Persistent Organic Pollutants Not applicable

The Rotterdam Convention Not applicable

16. OTHER INFORMATION

Supplier Safety Data Sheet 08/ 2016

Reason(s) For Issue: First Issue Primary SDS

Issuing Date: 30-Nov-2021

This Safety Data Sheet has been prepared by Ixom Operations Pty Ltd (Toxicology and SDS Services).

Revision Note:
The symbol (*) in the margin of this SDS indicates that this line has been revised.

Key or legend to abbreviations and acronyms used in the safety data sheet
Legend Section 8: EXPOSURE CONTROLS/PERSONAL PROTECTION

TWA	TWA (time-weighted average)	STEL	STEL (Short Term Exposure Limit)
Ceiling	Maximum limit value	*	Skin designation
C	Carcinogen		

Key literature references and sources for data used to compile the SDS

EPA (Environmental Protection Agency)
Acute Exposure Guideline Level(s) (AEGL(s))
U.S. Environmental Protection Agency Federal Insecticide, Fungicide, and Rodenticide Act
U.S. Environmental Protection Agency High Production Volume Chemicals
Food Research Journal
Hazardous Substance Database
International Uniform Chemical Information Database (IUCLID)
Japan GHS Classification
Australian Industrial Chemicals Introduction Scheme (AICIS)
NIOSH (National Institute for Occupational Safety and Health)
National Library of Medicine's ChemID Plus (NLM CIP)
National Library of Medicine's PubMed database (NLM PUBMED)
National Toxicology Program (NTP)
New Zealand's Chemical Classification and Information Database (CCID)
Organization for Economic Co-operation and Development Environment, Health, and Safety Publications
Organization for Economic Co-operation and Development High Production Volume Chemicals Program
Organization for Economic Co-operation and Development Screening Information Data Set
RTECS (Registry of Toxic Effects of Chemical Substances)
World Health Organization

Disclaimer

This SDS summarises to our best knowledge at the date of issue, the chemical health and safety hazards of the material and general guidance on how to safely handle the material in the workplace. Since The Supplier cannot anticipate or control the conditions under which the product may be used, each user must, prior to usage, assess and control the risks arising from its use of the material.

If clarification or further information is needed, the user should contact their Supplier representative or The Supplier at the contact details on page 1.

The Supplier's responsibility for the material as sold is subject to the terms and conditions of sale, a copy of which is available upon request.

End of Safety Data Sheet

CF380DXL	

SAFETY DATA SHEET

EMERGENCY TELEPHONE NUMBER: + 1 - 587 - 353 - 2940 (24 Hrs)

Product Name: CF380DXL
Date Issued: April 29, 2021

Prepared by: HSE Dept
& Version: A7-1.0

1. PRODUCT IDENTIFICATION AND COMPANY IDENTIFICATION

Product Name:	CF380DXL
Product Purpose:	Fracturing Additive
Supplier Identification:	Fusion Technologies (Australia) Pty Ltd. 7 Noble Street Bridgeman Downs QLD, 4035 Australia

PREPARER'S TELEPHONE NUMBER: + 1 - 587 - 353 - 2940

2. HAZARDS IDENTIFICATION

HSNO Hazard classification
Respiratory sensitization : Category 1

Hazard Pictograms:



Signal word: Danger

Primary Routes of Exposure: Inhalation and skin

GHS Classification in accordance with 29 CFR 1910 (OSHA HCS)
Acute Toxicity Oral (Category 4), H302
Skin Corrosion /Irritation (Category 1), H314
Reproductive Toxicity (Category 1), H360

Hazard statements:

H302 - Harmful if swallowed
H314 - Causes severe skin burns and eye damage
H360 - May damage fertility or the unborn child

Precautionary statements:

P260 - Do not breathe mist, vapours, spray
P264 - Wash exposed skin thoroughly after handling
P270 - Do not eat, drink or smoke when using this product
P280 - Wear protective gloves, protective clothing, eye protection, face protection
P301 + P330 + P331 - If Swallowed: rinse mouth. Do NOT induce vomiting
P303 + P361 + P353 – If on skin (or hair): Remove/Take off immediately all contaminated clothing. Rinse skin with water/shower P304 + P340 – In inhaled: remove victim to fresh air and keep at rest in a position comfortable for breathing
P305 + P351 + P338 - If in eyes: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing
P310 - Immediately call a POISON CENTER or doctor/physician
P363 - Wash contaminated clothing before reuse
P405 - Store locked up
P501 - Dispose of contents/container to comply with local, state and federal regulations

Human health effects:

Eye: Corrosive. May cause severe irritation with corneal injury which may result in permanent impairment of vision, even blindness.
Skin: Corrosive. Initial contact may result in itching with increasing irritation if not removed. Causes severe skin irritation with tissue destruction. Prolonged contact and badly damaged skin may result in absorption causing redness and peeling of skin.
Ingestion: Maybe fatal if swallowed. Causes burns to the mouth, throat and stomach. Symptoms may include nausea, headache, and vomiting. Cardiac failure, pulmonary edema, and severe kidney

damage may develop. Potassium carbonate is high caustic, and ingestion of either the granular or liquid forms will cause severe burning and pain in lips, mouth, tongue, throat and stomach.
Inhalation: Inhalation of mist may cause damage to nasal and respiratory passages. Inhalation of large amounts may cause nausea, vomiting and diarrhea. Irritation may lead to chemical pneumonitis and pulmonary edema.
Chronic: May cause asthma, lung diseases and skin diseases.

3. PRODUCT COMPOSITION/INGREDIENTS

Chemical Name	CAS #	% by Weight
Sodium Gluconate	527-07-1	15 to 40
Boric Acid	10043-35-3	7 to 13
Potassium Hydroxide	1310-58-3	15 to 40

4. FIRST AID MEASURES

Eye Contact: Rinse eyes immediately with copious amounts of water and under the eyelids for at least 30 minutes. If symptoms persist seek medical advice.

Skin Contact: Remove contaminated clothing. Immediately wash off all material with soap and copious amounts of water. Remove all contaminated clothing and footwear. Discard contaminated leather articles such as shoes and belt.

Ingestion: Do not induce vomiting without medical advice. Seek medical advice. If the victim is not breathing, perform resuscitation using an approved respiratory barrier.

Inhalation: Remove to fresh air, treat symptomatically. If symptoms persist, seek medical advice. If person is not breathing and heart has stopped, begin performing cardiopulmonary resuscitation immediately.

5. FIRE FIGHTING MEASURES

Flashpoint: Not determined
Auto-Ignition Temperature: Not determined

Lower Explosion Limit: Not determined
Upper Explosion Limit: Not determined

Extinguishing Media: Water fog or fine spray, carbon dioxide or dry chemical foam. Water spray or fog for larger fires is acceptable.

Special Fire Fighting Procedures: Cool tanks and containers with water spray. Do not flush into surface water or sanitary sewer system. Keep product and empty containers away from heat and ignition sources.

Unusual Fire & Explosion Hazard: Heating can release hazardous gases

Hazardous Combustion Products: May evolve oxides of nitrogen, potassium and carbon under fire conditions.

Protective Equipment for Firefighters: Self contained breathing apparatus

6. ACCIDENTAL RELEASE MEASURES

Personal Precautions: Avoid contact with skin, eyes and clothing. Evacuate personnel to safe areas. Keep people away from and upwind of spill or leak. PPE: see section 8.

Environmental Precautions: Do not contaminate surface water. Do not release into the environment. Prevent product from entering any drains. Do not flush product into surface water or sanitary sewer systems.

Methods For Cleaning Up: Sweep up and shovel and then place into an appropriate waste container. Remove soiled refuse and place in a suitable disposal container.

Disposal: Dispose of material in compliance with local, provincial and Federal regulations. See Section 13.

7. HANDLING AND STORAGE

Handling Precautions: Handle wearing appropriate PPE as per section 8. Ensure adequate ventilation is available to avoid breathing vapors. Avoid contact with

	eyes, skin and clothing. Do not ingest. Empty containers may contain product residues. Keep the containers closed when not in use. Protect against physical damage. Do not consume food, drink or smoke when handling this material. When mixing, slowly add to water to minimize heat generation and spattering.
Storage Precautions:	Store according to State and Federal regulations. Store in a cool, dry, well-ventilated area. Place away from incompatible materials. Keep containers tightly closed. Store at ambient temperatures. Tanks must be diked.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Components with workplace control parameters:

Ingredient	Exposure Limits
Boric Acid	6 mg/m³ STEL 2 mg/m³ TLV-TWA
Sodium Hydroxide	2 mg/m³ Ceiling

Personal protective equipment:

Eye protection	Wear safety glasses with side shields or chemical goggles. Wear a face shield if splashing hazard exists.
Hand protection	Wear PVC, rubber or nitrile gloves.
Skin protection	Wear standard protective clothing – consider selecting type of protective clothing depending on quantity of chemical to be handled.
Respiratory protection	If exposure exceeds occupational exposure limits, use an appropriate NIOSH-approved respirator. For most conditions, no respirator protection is needed; however, if handling at elevated temperatures without sufficient ventilation, use an approved air-purifying respirator. Organic vapor cartridge with a particulate pre-filter.
Hygiene measures	Keep an eye wash fountain and safety shower available

9. PHYSICAL AND CHEMICAL PROPERTIES

Form:	Liquid
Color:	Colourless
Odor:	Characteristic
pH:	> 14
Density:	1.44
Solubility:	Soluble
Freezing Point:	-20°C

10. STABILITY AND REACTIVITY

Stability:	Stable under normal conditions.
Conditions to Avoid:	Avoid excessive heat, open flames and all ignition sources. Incompatible materials.
Materials to Avoid:	Strong oxidizing agents, strong acids and bases. Contact with reactive metals may produce flammable hydrogen gas.
Hazardous Polymerization:	Will not occur
Hazardous Decomposition Products:	Oxides of nitrogen, potassium and carbon.
Under Fire Conditions:	Heating can release hazardous gases

11. TOXICOLOGICAL INFORMATION

Ingredients	Acute Oral Toxicity	LD50/oral/rat	LC50/inhalation/rat	LD50/dermal/4hr/rabbit
Sodium Gluconate	No data available	No data available	No data available	No data available
Boric Acid	No data available	2,660 mg/kg	>0.16 mg/L in 4 hr	>2,000 mg/kg
Sodium Hydroxide	No data available	No data available	No data available	1350 mg/kg

Sensitization: Possible and may cause allergic reaction

Mutagenic Effects: Possible

Reproductive Toxicity: Boric acid studies in rat, mouse and dog at high doses, have demonstrated effects on fertility and testes. Boric acid studies in rat, mouse, and rabbit demonstrate developmental effects on the fetus, including fetal weight loss and minor skeletal variations. The doses administered were many times in excess of those to which humans would normally be exposed

Carcinogenic Effects: Boric acid is listed as A4 Carcinogens by the International Agency for Research on Cancer (IARC), the National Toxicology Program (NTP) or the American Conference of Governmental Industrial Hygienists (ACGIH).

Teratogenicity and Embryo Toxicity: See information listed above in reproductive category.

Human Experience: High

Other Toxicity Information: Toxicological Synergistic products: none known.

12. ECOLOGICAL INFORMATION

Ingredients	Ecotoxicity – Fish Species Data	Acute Crustaceans Toxicity	Ecotoxicity – Fresh water Algae
Sodium Gluconate	Not available	Not available	Not available
Boric Acid	1,020 mg/L LC50 (Carassius auratus) 72 h flow through	Not available	Not available
Sodium Hydroxide	Not available	Not available	Not available

Persistence and Degradability: Material is not readily biodegradable
Mobility: Product is liquid and therefore readily mobile.

13. DISPOSAL INFORMATION

Waste Residues/Unused Product and Package Dispose of waste in an approved incinerator or waste treatment site, in accordance with all applicable regulations. Do not dispose of wastes in local sewer or with normal garbage. Empty containers should be recycled locally or taken away for waste disposal.

14. TRANSPORT INFORMATION

The shipper/consignor/sender is responsible to ensure that the packaging, labeling, and markings are in compliance with the selected mode of transport.

Typical proper shipping name for this product are as follows:

SODIUM HYDROXIDE, SOLUTION	CLASS 8	UN 1824	PKG GRP: II

Important Note: This information does not take the place of shipping paper (Bill of Lading or BOL)

15. REGULATORY INFORMATION

None available.

16. OTHER INFORMATION

NFPA 704M RATING

Health: 3	Flammability: 0	Instability: 1	Other: n/a

HMIS

Health: 3	Flammability: 0	Instability: 1	Other: n/a

0= insignificant 1= slight 2= moderate 3= high 4= Extreme * = Chronic Hazard

Label Hazard Warning: Corrosive

Label Precautions: Inhalation of mist may cause damage to nasal and respiratory passages. Inhalation of large amounts may cause nausea, vomiting and diarrhea. Irritation may lead to chemical pneumonitis and pulmonary edema.
Corrosive. May cause severe irritation with corneal injury which may result in permanent impairment of vision, even blindness.
Corrosive. Initial contact may result in itching with increasing irritation if not removed. Causes severe skin irritation with tissue destruction. Prolonged contact and badly damaged skin may result in absorption causing redness and peeling of skin.

Label First Aid: Wash product off of skin or out of eyes. If swallowed, do not induce vomiting without medical advice. If irritation develops, seek medical attention.

This material safety data sheet provides health and safety information for the safe use of this product provided it is used as recommended per the associated product literature. Users of this product should be aware of the recommended safety precautions. For any other use, exposures must be evaluated so

that appropriate handling and training programs can be created and implemented to insure safe workplace operations. Consult with Fusion Technologies for any additional information.

This material safety data sheet provides health and safety information for the safe use of this product provided it is used as recommended per the associated product literature. Users of this product should be aware of the recommended safety precautions. For any other use, exposures must be evaluated so that appropriate handling and training programs can be created and implemented to insure safe workplace operations. Consult with Fusion Technologies for any additional information.

SAFETY DATA SHEET

CONDOR ENERGY SERVICES CF8800

Section: 1. PRODUCT AND COMPANY IDENTIFICATION

Product name	:	CONDOR ENERGY SERVICES CF8800
Other means of identification	:	Manufactured exclusively for Condor Energy Services by NALCO Champion
Recommended use	:	EMULSION BREAKER
Restrictions on use	:	Refer to available product literature or ask your local Sales Representative for restrictions on use and dose limits.
Company	:	ChampionX Australia Pty Ltd Suite 1/5 Brodie-Hall Drive, Technology Park Bentley WA 6102 Australia TEL: +61 8 9473 9000
Emergency telephone number	:	CHEMCALL 1800 127 406, International: +64 4 917 8888
Issuing date	:	08.01.2020

Section: 2. HAZARDS IDENTIFICATION

GHS Classification

Oxidizing solids	:	Category 1
Acute toxicity (Oral)	:	Category 4
Skin corrosion/irritation	:	Category 2
Serious eye damage/eye irritation	:	Category 2A
Germ cell mutagenicity	:	Category 2
Carcinogenicity	:	Category 2
Specific target organ toxicity - single exposure	:	Category 3 (Respiratory system)

GHS Label element

Hazard pictograms :



Signal Word : Danger

Hazard Statements : May cause fire or explosion; strong oxidiser.
Harmful if swallowed.
Causes skin irritation.
Causes serious eye irritation.
May cause respiratory irritation.
Suspected of causing genetic defects.
Suspected of causing cancer.

Precautionary Statements : **Prevention:**
Obtain special instructions before use. Do not handle until all safety precautions have been read and understood. Keep away from heat/sparks/open flames/hot surfaces. - No smoking. Keep/Store away from clothing and other combustible materials. Avoid breathing dust/ fume/ gas/ mist/ vapours/ spray. Wear fire resistant or flame retardant clothing. Do not eat, drink or smoke when using this product. Wear protective gloves/ protective clothing/ eye protection/ face

protection.
Response:
IF SWALLOWED: Call a POISON CENTER or doctor/ physician if you feel unwell. Rinse mouth. IF ON SKIN: Wash with plenty of soap and water. IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing. Call a POISON CENTER or doctor/ physician if you feel unwell. IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. IF ON CLOTHING: rinse immediately contaminated clothing and skin with plenty of water before removing clothes. In case of major fire and large quantities: Evacuate area. Fight fire remotely due to the risk of explosion. If eye irritation persists: Get medical advice/ attention. Take off contaminated clothing and wash it before reuse. Call a POISON CENTER or doctor/ physician if you feel unwell.
Disposal:
Dispose of contents/container to an approved facility in accordance with local, regional, national and international regulations.

Other hazards : None known.

Section: 3. COMPOSITION/INFORMATION ON INGREDIENTS

Pure substance/mixture : Substance

Chemical Name	CAS-No.	Concentration: (%)
Sodium Bromate	7789-38-0	60 - 100

Section: 4. FIRST AID MEASURES

In case of eye contact : Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Get medical attention.

In case of skin contact : Wash off immediately with plenty of water for at least 15 minutes. Use a mild soap if available. Get medical attention if irritation develops and persists.

If swallowed : Rinse mouth. Get medical attention if symptoms occur.

Contact the Poison's Information Centre (eg Australia 13 1126; New Zealand 0800 764 766).

If inhaled : Remove to fresh air. Treat symptomatically. Get medical attention if symptoms occur.

Protection of first-aiders : In event of emergency assess the danger before taking action. Do not put yourself at risk of injury. If in doubt, contact emergency responders. Use personal protective equipment as required.

Notes to physician : Treat symptomatically.

Most important symptoms and effects, both acute and delayed : See Section 11 for more detailed information on health effects and symptoms.

Section: 5. FIREFIGHTING MEASURES

Suitable extinguishing media : Use extinguishing measures that are appropriate to local circumstances and the surrounding environment.

Unsuitable extinguishing : None known.

media

Specific hazards during firefighting	:	Oxidizer. Contact with other material may cause fire.
Hazardous combustion products	:	Hydrogen halides metal oxides
Special protective equipment for firefighters	:	Use personal protective equipment.
Specific extinguishing methods	:	Fire residues and contaminated fire extinguishing water must be disposed of in accordance with local regulations.
Hazchem Code	:	1Y

Section: 6. ACCIDENTAL RELEASE MEASURES

Initial Emergency Response Guide No	:	31
Personal precautions, protective equipment and emergency procedures	:	Ensure adequate ventilation. Ensure clean-up is conducted by trained personnel only. Refer to protective measures listed in sections 7 and 8.
Environmental precautions	:	Do not allow contact with soil, surface or ground water.
Methods and materials for containment and cleaning up	:	Sweep up and shovel into suitable containers for disposal.

Section: 7. HANDLING AND STORAGE

Advice on safe handling	:	Avoid contact with skin and eyes. Do not ingest. Do not breathe dust/fume/gas/mist/vapours/spray. Wash hands thoroughly after handling. Use only with adequate ventilation.
Conditions for safe storage	:	Keep in a cool, well-ventilated place. Keep away from reducing agents. Keep away from combustible material. Keep out of reach of children. Keep container tightly closed. Store in suitable labelled containers.
Suitable material	:	Keep in properly labelled containers.
Unsuitable material	:	not determined

Section: 8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Components with workplace control parameters

Contains no substances with occupational exposure limit values.

Engineering measures	:	Effective exhaust ventilation system. Maintain air concentrations below occupational exposure standards.

Personal protective equipment

Eye protection	:	Safety goggles Face-shield
Hand protection	:	Wear the following personal protective equipment:

		NEOPRENE, NITRILE, OR NATURAL RUBBER GLOVES Standard glove type. Gloves should be discarded and replaced if there is any indication of degradation or chemical breakthrough.
Skin protection	:	Flame retardant protective clothing
Respiratory protection	:	When workers are facing concentrations above the exposure limit they must use appropriate certified respirators.
Hygiene measures	:	Handle in accordance with good industrial hygiene and safety practice. Remove and wash contaminated clothing before re-use. Wash face, hands and any exposed skin thoroughly after handling.

The Personal Protective Equipment (PPE) recommendations provided above have been made in good faith based on typical expected conditions of use. PPE selection should always be completed in conjunction with a proper risk assessment and in accordance with a PPE management program.

Section: 9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance	:	Granular
Colour	:	white
Odour	:	odourless
Flash point	:	Not applicable.
pH	:	no data available
Odour Threshold	:	no data available
Melting point/freezing point	:	no data available
Initial boiling point and boiling range	:	380 °C, Decomposes on heating.
Evaporation rate	:	no data available
Flammability (solid, gas)	:	no data available
Upper explosion limit	:	no data available
Lower explosion limit	:	no data available
Vapour pressure	:	no data available
Relative vapour density	:	no data available
Relative density	:	3.34, (20 °C),
Density	:	no data available
Water solubility	:	360 g/l completely soluble (20 °C)
Solubility in other solvents	:	no data available
Partition coefficient: n-octanol/water	:	no data available
Auto-ignition temperature	:	no data available
Thermal decomposition	:	no data available
Viscosity, dynamic	:	no data available
Viscosity, kinematic	:	no data available
Molecular weight	:	no data available
VOC	:	no data available

Section: 10. STABILITY AND REACTIVITY

Reactivity	:	No dangerous reaction known under conditions of normal use.
Chemical stability	:	Stable under normal conditions.
Possibility of hazardous reactions	:	No dangerous reaction known under conditions of normal use.
Conditions to avoid	:	None known.
Incompatible materials	:	None known.
Hazardous decomposition products	:	In case of fire, hazardous decomposition products may be produced such as: Hydrogen halides metal oxides

Section: 11. TOXICOLOGICAL INFORMATION

Information on likely routes of exposure	:	Eye contact, Skin contact

Potential Health Effects

Eyes	:	Causes serious eye irritation.
Skin	:	Causes skin irritation.
Ingestion	:	Harmful if swallowed.
Inhalation	:	May cause respiratory tract irritation.
Chronic Exposure	:	Suspected of causing genetic defects. Suspected of causing cancer.

Experience with human exposure

Eye contact	:	Redness, Pain, Irritation
Skin contact	:	Redness, Irritation
Ingestion	:	Vomiting
Inhalation	:	Respiratory irritation, Cough

Toxicity

Product

Acute oral toxicity	:	Acute toxicity estimate: 385 mg/kg
Acute inhalation toxicity	:	no data available
Acute dermal toxicity	:	no data available
Skin corrosion/irritation	:	no data available
Serious eye damage/eye irritation	:	no data available
Respiratory or skin sensitization	:	no data available

Carcinogenicity	:	Suspected of causing cancer.
Reproductive effects	:	No toxicity to reproduction
Germ cell mutagenicity	:	Suspected of causing genetic defects.
Teratogenicity	:	no data available
STOT - single exposure	:	no data available
STOT - repeated exposure	:	no data available
Aspiration toxicity	:	No aspiration toxicity classification

Human Hazard Characterization

Based on our hazard characterization, the potential human hazard is: High

Section: 12. ECOLOGICAL INFORMATION

Ecotoxicity

Environmental Effects	:	This product has no known ecotoxicological effects.

Product

Toxicity to fish	:	no data available
Toxicity to daphnia and other aquatic invertebrates	:	no data available
Toxicity to algae	:	no data available

Persistence and degradability

no data available

Mobility

The environmental fate was estimated using a level III fugacity model embedded in the EPI (estimation program interface) Suite TM, provided by the US EPA. The model assumes a steady state condition between the total input and output. The level III model does not require equilibrium between the defined media. The information provided is intended to give the user a general estimate of the environmental fate of this product under the defined conditions of the models.
If released into the environment this material is expected to distribute to the air, water and soil/sediment in the approximate respective percentages;

Air	:	<5%
Water	:	30 - 50%
Soil	:	50 - 70%

Bioaccumulative potential

no data available

Other information

no data available

ENVIRONMENTAL HAZARD AND EXPOSURE CHARACTERIZATION
Based on our hazard characterization, the potential environmental hazard is: Low

Section: 13. DISPOSAL CONSIDERATIONS

Disposal methods	:	Where possible recycling is preferred to disposal or incineration. If recycling is not practicable, dispose of in compliance with local regulations. Dispose of wastes in an approved waste disposal facility.
Disposal considerations	:	Dispose of as unused product. Empty containers should be taken to an approved waste handling site for recycling or disposal. Do not re-use empty containers.

Section: 14. TRANSPORT INFORMATION

The shipper/consignor/sender is responsible to ensure that the packaging, labeling, and markings are in compliance with the selected mode of transport.

Land transport

Proper shipping name	:	SODIUM BROMATE
UN/ID No.	:	UN 1494
Transport hazard class(es)	:	5.1
Packing group	:	II
IERG No	:	31
Hazchem Code	:	1Y
Special precautions for user	:	Dangerous goods of Class 5.1 (Oxidising Agent) are incompatible in a placard load with any of the following: Class 1 Explosives Class 2.1 Flammable gases Class 2.3 Poisonous gases Class 3 Flammable liquids Class 4.1 Flammable solids Class 4.2 Spontaneously combustible substances Class 4.3 Dangerous when wet substances Class 5.2 Organic peroxides Class 7 Radioactive substances Class 8 Corrosives

Air transport (IATA)

UN/ID No.	:	UN 1494
Proper shipping name	:	SODIUM BROMATE
Technical name(s)	:	
Transport hazard class(es)	:	5.1
Packing group	:	II

Sea transport (IMDG/IMO)

UN/ID No.	:	UN 1494
Proper shipping name	:	SODIUM BROMATE
Technical name(s)	:	
Transport hazard class(es)	:	5.1
Packing group	:	II

Section: 15. REGULATORY INFORMATION

Standard for the Uniform Scheduling of Medicines and Poisons	:	Schedule 6

INTERNATIONAL CHEMICAL CONTROL LAWS :

United States TSCA Inventory
The substances in this preparation are included on or exempted from the TSCA 8(b) Inventory (40 CFR 710)

Canadian Domestic Substances List (DSL)
The substances in this preparation are listed on the Domestic Substances List (DSL), are exempt, or have been reported in accordance with the New Substances Notification Regulations.

Taiwan Chemical Substance Inventory
All substances in this product comply with the Taiwan Existing Chemical Substances Inventory (ECSI).

Australia. Industrial Chemical (Notification and Assessment) Act
All substances in this product comply with the National Industrial Chemicals Notification & Assessment Scheme (NICNAS).

Korea. Korean Existing Chemicals Inventory (KECI)
All substances in this product comply with the Chemical Control Act (CCA) and are listed on the Existing Chemicals List (ECL)

Japan. ENCS - Existing and New Chemical Substances Inventory
All substances in this product comply with the Law Regulating the Manufacture and Importation Of Chemical Substances and are listed on the Existing and New Chemical Substances list (ENCS).

Philippines Inventory of Chemicals and Chemical Substances (PICCS)
All substances in this product comply with the Republic Act 6969 (RA 6969) and are listed on the Philippines Inventory of Chemicals & Chemical Substances (PICCS).

China Inventory of Existing Chemical Substances
All substances in this product comply with the Provisions on the Environmental Administration of New Chemical Substances and are listed on or exempt from the Inventory of Existing Chemical Substances China (IECSC).

New Zealand. Inventory of Chemicals (NZIoC), as published by ERMA New Zealand
All substances in this product comply with the Hazardous Substances and New Organisms (HSNO) Act 1996,and are listed on or are exempt from the New Zealand Inventory of Chemicals.

Section: 16. OTHER INFORMATION

REFERENCES

Hazardous Substances Data Bank, National Library of Medicine, Bethesda, Maryland (TOMES CPS™ CD-ROM Version), Micromedex, Inc., Englewood, CO.

IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man, Geneva: World Health Organization, International Agency for Research on Cancer.

Integrated Risk Information System, U.S. Environmental Protection Agency, Washington, D.C. (TOMES CPS™ CD-ROM Version),
Micromedex, Inc., Englewood, CO.

Annual Report on Carcinogens, National Toxicology Program, U.S. Department of Health and Human Services, Public Health Service.

Registry of Toxic Effects of Chemical Substances, National Institute for Occupational Safety and Health, Cincinnati, OH,
(TOMES CPS™ CD-ROM Version), Micromedex, Inc., Englewood, CO.

The Teratogen Information System, University of Washington, Seattle, WA (TOMES CPS™ CD-ROM Version), Micromedex, Inc., Englewood, CO.

Revision Date	:	08.01.2020
Date of first issue	:	09.06.2016
Version Number	:	1.2
Prepared By	:	Regulatory Affairs

REVISED INFORMATION: Significant changes to regulatory or health information for this revision is indicated by a bar in the left-hand margin of the SDS.

The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as a guidance for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text.

SAFETY DATA SHEET

Revision date: 24-Jan-2022

Revision Number 1

1. IDENTIFICATION OF THE MATERIAL AND SUPPLIER

Product identifier

Product Name CF8550EA

Product Code(s) 000000069052

Other means of identification

UN number 1444

Synonyms Manufactured exclusively for Condor Energy Services by Fusion Technologies (Australia) Pty Ltd

Recommended use of the chemical and restrictions on use

Recommended use Hydraulic fracturing additive.

Uses advised against No information available.

Supplier
Fusion Technologies Australia Pty Ltd
ABN: 50 636 538 960
Street Address: 7 Noble Street
Bridgeman Downs QLD 4035
Australia

Telephone number: +61 (0)460 047 656
Website: www.fusiontechinc.net

Emergency telephone number

Emergency telephone number **1800 033 111 (ALL HOURS)**

Please ensure you refer to the limitations of this Safety Data Sheet as set out in the "Other Information" section at the end of this Data Sheet.

2. HAZARDS IDENTIFICATION

GHS Classification

Classified as a hazardous chemical in accordance with the criteria of Safe Work Australia - Globally Harmonized System (GHS).

Classified as dangerous goods in accordance with the Australian Code for the Transport of Dangerous Goods by Road and Rail (ADG).

Oxidizing solids	Category 3
Acute toxicity - Oral	Category 4
Respiratory sensitization	Category 1
Skin sensitization	Category 1
Specific target organ toxicity (single exposure)	Category 3

SIGNAL WORD
Danger

Label elements

Flame over circle
Exclamation mark
Health hazard



Hazard statements
H302 - Harmful if swallowed
H334 - May cause allergy or asthma symptoms or breathing difficulties if inhaled
H317 - May cause an allergic skin reaction
H335 - May cause respiratory irritation
H272 - May intensify fire; oxidizer

Precautionary Statements - Prevention
Keep away from heat, hot surfaces, sparks, open flames and other ignition sources. No smoking
Keep/Store away from clothing/ combustible materials
Do not eat, drink or smoke when using this product
Wear protective gloves / protective clothing / eye protection / face protection
Avoid breathing dust / fume / gas / mist / vapours / spray
Use only outdoors or in a well-ventilated area
In case of inadequate ventilation wear respiratory protection
Wash face, hands and any exposed skin thoroughly after handling
Contaminated work clothing should not be allowed out of the workplace
Precautionary Statements - Response
IF exposed:
IF IN EYES If eye irritation persists: Get medical advice/attention
IF ON SKIN: Gently wash with plenty of soap and water If skin irritation or rash occurs: Get medical advice/attention Take off contaminated clothing and wash before reuse
IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing
If experiencing respiratory symptoms: Call a POISON CENTER or doctor
IF SWALLOWED: Call a POISON CENTER or doctor/physician if you feel unwell
Rinse mouth
In case of fire: Use extinguishing media as outlined in Section 5 of this Safety Data Sheet to extinguish.
Precautionary Statements - Storage
Store in a well-ventilated place. Keep container tightly closed
Store locked up
Precautionary Statements - Disposal
Dispose of contents/container in accordance with local, regional, national, and international regulations as applicable

Other hazards which do not result in classification
Poisons Schedule (SUSMP) 6

3. COMPOSITION/INFORMATION ON INGREDIENTS

Chemical name	CAS No.	Weight-%
Ammonium persulfate	7727-54-0	60-90%
Talc	14807-96-6	<5%
Non-hazardous ingredients	Proprietary	Balance

4. FIRST AID MEASURES

Description of first aid measures

General advice Take a copy of the Safety Data Sheet when going for medical treatment.

Inhalation Remove to fresh air and keep at rest in a position comfortable for breathing. If breathing is difficult, (trained personnel should) give oxygen. Give artificial respiration if victim is not breathing. Get immediate medical advice/attention.

Eye contact Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Do not rub affected area. Seek immediate medical attention/advice.

Skin contact Remove and isolate contaminated clothing and shoes. Wash off immediately with plenty of water. Get medical attention if symptoms occur. Allergic symptoms may be delayed.

Ingestion Rinse mouth thoroughly with water. Do NOT induce vomiting. Drink 1 or 2 glasses of water. Get immediate medical advice/attention.

Most important symptoms and effects, both acute and delayed

Symptoms May cause allergic skin reaction. May cause allergy or asthma symptoms or breathing difficulties if inhaled.

Indication of any immediate medical attention and special treatment needed

Note to physicians Treat symptomatically.

5. FIRE FIGHTING MEASURES

Suitable Extinguishing Media

Suitable Extinguishing Media Water spray or fog is preferred; if water not available use dry chemical, CO2 or regular foam.

Unsuitable extinguishing media No information available.

Specific hazards arising from the chemical

Specific hazards arising from the chemical Oxidizer. Non-combustible, substance itself does not burn but may decompose upon heating to produce corrosive and/or toxic fumes. Promotes the combustion (oxidizer). Can cause fire and explosion when in contact with flammable substances. Any material contaminated with the product (e.g. clothes) ignites easily and burns vigorously - increased fire hazard. Containers may explode when heated.

Hazardous combustion products Carbon oxides.

Special protective actions for fire-fighters

Special protective equipment for fire-fighters	Firefighters should wear self-contained breathing apparatus and full firefighting turnout gear. Cool containers with flooding quantities of water until well after fire is out.
Hazchem code	1Z

6. ACCIDENTAL RELEASE MEASURES

Personal precautions, protective equipment and emergency procedures

Personal precautions	Ensure adequate ventilation. Evacuate personnel to safe areas. Stop leak if you can do it without risk. Avoid breathing dust / fume / gas / mist / vapours / spray. Avoid generation of dust.
Other information	ELIMINATE all ignition sources (no smoking, flares, sparks or flames in immediate area).
For emergency responders	Use personal protection recommended in Section 8.

Environmental precautions

Environmental precautions	See Section 12 for additional Ecological Information.

Methods and material for containment and cleaning up

Methods for containment	Cover powder spill with plastic sheet or tarp to minimize spreading. Prevent dust cloud.
Methods for cleaning up	Take up with inert, damp, non-combustible material using clean non-sparking tools and place into loosely covered plastic containers for later disposal. Do not dry sweep dust. Wet dust with water before sweeping or use a vacuum to collect dust. Keep in suitable, closed containers for disposal. Prevent product from entering drains.

7. HANDLING AND STORAGE

Precautions for safe handling

Advice on safe handling	Handle in accordance with good industrial hygiene and safety practice. Avoid contact with skin, eyes, and clothing. Avoid breathing dust or spray mist. Take precautionary measures against static discharges.
General hygiene considerations	Take off contaminated clothing and wash it before reuse. Wash hands and face before breaks and immediately after handling the product. Wear suitable gloves and eye/face protection. When using do not eat, drink or smoke.

Conditions for safe storage, including any incompatibilities

Storage Conditions	Keep containers tightly closed in a dry, cool and well-ventilated place.
Incompatible materials	Acids. Alkalis. Combustible material. Halogenated compounds. Organic compounds.
Poisons Schedule (SUSMP)	6

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Control parameters

Exposure Limits	No value assigned for this specific material by Safe Work Australia. However, Workplace Exposure Standard(s) for constituent(s):

Chemical name	Australia	ACGIH TLV
Ammonium persulfate 7727-54-0	0.1 mg/m³ Peak	TWA: 0.1 mg/m³ persulfate

Talc (containing no asbestos fibres): 8hr TWA = 2.5 mg/m³

As published by Safe Work Australia Workplace Exposure Standards for Airborne Contaminants.

Peak Limitation - a maximum or peak airborne concentration of a particular substance determined over the shortest analytically practicable period of time which does not exceed 15 minutes.

TWA - The time-weighted average airborne concentration of a particular substance when calculated over an eight-hour working day, for a five-day working week.

These Workplace Exposure Standards are guides to be used in the control of occupational health hazards. All atmospheric contamination should be kept to as low a level as is workable. These workplace exposure standards should not be used as fine dividing lines between safe and dangerous concentrations of chemicals. They are not a measure of relative toxicity.

Appropriate engineering controls

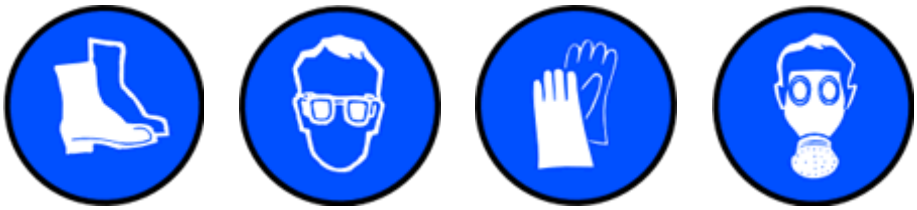
Engineering controls Apply technical measures to comply with the occupational exposure limits.

If in the handling and application of this material, safe exposure levels could be exceeded, the use of engineering controls such as local exhaust ventilation must be considered and the results documented. If achieving safe exposure levels does not require engineering controls, then a detailed and documented risk assessment using the relevant Personal Protective Equipment (PPE) (refer to PPE section below) as a basis must be carried out to determine the minimum PPE requirements.

Individual protection measures, such as personal protective equipment

The selection of PPE is dependent on a detailed risk assessment. The risk assessment should consider the work situation, the physical form of the chemical, the handling methods, and environmental factors.

OVERALLS, SAFETY SHOES, SAFETY GLASSES, GLOVES, DUST MASK.



Eye/face protection Wear safety glasses with side shields (or goggles).

Skin and body protection Wear suitable protective clothing. Long sleeved clothing.

Hand protection Wear suitable gloves.

Respiratory protection No protective equipment is needed under normal use conditions. If exposure limits are exceeded or irritation is experienced, ventilation and evacuation may be required. If determined by a risk assessment an inhalation risk exists, wear a dust mask/respirator meeting the requirements of AS/NZS 1715 and AS/NZS 1716.

Environmental exposure controls Avoid creating dust.

9. PHYSICAL AND CHEMICAL PROPERTIES

Information on basic physical and chemical properties

Physical state	Solid
Appearance	Crystalline Powder
Color	Beige
Odor	Faint Organic
Odor threshold	No information available.

Property	**Values**	**Remarks • Method**
pH	7.2	
pH (as aqueous solution)	No data available	None known
Melting point / freezing point	121°C (Decomposes on heating)	
Boiling point / boiling range	No data available	None known
Flash point	121°C	None known
Evaporation rate	No data available	None known
Flammability (solid, gas)	No data available	None known
Flammability Limit in Air		None known
Upper flammability or explosive limits	No data available	
Lower flammability or explosive limits	No data available	
Vapor pressure	No data available	None known
Vapor density	No data available	None known
Relative density	1.8	
Water solubility	Insoluble in water	
Solubility(ies)	No data available	None known
Partition coefficient	No data available	None known
Autoignition temperature	No data available	None known
Decomposition temperature	>120°C	
Kinematic viscosity	No data available	None known
Dynamic viscosity	No data available	None known

Other information

10. STABILITY AND REACTIVITY

Reactivity

Reactivity Oxidizer.

Chemical stability

Stability Stable under normal conditions. Unstable if heated.

Explosion data

Sensitivity to mechanical impact None.

Sensitivity to static discharge None.

Possibility of hazardous reactions

Possibility of hazardous reactions Can react violently with reducing agents. Contact with combustible material may cause fire.

Hazardous polymerization Hazardous polymerization does not occur.

Conditions to avoid

Conditions to avoid Dust formation. Extremes of temperature and direct sunlight.

Incompatible materials

Incompatible materials Acids. Alkalis. Combustible material. Halogenated compounds. Organic compounds.

Hazardous decomposition products

Hazardous decomposition products Carbon oxides. Nitrogen oxides. Oxides of sulfur.

11. TOXICOLOGICAL INFORMATION

Acute toxicity

Information on likely routes of exposure

Product Information No adverse health effects expected if the chemical is handled in accordance with this Safety Data Sheet and the chemical label. Symptoms or effects that may arise if the chemical is mishandled and overexposure occurs are:

Inhalation Irritating to respiratory system. May cause sensitization by inhalation. May cause allergy or asthma symptoms or breathing difficulties if inhaled.

Eye contact May cause irritation.

Skin contact May cause irritation. May cause sensitization by skin contact. Repeated or prolonged skin contact may cause allergic reactions with susceptible persons.

Ingestion Ingestion may cause gastrointestinal irritation, nausea, vomiting and diarrhoea.

Symptoms Irritating. Asthma-like and/ or skin allergy-like symptoms. May cause sensitization by inhalation and skin contact.

Numerical measures of toxicity - Product Information
No information available.

Component Information

Chemical name	Oral LD50	Dermal LD50	Inhalation LC50
Ammonium persulfate	= 495 mg/kg (Rat)	> 10000 mg/kg (Rabbit)	= 520 mg/L (Rat) 1 h

See section 16 for terms and abbreviations

Delayed and immediate effects as well as chronic effects from short and long-term exposure

Skin corrosion/irritation May cause skin irritation. Classification based on data available for ingredients.

Serious eye damage/eye irritation Mild eye irritation. Classification based on data available for ingredients.

Respiratory or skin sensitization May cause sensitization by inhalation and skin contact.

Germ cell mutagenicity No information available.

Carcinogenicity No information available.

Reproductive toxicity No information available.

STOT - single exposure May cause respiratory irritation.

STOT - repeated exposure No information available.

Aspiration hazard Not applicable.

12. ECOLOGICAL INFORMATION

Ecotoxicity

Ecotoxicity Keep out of waterways.

Chemical name	Algae/aquatic plants	Fish	Toxicity to microorganisms	Crustacea
Ammonium persulfate	-	LC50: =103mg/L (96h, Lepomis macrochirus) LC50: =76.3mg/L (96h, Oncorhynchus mykiss) LC50: =323mg/L (96h, Poecilia reticulata)	-	EC50: =120mg/L (48h, Daphnia magna)
Talc	-	LC50: >100g/L (96h, Brachydanio rerio)	-	-

Persistence and degradability

Persistence and degradability Not readily biodegradable.

Bioaccumulative potential

Bioaccumulation Bioaccumulation is not expected.

Mobility

Mobility in soil No information available.

Other adverse effects

13. DISPOSAL CONSIDERATIONS

Waste treatment methods

Waste from residues/unused products Dispose of in accordance with local regulations. Dispose of waste in accordance with environmental legislation.

Contaminated packaging Dispose of contents/containers in accordance with local regulations.

14. TRANSPORT INFORMATION

ADG
Classified as Dangerous Goods by the criteria of the Australian Dangerous Goods Code (ADG Code) for Transport by Road and Rail; DANGEROUS GOODS.

UN number 1444
Proper shipping name AMMONIUM PERSULPHATE
Hazard class 5.1
Packing group III
Hazchem code 1Z

IATA
Classified as Dangerous Goods by the criteria of the International Air Transport Association (IATA) Dangerous Goods Regulations

for transport by air; DANGEROUS GOODS.

UN number	1444
UN proper shipping name	AMMONIUM PERSULPHATE
Transport hazard class(es)	5.1
Packing group	III

IMDG
Classified as Dangerous Goods by the criteria of the International Maritime Dangerous Goods Code (IMDG Code) for transport by sea; DANGEROUS GOODS.

UN number	1444
UN proper shipping name	AMMONIUM PERSULPHATE
Transport hazard class(es)	5.1
Packing group	III
IMDG EMS Fire	F-A
IMDG EMS Spill	S-Q

15. REGULATORY INFORMATION

Safety, health and environmental regulations/legislation specific for the substance or mixture

National regulations

Australia
Classified as a hazardous chemical in accordance with the criteria of Safe Work Australia - Globally Harmonized System (GHS).

Classified as dangerous goods in accordance with the Australian Code for the Transport of Dangerous Goods by Road and Rail (ADG).

See section 8 for national exposure control parameters

Standard for the Uniform Scheduling of Medicines and Poisons (SUSMP)
Classified as a scheduled poison according to the Standard for Uniform Scheduling of Medicines and Poisons (SUSMP)
Poisons Schedule (SUSMP) 6

International Inventories

AIIC	This material is listed on the Australian Inventory of Industrial Chemicals.
NZIoC	All the constituents of this material are listed on the New Zealand Inventory of Chemicals.

Legend:
- Australian Inventory of Industrial Chemicals

International Regulations

The Montreal Protocol on Substances that Deplete the Ozone Layer Not applicable

The Stockholm Convention on Persistent Organic Pollutants Not applicable

The Rotterdam Convention Not applicable

16. OTHER INFORMATION

Supplier Safety Data Sheet 06/ 2020

Reason(s) For Issue: First Issue Primary SDS

Issuing Date: 24-Jan-2022

This Safety Data Sheet has been prepared by Ixom Operations Pty Ltd (Toxicology and SDS Services).

Revision Note:
The symbol (*) in the margin of this SDS indicates that this line has been revised.

Key or legend to abbreviations and acronyms used in the safety data sheet

Legend Section 8: EXPOSURE CONTROLS/PERSONAL PROTECTION

TWA	TWA (time-weighted average)	STEL	STEL (Short Term Exposure Limit)
Ceiling	Maximum limit value	*	Skin designation
C	Carcinogen		

Key literature references and sources for data used to compile the SDS

EPA (Environmental Protection Agency)
Acute Exposure Guideline Level(s) (AEGL(s))
U.S. Environmental Protection Agency Federal Insecticide, Fungicide, and Rodenticide Act
U.S. Environmental Protection Agency High Production Volume Chemicals
Food Research Journal
Hazardous Substance Database
International Uniform Chemical Information Database (IUCLID)
Japan GHS Classification
Australian Industrial Chemicals Introduction Scheme (AICIS)
NIOSH (National Institute for Occupational Safety and Health)
National Library of Medicine's ChemID Plus (NLM CIP)
National Library of Medicine's PubMed database (NLM PUBMED)
National Toxicology Program (NTP)
New Zealand's Chemical Classification and Information Database (CCID)
Organization for Economic Co-operation and Development Environment, Health, and Safety Publications
Organization for Economic Co-operation and Development High Production Volume Chemicals Program
Organization for Economic Co-operation and Development Screening Information Data Set
RTECS (Registry of Toxic Effects of Chemical Substances)
World Health Organization

Disclaimer

This SDS summarises to our best knowledge at the date of issue, the chemical health and safety hazards of the material and general guidance on how to safely handle the material in the workplace. Since The Supplier cannot anticipate or control the conditions under which the product may be used, each user must, prior to usage, assess and control the risks arising from its use of the material.

If clarification or further information is needed, the user should contact their Supplier representative or The Supplier at the contact details on page 1.

The Supplier's responsibility for the material as sold is subject to the terms and conditions of sale, a copy of which is available upon request.

End of Safety Data Sheet

SAFETY DATA SHEET

Revision date: 20-Apr-2022

Revision Number 1

1. IDENTIFICATION OF THE MATERIAL AND SUPPLIER

Product identifier

Product Name CF8200E

Product Code(s) 000000069059

Other means of identification

Recommended use of the chemical and restrictions on use

Recommended use Hydraulic fracturing fluid.

Uses advised against No information available.

Supplier
Condor Energy Services Ltd
ABN: 35 153 250 670
Brisbane Head Office: Level 11, 333 Ann Street
Brisbane QLD 4000
Australia

Telephone number: 07 3999 9044
Website: www.CondorEnergy.com.au

Emergency telephone number

Emergency telephone number **1800 033 111 (ALL HOURS)**

Please ensure you refer to the limitations of this Safety Data Sheet as set out in the "Other Information" section at the end of this Data Sheet.

2. HAZARDS IDENTIFICATION

GHS Classification

Classified as a hazardous chemical in accordance with the criteria of Safe Work Australia - Globally Harmonized System (GHS).

Not classified as dangerous goods in accordance with the Australian Code for the Transport of Dangerous Goods by Road and Rail (ADG)

Respiratory sensitization	Category 1

SIGNAL WORD

Danger

Label elements

Health hazard



Hazard statements
H334 - May cause allergy or asthma symptoms or breathing difficulties if inhaled

Precautionary Statements - Prevention
Avoid breathing dust / fume / gas / mist / vapours / spray
In case of inadequate ventilation wear respiratory protection
Precautionary Statements - Response
IF exposed or concerned
IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing
If experiencing respiratory symptoms: Call a POISON CENTER or doctor/physician
Precautionary Statements - Storage
No storage statements
Precautionary Statements - Disposal
Dispose of contents/container in accordance with local, regional, national, and international regulations as applicable

Other hazards which do not result in classification
Poisons Schedule (SUSMP) 5

3. COMPOSITION/INFORMATION ON INGREDIENTS

Chemical name	CAS No.	Weight-%
Mannanase (Mannan endo-1,4-beta-mannosidase)	37288-54-3	<5
Non-hazardous ingredients	Proprietary	Balance

4. FIRST AID MEASURES

Description of first aid measures

Emergency telephone number Poisons Information Center, Australia: 13 11 26

Inhalation Move victim to fresh air. Treatment should be symptomatic and supportive. Get immediate medical advice/attention. If breathing is difficult, (trained personnel should) give oxygen. Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.

Eye contact In case of eye contact, immediately flush eyes with plenty of water for at least 15 minutes. Get medical attention if symptoms occur.

Skin contact Wash off immediately with soap and plenty of water. Get medical attention if symptoms occur.

Ingestion Rinse mouth thoroughly with water. Get medical attention if symptoms occur.

Self-protection of the first aider Do not breathe fume, gas, mist, vapours, spray. Use personal protective equipment as

required.

Most important symptoms and effects, both acute and delayed

Symptoms May cause allergy or asthma symptoms or breathing difficulties if inhaled.

Indication of any immediate medical attention and special treatment needed

Note to physicians Treat symptomatically.

5. FIRE FIGHTING MEASURES

Suitable Extinguishing Media

Suitable Extinguishing Media Use extinguishing measures that are appropriate to local circumstances and the surrounding environment.

Unsuitable extinguishing media None known.

Specific hazards arising from the chemical

Specific hazards arising from the chemical Non-combustible, substance itself does not burn but may decompose upon heating to produce corrosive and/or toxic fumes.

Hazardous combustion products Carbon oxides.

Special protective actions for fire-fighters

Special protective equipment for fire-fighters Firefighters should wear self-contained breathing apparatus and full firefighting turnout gear. Use personal protection equipment.

6. ACCIDENTAL RELEASE MEASURES

Personal precautions, protective equipment and emergency procedures

Personal precautions Avoid breathing vapors or mists. Ensure adequate ventilation. Use personal protective equipment as required.

For emergency responders Use personal protection recommended in Section 8.

Environmental precautions

Environmental precautions Do not allow to enter into soil/subsoil. Keep out of waterways.

Methods and material for containment and cleaning up

Methods for containment Contain and collect spillage with non-combustible absorbent material, (e.g. sand, earth, diatomaceous earth, vermiculite) and place in container for disposal according to local / national regulations (see Section 13).

Methods for cleaning up Take up with sand or other non-combustible absorbent material and place into containers for later disposal. Dike to collect large liquid spills. Prevent product from entering drains.

7. HANDLING AND STORAGE

Precautions for safe handling

Advice on safe handling Handle in accordance with good industrial hygiene and safety practice. Avoid breathing dust / fume / gas / mist / vapours / spray. Ensure adequate ventilation.

General hygiene considerations Do not eat, drink or smoke when using this product.

Conditions for safe storage, including any incompatibilities

Storage Conditions Keep out of the reach of children. Keep container closed when not in use. Store in accordance with local regulations.

Incompatible materials None known.

Poisons Schedule (SUSMP) 5

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Control parameters

Exposure Limits No value assigned for this specific material by Safe Work Australia.

Appropriate engineering controls

Engineering controls Apply technical measures to comply with the occupational exposure limits.

If in the handling and application of this material, safe exposure levels could be exceeded, the use of engineering controls such as local exhaust ventilation must be considered and the results documented. If achieving safe exposure levels does not require engineering controls, then a detailed and documented risk assessment using the relevant Personal Protective Equipment (PPE) (refer to PPE section below) as a basis must be carried out to determine the minimum PPE requirements.

Individual protection measures, such as personal protective equipment

The selection of PPE is dependent on a detailed risk assessment. The risk assessment should consider the work situation, the physical form of the chemical, the handling methods, and environmental factors.

OVERALLS, SAFETY SHOES, SAFETY GLASSES, GLOVES.



Eye/face protection Wear safety glasses with side shields (or goggles).

Skin and body protection Wear suitable protective clothing.

Hand protection Protective gloves. Nitrile rubber.

Respiratory protection If determined by a risk assessment an inhalation risk exists, wear a suitable mist respirator meeting the requirements of AS/NZS 1715 and AS/NZS 1716.

Environmental exposure controls No information available.

9. PHYSICAL AND CHEMICAL PROPERTIES

Information on basic physical and chemical properties

Physical state	Liquid
Appearance	Clear
Color	Amber
Odor	Slight Fermentation
Odor threshold	No information available.

Property	**Values**	**Remarks • Method**
pH	4.8 - 6.5	None known
pH (as aqueous solution)	No data available	None known
Melting point / freezing point	0 °C	Pour Point
Boiling point / boiling range	100 °C	None known
Flash point	No data available	None known
Evaporation rate	No data available	None known
Flammability (solid, gas)	No data available	None known
Flammability Limit in Air		None known
Upper flammability or explosive limits	No data available	
Lower flammability or explosive limits	No data available	
Vapor pressure	No data available	None known
Vapor density	No data available	None known
Relative density	1.000 - 1.050	None known
Water solubility	No data available	None known
Solubility(ies)	No data available	None known
Partition coefficient	No data available	None known
Autoignition temperature	No data available	None known
Decomposition temperature	No data available	None known
Kinematic viscosity	No data available	None known
Dynamic viscosity	1 mPa s	None known

Other information

10. STABILITY AND REACTIVITY

Reactivity

Reactivity Non-reactive under normal conditions of use, storage and transport.

Chemical stability

Stability Stable under normal conditions.

Explosion data

Sensitivity to mechanical impact None.

Sensitivity to static discharge None.

Possibility of hazardous reactions

Possibility of hazardous reactions None under normal processing.

Conditions to avoid

Conditions to avoid None known based on information supplied.

Incompatible materials

Incompatible materials None known.

Hazardous decomposition products

Hazardous decomposition products Carbon oxides.

11. TOXICOLOGICAL INFORMATION

Acute toxicity

Information on likely routes of exposure

Product Information No adverse health effects expected if the chemical is handled in accordance with this Safety Data Sheet and the chemical label. Symptoms or effects that may arise if the chemical is mishandled and overexposure occurs are:

Inhalation May cause allergy or asthma symptoms or breathing difficulties if inhaled.

Eye contact May cause slight irritation.

Skin contact May cause irritation.

Ingestion Ingestion may cause gastrointestinal irritation, nausea, vomiting and diarrhoea.

Symptoms May cause allergy or asthma symptoms or breathing difficulties if inhaled.

Numerical measures of toxicity - Product Information
No information available.

See section 16 for terms and abbreviations

Delayed and immediate effects as well as chronic effects from short and long-term exposure

Skin corrosion/irritation No information available.

Serious eye damage/eye irritation No information available.

Respiratory or skin sensitization May cause sensitization by inhalation. Classification based on individual ingredients of the mixture.

Germ cell mutagenicity No information available.

Carcinogenicity No information available.

Reproductive toxicity No information available.

Developmental toxicity None known

STOT - single exposure No information available.

STOT - repeated exposure No information available.

Aspiration hazard No information available.

Chronic effects: No long term risks to humans are associated with this material when handled and used as directed on the label.

12. ECOLOGICAL INFORMATION

Ecotoxicity

Ecotoxicity Not considered to be harmful to aquatic life.

Persistence and degradability

Persistence and degradability Readily biodegradable.

Bioaccumulative potential

Bioaccumulation Bioaccumulation is not expected.

Mobility

Mobility in soil Expected to be mobile in soil.

Mobility Soluble in water.

Other adverse effects

Other adverse effects No information available.

13. DISPOSAL CONSIDERATIONS

Waste treatment methods

Waste from residues/unused products Dispose of in accordance with local regulations.

Contaminated packaging Dispose of in accordance with federal, state and local regulations. Dispose of wastes in an approved waste disposal facility. Empty containers should be taken to an approved waste handling site for recycling or disposal.

14. TRANSPORT INFORMATION

ADG
Not classified as Dangerous Goods by the criteria of the Australian Dangerous Goods Code (ADG Code) for transport by Road and Rail; NON-DANGEROUS GOODS.

IATA
Not classified as Dangerous Goods by the criteria of the International Air Transport Association (IATA) Dangerous Goods Regulations for transport by air; NON-DANGEROUS GOODS.

IMDG
Not classified as Dangerous Goods by the criteria of the International Maritime Dangerous Goods Code (IMDG Code) for transport by sea; NON-DANGEROUS GOODS.

15. REGULATORY INFORMATION

Safety, health and environmental regulations/legislation specific for the substance or mixture

National regulations

Australia
Classified as a hazardous chemical in accordance with the criteria of Safe Work Australia - Globally Harmonized System (GHS).

Not classified as dangerous goods in accordance with the Australian Code for the Transport of Dangerous Goods by Road and Rail (ADG)

See section 8 for national exposure control parameters

Poisons Schedule (SUSMP) 5

International Inventories

AIIC	All the constituents of this material are listed on the Australian Inventory of Industrial Chemicals.
NZIoC	All the constituents of this material are listed on the New Zealand Inventory of Chemicals.

Legend:
- Australian Inventory of Industrial Chemicals

International Regulations

The Montreal Protocol on Substances that Deplete the Ozone Layer Not applicable

The Stockholm Convention on Persistent Organic Pollutants Not applicable

The Rotterdam Convention Not applicable

16. OTHER INFORMATION

Supplier Safety Data Sheet 06/ 2020

Reason(s) For Issue: First Issue Primary SDS

Issuing Date: 20-Apr-2022

This Safety Data Sheet has been prepared by Ixom Operations Pty Ltd (Toxicology and SDS Services).

Revision Note:
1.

Key or legend to abbreviations and acronyms used in the safety data sheet

Legend Section 8: EXPOSURE CONTROLS/PERSONAL PROTECTION

TWA	TWA (time-weighted average)	STEL	STEL (Short Term Exposure Limit)
Ceiling	Maximum limit value	*	Skin designation
C	Carcinogen		

Key literature references and sources for data used to compile the SDS

EPA (Environmental Protection Agency)

Acute Exposure Guideline Level(s) (AEGL(s))
U.S. Environmental Protection Agency Federal Insecticide, Fungicide, and Rodenticide Act
U.S. Environmental Protection Agency High Production Volume Chemicals
Food Research Journal
Hazardous Substance Database
International Uniform Chemical Information Database (IUCLID)
Japan GHS Classification
Australian Industrial Chemicals Introduction Scheme (AICIS)
NIOSH (National Institute for Occupational Safety and Health)
National Library of Medicine's ChemID Plus (NLM CIP)
National Library of Medicine's PubMed database (NLM PUBMED)
National Toxicology Program (NTP)
New Zealand's Chemical Classification and Information Database (CCID)
Organization for Economic Co-operation and Development Environment, Health, and Safety Publications
Organization for Economic Co-operation and Development High Production Volume Chemicals Program
Organization for Economic Co-operation and Development Screening Information Data Set
RTECS (Registry of Toxic Effects of Chemical Substances)
World Health Organization

Disclaimer

This SDS summarises to our best knowledge at the date of issue, the chemical health and safety hazards of the material and general guidance on how to safely handle the material in the workplace. Since The Supplier cannot anticipate or control the conditions under which the product may be used, each user must, prior to usage, assess and control the risks arising from its use of the material.

If clarification or further information is needed, the user should contact their Supplier representative or The Supplier at the contact details on page 1.

The Supplier's responsibility for the material as sold is subject to the terms and conditions of sale, a copy of which is available upon request.

End of Safety Data Sheet

SAFETY DATA SHEET

Revision date: 16-Jul-2021

Revision Number 1

1. IDENTIFICATION OF THE MATERIAL AND SUPPLIER

Product identifier

Product Name CFBE5

Product Code(s) 000000069016

Other means of identification

UN number 2922

Synonyms Manufactured exclusively for Condor Energy Services by Fusion Technologies (Australia) Pty Ltd

Recommended use of the chemical and restrictions on use

Recommended use Biocidal product.

Uses advised against No information available.

Supplier
Fusion Technologies Australia Pty Ltd
ABN: 50 636 538 960
Street Address: 7 Noble Street
Bridgeman Downs QLD 4035
Australia

Telephone number: +61 (0)460 047 656
Website: www.fusiontechinc.net

Emergency telephone number

Emergency telephone number **1800 033 111 (ALL HOURS)**

Please ensure you refer to the limitations of this Safety Data Sheet as set out in the "Other Information" section at the end of this Data Sheet.

2. HAZARDS IDENTIFICATION

GHS Classification

Classified as a hazardous chemical in accordance with the criteria of Safe Work Australia - Globally Harmonized System (GHS).

Classified as dangerous goods in accordance with the Australian Code for the Transport of Dangerous Goods by Road and Rail (ADG).

Acute toxicity - Oral	Category 4
Acute toxicity - Inhalation (Vapors)	Category 3
Skin corrosion/irritation	Category 1 Sub-category B
Respiratory sensitization	Category 1
Skin sensitization	Category 1A
Specific target organ toxicity (single exposure)	Category 3
Acute aquatic toxicity	Category 1
Chronic aquatic toxicity	Category 2

SIGNAL WORD
Danger

Label elements

Skull and crossbones
Corrosion
Health hazard
Environment



Hazard statements
H331 - Toxic if inhaled
H302 - Harmful if swallowed
H335 - May cause respiratory irritation
H314 - Causes severe skin burns and eye damage
H334 - May cause allergy or asthma symptoms or breathing difficulties if inhaled
H317 - May cause an allergic skin reaction
H400 - Very toxic to aquatic life
H411 - Toxic to aquatic life with long lasting effects

Precautionary Statements - Prevention
Do not breathe mist, vapours, spray.
Use only outdoors or in a well-ventilated area
In case of inadequate ventilation wear respiratory protection
Wear protective gloves / protective clothing / eye protection / face protection
Wash face, hands and any exposed skin thoroughly after handling
Contaminated work clothing should not be allowed out of the workplace
Do not eat, drink or smoke when using this product
Avoid release to the environment
Precautionary Statements - Response

IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing
IF ON SKIN (or hair): Remove/Take off immediately all contaminated clothing. Rinse skin with water/shower
Wash contaminated clothing before reuse
If skin irritation or rash occurs: Get medical advice/attention
IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing
Immediately call a POISON CENTER or doctor/physician
IF SWALLOWED: Call a POISON CENTER or doctor/physician if you feel unwell
Rinse mouth
Collect spillage
Precautionary Statements - Storage
Store in a well-ventilated place. Keep container tightly closed

Store locked up

Precautionary Statements - Disposal

Dispose of contents/container in accordance with local, regional, national, and international regulations as applicable

Other hazards which do not result in classification

Poisons Schedule (SUSMP) 6

3. COMPOSITION/INFORMATION ON INGREDIENTS

Chemical name	CAS No.	Weight-%
Glutaraldehyde	111-30-8	20-50%
Methanol (methyl alcohol)	67-56-1	1-5%
Non-hazardous ingredients	Proprietary	Balance

4. FIRST AID MEASURES

Description of first aid measures

General advice Take a copy of the Safety Data Sheet when going for medical treatment.

Emergency telephone number Poisons Information Center, Australia: 13 11 26
Poisons Information Center, New Zealand: 0800 764 766

Inhalation Move to fresh air in case of accidental inhalation of vapors. Seek immediate medical attention/advice. If not breathing, give artificial respiration. Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.

Eye contact Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. Get immediate medical advice/attention.

Skin contact Wash off immediately with soap and plenty of water for at least 15 minutes. Remove and isolate contaminated clothing and shoes. Get immediate medical advice/attention. Wash contaminated clothing before reuse.

Ingestion Rinse mouth thoroughly with water. Never give anything by mouth to an unconscious person. Do NOT induce vomiting. Immediate medical attention is required.

Self-protection of the first aider Do not breathe vapor or mist. Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. Avoid contact with skin, eyes, and clothing.

Most important symptoms and effects, both acute and delayed

Symptoms Asthma-like and/ or skin allergy-like symptoms. May cause redness and tearing of the eyes. Burning sensation.

Indication of any immediate medical attention and special treatment needed

Note to physicians Treat symptomatically.

5. FIRE FIGHTING MEASURES

Suitable Extinguishing Media

Suitable Extinguishing Media Use extinguishing measures that are appropriate to local circumstances and the surrounding environment.

Unsuitable extinguishing media High volume water jet.

Specific hazards arising from the chemical

Specific hazards arising from the chemical Non-combustible. Environmentally hazardous.

Hazardous combustion products Carbon oxides.

Special protective actions for fire-fighters

Special protective equipment for fire-fighters Firefighters should wear self-contained breathing apparatus and full firefighting turnout gear. Use personal protection equipment.

Hazchem code 2X

6. ACCIDENTAL RELEASE MEASURES

Personal precautions, protective equipment and emergency procedures

Personal precautions Ensure adequate ventilation. Keep people away from and upwind of spill/leak. Avoid contact with skin, eyes and inhalation of vapors.

For emergency responders Use personal protection recommended in Section 8.

Environmental precautions

Environmental precautions Do not allow to enter into soil/subsoil. Keep out of waterways. See Section 12 for additional Ecological Information.

Methods and material for containment and cleaning up

Methods for containment Stop leak if you can do it without risk. Contain and collect spillage with non-combustible absorbent material, (e.g. sand, earth, diatomaceous earth, vermiculite) and place in container for disposal according to local / national regulations (see Section 13). Dike to collect large liquid spills.

Methods for cleaning up Soak up with inert absorbent material (e.g. sand, silica gel, acid binder, universal binder, sawdust). Sweep up and shovel into suitable containers for disposal. Avoid breathing dust or spray mist. Clean contaminated surface thoroughly.

7. HANDLING AND STORAGE

Precautions for safe handling

Advice on safe handling Handle in accordance with good industrial hygiene and safety practice. Do not breathe vapor or mist. Do not get in eyes. Avoid contact with skin. Wash thoroughly after handling. Ensure adequate ventilation. In case of insufficient ventilation, wear suitable respiratory equipment.

General hygiene considerations Remove and wash contaminated clothing and gloves, including the inside, before re-use. Take off contaminated clothing and wash it before reuse. When using do not eat, drink or smoke.

Conditions for safe storage, including any incompatibilities

Storage Conditions Keep container tightly closed in a dry and well-ventilated place. Store locked up. Keep in properly labelled containers.

This material is a Scheduled Poison and must be stored, maintained and used in accordance with the relevant regulations.

Incompatible materials None known based on information supplied.

Poisons Schedule (SUSMP) 6

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Control parameters

Exposure Limits No value assigned for this specific material by Safe Work Australia. However, Workplace Exposure Standard(s) for constituent(s):

Chemical name	Australia	ACGIH TLV
Glutaraldehyde 111-30-8	0.1 ppm Peak 0.41 mg/m³ Peak	Ceiling: 0.05 ppm activated and inactivated

Glutaraldehyde: Peak Limitation = 0.41 mg/m³ (0.1 ppm), Sen
Methyl alcohol (Methanol): 8hr TWA = 262 mg/m³ (200 ppm), 15 min STEL = 328 mg/m³ (250 ppm), Sk

As published by Safe Work Australia Workplace Exposure Standards for Airborne Contaminants.

TWA - The time-weighted average airborne concentration of a particular substance when calculated over an eight-hour working day, for a five-day working week.

STEL (Short Term Exposure Limit) - the airborne concentration of a particular substance calculated as a time-weighted average over 15 minutes, which should not be exceeded at any time during a normal eight hour work day. According to current knowledge this concentration should neither impair the health of, nor cause undue discomfort to, nearly all workers.

`Sen' Notice - sensitiser. The substance can cause a specific immune response in some people. An affected individual may subsequently react to exposure to minute levels of that substance and should not be further exposed to the substance.

`Sk' (skin) Notice - absorption through the skin may be a significant source of exposure. The exposure standard is invalidated if such contact should occur.

These Workplace Exposure Standards are guides to be used in the control of occupational health hazards. All atmospheric contamination should be kept to as low a level as is workable. These workplace exposure standards should not be used as fine dividing lines between safe and dangerous concentrations of chemicals. They are not a measure of relative toxicity.

Appropriate engineering controls

Engineering controls Apply technical measures to comply with the occupational exposure limits.

If in the handling and application of this material, safe exposure levels could be exceeded, the use of engineering controls such as local exhaust ventilation must be considered and the results documented. If achieving safe exposure levels does not require engineering controls, then a detailed and documented risk assessment using the relevant Personal Protective Equipment (PPE) (refer to PPE section below) as a basis must be carried out to determine the minimum PPE requirements.

Individual protection measures, such as personal protective equipment

The selection of PPE is dependent on a detailed risk assessment. The risk assessment should consider the work situation, the physical form of the chemical, the handling methods, and environmental factors.

OVERALLS, SAFETY SHOES, SAFETY GLASSES, GLOVES, RESPIRATOR.



Eye/face protection	Wear safety glasses with side shields (or goggles). If splashes are likely to occur:. Face protection shield.
Skin and body protection	Wear suitable protective clothing. Long sleeved clothing.
Hand protection	Wear suitable gloves. Nitrile rubber. Neoprene gloves. Impervious gloves.
Respiratory protection	No protective equipment is needed under normal use conditions. If exposure limits are exceeded or irritation is experienced, ventilation and evacuation may be required. If determined by a risk assessment an inhalation risk exists, wear an organic vapour respirator meeting the requirements of AS/NZS 1715 and AS/NZS 1716.
Environmental exposure controls	Do not allow into any sewer, on the ground or into any body of water. Local authorities should be advised if significant spillages cannot be contained.

9. PHYSICAL AND CHEMICAL PROPERTIES

Information on basic physical and chemical properties

Physical state	Liquid
Appearance	Clear
Color	Colourless
Odor	Pungent
Odor threshold	No information available.

Property	**Values**	**Remarks • Method**
pH	3 - 5	
pH (as aqueous solution)	No data available	None known
Melting point / freezing point	No data available	None known
Boiling point / boiling range	No data available	None known
Flash point	> 100°C	None known
Evaporation rate	No data available	None known
Flammability (solid, gas)	No data available	None known
Flammability Limit in Air		None known
Upper flammability or explosive limits	No data available	
Lower flammability or explosive limits	No data available	
Vapor pressure	No data available	None known
Vapor density	No data available	None known
Relative density	1.063	
Water solubility	Miscible in water	
Solubility(ies)	No data available	None known
Partition coefficient	No data available	None known
Autoignition temperature	No data available	None known
Decomposition temperature	No data available	None known
Kinematic viscosity	No data available	None known
Dynamic viscosity	No data available	None known

Other information

10. STABILITY AND REACTIVITY

Reactivity

Reactivity No information available.

Chemical stability

Stability Stable under normal conditions.

Explosion data

Sensitivity to mechanical impact None.

Sensitivity to static discharge None.

Possibility of hazardous reactions

Possibility of hazardous reactions None under normal processing.

Conditions to avoid

Conditions to avoid None known based on information supplied.

Incompatible materials

Incompatible materials None known based on information supplied.

Hazardous decomposition products

Hazardous decomposition products Carbon oxides.

11. TOXICOLOGICAL INFORMATION

Acute toxicity

Information on likely routes of exposure

Product Information No adverse health effects expected if the chemical is handled in accordance with this Safety Data Sheet and the chemical label. Symptoms or effects that may arise if the chemical is mishandled and overexposure occurs are:

Inhalation Toxic by inhalation. Vapors may be irritating to eyes, nose, throat, and lungs. May cause allergy or asthma symptoms or breathing difficulties if inhaled. May cause sensitization by inhalation.

Eye contact Causes serious eye irritation.

Skin contact Harmful in contact with skin. Causes severe burns. Repeated or prolonged skin contact may cause allergic reactions with susceptible persons.

Ingestion Harmful if swallowed. Can burn mouth, throat, and stomach. Ingestion may cause gastrointestinal irritation, nausea, vomiting and diarrhoea.

Symptoms Asthma-like and/ or skin allergy-like symptoms. May cause sensitization by inhalation and skin contact. Irritation/Corrosion. May cause redness and tearing of the eyes. Rashes. Coughing and/ or wheezing.

Numerical measures of toxicity - Product Information
No information available.

Numerical measures of toxicity - Component Information

Component Information

Chemical name	Oral LD50	Dermal LD50	Inhalation LC50
Glutaraldehyde	= 252 mg/kg (Rat)	= 1800 mg/kg (Rabbit) = 560 µL/kg (Rabbit)	= 40.1 ppm (Rat) 4 h = 23.5 ppm (Rat) 4 h
Methanol (methyl alcohol)	= 6200 mg/kg (Rat)	= 15840 mg/kg (Rabbit) = 15800 mg/kg (Rabbit)	= 64000 ppm (Rat) 4 h = 22500 ppm (Rat) 8 h

See section 16 for terms and abbreviations

Delayed and immediate effects as well as chronic effects from short and long-term exposure

Skin corrosion/irritation Causes burns.

Serious eye damage/eye irritation Causes serious eye irritation.

Respiratory or skin sensitization May cause sensitization by inhalation and skin contact.

Germ cell mutagenicity No information available.

Carcinogenicity No information available.

Reproductive toxicity No information available.

STOT - single exposure May cause respiratory irritation.

STOT - repeated exposure No information available.

Aspiration hazard No information available.

12. ECOLOGICAL INFORMATION

Ecotoxicity

Ecotoxicity Toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment.

Chemical name	Algae/aquatic plants	Fish	Toxicity to microorganisms	Crustacea
Glutaraldehyde	EC50: =0.61mg/L (72h, Desmodesmus subspicatus) EC50: =0.84mg/L (96h, Desmodesmus subspicatus)	LC50: 7.8 - 22mg/L (96h, Lepomis macrochirus) LC50: 2.6 - 4.8mg/L (96h, Oncorhynchus mykiss) LC50: 7.8 - 13mg/L (96h, Oncorhynchus mykiss) LC50: =5.4mg/L (96h, Pimephales promelas)	-	EC50: =14mg/L (48h, Daphnia magna) EC50: 0.56 - 1.0mg/L (48h, Daphnia magna)
Methanol (methyl alcohol)	-	LC50: =28200mg/L (96h, Pimephales promelas) LC50: >100mg/L (96h, Pimephales promelas) LC50: 19500 - 20700mg/L (96h, Oncorhynchus mykiss) LC50: 18 - 20mL/L (96h,	-	-

		Oncorhynchus mykiss) LC50: 13500 - 17600mg/L (96h, Lepomis macrochirus)		

Persistence and degradability

Persistence and degradability No information available.

Bioaccumulative potential

Bioaccumulation There is no data for this product.

Component Information

Chemical name	Partition coefficient
Glutaraldehyde	0.22
Methanol (methyl alcohol)	-0.77

Mobility

Mobility in soil No information available.

Other adverse effects

13. DISPOSAL CONSIDERATIONS

Waste treatment methods

Waste from residues/unused products Dispose of in accordance with local regulations. Dispose of waste in accordance with environmental legislation.

Contaminated packaging Dispose of contents/containers in accordance with local regulations.

14. TRANSPORT INFORMATION

ADG
Classified as Dangerous Goods by the criteria of the Australian Dangerous Goods Code (ADG Code) for Transport by Road and Rail; DANGEROUS GOODS.

UN number 2922
Proper shipping name CORROSIVE LIQUID, TOXIC, N.O.S. (CONTAINS GLUTARALDEHYDE)
Hazard class 8
Subsidiary hazard class 6.1
Packing group II
Hazchem code 2X

IATA
Classified as Dangerous Goods by the criteria of the International Air Transport Association (IATA) Dangerous Goods Regulations for transport by air; DANGEROUS GOODS.

UN number 2922
UN proper shipping name CORROSIVE LIQUID, TOXIC, N.O.S. (CONTAINS GLUTARALDEHYDE)
Transport hazard class(es) 8
Subsidiary hazard class 6.1
Packing group II

IMDG
Classified as Dangerous Goods by the criteria of the International Maritime Dangerous Goods Code (IMDG Code) for transport by sea; DANGEROUS GOODS.

UN number	2922
UN proper shipping name	CORROSIVE LIQUID, TOXIC, N.O.S. (CONTAINS GLUTARALDEHYDE)
Transport hazard class(es)	8
Subsidiary hazard class	6.1
Packing group	II

15. REGULATORY INFORMATION

Safety, health and environmental regulations/legislation specific for the substance or mixture

National regulations

Australia
Classified as a hazardous chemical in accordance with the criteria of Safe Work Australia - Globally Harmonized System (GHS).

Classified as dangerous goods in accordance with the Australian Code for the Transport of Dangerous Goods by Road and Rail (ADG).

See section 8 for national exposure control parameters

Standard for the Uniform Scheduling of Medicines and Poisons (SUSMP)
Classified as a scheduled poison according to the Standard for Uniform Scheduling of Medicines and Poisons (SUSMP)
Poisons Schedule (SUSMP) 6

National pollutant inventory
Subject to reporting requirement

Chemical name	National pollutant inventory
Glutaraldehyde - 111-30-8	10 tonne/yr Threshold category 1
Methanol (methyl alcohol) - 67-56-1	10 tonne/yr Threshold category 1

Banned and/or restricted
This product contains one or more substance(s) subject to prohibition, authorization or restriction. Verify that requirements related to using, handling, and storing substances subject to prohibition, authorization or restriction are met.

Chemical name	Carcinogen	Restricted substance
Methanol (methyl alcohol) - 67-56-1		For spray painting at a concentration of >1% by volume

International Inventories

AICS	All the constituents of this material are listed on the Australian Inventory of Industrial Chemicals.

Legend:
- Australian Inventory of Industrial Chemicals

International Regulations

The Montreal Protocol on Substances that Deplete the Ozone Layer Not applicable

The Stockholm Convention on Persistent Organic Pollutants Not applicable

The Rotterdam Convention Not applicable

16. OTHER INFORMATION

Supplier Safety Data Sheet 05/ 2020

Reason(s) For Issue: First Issue Primary SDS

Issuing Date: 16-Jul-2021

This Safety Data Sheet has been prepared by Ixom Operations Pty Ltd (Toxicology and SDS Services).

Revision Note:
The symbol (*) in the margin of this SDS indicates that this line has been revised.

Key or legend to abbreviations and acronyms used in the safety data sheet

Legend Section 8: EXPOSURE CONTROLS/PERSONAL PROTECTION

TWA	TWA (time-weighted average)	STEL	STEL (Short Term Exposure Limit)
Ceiling	Maximum limit value	*	Skin designation
C	Carcinogen		

Key literature references and sources for data used to compile the SDS

EPA (Environmental Protection Agency)
Acute Exposure Guideline Level(s) (AEGL(s))
U.S. Environmental Protection Agency Federal Insecticide, Fungicide, and Rodenticide Act
U.S. Environmental Protection Agency High Production Volume Chemicals
Food Research Journal
Hazardous Substance Database
International Uniform Chemical Information Database (IUCLID)
Japan GHS Classification
Australian Industrial Chemicals Introduction Scheme (AICIS)
NIOSH (National Institute for Occupational Safety and Health)
National Library of Medicine's ChemID Plus (NLM CIP)
National Library of Medicine's PubMed database (NLM PUBMED)
National Toxicology Program (NTP)
New Zealand's Chemical Classification and Information Database (CCID)
Organization for Economic Co-operation and Development Environment, Health, and Safety Publications
Organization for Economic Co-operation and Development High Production Volume Chemicals Program
Organization for Economic Co-operation and Development Screening Information Data Set
RTECS (Registry of Toxic Effects of Chemical Substances)
World Health Organization

Disclaimer

This SDS summarises to our best knowledge at the date of issue, the chemical health and safety hazards of the material and general guidance on how to safely handle the material in the workplace. Since The Supplier cannot anticipate or control the conditions under which the product may be used, each user must, prior to usage, assess and control the risks arising from its use of the material.

If clarification or further information is needed, the user should contact their Supplier representative or The Supplier at the contact details on page 1.

The Supplier's responsibility for the material as sold is subject to the terms and conditions of sale, a copy of which is available upon request.

End of Safety Data Sheet

SAFETY DATA SHEET
HYDROCHLORIC ACID SOLUTION

SECTION 1: Identification of the substance/mixture and of the company/undertaking

1.1. Product identifier

Product name HYDROCHLORIC ACID SOLUTION

Product No. H27

CAS number 7647-01-0

EC number 231-595-7

1.2. Relevant identified uses of the substance or mixture and uses advised against

Application Acidifier. Chemical intermediate. Laboratory reagent. Pickling and anodising metals, scale remover.

1.3. Details of the supplier of the safety data sheet

Supplier

Norkem Limited Australia
G19, Wheelers Hill Business Centre,
202 Jells Road, Wheelers Hill,
Vic 3150, Australia
T: +61 (0) 3 9560 0158
F: +61 (0) 3 9561 3935
datasheet@norkem.com

1.4. Emergency telephone number

Emergency telephone Australian Transport Contact Number: +61 (0) 2801 44558. New Zealand Transport Contact Number: +64 (0) 9929 1483. National Poison Information Number: 131126

SECTION 2: Hazards identification

2.1. Classification of the substance or mixture

Classification

Physical hazards Met. Corr. 1 - H290

Health hazards Skin Corr. 1B - H314 Eye Dam. 1 - H318 STOT SE 3 - H335

Environmental hazards Not classified.

2.2. Label elements

EC number 231-595-7

Pictogram



Signal word Danger

Hazard statements H290 May be corrosive to metals.
H314 Causes severe skin burns and eye damage.
H335 May cause respiratory irritation.

HYDROCHLORIC ACID SOLUTION

Precautionary statements	P280 Wear protective gloves/protective clothing/eye protection/face protection. P301+P330+P331 IF SWALLOWED: rinse mouth. Do NOT induce vomiting. P303+P361+P353 IF ON SKIN (or hair): Remove/Take off immediately all contaminated clothing. Rinse skin with water/shower. P305+P351+P338 IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. P310 Immediately call a POISON CENTER or doctor/physician. P403+P233 Store in a well-ventilated place. Keep container tightly closed.
Contains	HYDROCHLORIC ACID
Supplementary precautionary statements	P234 Keep only in original container. P260 Do not breathe vapour/spray. P261 Avoid breathing vapour/spray. P264 Wash contaminated skin thoroughly after handling. P271 Use only outdoors or in a well-ventilated area. P304+P340 IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing. P312 Call a POISON CENTER or doctor/physician if you feel unwell. P321 Specific treatment (see medical advice on this label). P363 Wash contaminated clothing before reuse. P390 Absorb spillage to prevent material damage. P405 Store locked up. P406 Store in corrosive resistant container with a resistant inner liner. P501 Dispose of contents/container in accordance with national regulations.

2.3. Other hazards

In contact with some metals can generate hydrogen gas, which can form explosive mixtures with air. Reacts with alkalis and generates heat.

SECTION 3: Composition/information on ingredients

3.2. Mixtures

HYDROCHLORIC ACID **> 25%**

CAS number: 7647-01-0 EC number: 231-595-7

Classification
Met. Corr. 1 - H290
Skin Corr. 1B - H314
Eye Dam. 1 - H318
STOT SE 3 - H335

The Full Text for all R-Phrases and Hazard Statements is Displayed in Section 16.

SECTION 4: First aid measures

4.1. Description of first aid measures

Inhalation	Move affected person to fresh air at once. Rinse nose and mouth with water. Get medical attention if any discomfort continues.
Ingestion	Rinse mouth thoroughly with water. Do not induce vomiting. Get medical attention immediately.
Skin Contact	Remove affected person from source of contamination. Remove contaminated clothing. Wash skin thoroughly with soap and water. Get medical attention immediately.

HYDROCHLORIC ACID SOLUTION

Eye contact Remove any contact lenses and open eyelids wide apart. Rinse with water. Continue to rinse for at least 15 minutes. Get medical attention.

4.2. Most important symptoms and effects, both acute and delayed

General information For further information, please refer to section 11.

Inhalation Irritating to respiratory system.

Skin contact Burning pain and severe corrosive skin damage. Corrosive to the respiratory tract.

Eye contact Causes serious eye damage. Corneal damage.

4.3. Indication of any immediate medical attention and special treatment needed

Notes for the doctor Treat symptomatically.

SECTION 5: Firefighting measures

5.1. Extinguishing media

Suitable extinguishing media The product is not flammable. Use fire-extinguishing media suitable for the surrounding fire.

5.2. Special hazards arising from the substance or mixture

Specific hazards In contact with some metals can generate hydrogen gas, which can form explosive mixtures with air.

5.3. Advice for firefighters

Special protective equipment for firefighters Wear positive-pressure self-contained breathing apparatus (SCBA) and appropriate protective clothing.

SECTION 6: Accidental release measures

6.1. Personal precautions, protective equipment and emergency procedures

Personal precautions Provide adequate ventilation. Do not touch or walk into spilled material. Avoid contact with skin, eyes and clothing. Wear protective clothing as described in Section 8 of this safety data sheet.

For non-emergency personnel Keep unnecessary and unprotected personnel away from the spillage.

6.2. Environmental precautions

Environmental precautions Do not discharge into drains or watercourses or onto the ground. If risk of water pollution occurs, notify appropriate authorities. The product may affect the acidity (pH) of water which may have hazardous effects on aquatic organisms.

6.3. Methods and material for containment and cleaning up

Methods for cleaning up Small Spillages: Neutralise spilled material with crushed limestone, slaked lime (calcium hydroxide), soda ash (sodium carbonate) or sodium bicarbonate. Absorb spillage with non-combustible, absorbent material. Collect and place in suitable waste disposal containers and seal securely. Flush contaminated area with plenty of water. Large Spillages: Contain and absorb spillage with sand, earth or other non-combustible material. Inform authorities if large amounts are involved. Collect and place in suitable waste disposal containers and seal securely.

6.4. Reference to other sections

Reference to other sections Wear protective clothing as described in Section 8 of this safety data sheet. Collect and dispose of spillage as indicated in Section 13.

SECTION 7: Handling and storage

7.1. Precautions for safe handling

HYDROCHLORIC ACID SOLUTION

Usage precautions Avoid spilling. Avoid contact with skin and eyes. Use personal protective equipment as required. Wear appropriate clothing to prevent any possibility of skin contact. Provide adequate ventilation.

7.2. Conditions for safe storage, including any incompatibilities

Storage precautions Store in tightly-closed, original container in a dry, cool and well-ventilated place. Store away from incompatible materials (see Section 10). Unsuitable container materials: Metals.

7.3. Specific end use(s)

Specific end use(s) The identified uses for this product are detailed in Section 1.2.

SECTION 8: Exposure Controls/personal protection

8.1. Control parameters

Occupational exposure limits

HYDROCHLORIC ACID

Ceiling value: 5 ppm 7.5 mg/m³

8.2. Exposure controls

Protective equipment



Appropriate engineering controls Provide adequate ventilation. Observe any occupational exposure limits for the product or ingredients. Use process enclosures, local exhaust ventilation or other engineering controls as the primary means to minimise worker exposure.

Eye/face protection Wear tight-fitting, chemical splash goggles or face shield. Personal protective equipment for eye and face protection should comply with European Standard EN166.

Hand protection Wear protective gloves. To protect hands from chemicals, gloves should comply with European Standard EN374. The most suitable glove should be chosen in consultation with the glove supplier/manufacturer, who can provide information about the breakthrough time of the glove material.

Other skin and body protection Provide eyewash station and safety shower. Wear appropriate clothing to prevent any possibility of skin contact.

Hygiene measures Do not smoke in work area. Wash hands at the end of each work shift and before eating, smoking and using the toilet. Wash promptly if skin becomes contaminated. Promptly remove any clothing that becomes contaminated. When using do not eat, drink or smoke.

Respiratory protection If ventilation is inadequate, suitable respiratory protection must be worn. Wear a respirator fitted with the following cartridge: Combination filter, type B+E/P3. Gas and combination filter cartridges should comply with European Standard EN14387.

Environmental exposure controls Emissions from ventilation or work process equipment should be checked to ensure they comply with the requirements of environmental protection legislation. In some cases, fume scrubbers, filters or engineering modifications to the process equipment will be necessary to reduce emissions to acceptable levels.

SECTION 9: Physical and Chemical Properties

9.1. Information on basic physical and chemical properties

Appearance Clear liquid.

Colour Colourless.

HYDROCHLORIC ACID SOLUTION

Odour	Odourless.
Odour threshold	Not applicable.
pH	pH (concentrated solution):
Melting point	<-20°C
Initial boiling point and range	109°C
Flash point	Not applicable.
Evaporation rate	No information available.
Flammability Limit - Lower(%)	Not applicable.
Other flammability	No information available.
Vapour pressure	No information available.
Vapour density	No information available.
Relative density	1.161
Partition coefficient	No information available.
Auto-ignition temperature	Not applicable.
Decomposition Temperature	No information available.
Viscosity	Not applicable.
Explosive properties	There are no chemical groups present in the product that are associated with explosive properties.
Oxidising properties	There are no chemical groups present in the product that are associated with oxidising properties.

9.2. Other information

Other information	Not available.

SECTION 10: Stability and reactivity

10.1. Reactivity

Reactivity	The following materials may react violently with the product: Alkalis.

10.2. Chemical stability

Stability	Stable at normal ambient temperatures and when used as recommended.

10.3. Possibility of hazardous reactions

Possibility of hazardous reactions	In contact with some metals can generate hydrogen gas, which can form explosive mixtures with air. Reacts with alkalis and generates heat.

10.4. Conditions to avoid

Conditions to avoid	Avoid excessive heat for prolonged periods of time.

10.5. Incompatible materials

Materials to avoid	Alkalis. Oxidising agents. Metals.

10.6. Hazardous decomposition products

Hazardous decomposition products	Hydrogen chloride (HCl). Hydrogen. Chlorine.

HYDROCHLORIC ACID SOLUTION

SECTION 11: Toxicological information

11.1. Information on toxicological effects

Acute toxicity - oral

Notes (oral LD_{50}) Data lacking.

Acute toxicity - dermal

Notes (dermal LD_{50}) Scientifically unjustified. Corrosive to skin.

Skin corrosion/irritation

Animal data Causes severe skin burns and eye damage.

Serious eye damage/irritation

Serious eye damage/irritation Causes serious eye damage.

Skin sensitisation

Skin sensitisation Not sensitising.

Germ cell mutagenicity

Genotoxicity - in vitro Does not contain any substances known to be mutagenic. Based on available data the classification criteria are not met.

Carcinogenicity

Carcinogenicity Does not contain any substances known to be carcinogenic. Based on available data the classification criteria are not met.

Reproductive toxicity

Reproductive toxicity - development Does not contain any substances known to be toxic to reproduction. Based on available data the classification criteria are not met.

Specific target organ toxicity - repeated exposure

STOT - repeated exposure Based on available data the classification criteria are not met.

SECTION 12: Ecological Information

Ecotoxicity Not regarded as dangerous for the environment.

12.1. Toxicity

12.2. Persistence and degradability

Persistence and degradability The product contains inorganic substances which are not biodegradable.

12.3. Bioaccumulative potential

Bioaccumulative Potential No data available on bioaccumulation.

Partition coefficient No information available.

12.4. Mobility in soil

Mobility Not known.

12.5. Results of PBT and vPvB assessment

Results of PBT and vPvB assessment This product does not contain any substances classified as PBT or vPvB.

12.6. Other adverse effects

Other adverse effects The product may affect the acidity (pH) of water which may have hazardous effects on aquatic organisms.

HYDROCHLORIC ACID SOLUTION

SECTION 13: Disposal considerations

13.1. Waste treatment methods

Disposal methods Dispose of waste to licensed waste disposal site in accordance with the requirements of the local Waste Disposal Authority.

SECTION 14: Transport information

14.1. UN number

UN No. Road 1789

UN No. Sea 1789

UN No., Air 1789

UN No. (ADN) 1789

14.2. UN proper shipping name

UN 1789 HYDROCHLORIC ACID, 8, II, (E)

Proper shipping name (ADR/RID) HYDROCHLORIC ACID

Proper shipping name (IMDG) HYDROCHLORIC ACID

Proper shipping name (ICAO) HYDROCHLORIC ACID

Proper shipping name (ADN) HYDROCHLORIC ACID

14.3. Transport hazard class(es)

ADR Class No. 8

ADR/RID classification code C1

ADR/RID label 8

IMDG Class 8

ICAO Class 8

ADN class 8

Transport labels



14.4. Packing group

ADR Pack Group II

IMDG packing group II

ADN packing group II

Air Pack Gr. II

14.5. Environmental hazards

Environmentally hazardous substance/marine pollutant

No.

14.6. Special precautions for user

HYDROCHLORIC ACID SOLUTION

EmS	F-A, S-B
ADR transport category	2
Emergency Action Code	2R
Hazard Identification Number (ADR/RID)	80
Tunnel restriction code	(E)

14.7. Transport in bulk according to Annex II of MARPOL73/78 and the IBC Code

Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code	Cat Z

SECTION 15: Regulatory information

15.1. Safety, health and environmental regulations/legislation specific for the substance or mixture

National regulations	Australian Inventory of Chemical Substances (AICS). Listed.
EU legislation	Regulation (EC) No 1272/2008 of the European Parliament and of the Council of 16 December 2008 on classification, labelling and packaging of substances and mixtures (as amended). Regulation (EC) No 1907/2006 of the European Parliament and of the Council of 18 December 2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) (as amended).

15.2. Chemical safety assessment

No chemical safety assessment has been carried out.

SECTION 16: Other information

General information	The following information is provided to conform with article 13 of the EC Directive on Packaging and Packaging Waste 94/62/EC: • Wherever possible we use returnable packaging and pallets. Details of these are on our Sales Contracts • For any non-returnable packaging the cost of disposal is at your expense, but we do have a list of reprocessors available • In most cases, but not all, we are able to supply products in returnable packaging but the additional cost of this will be for the customer's expense. Please ask for details with your specific requirements • Any products supplied in returnable packaging is clearly marked to this effect.
Revision date	28/09/2015
Revision	1
SDS No.	20833
Hazard statements in full	H290 May be corrosive to metals. H314 Causes severe skin burns and eye damage. H318 Causes serious eye damage. H335 May cause respiratory irritation.

This information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process. Such information is, to the best of the company's knowledge and belief, accurate and reliable as of the date indicated. However, no warranty, guarantee or representation is made to its accuracy, reliability or completeness. It is the user's responsibility to satisfy himself as to the suitability of such information for his own particular use.

NALCO Champion
An Ecolab Company

SAFETY DATA SHEET

Condor Energy Services CAI500LT

Section: 1. PRODUCT AND COMPANY IDENTIFICATION

Product name	:	Condor Energy Services CAI500LT
Other means of identification	:	Manufactured exclusively for Condor Energy Services by NALCO Champion
Recommended use	:	CORROSION INHIBITOR
Restrictions on use	:	Refer to available product literature or ask your local Sales Representative for restrictions on use and dose limits.
Company	:	ECOLAB PTY LTD 2 Drake Avenue Macquarie Park NSW 2113 Australia A.B.N. 59 000 449 990 TEL: 1300 654 224 FAX: +61 2 8870 8680
Emergency telephone number	:	1800 205 506 International: +64 7 958 2372
Issuing date	:	04.06.2019

Section: 2. HAZARDS IDENTIFICATION

GHS Classification

Flammable liquids	:	Category 2
Skin corrosion/irritation	:	Category 2
Serious eye damage/eye irritation	:	Category 1
Skin sensitization	:	Category 1
Specific target organ toxicity - single exposure	:	Category 3 (Central Nervous System)

GHS Label element

Hazard pictograms :



Signal Word : Danger

Hazard Statements :
Highly flammable liquid and vapour.
Causes skin irritation.
May cause an allergic skin reaction.
Causes serious eye damage.
May cause drowsiness or dizziness.

Precautionary Statements :
Prevention:
Keep away from heat/sparks/open flames/hot surfaces. - No smoking. Avoid breathing dust/ fume/ gas/ mist/ vapours/ spray. Wear protective gloves/ eye protection/ face protection.
Response:
IF ON SKIN (or hair): Remove/ Take off immediately all contaminated clothing. Rinse skin with water/ shower. IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing. Call a POISON CENTER or doctor/ physician if you feel unwell. IF IN EYES: Rinse cautiously with water for

several minutes. Remove contact lenses, if present and easy to do so. Continue rinsing.
Storage:
Store in a well-ventilated place.
Disposal:
Dispose of contents/ container to an approved waste disposal plant.

Other hazards : None known.

Section: 3. COMPOSITION/INFORMATION ON INGREDIENTS

Pure substance/mixture : Mixture

Chemical Name	CAS-No.	Concentration: (%)
Isopropanol	67-63-0	30 - 60
Ethoxylated C12-C16 Alcohol	68551-12-2	10 - 30
Ethoxylated Decanol	26183-52-8	5 - 10
Cinnamaldehyde	104-55-2	5 - 10
Ethoxylated Tallow Alkyl Amine	61791-26-2	1 - 5
Methanol	67-56-1	0.1 - 1

Section: 4. FIRST AID MEASURES

In case of eye contact : Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Get medical attention immediately.

In case of skin contact : Wash off immediately with plenty of water for at least 15 minutes. Use a mild soap if available. Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention immediately.

If swallowed : Rinse mouth with water. Do NOT induce vomiting. Never give anything by mouth to an unconscious person. Aspiration hazard if swallowed - can enter lungs and cause damage. Get medical attention immediately.

Contact the Poison's Information Centre (eg Australia 13 1126; New Zealand 0800 764 766).

If inhaled : Remove to fresh air. Treat symptomatically. Get medical attention if symptoms occur.

Protection of first-aiders : In event of emergency assess the danger before taking action. Do not put yourself at risk of injury. If in doubt, contact emergency responders. Use personal protective equipment as required.

Notes to physician : Treat symptomatically.

Most important symptoms and effects, both acute and delayed : See Section 11 for more detailed information on health effects and symptoms.

Section: 5. FIREFIGHTING MEASURES

Suitable extinguishing media : Use extinguishing measures that are appropriate to local circumstances and the surrounding environment.

Unsuitable extinguishing media : High volume water jet

Specific hazards during firefighting	:	Fire Hazard Keep away from heat and sources of ignition. Flash back possible over considerable distance. Beware of vapours accumulating to form explosive concentrations. Vapours can accumulate in low areas.
Hazardous combustion products	:	Carbon oxides nitrogen oxides (NOx) Sulphur oxides Hydrogen chloride
Special protective equipment for firefighters	:	Use personal protective equipment.
Specific extinguishing methods	:	Use water spray to cool unopened containers. Collect contaminated fire extinguishing water separately. This must not be discharged into drains. Fire residues and contaminated fire extinguishing water must be disposed of in accordance with local regulations. In the event of fire and/or explosion do not breathe fumes.
Hazchem Code	:	•3YE

Section: 6. ACCIDENTAL RELEASE MEASURES

Initial Emergency Response Guide No	:	14
Personal precautions, protective equipment and emergency procedures	:	Ensure adequate ventilation. Remove all sources of ignition. Keep people away from and upwind of spill/leak. Avoid inhalation, ingestion and contact with skin and eyes. When workers are facing concentrations above the exposure limit they must use appropriate certified respirators. Ensure clean-up is conducted by trained personnel only. Refer to protective measures listed in sections 7 and 8.
Environmental precautions	:	Do not allow contact with soil, surface or ground water.

Section: 7. HANDLING AND STORAGE

Advice on safe handling	:	Avoid contact with skin and eyes. Take necessary action to avoid static electricity discharge (which might cause ignition of organic vapours). Do not ingest. Keep away from fire, sparks and heated surfaces. Do not breathe dust/fume/gas/mist/vapours/spray. Do not get in eyes, on skin, or on clothing. Wash hands thoroughly after handling. Use only with adequate ventilation.
Conditions for safe storage	:	Keep away from heat and sources of ignition. Keep in a cool, well-ventilated place. Keep away from oxidizing agents. Keep out of reach of children. Keep container tightly closed. Store in suitable labelled containers.
Suitable material	:	Keep in properly labelled containers.
Unsuitable material	:	not determined

Section: 8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Components with workplace control parameters

Components	CAS-No.	Form of exposure	Permissible concentration	Basis
Isopropanol	67-63-0	TWA	400 ppm 983 mg/m3	AU OEL

		VLE	500 ppm 1,230 mg/m3	AU OEL
Isopropanol	67-63-0	WES-TWA	400 ppm 983 mg/m3	NZ OEL
		WES-STEL	500 ppm 1,230 mg/m3	NZ OEL
Isopropanol	67-63-0	TWA	200 ppm	ACGIH
		STEL	400 ppm	ACGIH
		TWA	400 ppm 980 mg/m3	NIOSH REL
		STEL	500 ppm 1,225 mg/m3	NIOSH REL
		TWA	400 ppm 980 mg/m3	OSHA Z1
Methanol	67-56-1	TWA	200 ppm 262 mg/m3	AU OEL
		VLE	250 ppm 328 mg/m3	AU OEL
Methanol	67-56-1	WES-TWA	200 ppm 262 mg/m3	NZ OEL
		WES-STEL	250 ppm 328 mg/m3	NZ OEL
Methanol	67-56-1	TWA	200 ppm	ACGIH
		STEL	250 ppm	ACGIH
		TWA	200 ppm 260 mg/m3	NIOSH REL
		STEL	250 ppm 325 mg/m3	NIOSH REL
		TWA	200 ppm 260 mg/m3	OSHA Z1

Engineering measures : Effective exhaust ventilation system. Maintain air concentrations below occupational exposure standards.

Personal protective equipment

Eye protection : Safety goggles
Face-shield

Hand protection : Wear the following personal protective equipment:
Nitrile rubber
butyl-rubber
Gloves should be discarded and replaced if there is any indication of degradation or chemical breakthrough.

Skin protection : Personal protective equipment comprising: suitable protective gloves, safety goggles and protective clothing

Respiratory protection : When workers are facing concentrations above the exposure limit they must use appropriate certified respirators.

Hygiene measures : Handle in accordance with good industrial hygiene and safety practice. Remove and wash contaminated clothing before re-use. Wash face, hands and any exposed skin thoroughly after handling. Provide suitable facilities for quick drenching or flushing of the eyes and body in case of contact or splash hazard.

Section: 9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance	:	liquid
Colour	:	clear amber
Odour	:	solvent-like, cinnamon-like
Flash point	:	22.2 °C, Method: Pensky-Martens closed cup
pH	:	4.0 - 6.0,(10 %), (25 °C), 75/25:IPA/H2O
Odour Threshold	:	no data available
Melting point/freezing point	:	Pour point: -34.4 °C
Initial boiling point and boiling range	:	79.5 °C, Method: ASTM D 86
Evaporation rate	:	no data available
Flammability (solid, gas)	:	no data available
Upper explosion limit	:	no data available
Lower explosion limit	:	no data available
Vapour pressure	:	23.4 hPa, (24 °C), ASTM D 5191, 135.8 hPa, (37.8 °C), ASTM D 5191,
Relative vapour density	:	no data available
Relative density	:	0.8856 - 0.9447, (20 °C),
Density	:	no data available
Water solubility	:	dispersible
Solubility in other solvents	:	no data available
Partition coefficient: n-octanol/water	:	no data available
Auto-ignition temperature	:	no data available
Thermal decomposition	:	no data available
Viscosity, dynamic	:	11.4 mPa.s (22 °C)
Viscosity, kinematic	:	no data available
Molecular weight	:	no data available
VOC	:	no data available

Section: 10. STABILITY AND REACTIVITY

Reactivity	:	No dangerous reaction known under conditions of normal use.
Chemical stability	:	Stable under normal conditions.
Possibility of hazardous reactions	:	No dangerous reaction known under conditions of normal use.
Conditions to avoid	:	Heat, flames and sparks.
Incompatible materials	:	Contact with strong oxidizers (e.g. chlorine, peroxides, chromates, nitric acid, perchlorate, concentrated oxygen, permanganate) may generate heat, fires, explosions and/or toxic vapors.
Hazardous decomposition products	:	In case of fire, hazardous decomposition products may be produced such as: Carbon oxides

nitrogen oxides (NOx)
Sulphur oxides
Hydrogen chloride

Section: 11. TOXICOLOGICAL INFORMATION

Information on likely routes of exposure : Inhalation, Eye contact, Skin contact

Potential Health Effects

Eyes : Causes serious eye damage.

Skin : Causes skin irritation. May cause allergic skin reaction.

Ingestion : Health injuries are not known or expected under normal use.

Inhalation : May cause drowsiness or dizziness.

Experience with human exposure

Eye contact : Redness, Pain, Corrosion

Skin contact : Redness, Pain, Irritation, Corrosion, Allergic reactions

Ingestion : Corrosion, Vomiting, Abdominal pain

Inhalation : Respiratory irritation, Cough, Dizziness, Drowsiness

Toxicity

Product

Acute oral toxicity	:	Acute toxicity estimate: > 2,000 mg/kg
Acute inhalation toxicity	:	Acute toxicity estimate: > 20 mg/l Exposure time: 4 h Test atmosphere: vapour
Acute dermal toxicity	:	Acute toxicity estimate: > 2,000 mg/kg
Skin corrosion/irritation	:	Result: Skin irritation
Serious eye damage/eye irritation	:	Result: Causes serious eye damage.
Respiratory or skin sensitization	:	no data available
Carcinogenicity	:	No component of this product present at levels greater than or equal to 0.1% is identified as probable, possible or confirmed human carcinogen by IARC.
Reproductive effects	:	No toxicity to reproduction
Germ cell mutagenicity	:	Based on available data, the classification criteria are not met.
Teratogenicity	:	no data available
STOT - single exposure	:	May cause drowsiness or dizziness.
STOT - repeated exposure	:	no data available
Aspiration toxicity	:	No aspiration toxicity classification

Human Hazard Characterization

Based on our hazard characterization, the potential human hazard is: High

Section: 12. ECOLOGICAL INFORMATION

Ecotoxicity

Environmental Effects : Harmful to aquatic life.

Product

Toxicity to fish : no data available

Toxicity to daphnia and other aquatic invertebrates : no data available

Toxicity to algae : no data available

Components

Toxicity to fish :

Isopropanol
LC50 Pimephales promelas (fathead minnow): 9,640 mg/l
Exposure time: 96 h

Ethoxylated C12-C16 Alcohol
LC50 : 1.5 mg/l
Exposure time: 96 h

Cinnamaldehyde
LC50 : 103.085 mg/l
Exposure time: 96 h

Ethoxylated Tallow Alkyl Amine
LC50 Fish: 1.1 mg/l
Exposure time: 96 h

Methanol
LC50 : 15,400 mg/l
Exposure time: 96 h

Components

Toxicity to daphnia and other aquatic invertebrates :

Isopropanol
LC50 Daphnia magna (Water flea): > 10,000 mg/l

Cinnamaldehyde
EC50 Daphnia magna (Water flea): 119.56 mg/l
Exposure time: 48 h

Methanol
EC50 : > 10,000 mg/l
Exposure time: 48 h

Components

Toxicity to algae :

Cinnamaldehyde
NOEC : 37.2314 mg/l
Exposure time: 72 h

Methanol
EC50 : 22,000 mg/l
Exposure time: 72 h

Components

Toxicity to bacteria	:	Isopropanol 1,050 mg/l Cinnamaldehyde 8.612 mg/l Methanol > 1,000 mg/l

Components

Toxicity to fish (Chronic toxicity)	:	Methanol NOEC: 7,900 mg/l Exposure time: 8.3 d

Persistence and degradability

no data available

Mobility

no data available

Bioaccumulative potential

no data available

Other information

no data available

ENVIRONMENTAL HAZARD AND EXPOSURE CHARACTERIZATION
Based on our hazard characterization, the potential environmental hazard is: Low

Section: 13. DISPOSAL CONSIDERATIONS

Disposal methods	:	The product should not be allowed to enter drains, water courses or the soil. Where possible recycling is preferred to disposal or incineration. If recycling is not practicable, dispose of in compliance with local regulations. Dispose of wastes in an approved waste disposal facility.
Disposal considerations	:	Dispose of as unused product. Empty containers should be taken to an approved waste handling site for recycling or disposal. Do not re-use empty containers.

Section: 14. TRANSPORT INFORMATION

The shipper/consignor/sender is responsible to ensure that the packaging, labeling, and markings are in compliance with the selected mode of transport.

Land transport

Proper shipping name	:	FLAMMABLE LIQUID, N.O.S.
Technical name(s):	:	Isopropanol
UN/ID No.	:	UN 1993
Transport hazard class(es)	:	3

Packing group	:	II
IERG No	:	14
Hazchem Code	:	•3YE

Air transport (IATA)

UN/ID No.	:	UN 1993
Proper shipping name	:	FLAMMABLE LIQUID, N.O.S.
Technical name(s)	:	Isopropanol
Transport hazard class(es)	:	3
Packing group	:	II

Sea transport (IMDG/IMO)

UN/ID No.	:	UN 1993
Proper shipping name	:	FLAMMABLE LIQUID, N.O.S.
Technical name(s)	:	Isopropanol
Transport hazard class(es)	:	3
Packing group	:	II

Section: 15. REGULATORY INFORMATION

Standard for the Uniform Scheduling of Medicines and Poisons : Schedule 5

INTERNATIONAL CHEMICAL CONTROL LAWS :

Australia. Industrial Chemical (Notification and Assessment) Act
not determined

Section: 16. OTHER INFORMATION

REFERENCES

Hazardous Substances Data Bank, National Library of Medicine, Bethesda, Maryland (TOMES CPS™ CD-ROM Version), Micromedex, Inc., Englewood, CO.

IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man, Geneva: World Health Organization, International Agency for Research on Cancer.

Integrated Risk Information System, U.S. Environmental Protection Agency, Washington, D.C. (TOMES CPS™ CD-ROM Version),
Micromedex, Inc., Englewood, CO.

Annual Report on Carcinogens, National Toxicology Program, U.S. Department of Health and Human Services, Public Health Service.

Registry of Toxic Effects of Chemical Substances, National Institute for Occupational Safety and Health, Cincinnati, OH,
(TOMES CPS™ CD-ROM Version), Micromedex, Inc., Englewood, CO.

The Teratogen Information System, University of Washington, Seattle, WA (TOMES CPS™ CD-ROM Version), Micromedex, Inc., Englewood, CO.

Revision Date	:	04.06.2019
Version Number	:	1.0
Prepared By	:	Regulatory Affairs

REVISED INFORMATION: Significant changes to regulatory or health information for this revision is indicated by a bar in the left-hand margin of the SDS.

The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as a guidance for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text.
For additional copies of an SDS visit www.nalco.com and request access.

SAFETY DATA SHEET

Revision date: 19-Jul-2021

Revision Number 1

1. IDENTIFICATION OF THE MATERIAL AND SUPPLIER

Product identifier

Product Name CA370FE

Product Code(s) 000000069021

Other means of identification

Synonyms Manufactured exclusively for Condor Energy Services by Fusion Technologies (Australia) Pty Ltd

Recommended use of the chemical and restrictions on use

Recommended use Iron control additive.

Uses advised against No information available.

Supplier
Fusion Technologies Australia Pty Ltd
ABN: 50 636 538 960
Street Address: 7 Noble Street
Bridgeman Downs QLD 4035
Australia

Telephone number: +61 (0)460 047 656
Website: www.fusiontechinc.net

Emergency telephone number

Emergency telephone number **1800 033 111 (ALL HOURS)**

Please ensure you refer to the limitations of this Safety Data Sheet as set out in the "Other Information" section at the end of this Data Sheet.

2. HAZARDS IDENTIFICATION

GHS Classification

Not classified as a hazardous chemical in accordance with the criteria of Safe Work Australia - Globally Harmonized System (GHS)

Not classified as dangerous goods in accordance with the Australian Code for the Transport of Dangerous Goods by Road and Rail (ADG)

SIGNAL WORD
Not Hazardous

Label elements

Hazard statements
None

Other hazards which do not result in classification
Poisons Schedule (SUSMP) None allocated

3. COMPOSITION/INFORMATION ON INGREDIENTS

Chemical name	CAS No.	Weight-%
Sodium salt of organic acid	-	70-100%
Non-hazardous ingredients	Proprietary	Balance

4. FIRST AID MEASURES

Description of first aid measures

Emergency telephone number Poisons Information Center, Australia: 13 11 26
Poisons Information Center, New Zealand: 0800 764 766

Inhalation Remove to fresh air and keep at rest in a position comfortable for breathing. If symptoms persist, call a physician.

Eye contact Rinse thoroughly with plenty of water, also under the eyelids. If symptoms persist, call a physician.

Skin contact Take off contaminated clothing. Wash skin with soap and water. Get medical attention if irritation develops and persists.

Ingestion Rinse mouth. Do NOT induce vomiting. Drink 1 or 2 glasses of water. Get medical attention.

Most important symptoms and effects, both acute and delayed

Symptoms No information available.

Indication of any immediate medical attention and special treatment needed

Note to physicians Treat symptomatically.

5. FIRE FIGHTING MEASURES

Suitable Extinguishing Media

Suitable Extinguishing Media Water spray or fog is preferred; if water not available use dry chemical, CO2 or regular foam.

Unsuitable extinguishing media No information available.

Specific hazards arising from the chemical

Specific hazards arising from the chemical	Fine dust dispersed in air may ignite.

Special protective actions for fire-fighters

Special protective equipment for fire-fighters	Firefighters should wear self-contained breathing apparatus and full firefighting turnout gear. Use personal protection equipment.

6. ACCIDENTAL RELEASE MEASURES

Personal precautions, protective equipment and emergency procedures

Personal precautions	Ensure adequate ventilation. Remove all sources of ignition.
For emergency responders	Use personal protection recommended in Section 8.

Environmental precautions

Environmental precautions	See Section 12 for additional Ecological Information.

Methods and material for containment and cleaning up

Methods for containment	Stop leak if you can do it without risk. Cover powder spill with plastic sheet or tarp to minimize spreading. Keep out of drains, sewers, ditches and waterways.
Methods for cleaning up	Take up with inert, damp, non-combustible material using clean non-sparking tools and place into loosely covered plastic containers for later disposal. Avoid generation of dust. Vacuum or sweep material and place in a disposal container. Do not dry sweep dust. Wet dust with water before sweeping or use a vacuum to collect dust.

7. HANDLING AND STORAGE

Precautions for safe handling

Advice on safe handling	Handle in accordance with good industrial hygiene and safety practice. Avoid contact with skin and eyes. Avoid breathing dust or spray mist. Avoid generation of dust.

Conditions for safe storage, including any incompatibilities

Storage Conditions	Keep in a dry, cool and well-ventilated place. Store away from sources of heat or ignition.
Incompatible materials	Strong oxidizing agents.
Poisons Schedule (SUSMP)	None allocated

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Control parameters

Exposure Limits	No value assigned for this specific material by Safe Work Australia. However, Workplace Exposure Standard(s) for particulates:

Dusts not otherwise classified: 8hr TWA = 10 mg/m^3

As published by Safe Work Australia Workplace Exposure Standards for Airborne Contaminants.

TWA - The time-weighted average airborne concentration of a particular substance when calculated over an eight-hour working day, for a five-day working week.

These Workplace Exposure Standards are guides to be used in the control of occupational health hazards. All atmospheric contamination should be kept to as low a level as is workable. These workplace exposure standards should not be used as fine dividing lines between safe and dangerous concentrations of chemicals. They are not a measure of relative toxicity.

Appropriate engineering controls

Engineering controls Apply technical measures to comply with the occupational exposure limits.

If in the handling and application of this material, safe exposure levels could be exceeded, the use of engineering controls such as local exhaust ventilation must be considered and the results documented. If achieving safe exposure levels does not require engineering controls, then a detailed and documented risk assessment using the relevant Personal Protective Equipment (PPE) (refer to PPE section below) as a basis must be carried out to determine the minimum PPE requirements.

Individual protection measures, such as personal protective equipment

The selection of PPE is dependent on a detailed risk assessment. The risk assessment should consider the work situation, the physical form of the chemical, the handling methods, and environmental factors.

OVERALLS, SAFETY SHOES, CHEMICAL GOGGLES, GLOVES, DUST MASK.



Eye/face protection Wear safety glasses with side shields (or goggles).

Skin and body protection Wear suitable protective clothing.

Hand protection Wear suitable gloves.

Respiratory protection No protective equipment is needed under normal use conditions. If exposure limits are exceeded or irritation is experienced, ventilation and evacuation may be required. If determined by a risk assessment an inhalation risk exists, wear a dust mask/respirator meeting the requirements of AS/NZS 1715 and AS/NZS 1716.

Environmental exposure controls No information available.

9. PHYSICAL AND CHEMICAL PROPERTIES

Information on basic physical and chemical properties

Physical state	Solid
Appearance	Crystalline Powder
Color	White
Odor	Odourless
Odor threshold	No information available.

Property	Values	Remarks • Method
pH	5.5 - 8.0	None known
pH (as aqueous solution)	No data available	None known
Melting point / freezing point	169 - 172°C	None known
Boiling point / boiling range	No data available	None known
Flash point	No data available	None known
Evaporation rate	No data available	None known
Flammability (solid, gas)	No data available	None known
Flammability Limit in Air		None known
Upper flammability or explosive limits	No data available	
Lower flammability or explosive limits	No data available	
Vapor pressure	No data available	None known
Vapor density	No data available	None known
Relative density	No data available	None known
Water solubility	Soluble in water 160 g/L at 20°C	None known
Solubility(ies)	No data available	None known
Partition coefficient	No data available	None known
Autoignition temperature	No data available	None known
Decomposition temperature	No data available	None known
Kinematic viscosity	No data available	None known
Dynamic viscosity	No data available	None known

Other information

10. STABILITY AND REACTIVITY

Reactivity

Reactivity No information available.

Chemical stability

Stability Stable under normal conditions.

Explosion data

Sensitivity to mechanical impact None.

Sensitivity to static discharge None.

Possibility of hazardous reactions

Possibility of hazardous reactions None under normal processing.

Hazardous polymerization Hazardous polymerization does not occur.

Conditions to avoid

Conditions to avoid Heat, flames and sparks. Dust formation.

Incompatible materials

Incompatible materials Strong oxidizing agents.

Hazardous decomposition products

Hazardous decomposition products Carbon oxides.

11. TOXICOLOGICAL INFORMATION

Acute toxicity

Information on likely routes of exposure

Product Information No adverse health effects expected if the chemical is handled in accordance with this Safety Data Sheet and the chemical label. Symptoms or effects that may arise if the chemical is mishandled and overexposure occurs are:

Inhalation Inhalation of dust in high concentration may cause irritation of respiratory system.

Eye contact Mild eye irritation. Dust contact with the eyes can lead to mechanical irritation.

Skin contact May cause irritation.

Ingestion May cause gastrointestinal discomfort if consumed in large amounts.

Symptoms No information available.

Numerical measures of toxicity - Product Information

Numerical measures of toxicity - Component Information

Chemical name	Oral LD50	Dermal LD50	Inhalation LC50
Sodium salt of organic acid	> 5 g/kg (Rat)	-	-

See section 16 for terms and abbreviations

Delayed and immediate effects as well as chronic effects from short and long-term exposure

Skin corrosion/irritation No information available.

Serious eye damage/eye irritation No information available.

Respiratory or skin sensitization No information available.

Germ cell mutagenicity No information available.

Carcinogenicity No information available.

Reproductive toxicity No information available.

STOT - single exposure No information available.

STOT - repeated exposure No information available.

Aspiration hazard No information available.

12. ECOLOGICAL INFORMATION

Ecotoxicity

Ecotoxicity The environmental impact of this product has not been fully investigated. Keep out of waterways.

Persistence and degradability

Persistence and degradability No information available.

Bioaccumulative potential

Bioaccumulation No information available.

Mobility

Mobility in soil No information available.

Other adverse effects

13. DISPOSAL CONSIDERATIONS

Waste treatment methods

Waste from residues/unused products Dispose of in accordance with local regulations. Dispose of waste in accordance with environmental legislation.

Contaminated packaging Dispose of contents/containers in accordance with local regulations.

14. TRANSPORT INFORMATION

ADG
Not classified as Dangerous Goods by the criteria of the Australian Dangerous Goods Code (ADG Code) for transport by Road and Rail; NON-DANGEROUS GOODS.

IATA
Not classified as Dangerous Goods by the criteria of the International Air Transport Association (IATA) Dangerous Goods Regulations for transport by air; NON-DANGEROUS GOODS.

IMDG
Not classified as Dangerous Goods by the criteria of the International Maritime Dangerous Goods Code (IMDG Code) for transport by sea; NON-DANGEROUS GOODS.

15. REGULATORY INFORMATION

Safety, health and environmental regulations/legislation specific for the substance or mixture

National regulations

Australia
Not classified as a hazardous chemical in accordance with the criteria of Safe Work Australia - Globally Harmonized System (GHS)

Not classified as dangerous goods in accordance with the Australian Code for the Transport of Dangerous Goods by Road and Rail (ADG)

See section 8 for national exposure control parameters

Poisons Schedule (SUSMP) None allocated

International Inventories
AICS Complies.

Legend:
- Australian Inventory of Industrial Chemicals

International Regulations

The Montreal Protocol on Substances that Deplete the Ozone Layer Not applicable

The Stockholm Convention on Persistent Organic Pollutants Not applicable

The Rotterdam Convention Not applicable

16. OTHER INFORMATION

Reason(s) For Issue: First Issue Primary SDS

Issuing Date: 19-Jul-2021

This Safety Data Sheet has been prepared by Ixom Operations Pty Ltd (Toxicology and SDS Services).

Revision Note:
The symbol (*) in the margin of this SDS indicates that this line has been revised.

Key or legend to abbreviations and acronyms used in the safety data sheet

Legend Section 8: EXPOSURE CONTROLS/PERSONAL PROTECTION

TWA	TWA (time-weighted average)	STEL	STEL (Short Term Exposure Limit)
Ceiling	Maximum limit value	*	Skin designation
C	Carcinogen		

Key literature references and sources for data used to compile the SDS

EPA (Environmental Protection Agency)
Acute Exposure Guideline Level(s) (AEGL(s))
U.S. Environmental Protection Agency Federal Insecticide, Fungicide, and Rodenticide Act
U.S. Environmental Protection Agency High Production Volume Chemicals
Food Research Journal
Hazardous Substance Database
International Uniform Chemical Information Database (IUCLID)
Japan GHS Classification
Australian Industrial Chemicals Introduction Scheme (AICIS)
NIOSH (National Institute for Occupational Safety and Health)
National Library of Medicine's ChemID Plus (NLM CIP)
National Library of Medicine's PubMed database (NLM PUBMED)
National Toxicology Program (NTP)
New Zealand's Chemical Classification and Information Database (CCID)
Organization for Economic Co-operation and Development Environment, Health, and Safety Publications
Organization for Economic Co-operation and Development High Production Volume Chemicals Program
Organization for Economic Co-operation and Development Screening Information Data Set
RTECS (Registry of Toxic Effects of Chemical Substances)
World Health Organization

Disclaimer

This SDS summarises to our best knowledge at the date of issue, the chemical health and safety hazards of the material and general guidance on how to safely handle the material in the workplace. Since The Supplier cannot anticipate or control the conditions under which the product may be used, each user must, prior to usage, assess and control the risks arising from its use of the material.

If clarification or further information is needed, the user should contact their Supplier representative or The Supplier at the contact details on page 1.

The Supplier's responsibility for the material as sold is subject to the terms and conditions of sale, a copy of which is available upon request.

End of Safety Data Sheet

CAI401HT

SAFETY DATA SHEET

EMERGENCY TELEPHONE NUMBER: 1800 033 111 (ALL HOURS)

Product Name: CAI401HT
Date Issued: Nov 10th, 2022

Prepared by: Fusion Australia
& Version: A21-1.0

1. PRODUCT IDENTIFICATION AND COMPANY IDENTIFICATION

Product Name:	CAI401HT
Product Purpose:	Acid Corrosion Inhibitor
Supplier Identification:	Fusion Technologies (Australia) Pty Ltd. 7 Noble Street Bridgeman Downs QLD, 4035 Australia

PREPARER'S TELEPHONE NUMBER: +61 4600 47 656

2. HAZARDS IDENTIFICATION

Hazard Pictograms:



Signal word: Danger

Primary Routes of Exposure: Inhalation, Skin contact, eye contact

GHS Classification in accordance with WHMIS 2015
Serious eye damage (Category 1), H318
Acute toxicity, Dermal (Category 4), H311
Acute toxicity, Oral (Category 3), H302
Specific target organ toxicity - single exposure - Kidneys (Category 2), H370

Hazard Statements: H318 – Causes serious eye damage

H302+H312 – Harmful if swallowed or in contact with skin
H370 - Causes damage to organs

Precautionary Statements:

P210 - Keep away from heat, hot surfaces, sparks, open flames and other ignition sources. No smoking.
P260 - Do not breathe dust/ fume/ gas/ mist/ vapours/ spray.
P264 - Wash thoroughly after handling
P280 + P361 + P364 - Wear protective gloves/ protective clothing/ eye protection. Rinse immediately contaminated clothing and skin with plenty of water before removing clothes and wash before re-use.
P302 + P352 + P312 - If on skin: Wash with plenty of water. Call a POISON CENTER or doctor/ physician if you feel unwell.
P304 - If inhaled: Remove person to fresh air
P308 + P311 - If exposed or concerned: Call a POISON CENTER or doctor/ physician.
P403 + P233 – Store in a well-ventilated place. Keep container tightly closed.

Hazards not otherwise classified (HNOC) or not covered by GHS *– none*

Acute Effects: None known

3. PRODUCT COMPOSITION/INGREDIENTS

Chemical Name	CAS #	% by Weight
Ethylene Glycol	107-21-1	40 to 70
Cinnamaldehyde	104-55-2	10 to 30
Formic Acid	64-18-6	10 to 30
Alkylpyridine Quat	68909-18-2	5 to 20
2-Ethylhexanol PO/EO polymer	64366-70-7	5 to 20

4. FIRST AID MEASURES

Eye Contact: Rinse eyes immediately with copious amounts of water and under the eyelids for at least 15 minutes. If symptoms persist seek medical advice.

Skin Contact: Remove contaminated clothing and footwear. Immediately wash off all material with soap and copious amounts of water for at least 15 minutes. Contaminated clothing must be washed before reuse. Thoroughly clean contaminated shoes.

Ingestion: If swallowed, do not induce vomiting. Never give anything by mouth to an unconscious person. Obtain medical advice.

Inhalation: Remove victim to fresh air, treat symptomatically. If symptoms develop, seek medical advice.

5. FIRE FIGHTING MEASURES

Suitable extinguishing media: Use DRY chemicals, carbon dioxide, and dry powder. Water spray for larger fires is acceptable. NEVER use a water jet directly on the fire because it may spread to a larger area.

Unsuitable extinguishing media: High volume water jet

Specific hazards during firefighting: May evolve toxic fumes of oxides of carbon, nitrogen and/or sulphur under fire conditions. Formaldehyde.

	Vapors may travel to ignition source and flash back. Empty containers may contain product residue. Heating can release hazardous gases. Vapors may be ignited by static discharge.
Hazardous combustion products:	Decomposition products may include the following materials: Carbon oxides
Special protective equipment for firefighters:	Use personal protective equipment.
Specific extinguishing methods:	Fire residues and contaminated fire extinguishing water must be disposed of in accordance with local regulations.

6. ACCIDENTAL RELEASE MEASURES

Personal Precautions:	Avoid contact with skin, eyes and clothing. Evacuate personnel to safe areas. Keep people away from and upwind of spill or leak. PPE: see section 8.
Environmental Precautions:	Do not contaminate surface water. Do not release into the environment. Prevent product from entering any drains. Do not flush product into surface water or sanitary sewer systems. Harmful to aquatic organisms.
Emergency Procedures:	Prevent further leakage or spillage if safe to do so.
Methods For Cleaning Up:	Soak up spill with absorbent material and then place into an appropriate waste container. Remove soiled refuse and place in a suitable disposal container. Use non-sparking tools.
Disposal:	Dispose of material in compliance with local, Provincial and Federal regulations. See Section 13.

7. HANDLING AND STORAGE

Handling Precautions:	Handle wearing appropriate PPE as per section 8. Ensure adequate ventilation is available.
Storage Precautions:	Store in a cool, dry, well-ventilated area, away from heat and ignition sources. Tanks must be grounded and vented and should have vapor

	emission controls. Tanks must be diked. Place away from incompatible materials. All equipment must be grounded - bonded when transferring product in order to avoid static discharge from the equipment, and subsequent possible fire. Some attack: Polyethylene
Suitable material:	Satisfactory: Neoprene, phenolic resins, polyesters, natural rubber, butyl rubber Resistant: Polyvinyl chloride, unplasticized. Fixed storage containers, transfer containers and associated equipment should be grounded and bonded to prevent accumulation of static charge. Store in accordance with good industrial practices.Keep in properly labelled containers.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Occupational Exposure Limits:	*This product does contain substances that have an established exposure limit.* Ethylene Glycol: ACGIH – Aerosol (100mg/m³) CA OEL – TWA Particulate (10mg/m³) Formic acid: ACGIH – TWA (5 ppm) ACGIH – STEL (10 ppm)
Engineering Measures:	Use process enclosure, local exhaust ventilation, or other engineering controls to keep airborne levels below recommended exposure limits. Use explosion proof equipment.
Hygiene Recommendations:	Keep an eye wash fountain and safety shower available

Eye Protection:	Wear safety glasses with side shields and goggles/side shield where splashing hazard exists.
Hand Protection:	Appropriate chemical resistant gloves should be worn. Viton gloves. Polyvinyl alcohol gloves. Nitrile gloves. Butyl rubber gloves.
Respiratory Protection:	Respirator selection must be done by a qualified person and be based upon a risk assessment of the work activities and exposure levels. Respirators must be fit tested and users must be clean shaven where the respirator seals to the face. Exposure must be kept at or below the applicable exposure limits and the maximum use concentration of the respirator must not be exceeded. Positive pressure, full-face piece self-contained breathing apparatus; or Positive pressure, full-face piece supplied air respirator with an auxiliary positive pressure self-contained breathing apparatus.
Skin and Body Protection:	Wear chemical resistant pants and jackets, preferably butyl or nitrile rubber.

9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance:	Liquid
Colour:	Brown
Odour:	Characteristic
Flash point:	>100°C
pH:	1-3
Odour Threshold:	No data available
Melting point/freezing point:	-25°C
Initial boiling point and boiling range:	No data available
Evaporation rate:	No data available
Flammability (solid, gas):	No data available
Upper explosion limit:	No data available
Lower explosion limit:	No data available
Vapour pressure:	No data available

Relative vapour density:	No data available
Relative density:	1.12
Water solubility:	Soluble
Solubility in other solvents:	No data available
Partition coefficient: n-octanol/water:	No data available
Auto-ignition temperature:	No data available
Thermal decomposition temperature:	No data available
Viscosity, dynamic:	No data available
Viscosity, kinematic:	No data available
Molecular weight:	No data available
VOC:	No data available

10. STABILITY AND REACTIVITY

Stability:	Stable under normal conditions
Conditions to Avoid:	Temperature extremes, sources of heat and ignition and static discharge.
Materials to Avoid:	Contact with strong oxidizers as they may generate heat, fires, explosions and/or toxic vapors. Strong bases, organic acids, acetyl bromide, magnesium, strong mineral acids, aluminum powder, aluminum alkyl compounds. May attack some forms of plastic, rubber and coatings.
Hazardous Polymerization:	Will not occur
Hazardous Decomposition Products:	Oxides of carbon, nitrogen. Formaldehyde.

11. TOXICOLOGICAL INFORMATION

Acute LD50/oral:	7712 mg/kg (rat) (Ethylene Glycol)
Acute LC50/inhalation:	>2.5 mg/L (rat) (Ethylene Glycol), 6hr
Acute LD50/dermal:	>10,600 mg/kg (rabbit) (Ethylene Glycol)

Mutagenic Effects:	Not expected
Reproductive Toxicity:	Ingestion of large amounts of ethylene glycol has been shown to interfere with reproduction in animals.
Teratogenicity and Embryo Toxicity:	Ingestion of large amounts of ethylene glycol may produce birth defects.
Human Experience:	Based on hazard characterization, the potential human hazard is moderate.
Other Toxicity Information:	Ingestion of ethylene glycol can cause damage to liver and other organs.

12. ECOLOGICAL INFORMATION

Ingredients	Ecotoxicity - Fish Species Data	Acute Crustaceans Toxicity:	Ecotoxicity - Freshwater Algae Data
Ethylene Glycol	LC50, Pimephales promelas, static test, 96hr, 72,850mg/L	EC50, Daphnia magna, static test, 48hr, >100mg/l	EC50, activated sludge, 30min, 225mg/l
Formic Acid	LEC50, Danio rerio, static test, 96hr, 130mg/l	EC50, Daphnia magna, static test, 48hr, 365mg/l	ErC50, Psueodkirchneriella subcapitata, 72hr, 1240 mg/l

Other Information:
Do not allow product or runoff from fire control to enter storm or sanitary sewers, lakes, rivers, streams or public waterways. Block off drains and ditches. Spill areas must be cleaned and restored to original condition or to the satisfaction of authorities.

13. DISPOSAL INFORMATION

Waste Residues/Unused Product and Package	Dispose of waste containers in accordance with all applicable regulations.

14. TRANSPORT INFORMATION

Typical proper shipping name for this product are as follows:

Corrosive Liquid, Acidic, Organic, N.O.S	**CLASS 8**	**UN3265**	**PKG GRP: III**

Important Note: This information does not take the place of shipping paper (Bill of Lading or BOL)

15. REGULATORY INFORMATION

Australian Inventory of Chemical Substances (AICS)
May require notification before sale under Australian regulations.

All substances in this product comply with the National Industrial Chemicals Notification & Assessment Scheme (NICNAS).

CANADA: Workplace Hazardous Material Information System (WHMIS)
This product has been classified in accordance with the hazard criteria of the Hazardous Products Regulations (HPR) and is a WHMIS controlled product.

Canadian Environmental Protection Act (CEPA): The substance(s) in this SDS are included in or exempted from the Domestic Substance List (DSL)

National Pollutant Release Inventory (NPRI): This product contains the following substances listed in Part 1A (Core Substances) of the NPRI at a concentration of one percent or more by weight.

U.S. Regulatory Rules

Toxic Substances Control Act (TSCA): The substances in this SDS are included in or exempted from the TSCA 8(b) Inventory (40 CFR 710)

This section contains additional information that may have relevance to regulatory compliance. The information contained in this section is for reference only. Hybrid Chemical Technologies accepts no liability for the use of this information.

This section contains additional information that may have relevance to regulatory compliance. The information contained in this section is for reference only. Fusion Australia accepts no liability for the use of this information.

16. OTHER INFORMATION

NFPA 704M RATING

Health: 3	Flammability: 1	Reactivity: 0	Other: n/a

HMIS

Health: 3	Flammability: 1	Instability: 0	Other: n/a

0= insignificant 1= slight 2= moderate 3= high 4= Extreme * = Chronic Hazard

This is the Last Page of SDS

Disclaimer

This material safety data sheet provides health and safety information for the safe use of this product provided it is used as recommended per the associated product literature. Users of this product should be aware of the recommended safety precautions. For any other use, exposures must be evaluated so that appropriate handling and training programs can be created and implemented to insure safe workplace operations. Consult with Fusion Technologies for any additional information.

Condor Energy Services – Safety Data Sheet

CF 200

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

PRODUCT NAME: **CF 200**

APPLICATION: Friction Reducer

IMPORTER IDENTIFICATION:
Condor Energy Services Ltd
Level 4, 15 Ogilvie Road
Applecross WA 6153
Australia
+61 8 9315 5986

EMERGENCY TELEPHONE NUMBER(S): +61 430 138 290 (24 Hours)

+65 6542 9595

2. HAZARDS IDENTIFICATION

HAZARD CLASSIFICATION :

Not classified as hazardous according to Safe Work Australia. This product is not classified as a dangerous good according to national or international regulations.

SAFETY PHRASES
S24/25 - Avoid contact with skin and eyes.
S36/37/39 - Wear suitable protective clothing, gloves and eye/face protection.

3. COMPOSITION/INFORMATION ON INGREDIENTS

CHEMICAL NAME	CAS NO	% (w/w)
Ingredients determined not to be hazardous		100

4. FIRST AID MEASURES

EYE CONTACT :
Flush affected area with water. If symptoms develop, seek medical advice.

SKIN CONTACT :
Flush affected area with water. If symptoms develop, seek medical advice.

INGESTION :
DO NOT INDUCE VOMITING. If conscious, washout mouth and give water to drink. If symptoms develop, seek medical advice.

INHALATION :
Remove to fresh air, treat symptomatically. If symptoms develop, seek medical advice.

NOTE TO PHYSICIAN :
Based on the individual reactions of the patient, the physician's judgement should be used to control symptoms and clinical condition.

5. FIRE FIGHTING MEASURES

FLASH POINT : Not flammable

EXTINGUISHING MEDIA :
This product would not be expected to burn unless all the water is boiled away. The remaining organics may be ignitable. Use extinguishing media appropriate for surrounding fire.

FIRE AND EXPLOSION HAZARD :
May evolve oxides of carbon (COx) under fire conditions. May evolve oxides of nitrogen (NOx) and sulfur (SOx) under fire conditions.

SPECIAL PROTECTIVE EQUIPMENT FOR FIRE FIGHTING :
In case of fire, wear a full face positive-pressure self contained breathing apparatus and protective suit.

SENSITIVITY TO STATIC DISCHARGE :
Not expected to be sensitive to static discharge.

6. ACCIDENTAL RELEASE MEASURES

PERSONAL PRECAUTIONS :
Restrict access to area as appropriate until clean-up operations are complete. Use personal protective equipment recommended in Section 8 (Exposure Controls/Personal Protection). Stop or reduce any leaks if it is safe to do so. Ventilate spill area if possible. Notify appropriate government, occupational health and safety and environmental authorities.

METHODS FOR CLEANING UP :
SMALL SPILLS: Soak up spill with absorbent material. Place residues in a suitable, covered, properly labeled container. Wash affected area. LARGE SPILLS: Contain liquid using absorbent material, by digging trenches or by diking. Reclaim into recovery or salvage drums or tank truck for proper disposal. Clean contaminated surfaces with water or aqueous cleaning agents. Contact an approved waste hauler for disposal of contaminated recovered material. Dispose of material in compliance with regulations indicated in Section 13 (Disposal Considerations).

ENVIRONMENTAL PRECAUTIONS :
Do not contaminate surface water.

7. HANDLING AND STORAGE

HANDLING :
Do not get in eyes, on skin, on clothing. Do not take internally. Use with adequate ventilation. Keep the containers closed when not in use. Ensure all containers are labeled.

STORAGE CONDITIONS :
Store in suitable labeled containers. Store the containers tightly closed. Store separately from oxidizers.

SUITABLE CONSTRUCTION MATERIAL :
Stainless Steel 304, Neoprene, Viton, Buna-N, Polypropylene, Polyethylene, Polyurethane, EPDM, Epoxy phenolic resin, HDPE (high density polyethylene), PVC

UNSUITABLE CONSTRUCTION MATERIAL :
Brass, Hypalon, Mild steel

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

OCCUPATIONAL EXPOSURE LIMITS

None of the components have been assigned an exposure standard by Safe Work Australia (Australia) or EPA (New Zealand).

ENGINEERING MEASURES :
General ventilation is recommended.

PERSONAL PROTECTION

RESPIRATORY PROTECTION :
Respiratory protection is not normally needed.

HAND PROTECTION :
NEOPRENE, NITRILE, OR PVC GLOVES Breakthrough time not determined as preparation, consult PPE manufacturers.

SKIN PROTECTION :
Wear standard protective clothing.

EYE PROTECTION :
Wear safety glasses with side-shields.

HYGIENE RECOMMENDATIONS :
Use good work and personal hygiene practices to avoid exposure. Keep an eye wash fountain available. Keep a safety shower available. If clothing is contaminated, remove clothing and thoroughly wash the affected area. Launder contaminated clothing before reuse. Always wash thoroughly after handling chemicals. When handling this product never eat, drink or smoke.

ENVIRONMENTAL EXPOSURE CONTROL PRECAUTIONS :
Consider the provision of containment around storage vessels.

9. PHYSICAL AND CHEMICAL PROPERTIES

PHYSICAL STATE	Liquid
APPEARANCE	Milky White
ODOR	Mild
pH	No data available.
VAPOR PRESSURE	No data available.
VAPOR DENSITY	No data available.
SPECIFIC GRAVITY	1.198 - 1.225 (23.88 °C)
DENSITY	No data available.
SOLUBILITY IN WATER	Complete
OCTANOL/WATER COEFFICIENT (log Kow)	-0.9 Product (estimated) OECD 117
MELTING POINT	No data available.
BOILING POINT	No data available.
FLASH POINT	Not flammable
LOWER EXPLOSION LIMIT	No data available.
UPPER EXPLOSION LIMIT	No data available.
AUTOIGNITION TEMPERATURE	No data available.

Note: These physical properties are typical values for this product and are subject to change.

10. STABILITY AND REACTIVITY

STABILITY :
Stable under normal conditions.

CONDITIONS TO AVOID
: Extremes of
temperature

INCOMPATIBLE MATERIALS :
Contact with strong oxidizers (e.g. chlorine, peroxides, chromates, nitric acid, perchlorate, concentrated oxygen, permanganate) may generate heat, fires, explosions and/or toxic vapors. SO2 may react with vapors from neutralizing amines and may produce a visible cloud of amine salt particles.

HAZARDOUS DECOMPOSITION PRODUCTS :
Under fire conditions: Oxides of carbon, Oxides of nitrogen, Oxides of sulfur

HAZARDOUS REACTIONS :
Hazardous polymerization will not occur.

11. TOXICOLOGICAL INFORMATION

OVERVIEW OF HEALTH HAZARDS

ACUTE HAZARDS - EYE CONTACT
May cause irritation with prolonged contact.

ACUTE HAZARDS - SKIN CONTACT
May cause irritation with prolonged contact.

ACUTE HAZARDS - INGESTION
Not a likely route of exposure. No adverse effects expected.

ACUTE HAZARDS - INHALATION
Not a likely route of exposure. No adverse effects expected.

CHRONIC HAZARDS :
No adverse effects expected other than those mentioned above.

SUMMARY OF TOXICITY INFORMATION

ACUTE TOXICITY DATA :
No toxicity studies have been conducted on this product.

SENSITIZATION :
This product is not expected to be a sensitizer.

CARCINOGENICITY :
None of the substances in this product are listed as carcinogens by the International Agency for Research on Cancer (IARC), the National Toxicology Program (NTP) or the American Conference of Governmental Industrial Hygienists (ACGIH).

For additional information on the hazard of the preparation, please consult section 2 and 12.

HUMAN HAZARD CHARACTERIZATION
Based on our hazard characterization, the potential human hazard is: Low

12. ECOLOGICAL INFORMATION

ECOTOXICOLOGICAL EFFECTS:

The following results are for the product.

AQUATIC PLANT RESULTS :

Species	Exposure	Test Type	Value	Test Descriptor
Marine Algae (Skeletonema costatum)	72 hrs	LC50	165.54 mg/l	Product
Marine Algae (Skeletonema costatum)	72 hrs	NOEC	10 mg/l	Product

MOBILITY AND BIOACCUMULATION POTENTIAL :

The environmental fate was estimated using a level III fugacity model embedded in the EPI (estimation program interface) Suite TM, provided by the US EPA. The model assumes a steady state condition between the total input and output. The level III model does not require equilibrium between the defined media. The information provided is intended to give the user a general estimate of the environmental fate of this product under the defined conditions of the models.

If released into the environment this material is expected to distribute to the air, water and soil/sediment in the approximate respective percentages;

Air	Water	Soil/Sediment
<5%	10 - 30%	70 - 90%

The portion in water is expected to be soluble or dispersible.

This preparation or material is not expected to bioaccumulate.

PERSISTENCY AND DEGRADATION :

The organic portion of this preparation is expected to be inherently biodegradable.

ENVIRONMENTAL HAZARD AND EXPOSURE CHARACTERIZATION
Based on our hazard characterization, the potential environmental hazard is: Moderate

13. DISPOSAL CONSIDERATIONS

Dispose of wastes in an approved waste treatment / disposal site, in accordance with all applicable regulations. Do not dispose of wastes in local sewer or with normal garbage.

Triple rinse (or equivalent) all containers and offer for recycling or reconditioning, or puncture and dispose of in a sanitary landfill, or by other procedures approved by state and local authorities.

14. TRANSPORT INFORMATION

The information in this section is for reference only and should not take the place of a shipping paper (bill of lading) specific to an order. Please note that the proper Shipping Name / Hazard Class may vary by packaging, properties, and mode of transportation. Typical Proper Shipping Names for this product are as follows.

LAND TRANSPORT
Proper Shipping Name : PRODUCT IS NOT REGULATED DURING TRANSPORTATION

AIR TRANSPORT (ICAO/IATA)
Proper Shipping Name : PRODUCT IS NOT REGULATED DURING TRANSPORTATION

MARINE TRANSPORT (IMDG/IMO)
Proper Shipping Name : PRODUCT IS NOT REGULATED DURING TRANSPORTATION

15. REGULATORY INFORMATION

AUSTRALIA :

NICNAS
All substances in this product comply with the National Industrial Chemicals Notification & Assessment Scheme (NICNAS).

SUSDP SCHEDULE : Not Listed

16. OTHER INFORMATION

This product material safety data sheet provides health and safety information. The product is to be used in applications consistent with our product literature. Individuals handling this product should be informed of the recommended safety precautions and should have access to this information. For any other uses, exposures should be evaluated so that appropriate handling practices and training programs can be established to insure safe workplace operations. Please consult your local sales representative for any further information.

REFERENCES

Hazardous Substances Data Bank, National Library of Medicine, Bethesda, Maryland (TOMES CPS™ CD-ROM Version), Micromedex, Inc., Englewood, CO.

IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man, Geneva: World Health Organization, International Agency for Research on Cancer.

Integrated Risk Information System, U.S. Environmental Protection Agency, Washington, D.C. (TOMES CPS™ CD-ROM Version),
Micromedex, Inc., Englewood, CO.

Annual Report on Carcinogens, National Toxicology Program, U.S. Department of Health and Human Services, Public Health Service.

Registry of Toxic Effects of Chemical Substances, National Institute for Occupational Safety and Health, Cincinnati, OH,
(TOMES CPS™ CD-ROM Version), Micromedex, Inc., Englewood, CO.

The Teratogen Information System, University of Washington, Seattle, WA (TOMES CPS™ CD-ROM Version), Micromedex, Inc., Englewood, CO.

Prepared By: Condor Energy HSEQ Department
Date issued: 27 March 2014
Version Number: 1.0

Appendix E Tier 2 Assessment – Avian Wildlife

Table E-1
Tier 2 Assessment - Summary
Condor Energy Northern Territory Tenement - Chemical Risk Assessment

Common Name	Scientific Name	Body Mass (Kg)								Drinking WIR (L/day)[3,4]
		Sex[1]	N	Mean	Standard Deviation	Min	Max	Location	Source ID[2]	Mean
Crested Pigeon	*Ocyphaps lophotes*	**B**	**21**	**0.204**	**---**	**0.142**	**0.26**	**Australia**	**515a**	**0.020**
Willie Wagtail	*Rhipidura leucophrys picata*	**B**	**13**	**0.0201**	**---**	**0.0145**	**0.0255**	**Australia**	**518a**	**0.004**
Peaceful Dove	*Geopelia placida*	**B**	**38**	**0.0478**	**---**	**0.035**	**0.065**	**Australia**	**515a**	**0.008**
Cattle Egret	*Bubulcus ibis*	M	27	0.372	---	0.296	0.46	FL, USA	1207	0.0304
Cattle Egret	*Bubulcus ibis*	**F**	**59**	**0.36**	**---**	**0.27**	**0.512**	**FL, USA**	**1207**	**0.0298**
Brown Honeyeater	*Lichmera indistincta*	M	37	0.0118	0.0015	0.009	0.015	Australia	517	0.0030
Brown Honeyeater	*Lichmera indistincta*	**F**	**15**	**0.0106**	**0.0021**	**0.008**	**0.014**	**Australia**	**517**	**0.0028**

Notes:

1, Sex: M, Male; F, Female; B, Both

2, Body mass statistics compiled in Dunning (2008); Original source documents based on Source ID in Dunning (2008) include:

515a, *Higgins, P J and S J J F Davies 1996 Handbook of Australian, New Zealand and Antarctic birds Oxford University Press, Mel-bourne, Australia Volume 3*

518a, *Higgins, P J , J M Peter, and S J Cowling 2006 Handbook of Australian, New Zealand and Antarctic birds Oxford University Press, Melbourne, Australia Volume 7*

1207, *Telfair, R C 1994 Cattle Egret (Bubulcus ibis) In The Birds of North America, A Poole and F Gill (editors) The Birds of North America, Inc , Philadelphia, PA,* and The American Ornithologists' Union, Washington, DC Number 113

517, *Higgins, P J , J M Peter, and W K Steele 2001 Handbook of Australian, New Zealand and Antarctic birds Oxford University Press, Melbourne, Australia Volume 5*

3, Drinking water ingestion rate (WIR) based on the allometric relationship developed by Calder and Braun (1983), where WIR (L/day) = 0.059 x BW $(Kg)^{0.67}$

4, Proposed WIR shown in bold, estimated based on the arithmetic mean of female or combined body mass; WIR may be estimated based on other body mass statistics depending on the appropriate exposure scenario.

kg = kilogram

Table E-2
Tier 2 Assessment - Crested Pigeon
Condor Energy Northern Territory Tenement - Chemical Risk Assessment

Constituent Name	CAS No.	Mammal NOAELt	Mammal NOAEL		Avian NOAELt [1]	Avian NOAEL		Avian Receptor	
			Test Animal			Test Animal		Crested Pigeon	
			Animal	Body Weight (kg)		Animal	Body Weight (kg)	Body Weight (kg)	Derived TRV
Glutaraldehyde	111-30-8	4	Rat	0.35	206	Mallard Duck	1.58	0.204	3.4E+02

Notes:
NOAELt = No observed adverse effect level test animal
kg = kilogram
NA = not applicable
TRV = toxicity reference value
1/ If an avian NOAEL was not available, the mammal NOAEL was used to derive the TRV for the avian receptor.

$$Derived\ TRV = NOAEL_{test} * \left(\frac{Body\ Weighttest}{Body\ WeightAvian}\right)^{(1/4)}$$

Exposure Route	Parameter Code	Parameter Definition	Units (a)	Parameter Value	Source (b)
Ingestion	IR	Ingestion rate	l/day	0.020	Table E-1
	EF	Exposure frequency	day/yr	21	BPJ
	ED	Exposure duration	yr	1	BPJ
	BW	Body weight	kg	0.204	Table E-1
	AT-NC	Averaging time - noncancer	days	365	BPJ

Notes:
a/ Units:
l/day = litres per day
day/yr = days per year
yr = year
kg = kilogram
b/ References:
BPJ - Best Professional Judgement

Constituent Name	CAS No.	EPC [1]	Toxicity	Total Intake (mg/kg/day)	Hazard Quotient
		CW (mg/l)	TRVs		Ingestion
Glutaraldehyde	111-30-8	470	3.4E+02	2.7E+00	7.8E-03
				Cumulative:	**7.8E-03**

Notes:
CW = concentration in water
EPC = exposure point concentration
mg/kg/day = milligrams per kilograms per day
mg/l = milligrams per litre
NA = not available/applicable
TRV = toxicity reference value
1/ EPC is injected concentration presented on Table 1.

$$Total\ Intake = \frac{EPC\ \times IR\ \times EF\ \times ED}{BW\ \times ED\ x\ 365\ ^{days}/_{year}}$$

$$Hazard\ Quotient = \frac{Total\ Intake\ \left(\frac{mg}{kg-day}\right)}{TRV\ \left(\frac{mg}{kg-day}\right)}$$

Table E-3
Tier 2 Assessment - Willie Wagtail
Condor Energy Northern Territory Tenement - Chemical Risk Assessment

Constituent Name	CAS No.	Mammal NOAELt	Mammal NOAEL		Avian NOAELt [1]	Avian NOAEL		Avian Receptor	
			Test Animal			Test Animal		Willie Wagtail	
			Animal	Body Weight (kg)		Animal	Body Weight (kg)	Body Weight (kg)	Derived TRV
Glutaraldehyde	111-30-8	4	Rat	0.35	206	Mallard Duck	1.58	0.0201	6.1E+02

Notes:
NOAELt = No observed adverse effect level test animal
kg = kilogram
NA = not applicable
TRV = toxicity reference value
1/ If an avian NOAEL was not available, the mammal NOAEL was used to derive the TRV for the avian receptor.

$$Derived\ TRV = NOAEL_{test} * \left(\frac{Body\ Weighttest}{Body\ WeightAvian}\right)^{(1/4)}$$

Exposure Route	Parameter Code	Parameter Definition	Units (a)	Parameter Value	Source (b)
Ingestion	IR	Ingestion rate	l/day	0.004	Table E-1
	EF	Exposure frequency	day/yr	21	BPJ
	ED	Exposure duration	yr	1	BPJ
	BW	Body weight	kg	0.0201	Table E-1
	AT-NC	Averaging time - noncancer	days	365	BPJ

Notes:
a/ Units:
l/day = litres per day
day/yr = days per year
yr = year
kg = kilogram
b/ References:
BPJ - Best Professional Judgement

Constituent Name	CAS No.	EPC [1]	Toxicity	Total Intake (mg/kg/day)	Hazard Quotient
		CW (mg/l)	TRVs		Ingestion
Glutaraldehyde	111-30-8	470	6.1E+02	5.8E+00	9.4E-03
				Cumulative:	**9.4E-03**

Notes:
CW = concentration in water
EPC = exposure point concentration
mg/kg/day = milligrams per kilograms per day
mg/l = milligrams per liter
NA = not available/applicable
TRV = toxicity reference value
1/ EPC is injected concentration presented on Table 1.

$$Total\ Intake = \frac{EPC\ \times IR\ \times EF\ \times ED}{BW\ \times ED\ x\ 365\ ^{days}/_{year}}$$

$$Hazard\ Quotient = \frac{Total\ Intake\ \left(\frac{mg}{kg-day}\right)}{TRV\ \left(\frac{mg}{kg-day}\right)}$$

Table E-4
Tier 2 Assessment - Peaceful Dove
Condor Energy Northern Territory Tenement - Chemical Risk Assessment

Constituent Name	CAS No.	Mammal NOAELt	Mammal NOAEL		Avian NOAELt [1]	Avian NOAEL		Avian Receptor	
			Test Animal			Test Animal		Peaceful Dove	
			Animal	Body Weight (kg)		Animal	Body Weight (kg)	Body Weight (kg)	Derived TRV
Glutaraldehyde	111-30-8	4	Rat	0.35	206	Mallard Duck	1.58	0.0478	4.9E+02

Notes:
NOAELt = No observed adverse effect level test animal
kg = kilogram
NA = not applicable
TRV = toxicity reference value
1/ If an avian NOAEL was not available, the mammal NOAEL was used to derive the TRV for the avian receptor.

$$Derived\ TRV = NOAEL_{test} * \left(\frac{Body\ Weighttest}{Body\ WeightAvian}\right)^{(1/4)}$$

Exposure Route	Parameter Code	Parameter Definition	Units (a)	Parameter Value	Source (b)
Ingestion	IR	Ingestion rate	l/day	0.008	Table E-1
	EF	Exposure frequency	day/yr	21	BPJ
	ED	Exposure duration	yr	1	BPJ
	BW	Body weight	kg	0.0478	Table E-1
	AT-NC	Averaging time - noncancer	days	365	BPJ

Notes:
a/ Units:
l/day = litres per day
day/yr = days per year
yr = year
kg = kilogram
b/ References:
BPJ - Best Professional Judgement

Constituent Name	CAS No.	EPC [1]	Toxicity	Total Intake (mg/kg/day)	Hazard Quotient
		CW (mg/l)	TRVs		Ingestion
Glutaraldehyde	111-30-8	470.14	4.9E+02	4.4E+00	8.8E-03
				Cumulative:	**8.8E-03**

Notes:
CW = concentration in water
EPC = exposure point concentration
mg/kg/day = milligrams per kilograms per day
mg/l = milligrams per liter
NA = not available/applicable
TRV = toxicity reference value
1/ EPC is injected concentration presented on Table 1.

$$Total\ Intake = \frac{EPC\ \times IR\ \times EF\ \times ED}{BW\ \times ED\ x\ 365\ ^{days}/_{year}}$$

$$Hazard\ Quotient = \frac{Total\ Intake\ \left(\frac{mg}{kg-day}\right)}{TRV\ \left(\frac{mg}{kg-day}\right)}$$

Table E-5
Tier 2 Assessment - Cattle Egret
Condor Energy Northern Territory Tenement - Chemical Risk Assessment

Constituent Name	CAS No.	Mammal NOAELt	Mammal NOAEL		Avian NOAELt [1]	Avian NOAEL		Avian Receptor	
			Test Animal			Test Animal		Cattle Egret	
			Animal	Body Weight (kg)		Animal	Body Weight (kg)	Body Weight (kg)	Derived TRV
Glutaraldehyde	111-30-8	4	Rat	0.35	206	Mallard Duck	1.58	0.36	3.0E+02

Notes:
NOAELt = No observed adverse effect level test animal
kg = kilogram
NA = not applicable
TRV = toxicity reference value
1/ If an avian NOAEL was not available, the mammal NOAEL was used to derive the TRV for the avian receptor.

$$Derived\ TRV = NOAEL_{test} * \left(\frac{Body\ Weighttest}{Body\ WeightAvian}\right)^{(1/4)}$$

Exposure Route	Parameter Code	Parameter Definition	Units (a)	Parameter Value	Source (b)
Ingestion	IR	Ingestion rate	l/day	0.030	Table E-1
	EF	Exposure frequency	day/yr	21	BPJ
	ED	Exposure duration	yr	1	BPJ
	BW	Body weight	kg	0.36	Table E-1
	AT-NC	Averaging time - noncancer	days	365	BPJ

Notes:
a/ Units:
l/day = litres per day
day/yr = days per year
yr = year
kg = kilogram
b/ References:
BPJ - Best Professional Judgement

Constituent Name	CAS No.	EPC [1]	Toxicity	Total Intake (mg/kg/day)	Hazard Quotient
		CW (mg/l)	TRVs		Ingestion
Glutaraldehyde	111-30-8	470.1400	3.0E+02	2.2E+00	7.5E-03
				Cumulative:	**7.5E-03**

Notes:
CW = concentration in water
EPC = exposure point concentration
mg/kg/day = milligrams per kilograms per day
mg/l = milligrams per liter
NA = not available/applicable
TRV = toxicity reference value
1/ EPC is injected concentration presented on Table 1.

$$Total\ Intake = \frac{EPC\ \times IR\ \times EF\ \times ED}{BW\ \times ED\ x\ 365\ ^{days}/_{year}}$$

$$Hazard\ Quotient = \frac{Total\ Intake\ \left(\frac{mg}{kg-day}\right)}{TRV\ \left(\frac{mg}{kg-day}\right)}$$

Table E-6
Tier 2 Assessment - Brown Honeyeater
Condor Energy Northern Territory Tenement - Chemical Risk Assessment

Constituent Name	CAS No.	Mammal NOAELt	Mammal NOAEL		Avian NOAELt [1]	Avian NOAEL		Avian Receptor	
			Test Animal			Test Animal		Brown Honeyeater	
			Animal	Body Weight (kg)		Animal	Body Weight (kg)	Body Weight (kg)	Derived TRV
Glutaraldehyde	111-30-8	4	Rat	0.35	206	Mallard Duck	1.58	0.0106	7.2E+02

Notes:
NOAELt = No observed adverse effect level test animal
kg = kilogram
NA = not applicable
TRV = toxicity reference value
1/ If an avian NOAEL was not available, the mammal NOAEL was used to derive the TRV for the avian receptor.

$$Derived\ TRV = NOAEL_{test} * \left(\frac{Body\ Weighttest}{Body\ WeightAvian}\right)^{(1/4)}$$

Exposure Route	Parameter Code	Parameter Definition	Units (a)	Parameter Value	Source (b)
Ingestion	IR	Ingestion rate	l/day	0.0028	Table E-1
	EF	Exposure frequency	day/yr	21	BPJ
	ED	Exposure duration	yr	1	BPJ
	BW	Body weight	kg	0.0106	Table E-1
	AT-NC	Averaging time - noncancer	days	365	BPJ

Notes:
a/ Units:
l/day = litres per day
day/yr = days per year
yr = year
kg = kilogram
b/ References:
BPJ - Best Professional Judgement

Constituent Name	CAS No.	EPC [1]	Toxicity	Total Intake (mg/kg/day)	Hazard Quotient
		CW (mg/l)	TRVs		Ingestion
Glutaraldehyde	111-30-8	470.14000	7.2E+02	7.2E+00	9.9E-03
				Cumulative:	**9.9E-03**

Notes:
CW = concentration in water
EPC = exposure point concentration
mg/kg/day = milligrams per kilograms per day
mg/l = milligrams per liter
NA = not available/applicable
TRV = toxicity reference value
1/ EPC is injected concentration presented on Table 1.

$$Total\ Intake = \frac{EPC\ \times IR\ \times EF\ \times ED}{BW\ \times ED\ x\ 365\ ^{days}/_{year}}$$

$$Hazard\ Quotient = \frac{Total\ Intake\ \left(\frac{mg}{kg-day}\right)}{TRV\ \left(\frac{mg}{kg-day}\right)}$$