

Modification Notice - Regulation 22

Interest Holder	Santos QNT Pty Ltd		EMP Title	McArthur Basin Hydraulic Fracturing Program NT Exploration Permit (EP) 161	Unique EMP ID No.	STO3-8	Change/Mod No.	2	Date	23/12/22
Brief Description	The modifications to the EMP, controls and monitoring reflect reduced operational activity and associated reduced risk on the Tanumbirini well pad as described in letter from the interest holder to DEPWS dated 23 December 2022.									
Geospatial Files Included?	No									
Does the proposed change result in a new, or increased, potential or actual environmental impact or risk?	If an INCREASE in an existing potential or actual environmental impact or risk is it provided for in the approved EMP?	Does the proposed change require additional mitigation measures to be included?	Has additional stakeholder engagement been conducted?	Does it require additional environmental performance standards and measurement criteria?	Does it affect compliance with Sacred Site Authority Certificates?	Does it affect current rehabilitation, weed, fire, wastewater, erosion and sediment control, spill or emergency response plans?	Will the environmental outcome continue to be achieved and will the impacts and risks be managed to ALARP and acceptable?			
No	N/A	No	No	No	No	No	No	Yes		
Current EMP Text					Amended EMP Text					
Description of the Activity Following the completion of the well drilling operations, the operator is seeking approval to conduct a program of hydraulic fracture stimulations and appraisal (production) tests of the Velkerri Formation at the Tanumbirini (Tanumbirini-1 (HFS commenced in 2019 and is ongoing), Tanumbirini-2H, Tanumbirini-3H) and Inacumba (Inacumba-1/1H, Inacumba-2H) locations. The Hydraulic Fracturing Program will commence only after a successful drilling and well integrity assessment is complete for each individual well. The Drilling and Civil works required to prepare for the Hydraulic Fracturing Program, including the upgrading					Description of the Activity Following the completion of the well drilling operations, the operator is seeking approval to conduct a program of hydraulic fracture stimulations and appraisal (production) tests of the Velkerri Formation at the Tanumbirini (Tanumbirini-1 (HFS commenced in 2019 and is ongoing), Tanumbirini-2H, Tanumbirini-3H) and Inacumba (Inacumba-1/1H, Inacumba-2H) locations. The Hydraulic Fracturing Program will commence only after a successful drilling and well integrity assessment is complete for each individual well. The Drilling and Civil works required to prepare for the Hydraulic Fracturing Program, including the upgrading of access tracks and creation					

<p>of access tracks and creation of infrastructure at the lease pad, are covered in separate EMPs which have been submitted to the Department of Environment, Parks and Water Security (DEPWS).</p> <p>The HFS program will be followed by production testing. It is anticipated that the production testing of each well will run between 90 and 300 days.</p> <p>HFS is not part of the drilling process but is a completion technique applied after the well is drilled. The intent of HFS is to place a highly conductive channel (sand size proppant) into the reservoir to Santos Ltd I Environment Management Plan: McArthur Basin Hydraulic Fracturing Program I 1 September 2021 Page iii increase the flow capacity of the well and increase the production of gas. The process involves the injection of a water based fluid system, at high pressure, into a cased wellbore over a number of intervals or stages along the reservoir interval(s) intersected by a well. This technique is typically used in low permeability reservoirs that cannot otherwise sustain economic production, such as shale. It is a process that has been used in the oil and gas industry since 1947 and has been successfully used on wells in the Cooper Basin for nearly 50 years. This activity is currently performed in many basins around Australia, including the Amadeus Basin in the Northern Territory.</p> <p>On completion of production testing, the wells will either be suspended for future re-entry, suspended on build-up, or decommissioned with permanent cement plugs. For suspended wells, wellbore barriers will be put in place and will be monitored through a Well Integrity Monitoring Plan; and the well and well-pad will be monitored and maintained. At the completion of operations all surface infrastructure will be removed (excluding the well head).</p>	<p>of infrastructure at the lease pad, are covered in separate EMPs which have been submitted to the Department of Environment, Parks and Water Security (DEPWS). The HFS program will be followed by production testing. It is anticipated that the production testing of each well will run between 90 and 300 days.</p> <p>HFS is not part of the drilling process but is a completion technique applied after the well is drilled. The intent of HFS is to place a highly conductive channel (sand size proppant) into the reservoir to Santos Ltd I Environment Management Plan: McArthur Basin Hydraulic Fracturing Program I 1 September 2021 Page iii increase the flow capacity of the well and increase the production of gas. The process involves the injection of a water based fluid system, at high pressure, into a cased wellbore over a number of intervals or stages along the reservoir interval(s) intersected by a well. This technique is typically used in low permeability reservoirs that cannot otherwise sustain economic production, such as shale. It is a process that has been used in the oil and gas industry since 1947 and has been successfully used on wells in the Cooper Basin for nearly 50 years. This activity is currently performed in many basins around Australia, including the Amadeus Basin in the Northern Territory.</p> <p>The modifications to the EMP dated 23 December 2022, updated controls and monitoring reflect reduced operational activity and associated reduced risk on the Tanumbirini well pad.</p> <p>If there is a requirement for increased operational activity, resulting in an increased environmental risk, to be conducted under this EMP (STO3-8) then a revised Modification Notice will be submitted to ensure appropriate monitoring and reporting will be conducted.</p> <p>On completion of production testing, the wells will either be suspended for future re-entry, suspended on build-up, or decommissioned with permanent cement plugs. For suspended wells, wellbore barriers will be put in place and will be monitored through a Well Integrity Monitoring Plan; and the well and well-pad will be monitored and maintained. At the completion of operations all surface infrastructure will be removed (excluding the well head).</p>
<p>See: Table 8-1 Environmental Outcomes, Environmental Performance Standards and Measurement Criteria</p>	<p>See revised wording shaded in grey in updated in Table 8-1 Environmental Outcomes, Environmental Performance Standards and Measurement Criteria (below)</p>
<p>See: Table 6-1 Risk Assessment for proposed activities</p>	<p>See revised wording shaded in grey in updated in Table 6-1 Risk Assessment for proposed activities (below)</p>

<p>See: Table 8-5 Environmental Monitoring</p>	<p>See revised wording shaded in grey in updated in Table 8-5 Environmental Monitoring (below)</p>
<p>3.3.9 Flow-back and Well Testing Activities</p> <p>An onsite, 24 hr per day water management crew will be on location to:</p> <ul style="list-style-type: none"> record and track daily pond volumes, and ensure minimum freeboards are maintained track water movement (Input from bores, water transfer, rainfall, and flowback. Output from evaporation, road watering) pump water from the top of the cover(s) during rainfall ensure early detection of any leaks transfer water to enclosed ponds within 8 hrs of a Significant Rainfall Event amend pond(s) as required to manage flowback requirements <p>The crew will be based at the Wellsite to ensure continuity of service</p>	<p>3.3.9 Flow-back and Well Testing Activities</p> <p>During flowback activities onsite, 24 hr per day water management crew will be on location to:</p> <ul style="list-style-type: none"> record and track daily pond volumes, and ensure minimum freeboards are maintained track water movement (Input from bores, water transfer, rainfall, and flowback. Output from evaporation, road watering) pump water from the top of the cover(s) during rainfall ensure early detection of any leaks transfer water to enclosed ponds within 8 hrs of a Significant Rainfall Event amend pond(s) as required to manage flowback requirements <p>The crew will be based at the Wellsite to ensure continuity of service</p>
<p>7.2.2.3 Fire Mitigation Measures</p> <p>All project infrastructure will be designed and constructed to mitigate risks of ignition. Project specific requirement to mitigate risk of ignition include:</p> <ul style="list-style-type: none"> Fire-fighting equipment and competent fire-fighting personnel will be available. vehicles will be equipped with portable fire extinguishers. Machinery and vehicles should be parked in areas of low fire risk and be free of any combustible material. Any petrol motor vehicles or petrol-powered pumps will be fitted with spark arresters. All vehicles will be equipped with operational VHF and / or UHF radio transceivers. Smoking will only be permitted in areas clear of vegetation, and there will be no disposal of butts. 	<p>7.2.2.3 Fire Mitigation Measures</p> <p>All project infrastructure will be designed and constructed to mitigate risks of ignition. Project specific requirement to mitigate risk of ignition include:</p> <ul style="list-style-type: none"> Fire-fighting equipment and competent fire-fighting personnel will be available during stimulation, flowback and testing activities. vehicles will be equipped with portable fire extinguishers. Machinery and vehicles should be parked in areas of low fire risk and be free of any combustible material. Any petrol motor vehicles or petrol-powered pumps will be fitted with spark arresters. All vehicles will be equipped with operational VHF and / or UHF radio transceivers. <p>Smoking will only be permitted in areas clear of vegetation, and there will be no disposal of butts.</p>
<p>7.2.3.2 Operational Fire Monitoring</p>	<p>7.2.3.2 Operational Fire Monitoring</p>

<p>The Santos Onsite Company Representative is responsible for monitoring for bushfire alerts (primarily via the https://securent.nt.gov.au/alerts and https://www.bushfires.nt.gov.au/incidentmap/ websites and notifying all site personnel of the risks of fire. Communication of these alerts will via the daily toolbox meetings. Where bushfire alert information becomes known after the toolbox meeting, the Onsite Company Representative will communicate to all site personnel.</p>	<p>Whenever personnel are onsite the Santos Onsite Company Representative is responsible for monitoring for bushfire alerts (primarily via the https://securent.nt.gov.au/alerts and https://www.bushfires.nt.gov.au/incidentmap/ websites and notifying all site personnel of the risks of fire. Communication of these alerts will via the daily toolbox meetings. Where bushfire alert information becomes known after the toolbox meeting, the Onsite Company Representative will communicate to all site personnel.</p>
<p>Appendix H: Spill Management Plan 4.2 Minimising the Risk of a Spill</p> <p>Through the implementation of the mitigations measures provided in the Table 6-1 of this EMP the following mitigation measures will be taken to minimise the risk of a spill at the well pad:</p> <ul style="list-style-type: none"> • Daily checks of pits, dams, flowlines, tanks and chemical storage areas. <p>4.3 Spill Detection</p> <p>The hydraulic fracturing program will utilise a leak detection system designed to quickly identify the presence of leaks. The leak detection system includes the following:</p> <ul style="list-style-type: none"> • Each pond has two unperforated liners, plus a third liner that is connected to the leak detection system. • common sunken leak detection system is connected hydraulically via pipe work to a sunken leak detection system. • a leak is detected at the leak detection manifold, an audible alarm and flashing light will be activated. • Alarm system will be connected via the flowback/well test DAQ (data acquisition system) to ensure immediate response. 	<p>Appendix H: Spill Management Plan 4.2 Minimising the Risk of a Spill</p> <p>Through the implementation of the mitigations measures provided in the Table 6-1 of this EMP the following mitigation measures will be taken to minimise the risk of a spill at the well pad:</p> <ul style="list-style-type: none"> • Daily Monthly checks of pits, dams, flowlines, tanks and chemical storage areas. <p>4.3 Spill Detection</p> <p>The hydraulic fracturing program will utilise a leak detection system designed to quickly identify the presence of leaks. The leak detection system includes the following:</p> <ul style="list-style-type: none"> • Each pond has two unperforated liners, plus a third liner that is connected to the leak detection system. • common sunken leak detection system is connected hydraulically via pipe work to a sunken leak detection system. • a leak is detected at the leak detection manifold, an audible alarm and flashing light will be activated. • Alarm system will be connected via telemetry the flowback/well test DAQ (data acquisition system), or other, to ensure immediate response.

Table 8-1 Environmental Outcomes, Environmental Performance Standards and Measurement Criteria

Risk Sources	Environmental Outcome	Environmental Performance Standards	Measurement Criteria and Records
Environmental Value: Terrestrial Ecosystems			
<p>Vehicle and plant movements generating noise and vibration and disturbing wildlife Vehicle movement, project activities and camps generating light and disturbing wildlife Disturbance, injury or death to terrestrial fauna due to vehicle strike, HFS activities and / or entrapment in open excavations Waste stored inappropriately attracting native fauna</p>	<p>No significant impact to threatened flora or fauna species, their habitat or sites of conservation significance resulting from conduct of the regulated activity.</p>	<p>Avoid impacts to threatened flora or fauna species, their habitat or sites of conservation significance</p>	<p>IVMS records show 60 km/hr speed limit adhered to and any non-compliance recorded Site induction records show all personnel have completed site inductions which include driving. IVMS records show no off-road driving. Equipment maintenance logs demonstrate engines and machinery have been maintained in accordance with required maintenance schedule and have been fitted with noise suppression devices. Audit records of lighting at the camp show inward-facing lights that are adequate for safe operations. Daily checklist shows inspection of fences, excavations, pits, storages for entrapped fauna and fauna escapes intact. Daily checklist shows inspection of pits and storages, using camera via telemetry or visual inspection, for entrapped fauna and fauna escapes intact. Monthly checklist shows inspection of pits and storages for entrapped fauna. Daily checklist shows all domestic waste receptacles have lids secured. Audit records show only waste from approved wastewater systems and grey water disposed of to land.</p>
<p>Vehicle and plant movements generating dust and depositing on flora</p>		<p>Avoid dust associated impacts to threatened flora or fauna species, their</p>	<p>Records show when and where water trucks have been used for dust control including weather condition observations. IVMS records show no off-road driving.</p>

Risk Sources	Environmental Outcome	Environmental Performance Standards	Measurement Criteria and Records
Plant and vehicles distributing weeds from outside or within the project area		habitat or sites of conservation.	IVMS records show 60 km/hr speed limit adhered to and any non-compliance recorded.
		No introduction of new species of weeds or plant pathogens, or increase in abundance of existing weed species, as a result the regulated activity.	<p>Weed monitoring shows no new weed species introduced to work area. Weeds identified in work areas will be treated in accordance with advice from NT Weeds Management Officer.</p> <p>Audit records show weed management plan implemented.</p> <p>Hygiene declaration available for all vehicles coming into EP161 on each occasion.</p> <p>Site induction records show all personnel have completed site inductions, which include information on weeds in the region and method of spread.</p>
Ignition sources from flare, plant and machinery, cigarettes causing fire.		No uncontrolled fire in EP161 as a result of conduct of the regulated activity.	Santos's records system shows no uncontrolled fires as a result of the regulated activity.
			Site induction records show all personnel have completed site inductions, which include information on fire risk and impact to landholder for unplanned fire.
			Weekly checklist shows SDS available and appropriate firefighting equipment are stationed at flammable material stores
			Weekly checklist shows all vehicles have portable fire extinguishers and operational VHF or UHF radio transceivers.
			Vegetation free safety zones around flares; vegetation will not be exposed to a radiant heat exceeding 6.31kW/m2 from flares.
			No use of petrol motor vehicles and audits show all petrol powered pumps have spark arresters fitted.
			Training records shows staff trained in use of fire-fighting equipment.
			Training records verify that operations personnel participate in at least annual fire and emergency drills.

Risk Sources	Environmental Outcome	Environmental Performance Standards	Measurement Criteria and Records
			<p>Vegetation removal requirements will be assessed during the post wet weed survey when vegetation growth will be greatest. If required, slashing / grading will occur to remove well site vegetation.</p> <p>Records show toolbox meeting discussions of fire risk levels and fire risk management and remedial actions.</p> <p>Records show daily assessment of fire risk during dry season.</p> <p>No smoking from flare, plant and other machinery allowed on site and any instance of smoking recorded as a nonconformance.</p>
<p>Inappropriate storage or handling of potentially hazardous substances</p> <p>Transport vehicle accident due to weather</p> <p>Overflow of tanks or pits</p> <p>Leaks from storage tanks and flowline failure</p> <p>Chemical leaks and spills</p>		<p>No releases of wastes, wastewater, chemicals or hydrocarbons resulting in significant impact to threatened flora or fauna species, their habitat or sites of conservation significance</p>	<p>Weekly inspection checklists confirm (via camera telemetry or visual inspection) all hazardous materials are stored and managed in accordance with the EMP, the Code of practice and the WOMP e.g. chemicals will be stored in a bunded dangerous goods storage area, routine inspection of chemical stores.</p> <p>Remediation to commence immediately after spills, recorded in the Santos Incident Management System and reported to DEPWS when required.</p> <p>Daily inspection records confirm the freeboard is maintained in accordance with the WWMP, e.g. 1.5m in the wet season for open tanks containing wastewater, and that the pit/tank integrity is maintained.</p> <p>Audit records show Bureau of Meteorology provided timely notification of significant rainfall event and site evacuation plan put into place following notification.</p>
Environmental Value: Terrestrial Environmental Quality			
<p>Vehicles leave the previously constructed roads or work areas</p>	<p>No significant impact to the quality and integrity of land and soils resulting from conduct of the regulated activity</p>	<p>No unauthorised physical disturbance to soil.</p>	<p>Site induction records shows all personnel have completed site inductions which include driving.</p> <p>Records show the erosion and sediment control plan implemented prior to the commencement of the activity</p> <p>IVMS records show no off-road driving.</p>

Risk Sources	Environmental Outcome	Environmental Performance Standards	Measurement Criteria and Records
<p>Inappropriate storage or handling of potentially hazardous substances</p> <p>Transport vehicle accident due to weather</p> <p>Overflow of tanks or pits</p> <p>Leaks from storage tanks and flowline failure</p> <p>Chemical leaks and spills</p>		<p>Weekly inspection checklists confirm all hazardous materials are stored and managed in accordance with the EMP, the Code of practice and the WOMP e.g. chemicals will be stored in a bunded dangerous goods storage area, routine inspection of chemical stores.</p>	<p>Weekly inspection checklists confirm (via camera telemetry or visual inspection) all hazardous materials are stored and managed in accordance with the EMP, the Code of practice and the WOMP e.g. chemicals will be stored in a bunded dangerous goods storage area, routine inspection of chemical stores.</p>
			<p>Remediation to commence immediately after spills, recorded in the Santos Incident Management System and reported to DEPWS when required.</p>
			<p>Daily inspection records confirm the freeboard is maintained in accordance with the WWMP, e.g. 1.5m in the wet season for open tanks containing wastewater, and that the pit/tank integrity is maintained.</p>
			<p>Audit records show Bureau of Meteorology provided timely notification significant rainfall event and site evacuation plan put into place following notification.</p>
Environmental Value: Inland Environmental Water Quality			
<p>Cross-flow during hydraulic fracturing, testing and decommissioning. Faults or major structures enables crossflow Insufficient isolation between wells in target formation</p>	<p>No impact on Inland environmental water quality resulting from conduct of the regulated activity</p>	<p>No releases of wastes, wastewater, chemicals, hydrocarbons resulting in contamination of the waters.</p>	<p>Records confirm well critical acceptance criteria met.</p>
			<p>Well control monitoring demonstrates adequate well control.</p>
			<p>Weekly inspection checklists confirm (via camera telemetry or visual inspection) all hazardous materials are stored and managed in accordance with the EMP, the Code of practice and the WOMP.</p>
			<p>Remediation to commence immediately after spills, recorded in the Santos Incident Management System and reported to DEPWS when required.</p>
			<p>Road conditions for heavy vehicle transport will be assessed prior to mobilisation on unsealed roads.</p>
			<p>Daily inspection records confirm the freeboard is maintained in accordance with the WWMP, e.g. 1.5m in the wet season for open tanks containing wastewater, and that the pit/tank integrity is maintained.</p>

Risk Sources	Environmental Outcome	Environmental Performance Standards	Measurement Criteria and Records
			Audit records show Bureau of Meteorology provided timely notification significant rainfall event and site evacuation plan put into place following notification.
Project groundwater extraction results in the reduction in groundwater quantity		No reduction to groundwater resource availability in the area as a result of the regulated activity.	Reported groundwater extraction volumes do not exceed annual licence limit for relevant water source.
			Groundwater monitoring results show static water level is relatively unchanged as a result of the regulated activity and water availability is unchanged as a result of the regulated activity.
Environmental Value: Air Quality and Atmospheric Processes			
Vehicle and plant movements	No significant impact on air quality and minimise greenhouse gas emissions as a result of the regulated activity.	Minimise greenhouse gas emissions resultant from the regulated activity.	Audit records demonstrate that actual emissions were reported in compliance with NGRS.
			Annual greenhouse gas emissions reported to DEPWS, including a comparison of actual emissions and estimated emissions in the EMP.
Production testing flaring			Equipment maintenance logs demonstrate engines and machinery have been maintained in accordance with required maintenance schedule.
			Reducing the production testing period to well below 300 days if the required data for confirming development potential of the reservoir can be obtained in a shorter timeframe
Fugitive emissions	In accordance with Clause B.4.13.2(k) gas will be flared in the first instance, unless there is insufficient gas flow or there is a safety hazard. If the separator is bypassed, this will be recorded in the daily report.		
	If leaks are identified, they are classified in accordance with section D.5.5 of the Code, and Leak Response and Notification is in accordance with the MEMP.		
Environmental Value: Human Health			

Risk Sources	Environmental Outcome	Environmental Performance Standards	Measurement Criteria and Records
Noise from vehicle movements and HFS activities results in noise disturbance to landholders	No reduction in amenity or impact on the respiratory health of nearby stakeholders as a result of the regulated activity	Dust generation on the well pad and access tracks in the dry season will be minimised.	Records show when and where water trucks have been used for dust control including weather condition observations.
			Site induction records show all personnel have completed site inductions which include driving.
			IVMS records show 60 km/hr speed limit adhered to and any non-compliance recorded.
			IVMS records show no off-road driving.
			Stakeholder engagement records demonstrate dust complaints were investigated and actioned appropriately.
Environmental Factor: Communities and Economy			
Noise from vehicle movements and HFS activities results in noise disturbance to landholders	Minimise negative impact to communities and enhance the economy as a result of the regulated activity	Noise complaints from vehicle movements and activities associated with the regulated activity are minimised.	Stakeholder engagement records demonstrate noise complaints were investigated and actioned appropriately
Vehicle movements, HFS activities, and entrapment in open pits results in disturbance, injury or death to livestock		Disturbance, injury or death to livestock from vehicle movements and project activities avoided through active stakeholder engagement	Equipment maintenance logs demonstrate engines and machinery have been maintained in accordance with required maintenance schedule and have been fitted with noise suppression devices.
Vehicle and plant movements throughout the project area results in disturbance to landholders		Disturbance to landholders from vehicle movements and HFS activities minimised.	Daily Monthly inspection records show fences are intact, gates are left in the condition in which they were found and no livestock entrapment.
			No livestock deaths from vehicle movements and project activities.
		Site induction records show all personnel have completed site inductions which include driving.	
		Stakeholder engagement records demonstrate active stakeholder engagement (e.g. notification prior to the commencement of activities).	
		Stakeholder engagement records demonstrate active stakeholder engagement (e.g. notification prior to the commencement of activities).	
		Stakeholder engagement records demonstrate vehicle movement and/or HFS activity complaints are investigated and actioned appropriately.	

Risk Sources	Environmental Outcome	Environmental Performance Standards	Measurement Criteria and Records
			Site induction records show all personnel have completed site inductions which include driving.
Environmental Factor: Culture and heritage			
Vehicle and plant movements throughout the project area results in disturbance to sacred sites.	Protect sacred sites, culture and heritage	No impact to sacred sites, culture and heritage as a result of project activities.	<p>Audit records show that all activities occur within the areas shown in AAPA Authority Certificate C2019/043.</p> <p>Records show that sacred site data provided for it in the GIS is accurate, maintained and updated</p>

Table 6-1 Risk Assessment for proposed activities

Risk Event	Potential Impact	Relevant Environmental Factor	Risk Source	Initial Risk Ranking*			Mitigation and Management Measures	Residual Risk Ranking*			Effective Controls	Uncertainty Ranking	
				L	C	R		L	C	R			
Physical disturbance including vehicle and plant movements	Disturbance to soil	Terrestrial environmental quality	Vehicles leave the previously constructed roads or work areas	F	I	2	Driving is only permitted on designated access roads	A.3.1 Site Selection and Planning A.3.4 Erosion and sediment control	C	I	1	Yes	Type A Risk - Risks are well-understood with established management practices (e.g. Land Clearing Guidelines and the ESCP)
Physical disturbance including vehicle and plant movements	Disturbance to Aboriginal archaeological sites	Culture and Heritage	Vehicles leave the previously constructed roads or work areas	B	II	1	Archaeological surveys completed by independent consultant(s) prior to activity commencement. Results indicate that no Aboriginal archaeological or historical sites/relics will be encountered or impacted by proposed activities in this portion of EP161 Driving is only permitted on designated access roads	A.3.1 Site Selection and Planning	A	I	1	Yes	Type A Risk - Risks are well-understood heritage survey complete with avoidance measures in place
Groundwater extraction	Reduction in groundwater quantity	Hydrological processes	Use of groundwater for project activities	B	II	1	Valid water extraction licence in place prior to extraction Compliance with water extraction licence limits and conditions Ensure groundwater extraction is limited to the volumes required by the hydraulic fracture program (See water use estimates in Section 3.8). Bore numbers and estimated extraction volumes will be provided to DITT and DEPWS.	A.3.1 Site Selection and Planning B.4.17 Groundwater monitoring	A	II	1	Yes	Type A Risk - Risks are well-understood. The regional understanding of the CLA is sufficient to understand the risks. Groundwater Monitoring has been undertaken and will continue.
Groundwater extraction	Reduction in groundwater available for other users	Communities and economy	Use of groundwater for project activities	B	IV	2	Valid water extraction licence in place prior to extraction Compliance with water extraction licence limits and conditions Ensure groundwater extraction is limited to the volumes required by the hydraulic fracture program (See water use estimates in Section 3.8). Bore numbers and estimated extraction volumes will be provided to DITT and DEPWS.	B.4.17 Groundwater monitoring	A	III	1	Yes	Type A Risk - Risks are well-understood. The regional understanding of the CLA is sufficient to understand the risks. Groundwater Monitoring has been undertaken and will continue.
Creation of dust	Smothering of flora	Terrestrial ecosystems	Vehicle and plant movements	F	II	3	Driving is only permitted on designated access roads. Speeds on unsealed roads will be limited to a maximum of 60 km/hr. Water trucks will be used, to manage dust emissions from vehicle movement associated with hydraulic fracture activities as appropriate.	A.3.1 Site Selection and Planning A.3.5 Biodiversity protection	B	I	1	Yes	Type A Risk - Risks are well-understood with established and proven management practices.
Creation of dust	Loss of amenity	Communities and economy	Vehicle and plant movements	F	I	2	Driving is only permitted on designated access roads. Speeds on unsealed roads will be limited to a maximum of 60 km/hr.	A.3.1 Site Selection and Planning A.3.4 Erosion and sediment control	A	I	1	Yes	Type A Risk - Risks are well-understood with established and proven management practices.

Risk Event	Potential Impact	Relevant Environmental Factor	Risk Source	Initial Risk Ranking*			Mitigation and Management Measures		Residual Risk Ranking*			Effective Controls	Uncertainty Ranking
				L	C	R	EMP Commitments	Relevant Code of Practice	L	C	R		
							Water trucks will be used, to manage dust emissions from vehicle movement associated with hydraulic fracture activities as appropriate.						
Creation of dust	Public ingesting dust	Human health	Vehicle and plant movements	D	II	2	Driving is only permitted on designated access. Speeds on unsealed roads will be limited to a maximum of 60 km/hr. Water trucks will be used, to manage dust emissions from vehicle movement and hydraulic fracture activities as appropriate.	A.3.1 Site Selection and Planning A.3.4 Erosion and sediment control	B	I	1	Yes	Type A Risk - Risks are well-understood with established and proven management practices.
Creation of atmospheric emissions	Reduction in air quality	Air quality and greenhouse gas	Vehicle and plant movements	C	II	2	Vehicles and fixed plant maintained as per maintenance schedule.	A.3.1 Site Selection and Planning	B	I	1	Yes	Type A Risk - Risks associated with diesel combustion are well known, both within Australia and Internationally. Methods for estimating emissions are available via the National Pollutant Inventory and NGERs.
Creation of atmospheric emissions	Reduction in air quality	Air quality and Atmospheric processes	Fugitive emissions	C	II	2	Wells to be constructed with cement isolation All cement slurries to be laboratory tested for ensure slurry is fit for purpose. Cement placement modelling conducted prior to the job including but not limited to casing standoff, anticipated job pressures and equivalent circulating densities A geohazard assessment was used to select the well locations to mitigating shallow gas hazards Baseline methane monitoring was completed by CSIRO prior to commencing stimulation as per the Code of Practice for Petroleum activities. Gas detection monitoring will be conducted during all phases of the hydraulic fracturing operations. All wells will be monitored every six months for any leaks Emissions will be reported in accordance with the NGERs. The Methane Emissions Management Plan (Appendix J) will be implemented	A.3.1 Site selection and planning D.4.1 Baseline Methane assessment D.5.9.4 Other fugitive emissions D.5.1 Methane Emissions management Plan	B	I	1	Yes	Type A Risk - Risks and impacts associated with fugitive emissions are well known. Emissions during petroleum activities are estimated using the NGERs estimation tools.

Risk Event	Potential Impact	Relevant Environmental Factor	Risk Source	Initial Risk Ranking*			Mitigation and Management Measures	Residual Risk Ranking*			Effective Controls	Uncertainty Ranking	
				L	C	R		L	C	R			
Creation of atmospheric emissions	Reduction in air quality	Air quality and Atmospheric processes	Production Testing flaring	F	II	3	Gas detection monitoring will be conducted during all phases of the flowback and production testing operations. All flaring will be measured using flow meters compliant with NGRS. Emissions will be reported in accordance with the NGRS. In accordance with Clause B.4.13.2(k) gas will be flared in the first instance, unless there is insufficient gas flow or there is a safety hazard The Methane Emissions Management Plan (Appendix J) will be implemented	D.5.9 Venting and Flaring D.4.1 Baseline Methane assessment D.4.3 Routine periodic atmospheric monitoring programme D.5.1 Methane Emissions management Plan	E	1	2	Yes	Type A Risk - Risks and impacts associated with flaring activities are well understood and proven management practices are established.
Noise and vibration from project activities	Disturbance to native fauna	Terrestrial ecosystems	Vehicle movements and hydraulic fracture activities	D	II	2	Engines/Machinery will be maintained as per planned maintenance systems. Engines/machinery will have noise suppression devices. Project activities will comply with the requirements of the Northern Territory Noise Management Framework Guideline.	A.3.1 Site selection and planning A.3.3 Noise	C	I	1	Yes	Type A Risk - Risks are well-understood with established and proven management practices.
Noise and vibration from project activities	Disturbance to landholders	Communities and economy	Vehicle movements and hydraulic fracture activities	D	II	2	Engines/Machinery will be maintained as per planned maintenance systems. Engines/machinery will have noise suppression devices. Wells are located >8 km from the Tanumbirini homestead. Hydraulic fracturing activity and majority of vehicle movements will be limited to daylight hours. Project activities will comply with the requirements of the Northern Territory Noise Management Framework Guideline.	A.3.1 Site selection and planning A.3.3 Noise	B	I	1	Yes	Type A Risk - Risks are well-understood with established and proven management practices. Land access agreements are in place and stakeholder engagement is ongoing.
Light from project activities	Disturbance to native fauna	Terrestrial ecosystems	Production Testing	F	2	3	Night time operations restricted (e.g. No HFS pumping will occur at night) Lighting required for well operations (e.g. wireline, slickline, coiled tubing, and production testing) may be limited to direct area immediately around the wellhead location. Lighting would be faced toward the wellhead and work areas to provide adequate lighting for safe operations, without excessive overspill.	D.5.9 Venting and Flaring D.4.1 Baseline Methane assessment D.4.3 Routine periodic atmospheric monitoring programme D.5.1 Emissions management Plan	C	1	1	Yes	Type A Risk - Risks are well-understood with established and proven management practices. Santos has extensive experience in managing disturbance to native fauna.

Risk Event	Potential Impact	Relevant Environmental Factor	Risk Source	Initial Risk Ranking*			Mitigation and Management Measures	Residual Risk Ranking*			Effective Controls	Uncertainty Ranking	
				L	C	R		L	C	R			
Light from project activities	Disturbance to native fauna	Terrestrial ecosystems	Vehicle movements and hydraulic fracture activities at night Lighting from camp.	F	I	2	Task focussed lighting will be used and all boundary lighting for the camp will be positioned to face inwards to provide adequate lighting for safe operations, without excessive overspill. Hydraulic fracturing activity and majority of vehicle movements will be limited to daylight hours. Lighting required for well operations (e.g. wireline, slickline, coiled tubing, and production testing) may be limited to direct area immediately around the wellhead location. Lighting would be faced toward the wellhead and work areas to provide adequate lighting for safe operations, without excessive overspill.	A.3.1 Site selection and planning 4.3.2 Well pad site selection requirements	B	I	1	Yes	Type A Risk - Risks are well-understood with established and proven management practices. Santos has extensive experience in managing disturbance to native fauna.
Light from project activities	Disturbance to landholders	Communities and economy	Vehicle movements and hydraulic fracture activities at night, Lighting from camp.	F	I	2	Task focussed lighting will be used and all boundary lighting will be positioned to face inwards to provide adequate lighting for safe operations, without excessive overspill. Wells are located >8 km from the Tanumbirini homestead.	A.3.1 Site selection and planning 4.3.2 Well pad site selection requirements	B	I	1	Yes	Type A Risk - Risks are well-understood with established and proven management practices. Land access agreements are in place.
Fauna interaction	Disturbance, injury or death to terrestrial fauna	Terrestrial ecosystems	Vehicle movements, hydraulic fracture activities, flaring and entrapment	E	I	2	Appropriate separation distances between flares and surrounding vegetation that provides fauna habitat Fauna ladders will be installed at all open pits. Driving is only permitted on designated access roads and seismic lines. Speeds on unsealed roads will be limited, with to a maximum of 60 km/hr. All tank pads are above ground, with steep sides, to prevent ease of animal entry. For produced water and flowback fluid treatment processes occurring outside of enclosed tanks, the minimum freeboard requirements detailed in the WWMP (1.5m for the wet season and 0.3m for the dry season) will be maintained in all tanks. In accordance with the Code flowback fluid will be transferred to enclosed / covered tanks at least 8 hours in advance of a forecast significant rainfall event. If monitoring shows the flowback fluid volume may exceed total storage capacity for enclosed tanks, flowback into tanks will cease. Options to manage flowback also include additional pond covers to increase the enclosed tank capacity, adding additional ponds with covers, and choking back well(s) to reduce flowback water rate. All HFS work tanks are enclosed.	A.3.5 Biodiversity protection A.3.8 Containment of contaminants	C	I	1	Yes	Type A Risk - Risks are well-understood with established and proven management practices (e.g. site roads are speed limited). Santos has extensive experience in managing fauna interactions and entrapment.

Risk Event	Potential Impact	Relevant Environmental Factor	Risk Source	Initial Risk Ranking*			Mitigation and Management Measures		Residual Risk Ranking*			Effective Controls	Uncertainty Ranking
				L	C	R	EMP Commitments	Relevant Code of Practice	L	C	R		
							<p>Daily Monthly checks of tank pads throughout the hydraulic fracturing program. Potential avian wildlife exposure to selected chemical additives and/or flowback assessed (See Appendix A)</p>						
Fauna interaction	Disturbance, injury or death to livestock	Communities and economy	Vehicle movements, hydraulic fracture activities, and entrapment.	E	I	2	<p>Relevant landowners and occupiers are notified prior to the commencement of the activity. All gates are left in the condition in which they were found (i.e. open / closed). When necessary, all fences are restored to satisfaction of landowner / managers. Speeds on unsealed roads will be limited to a maximum of 60 km/hr. Pits and dams will be fenced. Daily Monthly checks infrastructure throughout the hydraulic fracture program</p>	A.3.5 Biodiversity protection A.3.8 Containment of contaminants	C	I	1	Yes	Type A Risk - Risks are well-understood with established and proven management practices (e.g. site roads are speed limited).
Introduction of pest species	Loss of native vegetation through competition for resources	Terrestrial ecosystems	Plant and vehicles carrying weeds from outside the project area. Spread of weeds in project area through vehicle movements.	D	III	3	<p>A Weed Management Plan has been developed for the project (Appendix E). Mitigation measures described in the Weed Management Plan for the project will be implemented.</p>	A.3.6 Weed management A.5.3 Biodiversity protection	B	III	2	Yes	Type A Risk - Risks are well-understood with established and proven management practices. Baseline weed survey complete and DEPWS approved weed management plans in place.
Introduction of pest species	Loss of pasture species through competition for resources	Communities and economy	Plant and vehicles carrying weeds from outside the project area. Spread of weeds in project area through vehicle movements.	D	II	2	<p>A Weed Management Plan has been developed for the project (Appendix E). Mitigation measures described in the Weed Management Plan for the project will be implemented.</p>	A.3.6 Weed management	B	II	1	Yes	Type A Risk - Risks are well-understood with established and proven management practices. Baseline weed survey complete and DEPWS approved weed management plans in place.

Risk Event	Potential Impact	Relevant Environmental Factor	Risk Source	Initial Risk Ranking*			Mitigation and Management Measures	Residual Risk Ranking*	Effective Controls	Uncertainty Ranking			
				L	C	R							
Fire	Disturbance or death to terrestrial fauna, loss of terrestrial flora	Terrestrial ecosystems	Ignition sources from plant and machinery Inappropriate disposal of cigarettes.	C	III	2	<p>Implementation of Fire Management Plan (Section 7.2). Unplanned fires caused by Santo's activities recorded. Fire extinguishers available at location and trained personnel are on site during stimulation, flowback and testing activities. All vehicles will be equipped with portable fire extinguishers. Machinery and vehicles should be parked in areas of low fire risk. Any petrol motor vehicles or petrol-powered pumps will be fitted with spark arresters. All vehicles will be equipped with operational VHF and / or UHF radio transceivers. Smoking will only be permitted in areas clear of vegetation, and there will be no disposal of butts to land. All personnel will receive information prior to the commencement of the activity relating to:</p> <ul style="list-style-type: none"> • Provisions of the Emergency Response Plan including procedures during a fire emergency • The operation of firefighting equipment and communications • Restricted smoking requirements <p>meetings will be conducted to:</p> <ul style="list-style-type: none"> • Alert the workforce of the fire risk level for the day • Discuss any fire risk management breaches and remedial actions 	A.3.7 Fire management	B	II	1	Yes	Type A Risk - Risks associated with bushfire are well known, with numerous literature and NT Government mapping and management plans in place.
Fire	Disturbance or death to terrestrial fauna, loss of terrestrial flora	Terrestrial ecosystems	Production testing, flaring	C	III	2	<p>Implementation of Fire Management Plan (Section 7.2). Firebreaks to be implemented around the lease with minimum setbacks to infrastructure based on flaring design. Flares will be located with at least 30m from vegetation to ensure safe operations during fire danger periods. The fire protection zone surrounding the lease pad and flare will be devoid of trees. Flares and flare stacks must be designed, prepared and operated in accordance with industry standards: ANSI B31.3, NACE MR-01-075, API 521, API 537. All flare pits and flare stacks must be positioned as per hazardous area classification. Flaring to have an appropriate buffer, with proper barriers to prevent access by wildlife.</p>	D.5.9 Venting and Flaring D.4.1 Baseline Methane assessment D.5.1 Emissions management Plan	B	II	1	Yes	Type A Risk - Risks associated with bushfire are well known, with numerous literature and NT Government mapping and management plans in place.

Risk Event	Potential Impact	Relevant Environmental Factor	Risk Source	Initial Risk Ranking*			Mitigation and Management Measures		Residual Risk Ranking*			Effective Controls	Uncertainty Ranking
				L	C	R	EMP Commitments	Relevant Code of Practice	L	C	R		
							The vertical flare stack will be monitored during flaring. Implementation of the Emergency Response Plan.						
Fire	Injury or death to livestock, loss of pasture, dwellings and infrastructure	Communities and economy	Ignition sources from plant and machinery) Inappropriate disposal of cigarettes.	C	III	2	Implementation of Fire Management Plan (Section 7.2). Fire-fighting equipment and competent fire-fighting personnel will be available during stimulation, flowback and testing activities. All vehicles will be equipped with portable fire extinguishers. Machinery and vehicles should be parked in areas of low fire risk and be free of any combustible material. Alert neighbouring landholders in the event of a fire originating from Santos' activities. Any petrol motor vehicles or petrol-powered pumps will be fitted with spark arresters. All vehicles will be equipped with operational VHF and / or UHF radio transceivers. Smoking will only be permitted in areas clear of vegetation, and there will be proper disposal of butts. All personnel will receive information prior to the commencement of the activity relating to: • Provisions of the Emergency Response Plan including procedures during a fire emergency • The operation of firefighting equipment and communications • Restricted smoking requirements meetings will be conducted to: • Alert the workforce of the fire risk level for the day • Discuss any fire risk management breaches and remedial actions.	A.3.7 Fire management	B	II	1	Yes	Type A Risk - Risks associated with bushfire are well known, with numerous literature and NT Government mapping and management plans in place.
Fire	Injury or death to livestock, loss of pasture, dwellings and infrastructure	Communities and economy	Production testing, flaring	C	III	2	Implementation of Fire Management Plan (Section 7.2). Firebreaks to be implemented around the lease with minimum setbacks to infrastructure based on flaring design. Flares will be located with at least 30m from vegetation to ensure safe operations during fire danger periods. Alert neighbouring landholders in the event of a fire originating from Santos' activities. The fire protection zone surrounding the lease pad and flare will be devoid of trees.	A.3.7 Fire management D.5.9 Venting and Flaring	B	II	1	Yes	Type A Risk - Risks associated with bushfire are well known, with numerous literature and NT Government mapping and management plans in place.

Risk Event	Potential Impact	Relevant Environmental Factor	Risk Source	Initial Risk Ranking*			Mitigation and Management Measures		Residual Risk Ranking*			Effective Controls	Uncertainty Ranking
				L	C	R	EMP Commitments	Relevant Code of Practice	L	C	R		
							Flares and flare stacks must be designed, prepared and operated in accordance with industry standards: ANSI B31.3, NACE MR-01-075, API 521, API 537. All flare pits and flare stacks must be positioned as per hazardous area classification. Flaring to have an appropriate buffer, with proper barriers to prevent access by livestock. The vertical flare stack will be monitored during flaring. Implementation of the Emergency Response Plan.						
Disturbance to landholder/public	Disturbance to landholders activities	Communities and economy	Vehicle and plant movements throughout the project area	D	II	2	Relevant landowners and occupiers are notified prior to activity of preparation of camp sites and undertaking of operations. Unplanned fires caused by Santo's activities recorded. Inductions for all employees and contractors cover pastoral, conservation, legislation and infrastructure issues. System is in place for logging public/landholder complaints to ensure that issues are addressed. Damage to station tracks and fences is reported and restored to satisfaction of landowner / managers. All gates are left in the condition in which they were found (i.e. open / closed). Speeds on unsealed roads will be limited to a maximum of 60 km/hr.	A.3.1 Site selection and planning 4.3.2 Well pad site selection requirements	B	I	1	Yes	Type A Risk - Risks are well-understood with established and proven management practices. Land access agreements are in place and stakeholder engagement is ongoing.

Risk Event	Potential Impact	Relevant Environmental Factor	Risk Source	Initial Risk Ranking*			Mitigation and Management Measures	Residual Risk Ranking*			Effective Controls	Uncertainty Ranking	
				L	C	R		L	C	R			
Chemical spills and leaks associated with chemical and fuel storage and handling	Localised contamination of soil	Terrestrial Environmental Quality	Inappropriate storage or handling of hazardous substances, including stimulation fluid and flowback fluid wastewater. Poor refuelling or fuel transfer practices	D	III	3	<p>Implementation of the Wastewater Management Plan (Appendix G).</p> <p>Implementation of the Spill Management Plan (Appendix H).</p> <p>In accordance with the Code flowback fluid will be transferred to enclosed / covered tanks at least 8 hours in advance of a forecast significant rainfall event.</p> <p>If monitoring shows the flowback fluid volume may exceed total storage capacity for enclosed tanks, flowback into tanks will cease. Options to manage flowback also include additional pond covers to increase the enclosed tank capacity, adding additional ponds with covers, and choking back well(s) to reduce flowback water rate.</p> <p>All HFS work tanks are enclosed.</p> <p>Bunded containment for storage of liquid hydraulic fracturing materials.</p> <p>Spill containment for storage of liquid hydraulic fracture chemicals</p> <p>Spill management kits located onsite for response to any small scale spills</p> <p>Use of drip trays for transfers.</p> <p>Remediation to commence immediately after spills, recorded in the Santos Incident Management System and reported to DEPWS when required.</p> <p>Fuel and other lubricants will be appropriately stored and managed, in accordance with industry standards.</p> <p>Pre-spud checks / Pre-job checks when transferring fluids</p> <p>Appropriate bunding in use for storage of chemicals and where required adherence to standards</p> <p>Hydraulic fracture fluid system mixed into small volumes as needed, contained and monitored in engineered fluid storage tanks.</p> <p>A multi-well WOMP has been developed to cover well activities. The multi-well HFS event will not commence until the multi-pad WOMP has been approved. Comprehensive spill modelling has been conducted (Attachment B, Appendix A). Chemical Risk Assessment of all chemical used in the proposed HFS (Appendix A).</p>	A.3.8 Containment of contaminants B.4.16 Site material and fluid management C.4.2 Management of Produced water and Flowback Fluid C.7.2 Spill management plan	B	III	2	Yes	Type A Risk - Risks are well-understood with established and proven management practices. Comprehensive spill modelling completed. Santos has extensive experience in conventional and unconventional petroleum wells in the NT and across Australia and this experience includes managing storage and handling of hazardous substances.
Chemical spills and leaks associated	Reduction in surface and groundwater water quality	Inland Water Environmental Quality	Inappropriate storage or handling of hazardous	D	III	3	<p>Implementation of the Wastewater Management Plan (Appendix G).</p> <p>Implementation of the Spill Management Plan (Appendix H).</p>	A.3.8 Containment of contaminants B.4.16 Site material and fluid management	B	II	2	Yes	Type A Risk - Risks are well-understood with established and proven management practices. Comprehensive

Risk Event	Potential Impact	Relevant Environmental Factor	Risk Source	Initial Risk Ranking*			Mitigation and Management Measures		Residual Risk Ranking*			Effective Controls	Uncertainty Ranking
				L	C	R	EMP Commitments	Relevant Code of Practice	L	C	R		
with chemical and fuel storage and handling			substances, including stimulation fluid and flowback fluid wastewater. Poor refuelling or fuel transfer practices				<p>For produced water and flowback fluid treatment processes occurring outside of enclosed tanks, the minimum freeboard requirements detailed in the WWMP (1.5m for the wet season and 0.3m for the dry season) will be maintained in all tanks. In accordance with the Code flowback fluid will be transferred to enclosed / covered tanks at least 8 hours in advance of a forecast significant rainfall event.</p> <p>All HFS fluid tanks for make-up fluid are enclosed. Installation of pressure control equipment systems. Bunded containment for storage of hydraulic fluid. Spill containment for storage of liquid hydraulic fracture chemicals.</p> <p>Spill management kits located onsite for response to any small scale spills.</p> <p>Use of drip trays for transfers.</p> <p>Remediation to commence immediately after spills, recorded in the Santos Incident Management System and reported to DEPWS when required.</p> <p>Fuel and other lubricants will be appropriately stored and managed, in accordance with industry standards. Appropriate bunding in use for storage of chemicals and flowback fluid and where required adherence to standards.</p> <p>Hydraulic fracture fluid system mixed into small volumes as needed, contained and monitored in engineered fluid storage tanks.</p> <p>There is only one mix tank used during fracturing operations, and this tank is instrumented with tank levels and constantly supervised. There are work tanks with fresh water that do not have tank levels, but have constant supervision by personnel during fracturing operations.</p> <p>Freeboard design of engineered storage tanks allows for ease of control of flowback fluids without risk of overfilling.</p> <p>Comprehensive spill modelling has been conducted (Attachment B, Appendix A).</p> <p>Chemical Risk Assessment of all chemical used in the proposed HFS (Appendix A).</p>	C.3 Well site water management C.4.2 Management of Produced water and Flowback Fluid C.7.2 Spill management plan				WOMP developed and approved before activity commences Comprehensive WOMP developed and approved before activity commences Santos has extensive experience in conventional and unconventional petroleum wells in the NT and across Australia. Control and monitoring bores as per Preliminary Guidelines: Groundwater Monitoring bores for Exploration Petroleum Wells in the Beetaloo Sub-Basin	

Risk Event	Potential Impact	Relevant Environmental Factor	Risk Source	Initial Risk Ranking*			Mitigation and Management Measures	Residual Risk Ranking*			Effective Controls	Uncertainty Ranking	
				L	C	R		L	C	R			
Loss of stimulation fluid, flowback fluid recovery from a multi-well pad operation	Reduction in surface and groundwater water quality	Inland Water Environmental Quality	Insufficient isolation between wells in target formation at a multi-well pad operation. Poor well design.	C	III	2	<p>Design requirements for a multi-well pad will be approved in the WOMP</p> <p>A geohazard assessment has been performed to mitigate for subsurface hazards such as abnormal pressure zones, shallow gas, lost circulation and potential zones of instability.</p> <p>Hydraulic fracture diagnostics including pressure and ground motion accelerometer monitoring is used to determine the spatial extent and orientation of the induced fracture.</p> <p>Distance of target shale formation (Velkerri formation) from nearest high quality aquifer (Cambrian Limestone aquifer) is over 2000 m.</p> <p>Code of Practice: Onshore Petroleum Activities (the code) will be implemented.</p> <p>The code includes requirements for well operations and wastewater management.</p> <p>Chemical Risk Assessment of all chemicals used in the proposed HFS (Appendix A)</p> <p>A multi-well WOMP has been developed to cover well activities. The multi-well HFS event will not commence until the multi-pad WOMP has been approved. Implementation of the Wastewater Management Plan (Appendix G). Implementation of the Spill Management Plan (Appendix H).</p>	<p>B.4.1 Well Integrity management B.4.2 Aquifer protection B.4.3 Well design and well barriers B.4.6 Casing and tubing B.4.7 Primary cementing B.4.9 Well control B.4.13 Hydraulic stimulation and flowback operations B.4.17 Groundwater monitoring C.4.2 Management of Produced water and Flowback Fluid C.7.2 Spill management plan</p>	B	II	2	Yes	Type A Risk - Risks are well-understood with established and proven management practices. Comprehensive WOMP developed and approved before activity commences Santos has extensive experience in conventional and unconventional petroleum wells in the NT and across Australia Control and monitoring bores as per Preliminary Guidelines: Groundwater Monitoring bores for Exploration Petroleum Wells in the Beetaloo Sub-Basin

Risk Event	Potential Impact	Relevant Environmental Factor	Risk Source	Initial Risk Ranking*			Mitigation and Management Measures		Residual Risk Ranking*			Effective Controls	Uncertainty Ranking
				L	C	R	EMP Commitments	Relevant Code of Practice	L	C	R		
Loss of stimulation fluid, flowback fluid recovery	Reduction in groundwater and surface water quality	Inland Water Environmental Quality	Cross-flow during hydraulic fracture stimulation, Faults or major structures enables crossflow.	C	IV	3	<p>Installation of pressure control equipment systems. A geohazard assessment has been performed to mitigate for subsurface hazards such as abnormal pressure zones, shallow gas, lost circulation and potential zones of instability.</p> <p>Hydraulic fracture diagnostics including pressure and ground motion accelerometer monitoring is used to determine the spatial extent and orientation of the induced fracture.</p> <p>Distance of target shale formation from nearest aquifer of use is over 2000 m.</p> <p>Locating of wells off-structures using seismic data for control.</p> <p>Wells are located away from major faults and structures based on seismic data control; further seismic data acquisition planned where "dip" and "strike" line control is not available.</p> <p>Ground water monitoring bores installed on location prior to hydraulic fracture operations.</p> <p>Baseline monitoring conducted six months prior to and post hydraulic fracture operations.</p> <p>Shallow aquifers isolated behind cemented concentric casing strings.</p> <p>Cemented casing, following the Code of Practice requirements, will prevent aquifer cross-flow once well is constructed and passes well acceptance criteria. Specifically the casing is designed to:</p> <ul style="list-style-type: none"> • Maintain hole stability and withstand all planned life cycle well loading conditions without loss of well integrity • Ensure the establishment of the well barriers required at various stages of the well life. • Ensure equivalent circulating density in the next hole section does not exceed the fracture propagation pressure while maintaining the required static overbalance. • Ensure the formation strength at the previous casing shoe or at a deeper zone will not be exceeded whilst circulating out a gas influx taken from the bottom of the open hole with the anticipated fluid weight and 0.5 ppg (60 g/l) kick intensity over prognoses formation pressure. <p>Code of Practice: Onshore Petroleum Activities (the code) will be implemented. The code includes requirements for well operations and wastewater management.</p>	<p>B.4.1 Well Integrity management B.4.2 Aquifer protection B.4.3 Well design and well barriers B.4.6 Casing and tubing B.4.7 Primary cementing B.4.9 Well control B.4.13 Hydraulic stimulation and flowback operations B.4.17 Groundwater monitoring C.4.2 Management of Produced water and Flowback Fluid C.7.2 Spill management plan</p>	B	II	2	Yes	Type A Risk - Risks are well known and have been extensively assessed through the Scientific Inquiry into Hydraulic Fracturing in the Northern Territory (2018) Final Report. In addition the CSIRO regional baseline monitoring program is underway and the knowledge of the regional aquifers is well established. Comprehensive WOMP developed and approved before activity commences Santos has extensive experience in conventional and unconventional petroleum wells in the NT and across Australia. Control and monitoring bores as per Preliminary Guidelines: Groundwater Monitoring bores for Exploration Petroleum Wells in the Beetaloo Sub-Basin

Risk Event	Potential Impact	Relevant Environmental Factor	Risk Source	Initial Risk Ranking*			Mitigation and Management Measures		Residual Risk Ranking*			Effective Controls	Uncertainty Ranking
				L	C	R	EMP Commitments	Relevant Code of Practice	L	C	R		
							Chemical Risk Assessment of all chemical used in the proposed HFS (Appendix A) A multi-well WOMP has been developed to cover well activities. The multi-well HFS event will not commence until the multi-pad WOMP has been approved.						

Risk Event	Potential Impact	Relevant Environmental Factor	Risk Source	Initial Risk Ranking*			Mitigation and Management Measures		Residual Risk Ranking*			Effective Controls	Uncertainty Ranking
				L	C	R	EMP Commitments	Relevant Code of Practice	L	C	R		
Loss of stimulation fluid, flowback fluid recovery	Impacts to groundwater dependant ecosystems	Terrestrial ecosystems	Cross-flow during hydraulic fracture stimulation, Faults or major structures enables crossflow.	C	IV	3	<p>Installation of pressure control equipment systems. A geohazard assessment has been performed to mitigate for subsurface hazards such abnormal pressure zones, shallow gas, lost circulation and potential zones of instability.</p> <p>Hydraulic fracture diagnostics including pressure and ground motion accelerometer monitoring is used to determine the spatial extent and orientation of the induced fracture.</p> <p>Distance of target shale formation from nearest aquifer of use is over 2000 m.</p> <p>Locating wells off-structures using seismic data for control.</p> <p>Wells are located away from major faults and structures based on seismic data control; further seismic data acquisition planned where "dip" and "strike" line control is not available.</p> <p>Ground water monitoring bores installed on location prior to hydraulic fracture operations.</p> <p>Baseline monitoring conducted six months prior to hydraulic fracture operations.</p> <p>Shallow aquifers isolated behind cemented concentric casing strings.</p> <p>Cemented casing, following the Code of Practice requirements, will prevent aquifer cross-flow once well is constructed and passes well acceptance criteria.</p> <p>Code of Practice: Onshore Petroleum Activities (the code) will be implemented.</p> <p>The code includes requirements for well operations and wastewater management.</p> <p>Chemical Risk Assessment of all chemical used in the proposed HFS (Appendix A)</p> <p>A multi-well WOMP has been developed to cover well activities. The multi-well HFS event will not commence until the multi-pad WOMP has been approved.</p>	<p>B.4.1 Well Integrity management B.4.2 Aquifer protection B.4.3 Well design and well barriers B.4.6 Casing and tubing B.4.7 Primary cementing B.4.9 Well control B.4.13 Hydraulic stimulation and flowback operations B.4.17 Groundwater monitoring C.4.2 Management of Produced water and Flowback Fluid C.7.2 Spill management plan</p>	B	II	2	Yes	Type A Risk - Risks are well known and have been extensively assessed through the Scientific Inquiry into Hydraulic Fracturing in the Northern Territory (2018) Final Report. In addition the CSIRO regional baseline monitoring program is underway and the knowledge of the regional aquifers is well established. Chemical risk assessment and ecotox assessment conducted Santos has extensive experience in conventional and unconventional petroleum wells in the NT and across Australia. Control and monitoring bores as per Preliminary Guidelines: Groundwater Monitoring bores for Exploration Petroleum Wells in the Beetaloo Sub-Basin

Risk Event	Potential Impact	Relevant Environmental Factor	Risk Source	Initial Risk Ranking*			Mitigation and Management Measures	Residual Risk Ranking*			Effective Controls	Uncertainty Ranking	
				L	C	R		L	C	R			
Transport of chemicals and wastewater on unsealed roads during the wet season	Localised contamination of soil	Terrestrial environmental quality	Transport vehicle accident due to weather Transport vehicle stuck due to mechanical or weather events	C	III	2	A risk assessment of road conditions for heavy vehicle transport will be conducted prior to mobilisation on unsealed roads using detailed weather forecasting. Road conditions for heavy vehicle transport will be assessed prior to mobilisation on unsealed roads. If the conditions are assessed to be unsuitable for heavy vehicle transport, there will be no transport of chemicals or wastewater. In the event of a truck being stuck due to mechanical or weather reason, transfer or recovery will only occur once safe and the risk of spills are ALARP. Only licenced waste transporters to be used to transport listed wastes. The proposed activity has a Land Access and Compensation Agreement in place with the landholder which includes "make good" provisions in the event of damage to roads and other infrastructure on the property as a result of the activity.	A.3.8 Containment of contaminants C.7.2 Spill management plan	A	II	1	Yes	Type A Risk - Risks are well-understood with established management practices. Rainfall data and the use of enclosed tanks for transport.
Transport of chemicals and wastewater on unsealed roads during the wet season	Reduction in surface and groundwater water quality	Inland Water Environmental Quality	Transport vehicle accident due to weather Transport vehicle stuck due to mechanical or weather events	C	2	2	A risk assessment of road conditions for heavy vehicle transport will be conducted prior to mobilisation on unsealed roads using detailed weather forecasting. Road conditions for heavy vehicle transport will be assessed prior to mobilisation on unsealed roads. If the conditions are assessed to be unsuitable for heavy vehicle transport, there will be no transport of chemicals or wastewater. In the event of a truck being stuck due to mechanical or weather reason, transfer or recovery will only occur once safe and the risk of spills are ALARP. Only licenced waste transporters to be used to transport listed wastes. The proposed activity has a Land Access and Compensation Agreement in place with the landholder which includes "make good" provisions in the event of damage to roads and other infrastructure on the property as a result of the activity.	A.3.8 Containment of contaminants C.7.2 Spill management plan	A	2	1	Yes	Type A Risk - Risks are well-understood with established management practices. Rainfall data and the use of enclosed tanks for transport.
Waste	Fauna attracted to waste	Terrestrial ecosystems	Waste stored inappropriately attracting native fauna	F	II	2	Waste will be segregated and stored on site and all putrescible waste material will be held in fauna proof containers. Only waste from approved wastewater systems and grey water will be disposed of to land. Licenced waste contractor will be used for any offsite transfer or disposal.	C.7.1 Wastewater management plan	B	I	1	Yes	Type A Risk - Risks are well-understood with established and proven management practices. Santos has extensive experience in managing wastes to avoid attracting native fauna.

Risk Event	Potential Impact	Relevant Environmental Factor	Risk Source	Initial Risk Ranking*			Mitigation and Management Measures	Residual Risk Ranking*			Effective Controls	Uncertainty Ranking	
				L	C	R		L	C	R			
Waste	Reduction in surface water and groundwater quality	Inland Water Environmental Quality	Overflow of fluid storage tanks Leaks and Leaching from storage tanks Flowline failure	D	IV	4	<p>Implementation of the Wastewater Management Plan (Appendix G). Implementation of the Spill Management Plan (Appendix H). Daily monitoring of weather and for predicted significant rainfall events will be undertaken. For produced water and flowback fluid treatment processes occurring outside of enclosed tanks, the minimum freeboard requirements detailed in the WWMP (1.5m for the wet season and 0.3m for the dry season) will be maintained in all tanks. All produced water and flowback fluid must be held in above-ground tanks at all times Stored volume and available freeboard for all produced water and flowback fluid storage facilities must be monitored at least weekly Flowback fluid tank levels and flowlines will be monitored during and after significant rainfall events. Flowback fluid tanks and will be appropriately designed and constructed with an impermeable containment barrier. Flowback fluid tank design includes, double lined tanks, leak detection systems, Tank pad will be bunded Bunded tank pad will accommodate the volume of the largest tank Tank storage volumes monitored for loss of containment, alarm system will be connected via telemetry.</p>	A.3.8 Containment of contaminants B.4.16 Site material and fluids management C.4.2 Management of produced water and flowback fluid C.7.2 Spill management plan C.7.1 Wastewater management plan	B	III	2	Yes	Type A Risk - Risks are well known and have been extensively assessed through the Scientific Inquiry into Hydraulic Fracturing in the Northern Territory (2018) Final Report. Comprehensive spill modelling completed. Chemical risk assessment and ecotox assessment conducted Santos has extensive experience in conventional and unconventional petroleum wells in the NT and across Australia including the management of fluids.
Waste	Impact to soil quality	Terrestrial Environmental Quality	Overflow of fluid storage tanks Leaks and Leaching from storage tanks Flowline failure	D	III	2	<p>Storage tanks are designed and operated to prevent overtopping due to rainfall and designed with enough freeboard to accommodate total rainfall anticipated. Wastewater management contractor is required to have a Journey Management Plan All wastes to be transported in accordance with the NT Waste Management and Pollution Control Act All dangerous goods to be transported in accordance with the NT Dangerous Goods Act and Australian Dangerous Goods Code. Code of Practice: Onshore Petroleum Activities (the code) will be implemented. The code includes requirements for well operations and wastewater management. Implementation of an approved Spill Management Plan and Wastewater Management Plan, as defined by the code.</p>	C.6.1 Water and Wastewater tracking and reporting C.7.2 Spill management plan	B	II	2	Yes	Type A Risk - Risks are well known and have been extensively assessed through the Scientific Inquiry into Hydraulic Fracturing in the Northern Territory (2018) Final Report. Comprehensive spill modelling completed. Chemical risk assessment and ecotox assessment conducted Santos has extensive experience in conventional and unconventional petroleum wells in the NT and across Australia including the management of fluids.

Risk Event	Potential Impact	Relevant Environmental Factor	Risk Source	Initial Risk Ranking*			Mitigation and Management Measures		Residual Risk Ranking*			Effective Controls	Uncertainty Ranking
				L	C	R	EMP Commitments	Relevant Code of Practice	L	C	R		
							A multi-well WOMP has been developed to cover well activities. The multi-well HFS event will not commence until the multi-pad WOMP has been approved.						

Table Error! No text of specified style in document.-1 Environmental Monitoring

Monitoring program	Description	Frequency
Induction Monitoring	Ensure induction records are kept to demonstrate what was covered in the induction and who was inducted	Following any site induction
Baseline soil monitoring	An assessment of physical properties of representative baseline soils at each well site will be conducted in accordance with the code.	Prior to establishing the well site
Daily Inspection Checklist	<p>Daily Inspection during operations includes:</p> <ul style="list-style-type: none"> • Daily checks, using camera via telemetry or visual inspection, of storage tanks / ponds integrity • Real time monitoring of conditions during HFS operations including gas detection monitoring. • Daily monitoring of weather and for predicted significant rainfall events will be undertaken • Daily checks of freeboard, using camera via telemetry or visual inspection. • Monitoring freeboard during and after rainfall events, using camera via telemetry or visual inspection. • Inspection of fences, excavations, pits, storages for entrapped fauna and fauna and to ensure escapes are intact. Daily checklist, using camera via telemetry or visual inspection, for fauna escapes intact. • Monthly checklist shows inspection of pits and storages for entrapped fauna. • Inspection of all domestic waste receptacles to ensure they have lids secured. 	Daily During operations
Flowback Fluid Monitoring	The fluid levels in tanks containing flowback fluids will be monitored to calculate the stored volume.	Daily During operations
Weather monitoring	Monitoring of weather and for predicted significant rainfall events will be undertaken. The Bureau of Meteorology have been engaged to provide rapid and accurate notifications in of a significant rainfall event	Daily During operations
Weed Monitoring	A post wet-season weed survey will be conducted of both lease pads and access tracks. All weed monitoring and survey activities will be recorded in accordance with the <i>NT Weed Data Collection Guidelines</i>	Annual to coincide with the end of the wet season
Groundwater Monitoring	Detect changes in groundwater as a result of drilling and stimulation activities. Monitoring will be done in accordance with Government guidelines for groundwater monitoring for petroleum operations such as <i>Preliminary Guideline: Groundwater Monitoring Bores for Exploration Petroleum Wells in the Beetaloo Sub-basin.</i>	Ongoing For control monitoring bores - 6 months prior to drilling, and

Monitoring program	Description	Frequency
		preferably to include both wet season and dry season samples
	Volume of water that is abstracted from the water bore will be measured using flowmeter. This will be recorded weekly during bore operations	Ongoing
	Fluid levels in storages containing abstracted groundwater will be monitored to provide a measure of the stored quantity of water.	Monthly Daily during operations
Rehabilitation Monitoring	Photo points established and revisited as part of the civils scope.	Photo points established and revisited.
Operational Fire Monitoring	Whenever personnel are onsite, Onsite Company Representative is responsible for monitoring for bushfire alerts (primarily via the https://secure.nt.gov.au/alerts and https://www.bushfires.nt.gov.au/incidentmap/ websites and notifying all site personnel of the risks of fire. Communication of these alerts will via the daily toolbox meetings conducted during operations whenever personnel are onsite.	Daily During operations
Fire Fuel Load Monitoring	Vegetation removal requirements will be assessed during the post wet weed survey when vegetation growth will be greatest. If required, slashing / grading will occur to remove well site vegetation.	Annual to coincide with the end of the wet season done in conjunction with the weed survey