BEETALOO SUB-BASIN BEETALOO W-1

Environment Management Plan

Exploration Permit 117

Review record

Rev	Date	Reason for issue	Author	Reviewer	Approver
0	02/07/2021	EMP submission	M.Kernke	R Ully	A. Cote
1	14/07/2021	Minor updates to respond to prolongment comments			M. Kernke
1.1	25/08/2021	Minor updates to respond to regulation 10 notification	R.Ully		M.Kernke

Executive Summary

Origin Energy B2 Pty Ltd (Origin) is a registered holder and the operator of exploration permit (EP) 117, which is located in the Beetaloo Sub-basin (Figure 1). This Environment Management Plan (EMP) forms the basis of Origin's application to the Northern Territory (NT) Minister for Environment to cover the forward exploration program proposed for the existing Beetaloo W exploration site for the 2021–2026 period.

The Beetaloo W site is an existing site located on the Beetaloo pastoral station within EP117 (Figure 2). Targeting the Velkerri and Kyalla formations, the Beetaloo W-1 exploration well was drilled in September 2016. The exploration well successfully proved the lateral continuity of both the Velkerri and Kyalla shales over the Beetaloo Sub-basin. The Beetaloo W-1 exploration well has been suspended since this time, awaiting further regional exploration results prior to determining the future of the exploration well.

The key outcomes from the forward proposed regulated activities will be used to manage the existing Beetaloo W site and associated Beetaloo W-1 exploration well in a safe, stable and non-polluting manner. Data collected through the proposed programs will be used to understand the technical and commercial viability of the Velkerri dry and Kyalla wet gas shale resource by evaluate the geo-mechanical and reservoir properties of the Velkerri and Kyalla shales through a Diagnostic Fracture Injection Test (DFIT).

The proposed regulated activities covered in this EMP are detailed in Table 1 and can be summarised as:

- Civil maintenance of Beetaloo W site including erosion and sediment controls (ESC) on the access tracks, gravel pits, lease pad and access tracks
- Sub-surface data collection, including execution of a DFIT on the Velkerri and Kyalla shale members
- Extended pressure monitoring from the Beetaloo W-1 well
- Operation of a temporary camp, offices and equipment storage areas
- Routine reservoir data acquisition using reservoir evaluation tools (and other data collection methods)
- Maintenance and monitoring of infrastructure on the Beetaloo W site, including well interventions, work overs, completion and general well maintenance and diagnostic activities
- Suspension and/or abandonment of the Beetaloo W-1 exploration well
- Rehabilitation of the site upon completion of exploration activities.

The EMP has been prepared in compliance with the NT Petroleum (Environment) Regulations 2016, the Code of Practice and the Exploration Agreements between Origin, Native Title holders and the Northern Land Council (NLC).

The overall objective of the EMP is to ensure that the proposed activities, are carried out in a manner by which the environmental impacts and risks will be reduced to a level that is as low as reasonably practicable and are acceptable.

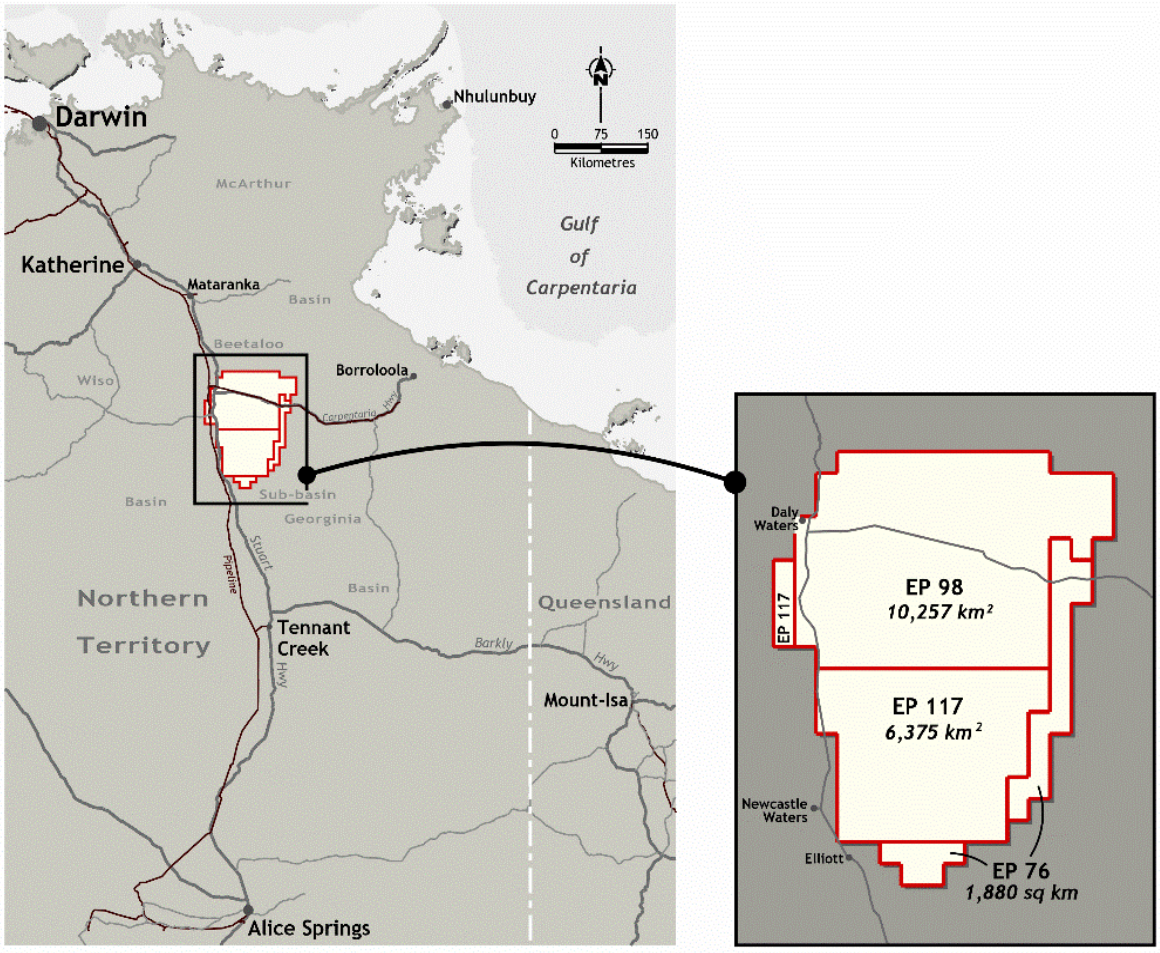

Figure 1: Location of Origin permit area

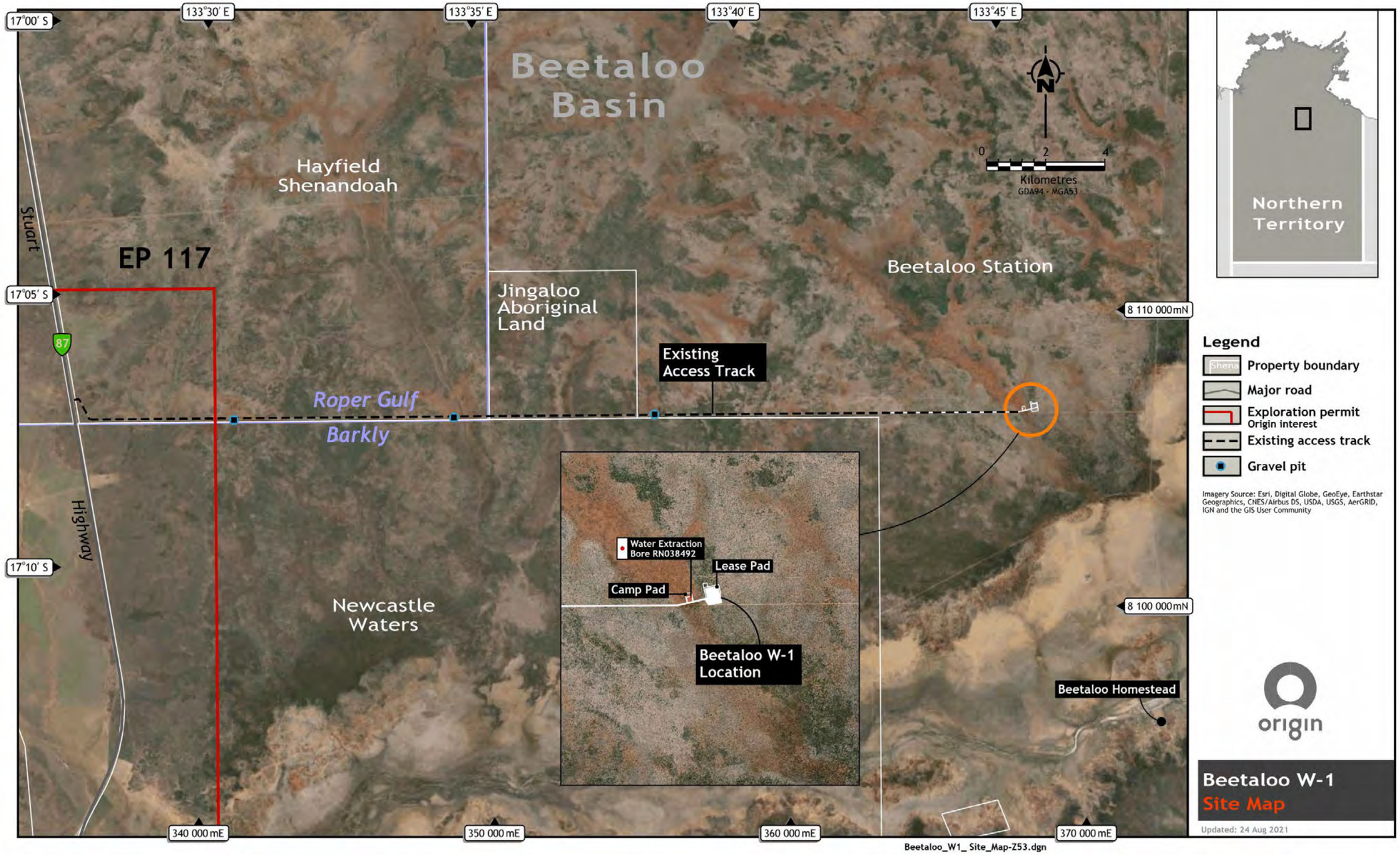

Figure 2: Location of the Beetaloo W-1 well and proposed regulated activities on Beetaloo W site

Table 1: Description of the exploration and appraisal activities

Component	Existing Beetaloo W-1	Revised EMP scope
General		
Number of E&A wells	1 existing exploration well: Beetaloo W-1	No change—no drilling proposed
Number of stimulations	N/A the Beetaloo W-1 exploration well has not been stimulated	N/A no stimulations proposed
Number of water extraction/monitoring bores	1 existing bore RN 038492	An additional 6 bores may be installed to comply with the Code of Practice requirements.
Number of gravel pits	3 existing	3 existing
Operational workforce	N/A site suspended	~<20 people during site operations where required
Main camp capacity	N/A no camp located at site	~20 people—existing camp pad to be utilized where required
Disturbance		
AAPA certificate	All works covered under C2020/003	
Total area of disturbance	5.85 ha (3 ha lease pad, 1.1 ha camp pad, 0.5 ha access track and 1.25ha gravel pits)	No change to total disturbance values—existing lease pad, camp pad, gravel pits and access tracks to be utilised
Traffic		
Peak traffic movements (per day)	N/A site suspended	<10 vehicles per day peak during mobilisation and demobilisation. Likely to be restricted to several days over a 1-2 week period per year
Average traffic movements during operations	N/A site suspended	1 light vehicle per fortnight
Water use and stormwater management		
Groundwater extraction license	N/A all take previously authorized under the *NT Petroleum Act*	All take covered under existing WEL GRF 10285
Estimated groundwater usage	N/A	~<1ML
Stormwater retention basin	N/A	N/A

Component	Existing Beetaloo W-1	Revised EMP scope
Wastewater management		
Wastewater generation	N/A	No material volumes of wastewater anticipated to be generated. Any incidental wastewater will be managed in accordance with the Code of Practice as discussed in section 3.14.
Greenhouse gasses and emissions		
Flares	N/A site suspended	N/A no flaring or venting proposed
tCO_2-e emissions	N/A	46 tCO_2^e

The proposed activities will occur within the subject land area which has been approved by the Native Title Holders and the Northern Land Council (NLC) and covered by AAPA Certificate C2020/003.

Description of the existing environment

The Beetaloo W site is located on the Beetaloo Station, which is subject to pastoral land use. A Land Condition Assessment was completed in 2014, and again in 2018, to review the physical, natural and cultural heritage environment of the existing Beetaloo W site. A summary of the existing environment in which the existing lease pad is located is provided in Table 2.

The existing Beetaloo W disturbance footprint including lease pad, camp pad and gravel pit is approximately 5.85 ha, as shown in Figure 2, Figure 3 and Table 5. The Beetaloo W-1 well is located on the existing Beetaloo W lease pad, which was constructed in 2015 to enable exploration activities.

The Beetaloo W site is located within open Eucalypt woodland with dense grass and shrub (Acacia) cover. This vegetation type is widespread in the tropical savannas of the Northern Territory and may provide habitat for some threatened species such as the Gouldian Finch *(Erythrura gouldiae).*

Ongoing routine field weed surveys have been completed at the location since 2014. Parkinsonia (Parkinsonia aculeata) (Class B & C under the NT *Weeds Management Act 2016* and a Weed of National Significance (WONS)) was found along the Beetaloo W access track and is subject to active treatment. The low number of weed species in and around the site indicates the surrounding habitat is in good condition. Weed management and water bore RN 0384922013will continue to focus on preventing the introduction and spread of weeds.

Aboriginal Areas Protection Authority Certificate 2020/003 has been granted covering the proposed activity area. The Beetaloo W access track intersects a restricted work area for which limits activities within this defined area. There are no restricted work areas (RWA) within the immediate vicinity of the Beetaloo W lease pad, with the closest being located over 5km away. An RWA is located along the Beetaloo W-1 access track and all restrictions will be complied with when operating in this area.

Figure 3: Overview of the existing Beetaloo W site

Table 2: Summary of existing environment and surrounds at Beetaloo W-1

Site ID	Beetaloo W-1	Habitat survey photos of the vegetation/habitat of the surrounding environment	
Location	17.12038 S 133.76165 E		
Landform and soil	Plains and rises associated with deeply weathered profiles (laterite) including sand sheets and other depositional products; sandy and earth soils		
Habitat type	Open eucalypt woodland		
Vegetation community	Open woodland with a dense shrub (Acacia) and grass layer		
Dominant flora species	Canopy dominated by *Acacia shirlyi, Bullwaddy, Corymbia dichromophloia*. Shrub layer including *Acacia lysiphloia, Acacia polycarpa, Terminalia canescens.* Ground layer species include *Aristida latifolia, Gardenia ewartii, Triodia bitexta*		
Habitat condition	No core habitat for threatened fauna was identified at the sites. Good condition with evidence of grazing. Hollow bearing trees and logs were sparse throughout the area. The habitat contained moderate refuge opportunities in the form of leaf litter, grass cover,		

Site ID	Beetaloo W-1	Habitat survey photos of the vegetation/habitat of the surrounding environment
	and woody debris. Good continuous cover adjoining adjacent woodland habitat. Vegetation is noted to be multi-aged with some fire scars, suggesting this is the cause of the age differences. No evidence of weeds or feral animals. No wetlands recorded; however, it was noted that more bird calls present at this location.	**Hydrogeology** Groundwater use to support the program is anticipated to be restricted to the Gum Ridge Formation. The overlying Anthony Lagoon Beds and undifferentiated Cretaceous are saturated at this site and may be viable extraction targets. At the current time Origin hold a licenced groundwater allocation only for the Gum Ridge Formation.
Potential listed threatened species	Some species may possibly occur and are known to occur in the wider landscape. Threatened species Grey Falcon, Northern Shrike-tit, Yellow-spotted Monitor, Plains Death Adder, Gouldian Finch. The activity is not anticipated to impact upon these species.	
Weeds	No Weeds of National Significance or weeds declared under the NT *Weeds Management Act* 2001 present.	

Key environmental risks assessed in the program

The environmental, heritage and social risks associated with the proposed ongoing regulated activity program has been assessed utilising the Origin risk assessment framework. The detailed risk assessment presents the range of potential impacts, corresponding mitigation measures and residual risk ratings based on their assessed worst-case consequence and likelihood of occurrence. Key risks assessed under this EMP include:

- Management of erosion and sediment control
- Managing the risk of bushfire in the area
- Mitigating the introduction and spread of weeds

47 risks sources were identified associated with the proposed activities. It was considered that with the appropriate controls implemented to mitigate the impacts, there were no residual risks above a rating of low (Table 3). This is consistent with the nature of activities proposed under this EMP.

Table 3: Summary of residual risk ratings

	Residual Environmental Risk Level			
	Low	Medium	High	Very High
Total 47	47	0	0	0

The assessment demonstrates that the risks associated with the EMP activities have been reduced to as low as reasonably practicable (ALARP) and are acceptable. The environmental outcomes to be achieved during the proposed activities include no significant impacts to the following aspects:

- Ecological function and productivity of soils
- Ecological function of surface water bodies
- The viability of groundwater systems to support ecological, economic and community activities
- The protection of high valued habitats and threatened flora and fauna
- The maintenance of air quality
- The minimisation of GHG emissions
- The protection and enhancement of community and cultural values, places and amenity.

At completion of the activities, rehabilitation will be conducted as described in section 3.20.

Stakeholder engagement

Stakeholder engagement for Origin's Exploration project has focused on the host Traditional Owners facilitated by the Northern Land Council (NLC) and host pastoralists directly affected by the proposed activity. Detailed community and stakeholder engagement to fulfill the requirements of the Northern Territory (NT) Petroleum (Environment) Regulations 2016 has been completed with the host Pastoralists (Beetaloo Station) and determined host Traditional Owners (Native Title Holders). Information on the stakeholder engagement completed is provided in section 5. Stakeholder engagement on Origin's current and proposed is ongoing, with engagement completed on a monthly to annual basis—depending on the nature of the proposed activities and agreed stakeholder engagement frequency.

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Appendix J Environmental Commitment Register

Appendix K Emergency Response Plan

Appendix L Archaeological Survey Report

1 Introduction

Origin Energy B2 Pty Ltd (Origin) is a registered holder and the operator of Exploration Permit (EP) 117, which is located in the Beetaloo Sub-basin (Figure 1). This Environment Management Plan (EMP) forms the basis of Origin's application to the Northern Territory (NT) Minister for Environment to cover the forward exploration program proposed for the existing Beetaloo W exploration site for the 2021–2026 period.

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The proposed regulated activities covered in this EMP are detailed in Table 4 and can be summarised as:

- Civil maintenance of Beetaloo W site—including erosion and sediment controls (ESC) on the access tracks, gravel pits, lease pad and access tracks
- Sub-surface data collection, including execution of a DFIT on the Velkerri and Kyalla shale members
- Extended pressure monitoring from the Beetaloo W-1 well
- Operation of a temporary camp, offices and equipment storage areas
- Routine reservoir data acquisition using reservoir evaluation tools (and other data collection methods)
- Maintenance and monitoring of infrastructure on the Beetaloo W site, including well interventions, work overs, completion and general well maintenance and diagnostic activities
- Suspension and/or abandonment of the Beetaloo W-1 exploration well
- Rehabilitation of the site upon completion of exploration activities.

The overall objective of this EMP is to ensure that the proposed activities, are carried out in a manner by which the environmental impacts and risks will be reduced to a level that is as low as reasonably practicable (ALARP) and are acceptable.

Table 4: Beetaloo W-1 site activity summary table

Component	Existing Beetaloo W-1	Revised EMP scope
General		
Number of E&A wells	1 existing exploration well: Beetaloo W-1	N/A—no drilling proposed
Number of stimulations	N/A the Beetaloo W-1 exploration well has not been stimulated	N/A no stimulations proposed
Number of water extraction/monitoring bores	1 existing bores RN 038492	An additional 6 bores may be installed to comply with the Code of Practice requirements or water supply requirements.
Number of gravel pits	3 existing	3 existing
Operational workforce	N/A site suspended	~<20 people during site operations where required
Main camp capacity	N/A no camp located at site	~20 people—existing camp pad to be utilized where required
Disturbance		
AAPA certificate	All works covered under C2020/003	
Total area of disturbance	5.85 ha (3ha lease pad, 1.1 ha camp pad , 0.5 ha access track and 1.25ha gravel pits)	No change to total disturbance values—existing lease pad, camp pad, gravel pits and access tracks to be utilised
Traffic		
Peak traffic movements (per day)	N/A site suspended	<10 vehicles per day peak during mobilisation and demobilisation. Likely to be restricted to several days over a 1-2 week period per year.
Average traffic movements during operations	N/A site suspended	1 light vehicle per fortnight
Truck load-out: wastewater transport	N/A site suspended	~1-2 B-triple loads
Water use and stormwater management		
Groundwater extraction license	N/A all take previously authorized under the *NT Petroleum Act*	All take covered under existing WEL GRF 10285

Component	Existing Beetaloo W-1	Revised EMP scope
Estimated groundwater usage	N/A	~<1ML
Stormwater retention basin	N/A	N/A
Wastewater management		
Wastewater volumes	N/A	No material volumes of wastewater anticipated to be generated. Any incidental wastewater will be managed in accordance with the Code of Practice as discussed in section 3.14
Greenhouse gasses and emissions		
Flares	N/A site suspended	N/A no flaring or venting proposed
tCO_2-e emissions	N/A	46 tCO_2^e

1.1 Project boundary

The boundary of this EMP is defined as the area which may be affected by E&A activities within EP 117. The proposed locations of the infrastructure and associated regulated activities are provided in Table 5 and Figure 2. The boundary areas include:

- Existing access tracks to and from the Beetaloo W-1 site from the Stuart Highway
- Existing Beetaloo W-1 lease pad
- Existing Beetaloo W-1 camp pad and existing water bore RN 038492
- Existing Beetaloo W-1 gravel pits

Table 5: Beetaloo W-1 and associated infrastructure covered under this EMP

Exploration Permit	Infrastructure name	Station	Zone*	Approx. Easting	Approx. Northing	Approx. area
EP117	Existing Beetaloo W-1 lease pad	Beetaloo	53	368312	8106695	3ha
EP117	Existing Beetaloo W-1 camp pad, sewer spray field and water bore RN 038492	Beetaloo	53	367684	8106755	1.1ha
EP117	Existing 34km access track	Beetaloo	53	367808 335788	8106473 8107012	~33km
EP117	Gravel pit 1	Beetaloo	53	341177	8106350	0.5ha
EP117	Gravel pit 1	Beetaloo	53	348615	8106403	0.5ha
EP117	Gravel pit 1	Beetaloo	53	355401	8106540	0.25ha

** Geocentric Datum of Australia (GDA) 94*

1.2 Project proponent

The proponent for the project is Origin Energy B2 Pty Ltd as the Operator. Origin representatives can be contacted at origin_nt_beetaloo@originenergy.com.au.

2 Environmental legislation and other requirements

Key NT and Commonwealth legislation, agreements, operating consents, guidelines and Codes of Practice relevant to the activities described in this EMP are summarised in Table 6. This EMP has been prepared in relation to these requirements.

Table 6: Key legislation

Legislation	Requirement	How Origin meets the requirement	Administered by
Northern Territory			
Petroleum Act 1984	Petroleum exploration licences are required in the areas where activities are proposed	• Exploration permits obtained • Minister provides the final sign off	Department of Industry, Tourism and Trade (DITT)

Legislation	Requirement	How Origin meets the requirement	Administered by
		authorising Petroleum activities.	
	Compensation to be paid to native title holders and owners/occupiers of land where petroleum activities are proposed	• Exploration Agreements obtained with Native title holders • Compensation paid to pastoralists for all activities proposed under this EMP	
	The NT Schedule of Onshore Petroleum Exploration and Production Requirements ('NT Schedule') should be listed. It covers key regulatory requirements for operational management of well activities in conjunction with the NT Code of Practice for Petroleum Activities.	• Requirements addressed in the WOMP	
NT Petroleum (Environment) Regulations 2016	Ensuring all regulated activities have an approved EMP	This EMP has been developed to satisfy this requirement	Department of Environment, Parks and Water Security (DEPWS) NT Petroleum (Environment) Regulations 2016
	That the EMP is developed in accordance with the NT Petroleum (Environment) Regulations 2016	Origin has developed this EMP in accordance with the NT Petroleum (Environment) Regulation requirements	
	That stakeholder engagement for the regulated activities is undertaken	Origin has completed stakeholder engagement in accordance with the NT Petroleum (Environment) Regulations 2016, as summarised in section 5 of this EMP	
	Activities are to be conducted in accordance with the Code of Practice: Onshore petroleum activities in the Northern Territory	The EMP outlines how the activities will be conducted in accordance with the Code of Practice	

Legislation	Requirement	How Origin meets the requirement	Administered by
	Reporting requirements for incidents and hydraulic fracturing	The EMP summarises how incidents and flowback monitoring results will be reported	
***Bushfires Management Act 2016* and associated regulations**	Compliance with total fire bans and fire permitting	Origin will not undertake flaring. Where backburning (is required under the bushfire management plan, Origin will obtain a permit to light a fire in the open air on land during declared fire danger periods.	Bushfires NT
	Requirements for occupiers to prevent and control fires	Addressed through Origin's Bushfire Management Plan (Appendix A) which includes bushfire preventative and response measures	
	Aerial burning permits	Origin will acquire permits where aerial burning to manage fuel loads is proposed as a part of its ongoing bushfire management activities. Origin does not consider that aerial burning will be required	
Control of Roads Act 1953* and *Northern Territory Traffic Act 1987	Any proposed development which may affect the Territory road network, including traffic, operation, management, capacity or safety, or result in the construction or installation of new infrastructure within the NTG road network, requires assessment and Road Agency Approval	Origin has completed engagement with the Department of Infrastructure, Planning and Logistics (DPIL) regarding proposed and ongoing traffic management	Department of Infrastructure, Planning and Logistics (DPIL)

Legislation	Requirement	How Origin meets the requirement	Administered by
Environmental Protection Act 2019	Activities which have the potential to cause a significant impact to the environment are required to be referred to the NT EA for assessment under the *EP Act*	Origin has completed a self-assessment and the level of potential environmental impact is not considered significant	Northern Territory Environment Protection Authority (NT EPA) DEPWS
Environmental Protection (National Pollutant Inventory) Objective 2004	Requirement for facilities that trigger a reporting threshold as defined in the Commonwealth National Environmental Protection (National Pollutant Inventory) Measure to estimate specific contaminant emissions on an annual basis. A report must be submitted to the Chief Executive officer within 3 months of the end of the reporting period	Where a threshold has been exceeded, Origin shall provide the required emission estimate report to the Chief Executive Officer within 3 months	DEPWS
Heritage Act 2011	Requirements to avoid impacts to heritage places and objects	Origin completed desktop studies and field scouts to confirm the presence/absence of heritage places and objects within the vicinity of the proposed activities	Heritage Branch, Department of Tourism and Culture
Northern Territory Aboriginal Sacred Sites Act 1989	The legislation establishes a procedure for the protection and registration of sacred sites and the issuing of sacred site clearance certificates. Access and work within sacred sites require authorisation	• All areas of Origin's proposed activities have had sacred site clearances completed by Traditional Owners • AAPA certificates for all exploration activities have been obtained for all activities proposed in this EMP	Aboriginal Areas Protection Authority (AAPA) Minister for Environment

Legislation	Requirement	How Origin meets the requirement	Administered by
Public and Environmental Health Act 2011	Requirements for camp kitchens and wastewater (sewage and greywater) management and permitting in the NT	Origin's camps are registered, and a wastewater works design approval for the main camp and mini-camp sewage treatment plan irrigation area has been obtained	Department of Health
Radiation Protection Act 2004	Requirements for the management of radiation for the health and safety of community and protection of the environment	Origin complies with the Act proper handling of and disposal of potentially radioactive substances (such as scales)	Department of Health
Territory Parks and Wildlife Conservation Act 1976	Prohibits impacts to protected places, impacts to threatened flora and fauna and interference with protected wildlife	Origin complies with the Act through the avoidance of impacts to protected places (essential habitat, sanctuaries, parks etc.) and flora and fauna. This is completed through ecological surveys and the controls implemented to limit the impact on wildlife	Parks Wildlife and Heritage Division of the Department of Tourism Sport and Culture
Transport of Dangerous Goods by Road and Rail (National Uniform Legislation) Regulations 2011	Regulations stipulating the transportation requirements for dangerous goods by road and rail. This includes implementing all required signage, spill management, reporting and licencing requirements for chemical transportation during exploration activities	Any chemical transported and stored for exploration activities is undertaken in a manner that will comply with these requirements	NT Worksafe, Department of the Attorney-General and Justice
Waste Management and Pollution	Requirements covering general environmental duty, waste management, including waste management hierarchy, waste	• The storage, transportation and disposal of wastes will comply with	NT EPA

Legislation	Requirement	How Origin meets the requirement	Administered by
Control Act 1998	transportation and waste disposal requirements	the requirements of this Act • The transportation and disposal of listed wastes will only be completed by a licenced contractor and at a licenced disposal facility • Any interstate disposal will be completed with an approved consignment authority	
	S12 General environmental duty—applies to activities outside of the lease area, or if a spill or leak occurs that leaves the lease area, or 1km from the centreline of a pipeline	Origin will conduct all activities outside the approved disturbance area (camp area, lease pad, access tracks authorised in the EMP) in a manner that prevents environmental harm	
	S14 Duty to notify of incidents causing or threatening to cause pollution—applies if an incident occurs outside of the lease area, or if a spill or leak occurs that leaves the lease area, or 1km from the centreline of a pipeline, that causes or threatens to cause material or serious environmental harm.	Origin will report all incidents that causes or threatens to cause pollution beyond the boundary of the authorised activity (beyond the lease or camp pad), in accordance with Section 14 of the WMPCA	
Water Act 1992 and Water Regulations 1992	The Act requires that all groundwater take in the Beetaloo Sub-basin must have obtained a Water Extraction Licence (WEL)	Origin has obtained a Water Extraction Licence (WEL) GRF 10285 covering water usage required to complete exploration activities. Water	Water Resources Division, Department of Environment, Parks and Water Security (DEPWS)

Legislation	Requirement	How Origin meets the requirement	Administered by
		extraction licences will be renewed periodically as required to support operational activities.	
	The take of surface water for petroleum activities is prohibited	No surface water take is proposed under this activity	
	Prohibits wastewater releases to surface water bodies or reinjection	No wastewater release to surface water proposed	
Weeds Management Act 2001	Requires the occupier of the land (in this case Origin) to: • prevent the land being infested with a declared weed • prevent a declared weed or potential weed on the land spreading to other land • notify the weeds officer of the presence of the declared weed • comply with any declared weed management plans	Origin will comply with the requirement of this Act through the implementation of weed prevention, detection and eradication controls through its approved weed management plan (Appendix B)	Weed Management Branch, Department of Environment, Parks and Water Security (DEPWS)
Work Health and Safety (National Uniform Legislation) Act 2011	Provides for a nationally consistent framework to secure the health and safety of workers and workplaces. Includes requirements for hazardous chemical assessments, hazardous chemical register, access to safety data sheets, labelling, and the use, handling, generation and storage of hazardous chemicals at a workplace.	Origin has a Safety Management Plan that outlines how the requirements of the Act are achieved. This includes the management of chemical storage dossiers, safety data sheets (SDS) and appropriate procedures and controls to prevent worker exposure to hazards.	NT WorkSafe, Department of the Attorney-General and Justice
Commonwealth			
Environment Protection and Biodiversity	Requires approvals for any activity likely to have an impact on a Matter of National Environmental Significance (MNES)	A self-assessment was completed as a part of this EMP to determine whether a MNES is likely to be impacted by	Department of Agriculture, Water and Environment

Legislation	Requirement	How Origin meets the requirement	Administered by
Conservation Act 1999		the proposed activities within this EMP. Impacts to MNES are not anticipated to occur	
National Greenhouse and Energy Reporting Act 2007	An Act that requires operators who generate emissions over a threshold to report information related to greenhouse gas emissions, greenhouse gas projects, energy consumption and energy productions of corporations	All energy consumption and greenhouse gas data used/generated as a result of this activity will be reported in accordance with this Act	Department of Industry, Science, Energy and Resources
National Environment Protection Council Act 1994 **National Environment Protection (Assessment of Site Contamination) Measure 1999 (NEPM)**	This Act provides a nationally consistent approach to the assessment of site contamination to ensure sound environmental management practices to protect human health and the environment	Origin uses the NEPM to assess risk of contamination and for the assessment of potentially contaminated sites.	Department of Agriculture, Water and Environment
Native Title Act 1993	Legislation that provides for ways in which future dealings affecting native title may proceed and the recognition and protection of native title. The Right to Negotiate requirements are the most relevant provisions applying to Origin's exploration activities.	• The Right to Negotiate process was applied to the grant of Origin's permits, resulting in Section 31 Agreements and Exploration (Ancillary) Agreements covering Origin's permits. The Traditional Owners were and continue to be represented by the Northern Land Council (NLC) • Origin continues to implement the	Prime Minister and Cabinet

Legislation	Requirement	How Origin meets the requirement	Administered by
		Exploration Agreements, in collaboration with the NLC, with all work programmes being reviewed and approved by Traditional Owners • Origin has the consent of the Traditional Owners for activities proposed in this EMP, evidenced by the Section 31 Agreements and the implementation of the relevant Exploration Agreement	

2.1 Alignment with the principles of Ecologically Sustainable Development

This EMP is consistent with the principles of Ecologically Sustainable Development (ESD) through the adoption of responsible practices that are designed to maximise social benefit, while minimising the level of impact on the surrounding ecosystems.

Principles of Ecologically Sustainable Development (as defined in the NT Petroleum (Environment) Regulations 2016)

1. Decision making principle—decision-making processes should effectively integrate both long-term and short-term economic, environmental, social and equitable considerations
2. Precautionary principle—if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation
3. Principle of evidence-based decision making—decisions should be based on the best available evidence in the circumstances that is relevant and reliable
4. Principle of intergenerational and intragenerational equity—that the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations
5. Principle of sustainable use—natural resources should be used in a manner that is sustainable, prudent, rational, wise and appropriate

6. Principle of biological diversity and ecological integrity—the conservation and maintenance of biological diversity and ecological integrity should be a fundamental consideration in decision-making
7. Principle of improved valuation, pricing and incentive mechanisms—improved valuation, pricing and incentive mechanisms should be promoted including market based environmental incentives, the polluter pays principle, life cycle analyses, and the inclusion of environmental factors in the valuation of assets and services

Origin's exploration activities align with the principles of ESD:

- Exploration activities are an essential step in defining a potential future commercial resource which can generate sustainable, long-term benefits to the local community, to the Barkly region generally and more broadly into the rest of the NT (Principles 1 and 5)
- Complying with the Code of Practice and industry best practice to reduce the risk to the environment and communities to an acceptable level. Noting the Inquiry Panel's Final Report Statement that "provided that all of the recommendations made in this Report are adopted and implemented in their entirety, not only should the risks associated with an onshore shale gas industry be minimised to an acceptable level, in some instances, they can be avoided altogether." (Scientific Inquiry into Hydraulic Fracturing in the Northern Territory 2018) (All principles)
- The activities that are the subject of the EMP do not constitute threats of serious or irreversible environmental damage and there is no impact on the conservation of biological diversity and ecological integrity (Principles 4 and 6)
- Beyond royalty payments to the NT Government (as owner of the natural resource), and payments to Native Title Holders (as per Exploration Agreements) and host pastoralists (as per Access and Compensation Agreements), Origin seeks to maximise broad-based local participation in education, training, employment and enterprise opportunities engendered by its presence (Principles 1 and 5)
- Prioritising the use of local employment to deliver exploration activities (Principles 1 and 5)
- Obtaining sacred site clearances from host Traditional Owners through open engagement with custodians, the Statutory Representative body—the Northern Land Council (NLC) and the Aboriginal Ara Protection Authority (AAPA) (Principles 1, 4 and 5)
- Obtaining Land Access Agreements with host pastoralists (Principles 1 and 5)

3 Description of regulated activities

This EMP covers the regulated activities required to enable Origin to maintain the existing Beetaloo W site and forward data collection program for the Beetaloo W-1 exploration well. It also covers the regulated activities associated with the maintenance, monitoring, suspension and abandonment of the exploration well. To accommodate this scope, the activities summarised in Table 7 are proposed to be executed under this EMP.

Table 7: Description of the exploration activities for the existing Beetaloo W-1 exploration well

Activity	Description
Site access and civil maintenance	• Use of existing access tracks to and from the Beetaloo W-1 site from the Stuart Highway

Activity	Description
	• Use of the existing cleared and graded Beetaloo W-1 lease pad, including lease pad, access tracks, camp pads, stockpile storage and laydown areas • Regrading existing lease pad, operational areas and access tracks • Operation and maintenance of the existing gravel pits • Maintenance of erosion and sediment control measures • Maintenance of fences and security • Weed management activities
Exploration well monitoring and maintenance	• Routine maintenance of the Beetaloo W-1 well head and surface equipment • Collection of cement bond log data using wireline • Sub-surface well maintenance, including casing and cement repairs • Minor storage of chemicals, fuels and wastes
Exploration well data collection	• Zonal perforations and reservoir data collection—such as running formation logging and reservoir evaluation tools • Diagnostic fracture injection tests on the Velkerri and Kyalla shale intervals • Minor storage of chemicals, fuels and wastes
Groundwater monitoring bore installation	• Installation of up to six (6) groundwater monitoring bores
Well suspension and decommissioning	• Suspension and decommissioning Beetaloo W-1 well in accordance with the Code of Practice
Camp operations	• Set-up of a 20-person capacity temporary camp to support site works (if required)
Site rehabilitation	• Decommissioning and removal of all surface infrastructure and wastes from site including the removal of the exploration well, cellar and all ancillary equipment • Final rehabilitation activities in accordance with the rehabilitation plan (Appendix C)

3.1 Beetaloo W-1 site setting

The Beetaloo W-1 site is an existing exploration location that consists of:

- Existing Beetaloo W-1 exploration well
- 3ha lease pad

- 1.1ha camp pad and groundwater extraction bore RN 038492
- 33km existing access track
- 3 existing gravel pits
- Existing groundwater extraction bore

A drone image of the Beetaloo W-1 location is provided in Figure 4. Drilling of Beetaloo W-1 exploration well was completed in 2016 under the Beetaloo Sub-basin, EP98 and EP117 Exploration Drilling Environment Plan (EP) (NT-2050-15-MP-10).

Figure 4: Drone image of the existing Beetaloo w-1 site

The Beetaloo W-1 site was originally chosen using a multi-criteria analysis based on the geological, environmental, cultural and social suitability of the site. Field ecological, cultural heritage and Native Title clearances were obtained to ensure avoidance of the following areas:

- High conservation value
- High habitat value
- Water courses or major overland flow paths
- Areas of cultural significance
- Sensitive receptors (homestead and communities)
- Existing pastoralist groundwater extraction bores.

A description of the existing environment is provided in section 3.21. The site is located in open woodland with a dense shrub (Acacia) and grass layer. This vegetation community is regionally extensive, not threatened and in good condition.

Approximate separation distances to the nearest environmental and community receptors are illustrated in Figure 5Figure 5 and includes:

- 7.5km from the closest pastoralist bore
- ~33km from the Stuart Highway
- 12km from the nearest homestead
- 16km from the nearest aboriginal community (Jingaloo)
- 45km from Frew Ponds
- 50 km from the town of Elliot
- 8.5km from the closest mapped watercourse (un-named tributary of Newcastle Creek (stream order 1)
- 60km from Lake Woods.

3.1.1 Existing Beetaloo W-1 exploration well

The Beetaloo W-1 well was the third well drilled in a three-well drilling exploration campaign completed over the 2015/16 period. The campaign aimed to test the presence, lateral continuity and reservoir quality of the primary target, the organic-rich mudstone units of the Velkerri shale (primary target) and Kyalla shale (secondary target) members.

The Beetaloo W-1 exploration well is located in the central portion of EP117. The location was selected based on pre-drill thermal maturity modelling which indicated dry gas and wet gas generation potential for the organic rich Velkerri and Kyalla shales respectively. The Beetaloo W-1 well was successfully spudded on the 22 July 2016. The well reached a total depth of 3,148 m below ground level (mbgl) within the lower Velkerri member on 6 September 2016. The well was cased and suspended, and the rig released on the 14 September 2016. A schematic of the existing Beetaloo W well is provided in Figure 6.

The well was designed and constructed with multiple sections of casing and cement strings, being the conductor casing, surface casing, intermediate casing and production casing. Verification of the well integrity of the Beetaloo W-1 exploration well was completed via the following tests:

- Cement returns observed at all sections—noting a cement top up job was completed on the 16” hole section due to formation losses believed to be in the unconsolidated sediments of the cretaceous formation
- Leak of test completed on the 10 ¾ inch surface casing section
- Casing pressure test completed on the 7 5/8 inch intermediate casing string to 5000psi
- Casing pressure test completed on the 4.5” production casing section completed prior to rig down. A 5,000 psi casing pressure test, confirmed that integrity of the E&A well

A well completion report was submitted to the DITT and is available at GEMIS: Beetaloo W-1 Well Completion Report (Basic) (nt.gov.au).

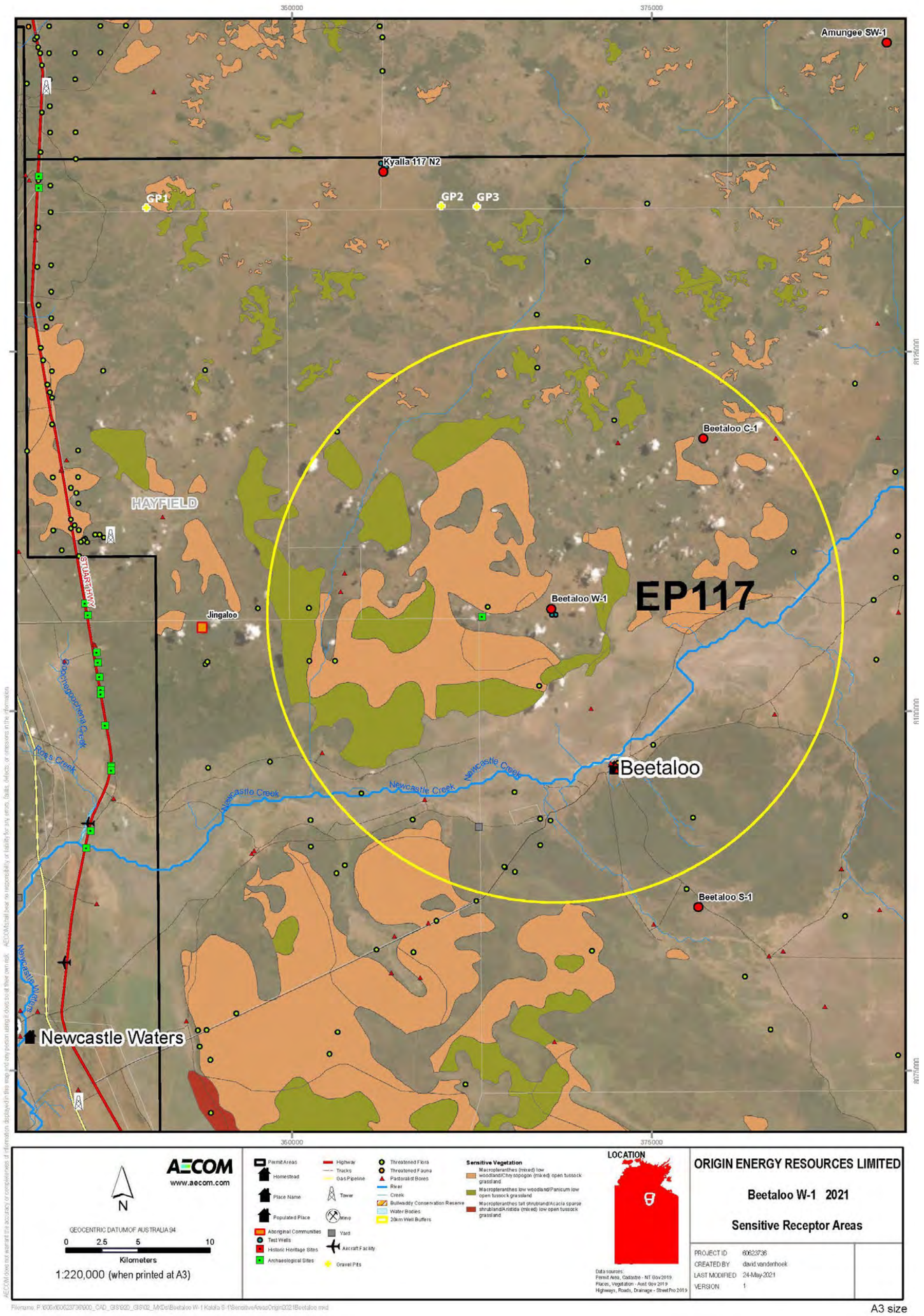

Figure 5: Beetaloo W-1 proximity to sensitive receptors

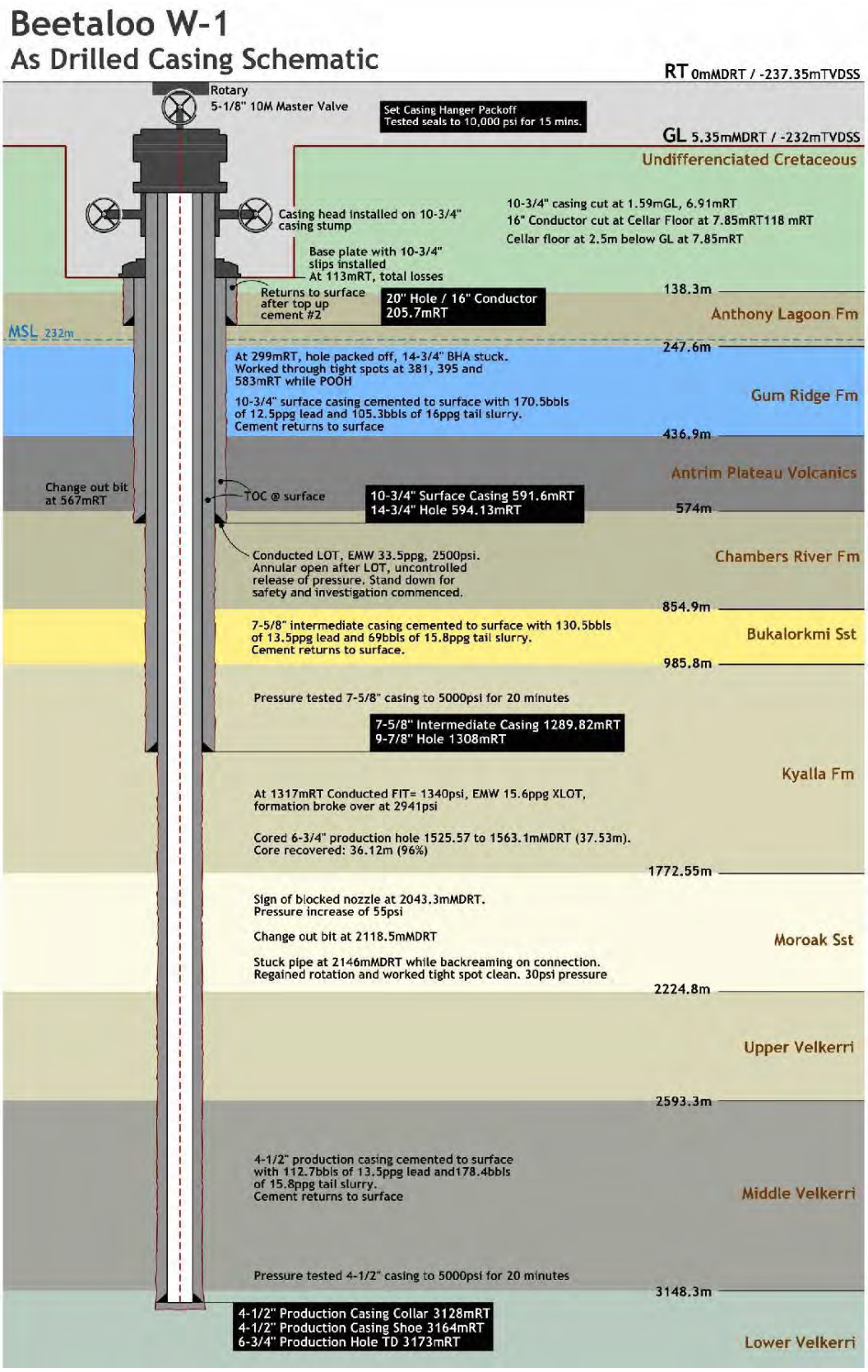

Figure 6: Beetaloo W-1 well completion diagram

3.2 Groundwater monitoring/extraction bore construction

To accommodate future exploration monitoring requirements, groundwater water monitoring bores may be drilled on the existing lease pad to satisfy groundwater baseline monitoring (in accordance with (the code of Practice) and extraction requirements. The monitoring bores will only be required where proposed future activities on the site include hydraulic fracture stimulation. It is anticipated that up to three impact and three control monitoring bores may be constructed, although he final number will depend on underlying aquifer units present and operational needs. Monitoring/ extraction bores may be constructed in three separate water bearing formations, consisting of the Undifferentiated Cretaceous Formation, the Anthony Lagoon Formation and the Gum Ridge Formation. Groundwater monitoring bores will only be constructed in a formation which is saturated and sufficiently permeable as to be considered an aquifer. Monitoring bores may be utilised for groundwater extraction, with all take undertaken in accordance with section 3.11.

All bores will be constructed in accordance with the Minimum Construction Requirements for water Bores in Australia (ed.4 2020).

Fresh water and drilling cuttings produced during water extraction bore drilling will be disposed of on-site in accordance with the Minimum Construction Requirements for Waters bores in Australia (ed.4 2020). Groundwater will be released to the ground in a controlled manner to minimise the risk of erosion. Cuttings will be raked and assimilated into the lease pad surface.

A bore work permit will be obtained for each bore and any groundwater take will be licenced in accordance with the *NT Water Act 1992*. On completion of each water bore, the relevant statement of bore and gamma log (where completed) will be provided to DEPWS.

3.3 Gravel extraction and pit management

Gravel will be sourced from the existing three gravel pits located along the access track. These pits were constructed in 2015 to support the surfacing of the Beetaloo W access track and lease/camp pads. The gravel pits were left open for the continued use by the pastoralists for ongoing access track maintenance and stock watering. The locations of the pits are provided in Figure 2 and Table 5.

Gravel may be extracted from these pits where required for maintenance or operational activities. Gravel pits will be operated in a manner to minimise erosion and off-site sediment release, as illustrated in Figure 7 and Figure 8. This includes the use of topsoil/overburden berms around the site, flow diversions, use of fallen debris for embankment stabilisation and other typical erosion and sediment controls (such as rock check drains etc.),

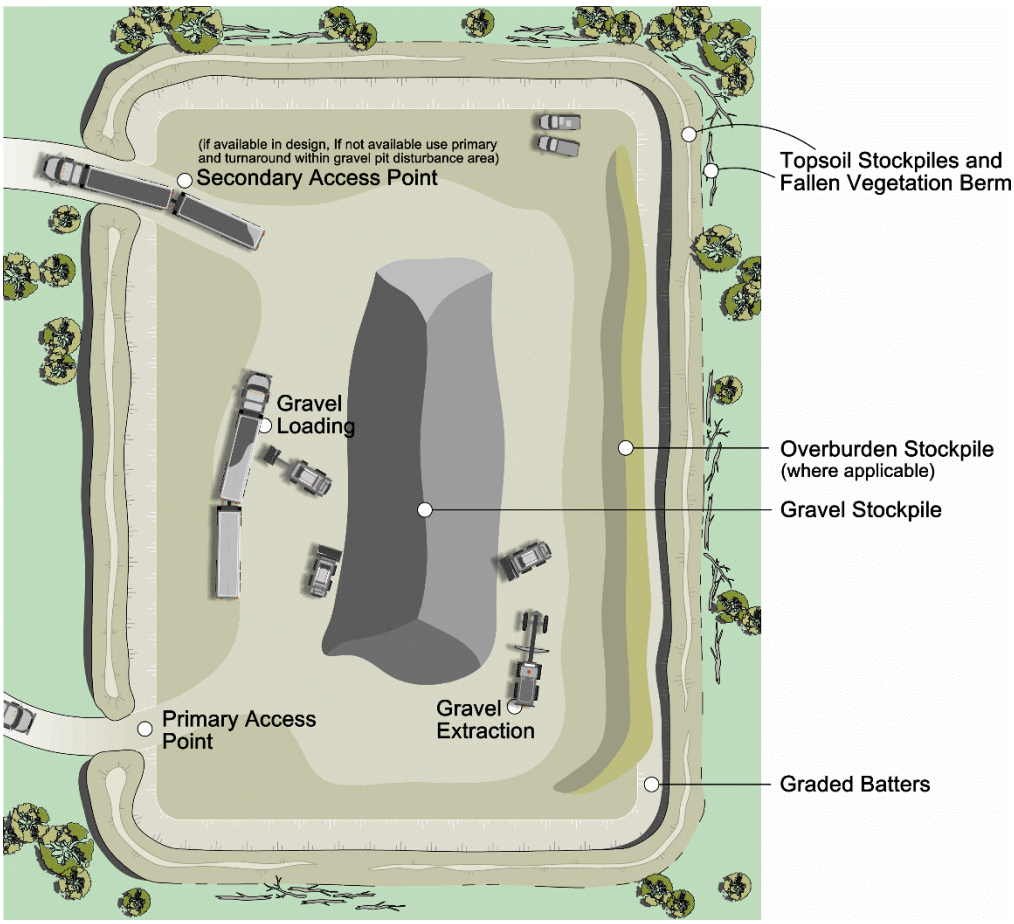

Figure 7: Typical gravel pit schematic

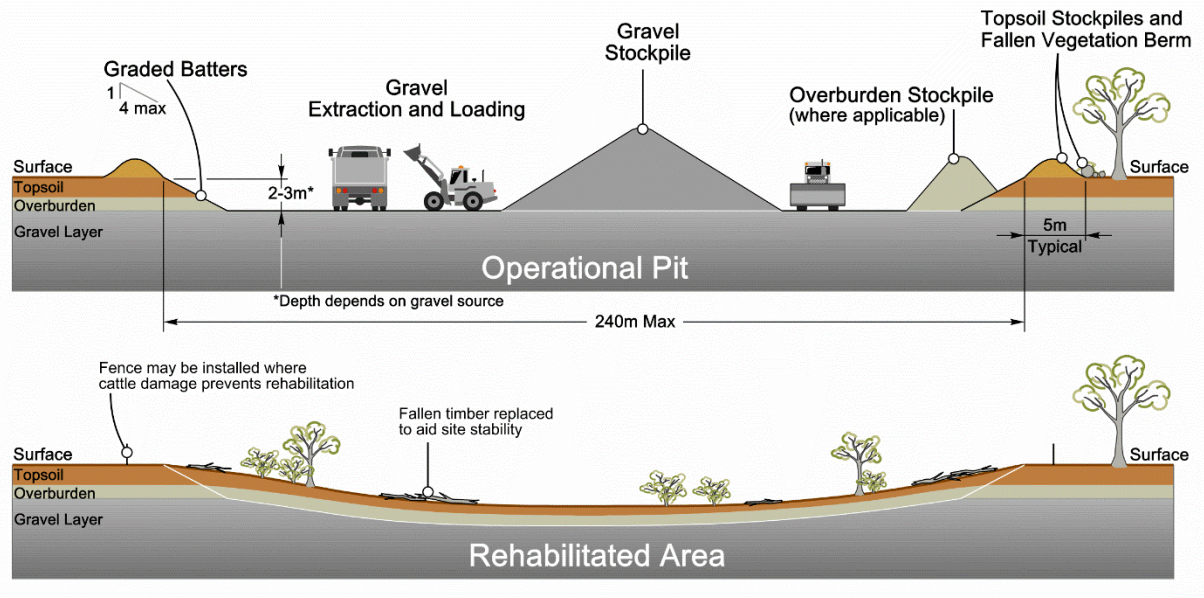

Figure 8: Typical gravel pit operations and rehabilitation schematic

3.4 Routine site maintenance

Civil maintenance will be performed periodically to ensure the site remains functional, safe and non-polluting. Activities to be completed periodically include:

- Vegetation management on the lease pad, camp pad and access tracks
- Firebreak maintenance
- Access track resurfacing and maintenance
- Lease and camp pad resurfacing
- Water extraction bore maintenance
- Erosion and sediment control maintenance and repair
- Weed management; and
- Fence and gate repair

Gravel will be required for ongoing maintenance activities, sourced from the existing pits located adjacent to the access track. These pits will be managed in accordance with Figure 8.

All maintenance will be completed in accordance with the principles outlined in the NT Land Clearing Guidelines (2019).

3.5 Routine well maintenance and well interventions

Well barriers are tested, and pressures monitored regularly to ensure their performance over the lifecycle of the well. Remediation of well integrity anomalies could include well integrity barrier replacements, i.e. valves, tubing, and/or barrier remediation, such as casing patches and cement squeezes to ensure pressure isolation. If remediation does not prove to be a feasible option, plugging and decommissioning operations will be considered to ensure well integrity.

Additional routine maintenance and diagnostic testing under this EMP includes:

- Wellhead maintenance—1-2 light vehicles and potentially a small truck (depending on the nature of the maintenance) with approximately three to five people to do 1-2 days of work on pressure testing, and maintaining the wellhead
- Cement bond logging-wireline/slickline to collect data on cement quality
- Casing pressure tests—pump truck and support vehicles to complete the test.
- Cement and casing remedial works—a small completion rig with 6-7 trucks to pull tubing and potential recompleted the well if required
- Wireline/Slickline—one truck to either set a plug downhole or run additional logs.
- Other ancillary works to support the ongoing maintenance of the Beetaloo W-1 well or to collect additional subsurface information.

3.6 Diagnostic Fracture Injection Test

Diagnostic Fracture Injection Tests (DFITs) may be conducted on the Beetaloo W-1 exploration well to evaluate the geo-mechanical and reservoir properties of the Velkerri and/or Kyalla shale formations. This data is utilised to determine the suitability and capacity of these formations for potential gas extraction activities. Prior to a DFIT, a cement bond log and casing pressure test is completed to ensure the integrity of the cement and steel casing. A DFIT involves the injecting of small volumes of a water (approximately 30 barrels (5,000L) per DFIT) and salts (sodium chloride and small amounts of biocides) at low pumping rates to create a small fracture in the target interval. The well is shut-in, and the pressure allowed to fall-off naturally. Monitoring the fall-off pressure over time allows information to be derived about the reservoir. The fluid does not contain proppant so that the fracture closes naturally when the fluid leaks off into formation. The analysis of pressure, during injection and after shut-in, provide powerful tools for understanding and subsequently informing the design for a future hydraulic fracturing process.

No wastewater is anticipated to be generated from the activity. Any wastewater generated would be managed under the Code of Practice.

Pressure monitoring at the Beetaloo W-1 well post DFIT, typically for 12 -24 months. Pressure monitoring involves installing pressure gauges to monitor the pressure build-up in the target reservoir over time. This activity requires very limited infrastructure, other than a telemetry skid to host het monitoring and communication equipment.

DFIT operations will be covered under a Well Operations Management Plan (WOMP), which will outline all the well integrity controls required to be maintained during a DFIT. The WOMP must be developed, submitted and approved by DIT prior to the commencement of activities.

Figure 9: Image of equipment utilised to perform a DFIT, including wireline unit, water truck and pump trucks

3.7 Well integrity management

The ongoing monitoring and well integrity management of the Beetaloo W-1 exploration well is illustrated in Figure 10. Origin's Operations team manage the ongoing integrity of the well through the Well Integrity Management Plan (WIMP). The WIMP defines monitoring, maintenance and integrity testing requirements and frequencies and well integrity assurance activities, this ultimately forms a part of the Well Operation Management Plan (WOMP). The WIMP and WOMP are both designed to satisfy the Code of Practice to ensure the integrity of a well throughout its life.

Information from all Origin wells is gathered and stored in a database and made available to key technical staff via a software tool—Well Integrity Management System (WIMS). WIMS contains information such as wellhead and production valve maintenance results, annular and tubing pressures, well operating windows, key well information and historical well integrity data and maintenance. WIMS is used in the identification and assurance of the integrity of each individual well and also outlines the well integrity status for each well.

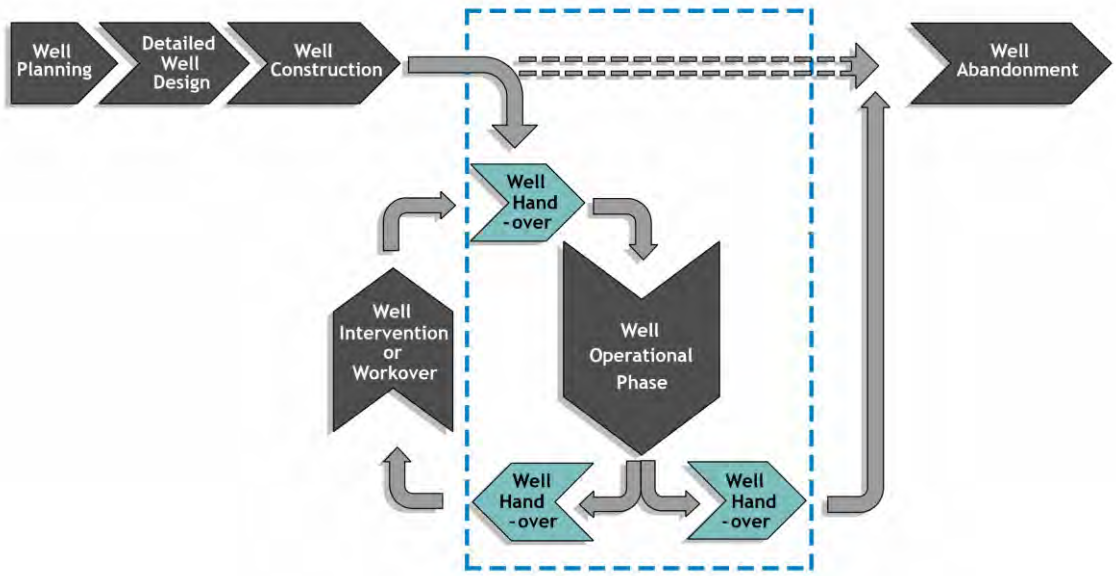

Figure 10: Well lifecycle with operational phase highlighted where well integrity monitoring is a key activity

3.8 Well suspension and decommissioning

Where well intervention activities are undertaken on the Beetaloo W-1 E&A well, the well will then be either suspended or decommissioned. If the well is suspended, barriers will be installed as per B.14.5 of the Code of practice, with cemented casing and a wellhead being the minimum requirement. While the well is suspended, pressures on the well will be routinely monitored as per Origin's WIMS to confirm well integrity is intact.

Where there is no further requirement to keep the Beetaloo W-1 well to support future E&A activities, the well will be decommissioned. To decommission the well, cement plugs will be installed as permanent barriers to flow prior to cutting off the wellhead. The cement plugs will be set and tested prior to decommissioning, as per Origin Standards and Section B.4.15.2 of the Code of Practice.

3.9 Chemical and fuel management

The anticipated chemicals and fuels that will be utilised/generated during maintenance and monitoring program activities are summarised in Table 8. No drilling or stimulation chemicals will be utilised during the program. A summary of the main chemical types to be utilised during the program include:

- Bulk diesel (to fuel equipment and generate power)
- Camp cooking wastes (cooking oil etc.) and wastewater (sewage) (discussed in section 3.9)
- Degreasers and domestic cleaning chemicals
- Typical workshop and maintenance chemicals including hydraulic oil, coolant, greases, paints, solvents and engine oils
- Incidental well maintenance chemicals and fluids, such as lubricants, biocides, anti-scale chemicals, DFIT fluids and well suspension fluids
- Waste DFIT return fluid

Only the volumes required (plus contingency, depending on storage container size) for the EMP activities will be stored on-site (i.e. no excessive storage volumes).

Table 8: Anticipated chemical volume and storage used for proposed regulated activities

Material name	Anticipated volume	Maximum volume	Unit	Storage area
Completion fluid (salt or polymer) weighted fluid used for well suspension activities	20	100	KL	Chemical storage area
Degreasers	100	300	L	Workshop
Diesel	50	100	KL	Diesel storage tanks
DFIT fluid (Salt weighted fluid)	10	50	KL	Chemical storage area
Engine oil	1,000	3,000	L	Workshop
Hydraulic oil	250	1,000	L	Workshop
Incidental chemicals (biocides, anti-scale, pH controls etc)	<100	500	Kg	Chemical storage area

3.10 Camps

A small 20-person camp located on the existing Beetaloo W-1 site may be utilised to support maintenance and data collection activities, with accommodation in Daly Waters used for all other activities. The camp will support two crews that will work 12-hour shifts, plus the camp staff, supervisory staff and service company personnel on an as-required basis. The main camp includes:

- accommodation
- ablutions and septic(s) waste treatment and irrigation
- recreation room
- kitchen and mess
- freezer unit
- site office
- generator and diesel storage
- water tank
- water treatment facility (reverse osmosis plant).

The camp has its own sewage treatment plant and wastewater treatment plant. A wastewater works design approval will be sought by the NT Department of Health prior to the operation of a camp where the throughput exceeds 2,000L per day (currently the default option).

Treated water will be dispersed via drainage away from the camp to the designated irrigation area. The designated irrigation areas are located adjacent to the camp pad. These areas will be approximately 50x50m and will have a fence to exclude livestock access.

The camp will be supplied with potable water sourced from the existing groundwater bores on-site. A temporary reverse osmosis water treatment plant is utilised, which produces up to5KL of potable

water per day. Water will be treated to comply with the Australian Drinking Water Guidelines (2011 NHMRC Australian Drinking Water Guidelines). Approximately 1,000L of RO reject is likely to be produced per day, which will have an Electrical Conductivity of approximately 1,500–2,000 µs/cm^3. This water will be re-used or blended (diluted) with raw water at a 4 to 1 ratio and used for dust suppression.

All camp kitchens have been registered under the NT *Food Act 2004* and comply with all food hygiene requirements.

The domestic solid waste generated by camp activities will be removed by a waste contractor in accordance with the NT WMPCA.

3.11 Water extraction and use

It is estimated that less than 1ML of water will be extracted from the Gum Ridge Formation per year to support the maintenance and monitoring program. All groundwater take is metered with continuous flow meters and reported to DEPWS as per the WEL GRF10285.

The extraction of water will be covered under a valid Water Extraction Licence (WEL). It is envisaged that water will be extraction from RN41132 on the Kyalla 117 N2 site (on the adjacent Hayfield/ Shenandoah Station) under the WEL GRF10285 and trucked to the Beetaloo W-1 site. This approval allows for an extraction of up to 175ML/year from the Gum Ridge Formation to cover all its proposed exploration until December 31, 2021. The WEL will be renewed periodically (i.e. beyond the 2021 licence period), to ensure sufficient water is available to support operations.

Groundwater will be used to supply potable water, with on-site water treatment used to provide water in accordance with the Australian Drinking Water Guidelines.

The cumulative impact associated with current and future groundwater takes were addressed in the Water Extraction Licence (WEL) GRF 10285 statement of reason. This WEL covered the anticipated (conservatively high) future water take for Origin's Beetaloo exploration activities. A copy of the WEL statement of reason is available from DEPWS Water Resources at http://www.ntlis.nt.gov.au/walaps-portal/report/current/gwel.

3.12 Wet season operations

The wet season, as defined in the code of Practice, extends from the month of October to the end of April. Activities will occur over the wet season to accommodate operational requirements, with the majority of work prioritised for the shoulder months (October, November and April). Where wet season operations are undertaken the following risk controls will be implemented:

- Chemicals, fuels, equipment and materials required for ongoing operations will be preferentially stored on-site prior to the onset of the wet season to minimise transportation risks
- All equipment required to respond to emergency situations will be on-site; this includes earth moving equipment, pumps, well control equipment etc., and equipment and materials to deal with well control issues, spills and other emergency events commensurate to the nature of the activity proposed
- All chemicals storage areas will be bunded, with covers used (where safe and appropriate) to prevent rain ingress and bund overflows
- Daily inspections will be completed on chemical storage areas
- No wastewater anticipated to be generated or stored on-site
- Personnel will be located within the basin regionally (at Daly Waters or an operating site within the Basin such as Kyalla 117 N2 or Velkerri 76 S2) at other times

- Helicopters will be used to transport people and supplies into and out of the site when access is restricted
- Transportation of wastewater or chemicals is not anticipated. Any transport undertaken during the wet season unless a task specific risk assessment is completed prior to the transport (to ensure site conditions are constantly updated) that demonstrates the risk is ALARP and acceptable (as per the Code of Practice)

3.13 Helicopter operations

If access to the site is prevented during operations, helicopters will be utilised to move people and supplies in and out of the site. Helicopter activities ensures the site can be accessed during all activities, regardless of the season.

The use of helicopters in the NT for transportation is a standard activity and ensures that personnel and material can be moved to and from the site during periods of wet weather or in emergencies.

All helicopter movements will be managed under an aviation journey management plan. This plan addresses the risk associated with vehicle selection, maintenance, flight routes and flight procedures.

Audits are completed prior to the engagement of a helicopter service provider and at least annually. This ensures all aircraft are being appropriately maintained and operated to reduce the risk of accident.

3.14 Wastewater management

Flowback or Drilling wastewater will not be generated by the activities under this EMP. Any minor volumes of ancillary wastewater generated through well intervention activities (such as completion fluids used for well control/ maintenance) are likely to be small and managed in accordance with the Code of Practice and Waste Management and Pollution Control Act. The management strategies are outlined in section 7.1 and include:

- All incidental wastewater fluids to be stored within tanks with secondary containment
- Enclosed wastewater tanks to be utilised
- Daily level monitoring during operations
- Weekly tank inspections when storing wastewater
- Wastewater to be transport to an existing wastewater storage area within the Beetaloo Basin for evaporation/treatment (such as Kyalla 117 N2) or to a licensed offsite wastewater disposal facility.

3.15 Stormwater management

The Beetaloo W site will be operated in a manner that minimises the contamination of stormwater and overland flow. Stormwater is typically characterised by low electrical conductivity (<100us/cm) and will contain sediment sourced from the cleared lease pad surface. The following describes how stormwater is managed on-site:

- The well site is designed to divert stormwater around cleared areas as much as reasonably practicable to prevent sediment transport
- Where stormwater collects in chemical storage bunds, stormwater that meets the quality outlined in Table 9 will be discharged off-site in controlled manner or re-used for dust suppression
- All stormwater above the specified limit will be treated as wastewater and managed accordance with the *Waste Management and Pollution Control Act*

- Once all work on the site has ceased and all contaminant sources have been removed from the lease pad, the site will be left in a stable, non-polluting state with appropriate erosion and sediment controls in place
- Erosion and sediment control plan (Appendix D) implemented.

Table 9: Stormwater release and re-use limits

Monitoring parameter	Release limit	Limit basis
Off-site release and dust suppression		
Electrical conductivity	1300µs/cm	Irrigation salinity values used due to the absence of adjacent watercourses, with the protection of soils the most relevant environmental Value (EV). The guideline was based on the irrigation water salinity ratings for moderately sensitive crops. (Sources from Table 9.2.5 of the ANZEC Guidelines (2000) Volume 3, Chapter 9, Primary Industries) Sodium adsorption ratio (SAR) of stormwater is anticipated to be low, well below <20. Receiving soils are sandy loam (as described in section 4.1.3), with SAR in irrigation water >20 permissible which will not increase the sodicity of soils (Sources from Table 9.2.6 ANZEC Guidelines (2000) Volume 3, Chapter 9, Primary Industries)
pH	6.5-9.5	Limit based upon the background surface water quality data[1] and Table 8.2.8 of the ANZECC Guidelines 2000 volume 2 Aquatic ecosystems-rationale and background information

3.16 Greenhouse gas emissions

Total greenhouse gas (GHG) emissions generated during exploration activities are summarised in Table 10.

Emissions from the activities covered under this EMP are estimated to be 46tCO_2^{e-}. The total greenhouse gas emissions are small when compared to the total 2018 greenhouse gas emissions for the

[1] HLA 2005 report summarising the Beetaloo Basin Surface water quality monitoring completed for Sweetpea Petroleum

NT (16,000,000 $tCO_2^{e)}$ and for Australia (536,500,000 tonnes) (Department of Industry, Science, Energy and Resources, 2020).

Greenhouse gas emission generation will be mitigated through adoption of the Code of Practice and implementation of a Methane Emission Management Plan (MEMP Appendix E). Mandatory requirements include:

- No venting or flaring proposed
- Six monthly routine leak detection and repair program to detect, repair and report leaks to be implemented (D.5.3)
- Pressure and gas testing all in service equipment to ensure any leaks are identified and fixed prior to commissioning (D.5.9)
- Flanges, valves and fittings are all API compliant and gas tight (D.5.9)
- Equipment is appropriately sized and regularly maintained to minimise diesel wastage. (D.5.9).

Table 10: Greenhouse gas (GHG) summary for the proposed activities

Activity	Anticipated volume	Total tCO_2e^	Estimate methodology and assumptions
Well maintenance (diesel combustion)	1KL/year	3	Diesel estimate using historic well maintenance multiplied by Table 3: Fuel combustion emission factors— liquid fuels and certain petroleum-based products for stationary energy purposes, Part 3 of Schedule 1 of the NGER Determination (July 2020): Energy Content Factor (GJ/kL) 38.6 CO_2 Factor 69.9 $kgCO_2$-e/ GJ of diesel CH_4 Factor 0.1 kgO_2-e/ GJ of diesel N_2O Factor 0.2 $kgCO_2$-e/ GJ of diesel
Transportation emissions (diesel combustion)	15kl	43	Diesel usage multiplied by NGERS emission factor from Table 4: Fuel combustion emission factors—fuels used for transport energy purpose, Division 4.2, Part 4 of Schedule 1 of the NGER Determination (July 2020): Energy Content Factor (GJ/kL) 38.6 CO_2 Factor 69.9 $kgCO_2$-e/ GJ of diesel CH_4 Factor 0.01 kgO_2-e/ GJ of diesel N_2O Factor 0.5 $kgCO_2$-e/ GJ of diesel
Total		**46**	

^ Based on Global Warming Potential (GWP) of $28tCO_2^e/tCH_4$ (Clean Energy Regulator 2020)

* https://www.api.org/~/media/files/ehs/climate-change/2009_ghg_compendium.ashx

3.16.1 GHG cumulative emissions

The total emissions for Origin's current approved, remaining and proposed activities are anticipated to be 8,130 tCO_2^e in 2021, increasing to 57,622tCO_2^e in the 2023 period (Table 11). The potential emissions of Origin's activities represent between 0.05% and 0.36% of the total NT GHG emissions for 2020 or 0.0015% to 0.01% of Australia's total emission.

Table 11: Greenhouse gas emission estimates from the Beetaloo Sub-basin—all Origin approved activities 2021–2023

Activity	2021	2022	2023
Beetaloo W-1 EMP (this scope)	46	46	46
Amungee NW-1H EMP	2,405	0	0
Kyalla 117 N2-1 drilling, stimulation and well testing[2]	4,865[3]	0	0
Velkerri 76 S2-1 drilling, stimulation and well testing	817	17,998	0
Kyalla 117 N2-2&3 drilling, stimulation and well testing[4]	0	30,398	30,397
Future (potential, not approved) two additional E&A wells and associated water bores, civil construction and drilling, stimulation and 3-months well testing (this assumes ongoing E&A success)	0	0	27,225
Forecasted annual emissions	**8,133**	**48,442**	**57,668**

When considering the broader emissions from the Beetaloo Sub-basin oil and gas explorers, the anticipated total (not annualised) emissions are between 222,906 to 335,786 tCO2e. This represents between 1.4% and 2.1% of the total NT GHG emissions for 2018 or 0.04% to 0.034% of Australia's total 2018 GHG emissions. It should be noted that this cumulative estimate is extremely conservative as it:

- Assumes all E&A wells are drilled and other associated activities are completed
- Assumes E&A wells stimulated are successful and trigger well testing
- Covers activities spread over multiple years

In comparison to the emission estimates from the other NT sectors (Figure 11), the foreseeable emissions from the onshore oil and gas industry in the Beetaloo Sub-basin is substantially lower than that of Stationary Energy (7,015,000tCO_2^e), land use, land use change and forestry (5,507,000 tCO_2^e) and agriculture (3,192,000 tCO_2^e) (Department of Industry, Science, Energy and Resources, 2018).

On a regional, national and activity perspective, the emissions from the industry are not considered significant.

[2] Assumes a total of 9-months of well test
[3] This is based upon the estimated remaining 2021 Kyalla 117 N2-1H scope
[4] Assumes a 6-month well test of all three E&A wells on the Kyalla 117 N2 site with activities split across the 2021/22 calendar year

Figure 18: Northern Territory, annual emissions by sector, 2005 and 2018

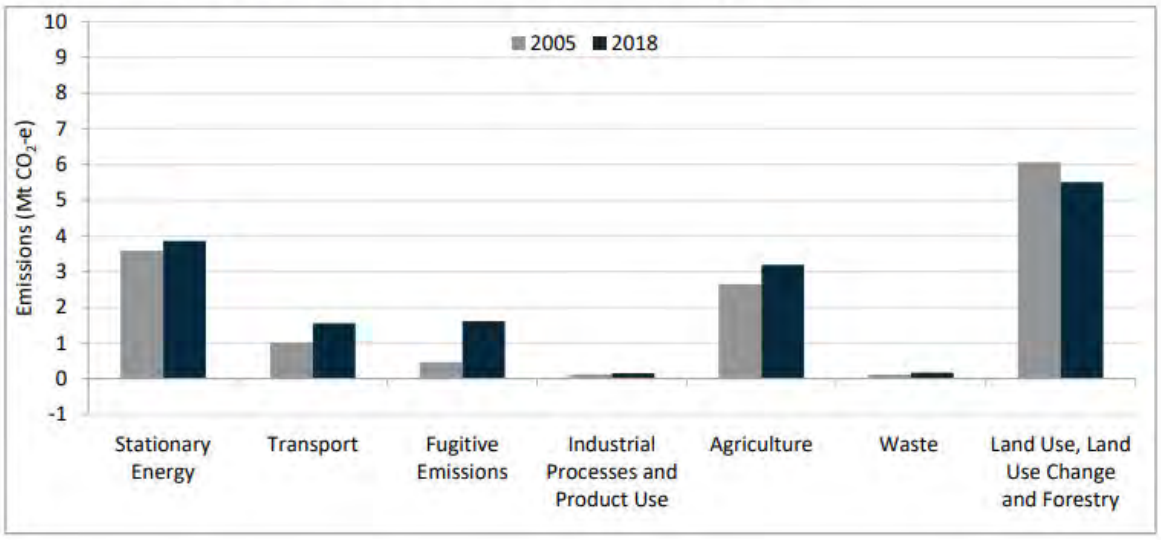

Figure 11: Exert from State and Territory Greenhouse Gas Inventory 2020 showing Northern Territory tonnes of CO2 equivalent by sector

3.17 Waste management

Waste management methods for the proposed exploration program are summarised in Table 12. Waste is managed in accordance with the internationally accepted guide for prioritising waste management practices, with the objective of achieving optimal environmental outcomes. Waste will be managed in accordance with the following hierarchy principals:

1. **Avoid:** eliminate the generation of wastes through design modification
2. **Reduce**: reduce unnecessary resource use or substitute a less resource intensive product or service
3. **Re-use**: re-use a waste without further processing
4. **Recycle**: recover resources from a waste
5. **Treatment**: treat the waste to reduce the hazard of the waste prior to disposal
6. **Disposal**: dispose of waste if there is no viable alternative

Waste transfer certificates for all listed waste will be retained and provided to DEPWS upon completion of the project. Historically, this has largely been restricted to waste oil and contaminated soils as most other regulated waste is either recycled or due to its insignificant volumes, backloaded with contractors who collectively dispose of this at their own facilities (i.e. a contractor will wait for multiple batteries to be ready for disposal rather than sending a waste collector out to recycle a single battery).

Wastewater produced during the program will be managed in accordance with section 3.14.

Table 12: Waste and disposal methods

Activity	Disposal method
Chemical container and cardboard packaging materials	**Recycled:** Compacted and collected at the site for transport to a licenced recycling centre

Activity	Disposal method
Food waste, paper and plastic	**Disposal:** Collected in dedicated waste bins for back-loading to an approved landfill
Extraction bore drilling cutting, muds and formation water (cuttings mixed with drilling fluids)	**Disposal** Freshwater, drilling cuttings and muds produced during water extraction bore drilling will be disposed of on-site in accordance with the Minimum Construction Requirements for Waters bores in Australia (ed.4 2020) for water bore drilling practices. Groundwater will be released to the ground in a controlled manner to minimise the risk of erosion. Cuttings will be raked and assimilated into the lease pad soils.
Glass and cans	**Recycled:** Collected in separate waste bins for recycling at an off-site facility
Secondary containment liners	**Disposal:** Used liners will be disposed of off-site at a licenced facility
Oily rags, oil-contaminated material, filters and any hydrocarbon material	**Recycled/Disposal**: Oil from machinery or encountered during drilling. Collected in suitable containers for disposal at approved landfill or recycled at an approved recycling facility.
Scrap metals	**Recycled:** Collected in designated skip for recycling at an approved location
Sewage and grey water	**Treatment:** Grey water and sewage treated and disposed of on-site in an approved, portable treatment system accordance with Department of Health Code of Practice for small on-site sewage and sullage treatment systems and disposal for reuse of sewage effluent. Sewage treated will be surface irrigated to a dedicated, fenced area. The area will be left vegetated, with no clearing required. Sludge removed from site and disposed of at an appropriately licenced facility. Uncontaminated stormwater will be tested (refer sections 3.12 and 3.15) and either released off-site or re-used for dust suppression.
Spill contaminated soils and water	**Disposal:** All contaminated material (solids and liquids) will be disposed of off-site at a licenced facility
Stormwater	**Discharged/Recycled/Disposal:** All stormwater will be collected on-site in a designated sediment retention system as described in section 3.15. Stormwater will be tested and either released off-site or recovered and either recycled within the drilling process or disposed of at a

Activity	Disposal method
	licenced wastewater treatment facility in accordance with the *NT Waste Management and Pollution Control Act 1998*.
Timber pallets (skids)	**Recycled:** Recycled at an approved facility
Vehicle tyres	**Disposal:** Disposed of at an approved landfill

3.18 Traffic

The access to Beetaloo W-1 site is via an existing pastoral access track located off the Stuart Highway, approximately 90km south of the town of Daly Waters (refer Figure 2). The Highway has a 130km/h posted speed limit in the vicinity of the project and is generally a two-lane, two-way road with a sealed width of 7 metres and unsealed or grassed shoulders varying between 2.5 and 5 metres in width. A conservative 700-1000 vehicle/hr/figure was used to determine the vehicle movement capacity of the Stuart Highway.

The periods of highest traffic generated from the Beetaloo W-1 activities will occur over a short duration associated with ad-hoc well intervention or maintenance activities. The peak maximum anticipated traffic flow increase associated with the activity is conservatively estimated at 10 vehicles per day during discrete activities. These periods of traffic are likely to be restricted to a 1-2 week period per year. Typical traffic levels outside of peak times (i.e. the remaining 50 weeks of the year) are likely to be one vehicle per fortnight. The anticipated traffic volume is considered insignificant when compared to the estimated LOS. Due to the limited increase in traffic volumes proposed by this activity, the risks associated with traffic is considered low.

3.19 Cumulative impact summary

This section provides a summary of the cumulative impacts associated with the proposed activity in accordance with Section 3b of the NT Petroleum (Environment) Regulations 2016. These include cumulative impacts associated with groundwater extraction, flora and fauna, greenhouse gas generation, traffic and social impacts. The assessment of cumulative impacts is summarised in Table 13.

Table 13: Summary of cumulative impacts addressed within the EMP

Aspect	Summary	EMP section
Water	Groundwater extraction cumulative impacts assessed under the Water Extraction Licence GRF 10285. This includes water use for Origin's future exploration program, adjacent petroleum operators and surrounding users. No material impacts on surrounding users expected.	Section 3.113.7
Flora and fauna	No additional clearing is proposed under this EMP. All other petroleum operators and pastoralists required to have a weed management plan.	Section 4.2
Greenhouse gases	Cumulative emissions from all of Origin's 2021-2023 activities has been provided. Emission levels are mainly attributed to	Section 3.16

Aspect	Summary	EMP section
	flaring. In a development scenario, gas production is likely to have 50% less emissions than coal, thus playing an important role as a transition or firming fuel to support large scale renewable energy supply. Other low emissions energy options, such as carbon capture and storage (CCS) enabled blue hydrogen , may reduce this emission level even further	
Traffic	Impacts of traffic are anticipated to be minor, with no reduction in level of service of the Stuart Highway. Maximum peak traffic level assessment considers cumulative user traffic load, with project movements anticipated to be 16 movements per day during demobilisation.	Section 3.18
Social	Risk associated with increased competition for labour from exploration activities, including other petroleum operators is low and well within the capacity of existing service providers. Ongoing engagement with local and regional businesses is underway, providing information and updates on the status of any future projects. Increased industrialisation of landscape resulting in a loss of amenity and tourism value considered low due to limited extent of petroleum activities, including from other petroleum or mining operators.	Section 4.6

3.20 Rehabilitation

The Beetaloo W-1 site forms part of Origin's ongoing exploration program, with ongoing activities beyond the scope of this EMP likely in the future. Once a determination has been made to decommission this site, the Beetaloo W-1 exploration well will be plugged and decommissioned, with the site (including gravel pits) rehabilitated in accordance with the Rehabilitation Management Plan (section 7.5) and the Code of Practice.

3.21 Timeframes

The anticipated key activity dates for the regulated activities are detailed in Table 14 and illustrated in Figure 12. It should be noted that the below timeframes are indicative, with final dates and decision to complete activities dependent on a range of additional considerations, including access, commercial and joint venture constraints.

Table 14: Anticipated activity dates

Activity	Estimated dates
Beetaloo W-1 site civil maintenance	May/October annually
Beetaloo W-1 site weed inspection	May/October annually
Beetaloo W-1 site leak detection	May/October annually
Beetaloo W-1 site erosion and sediment control	May/October annually
Beetaloo W-1 DFIT test	Q3/4 2021
Beetaloo W-1 12 month well maintenance	August annually
Beetaloo W-1 well abandonment	Q3 2026
Beetaloo W-1 lease pad rehabilitation	Q3 2026

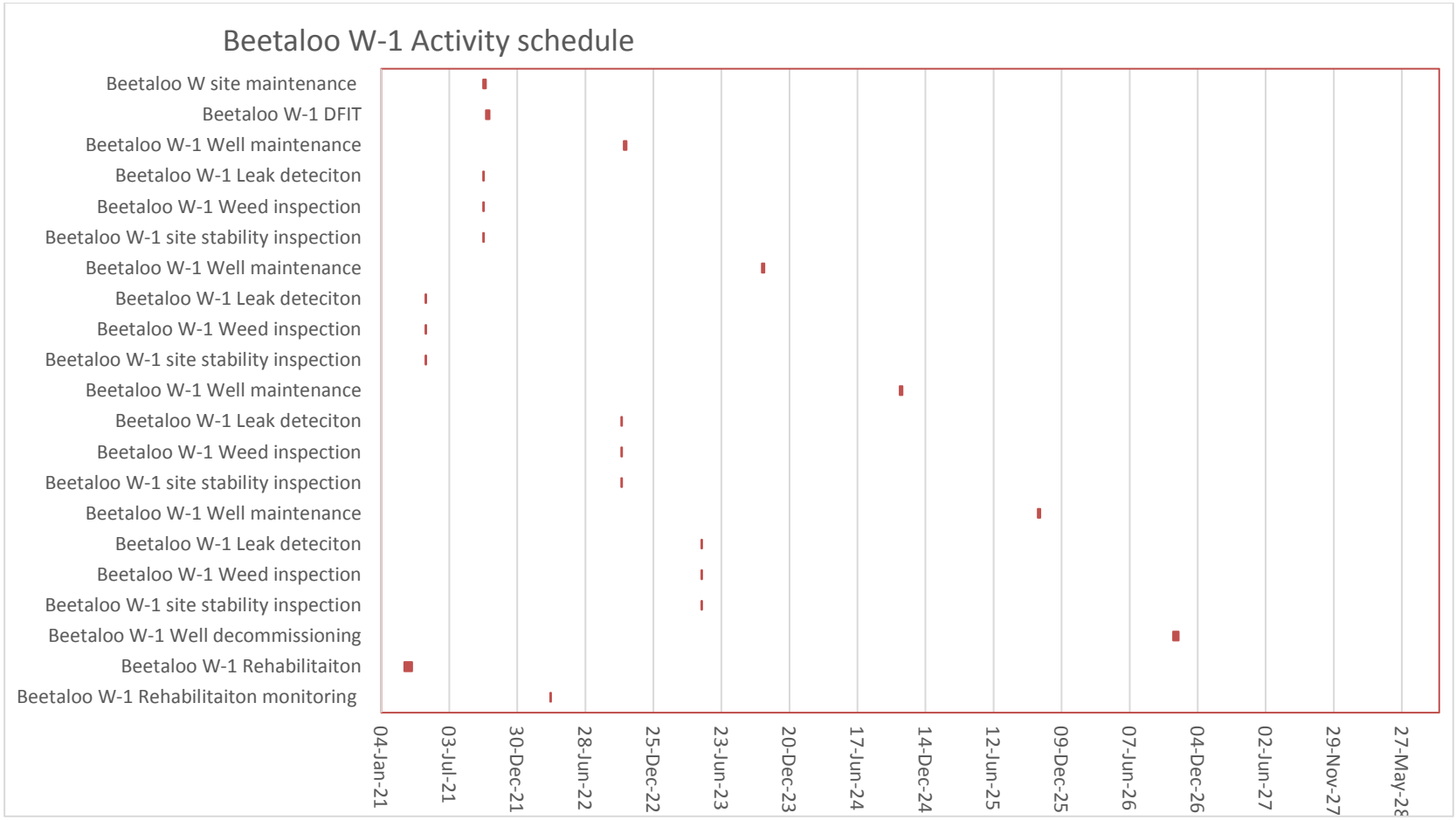

Figure 12: Timeline of Beetaloo W1 activities

4 Description of the existing environment

4.1 Physical environment

4.1.1 Climate

The climate of the permit areas is arid to semi-arid, with rainfall decreasing in frequency and quantity from north to south. The climate is monsoon influenced, with a distinctive wet summer between October and March, and a dry winter season between May and August. September and April are transitional months with occasional rainfall.

Rainfall in the north of the Beetaloo exploration area is recorded at 681mm at Daly Waters. The southern portion of the permit area records an average annual rainfall of 536mm at Newcastle Waters and 602mm at Elliott. Approximately 90% of the rainfall occurs during the wet season.

The area is characterised by a net precipitation deficit of between -1,800 to -2,150mm per year.

4.1.2 Geology

The Beetaloo Sub-basin comprises a thick sequence of mudstone and sandstone formations (er Group) that were deposited approximately 1,500-1,300 million years ago (Ma) (Table 16). The Roper Group is estimated to reach 5,000m 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 CLA comprises Anthony Lagoon Formation (upper CLA) and Gum Ridge Formation (lower CLA). The Georgina Basin is capped unconformably by a thin section of Cretaceous mudstone and sandstone (Albian aged ~100-113 Ma) and recent alluvial and laterite deposits.

At Beetaloo W-1, the organic-rich mudstone units of the middle Velkerri member of the Velkerri Formation (primary target) and the Kyalla Formation (secondary target) are considered viable shale targets. The Amungee Member of the Velkerri Formation typically comprises three organic-rich, mudstone and siltstone units separated by organic-lean, finely interbedded, variable mud, siltstone and sandstone rich intervals. The organic-rich units are informally referred to as the A, B and C shales (from oldest to youngest).

The Kyalla Formation displays a thick sequence of predominantly silty and micaceous mudstone with thin interbeds of siltstone and sandstone. Intermittent supply of course siliciclastic material also resulted in the formation of isolated packages of bedded sandstones. Three prospective shale intervals have been identified within the gross Kyalla Formation package and informally referred by Origin as the “upper Kyalla shale”, “middle Kyalla shale”, and “lower Kyalla shale”. Thermal maturity indicators including Methylphenanthrene (MPI) Index with vitrinite reflectance equivalent (Vre 0.66%) at Jamison-1 suggest the upper Kyalla shale lies primarily within the late stage of early oil generation window, whereas the middle and lower Kyalla shale’s fall within the late condensate gas to wet gas generation window.

The prospective target shales within the Velkerri and Kyalla are overlain with thick series of low permeability units (mudstone, siltstones, tight sandstone and Volcanic units) Kyalla Formation, Hayfield formation and Antrim plateau Volcanics. These formations provide an effective geological barrier, with the Gum Ridge formation separated from the closest prospective shale formation (the upper Kyalla shale at 1,033m) by approximately 600m.

4.1.3 Soils

The Stuart Plateau bioregion covers an area of 103,857 km^2 and comprises undulating plains on sandstones, with mostly neutral sandy red and yellow earth soils (ANRA, 2008).

The soil types located within the plateau range from the very strongly leached lateritic soils of the Tertiary land surface to the calcareous desert soils and desert loams in the southern drier areas.

The lateritic plains, located within EP98, are classed as very strongly leached soils of the Tertiary land surface. The three (3) main soil types located within the permit area, include:

1. **Tertiary Lateritic Red Earths:** which occur on the gently undulating topography. The soil profile can be described as:
    - **A-Horizon** Grey-brown sandy loam
    - **B-Horizon** Reddish-brown sandy clay loam
    - **C-Horizon** Red-brown to red light clay, overlying heavy ferruginous gravel and massive laterite
2. **Tertiary Lateritic Red Sands:** which occur on gently undulating to undulating topography of the Tertiary Lateritic Plain, formed from sandstones and complex parent materials of the deep sandy soils. The soil profile can be described as:
    - **A-Horizon** Grey-brown to brown sand
    - **B-Horizon** Brown sand
    - **C-Horizon** Red-brown to yellow-brown sand overlying pisolitic ferruginous gravel and massive laterite. Altered colouring of highly siliceous parent sandstone is only evident in the mottled and pallid zones
3. **Tertiary Lateritic Podzolic Soils:** formed on the gently undulating topography over a variety of rocks. These soils are located in the northern section of the Barkly Basin. The soil profile can be described as:
    - **A-Horizon** Grey sand
    - **B-Horizon** Yellowish-grey sand
    - **C-Horizon** Yellow-grey sandy loam with ferruginous gravel overlying massive laterite, mottled and pallid zones

Table 15 presents the erosion risk rating based on average monthly rainfall using the rating system provided in the IECA (2008) Table 4.4.2 for Daly Waters. All construction activities are anticipated to be undertaken on the existing lease pad with no additional clearing proposed. All civil construction activities will be conducted on the existing disturbed lease pad and are planned to be undertake in the dry season. The overall risk of erosion is considered very low.

Table 15: Erosion risk rating based on average monthly rainfall at Daly Waters

Item	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sep	Oct	Nov	Dec
Rainfall (mm)	165.4	165.4	120.1	23.6	5.0	5.6	1.5	1.7	4.9	22.5	59.4	110
Erosion risk*	H	H	H	VL	VL	VL	VL	VL	VL	VL	M	H

** E = Extreme (>225 mm); H = High (100+ to 225 mm); M = Moderate (45+ to 100 mm); L = Low (30+ to 45 mm); VL = Very Low (0 to 30 mm)*

4.1.4 Hydrology

The existing Beetaloo W-1 lease site falls within the Wiso River Basin. The Wiso River Basin covers the southern half of EP98 (south of the Carpentaria Highway) and the majority of EP76 and EP117 and is internally drained by Newcastle Creek and a number of small ephemeral creeks.

Newcastle Creek is approximately 9.3km to the south east of the lease pad and ultimately flows into Lake Woods, which is located approximately 60km to the south-west. Lake Woods covers an area of inundation of approximately 50,000ha in normal rainfall years, extending to 80,000ha in exceptionally wet years, after which it can retain water for several years (HLA, 2005). Lake Woods is described as a major quasi-permanent surface water body and is listed on the NT Government Sites of Conservation Significance and on the Directory of Important Wetlands in Australia (HLA, 2006b).

There are no major creeks in the immediate proximity of Beetaloo W-1 site that are likely to be directly impacted by the activities. The closest water course is an un-named tributary of Newcastle Creek (stream order 1) 8.5km from the Beetaloo W-1 lease pad.

During the wet season, it is likely the broader region could experience widespread periodic surface flooding, to a depth of 30cm, which has previously been identified by debris being collected on fence lines (HLA, 2005). However, the Beetaloo W lease is likely to remain dry as it is higher than surrounding areas.

4.1.5 Hydrogeology

Within the Beetaloo exploration area, groundwater use is primarily from the Cambrian Limestone Aquifer (CLA) with minor, localised use from other formations where shallower groundwater is intersected or where the CLA is not saturated. This includes:

- Overlying Cretaceous sediments where it is saturated in the central-south of the Beetaloo Sub-basin
- The Antrim Plateau Volcanics in the north-west
- The Bukalara Sandstone in the north-east.

Table 16 summarises the encountered stratigraphy confirmed during the Beetaloo W-1 exploration well drilling.

Across parts of the Beetaloo Sub-basin, undifferentiated Cretaceous deposits form the uppermost aquifer are targeted for stock use. Notably, a basal sandstone unit immediately overlying the CLA produces yields of up to 5L/s. Shallow, perched groundwater has also been documented in the laterised zone within the permit area with groundwater levels recorded between 1 and 6mbgl. These systems are dynamic with periodic saturation resulting from recharge during the wet season with no documented groundwater use. The CLA, comprising the Gum Ridge Formation and the Anthony Lagoon Beds, is an extensive regional aquifer system that forms the principal groundwater resource in the Beetaloo Sub-basin. The limestone in the CLA is commonly fractured and cavernous; regionally

bore yields of up to 100L/s have been recorded from this aquifer. In the vicinity of Beetaloo W-1, three formations contain viable groundwater resources including the undifferentiated Cretaceous, Anthony Lagoon Beds and Gum Ridge Formation. At Beetaloo W-1, the depth to groundwater is approximately 73 metres with little difference between the pressure heads in the three aquifers.

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 to be in the order of 100,000ML/year (NALWTF, 2009). Existing groundwater use in the Beetaloo Sub-basin is estimated at 6,000ML/year, primarily used for agricultural production (Fulton and Knapton 2015).

The Antrim Plateau Volcanics conformably underlies the CLA in the north and central part of the Beetaloo Sub-basin. Across much of the Basin it consists of sequences of massive basalt flows with negligible primary porosity. In the north-west of the Basin, where the formation is shallow and fractured, it forms a marginal aquifer, 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 exploration permits 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 100km north-west of the Beetaloo Sub-basin. Dry season flow in the Roper River has been gauged at 95,000-126,000ML/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. A Geological and Bioregional Assessment project led by CSIRO is currently collecting additional information on this recharge mechanism.

Limited information exists on the hydrogeological characteristics of the deeper Roper Group and undefined Neoproterozoic group sequence is available as it occurs at depth within the Beetaloo Sub-basin. This unit lies below the Georgina Basin which contains the CLA and other important aquifers. The deeper sandstone dominated formations may behave as aquifers, however, drilling results suggest these formations have limited potential as groundwater resources due to their depth, low permeability and high salinity. Groundwater in the Roper Group and undefined Neoproterozoic group is highly saline and contrasts with the shallower, utilised aquifers of the Georgina Basin sediments in which groundwater is generally of drinking water quality. A schematic of the Beetaloo W-1 within the underlying geological formations is provided in Table 16.

Table 16: Summary hydro-stratigraphy at the Beetaloo W-1 site

Province	Period/Age	Formation		Aquifer status	Encountered Depths (top and bottom) (mMDRT)	Regional Yield (L/s)	Avg. regional EC (ms/cm)
CARPENTARIA BASIN	CRETACEOUS ALBIAN (100-113Ma)	Undifferentiated		Regional aquifer—Undersaturated at location	0-138m	0.3-4	1,800
GEORGINA BASIN	CAMBRIAN	Cambrian Limestone Aquifer (CLA)	Anthony Lagoon Formation	Regional aquifer	138-260	1-10	1,600
			Gum Ridge Formation	Regional aquifer	260-437	0.3- >20	1,400
		Antrim Plateau Volcanics		Regional aquitard	437-574	0.3-5	900
		Bukalara Sandstone		Regional aquifer	Absent	0.3-5	1,000
Undefined—under NTGS review	NEOPROTEROZOIC	Hayfield Formation		Regional saline aquifer	574-865	ID	32,000
		Jamison Sandstone		Local saline unit	865-986	ID	138,000
BEETALOO SUB-BASIN (ROPER GROUP)	MESOPROTEROZOIC 1,300-1,500 Ma	Kyalla Formation		Regional aquitard	986-1,773	ID	ID
		Moroak Sandstone		Local saline unit	1,773-2,225	0.5-5	131,000
		Velkerri Formation		Regional aquitard	2,225-3,173	-	-

ID – insufficient data

4.1.5.1 Groundwater monitoring results

Baseline monitoring data has been collected from a network of groundwater bores across Origins EPs commencing in 2016 until present. A summary of the baseline monitoring data from the nearest groundwater bores that have been regularly monitored is provided in Table 17. Groundwater from these bores is interpreted to be from a combination of undifferentiated Cretaceous and Anthony Lagoon Beds. No bores are believed to intersect the Gum Ridge Formation within 30km of Beetaloo W1. Additionally, data collected during Origin's Beetaloo exploration program can be accessed via

the DEPWS website located at: https://depws.nt.gov.au/onshore-gas/onshore-gas-in-the-northern-territory/industry-compliance-and-reporting/groundwater-monitoring-results.

Table 17: Summary of groundwater monitoring results collected in the area closest to the Beetaloo W-1 site

			RN038492 (Beetaloo W-1 water bore)			RN037676		
Analyte	**unit**	**Reporting limit**	**No. results**	**Average**	**Maximum**	**No. results**	**Average**	**Maximum**
Alkalinity (Bicarbonate) as CaCO3	mg/L	1	6	53	58	3	236	251
Alkalinity (Total) as CaCO3	mg/L	1	6	53	58	3	236	251
Anions Total	meq/L	0.01	6	3.9	4.1	3	11	12.1
Calcium (Filtered)	mg/L	1	6	18	20	3	59	62
Cations Total	meq/L	0.01	6	4	4.32	3	11	11.6
Chloride	mg/L	1	6	70	79	3	170	179
Electrical Conductivity (Lab)	µS/cm	1	6	457	499	3	1,180	1,280
Magnesium (Filtered)	mg/L	1	6	16	17	3	40	44
Methane	mg/L	0.001	6	0.0099	0.052	3	0.0005	<0.001
pH (Lab)	pH_Units	0.01	6	6.7	7.55	3	7.4	7.59
Potassium (Filtered)	mg/L	1	6	7.8	9	3	9.7	11
Sodium (Filtered)	mg/L	1	6	37	40	3	107	111
Sulphate as SO4 (Filtered)	mg/L	1	6	41	43	3	87	102
Total Dissolved Solids	mg/L	1	6	243	254	3	613	668

			RN035824			RN036917		RN039992	
Analyte	**unit**	**Reporting limit**	**No. results**	**Average**	**Maximum**	**No. results**	**Maximum**	**No. results**	**Maximum**
Alkalinity (Bicarbonate) as CaCO3	mg/L	1	3	40	42	1	249	1	283
Alkalinity (Total) as CaCO3	mg/L	1	3	40	42	1	249	1	283
Anions Total	meq/L	0.01	3	3	3.14	1	17.9	1	9.73
Calcium (Filtered)	mg/L	1	3	14	14	1	91	1	71
Cations Total	meq/L	0.01	3	2.9	3.06	1	17.2	1	9.76
Chloride	mg/L	1	3	48	50	1	275	1	70
Electrical Conductivity (Lab)	µS/cm	1	3	368	382	1	1850	1	918
Magnesium (Filtered)	mg/L	1	3	11	12	1	50	1	44
Methane	mg/L	0.001	3	0.0097	0.022	1	0.006	1	<0.001
pH (Lab)	pH_Units	0.01	3	6.3	6.49	1	7.51	1	7.72
Potassium (Filtered)	mg/L	1	3	5.3	6	1	11	1	13
Sodium (Filtered)	mg/L	1	3	27	28	1	190	1	52
Sulphate as SO4 (Filtered)	mg/L	1	3	42	43	1	248	1	101
Total Dissolved Solids	mg/L	1	3	227	266	1	1,000	1	518

4.2 Biological environment

The description of the biological environment of the existing Beetaloo W-1 site has been described previously in the Beetaloo Sub-basin, EP98 and 117 Exploration drilling EMP, approved 30/06/2015.

A summary of the plan is available at:
https://depws.nt.gov.au/__data/assets/pdf_file/0010/258607/Origin-2015-Environmental-Plan-SummaryBeetaloo-Sub-Basin.PDF

An additional environmental survey of the Beetaloo exploration area (EP76, EP117 and EP98 containing the Beetaloo W-1 site) was completed in August 2018 (AECOM, 2018). The following section draws on previous reports and surveys, along with updated (March 2021) EPBC Protected Matters Search Report (PMSR) and searches of the NT NR Maps databases for the Beetaloo W site.

4.2.1 Bioregions

The Beetaloo W-1 lease site falls within the Stuart Plateau bioregion. The bioregion is characterised by undulating plains on sandstone with predominantly neutral sandy red and yellow earth soils. Dominant vegetation associations included extensive areas of Lancewood (*Acacia shirleyi*), Bullwaddy (*Macropteranthes kekwickii*) vegetation and associated fauna, including the Spectacled Hare-Wallaby (*Lagorchestes conspicillatus*). Land condition in the bioregion is moderate to good but is threatened by impacts from weeds, feral animals, pastoralism and changed fire regimes.

4.2.2 Vegetation communities

Vegetation communities within the permit areas have been ground-truthed during baseline assessments in 2004, 2006 (HLA, 2006; 2006c), 2010, 2014, 2016 and more recently in August 2018 (AECOM, 2011; 2014; 2016 and 2018). Surveys at the existing Beetaloo W site were completed in August 2014 and August 2018.

The Beetaloo W location has been evaluated through detailed habitat assessments which included identification of vegetation community, dominant flora species at each strata, habitat condition, disturbance factors (fire, weeds, erosion, feral fauna species), and fauna attributes (e.g. tree hollows, logs, grass cover, mistletoe abundance). The area of the proposed activity is largely characterised as Eucalyptus low woodland/Eucalyptus (mixed) low open woodland/Iseilema (mixed) tussock grassland. Adjacent vegetation communities include *Macropteranthes kekwickii* (Bullwaddy) low woodland/*Chrysopogon* (mixed) open tussock grassland. The access track to the lease pad is characterised as *Corymbia spp* open woodland with mixed *Terminalia spp*. shrubland over low tussock grassland (*Triodia bitextura*), with interspersed Bullwaddy and Lancewood communities dissected by the existing access track. The vegetation communities are considered regionally extensive and not subjected to extensive clearing. A summary of the survey of the existing Beetaloo W-1 site is shown in Table 18.

Table 18: Beetaloo W-1 summary of existing environment

Site ID	Beetaloo W-1	Habitat survey photos of the vegetation/habitat of the surrounding environment	
Location	17.12038 S 133.76165 E		
Landform and soil	Plains and rises associated with deeply weathered profiles (laterite) including sand sheets and other depositional products; sandy and earth soils		
Habitat type	Open eucalypt woodland		
Vegetation community	Open woodland with a dense shrub (Acacia) and grass layer		
Dominant flora species	Canopy dominated by *Acacia shirlyi, Bullwaddy, Corymbia dichromophloia*. Shrub layer including *Acacia lysiphloia, Acacia polycarpa, Terminalia canescens.* Ground layer species include *Aristida latifolia, Gardenia ewartii, Triodia bitexta*		
Habitat condition	No core habitat for threatened fauna was identified at the sites. Good condition with evidence of grazing. Hollow bearing trees and logs were sparse throughout the area. The habitat contained moderate refuge opportunities in the form of leaf litter, grass cover, and woody debris. Good		

Site ID	Beetaloo W-1	Habitat survey photos of the vegetation/habitat of the surrounding environment
	continuous cover adjoining adjacent woodland habitat. Vegetation is noted to be multi-aged with some fire scars, suggesting this is the cause of the age differences. No evidence of weeds or feral animals. No wetlands recorded; however, it was noted that more bird calls present at this location.	**Hydrogeology** Groundwater resources are likely to be available from the uppermost 3 geological formations, being the undifferentiated Cretaceous, Anthony Lagoon Beds and Gum Ridge Formation. For this project, groundwater used to support the program is anticipated to be restricted to the Gum Ridge Formation. The Anthony Lagoon formation and undifferentiated Cretaceous while saturated at this site are unlikely to be extraction target.
Potential listed threatened species	Some species may possibly occur and are known to occur in the wider landscape. Threatened species Grey Falcon, Northern Shrike-tit, Yellow-spotted Monitor, Plains Death Adder, Gouldian Finch. The activity is not anticipated to impact upon these species.	
Weeds	No Weeds of National Significance or weeds declared under the *NT Weeds Management Act 2001* present.	

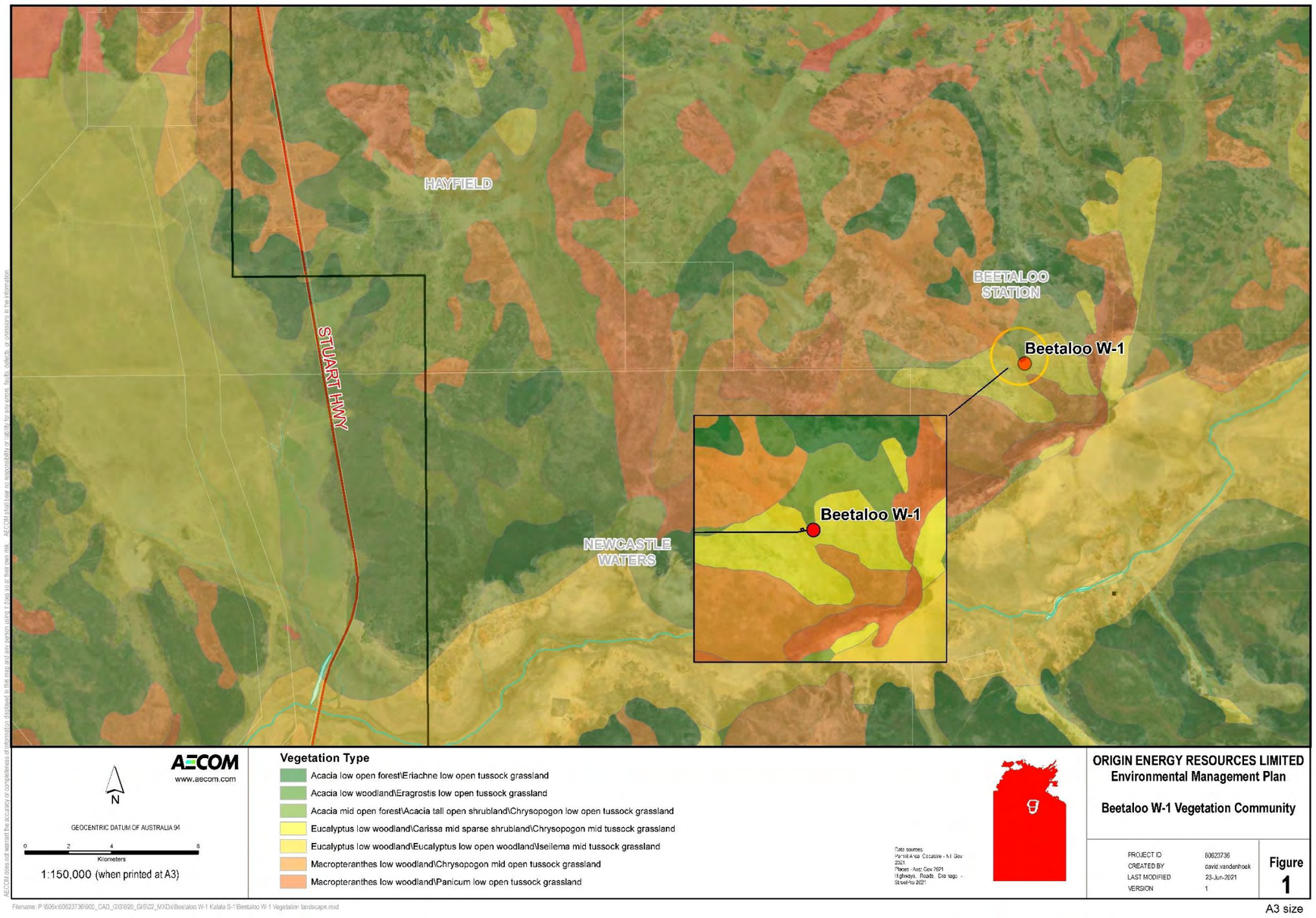

Figure 13: Vegetation communities surrounding the Beetaloo W-1 site

4.2.3 Flora

A total of 805 plant species have been recorded within the wider region, and during the August 2018 survey, 28 dominant flora species were identified. As the survey was conducted during the late dry season, grasses and other annual species were difficult or impossible to identify due to the lack of inflorescence or because they had already died-back.

No Commonwealth or NT threatened plant species were identified as occurring by the Protected Matters Searches or NRMap search.

The region supports fragmented stands of Bullwaddy, which is listed under the *TPWC Act* as 'Least Concern', which refers to species that are either widespread or common and cannot be categorised as Critically Endangered, Endangered, Vulnerable, Near Threatened or Data Deficient. However, Bullwaddy is significant in terms of the habitat it provides for a range of native species. The extent of Bullwaddy in the permit area is far more extensive than that indicated by the NT Herbarium records. Some clearing of Bullwaddy is likely to be required as part of the proposed exploration program.

4.2.4 Weeds

Regional Weed Management Plans (RWMP) have been developed for areas of the NT, with the Barkly and the Katherine RWMP overlapping Origin's Beetaloo exploration area.

The weed species of high risk of introduction or spread through Origin's activities are listed in Table 19. These high-risk weeds have been determined through consideration of the following criteria:

- Weed species that has been confirmed in the area within the relevant RWMP or through field surveys
- Weed species listed in a RWMP that are in close proximity to Origin tenure
- Weed species that is at risk of introduction through the use of machinery sourced from other regions in the NT or from other states

Weed baseline surveys were completed by AECOM in August 2018 covering the Beetaloo W-1 site and access tracks. Further surveys have been completed every 6 months since the original 2018 baseline exercise. These surveys have been completed with the DEPWS Weed Officer. The known locations of weeds on the Beetaloo W-1 site (from recent 2020 surveys) are provided in Figure 14.

Parkinsonia aculeata (Parkinsonia) and *Calotropis procera* (Rubber Bush) have previously been identified along/in close proximity to the Beetaloo W-1 exploration well 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.

Additional information on the full list of weeds and control measures for the development are provided in the Beetaloo Weed Management Plan (Appendix B).

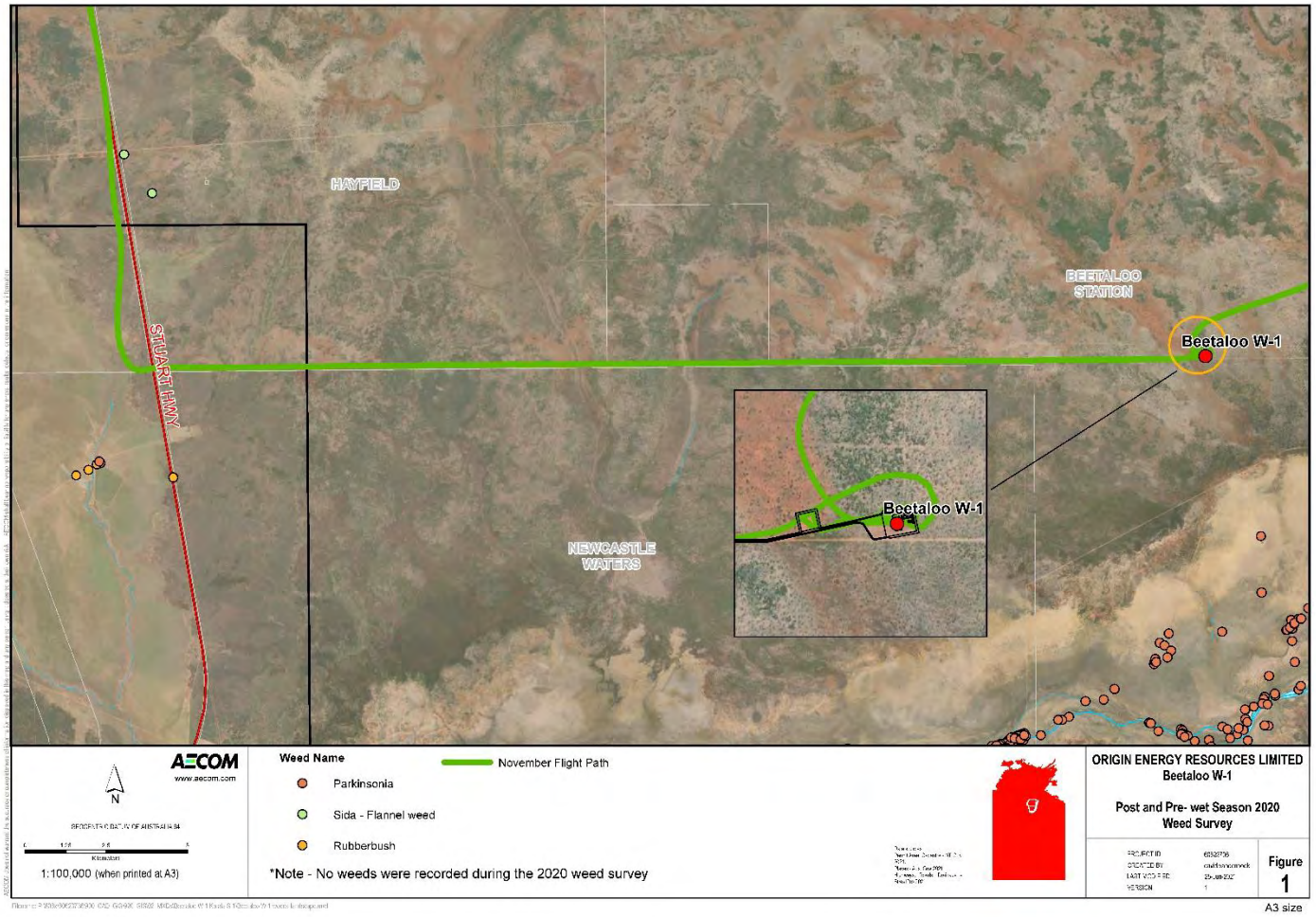

Figure 14: 2020 weed survey of the Beetaloo W1-2

Table 19: High priority weeds to be managed or prevented within the Beetaloo exploration area

Scientific name	Common name	Status	Priority reason
Acacia nilotica	Prickly Acacia	Class A, WoNS	Mapped in the exploration lease within the Katherine RWMP
Andropogon gayanus	Gamba Grass	Class A, WoNS	Mapped in the exploration lease within the Katherine RWMP
Calotropis procera	Rubber Bush	Class B and C	Mapped in the exploration lease within the Barkly RWMP
Hyptis suaveolens	Hyptis	Class B and C	Confirmed within exploration lease during previous weed Origin surveys
Jatropha gossypiifolia	Bellyache Bush	Class A, WoNS	Mapped in the exploration lease within the Katherine RWMP
Parkinsonia aculeata	Parkinsonia	Class B and C, WONS	Confirmed within exploration lease during previous weed Origin surveys and Mapped in the exploration lease within the Katherine RWMP
Prosopis pallida	Mesquite	Class A and C, WONS	Mapped in the area surrounding exploration lease within the Katherine and Barkly RWMP
Themeda quadrivalvis	Grader Grass	Class B and C, WoNs	Mapped in the area surrounding exploration lease within the Katherine RWMP. High potential introduction through sourcing of equipment from Katherine area
Xanthium occidentale	Noogoora Burr	Class B and C	Weed Management Branch—Mapping data DLRM databases (DLRM et al. 2018)
Parthenium hysterophorus	Parthenium	Class A and Class C, WoNS	Located in the broader region and potential introduction through equipment sourced from QLD

4.2.5 Fauna

Previous surveys and database searches indicate that the broader Beetaloo exploration area is an important area for a diverse array of fauna. The NT Fauna database provides records for the following

fauna species (excluding migratory birds): 32 species of mammal, 198 species of birds, 96 species of reptiles and 19 species of frogs. Surveys undertaken elsewhere within the region have recorded:

- 78 bird, 33 reptile, 11 mammal and 6 frog species in the Bullwaddy Conservation Reserve (PWCNT, 2005)
- 148 bird, 47 reptile, 21 mammal and 6 frog species in the Junction Stock Reserve and nearby Newcastle Waters (Fleming et al. 1983)
- 157 bird species within the project area as determined by a search of the Birds Australia Bird Atlas Database (Birds Australia, 2010)

The vegetation types (including open eucalypt woodland and Acacia forest/open woodland) in the region in the vicinity of the existing Beetaloo W-1 location provides habitat for a range of species. The areas have high native grass cover and include numerous species suitable for granivorous birds (seed eaters). Dense leaf litter and numerous logs provide suitable refuge and foraging sites for fauna such as reptiles. Many of the sites have a high density of hollow-bearing trees that provide important habitat for many fauna species. Although most of the species found in this vegetation type are widespread in the tropical savannas of the Northern Territory, some such as the threatened Crested Shrike-tit (*Falcunculus frontatus whitei*) are rare and known to utilise this habitat (DAWE, 2014, Ward, 2008).

In the broader area, Savanna grasslands and open woodland provide suitable habitat for species such as Emu (*Dromaius novaehollandiae*) and Australian Bush Turkey (*Ardeotis australis)*. Drainage lines and seasonally inundated grasslands may also provide habitat for migratory species during the wet season and are breeding areas for frogs. Due to the limited nature of the proposed regulated activity, disturbances on these areas or species are considered remote.

4.2.6 Significant fauna

The PMSR and searches of the NT NR Map fauna database, and records from the Atlas of Living Australia (ALA) of the Beetaloo exploration area indicate the potential presence of 12 fauna species listed as threatened under the *EPBC Act* and/or the *TPWC Act*. These included eight birds, three mammals and one reptile.

The likelihood assessment of species occurrence is based on the availability of suitable habitat within the permit area, records in the vicinity and distributional data. Therefore, many of the threatened and migratory fauna species indicated in databases as ‘occurring’ or ‘likely to occur’ have been assessed as ‘unlikely to occur’ within the proposed lease areas. As some areas in the proposed lease area have not been subject to intensive survey and some species are very cryptic, a conservative approach has been taken to assess species presence.

No core habitat for threatened fauna was identified at the sites (gravel pits, lease pad, camp pad and access tracks). However, some species possibly occur and are known to occur in the wider landscape. Threatened species that may possibly occur include:

- Plains Death Adder *(Acanthopsis hawkei)* (*Vulnerable EPBC Act* and *TPWC Act*)
- Gouldian Finch *(Erythrura gouldiae)* (*Endangered EPBC Act, Vulnerable TPWC Act*)
- Grey Falcon *(Falco hypoleucos)* (*Vulnerable TPWC Act*)
- Crested Shrike-tit (northern) *(Falcunculus frontatus whitei) (Vulnerable EPBC Act, Near Threatened TPWC Act)*
- Yellow-spotted Monitor *(Varanus panoptes) (Vulnerable TPWC Act).*

Given no clearing or intensive exploration activities are proposed activities, impacts on threatened fauna species resulting from the regulated activities covered in this EMP are considered unlikely.

4.2.7 Feral and pest animals

Feral animals known to occur within the region include:

- Pig (*Sus scrofa*)
- Wild dog (*Canis lupus familiaris*)
- Feral cat (*Felis catus*)
- Cane toad (*Bufo marinus*)
- Horse (*Equus caballus*)
- Donkey (*Equus asinus*)
- Water buffalo (*Bubalus bubalis*)
- Camel (*Camelus dromedarius*)
- Black rat (*Rattus rattus*)
- Domestic cattle (*Bos Taurus*)

During the August 2018 survey and previous exploration activities, cattle grazing occurs regularly in the areas adjacent to the Beetaloo W-1 site. Based on records and observations from sites in the broader Beetaloo exploration area, many species such as dogs/dingo, pigs and cane toads will be present in the vicinity of the site. The disturbance from cattle varies depending on the season, with the level of disturbance at the proposed sites likely to have resulted in less than 5% damage.

4.3 Fire regime

Fire is a natural occurrence in most Australian ecosystems and plays an important role in their ecology. Fire is generally excluded from Mitchell grasslands by pastoral management in order to maintain forage throughout the dry season (HLA, 2005), whereas fire is more frequent in the Stuart Plateau.

There was no evidence of fire impacts at the Beetaloo W-1 present during the 2018 survey. The mapped fire frequency across the Origin's tenure (including the Beetaloo W-1 site) is provided in Figure 15. The map highlights that the area is likely to have been burnt at least once since 2000.

A Bushfire Management Plan (BMP) has been developed to manage bushfire risks associated with the Beetaloo W site. This plan provides the hazard reduction strategies, resources and response to bushfire emergencies. The BMP is provided in Appendix A.

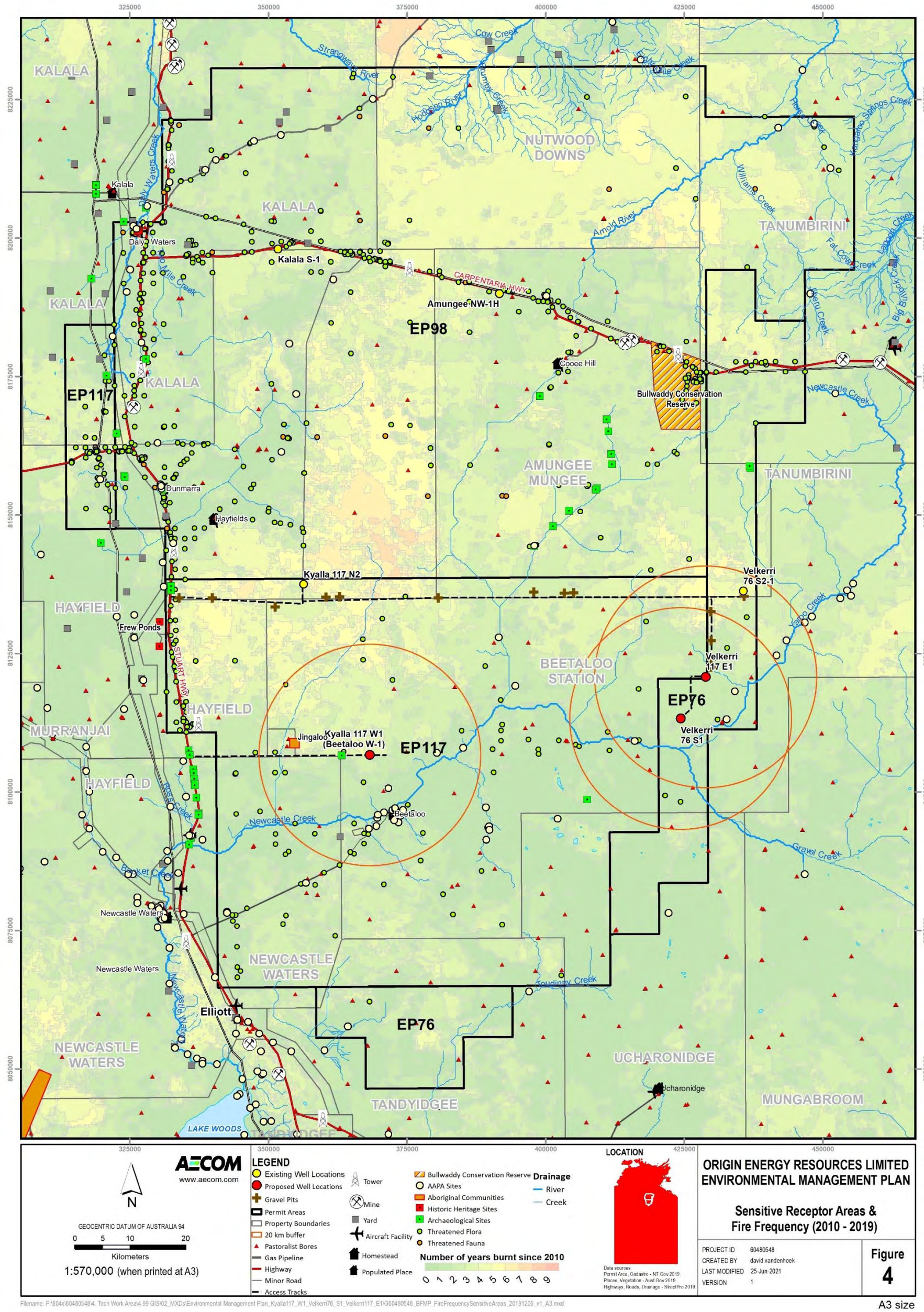

Figure 15: Fire frequency map of the Beetaloo Sub-basin

4.4 Groundwater Dependent Ecosystems

A search of the National Groundwater Dependent Ecosystems (GDE) Atlas was conducted on 20/05/2021. The dataset expresses the potential for groundwater interaction/use for river/spring/wetland ecosystems across Australia. It shows the ecosystems that rely on groundwater that has been discharged to the surface, such as baseflow or spring flow.

No known aquatic GDE are within 25km of the Beetaloo W-1 site. Several locations were identified as having a low-moderate aquatic GDE potential, all associated with Newcastle creek. Several potential (3:2 high and 1 low) terrestrial GDE associated with *Melaleuca citrolens* and *M. minutifolia* low woodland were also identified with the 25km buffer. All known and moderate potential GDE locations occurred at distances greater than 10km from the Beetaloo W-1 site.

Stygofauna are a form of GDE that inhabit the interstitial spaces of the cavities of alluvial, sedimentary and karstic aquifers. A recent report on stygofauna within the Beetaloo Sub-basin by the Gas Industry Social and Environment Research Alliance (GISERA) program identified the presence stygofauna assemblages in the CLA units of the Beetaloo Sub-basin[5], including within the vicinity of the existing Beetaloo W-1 site (Rees et al. 2020). The report found evidence of stygofauna being regionally extensive within the Beetaloo Sub-basin, with some species identified at locations separated by over 300km. This result logically confirms the continuity of the CLA and proves that stygofauna species are likely to be widespread across the basin. This reduces the potential risk of localised exploration activities on endemic stygofauna population, with the initial results indicating species are present regionally.

Based on the limited proposed groundwater extraction volumes and limited nature of the proposed activities at the Beetaloo W-1 site, impacts to GDE's and stygofauna are considered remote.

4.5 Environmental and cultural sensitivities

4.5.1 Native Title

One Native Title claim has been determined over the Beetaloo Pastoral station as defined in Table 20.

Table 20: Native Title and IULA Agreements current for EP117

Type	Well	Name	Summary
Native Title	Beetaloo W-1	NTD27/2010 Beetaloo Pastoral Lease	Native Title exists in parts of the determination area and is held by the Karranjini group; the Bamarrnganja group; the Warranangku group; the Pinda (OT Downs) group; and the Lija/Muwartpi group
Indigenous Land Use Agreement	All Sites	D12004/014 Jingaloo CLA ILUA	Registered for Community Living Area and Tenure resolution

The Native Title Petroleum Exploration Agreement between Origin and the NLC includes clauses for the protection of sacred sites, objects and sensitive areas related to Aboriginal activities in the area, including cultural, hunting and foraging activities. Site avoidance and clearance surveys occurred prior to any on ground activities and AAPA Certification is held for the location and all proposed activities.

[5] Further information is available on the GISERA website: https://gisera.csiro.au/wp-content/uploads/2021/03/GISERA-Project18-Stygofauna_final-report-20201208.pdf

The Native Title Agreement also includes clauses for the protection of the environment and site rehabilitation.

4.5.2 Archaeology assessment

An archaeological assessment, involving searches of the NT Heritage Register and Australia Heritage Database and a field survey, have been carried out by AECOM archaeologist, Luke Kirkwood, for the exploration sites and associated tracks. It should be noted that this survey covers additional sites that are not in the scope of this EMP.

A search of the NT Heritage Register identified 41 Aboriginal archaeological sites within a 125km by 125km area that encompasses the full area of Origins exploration sites. No archaeological sites are recorded within 15 km of any of Origins exploration sites.

A search of the Australia Heritage Database identified that no statutory listed heritage places within the proposed impact areas.

The field survey involved a combination of both pedestrian and helicopter survey of the proposed disturbance areas. During the inspections, notes were taken on landform, ground surface visibility and areas of exposure. The aim of the field survey was to identify any surface expressions of Aboriginal archaeological and cultural heritage values within the exploration area. Photographic records were taken at each proposed location. No culturally sensitive landforms or artefacts were identified during field surveys of the lease sites covered under this EMP. A copy of the historic archaeological report is provided in appendix L.

Sacred sites in the study area are primarily associated with drainage lines; natural landform features and stock routes, but there are also concentrations of sites nearby to old homesteads. The distribution of these sites may reflect historical patterns of Indigenous movements along drainage lines and subsequent development of stock routes on old Indigenous walking trails, or they may merely be indicative of the site clearance work undertaken along roads and tracks in the area. It is suspected that there will be a range of other sites also within the area, either not yet recorded, or known but not reported for cultural reasons.

AAPA certificate C2020/003 been granted covering all activities covered under this EMP. Restricted works areas (RWA) have been identified in the vicinity of the existing access track on the Beetaloo property to Beetaloo W-1. Restricted work areas are also associated with a chain of lagoons along Newcastle Creek which is approximately 8km from the Beetaloo W-1 lease pad. Minor maintenance may be completed in the access track RWA in accordance with the AAPA certificate. No work is proposed in the RWA's in the vicinity of Newcastle Creek.

4.5.3 Natural resources

During the 2018 Sacred Site clearance and avoidance survey, representatives of the Traditional Owners identified a number of natural resources of importance to Aboriginal people in the Beetaloo exploration area Table 21.

Table 21: Natural resources of importance in the permit areas

Scientific name	Common name	Usage
Grewia retusifolia	Emu-berry/Dog's Balls, Turkey Bush and Diddle	Fruit eaten. Leaves can be boiled, and body bathed in the liquid for treatment of a number of ailments.
Marsdenia australis	Bush Banana/Gillibi	Bush 'fruit' eaten when young, as it matures 'fruit' seeds becomes feathery for dispersal in the wind and are not eaten

Scientific name	Common name	Usage
Pterocaulon sp.		Used for treating flu
Acacia sp.	Acacia	Leaves boiled and used to treat flu
Acacia holosericea	Soapbush Wattle or strap wattle	Leaves used for washing
	Termite (unknown species)	Mounds pulverised and mixed with water, used to treat diarrhoea

4.5.4 Non-Indigenous heritage

In 1860, explorer John McDougall Stuart was the first European to penetrate the area now known as the 'Centre'. The first written descriptions of the area come from Stuart during his second attempt to cross the continent from south to north (HLA, 2005).

Development in the area began as pastoral lands with an increased interest in land settlement following the completion of the Overland Telegraph Line in 1873. Most attempts were unsuccessful with the Lancewood-Bullwaddy vegetation found to be impenetrable and the lack of surface water making the land unsuitable for cattle. Daly Waters was thus recognised as one of the last watering stops on the Murranji Stock Route.

It wasn't until the 1930s to 1950s, that the area saw regional economic growth with Daly Waters becoming a significant hub of air and mail services into the Northern Territory. The wartime years saw this role increase with Daly Waters again playing a major role in cross country transport and communication. This role continued until the early 1970s when the airport was closed to commercial traffic. The town and surrounding areas subsequently reverted to a primarily agriculture-based existence following the decline of air travel, but in recent times has seen commercial interest from the exploration for gas in the Beetaloo Sub-basin and the growth of the 'grey nomad' tourism market.

4.5.5 Historic heritage assessment

A search of relevant historic heritage registers identified several historic heritage sites within EP117. Frew Ponds, a reserve paying tribute to the building and joining of the Overland Telegraph Line is located 45km from the Beetaloo W-1 site.

4.5.6 Protected or conservation areas

There are no national parks, world heritage places, Commonwealth land, heritage places or critical habitat areas listed under the *EPBC Act* located within or adjacent to the Beetaloo exploration area.

The closest area is the Bullwaddy Conservation Reserve, which is located ~80km from the proposed activity area. The EPBC Listed Lake Woods is located ~60km from the site and is listed on the National Directory of Important Wetlands.

The risks to these receptors through aquifer contamination, spills and sediment release have been addressed in the risk assessment presented in Appendix I. The main mitigation measures/factors include:

- As the proposed site is ~80km away from the Bullwaddy Conservation Reserve and 60km (direct) from Lake Woods, contamination is not likely to reach the area given no generation or storage of material volumes of wastewater are proposed.
- Surface water flow is to the south into a tributary of Newcastle Creek, which flows to Lake Woods via Newcastle Waters. Any spill would need to exceed the capacity of the site bund

and travel over 60km to reach Lake Woods. A spill cannot impact the Bullwaddy Conservation Area as it is not in the overland flow path from the site.

- Groundwater direction is to the north west, which is not on the flow path of the Bullwaddy Conservation Reserve.

4.6 Social environment

4.6.1 Social context

The EMP activities will occur within the Barkly Regional Council area, which covers 323,514 km^2. The approximate population is estimated for the Barkly Region of 8,137 people (Barkly Regional Council, 2018).

The potential social and economic effects associated with the proposed exploration activities is considered to be minor and predominantly positive.

The closest neighbouring regional towns and communities identified as being within proximity to Origin's activities include:

- Dunmarra (~60kms)
- Tennant Creek (~350kms)
- Elliott (~50kms)
- Daly Waters (~100kms)
- Newcastle Waters (~48kms)

4.6.2 Pastoral activity

The Beetaloo W-1 site is located on the Beetaloo Station which is used for pastoral activities. The area has been subject to pastoral activities for over 150 years (AECOM, 20). The average size of a station in the Barkly Region is 8,186 km^2 (Bubb, 2004), which is large by global standards.

4.6.3 Other land uses in the area

A range of other land uses exist in the Beetaloo exploration area or in the larger region, including a range of public utilities and facilities. These include the following:

- Tourism—tourism is an important regional industry with the Stuart Highway being a major thoroughfare for tourists travelling in the area during the dry season. The local townships of Daily Waters, Dunmarra and Elliot provide consumables (food, fuel etc.) and accommodation. Several heritage areas of importance to regional tourism are in the broader region, including Elliott, Newcastle Waters and other heritage listed homesteads.
- Road networks—the Stuart Highway and Carpentaria Highway will be used to access the sites. In addition, there are numerous gravel roads connecting properties, and internal property tracks. All properties also have firebreaks on their boundaries and internally.
- Gas pipeline—a gas pipeline runs to the west of the Stuart Highway, along the eastern boundary of EP117 and crosses the boundary of one part of EP98. It also runs parallel with the Carpentaria Highway to the Gulf of Carpentaria, through EP98 and EP76.
- Alice Springs to Darwin Railway—The railway line runs to the west of the gas pipeline and Stuart Highway, and does not cross into any of the permit areas.
- Townships—the townships of Daly Waters and Dunmarra neighbour EP98 to the West.

- Conservation areas—including the Bullwaddy Conservation Reserve, which lies within EP98 and Lake Woods and the Junction Stock Reserve just outside the permit area.
- Heritage—there are seven heritage sites within the Beetaloo exploration area and several heritage areas of importance to regional tourism located in the broader region, including Elliott, Newcastle Waters and heritage-listed homesteads.
- Archaeological sites—the permit areas have a long history of Aboriginal association and 41 archaeological sites have previously been recorded within the permit areas, as well as registered sacred sites and areas of significance which are shown in the AAPA Abstract of Record.

5 Stakeholder engagement

5.1 Purpose and objectives

Origin's stakeholder engagement is focused on building respectful relationships with key stakeholders and developing a positive reputation founded on Origin's core values. Origin's consistent approach to stakeholder engagement has been to ensure that those persons and/or groups directly impacted/ affected and/or influenced by permit commitments have received Origin's full attention. Origin views the social acceptance and informed consent of these primary stakeholders of critical importance and relevance during this stage of low impact and small-scale exploration activities.

A stakeholder engagement plan has been implemented, which guides the way Origin undertakes stakeholder engagement above and beyond the NT Petroleum (Environment) Regulations 2016. This plan has been developed based upon the International Association for Public Participation (IAP2) (2015) Quality Assurance Standard for Community and Stakeholder Engagement.

5.2 Identification of stakeholders

The NT Petroleum (Environment) Regulations 2016 defines *stakeholder* as meaning:

(a) a person or body whose rights or activities may be directly affected by the environmental impacts or environmental risks of the regulated activity proposed to be carried out; or

(b) Host pastoralists recognised as the landholders of the nine Pastoral Lease Stations in Table 22

Regarding this EMP for the Beetaloo W-1 location, the owners of the pastoral lease for Beetaloo Station are recognised as the pastoralist stakeholder directly impacted.

Stakeholder and community engagement for the 2021 work program has been held with host pastoralists and Traditional Owners directly affected by the proposed activities. Activities performed under EP117 will be conducted in a manner consistent with the Code of Practice: Onshore Petroleum Activities in the Northern Territory, which Origin considers an appropriate regulatory instrument for ensuring Origin's activities are in line with community expectations and legislative requirement.

Origin also recognises and engages, where appropriate with a number of other interested parties that are not classified as directly affected under the Petroleum (Environment) Regulations. These include government agencies, Land Councils, local and regional suppliers, non-government organisations, councils and peak industry bodies.

Table 22: Pastoral properties in the permit area

Pastoral property	Permit areas			Contact details
	EP76	EP98	EP117	
Amungee Mungee		✓	✓	N/A
Kalala		✓	✓	N/A
Tanumbirini	✓	✓		N/A
Beetaloo	✓		✓	[redacted]
Hayfield/Shenandoah		✓	✓	N/A
Ucharonidge	✓		✓	N/A
Tandyidgee	✓	✓		N/A
Nutwood Downs		✓		N/A
Newcastle Waters			✓	N/A

5.3 Pastoralist stakeholder engagement

Origin has engaged with the representatives of the Beetaloo pastoral lease regarding the full range of exploration activities outlined in this revised EMP. As this is an existing approved site, the proposed ongoing works cover under this revised EMP are a variation to an existing land access agreements. The stakeholder engagement completed for this revised EMP is focused on this continuation of activities and builds upon the existing stakeholder engagement completed with the pastoralist since negotiations on the Beetaloo W-1 site began in 2014.

Key engagement efforts Origin has undertaken include:

- Historic engagement regarding the drilling, stimulation and well testing of the Beetaloo W-1 well in 2014-2016
- Ongoing engagement with the Beetaloo Station lessee regarding the status of the Beetaloo W-1 well
- Providing the landholder with copies of a Stakeholder Engagement Pack (SEP) covering the proposed 2021 (and ongoing) exploration activities and providing opportunity for the landholder to comment (Appendix G Part B)

Appendix G Part A and B summarises Origin's engagement with the leaseholders of the Beetaloo Station as a relevant stakeholder and provide information in accordance with section 7(2)(a) of the NT Petroleum (Environment) Regulations 2016.

5.4 Host Traditional Owner(s) engagement

The host Traditional Owners are provided in Table 20. Origin has undertaken detailed engagement with the host Traditional Owners through the Northern Land Council to facilitate an ongoing relationship between Origin and their host Traditional Owners. Engagement efforts undertaken by Origin include:

- Complying with the Exploration Agreement(s) between Origin, Native Title holders and the Northern Land Council (NLC) for EP117, EP98 and EP76

- Ongoing consultation regarding Origin work programs and proposed exploration activities, including the location(s) of all areas of disturbance and answering any questions or comments on the activity and its related impacts.
- In person consultation between Origin, host Traditional Owners and their statutory representative body, the Northern Land Council regarding Origin's proposed exploration activities
- Execution of Sacred Site clearance and avoidance surveys on the specific areas of land (~6kms in radius) with the relevant Traditional Owners between 10 September and 19 September 2018. A formal Northern Land Council Sacred Site Avoidance and Anthropological Report was provided to the AAPA to assist with the issuing of an Authority Certificate in compliance with the *Northern Territory's Aboriginal Sacred Sites Act.*
- Pursuant to the *Sacred Sites Act,* Origin holds AAPA Authority Certificate C2020/003 and shall comply with the conditions in the Certificate to ensure compliance to the *Sacred Sites Act*
- On country meetings held between NLC, Traditional Owners and Origin in April and May 2019 revisiting Origin's work program submission from July 2018 and field surveys with Traditional Owners in September 2018. The on country meetings conclude the engagement and consultation necessary with Traditional Owners prior to commencement of each years' activities
- Traditional Owners and Origin site tour in September 2020. The tour provided an overview of the Beetaloo exploration project and answered questions regarding exploration activities underway
- On country meetings with Traditional Owners, Origin and the NLC in March 2021 and early April 2021 to discuss Origin's work program for 2021, the outcomes of the Sacred Site clearance and avoidance surveys in September 2020 and address any questions about Origin's activities
- Ongoing communication between Origin and the Northern Land Council

The Traditional Owner stakeholder engagement summary is provided in Appendix G.

5.5 Stakeholder activities

Key considerations when understanding the consequences to pastoral operations and Traditional Owners include:

- Understanding pastoralist operations and determined Native Title Holder custodianship of the proposed area to plan petroleum activities to ensure co-existence
- Provision of payments and/or benefits to the Pastoral Lessee(s) and Native Title Holders for the impact of regulated activities on the proposed activity area in accordance with the relevant agreements.

5.6 Ongoing stakeholder and community engagement

Origin is committed to continuing to engage with stakeholders regarding the exploration activities under EP98, EP117 and EP76 and any associated environmental outcomes prior to, during and after performance of exploration activities.

Origin recognises the growing community interest in ensuring onshore natural gas development takes place in a safe and environmentally sound way and are committed to delivering operational excellence (which encapsulates our health, safety and environmental performance standards).

Origin has further committed to ongoing engagement with the relevant Traditional Owners, including annual work plan meetings and provision of draft work programs for future years of activity.

Detailed community and stakeholder engagement are underway, covering future exploration activities. This includes the following engagement activities:

- Pastoralists:
  - Weekly-monthly engagement with host pastoralists for which activity is proposed
  - Quarterly engagement with future host pastoralists for which activity is proposed within the 2021 time period
  - Annual consultation with all pastoralists, including surrounding pastoralists with no immediate proposed activities
  - Any other engagement frequency that is agreed to with the pastoralist
- Native Title holders of the area in which the activity is occurring
  - Ad hoc updates for the Northern Land Council when required, informing them of progress of exploration activities underway
  - Quarterly project status updates to the Northern Land Council informing them of progress of exploration activities underway
  - Site visits by Traditional Owners during exploration activity so that Traditional Owners can have first-hand observation of key activities
  - Work program surveys conducted by Traditional Owners, with the support of the NLC, to review work programs and ensure protection of sacred sites and objects
  - Annual on country meetings with Native Title Holders to discuss current work program status and future exploration activities

Broader community engagement that is in addition to the requirements outlined in section 7 of the Petroleum (Environment) Regulations will continue.

6 Environmental risk assessment

6.1 Origin's risk management approach

Origin utilises a robust risk management process for all its activities to achieve the following key outcomes:

- Risks are understood, eliminated or reduced and controlled to an acceptable level
- Controls are owned, assured and continuously reviewed for effectiveness
- All activities are compliant with regulatory standards and are guided by best practice
- Origin and its stakeholders are confident in the way activities are conducted to manage risks
- The approach aligns with the findings of the NT Inquiry Final Report and associated recommendations (as implemented via the Petroleum Code of Practice or legislation).

Risk management processes are mandated through the Origin Risk Management Policy and Directive, which includes a risk rating toolkit that is utilised from the Board through to frontline activity owners Figure 16. The toolkit considers the requirements of ISO 31000 and addresses risk identification, assessment and management.

Assessment of risk is completed using Origin's Risk Matrix (Figure 16) to assess and rate risks by assessing the combination of frequency of occurrence and the severity of the outcome of a potential event, including a worst-case scenario event. This allows quantification of a risk and determination can then be made about whether the risk can be accepted, or whether further mitigation is required.

An "unmitigated" or "inherent" risk, in the context of this EMP, is considered a risk with only standard industry and pre code of practice controls applied (i.e. controls acceptable prior to the implementation of the Code of Practice). These risks are used to identify the risk controls that are of highest priority, however they do not represent a real-world risk scenario as they do not include mandatory legislative requirements.

Origin risk management processes requires regular assessment of underlying (unmitigated[6]) risk from an activity, the residual risk once controls are applied, the effectiveness of controls (provided in Table 23) and the likelihood and consequence of a risk event. A risk is either accepted in accordance with strict delegations of authority or the activity does not proceed.

Table 23: Risk control effectiveness definition

Rating	Explanation
Effective	• Controls are well designed and address the root cause(s) of the risk. • Controls are recognised industry best practice. • All controls operate at the required level. • All controls are within the power of Origin, with few external factors beyond control. • Ongoing monitoring required.
Can Be Improved	• Majority of controls are well designed and address the root cause(s) of the risk. • Majority of controls operate at the required level. • Some controls are outside the power of Origin, with multiple external factors beyond control. • Ongoing monitoring required. • Certain controls can be improved or have elements below industry best practice.
Must Be Improved	• Most controls are not well designed and do not address the root cause(s) of the risk. • Most controls are not operating to the required level.

[6] Unmitigated or inherent risk is calculated assuming the standard practices deployed before the Code of Practice was implemented. This may vary depending on operators, hence the unmitigated risk of one operator may differ from another, depending on their internal risk management standards.

Rating	Explanation
	• A large number of controls are outside the power of Origin, with multiple external factors. • The majority of controls require improvement and are well below industry best practice.

Risk Management

Directive

Appendix 1 – Origin Risk Rating Toolkit

Step A – describe the risk
Identify and describe the risk in terms of what could happen, its causes and potential effective/impact on Origin's objectives.

Step B – identify and assess controls
Identify and assess existing controls using the Control Assessment Ratings. Consider any related significant incidents, near miss events and assurance activities when assessing controls.

Step C – assess the level of consequence
Decide on the level of consequence that best represents the risk. Determine the highest credible consequence level in all relevant consequence categories in the Risk Matrix, taking into account current control assessment.

Step D – assess the likelihood
Determine the likelihood level in the Risk Matrix that represents the chance of the risk occurring at each consequence level identified, taking into account current control assessments.

Step E – determine the level of residual risk
Use the Risk Matrix to determine the level of risk

Step F – determine the priority for risk treatment and approval
Using the Risk Treatment and Acceptance Criteria, determine the risk treatment required and who can approve/accept the risk at its current level.

Step G – assess the potential maximum consequence
Estimate the potential maximum consequence (plausible worse case level assuming all current controls fail) using the consequence categories.

Control Assessment Ratings

Rating	Explanation
Effective	▪ Controls are well designed and address the root cause/s of the risk. ▪ Controls operate to the required level. ▪ Ongoing monitoring required.
Can be improved	▪ Majority of controls are well designed and address the root cause/s of the risk. ▪ Majority of controls operate to the required level. ▪ Certain controls can be improved. ▪ Ongoing monitoring required.
Needs to be improved	▪ Majority of controls are not well designed and do not address the root cause/s of the risk. ▪ Majority of controls do not operate to the required level. ▪ Majority of controls require improvement.

Risk Treatment and Acceptance Criteria

Level of risk	Action required	Acceptance authority
VERY HIGH	▪ Risk treatment must be in place immediately ▪ Review risk quarterly at a minimum	ELT member*
HIGH	▪ Risk treatment must be considered (having regard to current business priorities) ▪ Review risk annually at a minimum	General Manager
MEDIUM	▪ Risk treatment may be considered ▪ Review risk two yearly at a minimum	Group/Asset (EM)/ Project Manager/ Manager/Lead (IG)
LOW	▪ No risk treatment required ▪ No ongoing review required unless determined by the relevant Group Manager	Site/Activity Manager/ Manager/Lead (IG)

* CEO acceptance required for risks with a Catastrophic consequence and Likely or above Likelihood

Figure 16: Origin's risk toolkit which describes the approach to identify, assess, control, treat and accept risks

Risk Matrix

CONSEQUENCE	IMPACT ON ORIGIN OPERATIONS – Conduct Business with Due Care: People	Environment and Community	IMPACT ON ORIGIN OPERATIONS – Create Value: EBIT	Cash flow	NPV	EXTERNAL RESPONSE – Decisions are Subject to Scrutiny: Stakeholder Perceptions	Laws, regulation and civil actions
6 CATASTROPHIC	Multiple fatalities ≥4 or life threatening illness or total permanent disability to a large exposed group (10 or more people)	Extensive permanent damage to endangered species, habitats, ecosystems or area/s of cultural significance Extensive irreversible loss of community livelihood. Long-term social unrest and outrage	>$200m	>$1b	>$1.5b	Multiple stakeholder groups confirming coordinated action, as reflected in media channels with significant reach and influence (eg. scheduled blockade or boycott covered in media for more than 1 week).	Criminal charges against any director or senior executive involving jail or loss of right to manage the company. Public inquiry – requiring considerable resources and Executive Management time. Loss of licence to operate an asset
5 CRITICAL	1 – 3 fatalities or life threatening illness or total permanent disability to a small exposed group (<10 people)	Extensive long term partially reversible damage to vulnerable species, unique habitats, ecosystems or area/s of cultural significance Extensive reversible loss of community livelihood. Prolonged community outrage.	>$50m - $200m	>$250m - $1b	>$375m - $1.5b	Multiple stakeholder groups mobilising and encouraging others to take action, as reflected in media channels with significant reach and influence (eg. social media campaign calling for protest, escalating over several days).	Criminal charges against any director, senior executive or senior manager not involving jail or loss of right to manage the company. Prolonged major litigation – exposure to significant damages / fines / costs. Suspension / restriction to operate an asset.
4 MAJOR	Injury or illness to one or more persons, resulting in permanent partial disability	Long term reversible impacts to listed species, habitats, ecosystems or area of cultural significance Significant impacts to community cost of living, business viability or social wellbeing. High levels of community tension.	>$20m - $50m	>$100m - $250m	>$150m - $375m	More than one stakeholder group's opinion or view influencing other stakeholders, reported through media channels with some reach and influence (eg. government comments in national media or in Parliament).	Criminal charges against any employee (not described above) Major litigation – exposure to damages / fines / costs.
3 SERIOUS	Injury or illness to one or more persons resulting in hospitalisation, 5 or more days lost time or alternative / restricted duties for 1 month or more	Serious medium term reversible impacts to low risk species, habitats, ecosystems or area/s of cultural significance Moderate impacts to community cost of living, business viability or social wellbeing. Moderate levels of community tension.	>$5m - $20m	>$25m - $100m	>$37.5m - $150m	More than one stakeholder group offering an opinion or view, reported through media channels with some reach and influence (eg. state based commentary lasting one 24 hour media cycle across internet, print, television, radio).	Non-compliance with conditions of licence to operate an asset or to conduct an activity. Litigation – exposure to damages / fines / costs.
2 MODERATE	Injury or illness to 1 or more persons resulting in medical treatment, up to 5 days lost time or alternative / restricted duties for up to 1 month	Moderate short term impacts to common regional species, habitats, ecosystems or area of cultural significance Small scale impacts to cost of living, business viability or social wellbeing. Isolated examples of community tension.	>$1m - $5m	>$500k - $25m	>$750k - $37.5m	A single stakeholder group drawing attention to an incident, issue or approach, conveyed though media channels with potential reach and influence (eg. some social media complaints or local media reports).	Moderate non-compliance with external mandatory obligations or breach of contractual or other legal obligations (not described above). Litigation possible.
1 MINOR	Injury or illness requiring first aid to 1 or more persons, or no treatment (record only)	Minor environmental or community impact - readily dealt with	>$100k - $1m	<$500k	<$750k	A person or organisation within stakeholder group signaling an interest in an incident, event or approach, using channels with limited reach or influence (eg. letter of complaint/commendation).	Minor non-compliance with external mandatory obligations or breach of contractual or other legal obligations.

CONSEQUENCE	LIKELIHOOD – 1 REMOTE: <1% chance of occurring within the next year. Only occurs as a '100 year event' or less frequent.	2 HIGHLY UNLIKELY: <10% chance of occurring within the next year. Could occur within decades.	3 UNLIKELY: <30% chance of occurring within the next year. Could occur within the next few years.	4 POSSIBLE: <60% chance of occurring within the next year. Could occur within months to years.	5 LIKELY: <90% chance of occurring within the next year. Could occur within weeks to months.	6 HIGHLY LIKELY: Likely to happen multiple times a year
6 CATASTROPHIC	HIGH	HIGH	VERY HIGH	VERY HIGH	VERY HIGH	VERY HIGH
5 CRITICAL	MEDIUM	MEDIUM	HIGH	VERY HIGH	VERY HIGH	VERY HIGH
4 MAJOR	MEDIUM	MEDIUM	MEDIUM	HIGH	VERY HIGH	VERY HIGH
3 SERIOUS	LOW	MEDIUM	MEDIUM	MEDIUM	HIGH	HIGH
2 MODERATE	LOW	LOW	MEDIUM	MEDIUM	MEDIUM	MEDIUM
1 MINOR	LOW	LOW	LOW	MEDIUM	MEDIUM	MEDIUM

* Cash Flow - change from expectation over the life of the exposure. EBIT change from expectation over 12 – 18 month period.

Figure 17: Origin's Risk Matrix

6.2 ALARP

Origin's risk management process requires risks to be managed to ALARP. A risk can be considered to have been reduced to ALARP when all reasonably practicable control measures (both preventative and mitigative) have been identified and implemented to reduce the risk of identified events. A key element of demonstrating ALARP is that good practice is followed, where good practice is defined as the recognised risk management practices and measures that are used by competent organisations to manage well understood hazards arising from their activities. This definition incorporates good practice as defined in codes and standards, and a consensus of good practice within the industry. ALARP is not a final position over the life of an asset or project.

The practicability and the reasonability of control measures can change over time due to changes in technology (that can make measures more readily available), industry standards (that can commoditise once-cutting-edge technology) and the socio-technical landscape (that can modify societal expectations).

In the NT context, ALARP and the definition of acceptable risk levels was a key feature of the NT Inquiry Final Report. For each aspect, acceptability criteria were defined, with recommendations outlined to reduce the potential risk to below the acceptable level. With the adoption of all recommendations by the NTG, the new Code of Practice and associated regulatory changes provides a high level of inherent protection to ensure activities are undertaken in a safe and consistent manner.

Origin considers ALARP to be achieved where the residual risk is low, whereby any additional control measures applied will not reduce the risk any further.

If the residual risk of low is not achieved, Origin considers ALARP to be achieved where the following criteria have been met:

1. The requirements of the code of Practice have been met
2. All reasonably practicable site-specific controls have been identified and implemented and
3. The cost of further reducing the risk is unreasonable compared to the environmental benefit gained from implementing the control measure.

6.3 Risk acceptability

Origin uses a series of criteria provided in Table 24 to determine the acceptability of a residual risk. Each residual risk event outlined in Appendix F is assessed against these criteria to determine whether Origin believes the residual risk is acceptable. The outcome of the residual risk acceptability assessment and outcome is provided in Appendix F.

Table 24: Residual risk acceptability criteria

#	Criteria	Origin's acceptance threshold
1	Residual risk level	Consistent with Origin's risk acceptance criteria: **Very high risk**—not acceptable **High risk**—residual risk may be conditionally accepted where the residual risk is ALARP and the risk is signed off by a General Manager with risk treatment applied to improve, control or further modify risk. Risk reviews are to occur annually with the intent to reduce the risk severity lower.

#	Criteria	Origin's acceptance threshold
		Medium–Low risk—residual risk is accepted when ALARP is demonstrated
2	Legislative requirements and regional strategies and conservation plans	1. Consistent with legislative requirements, including Code of Practice 2. Consistent with regional strategies and conservation/threat abatement plans
3	Stakeholder expectations	Consistent with the commitments made in stakeholder engagement and/or agreements
4	Industry guidelines and best practice	Is consistent with petroleum standards (such as API and the Oil and Gas UK standards), best practice and controls used in other NT industries
5	Scientific uncertainty in the data used to determine the environmental impact or risk	**Low uncertainty:** Accepted Risks are well understood, and uncertainty is minimal **Moderate uncertainty:** Accepted using well-established data and assessment methods. Some uncertainty exists, with routine monitoring and performance criteria in place to detect and respond to any impacts arising from a risk. **High**: Conditional acceptance—significant uncertainty exists with data and assessment methodologies unproven. A precautionary approach will mean that uncertainty is replaced by conservative assumptions that will require additional control measures being implemented to prevent, detect and respond to any impacts arising from a risk.
6	Ecological Sustainable Development Principles	Risk is consistent with the principles of ESD as defined in section 2.1. This also includes weighting to consider the social and economic benefits of the project

6.4 Assessment of Scientific Uncertainty

The Petroleum (Environment) Regulations requires an assessment of uncertainty as a part of the risk assessment process. The assessment of potential impacts and effectiveness of controls must demonstrate that the activities are carried out in a manner consistent with the Principles of Ecologically Sustainable Development (ESD) and the Precautionary Principle.

Impact and risk identification must include consideration of uncertainty regarding impacts and risks for the activity where a precautionary approach is appropriate. Uncertainty is high where confidence in the available information is low in identifying risk or the effectiveness of a management control. Additional baseline studies or other safeguards may be required to increase the accuracy of an assessment to determine the acceptability of a risk.

Scientific certainty is qualitatively assessed using a generic means of ranking the data available in accordance with Table 25. Considerations of uncertainty have been included in the risk assessment discussed in section 6.5.

Table 25: Scoring system for Scientific Uncertainty (DEFRA, 2013)

Ranking Scientific Uncertainty	
Score	**Description**
Low (1)	• Comprehensive data with strong evidence in multiple peer reviewed data • Little disagreement between authors or experts • Considerable and consistent on-ground experience and/or monitoring
Medium (2)	• Some or incomplete data available • Evidence provided based on a small number of references • Authors or experts conclusions vary • Limited on-ground experience and/or monitoring
High (3)	• Scarce or no data available; evidence provided in unpublished reports • Few on-ground observations • Authors and experts conclusions vary considerably

6.5 Risk assessment outcomes

The environmental, heritage and social risks associated with the activities covered under this EMP have been assessed utilising the Origin risk assessment framework described in section 6.1. The detailed risk assessment presents the range of potential impact-causing activities, corresponding mitigation measures and residual risk ratings based on their assessed worst-case consequence and likelihood of occurrence. The assessment also cross-referenced the various risk assessment outcomes in the NT Inquiry Final Report, to ensure consistency.

Site specific conditions and cumulative impacts have also been considered during the assessment. Cumulative impacts have included the following:

- A total of five future Origin E&A wells for the 2021–2022 period as per the current approved tenure work plan.
- Existing land users (predominately pastoralists).

There were 47 risk sources identified, with no residual risks above a ‘low’ risk ranking. This is consistent with the scale of the activities proposed under this EMP.

The level of uncertainty for each risk was also assessed. There was no uncertainty level above 'Low', which is consistent with the scale of the activity and the knowledge of impacts associated with the proposed activities under this EMP.

Table 26 provides a count of the post-treatment environmental risks associated with this EMP. A copy of the risk assessment is provided in Appendix F.

Table 26: Count of Residual Environmental Risks for the Beetaloo W-1 program

	Residual Environmental Risk Level			
	Low	Medium	High	Very High
Total 47	47	0	0	0

6.6 Environmental outcomes, performance standards and measurement criteria

The following section provides the environmental outcomes, performance standards and measurement criteria of each environmental aspect, based on the risk assessment presented in Appendix F. Tables 28 to 34 provide the environmental outcomes, performance standards and measurement criteria to demonstrate whether controls have been effective during the activity and that the stated environmental outcomes have been achieved.

6.6.1 Soils

Table 27: Environmental outcomes, performance standards and measurement criteria—Soils

Environmental performance measures: Soil				
Environmental outcome	**Environmental performance standards**		**Measurement criteria**	**Records**
No significant impact to the ecological function and productivity of soils surrounding Beetaloo W as a result of Origin's exploration activities	S-1	No releases of contaminants (chemicals, wastes or liquid hydrocarbons)outside of Origin's lease pad	Weekly site inspections completed during operations confirm no releases of chemicals, hydrocarbons and wastes outside of Origin's lease disturbance area	Weekly records of site inspections during operations retained
				OCIS incidents of off-site releases of contaminant retained
	S-2	No reportable spills resulting from Origin's exploration activities	Weekly site inspections during operations confirm no reportable spills	Weekly records of site inspections retained
				OCIS incidents of reportable incidents relating to spills
	S-3		Zero reportable incidents resulting from chemical or waste transportation accidents	OCIS incidents of reportable incidents relating to transportation accidents and spills
	S-4	Erosion and sediment control in place and working effectively	6-monthly site stability inspections confirm ESC in place and working effectively	ESC inspection records retained

	S-5		Evidence of maintenance performed on all material erosion and sediment control events	Maintenance records retained
Risk sources	• Soil compaction from access tracks and leases (Risk ID 9) • Soil erosion from cleared areas (access tracks, lease pads and camp pads) (Risk ID 10) • Spills/leaks from the on-site storing and handling of fuels, chemicals and wastes (Risk ID 11) • Chemical and waste transportation accident (Risk ID 12) • Greywater and sewerage disposal (camps) (Risk ID 13)			

6.6.2 Surface water

Table 28: Environmental outcomes, performance standards and measurement criteria—Surface water

Environmental performance measure: Surface water				
Environmental outcome	**Environmental performance standards**		**Measurement criteria**	**Records**
No significant impact on surface water quality as a result of Origin's exploration activities	SW-1	During operations, no off-site release of contaminants from chemical, hydrocarbon and waste storage areas	All stormwater discharges from bunds monitored by operators prior to release, with results confirm stormwater is within the approved limits listed in Table 9	Discharge monitoring results retained for each stormwater release
	SW-2	No reportable spill, including offsite releases of contaminants resulting from Origin's exploration activities	Weekly site inspections completed during operations confirm no releases of chemicals, hydrocarbons and wastes outside of the Beetaloo W-1 site	Weekly records of site inspections retained during operations
				OCIS incidents of off-site releases retained
	SW-3	Erosion and sediment control in place and working effectively	All material erosion and sediment control events are rectified as soon practicable upon identification	OCIS incidents of reportable incidents relating to spills
Risk sources	• Transportation accident releasing chemical or waste (Risk ID 5) • Storage and handling of fuels and minor chemical storages (Risk ID 6) • Release of stormwater from activities to surface water (Risk ID 7) • Runoff from sewage treatment irrigation areas (Risk ID 8)			

6.6.3 Groundwater

Table 29: Environmental outcomes, performance standards and measurement criteria—Groundwater

Environmental performance measure: Groundwater				
Environmental outcome	**Environmental performance standards**		**Measurement criteria**	**Records**
No material changes in groundwater quantity and quality that impact on environmental or pastoral users.	GW-1	No groundwater extraction above the approved WEL level.	Total groundwater extraction volume below the water extraction level (WEL) of 175Ml/year	Groundwater take records retained
	GW-2			
Risk sources	• Cross flow of formation through inadequate well barrier maintenance. (Risk ID 1) • Cross flow of formation through connection created through DFIT operations (Risk ID 2) • Over extraction of groundwater for well testing activities (Risk ID 3) • Cumulative impact from regional groundwater take exceeds the natural recharge rate of the Basin (Risk ID 43)			

6.6.4 Ecology—flora, fauna and habitats

Table 30: Environmental outcomes, performance standards and measurement criteria—Ecology

Environmental performance measures: Ecology				
Environmental outcome	**Environmental performance standards**		**Measurement criteria**	**Records**
No significant impact to high valued habitats and threatened flora and fauna as a result of Origin's exploration activities	EC-1	No releases of contaminants off the lease into the surrounding vegetation	Weekly site inspections during operations confirm no off-site releases of chemicals or fuels etc.	Weekly site inspection completed during operations
	EC-2	No uncontrolled bushfires caused by Origin's exploration activities	Zero reported incidents of uncontrolled bushfire caused by Origin's activities	Fire incident data to be retained for all Origin unplanned fires
	EC-3	Weed surveys completed on all Origin disturbed areas	6-monthly pre- and post-wet season weed surveys completed on all Origin controlled disturbed areas	Annual weed monitoring and management report
	EC-4	Year-on-year decline in the size and density of all weed infestations introduced as a result of Origin's activities	Annual report demonstrates weed infestation size and density of weed outbreaks introduced by Origin's activities are reducing each year	Annual weed monitoring and management report

Risk sources	• Activity (vehicle and machinery) noise and lighting on well pads and access tracks (Risk ID 14) • Introduction and spread of weeds in the area (Risk ID 15) • Accidental ignition of fire from exploration activities (maintenance, well intervention and general access) (Risk ID16) • Poor rehabilitation of the site reduces regional habitat and promotes weed invasions (Risk ID 17) • Contaminants in waste and soil pass through the food chain and bioaccumulate in fauna causing detrimental impacts to local species and communities (Risk ID 18) • Vehicle collisions with fauna/fauna mortality results in a localised decline in species abundance (Risk ID 19) • Encouragement of feral animals and other pest species increases leading to competition with native species. This includes the introduction of cane toads (Risk ID 20)

6.6.5 Air Quality and Greenhouse Gas emissions

Table 31: Environmental outcomes, performance standards and measurement criteria—Air quality and GHG emissions

Environmental performance measure: Air quality and GHG emissions				
Environmental outcome	**Environmental performance standards**		**Measurement criteria**	**Records**
No significant impact on air quality and no excess greenhouse gas emissions as a result of Origin's exploration activities	AQ-1	Venting to be eliminated as far as reasonably practicable	Daily reports confirm the absence of cold venting	Gas flow volumes recorded
	AQ-2	All greenhouse gasses reporting in accordance with NGERS requirements	All emissions related data (fuel use, flaring volumes etc.) reported in accordance with NGERS requirements	Emission related data (fuel use, flare volumes, etc.) retained
	AQ-3	All leaks detected and repaired in accordance with code of practice	6-monthly leak detection program completed on surface equipment.	Leak detection records retained
	AQ-4		Minor leaks rectified as per Code of Practice within 30-days	Leaks and management recorded in OCIS
	AQ-5		A significant leak is repaired as per the Code of Practice within 72-hours	Leaks and management recorded in OCIS
Risk sources	• Bushfire from accidental ignition by site activities (civil work, grinding) or personnel (Risk ID 37) • Dust emissions from regulated and truck movements (Risk ID 38) • Emissions from the combustion of diesel (Risk ID 38 • Uncontrolled release of gas encountered during well intervention activities, from operator error or vehicle collision (Risk ID 39) • Uncontrolled release of gas from well due to sabotage (Risk ID 40) • Leak of gas from wells (Risk ID 41) • Cumulative impact of exploration activities on amenity through additional dust generation (Risk ID 42) • Cumulative impact of exploration activities on NT and Australian greenhouse gas emissions (Risk ID 43)			

6.6.6 Community

Table 32: Environmental outcomes, performance standards and measurement criteria—Lighting, noise, vibration and visual amenity

Environmental performance measures: Community				
Environmental outcome	**Environmental performance standards**		**Measurement criteria**	**Records**
No significant negative impacts to the community as a result of Origin's exploration activities	CO-1	All valid community complaints of nuisance investigated and resolved	All valid community complaints responded to within 24-hours with actions to remedy nuisance implemented as soon as practicable (depending on the nature of the complaint)	OCIS records of community complaints and actions completed
	CO-1	>60% of addressable spend to be from NT businesses i.e. 60% of services or material that can be provided by NT businesses are provided by NT business.	Project expenditure data confirms the NT business spend on the Beetaloo exploration project exceeds >60% of addressable[1] spend of the project	Data on NT business spend retained
Risk sources	• Industrialisation of landscape (Risk ID 24) • Increased traffic (Risk ID 25) • Light emissions impact on sensitive receptor (such as pastoralist) (Risk ID 26) • Influx of workers to region (Risk ID 27) • Noise emissions from activities (Risk ID 28) • Introduction and spread of weeds in the area (Risk ID 29) • Over extraction of groundwater (Risk ID 30) • Bushfire from accidental ignition by site activities (civil works, drilling, flaring grinding) or personnel (Risk ID 31) • Poor rehabilitation of exploration infrastructure (Risk ID 32)			

[1]Addressable spend is defined as a service or material that can be reasonably provided by an NT business at similar quality, timeliness and cost.

	• Disruption of agricultural operations due to ongoing access, traffic and helicopter movements (Risk ID 33) • Increased risk of vehicle accident (Risk ID 34) • Exploration activities compete with agricultural industry for resources (Risk ID 35) • Emissions from the combustion of diesel (Risk ID 36) • Dust emissions from regulated activities and truck movements (Risk ID 37) • Particulate emissions from bushfires (Risk ID 38) • Cumulative impacts on amenity (Risk ID 39) • Cumulative impacts on surface water quality (Risk ID 40)

6.6.7 Cultural heritage

Table 33: Environmental outcomes, performance standards and measurement criteria—Cultural heritage

Environmental performance measures: Cultural heritage				
Environmental outcome	**Environmental performance standards**		**Measurement criteria**	**Records**
No significant impact on sacred sites and environmental values as a result of Origin's exploration activities	EC-1	No non-compliances with AAPA certificate conditions	No unauthorised work within Restricted Work Areas (RWA)	OCIS incidents retained where unauthorised activities are identified
	EC-2		No impacts to sacred sites from contaminant spills or fires resulting from Origin's activities	OCIS incidents retained where unauthorised activities are identified
	EC-3		Site inductions completed on all employees and contractors which include information on RWA's and approved activity areas	Records of inductions retained
Risk sources	• Sites disturbed directly by exploration activities (Risk ID 21) • Accidental ignition by site activities (civil works, well interventions, grinding) or site personnel (Risk ID 22) • Personnel unauthorised access to sacred site (Risk ID 23)			

7 Management Plans

The following section provides a high-level summary of the various management plans required to be implemented in accordance with the Code of Practice.

7.1 Wastewater management plan

Material volumes of wastewater are not anticipated. Any incidental wastewater generated during the activities (such as completion fluids) will be managed in accordance with the Code of Practice and the wastewater management plan provided in Appendix H.

The management strategies are outlined in the wastewater management plan include:

- All incidental wastewater fluids to be stored within tanks with secondary containment
- Enclosed wastewater tanks to be utilised
- Daily level monitoring during operations
- Weekly tank inspections when storing wastewater
- Wastewater to be transport to an existing wastewater storage area within the Beetaloo Basin for evaporation/treatment (such as Kyalla 117 N2) or to a licensed offsite wastewater disposal facility.

7.2 Spill management plan

The use of secondary containment to prevent spills during all regulated activities is a regulatory requirement embedded in national and state chemical handling legislation and guidelines. These requirements have been further covered in the Code of Practice.

A Spill Management Plan (SPMP) has been developed covering Origin's proposed exploration activities. This SPMP is provided in Appendix H.

An example of bunding used for previous drilling and stimulation activities within the basin is provided in Figure 18.

Figure 18: Example of spill mats used to contain potential contaminants

7.3 Methane emission management plan

A methane emission management plan (MEMP) is required to be developed to demonstrate how methane emissions will be managed. The MEMP describes how Origin:

- Mitigates the generation of methane emissions, such as the minimisation of venting and use of reduced emission completions
- Outlines the required leak detection and repair programs
- Summarises the leak reporting requirements

A copy of the MEMP is provided in Appendix E.

7.4 Erosion and sediment control plan

An erosion and sediment control plan has been developed to outline how the site will be operated to minimise the risk of erosion and sediment releases to the surrounding environment. The ESCP is provided in Appendix D.

7.5 Rehabilitation plan

Once a determination has been made to decommission the Beetaloo W site, the Beetaloo W-1 well will be plugged and decommissioned, with the lease pad and associated infrastructure rehabilitated. All tanks, surface infrastructure and wastes will be removed from site and disposed of in accordance with the *NT Waste Management and Pollution Control Act 1998*.

All remaining assets with a residual beneficial use (such as water bores, gravel pits, laydown yards, gates, fences, freshwater tanks etc.) will be offered for transfer to the pastoralist, subject to DEPWS approval and compliance with the Code of Practice. Prior to considering the transfer of ownership, Origin will:

- Undertake an assessment of the current status of the asset and whether it can be beneficially used by the local pastoralist. Where a beneficial use is anticipated, identify works required

to be undertaken to ready the asset for transfer (i.e. any repairs, site remediation, equipment removal etc.)

- Obtain written agreement from the pastoralist to take ownership of the asset and document any stipulated liabilities.

Where an asset cannot be beneficially utilised, the site will be rehabilitated to the pre-existing condition using assisted natural regeneration. This will include:

- Removal of all surface facilities
- Removal of all weeds and contaminated materials/wastes
- Re-spreading of stockpiled topsoil
- Backfilling of all open sumps
- Reshaping the site to as close to natural form as possible
- Ripping or scarifying any compacted surface
- Spreading of stockpiled vegetation to aid in surface water flow control
- Spreading seed of suitable local native species which has been determined through analogue sites representative surrounding vegetation communities
- Any native seed supply and rehabilitation services will be sourced using Indigenous suppliers (where available).
- Yearly monitoring of the rehabilitation success requirements to assess the rehabilitation status of a site and determine where additional remedial works are required.

The rehabilitation plan is provided in Appendix C. A schematic of a rehabilitated gravel pit is provided in Figure 8.

7.6 Weed management plan

Exploration activities are undertaken in accordance with Origin's Beetaloo Weed Management Plan (NT-2050-PLN-019) Appendix B. This plan has been developed in accordance with the Weed Management Planning Guide: Onshore Shale Gas Developments Project.

Weed surveys have confirmed the proposed area of activity has an extremely low presence of weeds. Efforts will therefore focus on both eliminating the potential introduction of weeds into the region and preventing the spread of existing weeds.

From a cumulative impact perspective, the risks of increasing weed pressure in the area are reduced through the mandated use of weed hygiene inspections/certification for all equipment and vehicles and routine weed monitoring and maintenance. Any weeds that are introduced into the activity areas will be promptly identified and managed, reducing the potential additional stress to the region.

7.7 Bushfire management plan

A bushfire management plan (BMP) has been developed to outline the controls to prevent, detect and respond to fires associated with Origin's activities. Controls implemented include:

- Implementation and maintenance of firebreaks
- Monitoring during periods of high fire danger
- Fire response and reporting

A copy of the BMP is provided in Appendix A

7.8 Well Operations Management Plan

A Well Operations Management Plan (WOMP) must be developed and submitted to the Minister for Industry, Tourism and Trade (DITT) for approval prior to the commencement of activities. The WOMP is a separate approval from the EMP and provides an operational description of how Origin plans to operate, suspend and decommission the Beetaloo W-1 exploration well in a manner that ensures all risk to the environment are reduced to As Low As Reasonably Practicable (ALARP).

8 Implementation strategy

8.1 Corporate environmental policy

Origin's activities are governed by the Origin Health, Safety and Environment Management System (HSEMS). This system is underpinned by Origin's Health, Safety and Environment (HSE) Policy (Figure 20) which is designed to "Conduct our business in a way that causes no harm to the health and safety of people and has no unforeseen impacts to the environment".

8.2 Environment, Health and Safety Management Systems

Origin has a mature HSEMS which contains the policies and procedures that Origin has in place to manage and minimise the impact from its activities. In addition to meeting legal requirements, Origin's activities are also governed by several additional internal directives and risk control directives designed to ensure best practice in environmental risk management.

An overview of the Origin HSEMS and the associated directives is provided in Figure 19.

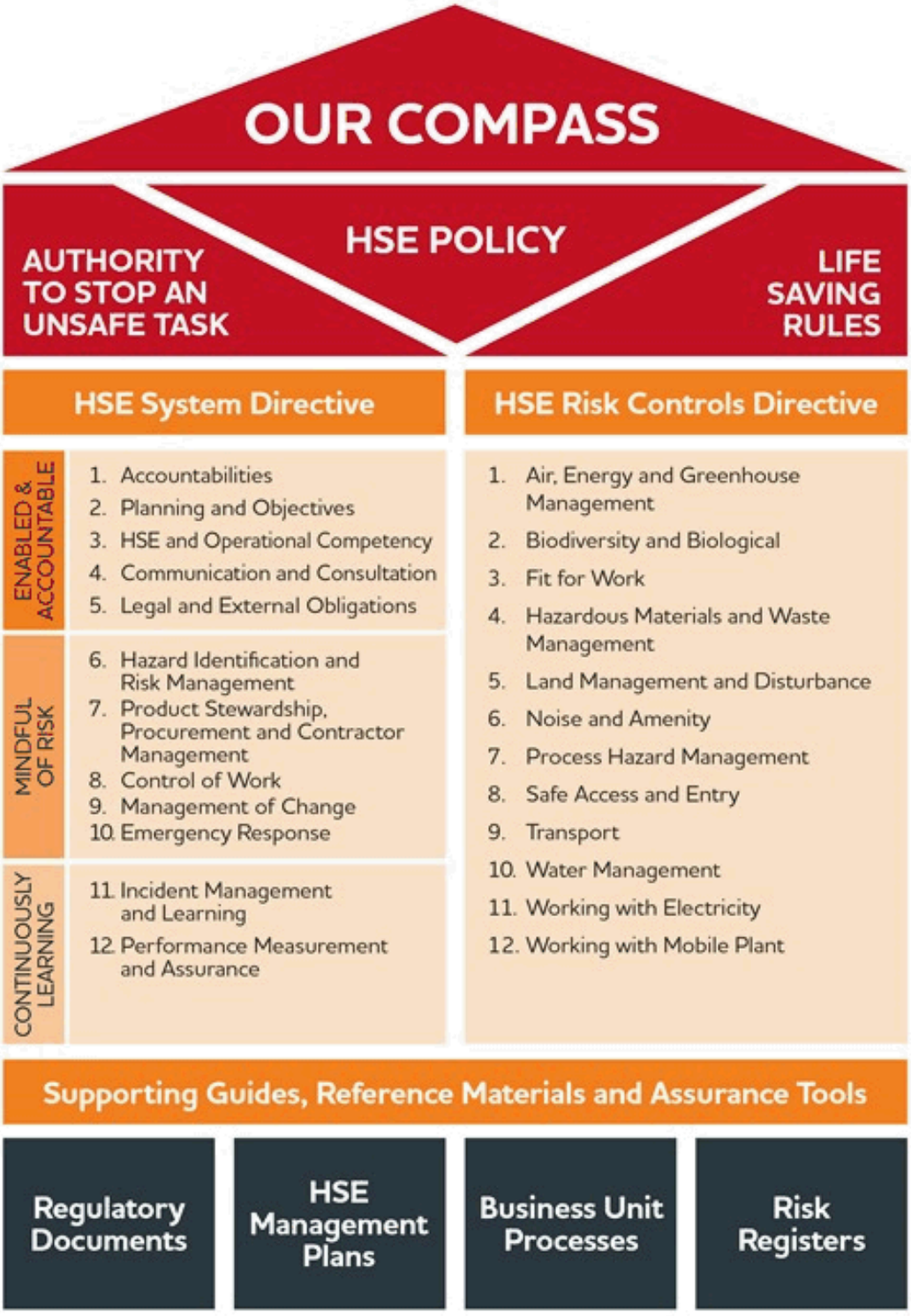

Figure 19: Origin's HSEMS structure

OUR HEALTH, SAFETY AND ENVIRONMENT POLICY

origin

OUR PRINCIPLE OF DUE CARE

We care about the wellbeing of our people and our impact on the environment.

OUR HSE ASPIRATION

To conduct our business in a way that causes no harm to the health and safety of people and has no unforeseen impacts to the environment.

OUR HSE ACTIONS

We all believe that our HSE aspiration is achievable and we embrace our responsibility for supporting it by:

Always mindful of risk

Recognising that risk is present in every task we do and taking the time to identify and understand these risks and manage them safely and responsibly.

Enabled and accountable

Taking ownership and using our authority, resources, systems and competencies to manage the risks associated with our work. We stop work when confronted by an unknown hazard and proceed only when satisfied we can continue safely and responsibly.

Continuously learning

Being open and transparent about how well we are doing and relentless in learning from our experience to manage our risks. We work together effectively, welcome any feedback and recognise that we can always do better.

Our Compass and HSE Management System set out how we will implement this policy.

Frank Calabria
CEO
Origin Energy

ORG-HSE-POL-001 November 2016

Figure 20: Origin's Health, Safety and Environment (HSE) Policy

8.3 Roles and responsibilities

The following sections describe, in detail, the management strategies for specific components of the landscape, such as soil, groundwater and vegetation, and the cultural and social environment, in relation to the different impact-causing activities that may occur.

The management hierarchy is illustrated in Figure 21. Each management area has been assigned to specific positions within the exploration team as follows:

- **Asset Manager**: Responsible for the overall operations in the Origin's activities in the exploration permit area.
- **Project Manager**: Oversees the whole planning and execution of the exploration program and is the person ultimately responsible for ensuring all other parties are working within the HSE guidelines. The Project Manager's role is predominantly office-based. The Project Manager will be responsible for notifying the Minister, the occupier of the land on which the activity is to be carried out and the owner of the land on which the activity is to be carried out (unless the owner is also the occupier).
- **Civil Construction Superintendent**: Person based in the field responsible for ensuring all areas of operations and construction are carried out in accordance with the EMP and Origin's HSE Policy. All contractors report to this position, who is responsible to the Project Manager.

  This role will also cover the role of the **Weeds Officer**, who will be responsible for:

  - 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 Northern Territory 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 civil-related complaints and incidents in accordance with the pre-determined strategies in this EMP or relevant ERP.
  - Review and update of WMPs to remain effective in communication with relevant landholders and Regional Weed Officer – Onshore Shale Gas Development in consideration of monitoring results and emerging weed issues for both gas and pastoral operations.
- **Drilling and Completions Lead**: Person responsible for ensuring the well testing activities are designed and implemented in accordance with the NT legislation and Code of Practice.
  - Ensures all well testing activities are undertaken in accordance with the NT Petroleum Code of Practice.
  - Selection and design of equipment and practices to manage environmental risk.
  - Responsible for selecting and engaging well testing contractors.
  - Ensuring all contractors comply with the contract terms including compliance with the EMP requirements.

- **Drilling and Completions Superintendent**: Person responsible for ensuring the drilling, stimulation and well testing activities are executed in accordance with the works program, EMP and Origin's HSE Policy. This role reports to the Growth Assets Drilling and Completions Lead.
    - Ensures all well testing activities are undertaken in accordance with the NT Petroleum Code of Practice.
    - Selection and design of equipment and practices to manage environmental risk.
    - Responsible for selecting and engaging well testing contractors.
    - Ensuring all contractors comply with the contract terms including compliance with the EMP requirements.
- **Well Site Representative:** Person based at the well pad responsible for ensuring all areas of drilling, completion and well testing are carried out in accordance with the EMP and Origin's HSE Policy. All well testing contractors report to this position, who reports to the Drilling and Completions Superintendent.

  This role reports to the Drilling and Completions Superintendent and is responsible for:
    - Planning and execution of the well testing activities when on-site, including understanding and communicating the environmental requirements of this plan.
    - Facilitate training of all workers (including contractors) in accordance with the management of weeds, spills, waste, emissions and other aspects.
    - Ensuring all reporting requirements are met.
    - Act as the designated point of contact for, and rapidly responding to, any drilling, stimulation and well testing environmental incidents and emergencies in accordance with the pre-determined strategies in this EMP or relevant ERP.
    - Undertake field inspection and assurance activities.
- **Lead Contractor:** A nominated member within each contracting company (Well Testing service providers) that are responsible for delivering the commitments outlined in this plan. The Lead Contractor for each service provider will comply with the nominated contractual terms and work instructions issued under this EMP. The Lead Contractor must ensure all staff are aware of their obligations, are approximately trained and that procedures and controls are fully implemented and complied with.
- **Civil Design Engineer:** An individual or organisation that provides professional or expert advice in the field of civil engineering and design. They determine the best locations, design, materials and construction techniques for undertaking a project to ensure it meets the needs of the end user.
- **Health Safety and Environment Representative (HSE Representative):** Origin representative providing guidance and advice to site personnel on the day-to-day management of the environment. This role will also support the nominated Weeds Officer, specifically in the planning and reporting phases.
- **Field Personnel**: All staff including Origin and contractors that are working in the exploration permit areas. Responsible for day-to-day management and reporting of environmental aspects.

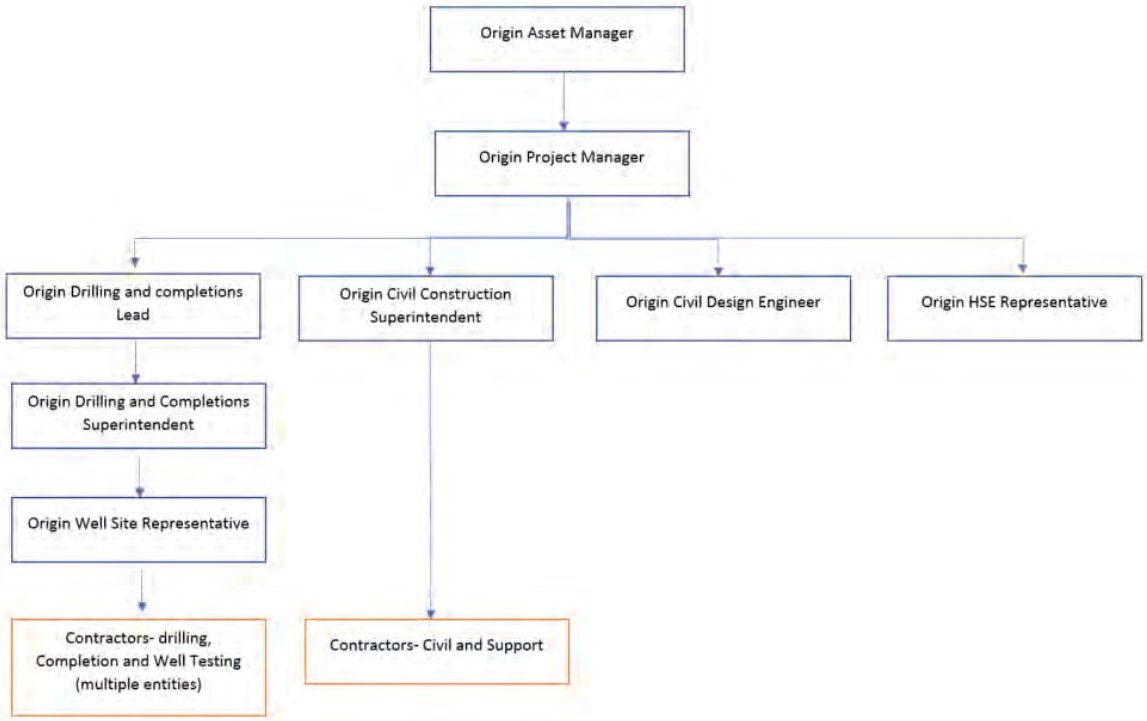

Figure 21: Beetaloo Project Organisation Chart

8.4 Training and awareness

Origin's HSEMS outlines the policies and procedures governing the training and competency of all personnel (staff and contractors) to ensure they can fulfil their obligations under this EMP and the broader Origin HSEMS.

The majority of work undertaken under this will be via contractors under supervision of Origin staff. Assuring the level of training and competency of the selected contractors and supervisors is therefore a major focus of the HSE EMS implementation strategy.

These systems include:

- General Origin HSE induction
- Contractor HSE prequalification process
- Contractor management system
- Site-specific inductions
- Task-specific training, procedures and competency requirements

Contractors will be required to demonstrate they have appropriate systems, procedures and training to manage specific risks covered under this EMP prior to award. The following aspects will be considered during tender award:

- Maturity of HSE systems and process
- Previous HSE performance
- Existing procedures and training:

  - Weed identification and management
  - Refuelling procedures
  - Procedures for avoidance of potential fauna habitat and any identified heritage sites
  - Hazardous material and waste management procedures
  - Spill management
  - Incident notification and management processes
- Internal training programs
- Internal auditing processes

All staff and contractors entering the site will be required to attend a site-specific induction. The induction covers the following aspects:

- Regulatory requirements for the area, including specific conditions on the exploration permits and agreements with the NLC
- Environmental considerations and special procedures to be used for environment protection, as well as protection of archaeological and cultural sites within the permit areas
- Safety procedures covering the safe use of vehicles, equipment and explosives first aid and HSE in remote area operations
- Emergency response training
- Landowner sensitivities, including Aboriginal communities and their specific cultural requirements
- Procedures for handling any culturally or archaeologically sensitive materials that may be discovered
- Provide training in safe storage and handling of flammable and combustible liquids

8.5 Monitoring

A series of monitoring programs has been developed under this EMP to:

- Monitor the take of groundwater
- Detect equipment methane leaks
- Monitor and detect weeds
- Monitor stormwater quality released from chemical storage areas
- Report on site stability and rehabilitation progress.

An overview of each of the monitoring programs is provided in Table 34.

In accordance with of C.5.1 (d) in the Code of Practice, where there are no NATA accredited laboratories for a specific analyte or substance, then duplicate samples must be sent to at least two separate laboratories for independent testing or evaluation.

Table 34: Monitoring program summary

Monitoring program	Purpose	Monitoring points	Parameters	Frequency	Investigation thresholds	Instrument calibration	Reference document
Groundwater take	Groundwater volume	Each groundwater extraction bore	Kilolitres	Continuous flow meter	Total extraction <1ML/yr	*N/A- approved DEPWS meter utilised with no calibration required*	*NT Water Act*
Stormwater	Manage stormwater collected within bunds during activities	Chemical storage areas	Field EC and pH	Prior to release	Off-site release and dust suppression limits: • pH 6-9 • EC 1300µs/cm	Instrument calibrated before use. pH probe calibrated with a two point calibration using a pH buffer of 7 and 10. EC meter calibrated with a 1413µs/cm (or similar) standard	N/A
Erosion and sediment control	To detect the presence of erosion and sedimentation from infrastructure	Inspection of all disturbed areas, including lease pads, access tracks, gravel pits, laydown yards, camp pads etc.	Visual inspection of infrastructure and erosion and sediment controls	Visual inspections pre- and post-wet season	Visible erosion or failure of erosion and sediment control	N/A	Origin's Approved Erosion and Sediment Control Plan (NT-2050-15-MP-0019)
Weeds	Identify weeds potentially introduced or spread by Origin's activities	Inspection of all disturbed areas, including lease pads, access tracks, gravel pits, laydown yards, camp pads etc.	Visual inspection	Visual inspections pre- and post-wet season	• Positive confirmation of the detection of a weed of national significance species within Origin's disturbance footprint • An increase in existing weed density and spatial extent	N/A	Origin's Weed Management Plan NT-2050-15-MP-0016.
Methane emission monitoring program	To identify and remediate gas leaks	Each exploration well	Methane (PPM)	6 monthly	>500PPM	Gas detector calibrated monthly with a 10ppm (or similar) methane calibration gas	Methane Emissions Management Plan (Appendix E)
Post rehabilitation	Monitor ongoing rehabilitation success	Inspection of all rehabilitated areas, including lease pads, access tracks, gravel pits and camp pads	Visual inspections of: • Stem count • Vegetation cover %	Annually	Decline in rehabilitation criteria value compared to previous year results	N/A	Section 3.20

Monitoring program	Purpose	Monitoring points	Parameters	Frequency	Investigation thresholds	Instrument calibration	Reference document
			• Species diversity % • Erosion				

8.5.1 Investigation and response framework

Where an exceedance of a monitoring program investigation trigger is observed from one of the monitoring programs outlined in Table 34, an investigation and response will be implemented as summarised in Figure 22.

The investigation and response process will be divided into the following components:

- Verification—is the result real?
- Evaluation—is the result related to petroleum activities?
- Remediation or management—what is the potential impact?
- Ongoing monitoring

The initial step in the process is *verification* of the measurement. This process begins with a check on integrity of the measurement, including a review of the protocol used to collect the measurement, calibration of equipment and the integrity of the monitoring infrastructure itself (such as the integrity of a monitoring bore). If the original data point is found to be correct, then a risk-based (appropriate to the scale and nature of the exceedances) investigation of the results is conducted and an evaluation phase is initiated.

The *evaluation* phase will have two major goals; to identify the origin or source of the trigger exceedance; and characterise the potential effects on environmental factors in order to reduce or eliminate negative consequences. This phase of investigation is conducted in a manner consistent with the type of threshold exceedance observed. Simple exceedances of water quality triggers during stormwater releases for example, may require simple investigations into the procedures and processes contributing to the event. Groundwater threshold exceedances may require more detailed assessment, whereby a comprehensive set of information is accessed and utilised, including a review of operational activities, the influence of other regional activities (e.g. mining or pastoral activities), changes in climatic conditions etc. Detailed investigation may include the identification of knowledge and/or data gaps and collection of additional data to fill these gaps and bring the issue into proper context.

If the *evaluation* phase of the investigation identifies the issue as being natural or not associated with petroleum activities, then the result is documented and monitoring continues. This may lead to the revision of a trigger or threshold. However, if the results indicate an influence of a petroleum activity, an assessment of risks is undertaken to assess the potential impact on environmental factors. This will involve a more in-depth evaluation or characterisation of the affected area and potential source. Regulatory notification may be required in accordance with section 8.8.

If the *evaluation* phase of the investigation indicates the influence of a petroleum activity, then mitigation measures may need to be implemented to prevent ongoing impacts to an environmental factor. These mitigation measures will be appropriate to the nature of the incident and will be based upon a risk assessment and technical feasibility assessments. Such mitigation measures may include:

- Stopping the activity and/or
- Modifying the activity to directly address the source of harm (i.e. additional procedures, training, ceasing or redesigning an activity) and/or
- Implementation of mitigation measures to reduce the potential effects (i.e. make good agreements, direct removal and treatment of contaminants etc.)

Upon implementation of mitigation measures, further *evaluation* through increased monitoring is undertaken to determine the success of the mitigation measures. If a positive result is observed, and trends begin to stabilise or reverse, then the result is documented and a return to regular monitoring occurs. If not, then the continued operation of the identified activity or activities causing the effected may need to be reviewed and adjusted in consultation with the regulator and other affected parties.

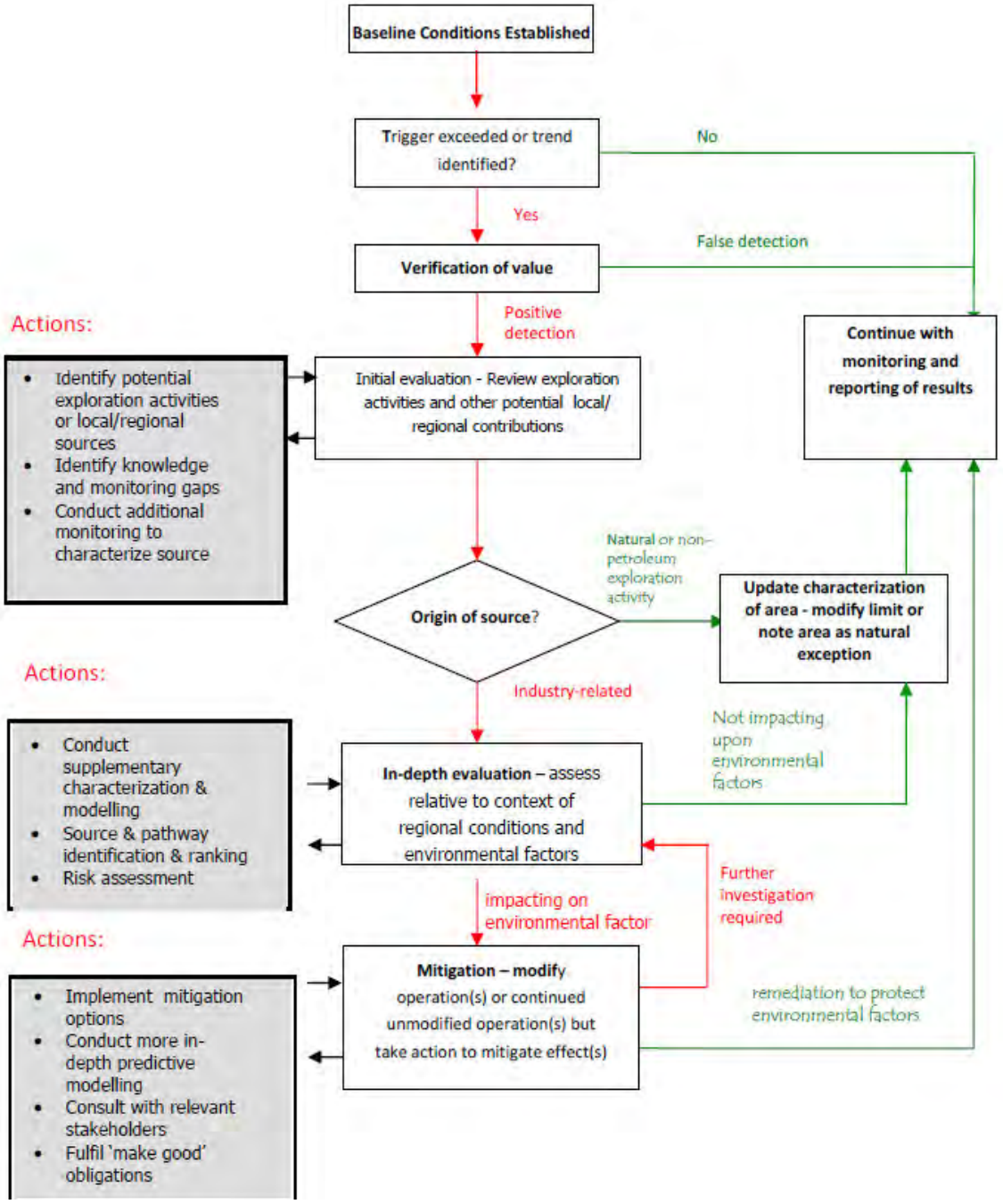

Figure 22: Investigation and response process

8.6 Environmental commitment summary

The responsibility for general environmental monitoring rests with all personnel engaged on the project. More specifically, Origin's Drilling Completion Lead and Well Site Representatives are responsible for delivering the relevant components of this plan.

The program environmental commitments outlined in Appendix J are sourced from the risk assessment (Appendix G) and environmental outcomes, performance standards and measurement criteria tables (Tables 28–34). The implementation and compliance against these risk controls will be assessed as part of the annual environmental report (refer in section 8.11).

Specific commitments will be to:

- Record information to track performance, including non-conformances and corrective actions
- Inspect and monitor operational controls on-site via regular environmental monitoring
- Assess the level of conformance with objectives and targets detailed in this EMP

The Operating Company Representative will undertake random site inspections and direct such action as may be considered necessary to protect, minimise or rectify any environmental concerns.

8.7 Work instructions

The work covered under this EMP will be executed by external contractors with Origin oversight. Efforts are therefore focused on effective contractor management, to ensure third parties are compliant with the relevant EMP commitment and contractual requirements. An overview of Origin's EMP implementation strategy is provided in Figure 23.

An instrument referred to as a 'work instruction' is the main mechanism by which Origin cascades the relevant environmental commitments to each contractor. The work instructions are designed to be a contractual document that outlines the minimum compliance requirements for a specific activity. The work instructions contain:

- Key compliance and system documents
- A list of compliance commitments and responsible person for a specific activity
- A list of inspections, procedures and other tools required to implement the content of the EMP
- Monitoring and reporting requirements
- 'Hold Points' which require a deliverable to be completed prior to entry into a new activity phase (i.e. prior to mobilisation, operation and demobilisation)
- Maps illustrating the approved disturbance areas and any restricted work areas.

The work instructions form a critical implementation and assurance tool in that an Origin representative must sign off the 'Hold Points' to ensure the various commitments have been achieved. This provides a clear, documented approach to demonstrate compliance which can be audited against.

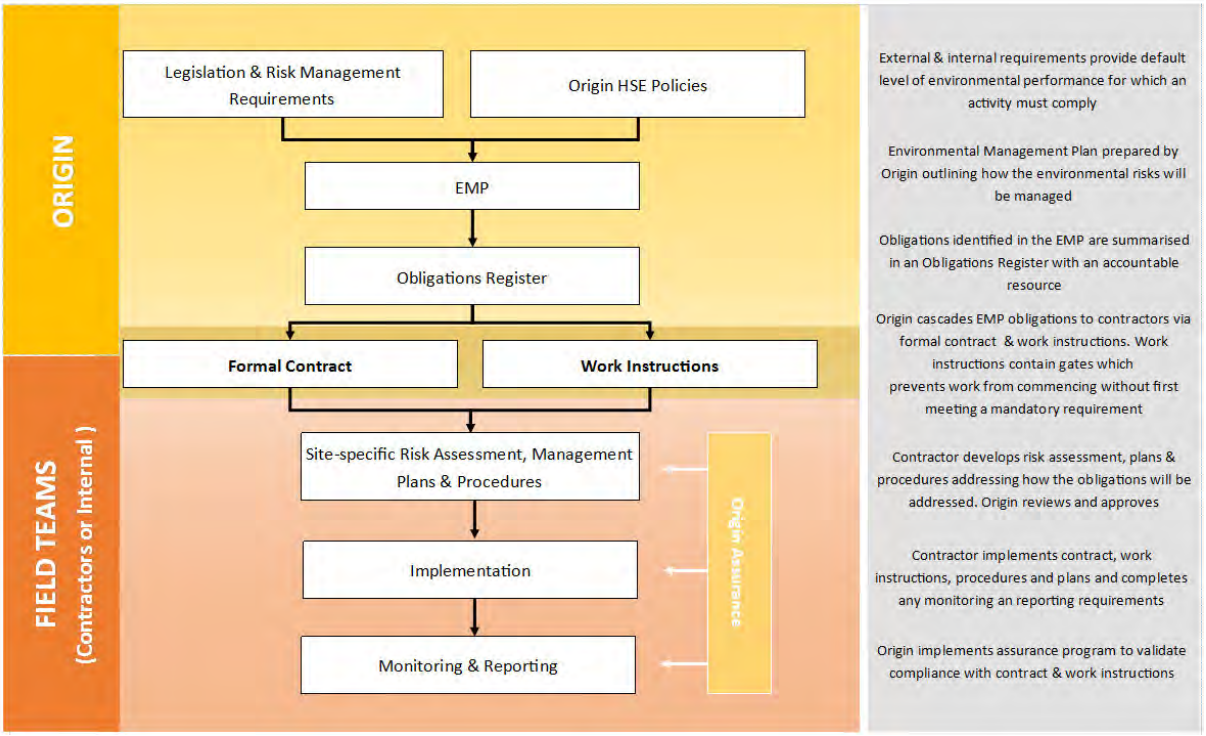

Figure 23: EMP implementation overview flowchart

8.8 Incident reporting

Incident reporting and investigation provides the mechanism to prevent a recurrence. All personnel are required to proactively report all incidents, near-misses and identification of potential hazards.

Origin utilises an online incident management and reporting system. Any environmental incident, near miss or observation is reported through the online incident reporting system. All personnel are encouraged to report minor events to act as an alert to environmental risks and to maintain a program of continual improvement.

8.8.1 Reportable environmental incident reporting

The NT Petroleum (Environment) Regulations 2016 define a reportable incident as an incident arising from a regulated activity that has caused, or has the potential to cause, material environmental harm or serious environmental harm as defined under the *Petroleum Act*. This also includes any potential or actual damage to a sacred site.

'Material environmental harm' is defined in section 117AAB(1) of the *Petroleum Act* to mean environmental harm that:

(a) is not trivial or negligible in nature

(b) consists of an environmental nuisance of a high impact or on a wide scale

(c) results, or is likely to result, in not more than $50,000 or the prescribed amount (whichever is greater) being spent in taking appropriate action to prevent or minimise the environmental harm or rehabilitate the environment; or

(d) results in actual or potential loss or damage to the value of not more than $50,000 or the prescribed amount (whichever is greater).

Origin will identify and assess incidents continuously to determine if they are reportable. Where an incident is reportable, DEPWS will be contacted (this may be verbal or in writing) as soon as practicable but no later than two hours after the first occurrence of the incident or after the time the interest holder becomes aware of the incident.

Notification will be via the DEPWS Onshore gas non-compliance hotline on 1800 413 567.

Any verbal report to DEPWS will be followed up by a written report from the Project Manager within 24-hours after giving verbal notice in accordance with the NT Petroleum (Environment) Regulations 2016. An initial report about a reportable incident must be given as soon as practicable, but not later than three days after the incident occurs, and must include comprehensive details about the following:

1. The results of any assessment or investigation of the conditions or circumstances that caused or contributed to the incident
2. The nature and extent of the material environmental harm or serious environmental harm that the incident caused or had the potential to cause
3. Any actions taken, or proposed to be taken, to clean up or rehabilitate an area affected by the incident
4. Any actions taken, or proposed to be taken, to prevent a recurrence of a similar incident.

A final report must be given as soon as practicable but no later than 30-days after the clean up or rehabilitation is complete. This must include a root cause analysis.

8.8.2 Recordable incidents

The NT Petroleum (Environment) Regulations 2016 define a recordable incident as an incident arising from a regulated activity that:

1. Has resulted in an environmental impact or environmental risk not specified in the current plan for the activity; or
2. Has resulted in a contravention of an environmental performance standard specified in the current plan for the activity; or
3. Is inconsistent with an environmental outcome specified in the current plan for the activity; and
4. Is not a reportable incident.

Origin will notify (this may be oral or in writing) DEPWS of a recordable incident as soon as practicable but no later than 15-days after the reporting period (agreed period or each 90-day period after the day on which the EMP is approved).

8.8.3 *NT Waste Management and Pollution Control Act 1998* incident reporting

In accordance with the *NT Waste Management and Pollution Control (WMPC) Act 1998,* where contaminants or waste is not confined within the land on which the petroleum activities are undertaken (i.e. the approved disturbance areas where the petroleum activity is occurring), Origin has a duty to notify of incidents causing or threatening to cause pollution as soon as practicable, but no less than 24-hours after becoming aware of the incident.

A notifiable incident is defined as an incident that causes, or is threatening or may threaten to cause, pollution resulting in material environmental harm or serious environmental harm.

A notification must include:

(a) the incident causing or threatening to cause pollution

(b) the place where the incident occurred

(c) the date and time of the incident

(d) how the pollution has occurred, is occurring or may occur

(e) the attempts made to prevent, reduce, control, rectify or clean up the pollution or resultant environmental harm caused or threatening to be caused by the incident

(f) the identity of the person notifying

Origin shall make all notification under the WMPCA via the NT EPA Pollution Hotline 1800 064 567.

8.8.4 Gas Leak reporting

Each gas leak shall be classified, repaired and reported in accordance with Table 35.

Table 35: Leak classification and remediation summary

Classification	Threshold	Notification	Comments
Minor Leak	>500ppm measured at the surface of the component in accordance with section 6.6.5.	All minor leaks must be documented	A minor leak is an unplanned release that does not occur during commissioning or bringing equipment back into service. These leaks should be corrected immediately as a part of commissioning
Significant Leak	>5000ppm (or 10%of the Lower Explosive Limit) when measured at 150mm above the leak source or A Liquid Petroleum (condensate/oil) loss of containment that exceeds 200L or The leak is too large or not safe to measure.	In the case of an emergency situation, DPIR must be notified within 24 hours via the emergency response hotline number 1300 935 250. Notification must include the date of identification, nature and level of the leak, infrastructure name, number and location as well as the initial actions to minimise the risk. The landowner or occupier of the property in which these leaks are occurring must be notified in the following circumstances: i) if the leak cannot be repaired immediately; and ii) if the leak is likely to affect any of the landowner's or occupier's facilities or activities. A written close-out report must be submitted within 5 business days of the remediation of the leak, specifying the date of	A significant leak is an unplanned release that does not occur during commissioning or bringing equipment back into service. These leaks should be corrected immediately as a part of commissioning

Classification	Threshold	Notification	Comments
		identification, nature and level of leak, location and name of the operating plant, and the rectification actions taken. If finalising the remediation is delayed more than 7 business days from the identification of the leak an update must be submitted on that day. The final close out report shall be provided when all work is completed. Where environmental impacts have occurred notification to DEPWS is undertaken as described in section 8.7.1 or 8.7.2 as appropriate.	

8.9 Monitoring, assurance and non-conformance management

In addition to regular monitoring as set out in this document, audits assessing compliance with this EMP and associated work instructions will be undertaken by Origin during the commencement of the activity. System deficiencies, adverse or potentially adverse environmental conditions arising from site activities may be subject to the issue of environmental non-conformances or corrective action requests. These non-conformances or corrective actions shall be logged, and remedial actions identified and implemented. The status of corrective actions will be tracked and reported annual in the annual environmental report.

Audits of implementation of the EMP commitments will be completed for each activity or at least annually. The results will be included in the annual environmental report.

Table 36: EMP audit schedule

Audit Type	Scope of Audit	Frequency	Responsibility
Operational assurance	Operational compliance checks to ensure risk management controls are implemented	Monthly	Origin HSE Representative
Annual assurance	Compliance against EMP commitments and risk management controls	Annually	Origin HSE Representative

8.10 Emergency Response Plan

An Emergency Response Plan has been developed covering the proposed activities within the EMP. The ERP provides a broad framework for managing potential emergency incidents to minimise the potential risk to human safety and the environment.

The ERP covers the following aspects pertinent to the Beetaloo W activities and associated infrastructure:

- Spills and loss of containment
- Bushfires
- Medical emergencies
- Flooding
- Emergency incident reporting

The ERP will be reviewed every three years to ensure the content is continually kept up to date. A copy of the ERP is provided in Appendix K.

8.11 Reporting

Internal and government reporting on performance standards will be carried out by the Origin authorised representative, and distributed to Origin management and the DEPWS, in accordance with Section 35 of the NT Petroleum (Environment) Regulations 2016. Quarterly and annual reports will be completed to summarise the compliance with this EMP, whether the environmental outcomes and performance standards in the plan were met and the details of any recordable and reportable incidents.

Table 37: EMP reporting schedule

Frequency	Report detail	Recipient
Prior to the commencement of construction and drilling	A commencement of construction or drilling activity notification	a) The Minister for Environment b) The occupier of the land in which the activity is carried out c) The owner for the land for which the activity is to be carried out
Only if required	Incident report summarising reportable incidents	DEPWS
Monthly	Monthly activity summary report	DEPWS
Quarterly	Quarterly incident report summarising recordable incidents during the period (during operational activities) and groundwater monitoring data	DEPWS
Annually	An annual environmental report will be prepared and submitted to the Minister covering the following: • Summary of the works completed under the EMP during the reporting period • Summary of performance against measurement criteria • A summary of environmental incidents that occurred during the year (i.e. reportable and recordable incidents that occurred) • Any environmental studies or research associated with the activity • Technical improvements • Consultation undertaken • Annual weed management performance reporting against NT-2050-15-MP-0016 • Results of related research or of an ongoing monitoring program • The relevant records outlined with section 6.6 Environmental Risk Management Summary tables	Origin management DEPWS

8.12 Record keeping

The following records will be retained within Origin's Document Management system for a period of five years:

- Records linked to measurement criteria, commitments and statutory reporting requirements
- Induction records
- Waste records
- Hazardous goods manifests
- Fuel usage
- Weed inspections
- Non-compliances and corrective action records
- Internal audits and inspection records
- Management of change records.

To the extent these documents are 'prescribed records' for the purpose of the NT Petroleum (Environment) Regulations 2016, they will be kept for the longer of five years following the period during which the petroleum interest is in force and 15-years after the record comes into existence.

8.13 Management of change

A management of change process will be implemented to ensure any changes to activities are appropriately assessed and communicated to ensure no additional un-intended risks or impacts are introduced. This allows adaptive management and the ability to use appropriate technologies.

It should be noted that changes can only be implemented to optimise environmental outcomes or to improve operational efficiency where no new regulated activity, risk (including risk level) or impact is introduced. Where a new risk (including risk level) or impact is introduced, then a revision of the EMP is required under the PER's.

8.14 EMP Review

Implementation of this EMP will be continually monitored and revised as required based on monitoring and audit results, complaints, employee and stakeholder feedback, change to the proposed work program or a material increase in risk level.

A formal review, update and resubmission of this EMP will be undertaken every five years.

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10 Acronyms and abbreviations

Acronym	Meaning
°C	Degrees Celsius
%	Percentage
AAPA	Aboriginal Areas Protection Authority
ABS	Australian Bureau of Statistics
AICS	Australian Inventory of Chemical Substances
ALA	Atlas of Living Australia
ALARP	As Low As Reasonably Practicable
ANZECC	Australian and New Zealand Environment Conservation Council
API	American Petroleum Institute
APPEA	Australian Petroleum Production and Exploration Association
AS	Australian Standard
BMP	Bushfire Management Plan
BPESC	Best Practice Erosion and Sediment Control
CAS number	Chemical Abstracts Services number
CEEVNT	Critically Endangered, Endangered, Vulnerable and Near Threatened
CLA	Cambrian Limestone Aquifer
COP	Code of Practice
Cth	Commonwealth
DAWE	Department of Agriculture, Water and the Environment (DAWE) (Commonwealth) (formerly Department of The Environment and Energy (DoTEE) (Cmwlth))
DEPWS	Department of Environment, Parks and Water Security (formerly Department of Environment and Natural Resources (DENR))
DITT	Department of Industry, Trade and Tourism (formerly Department of Primary Industries and Resource (DPIR))
DoH	Department of Health (NT)
EC	Electrical Conductivity
EIS	Environment Impact Statement
EMP	Environmental Management Plan

Acronym	Meaning
EP	Exploration Permit (e.g. EP76, EP98 and EP117)
EPA	Environment Protection Authority (NT)
EPBC	Environment Protection and Biodiversity Conservation Act
ERS	Emergency Response Plan
ESC	Erosion and sediment controls
ESCP	Erosion and Sediment Control Plan
GDE	Groundwater Dependent Ecosystems
GHG	Greenhouse Gas
GPS	Global Positioning Device
Ha	hectare
HFS	Hydraulic Fracture Stimulation
HSE	Health, Safety and Environment
HSEMPs	Health, Safety and Environmental Management Plans
HSEMS	Health, Safety and Environment Management System
IBA	Important Bird Area
IECA	International Erosion Control Association
ILUA	Indigenous Land Use Agreement
ISO	International Organisation for Standardisation
JV	Joint Venture
Km	Kilometre
km^2	Square Kilometres
km/hr	Kilometres per hour
LAG	Local Aboriginal Group
LOS	Level of Service
m	metre
Ma	Millions of years ago
MD	Measured Depth
MEMP	Methane Management Plan
Ml	Local Magnitude

Acronym	Meaning
Mm	millimetre
mMDRT	Meters measured depth below rotary table
MNES	Matters of National Environmental Significance
SDS	Safety Data Sheet
mTVDGL	metre True Vertical Depth below ground level
NATA	National Association of Testing Authorities
NEPM	National Environmental Protection Measure
NGERS	National Greenhouse and Energy Reporting Scheme
NICNAS	National Industrial Chemicals Notification and Assessment Scheme
NLC	Northern Land Council
NORMs	Naturally Occurring Radioactive Materials
NPI	National Pollutant Inventory
NT	Northern Territory
OHS	Occupational Health and Safety
PER	Public Environment Report
RWA	Restricted Work Area
SPMP	Spill Management Plan
SWL	Standing Water Level
tCO_2^e	tonnes of carbon dioxide equivalent
TDS	Total Dissolved Solids
TIA	Traffic Impact Assessment
TMP	Traffic Management Plan
TO	Traditional Owner
TVDSS	True Vertical Depth from Surface Sea level
TPWC Act	*Territory Parks and Wildlife Conservation Act*
TRH	Total Recoverable Hydrocarbons
TSS	Total Suspended Solids
VOCs	Volatile Organic Compounds
WBIV	Well barrier integrity verification

Acronym	Meaning
WEL	Water Extraction Licence
WIMP	Well Integrity Management Plan
WMP	Weed management Plan
WOMP	Well Operations Management Plan
WoNS	Weed of National Significance
WWMP	Wastewater Management Plan

Appendix A Bushfire Management Plan

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Bushfire Management Plan 2020/21

Beetaloo W-1 Lease

Location of Beetaloo W-1 Lease	
Property land uses	Gas exploration and cattle grazing
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 Origin's people, assets and operations and neighbouring land uses.

Fire Management Risks

- Ignitions (humans and lightening) on or off site resulting in harm to workers and loss of equipment.
- Fire scar mapping indicates the exploration area burns approximately every 3 to 5 years.
- Bullwaddy and Lancewood vegetation communities occur in areas across the permit and are fire sensitive. Hot fires have the ability to reduce habitat quality for both flora and fauna species which utilise these vegetation communities.
- Spread of high fuel load grassy weeds could increase fire intensity, e.g. Gamba, Grader and Buffel grass, within adjacent infrastructure areas and access tracks.

This Site Specific Bushfire Management Plan has been prepared for Origin to manage the risk from bushfire within the Beetaloo W-1 lease area. This Plan should be read in conjunction with the Overarching *Environmental Management Plan and Emergency Response Plans* for Origins operations in the Beetaloo Basin.

Bushfire Officer	Contact Details	Name
	Mobile : [redacted] Ro[redacted]u	Robert Wear

Properties	Contact Details		Name
Beetaloo Station	[redacted]	UHF	[redacted]
	[redacted]	VHF	
Newcastle Waters Station	Homestead	UHF	
		VHF	

Offsite Stakeholders	Contact Details	Name
National Response Centre	1800 076 251	24/7 contract line
Emergency	000 or 112 mobile	
Bushfire NT Katherine office (Savanna)	(08) 8973 8876	
Bushfire NT Alice Springs office (Barkly)	(08) 8952 3066	
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/	

Origins's Amungee NW-1 Lease Area Management Zones—Bushfire Management Actions

Well Pads and Tank Pads	• Remove all vegetation within the lease 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.
Fire management break	• A 10 m wide cleared perimeter around well pads and tank pads • An additional 10 m wide bare earth fire break incorporating a 4 m wide fire access trail
Fire access trails	• Create and maintain 4 m wide access trail by grading or spraying
Asset Protection Zone (APZ)	• Site Manager to assess fuel load prior to camp establishment and again at end of wet season if infrastructure is still in place. • Establish a 20 m low fuel zone around well pads and lease pads. • 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 fire fighting 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.

Annual Works Calendar

Month	Bushfire Risk	Action	Month	Bushfire Risk	Action
Jan	Low	• No fire management activity	July	Medium	• Manage vegetation onsite including weeds • Manage fire break and fire access trail • Monitor NAFI • Liaise with neighbour regarding bushfires
Feb	Low	• No fire management activity	Aug	High	• Monitor NAFI and visual scan horizon for smoke • Liaise with neighbour regarding bushfires • Review the preparedness planning requirements
Mar	Low	• Weed survey • Planning meeting with neighbour • Annual fire mapping to monitor changes to fire frequency in the relevant area.	Sept	High	• Monitor NAFI and visual scan horizon for smoke • Liaise with neighbour regarding bushfires • Review the preparedness planning requirements
Apr	Low	• No fire management activity	Oct	High	• Monitor NAFI and visual scan horizon for smoke • Liaise with neighbour regarding bushfires • Review the preparedness planning requirements
May	Medium	• Manage vegetation onsite including weeds • Manage fire break and fire access trail • Monitor NAFI • Liaise with neighbour regarding bushfires	Nov	High	• Monitor NAFI and visual scan horizon for smoke • Liaise with neighbour regarding bushfires • Review the preparedness planning requirements
June	Medium	• Manage vegetation onsite including weeds • Manage fire break and fire access trail • Monitor NAFI • Liaise with neighbour regarding bushfires	Dec	Medium	• Manage vegetation onsite including weeds • Manage fire break and fire access trail • Monitor NAFI • Liaise with neighbour regarding bushfires

Bushfire Preparedness

Preparedness 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 know risk (fire in the area), 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.

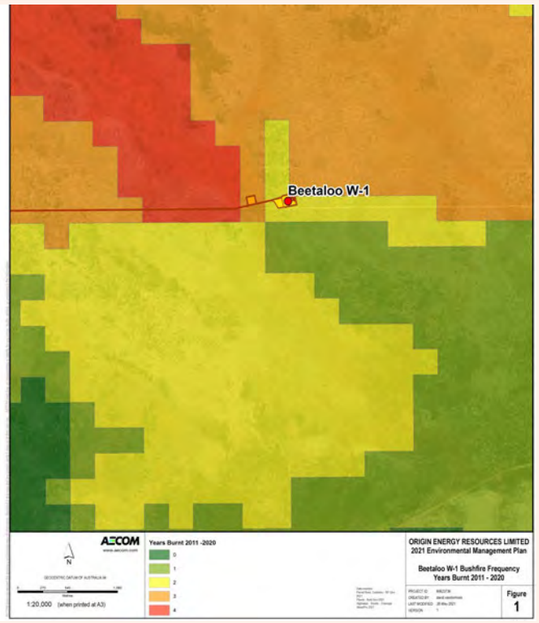
2. Alarm – Raise the alarm either on common radio channel or other agreed process.

3. Gather Information –

- ☐ **Location** – Direction from known reference points, (e.g. roads and infrastructure such as lease 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 (Contractors, Pastoralist or Emergency Services).
- ☐ **Response required** – Contractors and / or Pastoralist and / or Emergency Services.
- ☐ **Access** – Safe access and egress routes.

4. Notify Origin – Fire Officer/Supervisor

5. Notify Pastoralists – Refer to Property Contacts



Appendix B Weed Management Plan

BEETALOO BASIN EXPLORATION PROJECT

Weed Management Plan

Review record

Rev	Date	Reason for issue	Author	Reviewer	Approver
0	05/10/2018	Issue for release	A Court	M Kernke	M Hanson
1	29/03/2019	Issue for release	A Court	M Kernke	M Hanson
2	20/05/2019	Minor Update	A Court	M Kernke	M Hanson
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

Review due: 29/03/2024

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Weed Management Plan

NT-2050-15-MP-0016

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Review due: 29/03/2024

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1. Introduction

1.1 Objectives of the WMP

This WMP has been developed to ensure that the risk of weed introduction and spread, resulting from activities associated with Origin Exploration activities are mitigated to protect the economic, community, industry and environmental interests of the Territory.

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 with 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 on Figure 1.

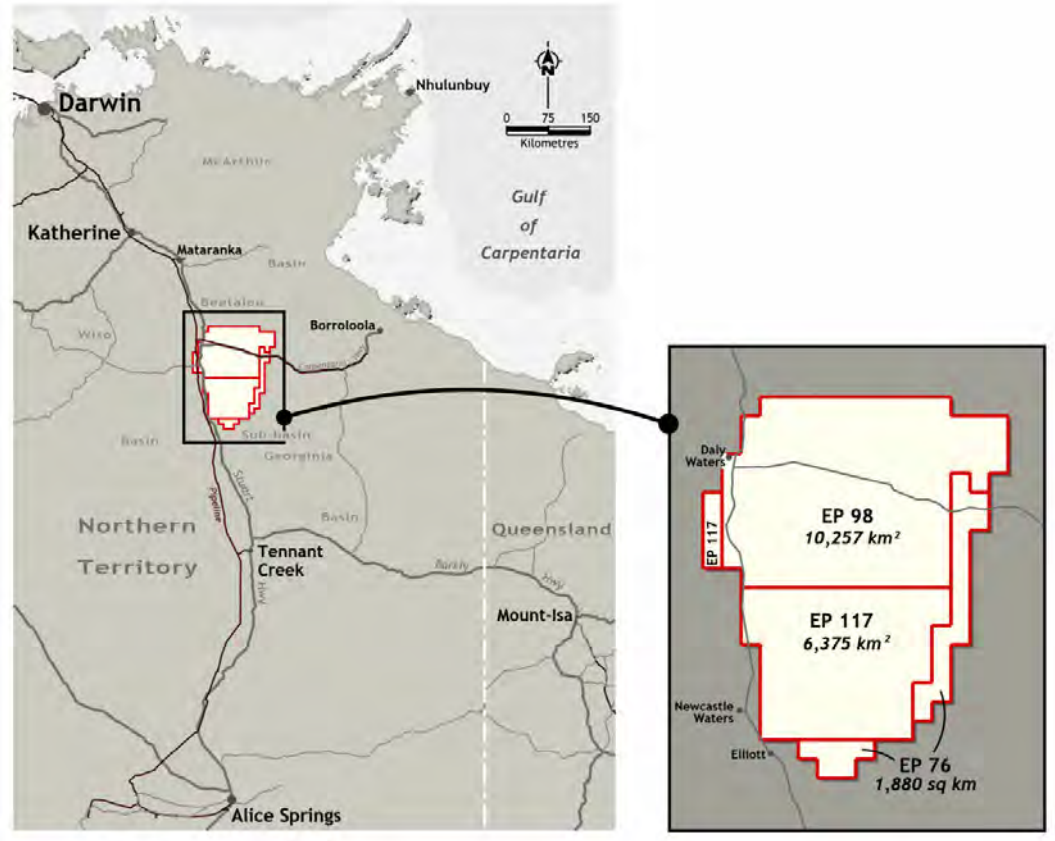

Figure 1 Location of Origin Permit Area

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1.2 Intent of the WMP

Weed control is considered to be a significant land management issue in the Northern Territory. This Weed Management Plan (WMP) forms a core component of Origin's overarching environmental management strategy and supports the various project Environmental Management Plan (EMP's).

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 Origin's activities.

This document is based upon the Weed Management Planning Guide - Onshore Shale Gas Development Projects produced by the Department of Environment, Parks and Water Security (DEPWS 2018).

2. Project Context

This plan covers all civil, drilling, stimulating, rehabilitation and routine maintenance/monitoring activities undertaken by Origin within permit EP76, EP98 and EP117 as detailed in Table 1. The proposed activities for the forward exploration program are highlighted within the table.

Table 1 Coordinates of centroid of proposed exploration lease areas

Exploration Permit	Lease Name	Zone*	Easting	Northing
EP98	Velkerri 98 E1-	53	415515	8180683
EP98	Velkerri 98 N1	53	392292	8189891
EP98	Kyalla 98 W1	53	364955	8177458
EP76	Velkerri 76 S1	53	424362	8113273
EP76	Velkerri 76 S2	53	435488	8136321
EP117	Kyalla 117 N2	53	356175	8137500
EP117	Stuart Highway Intersection	53	332371	8135170
EP117	Velkerri 117 E1	53	428861	8120782
EP117	Kyalla 117 W1	53	368079	8106696

Grey shading are planned sites for 2019/200

** Universal Transverse Mercator (UTM) geographic coordinate system is Geocentric Datum of Australia (GDA) 94.*

The primary activities subject to this WMP are:

- Access track construction, use and maintenance
- 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 presents the relevant legislation and statutory obligations for the project.

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3.1 Northern Territory Petroleum (Environment) Regulations

Petroleum Act 2016, Petroleum (Environment) Regulations 2016 and Code of Practice for Petroleum Activities with in the Northern Territory

The *Petroleum Act 2016* provides 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 Territory. 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 *Petroleum (Environment) Regulations 2016* requires 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 an acceptable level.

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

Under these regulations Origin is required to submit an EMP prior to any petroleum exploration or production activity.

EMP's 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.

This WMP is designed to support and implement the requirements of Origins Project Specific Environmental Management Plans.

3.2 Northern Territory 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 Northern Territory 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 identifies declared weeds (those which must be controlled) and provides a framework for weed management. It includes the following weed declaration classes:

Class A – to be eradicated
Class B – growth and spread to be controlled
Class C* – Not to be introduced into the Northern Territory
** 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.

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Currently there are statutory management plans for 10 high priority weed species in the Northern Territory.

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 Management Strategies (RWMS) have been developed for areas of the NT, with the Barkly and the Katherine RWMS overlapping Origin's Beetaloo exploration tenure. the aim of these regional plans is to assist in prioritising weed management by:

- 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 (EPBC) Act* (1999) are, among other things:

- 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 (DOTEE 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 norther Territory (The Threat abatement plan to reduce the impacts on northern Australia's biodiversity by the five listed grasses (2012)). This TAP covers a range of grasses originally introduced to support pastoralism, and includes Gamba Grass, Para grass, olive hymenachne, mission frass and annual mission grass. The controls in this WMP are designed to align with the 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 Northern Territory 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 Environmental Management Plan, 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 Northern Territory Government Regional Onshore Petroleum Weeds 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 Regional Onshore Petroleum Weeds Officer and affected landholders.
- Review and update of WMP's to remain effective in communication with relevant landholders and Regional Onshore Petroleum Weeds Officer in consideration of monitoring results and emerging weed issues for both gas and pastoral operations.

Origin has appointed **Robert Wear, Construction Superintendent** as the dedicated Weed Officer of the Beetaloo Exploration Activities. This role is supported by Origin's Approvals and HSE personnel.

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5. Weed Species Information

Weed surveys completed across the proposed and existing exploration areas indicate the abundance of weeds within the proposed and existing project area is low. *Hyptis suaveolens* (Hyptis), was identified along the access track to the proposed Velkerri 98-E1-1 site, whilst Gamba Grass (*Andropogon gayanus*) is also known to be in the broader region and is used by some Pastoralists in the region for wet season pasture. The pastoral properties using Gamba would be required to control the growth and spread to neighbouring areas (NTG, 2000).

Previous surveys within the permit area completed in 2014, 2015 and 2016 also confirmed the presence of Hyptis in the vicinity of the Carpentaria Highway and on Velkerri 98 N1-2 (Amungee NW-1) site. *Parkinsonia aculeata* (Parkinsonia) and *Calotropis procera* (Rubber Bush) have been previously identified along/in close proximity to the Beetaloo 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 2 and Section 9.

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.

- Origin exploration program weed survey data (2014-2018 results)
- Mapping data provided by the Weed Management Branch, DEPWS.
- Guidelines for the *Management of the Weeds of Beetaloo 2018* (DLRM et al 2018).
- Barkly and Katherine RWMS
- Department of the Environment and Energy (DOTEE) EPBC Act Protected Matters Report database.

Table 3 has been separated into priority weeds, RWMS alert species and other species previously identified in the area. Priority weed species are considered higher risk of being introduced or spread through the following criteria:

- Weed species that has been confirmed in the area within the relevant RWMS or through field surveys.
- Weed species listed in a RWMS that is in close proximity to Origin tenure.
- Weed species that are at risk of introduction through the use of machinery sourced from other regions in the NT or from other states.

Alert weed species are identified under the Katherine and Barkley RWMS. These species are not yet naturalised in the region, but have the potential to have a high level of impact to the region should it become established. The likelihood of the species naturalising and spreading in the region is perceived to be high (Department of Land Resource Management 2015).

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 and Figure 4.

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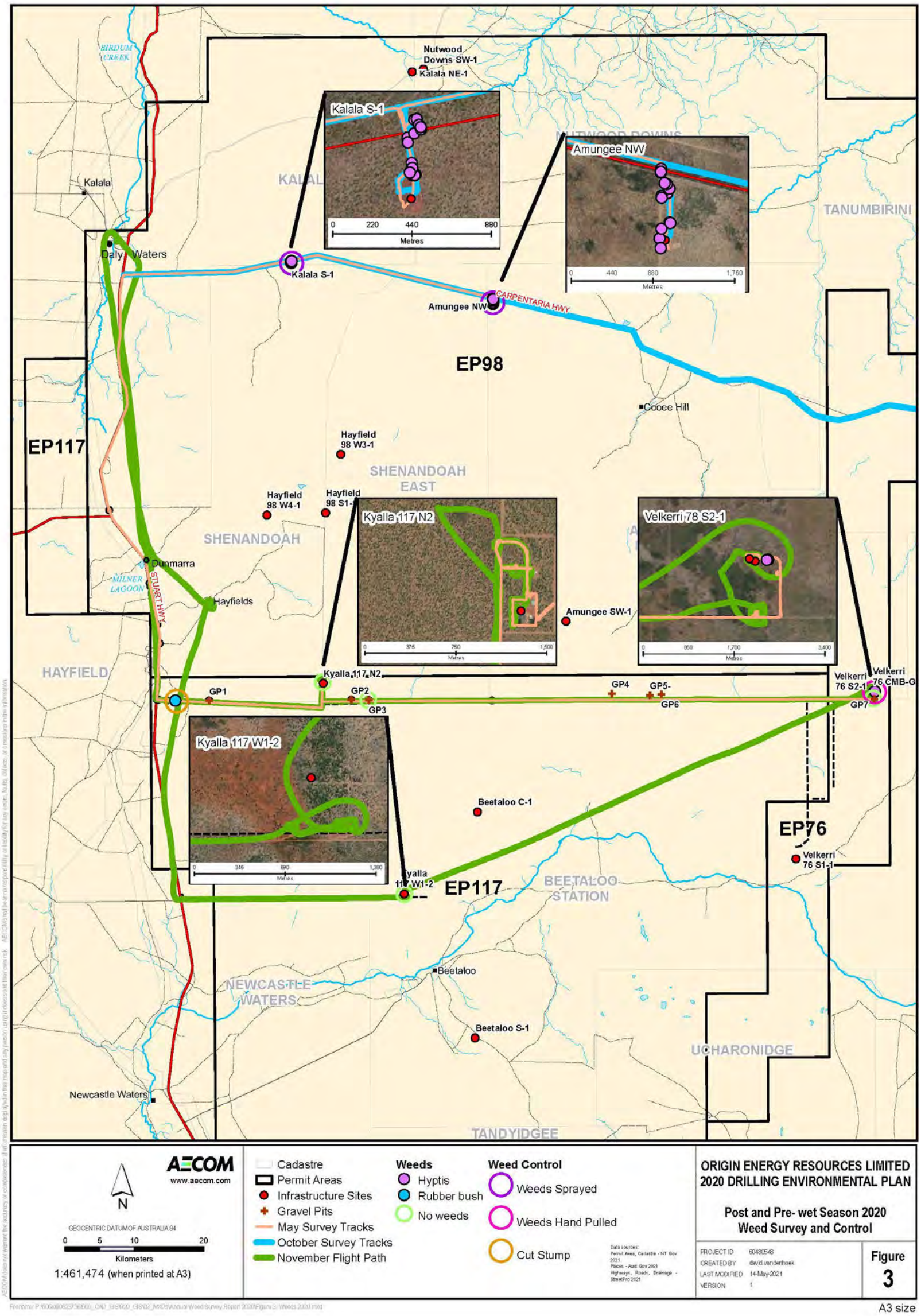

Figure 2 Location of Weeds Species in Permit Areas

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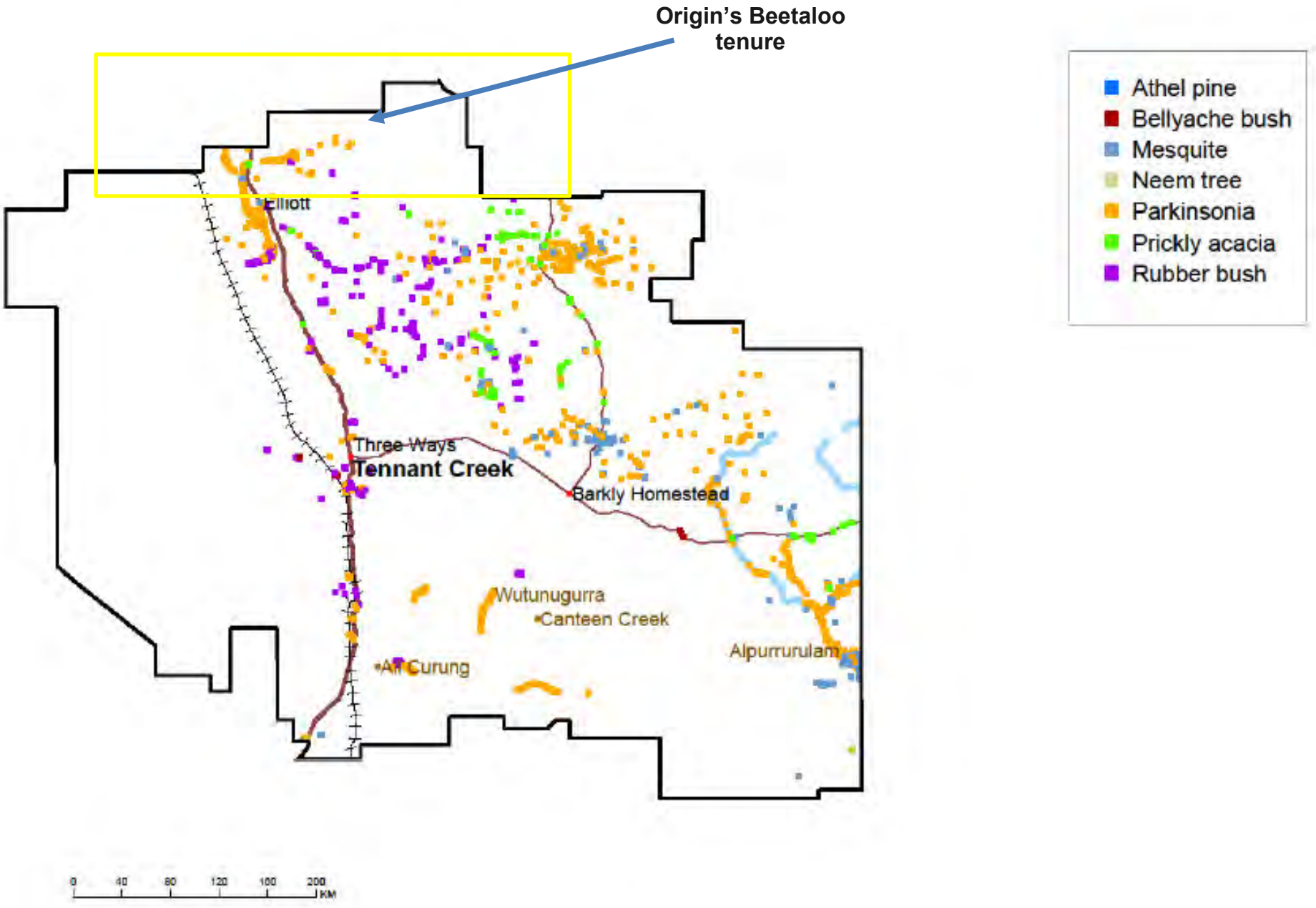

Figure 3 Barkly RWMS mapped priority weed locations

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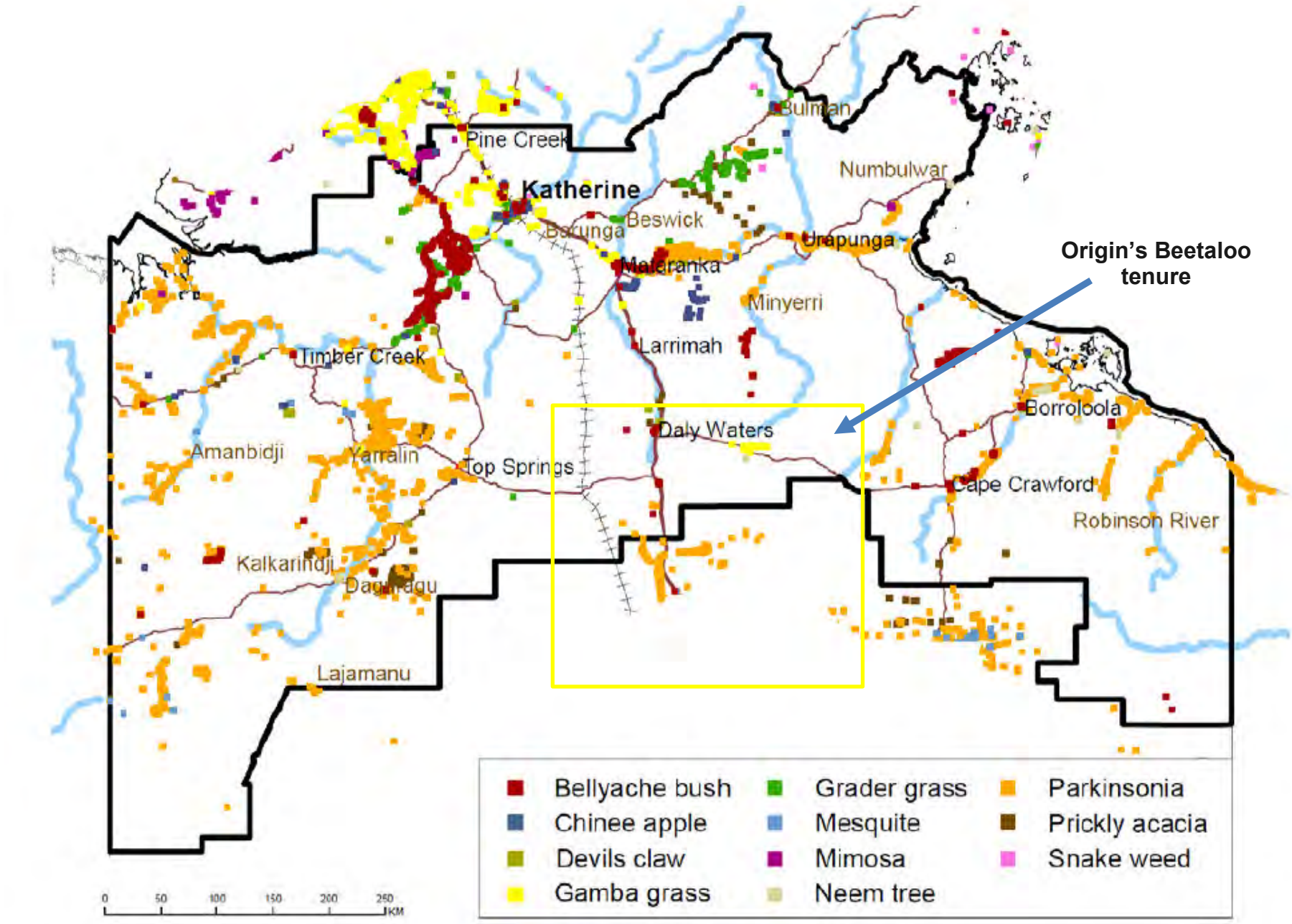

Figure 4 Katherine RWMS mapped priority weeds

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Table 2 NT listed weeds known of likely to occur within the Permit Area

Scientific Name	Common Name	Status	Data Source
Priority Weed Species			
Acacia nilotica	Prickly Acacia	Class A, WoNS	Mapped in the exploration lease within the Katherine RWMS
Andropogon gayanus	Gamba Grass	Class A WoNS	Confirmed within exploration lease. High potential introduction through sourcing of equipment from Katherine and Darwin area.
Calotropis procera	Rubber Bush	Class B and C	Mapped in the exploration lease within the Barkly RWMS
Hyptis suaveolens	Hyptis	Class B and C	Confirmed within exploration lease during previous weed Origin surveys
Jatropha gossypiifolia	Bellyache Bush	Class A, WoNS	Mapped in the exploration lease within the Katherine RWMS. Potential introduction through sourcing of equipment from Katherine area.
Parkinsonia aculeata	Parkinsonia	Class B and C, WONS	Confirmed within exploration lease during previous weed Origin surveys and Mapped in the exploration lease within the Katherine RWMS. Potential introduction through sourcing of equipment from Katherine area.
Prosopis pallida	Mesquite	Class A and C, WONS	Mapped in the area surrounding exploration lease within the Katherine and Barkly RWMS
Themeda quadrivalvis	Grader Grass	Class B and C, WoNs	Confirmed within the exploration lease and mapped in the area within the Katherine RWMS. High potential introduction through sourcing of equipment from Katherine area.
Parthenium hysterophorus	Parthenium	Class A and Class C, WoNS	Confirmed by DEPWS to occur within the exploration lease. Potential introduction through equipment sourced from QLD.
Alert Species under RWMS			
Cenchrus setaceum	Fountain grass	Class B and C	Alert Species within the Barkly Region
Cryptostegia grandiflora	Rubber vine	Class A and C, WONS	Alert Species within the Barkly and Katherine RWMS
Chromolaena odorata	Siam Weed	Class C	Alert Species Katherine RWMS

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Scientific Name	Common Name	Status	Data Source
Other species potentially found in region			
Alternanthera pungens	Khaki Weed	Class B and C	DLRM databases (DLRM *et al* 2018)
Azadirachta indica	Neem	Class B and C	Weed Management Branch – Mapping data
Cenchrus ciliaris	Buffel Grass	Not declared in NT	DOTEE Protected Matters Report
Cenchrus echinatus	Mossman River Grass	Class B and C	DLRM databases (DLRM *et al* 2018)
Datura ferox	Fierce Thornapple	Class A and C	DLRM databases (DLRM *et al* 2018)
Sida acuta	Spinyhead sida	Class B and C	Weed Management Branch – Mapping data
Sida cordifolia	Flannel Weed	Class B and C	Weed Management Branch – Mapping data DLRM databases (DLRM *et al* 2018)
Sida rhombifolia	Paddy's Lucerne	Class B and C	DLRM databases (DLRM *et al* 2018)
Xanthium occidentale	Noogoora Burr	Class B and C	Weed Management Branch – Mapping data DLRM databases (DLRM *et al* 2018)

Note: Declarations under the Northern Territory Weeds *Management Act 2001*:

6. Weed Management Mandatory Requirements

6.1 Weed hygiene declarations for vehicles and equipment

1. 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
2. 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.
3. 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
4. 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)
5. 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

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

6. A biosecurity declaration becomes invalid when:
   a) The vehicle or equipment has come into contact with known areas of weed infestations.
   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.

6.2 Weed hygiene declarations for loads and materials.

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 just as long as 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.

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

1. 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 Transportation

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.

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:

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- 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 Risks Assessment

As part of the development of the EMP for this project, Origin 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 3 below. Due to the low abundance of weeds within the proposed project area, management controls will primarily focus on preventing the introduction of weed species through appropriate equipment sourcing cleaning and inspection.

Table 3 Risk of weed introduction and spread and corresponding mitigation measures

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 Origins 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 Northern Territory 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 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	Importing materials from areas where weeds are present	Traversing of weed infested areas and creating	- Code of Practice for Petroleum Activities in the Northern Territory Part A- Surface Activities.

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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 Origins activities.		
Activity	**Potential Risks**		**Management Controls**
	Introduction of new weeds	**Spread of existing weeds**	
and monitoring bore pads	and creating opportunities for weed species to colonise disturbed areas	opportunities for weed species to colonise disturbed areas	- 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 Northern Territory 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. - 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.

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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 Origins activities.		
Activity	**Potential Risks**		**Management Controls**
	Introduction of new weeds	**Spread of existing weeds**	
			- 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 Northern Territory 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.
	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 Project Area, 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 (*Acacia nilotica*)
- Weed Management Plan for Bellyache Bush (*Jatropha gossypiifolia*)

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- 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 detail the legislated obligations of all land owners, land managers and land users in the Northern Territory to eradicate or manage and avoid further spread of the weed species. Conducting land management practices in accordance with the weed management plans will secure compliance with the requirements of the Act (Department of Land Resource Management 2015).

9. Annual Action Plan

An action plan for each of the weed species identified in the Project Area is presented in Table 4. Treatment options as contained in the Northern Territory 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 2019 Annual Weed Management Action Plan, Origin also commits to undertaking finer detailed weed mapping of all permit area, lease pads, access tracks and gravel pits, as well as any other areas disturbed as part activity.

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Table 4 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 7.1.	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 7.2.	Beetaloo access track
Rubber Bush *Calotropis procera*	6 monthly- pre-and post wet season	- Preferred October – March - April - July	Refer to section 7.3.	Close proximity to the Beetaloo access track Kyalla 117 N2 access track and Stuart Highway intersection

9.1 Hyptis (*Hyptis suaveolens*) treatment options

Table 5 includes herbicide and non-chemical treatment options for Hyptis *(Hyptis suaveolens) (*Northern Territory Government 2015).

Table 5 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.

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Non-chemical applications	- Manually remove all plant material; slash to encourage competition from desirable species.

Source: Northern Territory Weed Management Handbook (Northern Territory Government 2015).

9.2 Parkinsonia (*Parkinsonia aculeata*) treatment options

Table 6 includes herbicide and non-chemical treatment options for Parkinsonia *(Parkinsonia aculeata) (*Northern Territory Government 2015).

Table 6 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 / m2	**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 2015).

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Weed Management Plan

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9.3 Rubber bush (*Calotropis procera*) treatment options

Table 7 includes herbicide and non-chemical treatment options for Rubber bush *(Calotropis procera) (*Northern Territory Government 2015).

Table 7 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.	1.5-2g/m2	**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 (Northern Territory Government 2015).

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10. Notification Procedure

The Regional Onshore Petroleum Weeds 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 Project Area.

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 Origin's OCIS and corrective action initiated.

11. Recording

Records of weed inspections will be maintained by Origin.

Data on weed distribution will be maintained within Origin'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 Northern Territory Weed Data Collection Manual - Section One Technical Data Description (Weed Management Branch, 2015).

Data will be recorded using the guidelines provided in Appendix A using the data sheet provided in Appendix B (Weed Management Branch, 2015).

The Northern Territory Weed ID Deck (Northern Territory Government 2017) will be referenced to assist with identification of species that have been identified as likely or know to occur in the Permit Area.

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 Origin's OCIS 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 the Environment and Energy. 2018. *Key threatening processes under the EPBC Act.* http://www.environment.gov.au/biodiversity/threatened/key-threatening-processes accessed14 September 2018.

Department of Land Resource Management. 2015. *Barkly Regional Weed Management Plan 2015 - 2020.*

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Department of Natural Resources and Environment. 2018. *Weed Management Planning Guide - Onshore Shale Gas Development Projects.*

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.

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Northern Territory of Australia. 2017. *Northern Territory Weed ID Deck.*

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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.*

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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 metres. If it is a single plant or small patch you would choose 20 metres. The size 100 metres 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 eg: single plant, perhaps with seedlings.
3 = 1 -10%, More than one or two isolated plants but not a lot eg: a few small plants.
4 = 11-50%, A lot, up to half the area covered eg: a tree, dense patches of weeds.
5 = > 50%, Dominant cover is weed, more than half covered eg: 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
i.e: No treatment, Unknown, Treated, Foliar spray etc.

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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 metres. 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 eg: single plant, perhaps with seedlings.
3 = 1 -10%, More than one or two isolated plants but not a lot eg: a few small plants.
4 = 11-50%, A lot, up to half the area covered eg: a tree, dense patches of weeds.
5 = > 50%, Dominant cover is weed, more than half covered eg: 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
ie: No treatment, Unknown, Treated, Foliar spray etc.

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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 eg: single plant, perhaps with seedlings.
3 = 1 -10%, More than one or two isolated plants but not a lot eg: a few small plants.
4 = 11-50%, A lot, up to half the area covered eg: a tree, dense patches of weeds.
5 = > 50%, Dominant cover is weed, more than half covered eg: 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

ie: No treatment, Unknown, Treated, Foliar spray etc.

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Appendix B Example Weed Data Collection Sheet

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Weed Management Plan

NT-2050-15-MP-0016

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

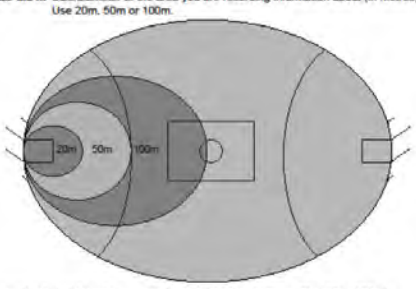
Notes:

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.

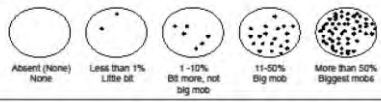


Example of size/diameter compared to a football oval. (Sizes 20m, 50m, 100m)

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



(extracted from *Northern Territory Weed Data Collection Manual - Section One Technical Data Description*

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Appendix C Rehabilitation Plan

Exploration Permit 117

Rehabilitation Management Plan Rev 1.0

Beetaloo W-1 Lease

Origin Rehabilitation Officer	Contact Details	Name
	Mobile : [redacted] Satellite phone [redacted]	Robert Wear

Location of Beetaloo W-1 Lease

Property land uses	Gas exploration and cattle grazing
Climate	The permit area is described as arid to semi-arid. Climate is influenced by the monsoon and there is a distinct wet and dry season. Most rainfall (90%) occurs during the summer months, between October and March. Annual rainfall varies across the permit area is around 680 mm, with rainfall totals show moderate variability and drought conditions are know to occur every 10 years.
Site Description (pre-disturbance)	Beetaloo W-1 (-17.120496 lat, 133.761782 long) is located in the EP117 tenement. The natural vegetation community that exists at Beetaloo W-1 is *Corymbia spp.* dominated woodland with a diverse understorey and dense grass cover. A large patch of *Acacia shirleyi* (Lancewood) is found to the north of the lease area. The dominant upper strata species is *Corymbia drysdalensis* and *C. ferruginea.* The mid strata consisted of *Terminalia canescens* and *Grevillea striata.* The understorey consisted of mostly grasses including *Themeda triandra, Heteropogon contortus, Chrysopogon fallax, Triodia bitextura.* The Landform at Beetaloo W-1 is characterised by plains and rises associated with deeply weathered lateritic profiles. Soils at this site are silty/loamy soils containing around 35% fines and 70% gravel and has a high risk of loosing structural integrity under moist conditions. Habitat surrounding the site is considered to be in good condition. The habitat contains good refuge opportunities in the form of dense leaf litter, dense grass cover, large woody debris and smaller tree hollows. A large patch of Lancewood/Bullwaddy is located nearby to the north of the lease pad.

Post Activity Rehabilitation Aim and Objectives

Site management aim	The aim is to rehabilitate any part of the land affected by the Regulated Petroleum Activity to a safe condition consistent with industry standards and in consultation with Landholder.
Rehabilitation objectives	The rehabilitation objective is to provide a stable land form, which supports a resilient self-sustaining vegetation community that can withstand impacts including fire and cattle grazing and is safe to humans and wildlife, whilst utilising appropriate site infrastructure for ongoing pastoral activities (i.e. access tracks, water bores, fencing and laydown areas).

Site Environment Summary

Infrastructure	Size (ha)	Soil Type / Slope	Vegetation Community / Dominant Species
Drill Lease Pad	2.9 ha	Lateritic silty Sand <1% Slope	Open *Corymbia spp.* woodland with *Chrysopogon spp.* open tussock grassland. Large Patch of *Acacia shirleyi* (Lancewood) on the northern boundary (see Figure1)
Camp Area	0.86 ha	As above	As above
Access Track	0.62 ha	As above	As above
Gravel Pits (x 3) GP1—17.12194, 133.507146 GP2—17.121902, 133.577016 GP3— 17.121088, 133.640772	GP1—0.46 ha GP2—0.35 ha GP3— 1.8 ha	As above	Open *Corymbia spp.* woodland with *Chrysopogon spp.* open tussock grassland.

Rehabilitation Strategy

Parameters	Methods	Objective
Vegetation	• Implement progressive rehabilitation within 12 months upon completion of petroleum activities. • Implement rehabilitation of lease pads upon cessation of use. • Disturbed areas to be allowed to naturally regenerate or revegetate on completion of Regulated Activity. • All compacted areas to be ripped and scarified to promote regeneration of vegetation, this may require assistance through spread of native seed stock. Where possible, native seed stock would be supplied by local Indigenous suppliers.	• Establish vegetation similar to adjacent vegetation species richness, cover and structure), unless agreement with landowner and Regulator for alternative use. • The type of ground cover applied to completed earthworks to be compatible with the anticipated long-term land use, environmental risk, and site rehabilitation measures.
Ground cover	• Previously removed vegetation and topsoil will be uniformly re-spread over disturbed area to assist with rehabilitation process through agencies of increased infiltration and return of seed-bearing topsoil, as well as reducing erosion. • If required, additional native seed mix from the area could be respread to speed up rehabilitation process.	
Landform stability	• All windrows are to be removed as soon as practicable.	

Rehabilitation Risks

Key Risks	Controls
Drought — impacting the establishment of rehabilitated vegetation	• Time rehabilitation actions to coincide with the beginning of the wet season, to ensure access to the site and maximise the establishment period of vegetation over the wet season • Re-spread topsoil across the site to utilise the local seed bank • Ongoing monitoring to identify if further seed inputs are required • Collection of seed from the local area to ensure seed stock is suited to the climatic conditions of the site.
Fire—impacting revegetation	• Establish a mix of perennial and annual grass species • Establish a mix of re-sprouter (eg. *Eucalypt spp*. and *Corymbia spp.*) and re-seeder species (eg. *Acacia spp.*) • Ongoing monitoring to determine fire impacts on revegetation. • Ongoing monitoring to determine if further seed inputs are required
Grazing —impacting revegetation	• Establish a mix of perennial and annual grass species • Re-spread timber with top soil • Ongoing monitoring to determine grazing impacts on revegetation. • Ongoing monitoring to determine if further seed inputs are required • Ongoing monitoring to determine if fencing is required
Exposed Ground — leading to an increase in weed establishment and/or erosion	• Remove windrows and topsoils • Respread of topsoil and vegetated matter across the site • Annual weed surveys of rehabilitated area once rehabilitation is established • Control of any weed incursions

Final Success Criteria

Canopy Cover (%)	• A minimum of 10-20% canopy cover for open woodland community. • It is noted that Acacia shrublands will recover faster than Eucalypt and Bullwaddy communities, however should have signs of regrowth following rehabilitation and within 12-18 months after rainfall.
Ground Cover (%)	• Minimum 60% ground cover using locally available material including reserved topsoil/cleared vegetation before the onset of the first wet season resulting in a minimum of 40% bare ground. • A minimum of 40-60% ground foliage cover and diversity to be achieved within the first 12 months and maintained for at least 3 years following rehabilitation. Success will be dependent on minimised cattle movements and rainfall.
Erosion	• Less than 5 % erosion should be evident after the first 12 months and no subsidence or erosion should be evident for at least 5 years after completion.
Weeds	• No establishment of weed species declared under the Northern Territory Weeds Management Act 2001.
Hazardous materials and waste	• All non-mineral drilling waste removed from site upon completion of works to licensed landfill facilities or recycling facilities.
Safety for humans and wildlife	• Rehabilitation of disturbance areas should be similar in landform to the surrounding area. No steep slopes or barriers to remain on site that endanger either wildlife or humans • Water bores and exploration wells to be sealed and isolated • Removal of all surface facilities including fencing (star pickets/fencing wire) • Remediation and backfilling of all sumps/ponds.

Monitoring Program and Schedule

Rehabilitation Stage	Timing	Method	Measurable attributes
Preliminary Assessment	6 to 9 Months post rehabilitation, end of wet season survey (February to June).	• Establish 5 permanent 100m x 4m woody species transects (one per hectare), with photo monitoring point/s, include 2 analogue sites in nearby undisturbed vegetation community. • Collect 1 x 1 m ground cover quadrats every 10 m along transect. • Transects to be randomly selected with start and end marked with star picket. • Edge effects (i.e. impacts from haul roads) minimised through reducing plot margins to <20m.	• Indication of seed germination and plant establishment rates. • Vegetation cover (species and abundance). • Land condition (e.g. erosion canopy cover, ground cover, habitat quality). • Weed presence (species and density). • Disturbance (fire and feral animal/cattle) • Incidental observations from surrounding area.
Early Rehabilitation	Years 1, 2 and 3 post rehabilitation, end of wet season survey (February to June).	• Monitoring to be undertaken using permanent transects. • Collect data as per preliminary methods. • Compare results from previous assessment to determine if require additional management inputs (i.e. seeding, stabilisation). • Review success criteria.	• Early assessment of rehabilitation will determine attributes of woody plants in each 100m x 4m transect. • Including assessment of species, Diameter at Breast Height (DBH) (>1.5cm) and height (>2m), in addition to parameters described within the preliminary assessment.
Long-Term Rehabilitation	Annually until final success criteria has been met, end of wet season survey (February to June).	• Monitoring to be undertaken using permanent transects. • Collect data as per preliminary methods. • Compare results from previous assessment to determine if require additional management inputs (i.e. seeding, stabilisation). • Review success criteria.	• Long-term assessment will determine establishment, recruitment and growth rate attributes of plant species, in addition to parameters described during Early Rehabilitation stage.

Beetaloo W-1 Corymbia sp. open woodland with open tussock grassland

Appendix D Erosion and sediment control plan

BEETALOO BASIN EXPLORATION PROJECT

Erosion and Sediment Control Plan

EP76, EP98 and EP117

This document outlines the basic principles for Contractors to develop site specific erosion and sediment control plans for Beetaloo Basin Exploration Program.

Review record

Rev	Date	Reason for issue	Reviewer/s	Consolidator	Approver
0	29/03/2019	Issued for use	A.Court	M.Kernke	M.Hanson
1	28/06/2019	Revised based on comments received by DEPWS	A.Court/J.Jentz	M.Kernke	M.Hanson
2	16/07/2019	Updated Primary ESCP	A.Court/J.Jentz	M.Kenke	M.Hanson
2.1	11/04/2021	Minor updated based upon 2021 scope	M.Kernke		M.Pollock
2.2	12/07/2021	Minor updated based upon 2021 scope	M.Kernke		M.Pollock

Review due: 05/11/2023

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Erosion and Sediment Control Plan

NT-2050-15-MP-019.

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1. Introduction

This Erosion and Sediment Control Plan (ESCP) has been developed to ensure best practice erosion and sediment controls are implemented during Origin Exploration activities within permit EP76, EP98 and EP117 to prevent erosion and offsite impacts such as sedimentation of waterways.

This ESCP has been developed to provide directions for Origin and contractors to implement erosion and sediment control (ESC) during construction of the lease pads and associated infrastructure, worker camps and access tracks as well as during ongoing maintenance and monitoring once sites are established.

The design of the lease pads and access tracks will comply with Northern Territory and local government statutory laws and regulations and are to be designed to meet all relevant and applicable codes and standards. This ESCP has been developed in accordance with the following guidelines:

- *Code of Practice for Petroleum Activities in the Northern Territory* (DEPWS, 2019)
- *Best Practice Erosion and Sediment Control* (IECA, 2008)
- *Land Clearing Guidelines (DEPWS, 2019)*
- *Erosion and Sediment Control Guidelines for Rural Development Environment Fact Sheet* (DLRM, 2018).

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

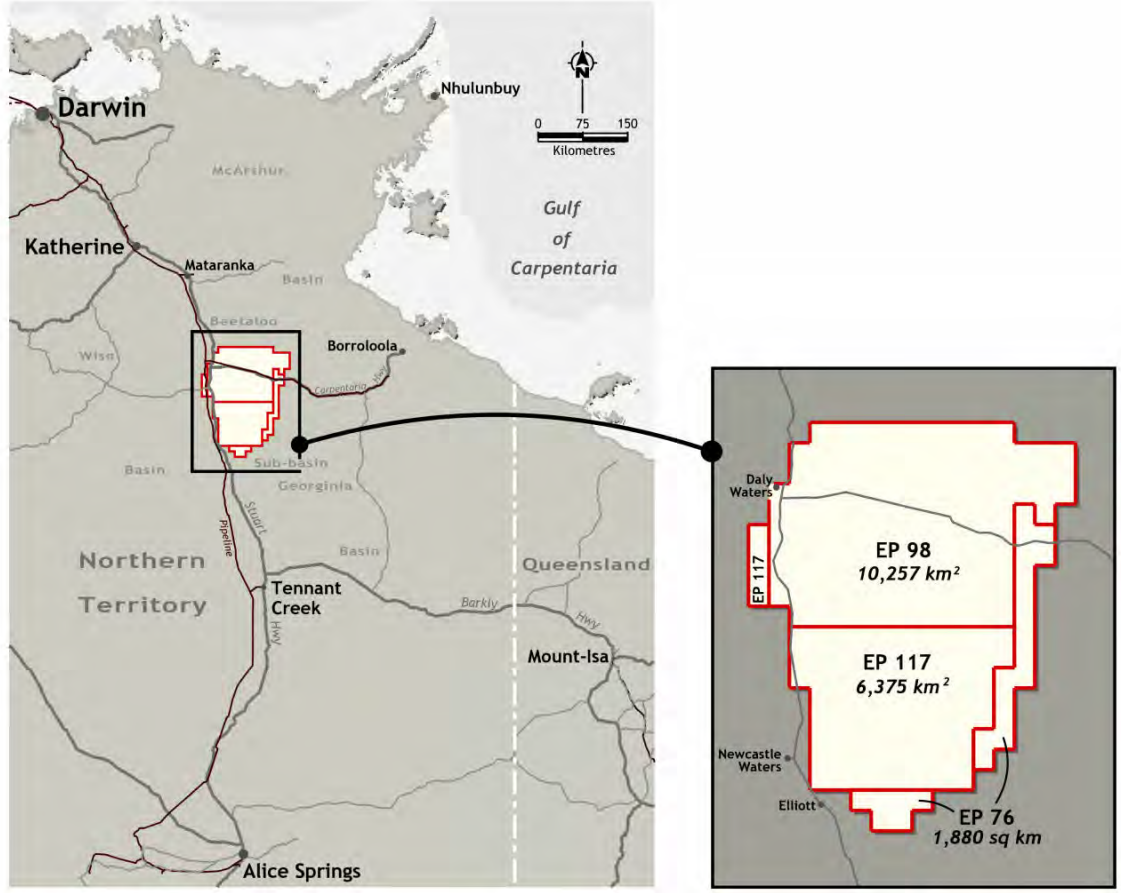

Figure 1 Location of Origin Permit Area

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2. Project Context

This plan covers all civil, drilling, stimulating, rehabilitation and routine maintenance/monitoring activities undertaken by Origin and their contractors within permit EP76, EP98 and EP117 as detailed in Table 1 and shown in **Figure 2**. The proposed activities for the Beetaloo Exploration program are highlighted within the table.

Table 1 Coordinates of centroid of proposed exploration lease areas

Exploration Permit	Lease Name	Zone*	Easting	Northing
EP98	Velkerri 98 E1-	53	415515	8180683
EP98	Velkerri 98 N1 (Amungee NW)	53	392292	8189891
EP98	Kyalla 98 W1	53	364955	8177458
EP76	Velkerri 76 S1	53	424362	8113273
EP76	Velkerri 76 S2	53	435488	8136321
EP117	Kyalla 117 N2	53	356175	8137500
EP117	Stuart Highway Intersection	53	332371	8135170
EP117	Velkerri 117 E1	53	428861	8120782
EP117	Beetaloo W-1 (Kyalla 117 W1	53	368079	8106696

** Universal Transverse Mercator (UTM) geographic coordinate system is Geocentric Datum of Australia (GDA) 94.*

The primary activities subject to this ESCP are:

- Construction and maintenance of lease pads, camp pads and stockpile areas
- Construction and maintenance of access tracks
- Construction and maintenance of gravel pits
- All other activities ancillary to the drilling, stimulation and well testing of an exploration well.

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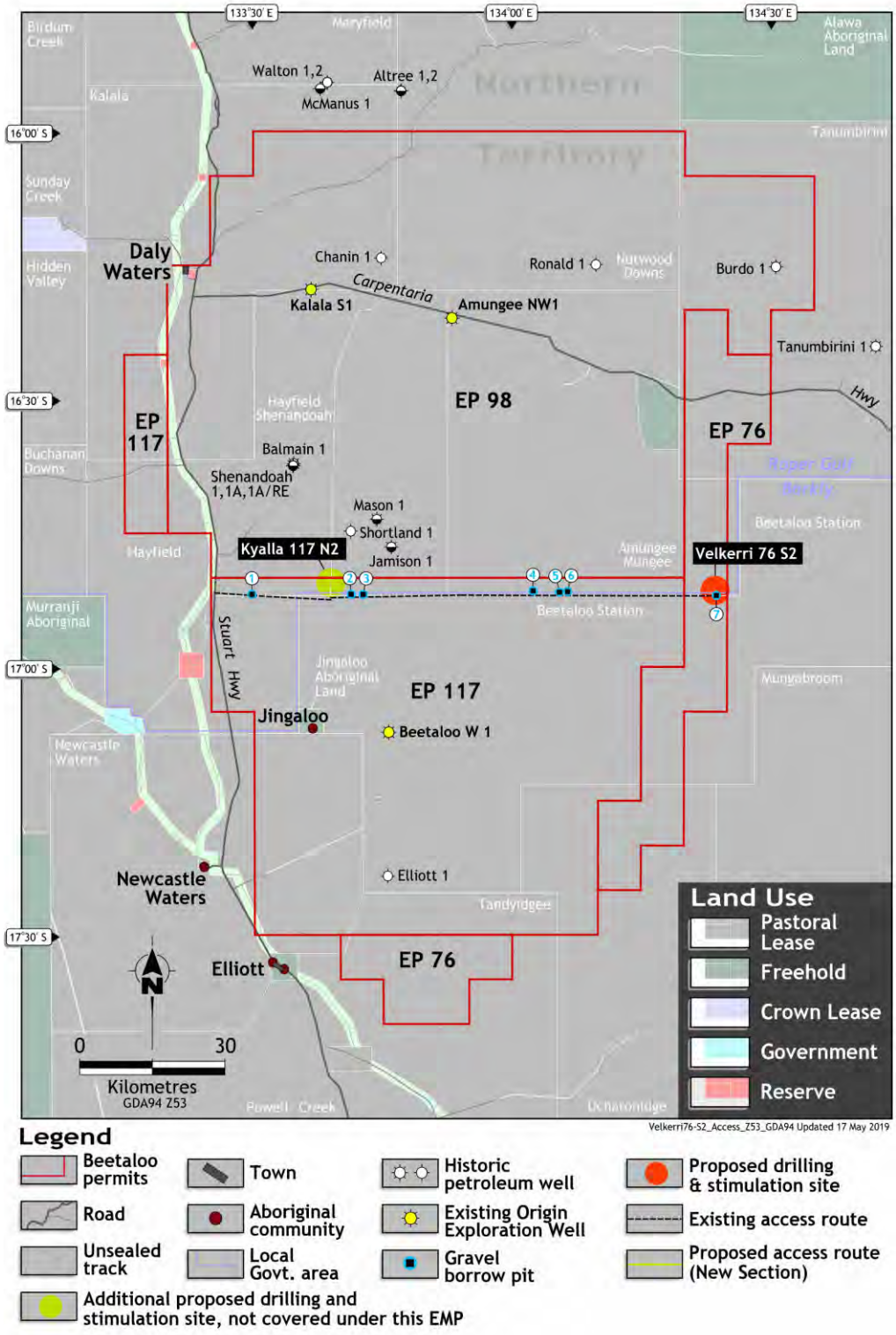

Figure 2 Location of 2019 Exploration Lease Areas

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3. Aim and Objective

The Primary ESCP aims to:

- Address key soil and water management issues, including legislative and client requirements.
- Determine the "Type" of ESC to be implemented during construction, post construction and until exploration activities are completed.
- Where practical identify, eliminate and reduce hazards and associated risks inherent in specific work activities, which if untreated could lead to a diminished product or create the potential for an accident, dangerous occurrence or environmental incident.

The objective of this Primary ESCP is to manage Origin's activities within the Permit Area in a manner that minimises the impacts upon soil, vegetation and surface water which may result from soil disturbance activities including land clearing and lease pad establishment.

This ESCP may be amended as required, in response to the Monitoring and Maintenance Programs described herein to avoid significant and/or sustained deterioration in downstream water quality. Standard drawings are provided as a guide, with the Construction Supervisor and Origin Engineers making final determination on site.

Strategies shall be developed, implemented and reviewed on a regular basis, so that risks are identified, measured and recorded throughout the course of the project.

Any changes to the ESCP will be subject to review and approval by the Department of Environment Parks and Water Security (DEPWS) Land Management Team.

3.1 Compliance with IECA Guideline

The ESCP has been prepared by suitably qualified and experienced personnel that understand the intent and minimum standards of IECA. The team that prepared the plan consist of the following:

- Alana Court – BEnvSci, PGDipEnvMgt. Principal Environmental Scientist with over 18 years' experience and completed the IECA erosion and sediment control training (2013). Over 10 years' experience providing advice to managing environmental requirements in the Beetaloo Basin including erosion and sediment control.
- James Jentz – BEng, RPEQ, CPEng. Civil Engineer with over 30 years' experience in the design and documentation of civil engineering projects. James has signed off all civil drawing under his qualification.

4. Civil Construction Schedule

All major civil construction and maintenance activities are to be completed during the dry season, being April to October each year. The erosion risk rating during this period is expected to be very low, as illustrated in Table 2.

Minor maintenance works are often completed during the wet season, being restricted to ongoing lease pad and access track maintenance. This works is essential in maintaining assets to mitigate the risk of erosion and offsite sediment release.

In the event that major civil construction activities continue through to the wet season (such as bulk earth works), the ESCP will be amended to cover the specific wet season operations. This revision will occur during October for approval by DEPWS Land Management Team and will be implemented between 1 November to the 31st March, based on the rainfall conditions in that permit area.

5. Permit Area Erosion Susceptibility

Erosion susceptibility varies throughout the Origin permit area, dependent upon the soil types, slope and extent of ground disturbance. Apart from the erosive impact of climatic conditions, soil erosion is influenced mainly by the inherent properties of the soils and the processes which occurred during the formation of the landscapes.

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Erosion will occur in the permit area if the land is used beyond its capacity, as is seen if land is overstocked or vehicle movements not controlled, for example. The locations of Origin's activities have been examined in the field to determine the risk of erosion occurring from Origin activities.

Factors considered include the following:

- Soil type (K factor) – soils with higher clay content are prone to generation of bulldust and are easily eroded by wind and water. Gravelly soils tend to be more robust to disturbance on the scale expected for Origin exploration activities. The primary soil type encountered during the geotechnical investigations for the lease areas can be described as silty SAND, SM with some gravel. These soils are considered to have a low to medium erodibility potential when the soils are disturbed.
- Slope – the slope of the site is one of the characteristics that will help to determine the risk of erosion during rainfall events, with steeply inclined areas a higher risk than small undulations in the landform. A slight undulation is consistent throughout the region which constitutes a gradient less than 2% which poses negligible risk from erosion generated from the slope of the project area. The site locations are considered generally flat with a slope of <1%. Areas with slope >2% have been avoided where possible. However, treatments are defined for sections less than 2% and greater than 2%. The relevant treatment will be implemented on a case by case basis on site.
- Aspect – the position of the access track and pads in relation to the direction of the contour should be considered and creation of tracks and the lease pads across (as opposed to parallel with) the contour should be avoided.
- Rainfall – Table 2 and Table 3 present the erosion risk rating based on average monthly rainfall using the rating system provided in the IECA (2008) Table 4.4.2 for Daly Waters (northern sites) and Newcastle Waters (southern sites). The construction activities for the exploration program are proposed to be completed during the 2019 dry season.

Table 2 Erosion Risk Rating based on average monthly rainfall at Daly Waters

-Item	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sep	Oct	Nov	Dec
Rainfall (mm)	165.4	165.4	120.1	23.6	5.0	5.6	1.5	1.7	4.9	22.5	59.4	110
Erosion Risk*	H	H	H	VL	VL	VL	VL	VL	VL	VL	M	H

** E = Extreme (>225 mm); H = High (100+ to 225 mm); M = Moderate (45+ to 100 mm); L = Low (30+ to 45 mm); VL = Very Low (0 to 30 mm)*

Table 3 Erosion Risk Rating based on average monthly rainfall at Newcastle Waters

Item	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sep	Oct	Nov	Dec
Rainfall (mm)	125.5	130.9	93.7	24.6	9.3	5.3	3.4	1.0	5.4	20.9	35.7	77.3
Erosion Risk*	H	H	M	VL	VL	VL	VL	VL	VL	VL	L	M

** E = Extreme (>225 mm); H = High (100+ to 225 mm); M = Moderate (45+ to 100 mm); L = Low (30+ to 45 mm); VL = Very Low (0 to 30 mm)*

5.1 Erosion Hazard Assessment for Origin sites with active construction

An Erosion Hazard Assessment for Origin's lease areas with active construction/ operations proposed has been conducted to inform the specific issues and actions that will be required for conducting activities within the permit area. Table 5 presents the results of the assessment. The IECA (2008) Explanatory Notes for the assessment are presented **Appendix A**.

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Table 4 Erosion Hazard Assessment for Origin sites

Condition (as described by IECA, 2008)	Points	Score				Trigger value
		Kyalla 117 N2	Velkerri 76 S2	Amungee NW	Gravel Pits	
AVERAGE SLOPE OF DISTURBANCE AREA [1]						
• not more than 3% [3% ≈ 33H:1V]	0	**0**	**0**	**0**	**0**	4
• more than 3% but not more than 5% [5% = 20H:1V]	1	**Comment** - Topographical survey of lease areas indicated (low relief) with a slope <1% (refer **Appendix B**)				
• more than 5% but not more than 10% [10% = 10H:1V]	2					
• more than 10% but not more than 15% [15% ≈ 6.7H:1V]	4					
• more than 15%	6					
SOIL CLASSIFICATION GROUP (AS1726) [2]						
• GW, GP, GM, GC	0	**2**	**2**	**2**	**0**	-
• SW, SP, OL, OH	1	Comment **– Geotechnical testing indicated SM - Silty sands, poorly graded sand-silt mixtures (refer** Appendix C**).**				
• SM, SC, MH, CH	2					
• ML, CL, or if imported fill is used, or if soils are untested	3	The identified gravel pits will contain a variety grade that will be used as a foundation for the access tracks. This constitutes a 0 score.				
EMERSON (DISPERSION) CLASS NUMBER [3]						
• Class 4, 6, 7, or 8	0	**0**	**0**	**0**		6
• Class 5	2	**Comment** – Class 4 – Sand Material, therefore Emerson test not applicable.				
• Class 3, (default value if soils are untested)	4					
• Class 1 or 2	6					
DURATION OF SOIL DISTURBANCE [4]						
• not more than 1 month	0	**2**	**2**	**0**	**2**	6
• more than 1 month but not more than 4 months	2	**Comment** – Clearing and earthworks are expected to be between 1 and 4 months. Ongoing maintenance beyond this period.				
• more than 4 months but not more than 6 months	4					
• more than 6 months	6					
AREA OF DISTURBANCE [5]						
• not more than 1000 m2	0	**6**	**6**	**5**	**4**	**6**
• more than 1000 m2 but not more than 5000 m2	1	**7.9 ha**	**9.7 ha**	**5.5 ha**	**Comment** –<10ha. Disturbance will be progressive and stabilisation at complete that unlikely to be disturbance at any one time greater than 4 ha.	
• more than 5000 m2 but not more than 1 ha	2					
• more than 1 ha but not more than 4 ha	4					
• more than 4 ha	6					
WATERWAY DISTURBANCE [6]						

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Condition (as described by IECA, 2008)	Points	Score				Trigger value
		Kyalla 117 N2	Velkerri 76 S2	Amungee NW	Gravel Pits	
• No disturbance to a watercourse, open drain or channel	0	**0**	**0**	**0**	**0**	0
• Involves disturbance to a constructed open drain or channel	1	**Comment –** Not in close proximity to natural water courses (refer **Appendix D**).				
• Involves disturbance to a natural watercourse	2					
REHABILITATION METHOD [7] Percentage of area (relative to total disturbance) revegetated by seeding without light mulching (i.e. worst-case revegetation method).						
• not more than 1%	1	**1**	**1**	**1**	**1**	N/A
• more than 1% but not more than 5%	2	**Comment –** Top soil replaced along batters to commence assisted natural regeneration.			Gravel pits to be stabilised post development to provide adequate degree of protection.	
• more than 5% but not more than 10%	3					
• more than 10%	4					
RECEIVING WATERS [8]						
• Saline waters only	0	**0**	**0**	**0**	**0**	-
• Freshwater body (e.g. creek or freshwater lake or river)	2	**Comment –** not located within the major flow pathway of Newcastle Creek and the small intermittent streams (distance of 3-20 Km away) (refer **Appendix D**).				
SUBSOIL EXPOSURE [9]						
• No subsoil exposure except of service trenches	0	**0**	**0**	**0**	**0**	-
• Subsoils are likely to be exposed	2					
EXTERNAL CATCHMENTS [10]						
• No external catchment	0	**1**	**1**	**1**	**1**	-
• External catchment diverted around the soil disturbance	1	Comment – refer to Civil Design Drawings (**Appendix E to Appendix I**)			**Comment –** External catchment diverted around soil disturbance.	
• External catchment not diverted around the soil disturbance	2					
ROAD CONSTRUCTION [11]						
• No road construction	0	**2**	**2**	**0**	**2**	-
• Involves road construction works	2					
pH OF SOILS TO BE REVEGETATED [12]						
• more than pH 5.5 but less than pH 8	0	**1**	**1**	**1**	**1**	-
• other pH values, or if soils are untested	1	**Comment –** Soil pH 5.0 to 5.1				
Total Score [13]		**15**	**15**	**10**	**11**	

The Erosion Hazard Assessment for works within the Origin permit area are equal to or below point score of 15, ranging from 10 points at the Amungee NW-1H site and 15 at Kyalla 117 N2 and Velkerri 76 S2. Based on the IECA explanatory note, the trigger values have not been reached and a detailed ESCP is not typically required (*For guidance purposes only: [13] A preliminary ESCP must be submitted to the local government for approval during the planning phase for any development that obtains a total point score of 17 or greater or when any trigger value is scored or exceeded)*.

5.2 Soil Loss Estimate

IECA (2008) soil loss estimation has been used to determine the type of controls the project should adopt to limit soil loss during construction when soils are exposed to rainfall. Long term average soil loss resulting from sheet and rill flow can be predicted using the Revised Universal Soil Loss Equation (RUSLE).

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Soil loss calculated using RUSLE for the project area was calculated as follows:

A = R . K . LS . C . P

Where A = annual soil loss due to erosion [tonnes/hectare/year (t/ha/yr)]

R = rainfall erosivity factor based on = **6297**)

K = soil erodibility factor of **0.055** for silty sand)

LS = topographic factor derived from slope length and slope gradient (**0.24**)

C = cover and management factor (**1**)

P = erosion control practice factor (**1.3**)

It is noted that the **annual R-factor of 6297** for the Katherine Region has been adopted as per comment received by DEPWS Land Management team. Since preparation of the initial ESCP, additional geotechnical information has been obtained which provides a larger sample size of the proposed permit areas. The geotechnical sampling completed on the sites has shown that the top 0.3 m of the site is "Silty Sand". As such, the K-factor has been revised to 0.055 for "Silty Loam" from Table E4 of the IECA Guidelines.

Revision of the LS-factor on more detailed design drawings shows a total slope length of approx. 200 m at a gradient of 0.00120 m/m (0.12%), indicative of the gradients across all sites. A LS factor of 0.24 was adopted, indicating a 200 m slope at 0.01 m/m (1%).

Based on the reviewed RUSLE soil loss methodology, **the Annual Soil Loss estimate using these values is 108 t/ha/yr**. Type 3 sediment controls are adequate with the revision to the RUSLE equation. In addition, Type 2 controls have been allowed for in design including settlement pond on the drill pads and rock filter dams at the Stuart Highway Intersection.

All the proposed civil construction activities for the exploration program are proposed to be completed during the 2021 dry season (July to October) when the erosion risk rating for rainfall is very low (refer to Table 2 and Table 3.

5.3 Erosion Risk and Determination of ESC

Erosion risk ratings for the Project area have been determined based on the average monthly erosivity (R-factor of 6297), average monthly rainfall depth (mm) (refer Table 2 and Table 3 above) and soil loss (estimated at 108t/ha/yr). As indicated in Table 5, the Project has an erosion risk rating of "very low" in the dry season to "extreme" during rainfall events.

Table 5 Erosion Risk Rating (adapted from IECA, 2008, Tables 4.4.1, 4.4.2 and 4.4.3)

Erosion Risk Rating	Average Monthly Erosivity (R-Factor)	Average Monthly Rainfall Depth (mm)	Soil Loss (t/ha/yr)
Very Low	0 to 60	0 to 30*	0 to 150
Low	60+ to 100	30+ to 45	150+ to 225
Moderate	100+ to 285	45+ to 100	225+ to 500
High	285+ to 1,500	100+ to 225	500+ to 1,500
Extreme	>1,500*	>225	>1,500

** It is noted that the monthly erosivity factor would only be triggered during rainfall events. The construction period is proposed to occur from July to October and based on assessment of the average monthly rainfall for the region (refer Table 2 and Table 3), the erosion risk rating is considered very low (0 to 30mm during this time). It is anticipated that at completion of construction the site would be stabilised for normal operation.*

Table 6, provides an indication of the "Type" of erosion and sediment controls that should be deployed during construction depending on annual soil loss. Based on the proposed construction schedule during the dry season, the Project is determined to trigger the use of Type 3 erosion and sediment controls, with some Type 2 controls allowed for in design including settlement pond on the drill pads and rock filter dams at the Stuart Highway Intersection.

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Table 6 Sediment Control Standard (adapted from IECA, 2008, Table 4.5.1)

Catchment Area (m^2)	Soil Loss Rate Limit (t/ha/yr)		
	Type 1	Type 2	Type 3
250	N/A	N/A	All Cases
1000	N/A	N/A	All Cases
2500	N/A	>75	75
>2500	>150	150	75

Table 7 provides a range of erosion and sediment controls that can be deployed on the Project for each 'Erosion and Sediment Control Type'.

Table 7 Classifications of Sediment Controls

Type 1	Type 2	Type 3
Sheet Flow		
Buffer Zone capable of infiltrating 100% of stormwater runoff or processed water Infiltration basin or sand filter bed capable of infiltration of 100% of flow	Buffer Zone capable of infiltrating the majority of stormwater runoff **Compost/Mulch Berm**	**Buffer Zone** Filter Fence Modular Sediment Trap Sediment Fence
Concentrated Flow		
Sediment basin (sized in accordance with design standard)	Sediment Basin (smaller than the design standard) Filter Tube Dam Rock Filter Dam Sediment Trench Sediment Weir	Coarse Sediment Trap Modular Sediment Trap U-shaped Sediment Trap
Dewatering Sediment Control		
Type F/D Sediment Basin Stilling Pond	Filter Bag or Filter Tube Filter Pond Filter Tube Dam Portable Sediment Tank Settling Pond Sump Pit	Filter Fence Grass Filter Bed Hydrocyclone Portable Sediment Tank Sediment Fence
In-stream Sediment Control		
Pump sediment-laden water to an off-stream Type F/D Sediment Basin or high filtration system	Filter Tube Barrier Modular Sediment Barrier Rock Filter Dam Sediment Weir	Modular Sediment Barrier Sediment Filter Cage

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Standard drawings for erosion and sediment controls are available at:

http://www.austieca.com.au/publications/book-6-standard-drawings.

The ESCP for Kyalla 117 N2, Velkerri 76 S2, Stuart Highway turn-in, Amungee NW 1H and typical cross section for water crossings are provided in **Appendix E**, **Appendix F, Appendix G**, **Appendix H**, **Appendix I** respectively.

Standard drawings that may be applicable for the Project, including controls for access tracks and stream crossings are provided in **Appendix J**. The final design of the ESC controls will be dependent on decisions made in the field by the Supervising Engineer and site conditions. Any significant changes to those identified in this ESCP will be reported through to DEPWS Land Management Team for review and approval. Origin and its civil contractors will be responsible for notifying of any changes.

5.3.1 Modifying the ESC Measures

It is possible that some ESC measures will require modification as the project is constructed and in response to the performance of ESC measures or changes in project circumstances. The modifications may be considered minor, moderate or significant. Moderate and minor changes will occur, and it is expected that significant modifications will be the exception. If significant erosion events occur, significant changes to the measures used will be required and should be approved by a CPESC or suitably qualified consulting engineer.

To accommodate the range of circumstances likely to occur, a change management decision matrix is presented in Table 8. Where changes are required these will be risked assessed through a change management process and kept in a change management register.

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Table 8 Change management decision matrix

Authority required	Minor	Moderate		Significant
	Maintenance of all measures	Removal or relocation of minor temporary controls	Permanent measure relocation	Permanent measure removal/revisions to ESCP
Origin Onsite Company Rep	✓	×	×	×
Site Supervisor	-	✓	×	×
CPESC	-	-	✓	✓
Consulting Engineer	-	-	✓	✓

✓ Authorised to undertake.
× Not Authorised to undertake.
- Denotes that authority level is not required

Examples of different types of sediment controls can be seen in 1.Appendix K**Error! Reference source not found.**. Examples of minor temporary controls would fall under Type 3 Sediment Controls while Type 2 Sediment Controls provide examples of permanent measures.

It is noted that minor and permanent are not indications of how long the sediment controls are in place. At completion of the activities related to the civil works, the disturbed areas to be restored and/or rehabilitated to pre-disturbed conditions consistent with the surrounding land use.

If ESC measures are observed to be ineffective (*e.g.* obvious sediment deposition has occurred, or is occurring in a waterway), the source of the sediment must be identified, and corrective ESC measures implemented.

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6. Erosion and Sediment Controls

Based on the erosion susceptibility of the exploration area, the ESCP measures to be adopted for Origins program are summarised in Table 9 below. These ESCP measures have been considered during the design and will be implemented by the Civil Contractors during the construction activities.

Table 9 Measures to be implemented for Erosion and Sediment Control

Activity	Management Controls
Land Clearing	- Undertake selective clearing (only clearing areas that are necessary for construction and ESC activities), using lighter machinery such as graders or smaller bulldozers, taking care not to overwork the site. Overworking the site can lead to the loss of topsoil, compaction, formation of windrows and wheel rutting. - Minimise tree clearing activities only during the dry season (April to October) to allow the ground surface to stabilise before the onset of the wet season (November to March). - Minimise impact to vegetation and soils within the 200 m native vegetation buffers along pastoral property boundaries and 50 m buffer for land adjoining NTG road reserves., as outlined in the *NTG Land Clearing Guidelines 2010*. - Undertake clearing for each stage in small units over time, keeping the disturbed areas small and time of exposure short, in conjunction with progressive re-vegetation (assisted natural regeneration using available topsoil). - Take all reasonable and practicable measures to minimise the removal of, or disturbance to, trees, shrubs and ground covers (organic or inorganic) that are to be retained. - If bulk tree clearing is required, it must occur in a manner that minimises disturbance to existing ground cover (organic or inorganic). - Bulk tree clearing and grubbing of the site must be immediately followed by specified temporary stabilisation measures (e.g. gravel, soil berm) prior to commencement of each stage of construction works. - Land clearing should not occur unless preceded by the installation of appropriate drainage and sediment control measures. The exception would be any land clearing necessary to allow installation of these control measures. Prior to land clearing, establish tree protection zones around vegetation to be retained e.g. identify with high-visibility tape, or light fencing. - All land clearing must be in accordance with the Federal, Territory and local government vegetation clearing requirements and IECA Table 4.4.7 Best practice land clearing and rehabilitation requirements. - All reasonable and practicable steps to be taken to apply best practice Erosion control measures following earthworks and site stabilised prior to anticipated rainfall. Disturbed areas will be stabilised in accordance with the rehabilitation plan.

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Activity	Management Controls
Access Track and Stuart Highway Turn-in Construction	- Where possible, use existing roads and tracks to access the lease areas, and where new tracks are required, they should be located along the most direct and practicable route to the lease area (noting Velkerri 76 S1 access track has been diverted around the sensitive Bullwaddy/Lancewood vegetation type). - Trucks entering and exiting the site will be constrained in such a manner to prevent dropping or tracking material on the Highway in accordance with the Road Agency Approval (ref 2018-0186-D2). - Monitor Stuart Highway during construction and operation. Where tracked material on the road pavement becomes a potential safety issue, Origin and its contractors will sweep and clean material off the road. If Stuart Highway Turn-in results in dust, dirt creating hazard to road users, additional ESC will be considered including installation of shaker grid or rock pad. - Minimise track width and surface disturbance (e.g. topsoil, seed and root stock) as far as practicable to allow safe passage of required equipment. Disturbed areas will be stabilised with a minimum 60% cover 30 days of completion if rainfall possible. - Where gravelling is warranted (Stuart Highway Turn-in), the formation process can remove undesirable material and/or box the imported material where it is required. Track formation will be required for the following reasons: • Drainage control, especially in areas where erosion or sediment influences are evident, any vegetation, topography, wheel rutting or compaction is likely to intercept, concentrate and channel water. • Where the topography of the track location or the drainage characteristics of the soil are likely to hinder access for a protracted time period following rain (e.g. 1 to 2 weeks). • Where natural side-slope poses a safety hazard to potential users of the track (e.g. Contractors, Land Owners). - Place scrub and vegetation cleared from the route adjacent to the route where practical to facilitate its return to the disturbed area. Where this occurs, spread the material out rather than form windrows. Allow disturbed areas to be stabilised and natural regeneration of the native grasses to occur. - Construct access tracks with table drains that are free draining. - Avoid road crowning to allow water to naturally cross the road. - Form tracks to allow off-road drainage. Where track intercepts the direction of overland flow and re-directs this flow to a non-natural drainage line, install erosion control works to minimise potential erosion. - The design and position of erosion control measures to be determined in the field by experienced operator and site engineer, based on the site characteristics of the access track location. - Where construction of table drains are deemed necessary, they should have a broad flat base at least 1 m wide and should not be graded to produce a 'V' shape. To minimise erosion, the slope should be no greater than 0.5% on erodible soils or 1% on stable soils. - Where encounter dispersive / erosive soils they should be stabilised with gypsum or other stabiliser, as determined by laboratory analysis of soils.

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Activity	Management Controls
	- Where cut-out drains are required, they should be spaced based on the slope of the area i.e. 0.5% slope, allow for cut-out draining every 170-180 m or 1 % slope, allow for cut-out drainage every 120-130 m etc. (refer to NT Road Drainage Fact Sheet). It is noted that the recommended distance between turn-out drains is a guide and may not apply to all locations along the access track. - Monitor road conditions to ensure deterioration does not occur. Assist in the maintenance and repair work on roads and tracks used. - Following completion of activities and within 2 years after the surrender of a lease, the land surrounding or affected by the installation of access tracks shall be restored in accordance with the site-specific rehabilitation plan and final determination of asset (i.e. if transferring asset ownership to landholder).
Infrastructure construction	- Pad construction to be in accordance with the typical ESCP (refer **Appendix E**). The topsoil berm dimension to be in accordance with the IECA Figure 1 Standard Drawing MB-01 presented in **Appendix F**. • Use topsoil berms to divert upstream runoff from undisturbed areas ('clean' water) around and away from disturbed areas, and back to the environment. • Use topsoil berms to contain / manage runoff from disturbed construction areas ('dirty' water) and prevent release to environment without treatment. • Treat runoff from construction areas through suitable sediment controls (e.g. sediment traps). • Configure berms so that upstream runoff does not mix with construction area runoff prior to treatment of construction area runoff. - Where topsoil stripping is required, the stripping depth would be in accordance with Technical Instruction (NT-2050-15-TI-0001) and amelioration rates agreed with the Construction Supervisor, Origin engineers and by a suitably qualified ESC practitioner. It is noted that the expected nominal depth of topsoil across the lease pads at both locations range from <100 mm to 150 mm. Final strip depth will be confirmed in the field. Any changes to the adopted ESCs will be reflected in the ESCP and to satisfaction of DEPWS. - Stockpile felled trees nearby for future use in rehabilitation. - Inspect on a regular basis in accordance with Section 5 Maintenance. - Damage or maintenance is undertaken by an appropriately qualified person i.e. contractor / Origin. - Following completion of activities and within 2 years after the surrender of a lease, the land surrounding or affected by the exploration wells shall be restored in accordance with the site-specific rehabilitation plan and final determination of asset (i.e. if transferring asset ownership to landholder).
Stream and Creek Crossings	Where a crossing is required to be upgraded, a bed level crossing as detailed in **Appendix B**, will be installed in accordance with the following: - Crossings will be aligned perpendicular to the water flow. Where ramps are required for improving the crossing, they will be aligned perpendicular to creek bed or drainage line, as much as possible using local materials. - Crossings will be located at stable and level crossing points. - All large shrubs and trees will be avoided along creeks and drainage lines during access track construction.

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<table>
<tr><th>Activity</th><th>Management Controls</th></tr>
<tr><td></td><td>
- Crossing will be constructed from clean rocks (minimal fine material) that are an equivalent or larger size than the natural bed material at the crossing.
- The surface is to be left rough and not to be over compacted (e.g. track-rolled finish or rougher).
- The lowest point of the bed level crossing will be installed at the level of the lowest point of the natural stream bed (preconstruction), within the footprint of the proposed crossing.
- There must be a height difference of at least 100 mm up to ≤ 300mm from the lowest point of the crossing to the edges of the low flow section of the crossing.
Where scour protection is required:
- Scour protection must abut the surface edge of the crossing at the same level (this is to ensure that there is no drop in elevation at the join).
- If the crossing is set below bed level then the surface of the scour protection must also be below bed level.
- The stream bed must abut the scour protection at the same level (this is to ensure that there is no drop in elevation at the join).
- The scour protection is installed at a gradient no steeper than 1 in 20 or the natural channel gradient, whichever is steeper.
- Scour protection must incorporate a low flow channel. Use clean rocks (minimal fine material), at least 100 mm diameter.
- Ensure the rock armouring is not over compacted but left at the same level and uneven (track-rolled finish or rougher).
- Use clean rocks (minimal fine material), at least 100 mm diameter.
- Any rock protection must be restricted to what is necessary to provide safe passage and be placed at bed level.
- The retention of vegetation buffers, as outlined in the NTG Land Clearing Guidelines 2019, as they relate to stream order has been considered for the siting of proposed access tracks and pads.
- As such, disturbance in the riparian buffers in accordance with the stream order of the encountered drainage lines will be in accordance with the buffers provided below:
<table>
<tr><th>Riparian class</th><th>Stream order</th><th>Minimum buffer width</th><th>Measured from</th></tr>
<tr><td>Drainage depression</td><td>Not applicable</td><td>25</td><td>The outer edge of the drainage depression, which is the extent of the associated poorly drained soils and associated vegetation</td></tr>
<tr><td>Intermittent streams</td><td>First</td><td>25</td><td>The outer edge of the riparian vegetation or levee (whichever is greater). If braided channels are present, the edge of the outer most stream channel</td></tr>
<tr><td>Intermittent streams</td><td>Second</td><td>50</td><td>As above</td></tr>
<tr><td>Creeks</td><td>Third and fourth</td><td>100</td><td>As above</td></tr>
<tr><td>Rivers</td><td>Fifth or higher</td><td>250</td><td>As above</td></tr>
</table>
</td></tr>
</table>

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Activity	Management Controls
	- - Site specific progressive ECP's should be approved by DEPWS prior to any disturbance. - Should activities pushout to the wet season, the ESCP to be reviewed and updated for Wet Season conditions. The revision to be reviewed and approved by DEPWS during October to allow implementation of the plan prior to the onset of the wet season. Wet season ESCP to be implemented between 1 November to 31 March. - The activities are to be completed in a manner that does not cause material change to the shape of a waterway, the volume, speed or direction of flow or likely flow of water in or into a waterway, or alteration to the stability of the bed or banks of a waterway, including by removal of vegetation. Waterways will require treatment to retain its existing profile. - Monitoring of creek and drainage crossing condition prior to, during and at completion of rehabilitation will be required. - The original topography of the creek or drainage bed will be reinstated by removing material related to treatment of retaining the waterway's existing profile following practical completion of the exploration program.
Gravel pit	- External catchments at gravel pits are to be diverted around the area of soil disturbance. - Gravel pits will be formed in a manner to be internally draining at all times during gravel extraction (i.e. a basin) and shall be maintained as such for the term of it's operational life until rehabilitated.
Soil and Stockpile Management	- Stockpile existing topsoil, where available, so that it can be reused on the site for ESC and future rehabilitation at completion of project. - Stockpiles of erodible material that has the potential to cause environmental harm if displaced, must be: (i) Appropriately protected from wind, rain, concentrated surface flow and excessive up-slope stormwater surface flows. (ii) Located at least 2m from any hazardous area or retained vegetation. (iii) Located up-slope of an appropriate sediment control system. (iv) Provided with an appropriate protective cover (synthetic or vegetative) if the materials are likely to be stockpiled for more than 28 days. (v) Provided with an appropriate protective cover (synthetic or vegetative) if the materials are likely to be stockpiled for more than 10 days during those months that have an erosion risk rating higher than medium. - A suitable flow diversion system must be established immediately up-slope of a stockpile of erodible material that has the potential to cause environmental harm if displaced, if the up-slope catchment area draining to the stockpile exceeds 1,500m^2. - Avoid creating windrows. Do not create windrows across creeks, use rollers when putting in tracks in preference to dozers, or walk the dozer with the blade raised off the ground.
Site Management and maintenance	- All materials, plant and equipment brought to the site are to be certified as "free" of weeds, soil pathogens and pests. - All disturbed areas identified as very low, low, medium or high erosion risk must be suitably stabilised prior to anticipated rainfall, from the day that soil disturbances on the area have been finalised- IECA Table 4.4.7.

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Activity	Management Controls
	- Tracks to be regularly inspected for early signs of erosion and soil degradation (generation of bulldust). Ongoing maintenance and repair work should be implemented as required on tracks. - No off-lease or off-road driving. - The construction schedule must aim to minimise the duration that any and all areas of soil are exposed to the erosive effects of wind, rain and surface water flow. - Land-disturbing activities must: (i) allow stormwater to pass through the site in a controlled manner and at non-erosive flow velocities. (ii) minimise soil erosion resulting from rain, water flow and/or wind. (iii) minimise adverse effects of sediment runoff, including safety issues. (iv) prevent, or at least minimise, environmental harm resulting from work-related soil erosion and sediment runoff. (v) ensure that the value and use of land/properties adjacent to the site (including access roads) are not diminished as a result of the adopted ESC measures. - Additional and/or alternative ESC measures must be implemented in the event that unacceptable off-site sedimentation is occurring as a result of the work activities. - Sediment deposited off the site as a direct result of an on-site activity, must be collected and the area appropriately rehabilitated as soon as reasonable and practicable, and in a manner that gives appropriate consideration to the safety and environmental risks associated with the sediment deposition. - At completion of the activities related to the civil works, the disturbed areas to be restored and/or rehabilitated to original pre-disturbed condition consistent with the surrounding land use.
Drainage Control	- Where reasonable and practicable, stormwater runoff entering the site, must be diverted around or through the area in a manner that minimises soil erosion and the contamination of water for all discharges. - All reasonable and practicable measures must be implemented to control flow velocities a manner that prevents soil erosion along drainage paths and at the entrance and exit of all drains and drainage pipes during storms up to the relevant design storm discharge. - Where reasonable and practicable, all waters discharged during construction must discharge onto stable land, in a non-erosive manner.
Erosion Control	- If synthetic reinforced erosion control mats or blankets are required, they must not be placed in, or adjacent to, riparian zones and watercourses if such materials are likely to cause environmental harm to wildlife or wildlife habitats. - A minimum 60% ground cover must be achieved on all non-completed earthworks exposed to accelerated soil erosion. If further construction activities or soil disturbances are likely to be suspended for more than 30 days during months when the expected rainfall erosivity is less than 60; • minimum 70% cover within 30 days if between 60 and 100;

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Activity	Management Controls
	• minimum 70% cover within 20 days if between 100 and 285; • minimum 80% cover within 10 days if between 285 and 1,500; and • minimum 95% cover within 5 days if greater than 1,500.
Sediment Control	- Optimum benefit must be made of every opportunity to trap sediment within the work site, and as close as practicable to its source. - Sediment pond to be installed and operated to both collect and retain sediment (refer to Drawing NT-2050-15-MP-0021 and NT-2050-15-MP-022 in Appendix E). Design details of the sediment pond is provided in NT-2050-20-DD-0023. - All reasonable and practicable measures must be taken to prevent, or at least minimise, the release of sediment from the site. - Sediment control devices must be de-silted and made fully operational as soon as reasonable and practicable after a sediment-producing event, if the device's sediment retention capacity falls below 75% of its design retention capacity. - Materials removed from sediment control devices must be disposed of in a manner that does not cause ongoing soil erosion or environmental harm. - Ensure that gravel tracks have adequate thickness to increase the structural stability for vehicle use. This minimises rapid deterioration. - Have onsite storage of emergency materials to establish and uphold the site's erosion and sediment controls.
Site Rehabilitation	- At the completion of activities and before the commencement of decommissioning activities, Origin will discuss any possible residual beneficial use of the assets with the landowner. Assets may include the well lease pads, tank pads, access tracks, accommodation camps, gravel pits and water infrastructure. If the landholder does request for infrastructure to remain in place, the proposed infrastructure will have ownership transferred following approval by DEPWS and the Pastoral Land Board. - Where assets cannot be beneficially used, the site will be rehabilitated using assisted natural regeneration to a safe, stable landform consistent with surrounding land use. Once Origin identifies the completion of activities within an area of the permit, rehabilitation will commence within that 12-month period. - Rehabilitation of disturbed areas will occur as soon as practicable following completion of works in accordance with Appendix XX Rehabilitation Plan to reduce exposed soils and minimise runoff from first flush events. - Rehabilitation of disturbed areas should follow a similar landform to the surrounding area. - The formation of steep slopes, barriers, fencing components should not be left on site which could endanger wildlife or humans. - After activities, establish vegetation to the standard of that registered in the pre-assessment, or better. - Remove and appropriately dispose of all synthetic erosion and sediment control materials. - - Gravel pits to have topsoil returned and re-profiled. - All compacted areas will be ripped and scarified to promote regeneration of vegetation, this may require assistance through spread of native seed stock.

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Activity	Management Controls
	- All disturbed areas will be allowed to naturally regenerate or be revegetated on completion of use. - At completion of activities, establish vegetation similar to adjacent vegetation, unless agreement with landowner for alternative use. - Stabilise disturbed areas quickly to reduce the potential for erosion. Methods of stabilisation will be site specific and based, in part, on laboratory analysis of soils for erosive and dispersive characteristics. - Previously removed vegetation and topsoil will be uniformly re-spread over disturbed area to assist with rehabilitation process through agencies of increased infiltration and return of seed-bearing topsoil. If required, additional native seed mix from the area could be respread to speed up rehabilitation process This will be confirmed during rehabilitation monitoring activities. - Windrows of debris that cannot be removed should be aligned down the contour or in a manner appropriate to avoid channelling and concentrating runoff. All other windrows are to be removed as soon as practicable. - The type of ground cover applied to completed earthworks is compatible with the anticipated long-term land use, environmental risk, and site rehabilitation measures.
Wet weather contingency	- 7-day forecast from the Bureau of Meteorology (BOM) to be monitored and the civil and water bore construction activities planned around the forecasts. - Where forecasts indicate rainfall is likely to result in an event that has potential to limit access to the work area, the civil and water bore contractor will stabilise the current work areas and go into standby mode until such time they can assess the track condition after an event to recommence activities. - Emergency response – a post-rainfall/flood damage reconnaissance and assessment will be undertaken as soon as the area becomes accessible. Any damage observed would be repaired as soon as practicable after the event and ensure the controls and measures are in place prior to the next rainfall event.

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7. Monitoring

7.1 Construction

Monitoring for soil erosion and related issues is undertaken at the following key stages:

- Assessment of existing erosion during siting of access track and well lease pads.
- Following completion of key phase of activity – e.g. inspected for early signs of compaction, erosion and soil degradation (generation of bulldust) following completion of the civil construction program.
- After more than 20 mm of rainfall has fallen in a 24-hr period.
- Vegetation recovery monitoring (refer below).

Additional, routine inspections are to be conducted monthly to assess:

- Erosion and sediment controls employed on site are in place and in working order.
- For wind erosion scalds, especially along the access tracks, well lease pads and camp areas.
- For erosion gullies forming along access tracks and well lease pads or around the field camp.
- Erosion along the extent of the access tracks would be assessed and compared to the results from the land condition assessment detailed within the relevant EMP.

When accessing the site after the wet season, all disturbed areas should be inspected for signs of accelerated erosion. If significant impacts are identified remediation works may need to be conducted.

7.2 Operations

Visual inspections to assess the impact risk levels and the likelihood of accelerated erosion occurring will be carried out throughout civil construction activities to ensure that mitigation measures are implemented. Regular assessments will be conducted to ensure that mitigation techniques are implemented efficiently and effectively. Greater emphasis will be required during the wet season.

Inspections of all disturbed areas are required before and after the wet season. Maintenance activities should be prioritised immediately; involving monitoring of the erosion and sediment rehabilitation procedures to ensure that issues are rectified.

7.3 Rehabilitation

Rehabilitation will be undertaken along all newly constructed access tracks to the well sites and gravel pits concurrently with the completion of the civil works from each lease pad location. Rehabilitation monitoring will commence pre and post initial wet season and then annually for 3 years.. This will determine whether additional rehabilitation works are required. A successful rehabilitation from preliminary, early and long-term stages are defined and include:

- Seed germination and plant establishment rates are sufficient and are observed.
- Safe for humans and wildlife. Assessment on the number of species present in the rehabilitated area.
- Stable, with appropriate vegetation cover.
- Non-polluting.
- Resilient, self-sustaining vegetation.
- Land condition suitable for existing pastoral land use

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7.4 Incident Reporting

The Constructor must follow incident reporting requirements covered in the Origin Incident Management Directive.

Sediment release and turbidity increase incidents can require some assessment to determine if they are reportable, as controls are only designed to cope with certain rain events (refer to IECA, 2008).

The Constructor must:

- Report sediment release and turbidity increase incidents.
- Include justification in each case of why the incident is, or is not, reportable to the regulator based on:
  - The state of the controls prior to the rainfall
  - The design standard applied (IECA, 2008)
  - The actual rainfall received, based on the nearest data source available
  - Whether the design storm event was exceeded or not; and
  - Whether environmental harm was caused or not.

7.5 Records

Records shall be retained demonstrating area have been inspected. Photographic records will be maintained over the duration of the activities for documenting soil disturbance.

All environmentally relevant incidents are to be recorded in a field log that must remain accessible to all relevant regulatory authorities.

Minimum records to be retained for each site include:

Location of disturbance	Area of Disturbance	Date	Closeout

7.6 ESCP Revisions

Where major changes are required to the proposed controls in the ESCP, DEPWS would be advised and revised Secondary ESCP provided for review and approval. In particular, should construction activities progress into the Wet Season, the ESCP should be updated during October and implemented between 1st November and maintained in place until 31st March.

7.7 Maintenance

All temporary erosion and sediment control measures, including drainage control measures, must be fully operational and maintained in proper working order during the project.

When undertaking construction work, erosion and sediment control measures must be inspected:

- at least daily (when work is occurring on-site) during the wet season
- within 24 hours of expected rainfall
- within 18 hours of a rainfall event of sufficient intensity and duration to cause runoff on-site or greater than 20mm in 24 hours.

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Once operational, inspections of the site will occur monthly until the site has been stabilised and then 6 monthly (before and after the wet season). Where erosion is observed, maintenance activities shall be undertaken as soon as practicable.

Sediment removed from sediment traps and places of sediment deposition must be disposed of in a manner that does not cause ongoing soil erosion or environmental harm.

Prior to the completion of activities on the ground, the construction areas will be stabilised to the satisfaction of the Construction Supervisor.

8. Site specific Erosion and sediment control plans

The controls outlined in the primary ESCP are to be implemented into a site specific erosion and sediment controls plans. These plans are provided below:

- Velkerri 76 S2 ESCP (1.Appendix F)
- Kyalla 117 N2 ESCP (1.Appendix E)
- Amungee NW-1 ESCP (1.Appendix I
- Beetaloo W-1 ESCP (1.Appendix J

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

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Appendix A Erosion Hazard Assessment Explanatory Notes

reference: IECA, 2008, *Best Practice Erosion and Sediment Control Hazard Assessment Form)*

Requirements: Specific issues or actions required by the proponent.

Warnings: Issues that should be considered by the proponent.

Comments: General information relating to the topic.

[1] **REQUIREMENTS:**

For sites with an average slope of proposed land disturbance greater than 10%, a preliminary ESCP must be submitted to the regulatory authority for approval during planning negotiations.

Proponents must demonstrate that adequate erosion and sediment control measures can be implemented on-site to effectively protect downstream environmental values.

If site or financial constraints suggest that it is not reasonable or practicable for the prescribed water quality objectives to be achieved for the proposal, then the proponent must demonstrate that alternative designs or construction techniques (e.g. pole homes, suspended slab) cannot reasonably be implemented on the site.

WARNINGS:

Steep sites usually require more stringent drainage and erosion controls than flatter grade sites.

COMMENTS:

The steeper the land, the greater the need for adequate drainage controls to prevent soil and mulch from being washed from the site.

[2] **REQUIREMENTS:**

If the actual soil K-factor is known from soil testing, then the Score shall be determined from Table 1.

If a preliminary ESCP is required during planning negotiations, then it must be demonstrated that adequate space is available for the construction and operation of any major sediment traps, including the provision for any sediment basins and their associated embankments and spillways. It must also be demonstrated that all reasonable and practicable measures can be taken to divert the maximum quantity of sediment-laden runoff (up to the specified design storm) to these sediment traps throughout the construction phase and until the contributing catchment is adequately stabilised against erosion.

WARNINGS:-

The higher the point score, the greater the need to protect the soil from raindrop impact and thus the greater the need for effective erosion control measures. A point score of 2 or greater will require a greater emphasis to be placed on revegetation techniques that do not expose the soil to direct rainfall contact during vegetation establishment, e.g. turfing and *Hydromulching*.

COMMENTS:

Table 2 provides an *indication* of soil conditions likely to be associated with a particular Soil group based on a statistical analysis of soil testing across NSW. This table provides only an initial estimate of the likely soil conditions.

The left-hand-side of the table provides an indication of the type of sediment basin that will be required (Type C, F or D). The right-hand-side of the table provides an indication of the likely erodibility of the soil based on the Revised Universal Soil Loss Equation (RUSLE) K-factor.

Table 3 provides some general comments on the erosion potential of the various soil groups.

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Table 1 – Score if soil K-factor is known

	RUSLE soil erodibility K-factor			
	K < 0.02	0.02<K<0.04	0.04<K<0.06	K > 0.06
Score	0	1	2	3

Table 2 – Statistical analysis of NSW soil data [1]

Unified Soil Class System	Likely sediment basin classification (%)			Probable soil erodibility K-factor (%) [2]			
	Dry	Wet		Low	Moderate	High	Very High
	Type C	Type F	Type D	K < 0.02	0.02<K<0.04	0.04<K<0.06	K > 0.06
GM	30	**58**	12	12	**51**	26	12
GC	**42**	33	25	13	**71**	17	0
SW	40	**48**	12	**49**	39	12	0
SP	**53**	32	15	**76**	18	5	1
SM	21	**67**	12	26	**48**	25	1
SC	26	**50**	24	16	**64**	18	2
ML	5	**63**	32	4	35	**45**	16
CL	9	**51**	39	12	**56**	19	13
OL	2	**80**	18	34	**61**	5	1
MH	12	41	**48**	15	19	**41**	25
CH	5	44	**51**	39	**43**	11	7

Notes: [1] Analysis of soil data presented in Landcom (2004).

[2] Soil erodibility based on Revised Universal Soil Loss Equation (RUSLE) K-factor.

Unified Soil Classification System (USCS)

GW Well graded gravels, gravel-sand mixtures, little or no fines

GP Poorly graded gravels, gravel-sand mixture, little or no fines

GM Silty gravels, poorly graded gravel-sand-silt mixtures

GC Clayey gravels, poorly graded gravel-sand-clay mixtures

SW Well graded sands, gravelly sands, little or no fines

SP Poorly graded sands, gravelly sands, little or no fines

SM Silty sands, poorly graded sand-silt mixtures

SC Clayey sands, poorly graded sand-clay mixtures

ML Inorganic silts & very fine sands, rock flour, silty or clayey fine sands with slight plasticity

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CL Inorganic clays, low–medium plasticity, gravelly clays, sandy clays, silty clays, lean clays

OL Organic silts and organic silt-clays of low plasticity

MH Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts

CH Inorganic clays of high plasticity, fat clays

OH Organic clays of medium to high plasticity

Table 3 – Typical properties of various soil groups [1]

Soil Groups	Typical properties [2]
GW, GP	• Low erodibility potential.
GM, GC	• Low to medium erodibility potential. • May create turbid runoff if disturbed as a result of the release of silt and clay particles.
SW, SP	• Low to medium erodibility potential.
SM, SC	• Medium erodibility potential. • May create turbid runoff if disturbed as a result of the release of silt and clay particles.
MH, CH	• Highly variable (low to high) erodibility potential. • Will generally create turbid runoff if disturbed.
ML, CL	• High erodibility potential. • Tendency to be dispersive. • May create some turbidity in runoff if disturbed.

Note: [1] After Soil Services & NSW DLWC (1998).

[2] Any soil can represent a high erosion risk if the binding clays or silts are unstable.

Table 4 provides **general** guidelines on the suitability of various soil groups to various engineering applications.

Table 4 – Engineering suitability based on Unified Soil Classification [1]

Unified Soil Class	USC Group	Embankments		Fill	Slope stability	Untreated roads
		Water retaining	Non-water retaining			
Well graded gravels	GW	Unsuitable	Excellent	Excellent	Excellent	Average
Poorly graded gravel	GP	Unsuitable	Average	Excellent	Average	Unsuitable
Silty gravels	GM	Unsuitable	Average	Good	Average	Average
Clayey gravels	GC	Suitable	Average	Good	Average	Excellent
Well graded sands	SW	Unsuitable	Excellent	Excellent	Excellent	Average
Poorly graded sands	SP	Unsuitable	Average	Good	Average	Unsuitable
Silty sands	SM	Suitable [2]	Average	Average	Average	Poor
Clayey sands	SC	Suitable	Average	Average	Average	Good
Inorganic silts	ML	Unsuitable	Poor	Average	Poor	Unsuitable
Inorganic clays	CL	Suitable [2]	Good	Average	Good	Poor

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Organic silts	OL	Unsuitable	Unsuitable	Poor	Unsuitable	Unsuitable
Inorganic silts	MH	Unsuitable	Poor	Poor	Poor	Unsuitable
Inorganic clays	CH	Suitable [2]	Average	Unsuitable	Average	Unsuitable
Organic clays	OH	Unsuitable	Unsuitable	Unsuitable	Unsuitable	Unsuitable
Highly organic soils	Pt	Unsuitable	Unsuitable	Unsuitable	Unsuitable	Unsuitable

Notes: [1] Modified from Hazelton & Murphy (1992)

[2] Suitable only after modifications to soil such as compaction and/or erosion protection

[3] If the soils have not been tested for Emerson Class, then adopt a score of 4.

REQUIREMENTS:

Works proposed on sites containing Emerson Class 1 or 2 soils have a very high pollution potential and must submit a conceptual ESCP to the regulatory authority for review and/or approval (as required by the authority) during planning negotiations.

WARNINGS:

Class 3 and 5 soils disturbed by cut and fill operations or construction traffic are highly likely to discolour stormwater (i.e. cause turbid runoff). Chemical stabilisation will likely be required if these soils are placed immediately adjacent to a retaining wall. Any disturbed Class 1, 2, 3 and 5 soils that are to be revegetated must be covered with a non-dispersive topsoil as soon as possible (unless otherwise agreed by the regulatory authority).

Class 1 and 2 soils are highly likely to discolour (pollute) stormwater if exposed to rainfall or flowing water. Treatment of these soils with gypsum (or other suitable substance) will most likely be required. These soils should not be placed directly behind a retaining wall unless it has been adequately treated (stabilised) or covered with a non-dispersible soil.

[4] The duration of disturbance refers to the total duration of soil exposure to rainfall up until a time when there is at least 70% coverage of all areas of soil.

REQUIREMENTS:

All land developments with an expected soil disturbance period greater than 6 months must submit a conceptual ESCP to the regulatory authority for review and/or approval (as required by the authority) during planning negotiations.

COMMENTS:

Construction periods greater than 3 months will generally experience at least some significant storm events, independent of the time of year that the construction (soil disturbance) occurs.

[5] **REQUIREMENTS:**

Development proposals with an expected soil disturbance in excess of 1ha must submit a conceptual ESCP to the regulatory authority for review and/or approval (as required by the regulatory authority) during planning negotiations.

The area of disturbance refers to the total area of soil exposed to rainfall or dust-producing winds either as a result of:

(a) the removal of ground cover vegetation, mulch or sealed surfaces;
(b) past land management practices;
(c) natural conditions.

WARNINGS:

A *Sediment Basin* will usually be required if the disturbed area exceeds 0.25ha (2500m^2) within any sub-catchment (i.e. land flowing to one outlet point).

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COMMENTS:

For soil disturbances greater than 0.25ha, the revegetation phase should be staged to minimise the duration for which soils are exposed to wind, rain and concentrated runoff.

[6] **REQUIREMENTS:**

All developments that involve earthworks or construction within a natural watercourse (whether that watercourse is in a natural or modified condition) must submit a conceptual ESCP to the regulatory authority for review and/or approval (as required by the regulatory authority) during planning negotiations.

Permits and/or licences may be required from the State Government, including possible submission of the ESCP to the relevant Government department.

[7] **REQUIREMENTS:**

No areas of soil disturbance shall be left exposed to rainfall or dust-producing winds at the end of a development without an adequate degree of protection and/or an appropriate action plan for the establishment of at least 70% cover.

COMMENTS:

Grass seeding without the application of a light mulch cover is considered the least favourable revegetation technique. A light mulch cover is required to protect the soil from raindrop impact, excessive temperature fluctuations, and the loss of essential soil moisture.

[8] **COMMENTS:**

All receiving waters can be adversely affected by unnatural quantities of sediment-laden runoff. Freshwater ecosystems are generally more susceptible to ecological harm resulting from the inflow of fine or dispersible clays than saline water bodies. The further inland a land disturbance is, the greater the potential for the released sediment to cause environmental harm as this sediment travels towards the coast.

For the purpose of this clause it is assumed that all sediment-laden runoff will eventually flow into saline waters. Thus, sediment-laden discharges that flow first into freshwater are likely to adversely affect both fresh and saline water bodies and are therefore considered potentially more damaging to the environment.

This clause does **not** imply that sediment-laden runoff will not cause harm to saline waters.

[9] **COMMENTS:**

This clause refers to subsoils exposed during the construction phase either as a result of past land practices or proposed construction activities. The exposure of subsoils resulting from the excavation of minor service trenches should not be considered.

[10] **WARNINGS:**

The greater the extent of external catchment, the greater the need to divert up-slope stormwater runoff around any soil disturbance.

COMMENTS:

The ability to separate “clean” (i.e. external catchment) stormwater runoff from “dirty” site runoff can have a significant effect on the size, efficiency and cost of the temporary drainage, erosion, and sediment control measures.

[11] **REQUIREMENTS:**

Permission must be obtained from the owner of a road reserve before placing any erosion and sediment control measures within the road reserve.

WARNINGS:

Few sediment control techniques work efficiently when placed on a road and/or around roadside stormwater inlets. Great care must be taken if sediment control measures are located on a public roadway, specifically:

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- safety issues relating to road users;
- the risk of causing flooding on the road or within private property.

The construction of roads (whether temporary or permanent) will usually modify the flow path of stormwater runoff. This can affect how "dirty" site runoff is directed to the sediment control measures.

COMMENTS:

"On-road" sediment control devices are at best viewed as secondary or supplementary sediment control measures. Only in special cases and/or on very small projects (e.g. kerb and channel replacement) might these controls be considered as the "primary" sediment control measure.

[12] **WARNINGS:**

Soils with a pH less than 5.5 or greater than 8 will usually require treatment in order to achieve satisfactory revegetation. Soils with a pH of less than 5 (whether naturally acidic or in acid sulfate soil areas) may also limit the choice of chemical flocculants (e.g. Alum) for use in the flocculation of *Sediment Basins*.

[13] **REQUIREMENTS:**

A preliminary ESCP must be submitted to the local government for approval during the planning phase for any development that obtains a total point score of 17 or greater or when any trigger value is scored or exceeded.

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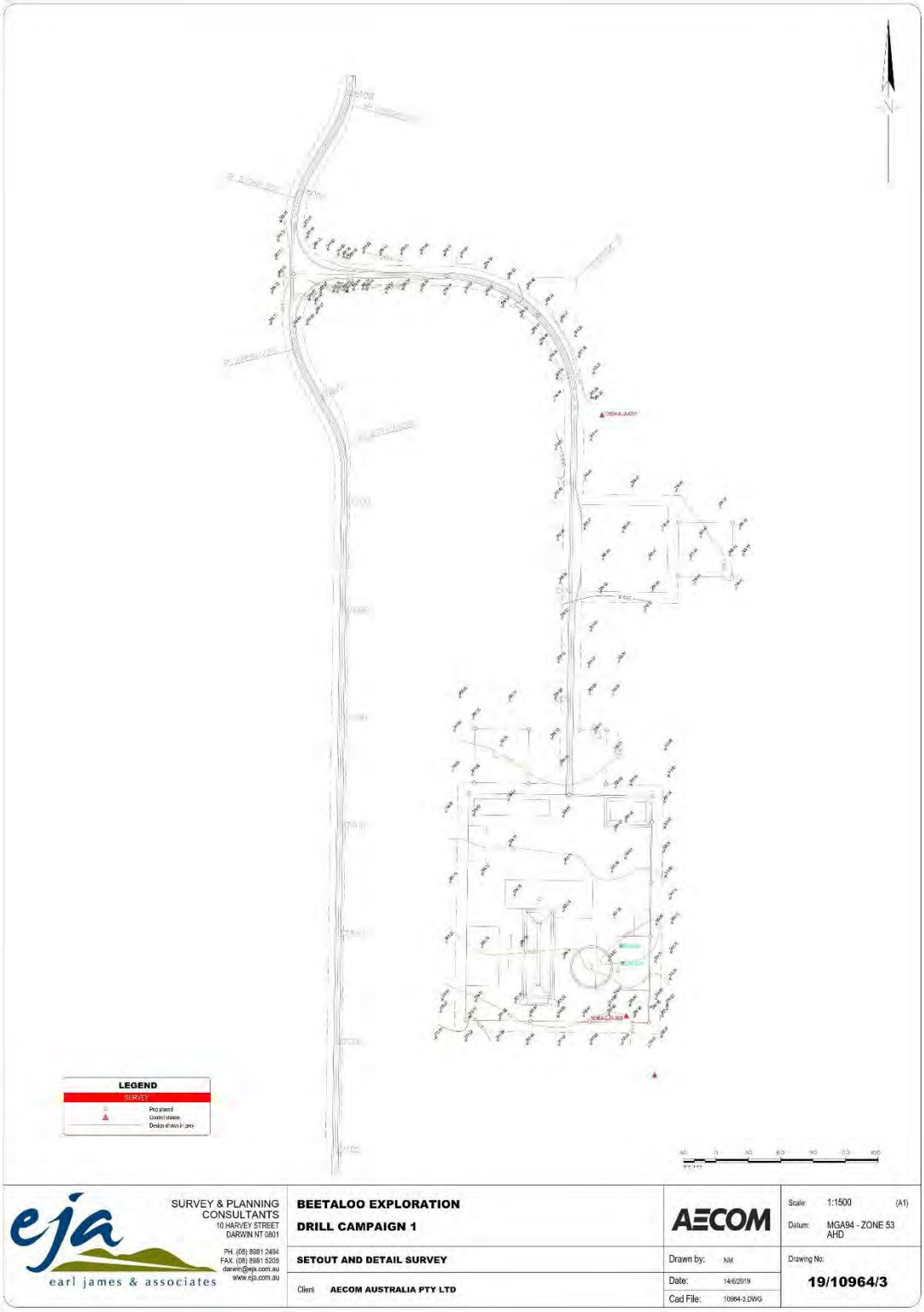
Appendix B Lease Pad and Stuart Highway Topographical Survey



Review due: 05/11/2023

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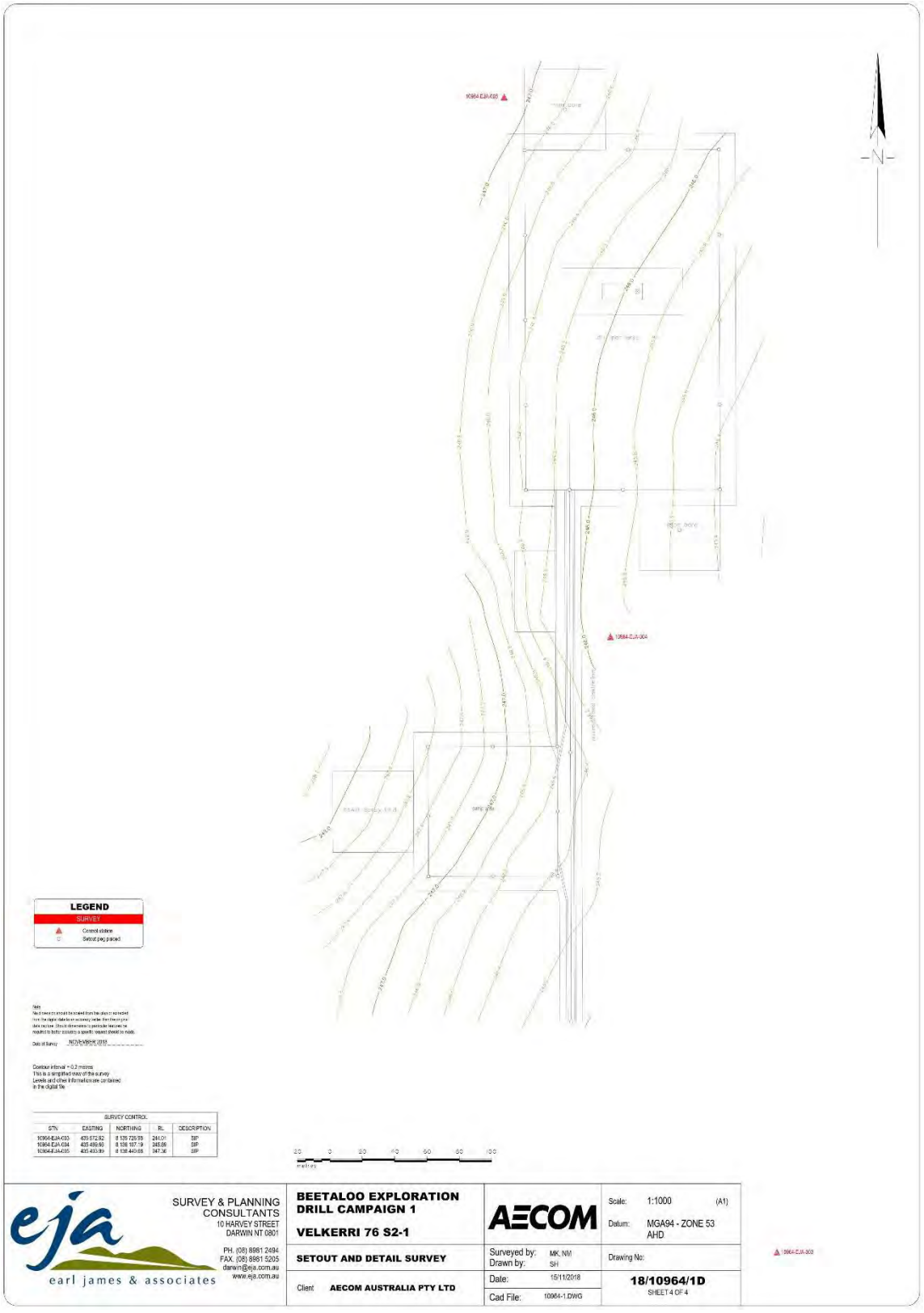
Erosion and Sediment Control Plan

NT-2050-15-MP-019.



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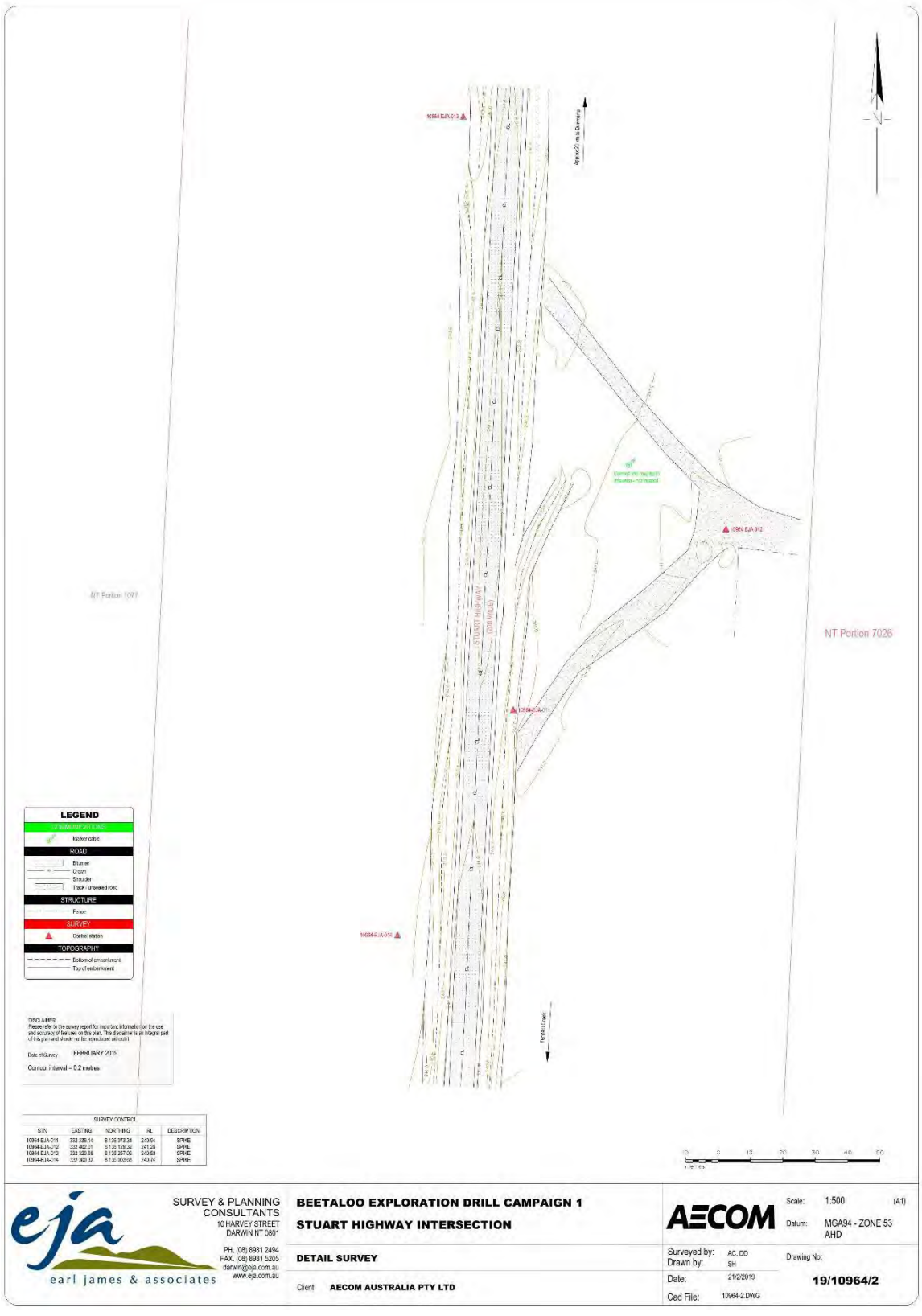

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Appendix C Geotechnical Laboratory Results

Material Test Report

Douglas Partners
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Email: dave.millard@douglaspartners.com.au
Accredited for compliance with ISO/IEC 17025 - Testing

NATA
Approved Signatory: Dave Millard
Engineering Geologist
NATA Accredited Laboratory Number: 828

Report Number: 677612.00-1
Issue Number: 2 - *This version supersedes all previous issues*
Date Issued: 29/01/2019
Client: AECOM Australia Pty Ltd
PO Box 73, Hunter Region NSW 2310
Contact: Jace Emberg
Project Number: 677612.00
Project Name: 60480548 - Beetaloo soil samples
Project Location: Beetaloo, NT
Work Request: 1466
Sample Number: 19-1466F
Date Sampled: 13/12/2018
Sampling Method: AS1289 1.2.1 6.4 - Sampling from layers in earthworks or pavement - uncompacted/compacted
Sample Location: **KYALLA01 (0.0 - 0.4m)**
Material: SAND, with silt

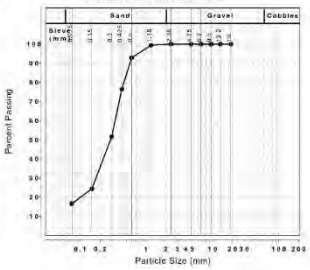
Particle Distribution (AS1289 3.6.1)		
Sieve	Passed %	Passing Limits
19 mm	100	
13.2 mm	100	
9.5 mm	100	
6.7 mm	100	
4.75 mm	100	
2.36 mm	100	
1.18 mm	99	
0.6 mm	93	
0.425 mm	76	
0.3 mm	52	
0.15 mm	24	
0.075 mm	16	

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Air Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	Not Obtainable		
Plastic Limit (%)	Not Obtainable		
Plasticity Index (%)	**Non Plastic**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Linear Shrinkage (%)	0.0		
Cracking Crumbling Curling	None		

Moisture Content (AS 1289 2.1.1)	
Moisture Content (%)	1.9

Particle Size Distribution



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Contact: Jace Emberg
Project Number: 677612.00
Project Name: 60480548 - Beetaloo soil samples
Project Location: Beetaloo, NT
Work Request: 1466
Sample Number: 19-1466G
Date Sampled: 13/12/2018
Sampling Method: AS1289 1.2.1 6.4 - Sampling from layers in earthworks or pavement - uncompacted/compacted
Sample Location: **KYALLA02 (0.0 - 0.4m)**
Material: Silty SAND

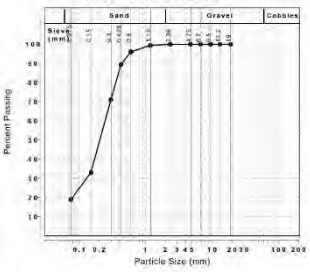
Particle Distribution (AS1289 3.6.1)		
Sieve	Passed %	Passing Limits
19 mm	100	
13.2 mm	100	
9.5 mm	100	
6.7 mm	100	
4.75 mm	100	
2.36 mm	100	
1.18 mm	99	
0.6 mm	96	
0.425 mm	89	
0.3 mm	71	
0.15 mm	33	
0.075 mm	19	

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Air Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	14		
Plastic Limit (%)	13		
Plasticity Index (%)	1		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Linear Shrinkage (%)	0.0		
Cracking Crumbling Curling	Cracking		

Moisture Content (AS 1289 2.1.1)	
Moisture Content (%)	2.3

Particle Size Distribution



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Project Number: 677612.00
Project Name: 60480548 - Beetaloo soil samples
Project Location: Beetaloo, NT
Work Request: 1466
Sample Number: 19-1466H
Date Sampled: 13/12/2018
Sampling Method: AS1289 1.2.1 6.4 - Sampling from layers in earthworks or pavement - uncompacted/compacted
Sample Location: **KYALLA03 (0.0 - 0.4m)**
Material: Silty SAND

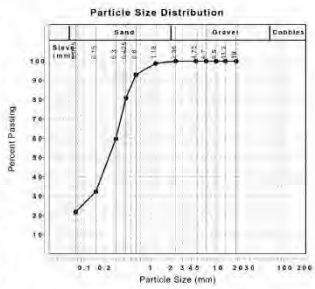
Particle Distribution (AS1289 3.6.1)		
Sieve	Passed %	Passing Limits
19 mm	100	
13.2 mm	100	
9.5 mm	100	
6.7 mm	100	
4.75 mm	100	
2.36 mm	100	
1.18 mm	99	
0.6 mm	93	
0.425 mm	81	
0.3 mm	60	
0.15 mm	32	
0.075 mm	22	

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Air Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	15		
Plastic Limit (%)	13		
Plasticity Index (%)	2		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Linear Shrinkage (%)	1.0		
Cracking Crumbling Curling	Cracking		

Moisture Content (AS 1289 2.1.1)	
Moisture Content (%)	3.1

Particle Size Distribution



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Contact: Jace Emberg
Project Number: 677612.00
Project Name: 60480548 - Beetaloo soil samples
Project Location: Beetaloo, NT
Work Request: 1466
Sample Number: 19-1466I
Date Sampled: 13/12/2018
Sampling Method: AS1289 1.2.1 6.4 - Sampling from layers in earthworks or pavement - uncompacted/compacted
Sample Location: **KYALLA04 (0.0 - 0.4m)**
Material: Silty SAND

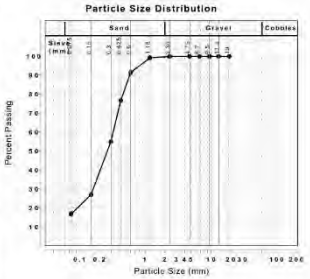
Particle Distribution (AS1289 3.6.1)		
Sieve	Passed %	Passing Limits
19 mm	100	
13.2 mm	100	
9.5 mm	100	
6.7 mm	100	
4.75 mm	100	
2.36 mm	100	
1.18 mm	99	
0.6 mm	91	
0.425 mm	77	
0.3 mm	55	
0.15 mm	27	
0.075 mm	17	

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried / Air Dried / Natural		
Preparation Method	Wet Sieve / Dry Sieve / Both Sieves		
Liquid Limit (%)	15		
Plastic Limit (%)	13		
Plasticity Index (%)	2		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Linear Shrinkage (%)	0.5		
Cracking Crumbling Curling	Cracking		

Moisture Content (AS 1289 2.1.1)	
Moisture Content (%)	2.0

Particle Size Distribution



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Erosion and Sediment Control Plan

NT-2050-15-MP-019.

Material Test Report

Report Number: 677612.00-1
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Client: AECOM Australia Pty Ltd
PO Box 73, Hunter Region NSW 2310
Contact: Jace Emberg
Project Number: 677612.00
Project Name: 60480548 - Beetaloo soil samples
Project Location: Beetaloo, NT
Work Request: 1466
Sample Number: 19-1466A
Date Sampled: 13/12/2018
Sampling Method: AS1289 1.2.1 6.4 - Sampling from layers in earthworks or pavement - uncompacted/compacted
Sample Location: **VELKERRI01 (0.0 - 0.4m)**
Material: Silty SAND, trace gravel

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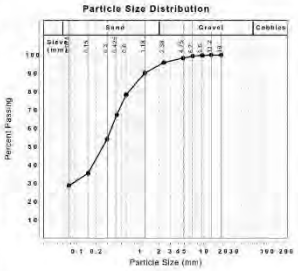
Particle Distribution (AS1289 3.6.1)		
Sieve	Passed %	Passing Limits
19 mm	100	
13.2 mm	100	
9.5 mm	100	
6.7 mm	99	
4.75 mm	98	
2.36 mm	96	
1.18 mm	90	
0.6 mm	78	
0.425 mm	67	
0.3 mm	54	
0.15 mm	35	
0.075 mm	29	

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Air Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	25		
Plastic Limit (%)	15		
Plasticity Index (%)	**10**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Linear Shrinkage (%)	4.5		
Cracking Crumbling Curling	Cracking		

Moisture Content (AS 1289 2.1.1)	
Moisture Content (%)	8.8

Particle Size Distribution



Material Test Report

Report Number: 677612.00-1
Issue Number: 2 - *This version supersedes all previous issues*
Date Issued: 29/01/2019
Client: AECOM Australia Pty Ltd
PO Box 73, Hunter Region NSW 2310
Contact: Jace Emberg
Project Number: 677612.00
Project Name: 60480548 - Beetaloo soil samples
Project Location: Beetaloo, NT
Work Request: 1466
Sample Number: 19-1466B
Date Sampled: 13/12/2018
Sampling Method: AS1289 1.2.1 6.4 - Sampling from layers in earthworks or pavement - uncompacted/compacted
Sample Location: **VELKERRI02 (0.0 - 0.4m)**
Material: Silty SAND

Douglas Partners
Douglas Partners Pty Ltd
Darwin Laboratory
Unit 2/14 Caryota Crt COCONUT GROVE NT 0810
Phone: (08) 8948 6800
Fax: (08) 8948 6899
Email: dave.millard@douglaspartners.com.au
Accredited for compliance with ISO/IEC 17025 - Testing

Approved Signatory: Dave Millard
Engineering Geologist
NATA Accredited Laboratory Number: 828

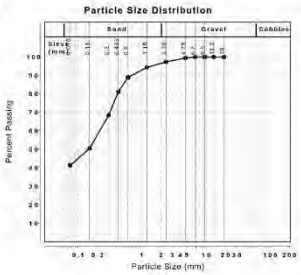
Particle Distribution (AS1289 3.6.1)		
Sieve	Passed %	Passing Limits
19 mm	100	
13.2 mm	100	
9.5 mm	100	
6.7 mm	100	
4.75 mm	99	
2.36 mm	97	
1.18 mm	94	
0.6 mm	89	
0.425 mm	81	
0.3 mm	68	
0.15 mm	50	
0.075 mm	41	

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Air Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	18		
Plastic Limit (%)	13		
Plasticity Index (%)	**5**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Linear Shrinkage (%)	3.5		
Cracking Crumbling Curling	Cracking		

Moisture Content (AS 1289 2.1.1)	
Moisture Content (%)	5.6

Particle Size Distribution



Material Test Report

Report Number: 677612.00-1
Issue Number: 2 - *This version supersedes all previous issues*
Date Issued: 29/01/2019
Client: AECOM Australia Pty Ltd
PO Box 73, Hunter Region NSW 2310
Contact: Jace Emberg
Project Number: 677612.00
Project Name: 60480548 - Beetaloo soil samples
Project Location: Beetaloo, NT
Work Request: 1466
Sample Number: 19-1466C
Date Sampled: 13/12/2018
Sampling Method: AS1289 1.2.1 6.4 - Sampling from layers in earthworks or pavement - uncompacted/compacted
Sample Location: **VELKERRI03 (0.0 - 0.4m)**
Material: Silty SAND

Douglas Partners
Douglas Partners Pty Ltd
Darwin Laboratory
Unit 2/14 Caryota Crt COCONUT GROVE NT 0810
Phone: (08) 8948 6800
Fax: (08) 8948 6899
Email: dave.millard@douglaspartners.com.au
Accredited for compliance with ISO/IEC 17025 - Testing

Approved Signatory: Dave Millard
Engineering Geologist
NATA Accredited Laboratory Number: 828

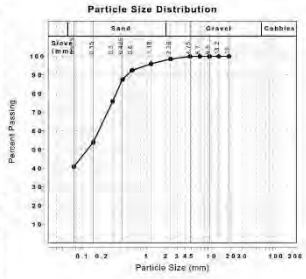
Particle Distribution (AS1289 3.6.1)		
Sieve	Passed %	Passing Limits
19 mm	100	
13.2 mm	100	
9.5 mm	100	
6.7 mm	100	
4.75 mm	100	
2.36 mm	99	
1.18 mm	96	
0.6 mm	92	
0.425 mm	88	
0.3 mm	76	
0.15 mm	54	
0.075 mm	41	

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Air Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	19		
Plastic Limit (%)	12		
Plasticity Index (%)	**7**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Linear Shrinkage (%)	3.5		
Cracking Crumbling Curling	Cracking		

Moisture Content (AS 1289 2.1.1)	
Moisture Content (%)	4.9

Particle Size Distribution



Material Test Report

Report Number: 677612.00-1
Issue Number: 2 - *This version supersedes all previous issues*
Date Issued: 29/01/2019
Client: AECOM Australia Pty Ltd
PO Box 73, Hunter Region NSW 2310
Contact: Jace Emberg
Project Number: 677612.00
Project Name: 60480548 - Beetaloo soil samples
Project Location: Beetaloo, NT
Work Request: 1466
Sample Number: 19-1466D
Date Sampled: 13/12/2018
Sampling Method: AS1289 1.2.1 6.4 - Sampling from layers in earthworks or pavement - uncompacted/compacted
Sample Location: **VELKERRI04 (0.0 - 0.4m)**
Material: Silty SAND

Douglas Partners
Douglas Partners Pty Ltd
Darwin Laboratory
Unit 2/14 Caryota Crt COCONUT GROVE NT 0810
Phone: (08) 8948 6800
Fax: (08) 8948 6899
Email: dave.millard@douglaspartners.com.au
Accredited for compliance with ISO/IEC 17025 - Testing

Approved Signatory: Dave Millard
Engineering Geologist
NATA Accredited Laboratory Number: 828

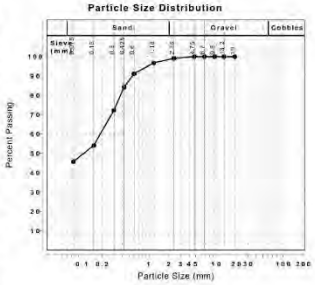
Particle Distribution (AS1289 3.6.1)		
Sieve	Passed %	Passing Limits
19 mm	100	
13.2 mm	100	
9.5 mm	100	
6.7 mm	100	
4.75 mm	100	
2.36 mm	99	
1.18 mm	97	
0.6 mm	91	
0.425 mm	84	
0.3 mm	72	
0.15 mm	54	
0.075 mm	46	

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Air Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	24		
Plastic Limit (%)	13		
Plasticity Index (%)	**11**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Linear Shrinkage (%)	4.5		
Cracking Crumbling Curling	Cracking		

Moisture Content (AS 1289 2.1.1)	
Moisture Content (%)	5.2

Particle Size Distribution



Review due: 05/11/2023

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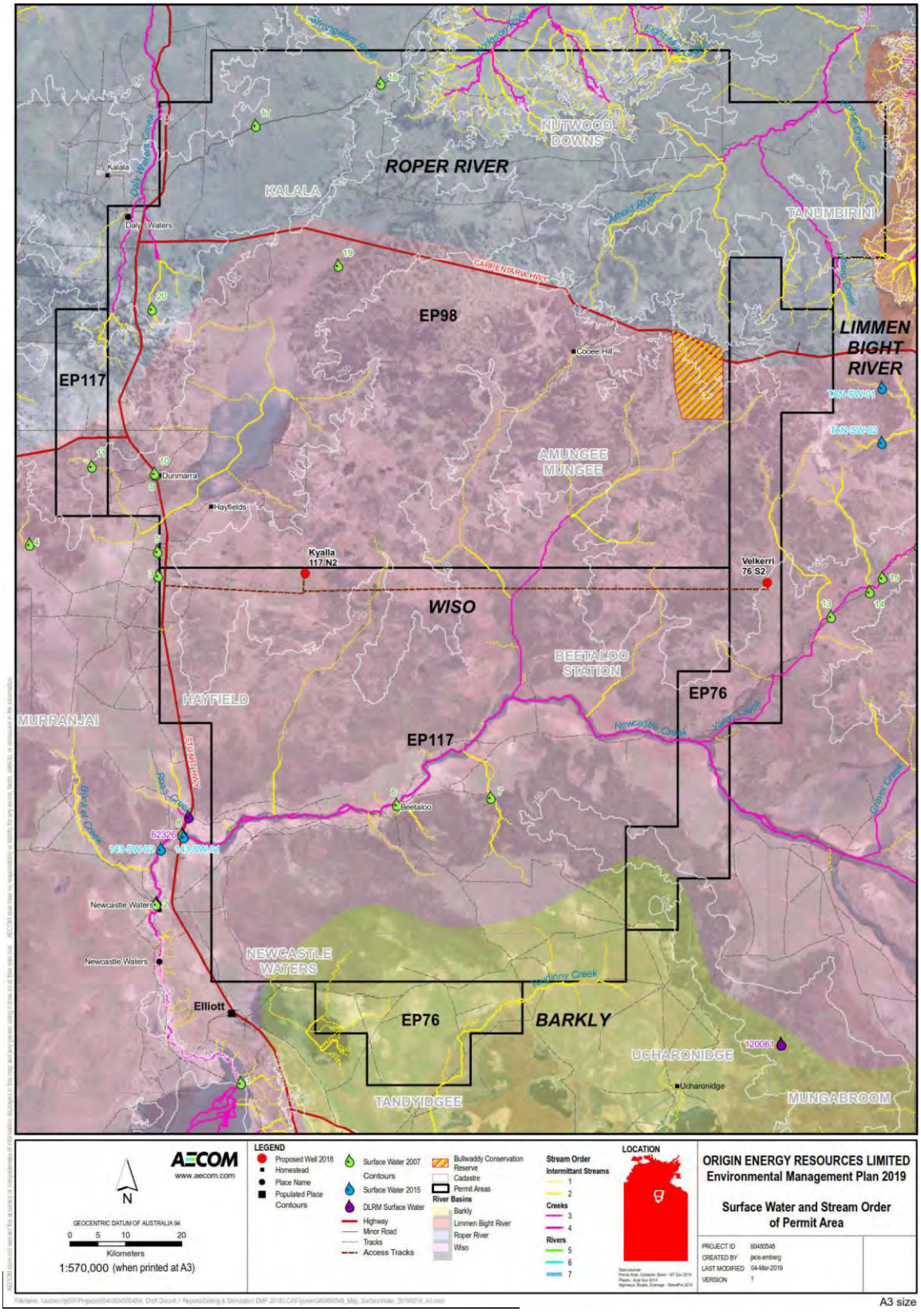
Appendix D Permit Area Surface Water



A3 size

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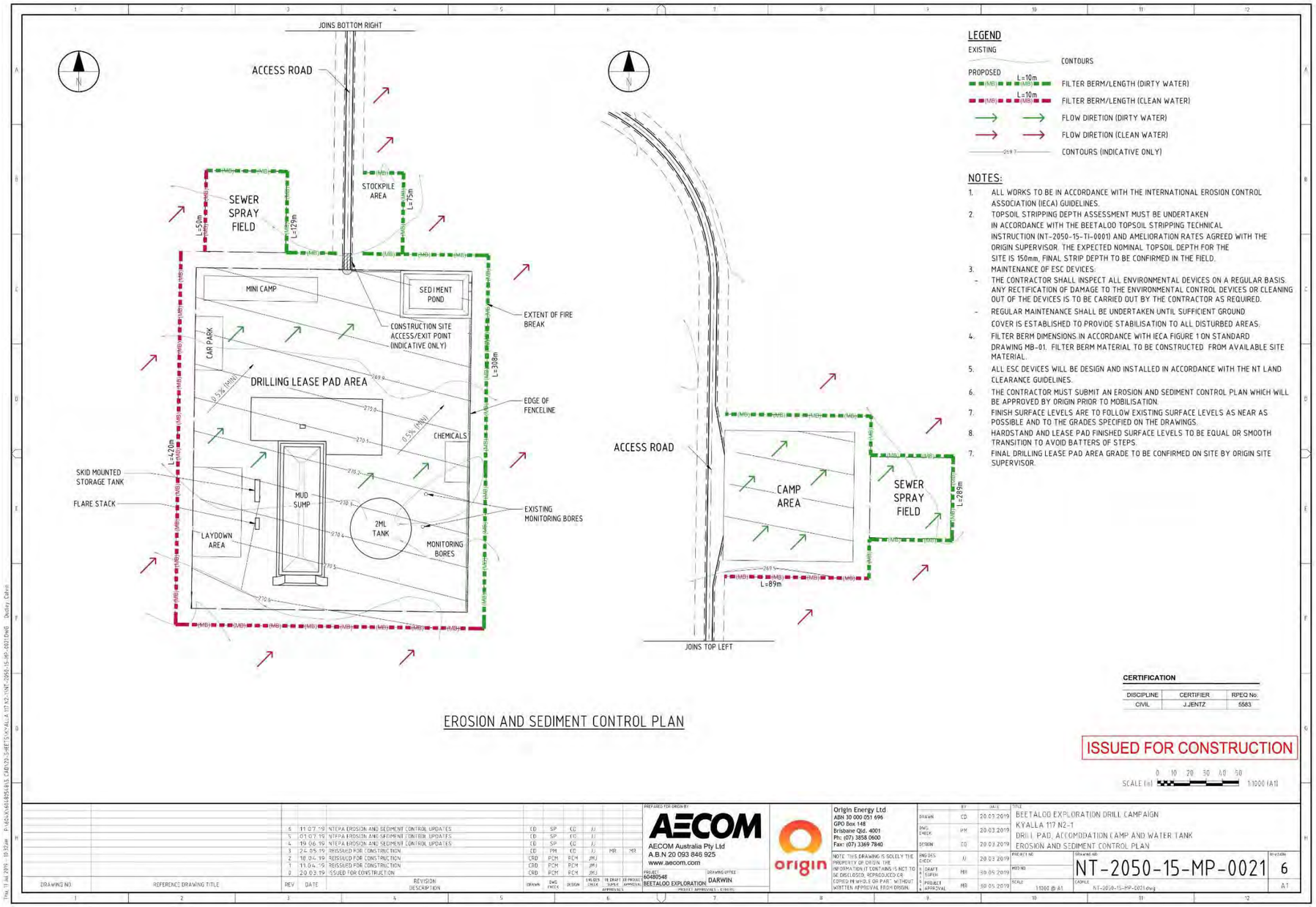
Appendix E Erosion and Sediment Control Plan for Kyalla 117 N2-1



Review due: 05/11/2023

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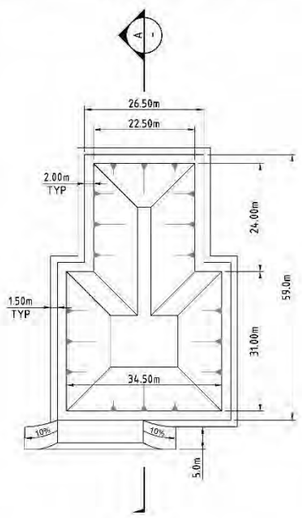
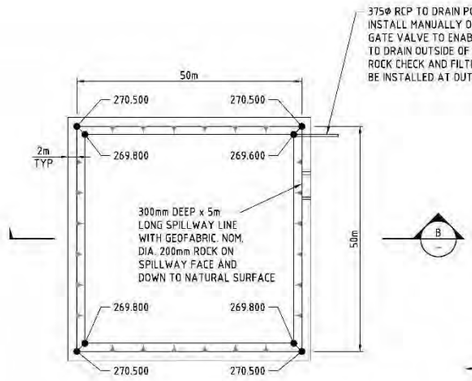


PLAN - MUD SUMP

Scale N.T.S.



PLAN - SECONDARY CONTAINMENT

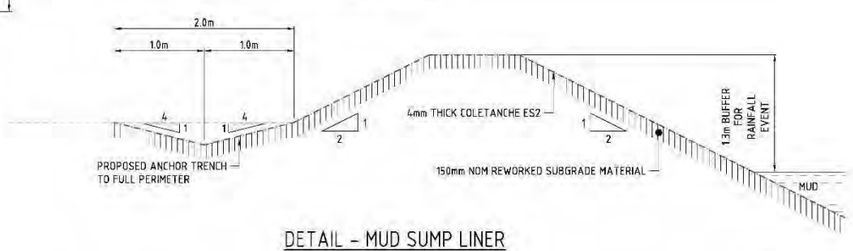
Scale N.T.S.

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-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. 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

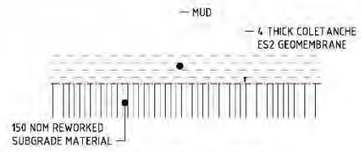
NOTES:

1. GEOSYNTHETICS ARE DRAWN EXAGGERATED FOR CLARITY.



DETAIL - MUD SUMP LINER

Scale N.T.S.

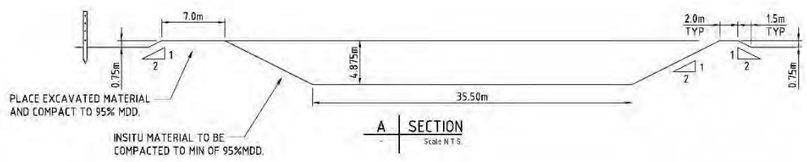


DETAIL - BASE LINER

Scale N.T.S.

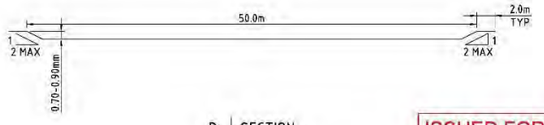
CERTIFICATION

DISCIPLINE	CERTIFIER	RPEQ No.
CIVIL	J.JENTZ	5583



A SECTION

Scale N.T.S.



B SECTION

Scale N.T.S.

ISSUED FOR CONSTRUCTION

REV	DATE	REVISION DESCRIPTION	DRAWN	2ND CHECK	DESIGN	3RD DISC CHECK	OR DRAFT BY PROJECT SUPT APPROVAL	OPNOM
1	18.04.19	RE-ISSUED FOR CONSTRUCTION	CRC	PCM	PCM	JKJ		
0	11.04.19	ISSUED FOR CONSTRUCTION	CRC	PCM	PCM	JKJ		

DRAWING NO.: NT-2050-20-DA-0022 | REFERENCE DRAWING TITLE: GENERAL ARRANGEMENT PLAN

PREPARED FOR ORIGIN BY: AECOM Australia Pty Ltd, A.B.N 20 093 846 925, www.aecom.com

PROJECT: 60485048 BEETALOO EXPLORATION | DRAWING OFFICE: DARWIN | PROJECT APPROVALS - OTHERS

Origin Energy Ltd
ABN 30 000 051 696
GPO Box 148
Brisbane Qld. 4001
Ph: (07) 3858 0600
Fax: (07) 3369 7840

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	BY	DATE
DRAWN	CRC	20.03.2019
DWG CHECK	PCM	20.03.2019
DESIGN	PCM	20.03.2019
ENGRS CHECK	JKJ	20.03.2019
C DRAFT & SUPR		
B PROJECT APPROVAL		

TITLE: BEETALOO EXPLORATION DRILL CAMPAIGN
KYALLA 117 N2-1
MUD SUMP DETAILS

PROJECT NO.: 60485048 | DRAWING NO.: NT-2050-20-DD-0030 | REVISION: 1
SCALE: 1:100 @ A1 | FILENAME: NT-2050-20-DD-0030.dwg | A1

Wed 01 May 2019 - 1:18pm - P:\60485048\GIS\CAD\DRAWINGS\NT-2050-20-DD-0030.DWG - Dudley, Catrin

Review due: 05/11/2023

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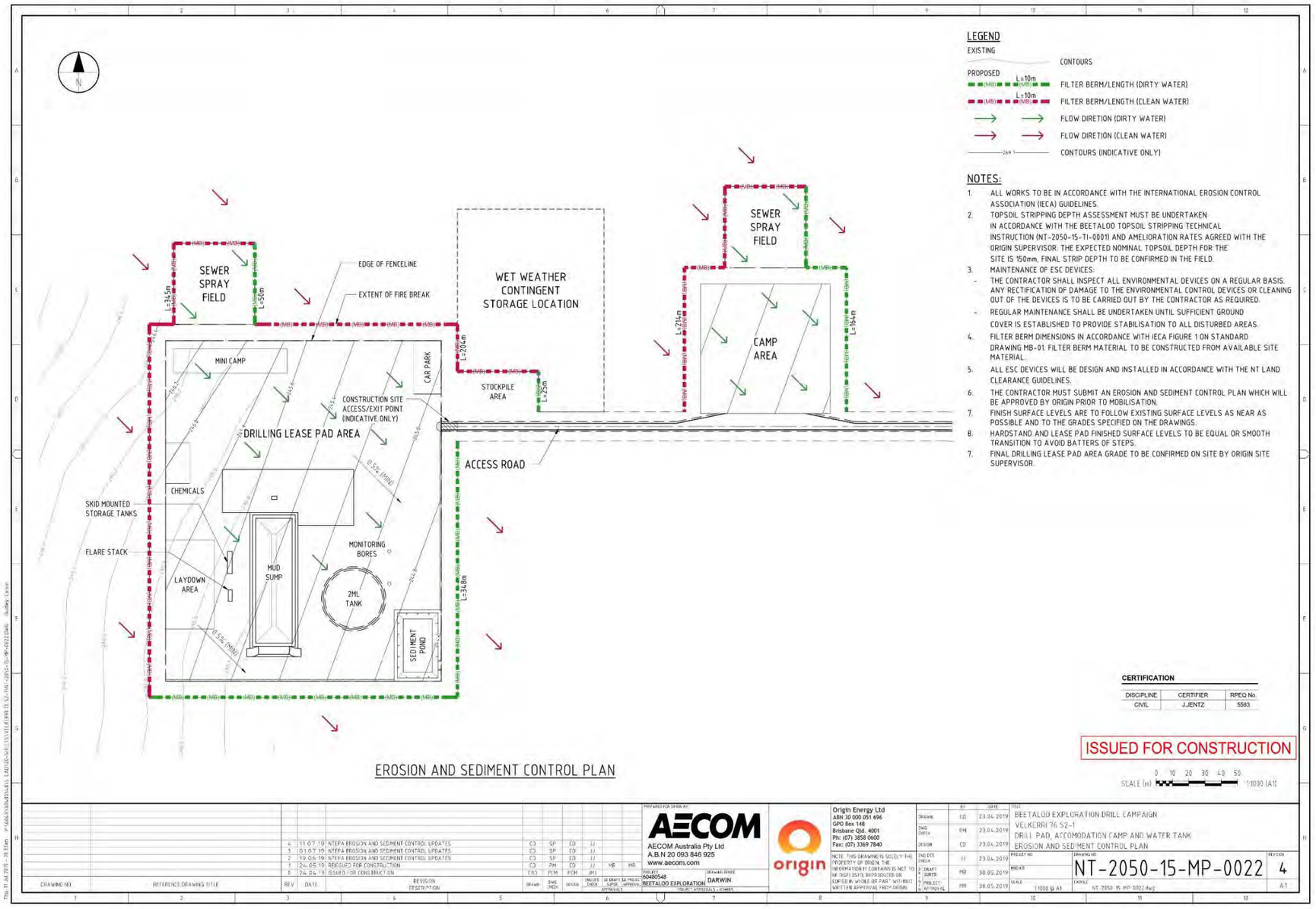
Appendix F Erosion and Sediment Control Plan for Velkerri 76 S2-1



Review due: 05/11/2023

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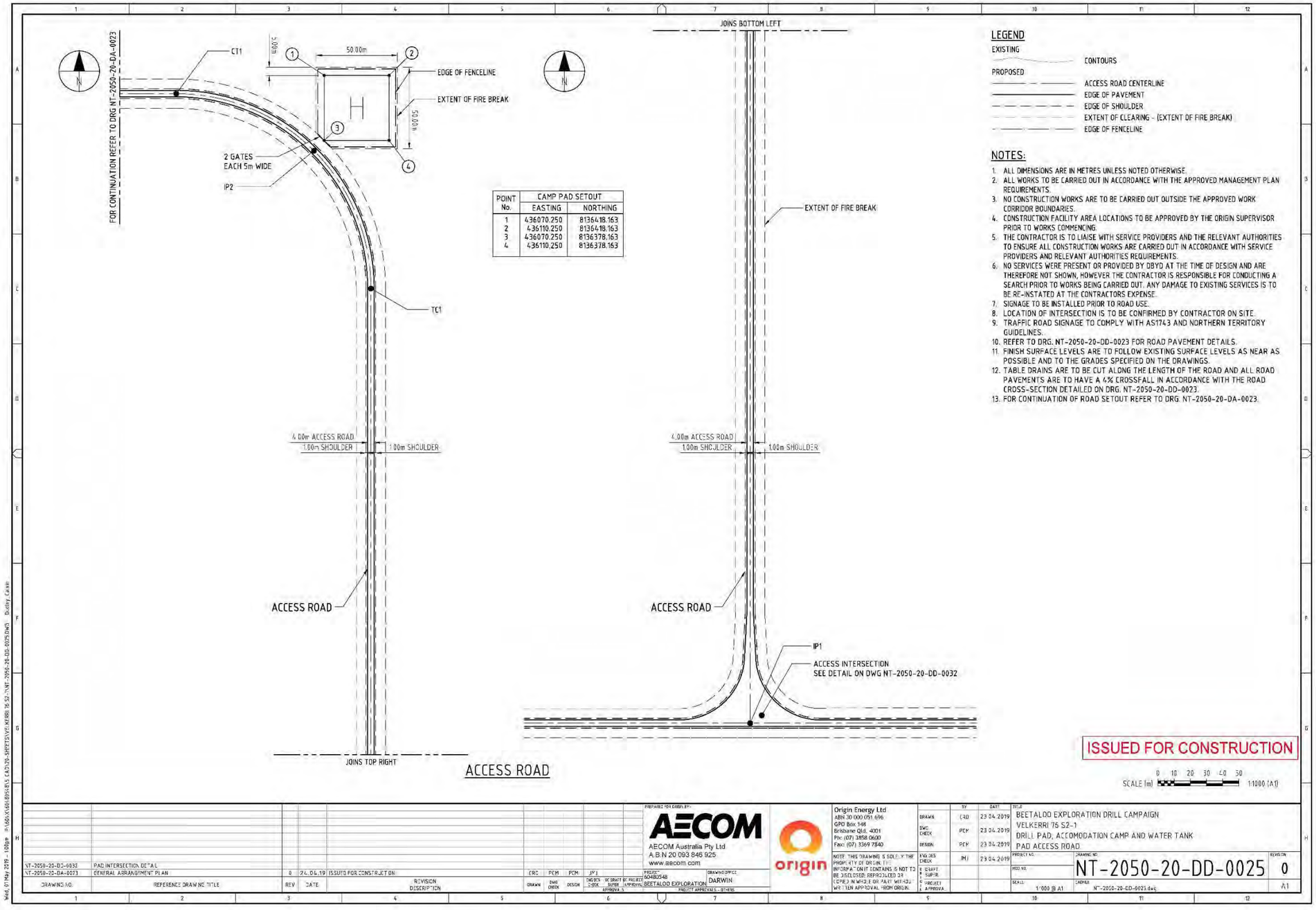
Erosion and Sediment Control Plan

NT-2050-15-MP-019.



POINT No.	CAMP PAD SETOUT	
	EASTING	NORTHING
1	436070.250	8136418.163
2	436110.250	8136418.163
3	436070.250	8136378.163
4	436110.250	8136378.163

LEGEND

EXISTING

- CONTOURS

PROPOSED

- ACCESS ROAD CENTERLINE
- EDGE OF PAVEMENT
- EDGE OF SHOULDER
- EXTENT OF CLEARING – (EXTENT OF FIRE BREAK)
- EDGE OF FENCELINE

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 ORIGIN SUPERVISOR 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.
8. LOCATION OF INTERSECTION IS TO BE CONFIRMED BY CONTRACTOR ON SITE.
9. TRAFFIC ROAD SIGNAGE TO COMPLY WITH AS1743 AND NORTHERN TERRITORY GUIDELINES.
10. REFER TO DRG. NT-2050-20-DD-0023 FOR ROAD PAVEMENT DETAILS.
11. FINISH SURFACE LEVELS ARE TO FOLLOW EXISTING SURFACE LEVELS AS NEAR AS POSSIBLE AND TO THE GRADES SPECIFIED ON THE DRAWINGS.
12. 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 DRG. NT-2050-20-DD-0023.
13. FOR CONTINUATION OF ROAD SETOUT REFER TO DRG. NT-2050-20-DA-0023.

DRAWING NO.	REFERENCE DRAWING TITLE
NT-2050-20-DD-0032	PAD INTERSECTION DETAIL
NT-2050-20-DA-0023	GENERAL ARRANGEMENT PLAN

REV	DATE	REVISION DESCRIPTION	DRAWN	DWG CHECK	DESIGN	TAG OUTS - S.BOX	DRAFT SUPER APPROVAL	RO PROJECT APPROVAL
0	24.04.19	ISSUED FOR CONSTRUCTION	CRC	PCM	PCM	JMJ		

PREPARED FOR ORIGIN BY:

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

PROJECT: 60480548 BEETALOO EXPLORATION
DRAWING OFFICE: DARWIN

Origin Energy Ltd
ABN 30 000 051 696
GPO Box 148
Brisbane Qld 4001
Ph: (07) 3858 0600
Fax: (07) 3369 7840

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		BY	DATE
DRAWN		CAD	23.04.2019
DWG CHECK		PEM	23.04.2019
DESIGN		PEM	23.04.2019
ENG DES CHECK		JMJ	23.04.2019
1. DRAFT SUPER.			
2. PROJECT APPROVAL			

TITLE:
BEETALOO EXPLORATION DRILL CAMPAIGN
VELKERRI 75 S2-1
DRILL PAD, ACCOMODATION CAMP AND WATER TANK
PAD ACCESS ROAD

PROJECT NO.:
WBS NO.:
DRAWING NO.: NT-2050-20-DD-0025
REVISION: 0
SCALE: 1:1000 @ A1
FILENAME: NT-2050-20-DD-0025.dwg
A1

Wed, 01 May 2019 - 1:08pm I:\60\XX\60480548\15 CAD\02-SHEETS\VELKERRI 76 S2-1\NT-2050-20-DD-0025.DWG Dudley Cavan

Review due: 05/11/2023

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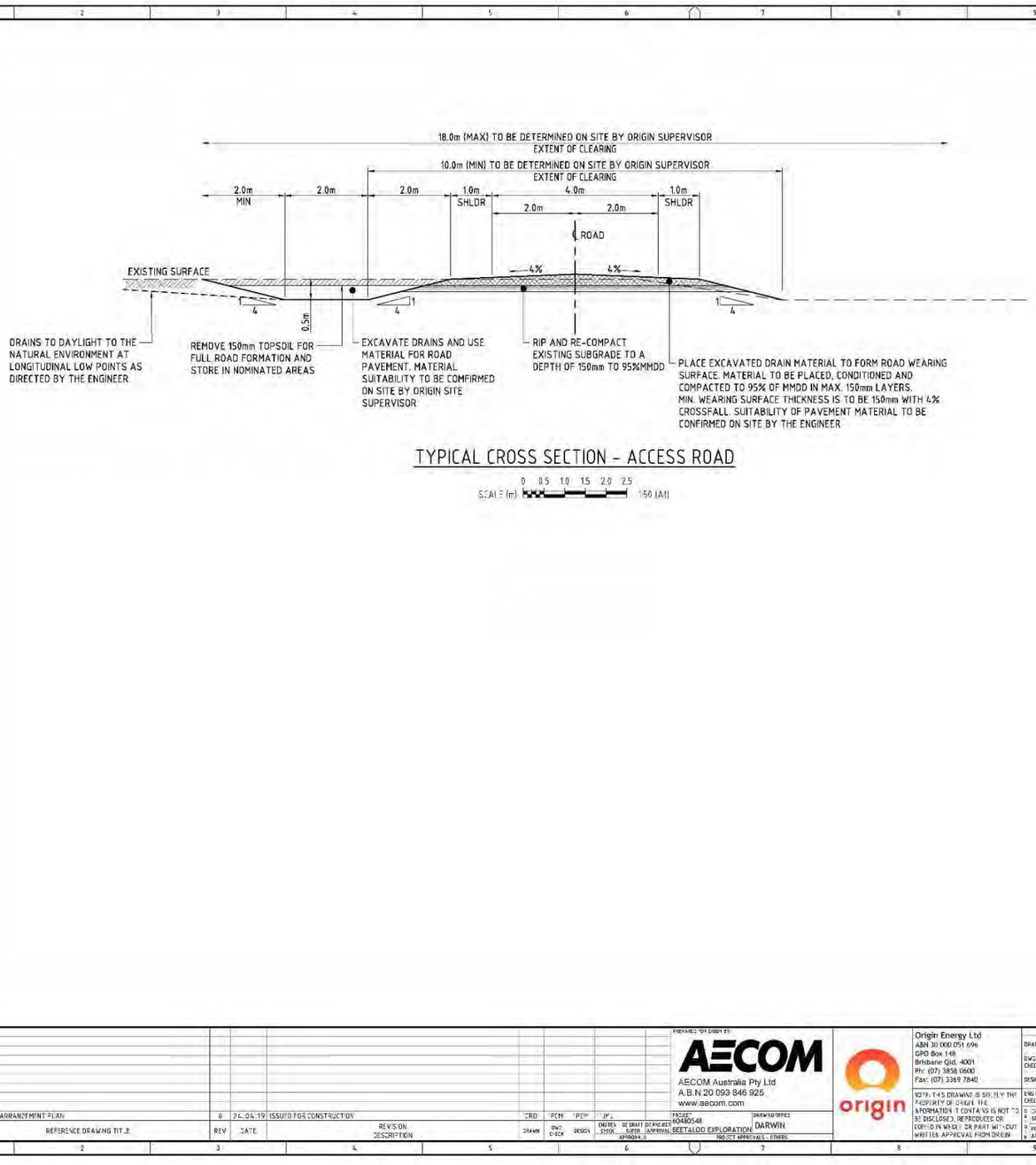

TYPICAL CROSS SECTION - ACCESS ROAD

SCALE (m) 0 0.5 1.0 1.5 2.0 2.5 1:50 (A1)

NOTES:

1. ENSURE THAT TABLE DRAINS ARE FREE DRAINING.
2. GROUND CONDITIONS AND SUITABLE MATERIALS TO BE CONFIRMED ON SITE BY SUPERINTENDENT.
3. CLEARED VEGETATION TO BE STORED ALONGSIDE NEW ROAD FOR FUTURE REHABILITATION.
4. REFER TO SPECIFICATION FOR COMPACTION REQUIREMENTS.
5. STRIPPED TOPSOIL TO BE STORED IN BERMS ALONGSIDE ROAD.
6. REFER TO SPECIFICATION FOR GENERAL REQUIREMENTS.
7. THE CONTRACTOR IS TO NOTIFY THE ORIGIN SUPERVISOR IF AREAS OF SOFT GROUND ARE ENCOUNTERED OR IF THE SPECIFICATION CANNOT BE ACHIEVED.
8. CLEAR, STRIP 150mm TOPSOIL AND STOCKPILE IN NOMINATED BUFFER ZONE TO ESTABLISH BORROW PITS.
9. THIS DRAWING MAY BE USED FOR TEMPORARY ACCESS APPLICATION TO NT ROADS.
10. 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	ENGRS CHECK	DRAFT SUPER	REVISED APPROVALS
NT-2050-20-DA-0023	GENERAL ARRANGEMENT PLAN	0	24.04.19	ISSUED FOR CONSTRUCTION	CRD	PCM	PCM	JMJ		

PREPARED FOR ORIGIN BY:
AECOM
AECOM Australia Pty Ltd
A.B.N 20 093 846 925
www.aecom.com

PROJECT 60430548 — DRAWING OFFICE DARWIN — BEETALOO EXPLORATION — PROJECT APPROVALS - OTHERS

Origin Energy Ltd
ABN 30 000 051 696
GPO Box 148
Brisbane Qld. 4001
Ph: (07) 3858 0800
Fax: (07) 3369 7840

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	BY	DATE
DRAWN	CRD	23.04.2019
DWG CHECK	PCM	23.04.2019
DESIGN	PCM	23.04.2019
ENG DES CHECK	JMJ	23.04.2019
S DRAFT & SUPTN		
S PROJECT & APPROVAL		

TITLE
BEETALOO EXPLORATION DRILL CAMPAIGN
VELKERRI 76 S2-1
DESIGN DETAILS

PROJECT NO.
PROJECT NO.
SCALE 1:1000 @ A1
DRAWING NO. NT-2050-20-DD-0023
REVISION 0
A1
CADFILE NT-2050-20-DD-0023.dwg

Wed, 01 May 2019 - 1:06pm R:\661\KIA\661815\CAD\20_SHEETS\VELKERRI 76 S2-1\NT-2050-20-DD-0023.DWG Dudley, Gavin

Review due: 05/11/2023

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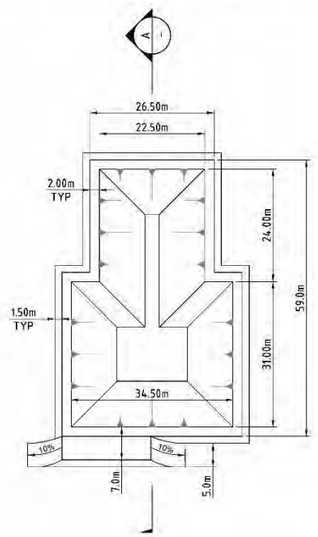
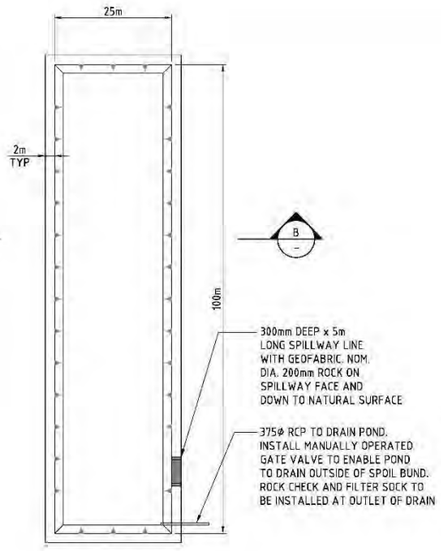


PLAN - MUD SUMP

Scale N.T.S.



PLAN - SECONDARY CONTAINMENT

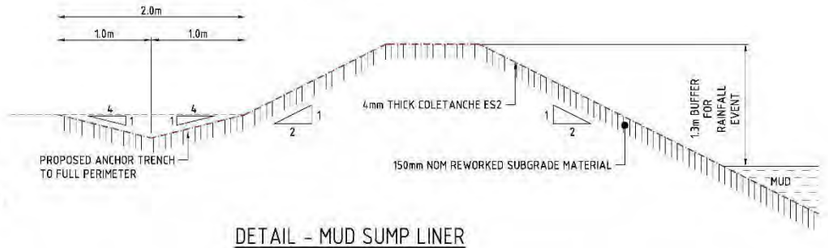
Scale N.T.S.

NOTES:

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

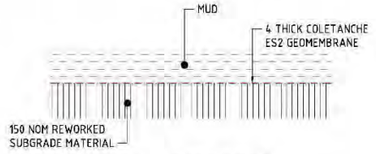
NOTES:

1. GEOSYNTHETICS ARE DRAWN EXAGGERATED FOR CLARITY.



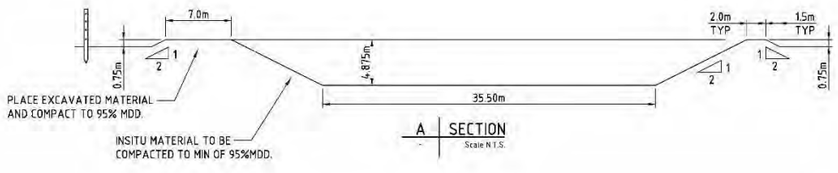
DETAIL - MUD SUMP LINER

Scale N.T.S.



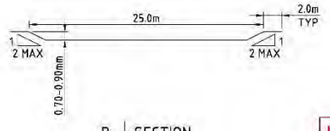
DETAIL - BASE LINER

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	ERD DRAWN	PCM DWG CHECK	PCM DESIGN	JMJ ENGRG CHECK	OC DRAFT OR PROJECT SUPER. APPROVAL
NT-2050-20-DA-0023	GENERAL ARRANGEMENT PLAN	0	26.04.19	ISSUED FOR CONSTRUCTION					

PREPARED FOR ORIGIN BY:
AECOM
AECOM Australia Pty Ltd
A.B.N 20 093 846 925
www.aecom.com
PROJECT 60480548
DRAWING OFFICE DARWIN
BEETALOO EXPLORATION
PROJECT APPROVALS - QA/QC

origin

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ABN 30 000 051 696
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	BY	DATE
DRAWN	LRD	23.04.2019
DWG CHECK	PCM	23.04.2019
DESIGN	PCM	23.04.2019
ENG DES CHECK	JMJ	23.04.2019
S. ENGR'G. SUPER.		
O. PROJECT S. APPROVAL		

TITLE
BEETALOO EXPLORATION DRILL CAMPAIGN
VELKERRI 76 S2-1
MUD SUMP DETAILS

PROJECT NO.
PROJ NO.
SCALE 1:000 @ A1
DRAWING NO. NT-2050-20-DD-0031
CADFILE NT-2050-20-DD-0031.dwg
REVISION 0
A1

Wed, 01 May 2019 - 1:57pm P:\605\WORK\60480548\15 EA\20-SHEETS\VELKERRI 76 S2-1\NT-2050-20-DD-0031.DWG Dudley, Calvin

Review due: 05/11/2023

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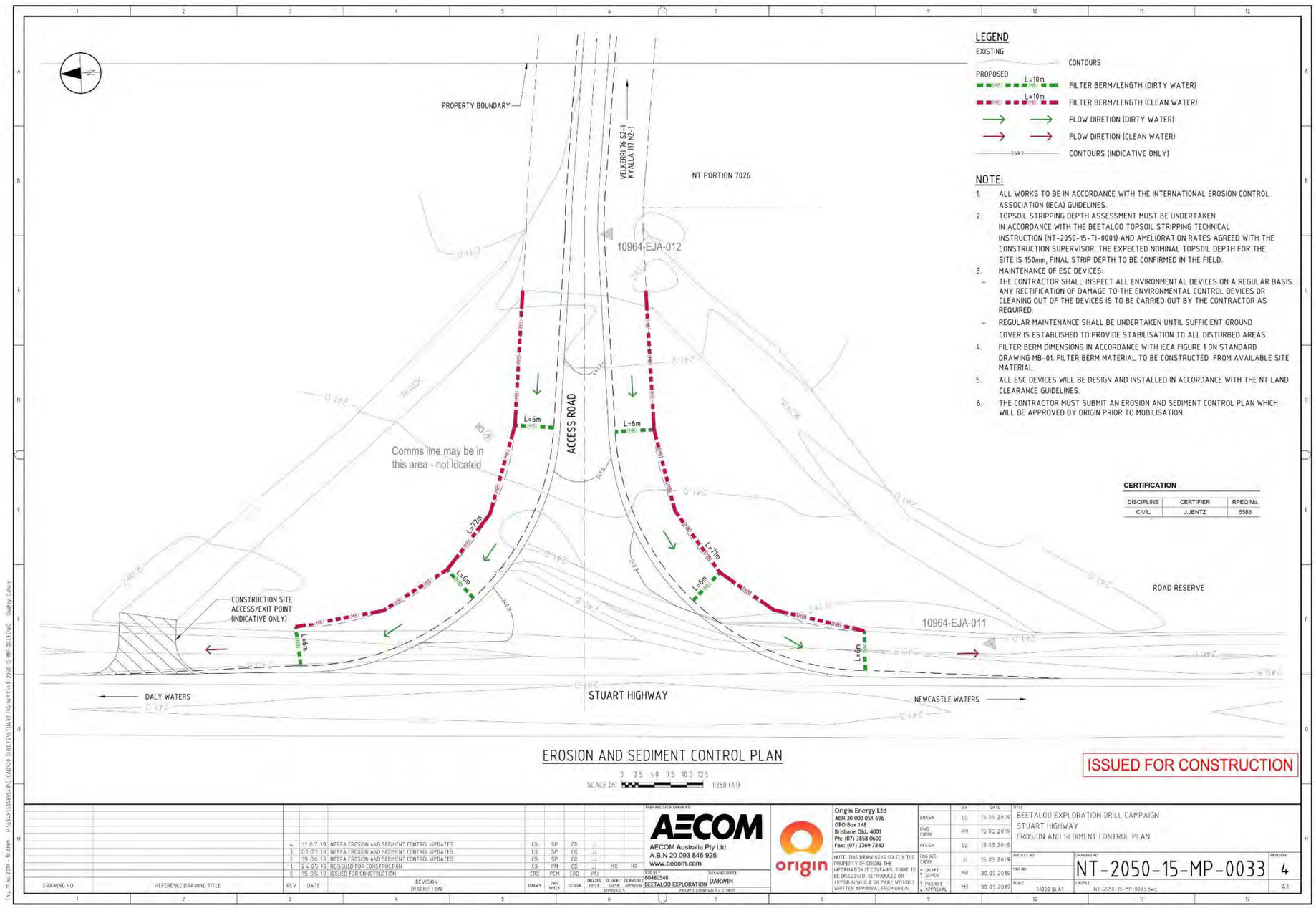
Appendix G Erosion and Sediment Control Plan for Stuart Highway Intersection Upgrade



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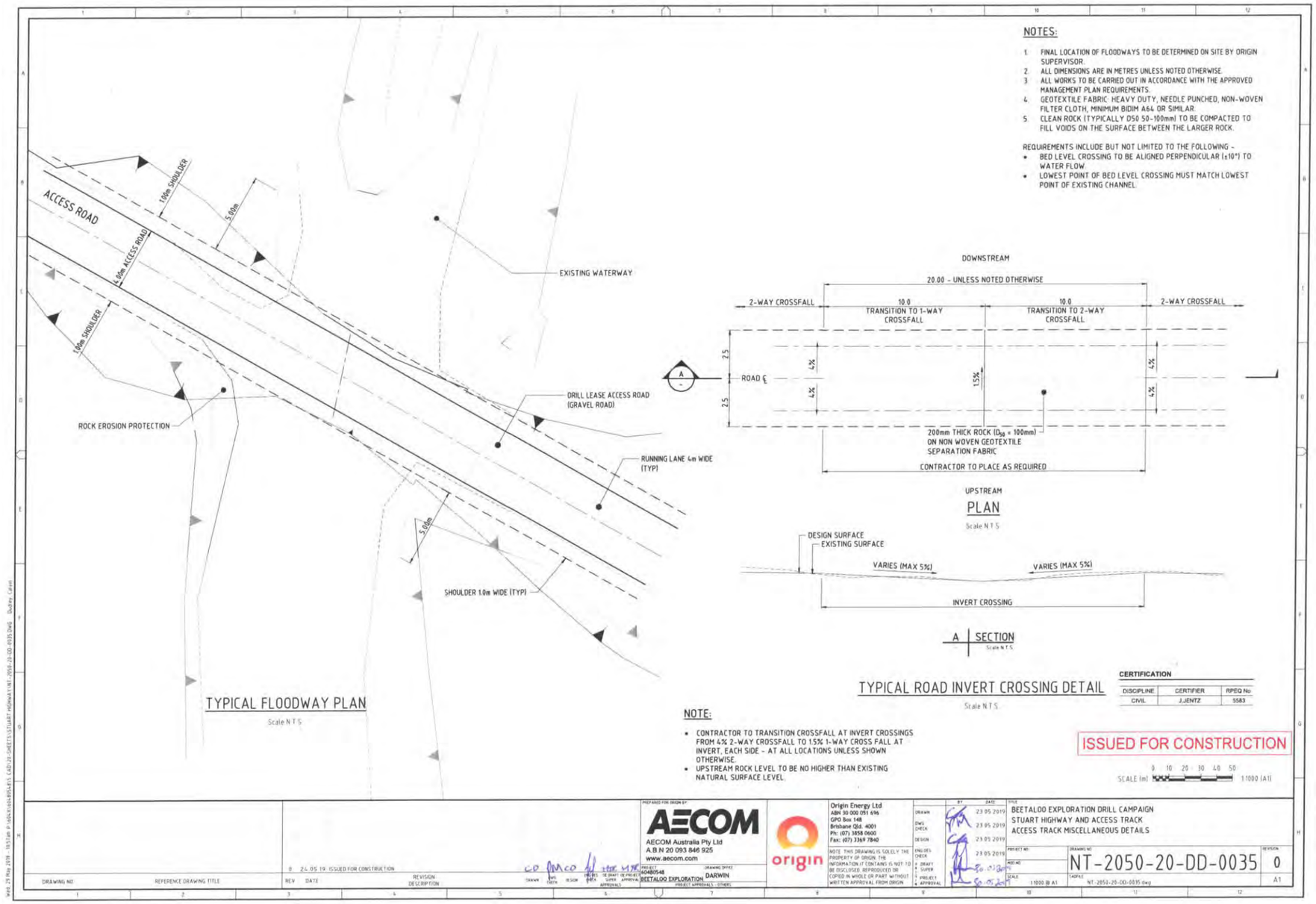
Appendix H Erosion and Sediment Control Plan for Typical Road Invert Crossing



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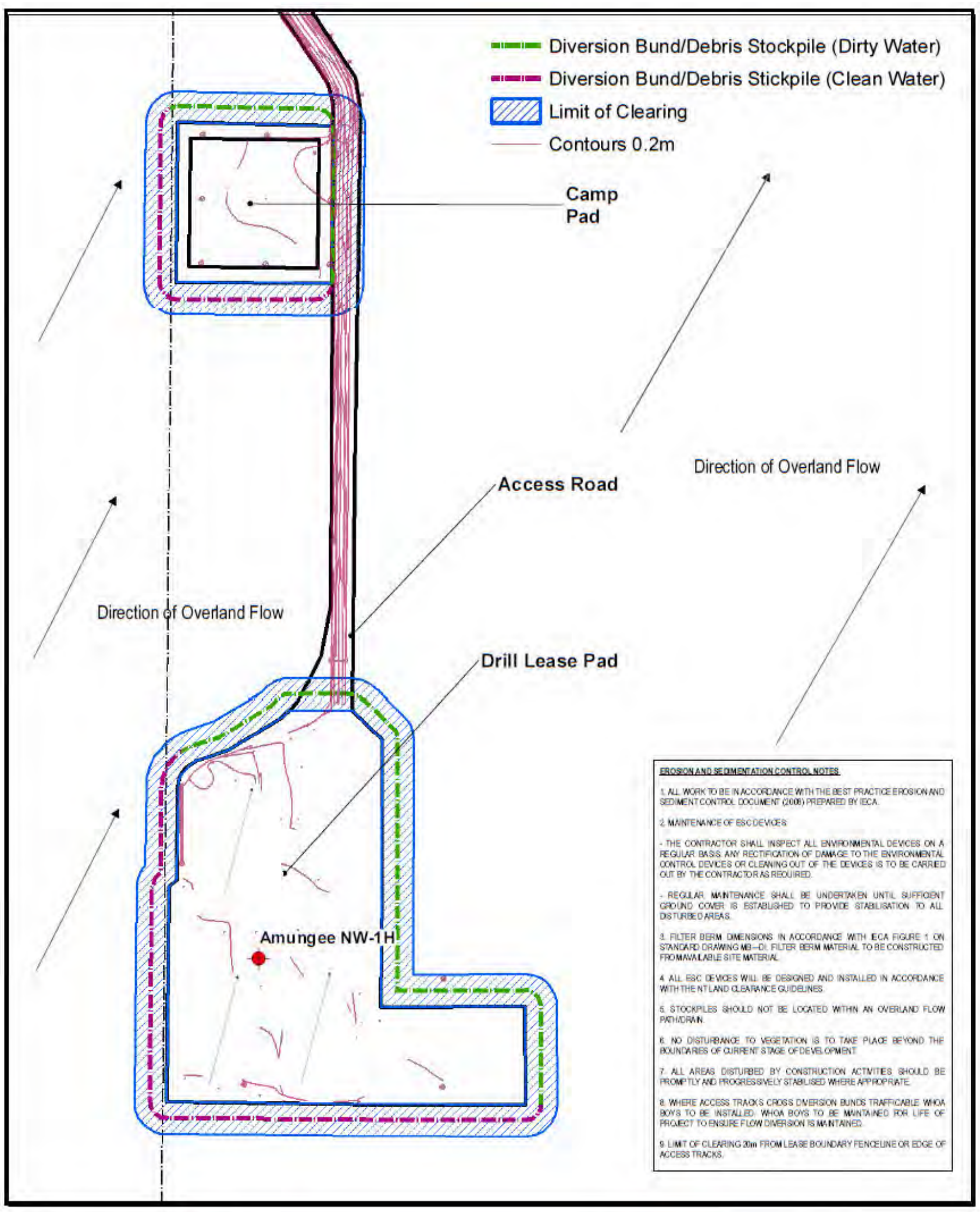
Appendix I Erosion and sediment control plan for the existing Amungee NW site



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Appendix J Erosion and sediment control plan for the existing Beetaloo W-1 site

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EROSION AND SEDIMENTATION CONTROL NOTES

1. ALL WORK TO BE IN ACCORDANCE WITH THE BEST PRACTICE EROSION AND SEDIMENT CONTROL DOCUMENT (2008) PREPARED BY IECA.

2. MAINTENANCE OF ESC DEVICES:

- THE CONTRACTOR SHALL INSPECT ALL ENVIRONMENTAL DEVICES ON A REGULAR BASIS. ANY RECTIFICATION OF DAMAGE TO THE ENVIRONMENTAL CONTROL DEVICES OR CLEANING OUT OF THE DEVICES IS TO BE CARRIED OUT BY THE CONTRACTOR AS REQUIRED.

- REGULAR MAINTENANCE SHALL BE UNDERTAKEN UNTIL SUFFICIENT GROUND COVER IS ESTABLISHED TO PROVIDE STABILISATION TO ALL DISTURBED AREAS.

3. FILTER BERM DIMENSIONS IN ACCORDANCE WITH IECA FIGURE 1 ON STANDARD DRAWING MB—DI. FILTER BERM MATERIAL TO BE CONSTRUCTED FROM AVAILABLE SITE MATERIAL.

4. ALL ESC DEVICES WILL BE DESIGNED AND INSTALLED IN ACCORDANCE WITH THE NT LAND CLEARANCE GUIDELINES.

5. STOCKPILES SHOULD NOT BE LOCATED WITHIN AN OVERLAND FLOW PATH/DRAIN.

6. NO DISTURBANCE TO VEGETATION IS TO TAKE PLACE BEYOND THE BOUNDARIES OF CURRENT STAGE OF DEVELOPMENT.

7. ALL AREAS DISTURBED BY CONSTRUCTION ACTIVITIES SHOULD BE PROMPTLY AND PROGRESSIVELY STABILISED WHERE APPROPRIATE.

8. WHERE ACCESS TRACKS CROSS DIVERSION BUNDS TRAFFICABLE WHOA BOYS TO BE INSTALLED. WHOA BOYS TO BE MAINTAINED FOR LIFE OF PROJECT TO ENSURE FLOW DIVERSION IS MAINTAINED.

9. LIMIT OF CLEARING 20m FROM LEASE BOUNDARY FENCELINE OR EDGE OF ACCESS TRACKS.

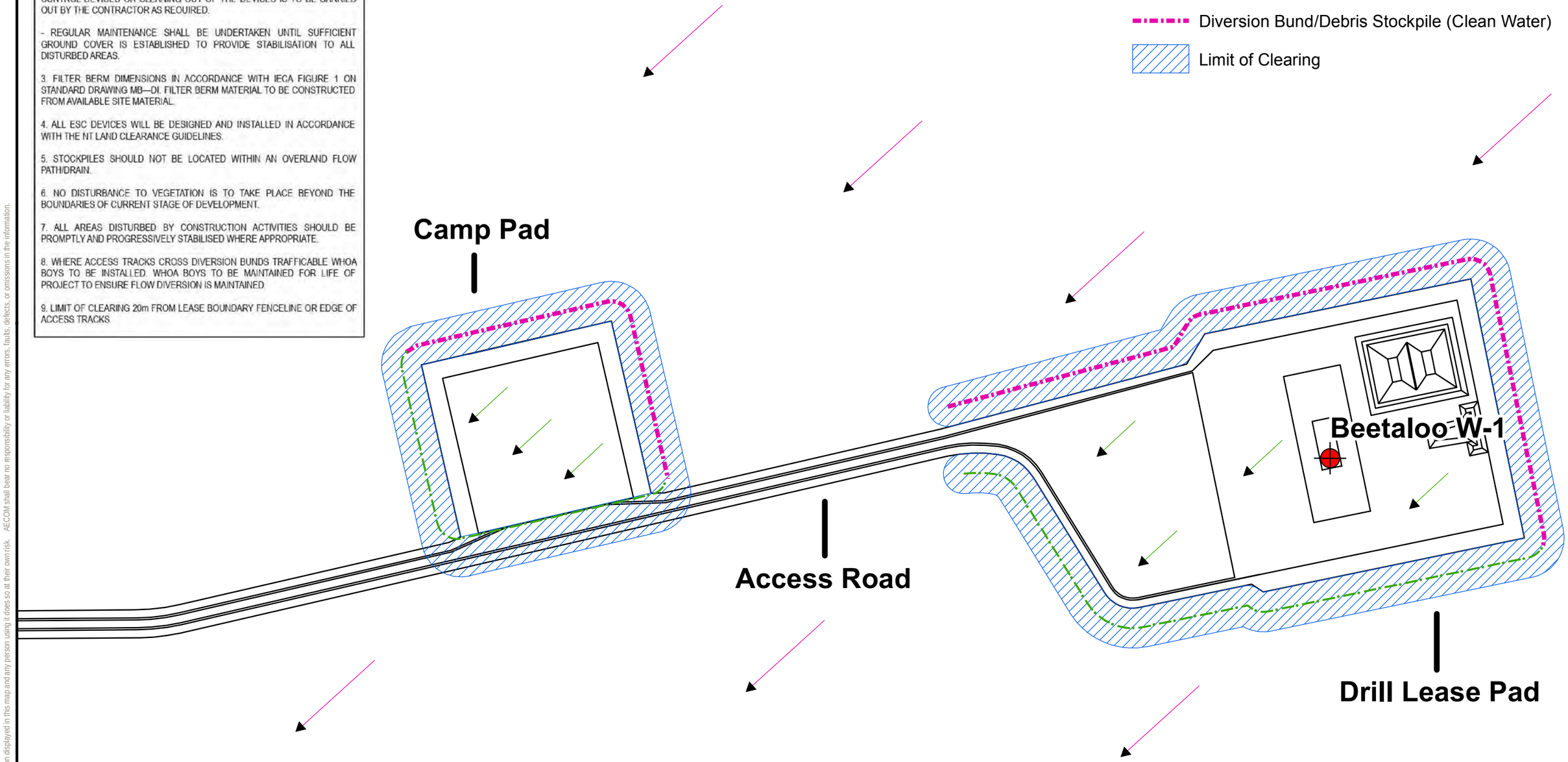
Flow Direction (Dirty Water)

Flow Direction (Clean Water)

Diversion Bund/Debris Stockpile (Dirty Water)

Diversion Bund/Debris Stockpile (Clean Water)

Limit of Clearing



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N

GEOCENTRIC DATUM OF AUSTRALIA 94

0 25 50 100
Metres

1:2,000 (when printed at A3)

Well

Lease Pad Layout

LOCATION

Data sources:
Permit Area, Cadastre - NT Gov 2021.
Places - Aust Gov 2021
Highways, Roads, Drainage - StreetPro 2021

ORIGIN ENERGY RESOURCES LIMITED
2021 Environmental Management Plan

Beetaloo W-1
Erosion and Sediment Control Plan

PROJECT ID	60623736
CREATED BY	david.vandenhoek
LAST MODIFIED	27-May-2021
VERSION	1

Figure
1

Filename: P:\606x\60623736\900_CAD_GIS\920_GIS\02_MXDs\Beetaloo W-1 Kalala S-1\Beetaloo W-1 ESCP.mxd

A3 size

Appendix K Other IECA Standard Specifications (as required)

MATERIALS

(i) MULCH MUST COMPLY WITH THE REQUIREMENTS OF AS4454.

(ii) MAXIMUM SOLUBLE SALT CONCENTRATION OF 5dS/m.

(iii) MOISTURE CONTENT OF 30 TO 50% PRIOR TO APPLICATION.

INSTALLATION

1. REFER TO APPROVED PLANS FOR LOCATION AND EXTENT. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION, EXTENT, MATERIAL TYPE, OR METHOD OF INSTALLATION CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.

2. WHEN SELECTING THE LOCATION OF A MULCH FILTER BERM, TO THE MAXIMUM DEGREE PRACTICAL, ENSURE THE BERM IS LOCATED:

(i) TOTALLY WITHIN THE PROPERTY BOUNDARIES;

(ii) ALONG A LINE OF CONSTANT ELEVATION (PREFERRED, BUT NOT ALWAYS PRACTICAL);

(iii) AT LEAST 1m, IDEALLY 3m, FROM THE TOE OF A FILL EMBANKMENT;

(iv) AWAY FROM AREAS OF CONCENTRATED FLOW.

3. ENSURE THE BERM IS INSTALLED IN A MANNER THAT AVOIDS THE CONCENTRATION OF FLOW ALONG THE BERM, OR THE UNDESIRABLE DISCHARGE OF WATER AROUND THE END OF THE BERM.

4. ENSURE THE BERM HAS BEEN PLACED SUCH THAT PONDING UP-SLOPE OF THE BERM IS MAXIMISED.

5. ENSURE BOTH ENDS OF THE BERM ARE ADEQUATELY TURNED UP THE SLOPE TO PREVENT FLOW BYPASSING PRIOR TO WATER PASSING OVER THE BERM.

6. ENSURE 100% CONTACT WITH THE SOIL SURFACE.

7. WHERE SPECIFIED, TAKE APPROPRIATE STEPS TO VEGETATE THE BERM.

MAINTENANCE

1. DURING THE CONSTRUCTION PERIOD, INSPECT ALL BERMS AT LEAST WEEKLY AND AFTER ANY SIGNIFICANT RAIN. MAKE NECESSARY REPAIRS IMMEDIATELY.

2. REPAIR OR REPLACE ANY DAMAGED SECTIONS.

3. WHEN MAKING REPAIRS, ALWAYS RESTORE THE SYSTEM TO ITS ORIGINAL CONFIGURATION UNLESS AN AMENDED LAYOUT IS REQUIRED OR SPECIFIED.

4. REMOVE ACCUMULATED SEDIMENT IF THE SEDIMENT DEPOSIT EXCEEDS A DEPTH OF 100mm OR 1/3 THE HEIGHT OF THE BERM.

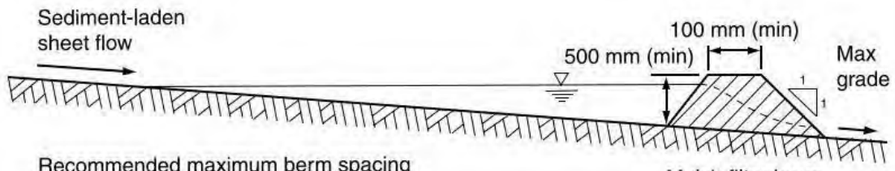
5. DISPOSE OF SEDIMENT IN A SUITABLE MANNER THAT WILL NOT CAUSE AN EROSION OR POLLUTION HAZARD.

REMOVAL (IF REQUIRED)

1. WHEN DISTURBED AREAS UP-SLOPE OF THE BERM ARE SUFFICIENTLY STABILISED TO RESTRAIN EROSION, THE BERM MAYBE REMOVED.

2. REMOVE ANY COLLECTED SEDIMENT AND DISPOSE OF IN A SUITABLE MANNER THAT WILL NOT CAUSE AN EROSION OR POLLUTION HAZARD.

3. REHABILITATE/REVEGETATE THE DISTURBED GROUND AS NECESSARY TO MINIMISE THE EROSION HAZARD.



Recommended maximum berm spacing

Land slope	Max spacing
< 2%	30 m
5%	25 m
10%	15 m
20%	8 m

Figure 1 - Typical placement of mulch filter berm

Drawn:	Date:		
GMW	Apr-10	Mulch Filter Berms	MB-01

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MATERIAL

ROCK MULCH: 25–75mm DURABLE, WEATHER RESISTANT AND EVENLY GRADED WITH 50% BY WEIGHT LARGER THAN THE SPECIFIED NOMINAL ROCK SIZE (IF SPECIFIED).

INSTALLATION

1. REFER TO APPROVED PLANS FOR LOCATION, EXTENT, AND APPLICATION DETAILS. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION, EXTENT, OR METHOD OF APPLICATION CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.

2. SPREAD ENOUGH ROCK TO COMPLETELY COVER THE SURFACE OF THE SOIL AT THE DENSITY OR THICKNESS SPECIFIED IN THE APPROVED PLANS. IF THE APPLICATION DENSITY IS NOT SUPPLIED, THEN APPLY AT A THICKNESS OF AT LEAST 50mm OR TWICE THE NOMINAL ROCK SIZE (WHICHEVER IS GREATER).

3. IF THE EXPOSED SOILS ARE DISPERSIVE, THEN ENSURE THESE SOILS ARE COVERED WITH A LAYER OF NON-DISPERSIVE SOIL (MINIMUM 200mm) BEFORE PLACEMENT OF ROCK.

4. MAKE ALL NECESSARY ADJUSTMENTS TO ENSURE ANY SURFACE FLOW IS ALLOWED TO PASS FREELY ACROSS THE TREATED AREA FOLLOWING ITS NATURAL DRAINAGE PATH.

MAINTENANCE

1. INSPECT ALL TREATED SURFACES FORTNIGHTLY AND AFTER RUNOFF-PRODUCING RAINFALL.

2. CHECK FOR RILL EROSION, OR DISLODGMENT OF THE ROCKS.

3. REPLACE ANY DISPLACED ROCKS TO MAINTAIN THE REQUIRED COVERAGE.

4. IF WASH-OUTS OCCUR, REPAIR THE SLOPE AND REINSTALL ROCK COVER.

5. IF THE ROCK MULCHING IS NOT EFFECTIVE IN CONTAINING THE SOIL EROSION IT SHOULD BE REPLACED, OR AN ALTERNATIVE EROSION CONTROL PROCEDURE ADOPTED.

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Drawn:	Date:		
GMW	Dec-09	Rock Mulching	MR-01

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PREPARATION

1. REFER TO APPROVED PLANS FOR LOCATION, EXTENT, AND DIMENSIONAL DETAILS. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION, OR EXTENT, CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.

2. TAKE ALL NECESSARY STEPS TO ENSURE DISTURBANCE TO THE BUFFER ZONE IS MINIMISED THROUGHOUT THE TIME IT IS USED AS A SEDIMENT TRAP.

3. TO THE MAXIMUM DEGREE PRACTICABLE, ENSURE FLOW PASSING THROUGH THE BUFFER ZONE IS NOT ALLOWED TO CONCENTRATE WITHIN DRAINAGE DEPRESSIONS, SWALES, RILLS OR WHEEL TRACKS.

4. WHERE NECESSARY, INSTALL APPROPRIATE DRAINAGE CONTROLS UP-SLOPE OF THE BUFFER ZONE TO DISTRIBUTE THE INFLOW ALONG THE FULLY LENGTH OF THE BUFFER ZONE AS 'SHEET FLOW'.

5. WHERE NECESSARY, INSTALL A COARSE SEDIMENT TRAP, SUCH AS A SEDIMENT FENCE, UP-SLOPE OF THE BUFFER ZONE TO REDUCE THE QUANTITY OF SEDIMENT PASSING ONTO THE GRASS. GENERALLY THIS IS REQUIRED IF LARGE QUANTITIES OF COARSE SEDIMENT ARE EXPECTED.

6. IF REQUIRED, INSTALL A LIGHT BARRIER FENCE TO CLEARLY IDENTIFY THE BUFFER ZONE AND HELP EXCLUDE CONSTRUCTION TRAFFIC.

MAINTENANCE

1. INSPECT THE BUFFER ZONE ON A REGULAR BASIS AND AFTER RUNOFF-PRODUCING RAINFALL.

2. ENSURE THAT THERE IS NO SOIL EROSION AND THAT SEDIMENT DEPOSITION IS NOT CAUSING THE CONCENTRATION OF FLOW THROUGH THE BUFFER ZONE, OR FLOW BYPASSING.

3. IF THE BUFFER ZONE HAS BEEN DISTURBED, TAKE NECESSARY STEPS TO RE-ESTABLISH SUITABLE SHEET FLOW CONDITIONS.

4. REMOVE EXCESSIVE ACCUMULATIONS OF SEDIMENT THAT MAY CAUSE THE CONCENTRATION OF FLOW. EXCESSIVE SEDIMENT SHOULD BE REMOVED AFTER EACH RUNOFF-PRODUCING RAINFALL EVENT, OR WHERE APPROPRIATE, EVENLY RAKED INTO THE SOIL. SEDIMENT SHOULD BE REMOVED IN A MANNER THAT AVOIDS DAMAGE TO THE BUFFER ZONE OR THE CREATION OF WHEEL TRACKS DOWN THE SLOPE.

5. EXCESSIVE SEDIMENT MAY BE DEFINED AS:

(i) ANY SEDIMENT THAT COVERS A PORTION OF THE GRASSED SURFACE; OR

(ii) SEDIMENT DEPOSITION SUCH THAT THE GRASS STRAND HEIGHT ABOVE THE SEDIMENT IS LESS THAN 50mm; OR

(iii) A DEPOSITION OF SEDIMENT IN EXCESS OF 750g/m^2 (APPROXIMATELY THE EQUIVALENT OF THREE 70mm DIAMETER BALLS OF DRY SOIL).

6. THE SOURCE OF ANY EXCESSIVE SEDIMENT SHOULD BE INVESTIGATED AND CONTROLLED WHERE PRACTICAL.

7. TAKE APPROPRIATE STEPS TO MAINTAIN AT LEAST 75% GRASS COVER OVER THE BUFFER ZONE.

8. WHERE PRACTICAL, MAINTAIN ANY GROUNDCOVER VEGETATION AT A HEIGHT GREATER THAN THE EXPECTED DEPTH OF WATER FLOW AND AT LEAST 50mm.

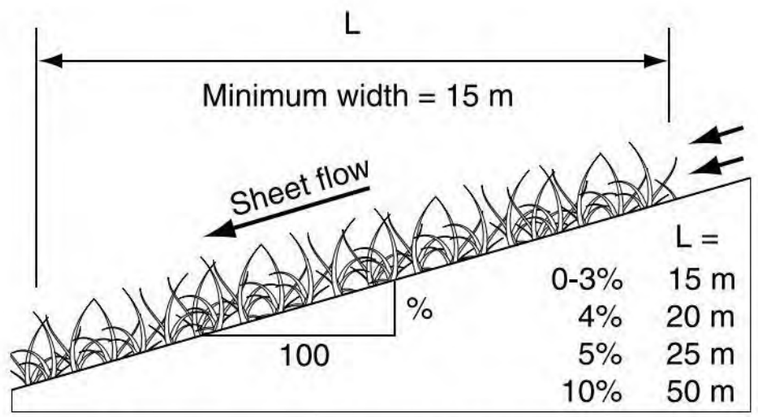

Figure 1 - Minimum dimensional requirements of a grassed buffer zone

Drawn:	Date:		
GMW	Apr-10	Buffer Zones (grassed)	BZ-01

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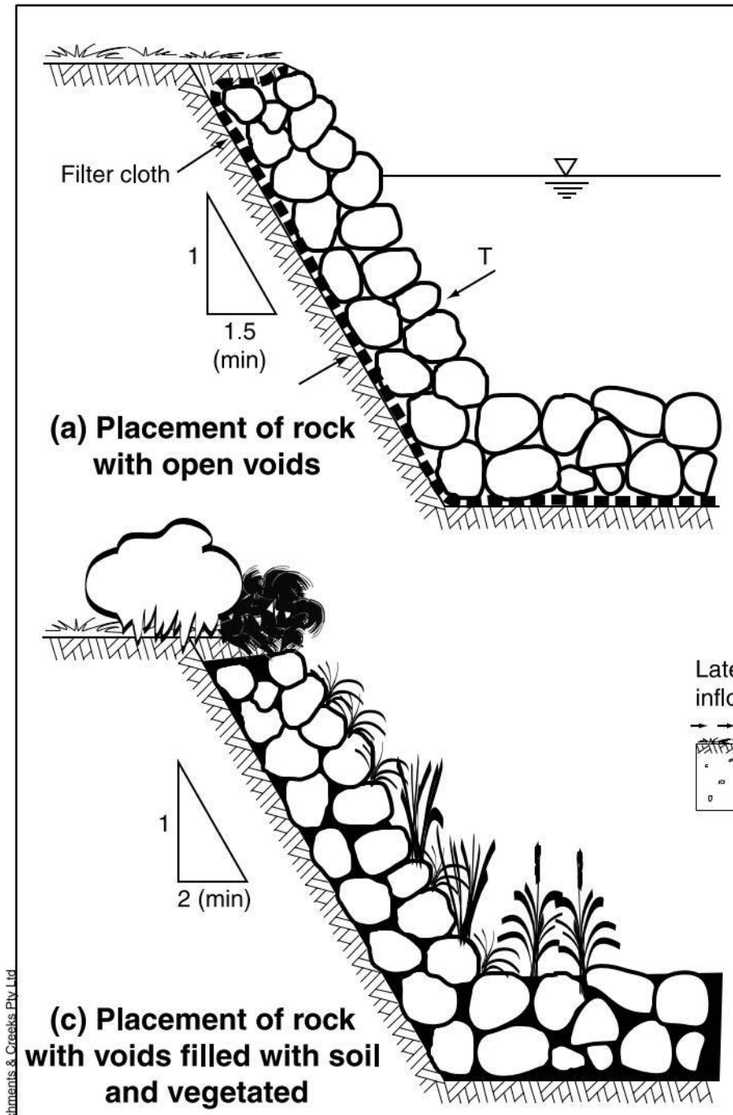
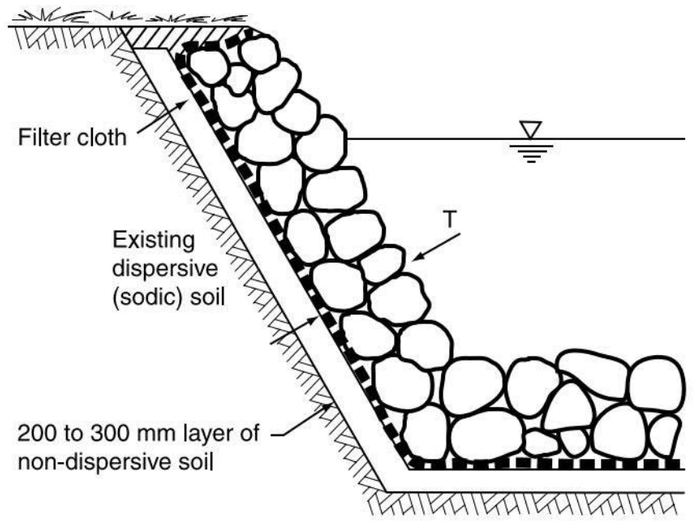
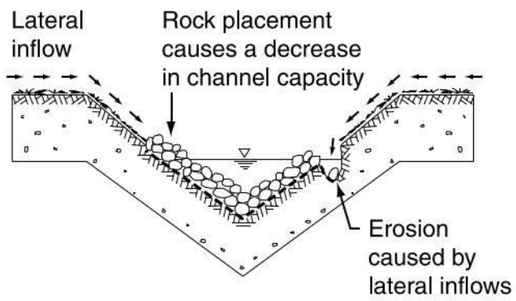


(a) Placement of rock with open voids

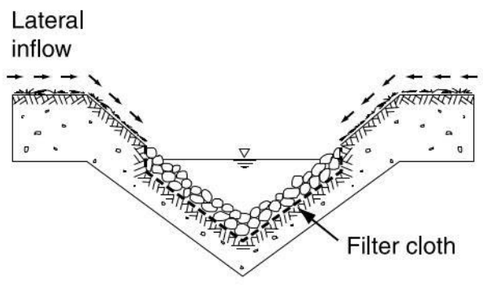
(c) Placement of rock with voids filled with soil and vegetated



(b) Placement of rock within a channel cut into dispersive soils



(d) Poor placement of rock along channel invert



(e) Good placement of rock along channel invert

Drawn:	Date:		
GMW	Dec-09	Rock Linings	RR-01

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MATERIALS

ROCK: HARD, ANGULAR, DURABLE, WEATHER RESISTANT AND EVENLY GRADED WITH 50% BY WEIGHT LARGER THAN THE SPECIFIED NOMINAL ROCK SIZE AND SUFFICIENT SMALL ROCK TO FILL THE VOIDS BETWEEN THE LARGER ROCK. THE DIAMETER OF THE LARGEST ROCK SIZE SHOULD BE NO LARGER THAN 1.5 TIMES THE NOMINAL ROCK SIZE. SPECIFIC GRAVITY TO BE AT LEAST 2.5.

GEOTEXTILE FABRIC: HEAVY-DUTY, NEEDLE-PUNCHED, NON-WOVEN FILTER CLOTH, MINIMUM BIDIM A24 OR EQUIVALENT.

INSTALLATION

1. REFER TO APPROVED PLANS FOR LOCATION, EXTENT AND INSTALLATION DETAILS. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION, EXTENT, OR METHOD OF INSTALLATION CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.

2. CLEAR THE PROPOSED CHANNEL AREA OF TREES, STUMPS, ROOTS, LOOSE ROCK, AND OTHER OBJECTIONABLE MATERIALS.

3. EXCAVATE THE CHANNEL TO THE LINES AND GRADES AS SHOWN ON THE PLANS. OVER-CUT THE CHANNEL TO A DEPTH EQUAL TO THE SPECIFIED DEPTH OF ROCK PLACEMENT SUCH THAT THE FINISHED ROCK SURFACE WILL BE AT THE ELEVATION OF THE SURROUNDING LAND.

4. ROCK MUST BE PLACED WITHIN THE CHANNEL AS SPECIFIED WITHIN THE APPROVED PLANS, INCLUDING THE PLACEMENT OF ANY SPECIFIED FILTER LAYER.

5. IF DETAILS ARE NOT PROVIDED ON THE ROCK PLACEMENT, THEN THE PRIMARY ARMOUR ROCK MUST BE EITHER PLACED ON:

(i) A FILTER BED FORMED FROM A LAYER OF SPECIFIED SMALLER ROCK (ROCK FILTER LAYER);

(ii) AN EARTH BED LINED WITH FILTER CLOTH;

(iii) AN EARTH BED NOT LINED IN FILTER CLOTH, BUT ONLY IF ALL VOIDS BETWEEN THE ARMOUR ROCK ARE TO BE FILLED WITH SOIL AND POCKET PLANTED IMMEDIATELY AFTER PLACEMENT OF THE ROCK.

6. IF A ROCK/AGGREGATE FILTER LAYER IS SPECIFIED, THEN PLACE THE FILTER LAYER IMMEDIATELY AFTER THE FOUNDATIONS ARE PREPARED. SPREAD THE FILTER ROCK IN A UNIFORM LAYER TO THE SPECIFIED DEPTH BUT A MINIMUM OF 150mm. WHERE MORE THAN ONE LAYER OF FILTER MATERIAL HAS BEEN SPECIFIED, SPREAD EACH LAYER SUCH THAT MINIMAL MIXING OCCURS BETWEEN EACH LAYER OF ROCK.

7. IF A GEOTEXTILE (FILTER CLOTH) UNDERLAY IS SPECIFIED, PLACE THE FABRIC DIRECTLY ON THE PREPARED FOUNDATION. IF MORE THAN ONE SHEET OF FABRIC IS REQUIRED TO OVER THE AREA, OVERLAP THE EDGE OF EACH SHEET AT LEAST 300mm AND PLACE ANCHOR PINS AT MINIMUM 1m SPACING ALONG THE OVERLAP.

8. ENSURE THE GEOTEXTILE FABRIC IS PROTECTED FROM PUNCHING OR TEARING DURING INSTALLATION OF THE FABRIC AND THE ROCK. REPAIR ANY DAMAGE BY REMOVING THE ROCK AND PLACING WITH ANOTHER PIECE OF FILTER CLOTH OVER THE DAMAGED AREA OVERLAPPING THE EXISTING FABRIC A MINIMUM OF 300mm.

9. WHERE NECESSARY, A MINIMUM 100mm LAYER OF FINE GRAVEL, AGGREGATE OR SAND SHOULD BE PLACED OVER THE FABRIC TO PROTECT IT FROM DAMAGE.

10. PLACEMENT OF ROCK SHOULD FOLLOW IMMEDIATELY AFTER PLACEMENT OF THE FILTER LAYER. PLACE ROCK SO THAT IT FORMS A DENSE, WELL-GRADED MASS OF ROCK WITH A MINIMUM OF VOIDS.

11. PLACE ROCK TO ITS FULL THICKNESS IN ONE OPERATION. DO NOT PLACE ROCK BY DUMPING THROUGH CHUTES OR OTHER METHODS THAT CAUSE SEGREGATION OF ROCK SIZES.

12. THE FINISHED SURFACE SHOULD BE FREE OF POCKETS OF SMALL ROCK OR CLUSTERS OF LARGE ROCKS. HAND PLACING MAY BE NECESSARY TO ACHIEVE THE PROPER DISTRIBUTION OF ROCK SIZES TO PRODUCE A RELATIVELY SMOOTH, UNIFORM SURFACE. THE FINISHED GRADE OF THE ROCK SHOULD BLEND WITH THE SURROUNDING AREA. NO OVERFALL OR PROTRUSION OF ROCK SHOULD BE APPARENT.

13. IMMEDIATELY UPON COMPLETION OF THE CHANNEL, VEGETATE ALL DISTURBED AREAS OR OTHERWISE PROTECT THEM AGAINST SOIL EROSION.

14. WHERE SPECIFIED, FILL ALL VOIDS WITH SOIL AND VEGETATE THE ROCK SURFACE IN ACCORDANCE WITH THE APPROVED PLAN.

MAINTENANCE

1. ROCK-LINED CHANNELS SHOULD BE INSPECTED PERIODICALLY AND AFTER SIGNIFICANT STORM EVENTS. CHECK FOR SCOUR OR DISLODGED ROCK. REPAIR DAMAGED AREAS IMMEDIATELY.

2. CLOSELY INSPECT THE OUTER EDGES OF THE ROCK PROTECTION. ENSURE WATER ENTRY INTO THE CHANNEL OR CHUTE IS NOT CAUSING EROSION ALONG THE EDGE OF THE ROCK PROTECTION.

3. CAREFULLY CHECK THE STABILITY OF THE ROCK LOOKING FOR INDICATIONS OF PIPING, SCOUR HOLES, OR BANK FAILURES.

4. REPLACE ANY DISPLACED ROCK WITH ROCK OF A SIGNIFICANTLY (MINIMUM 110%) LARGER SIZE THAN THE DISPLACED ROCK.

Catchments & Creeks Pty Ltd

Drawn:	Date:		
GMW	May-10	Rock Linings	RR-02

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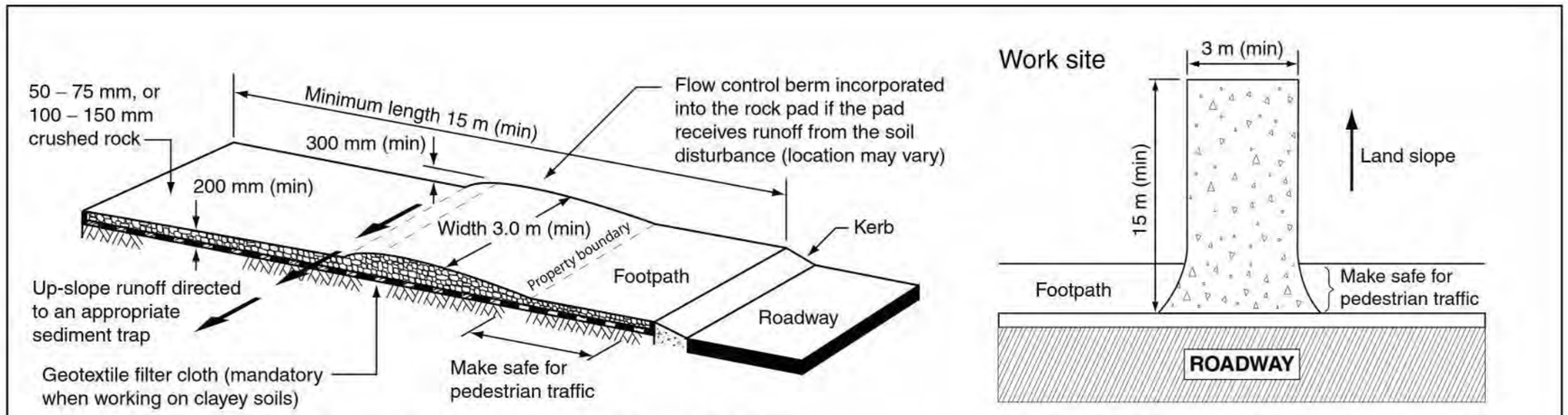
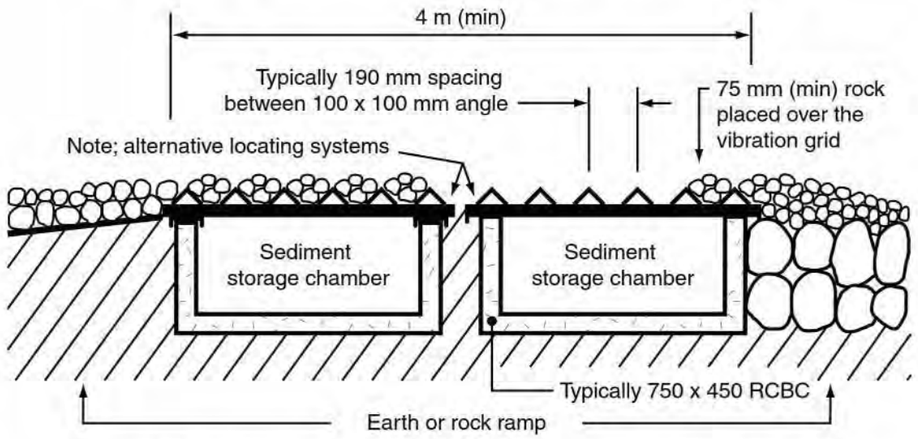
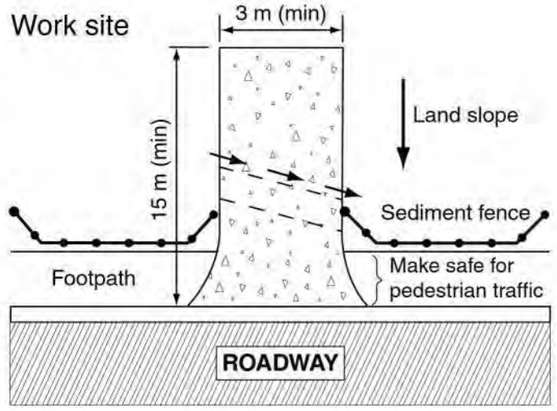


(a) Rock entry/exit pad for construction sites (refer to Standard Drawing Exit-03 for building sites)

(b) Rock pad sloping away from road



(c) Alternative low maintenance arrangement (still under development)



(d) Rock pad sloping towards the road

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Drawn:	Date:		
GMW	Apr-10	Construction Exit - Rock Pad (construction sites only)	Exit-01

Review due: 05/11/2023

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MATERIALS

ROCK: WELL GRADED, HARD, ANGULAR, EROSION RESISTANT ROCK, NOMINAL DIAMETER OF 50 TO 75mm (SMALL DISTURBANCES) OR 100 TO 150mm (LARGE DISTURBANCES). ALL REASONABLE MEASURES MUST BE TAKEN TO OBTAIN ROCK OF NEAR UNIFORM SIZE.

FOOTPATH STABILISING AGGREGATE: 25 TO 50mm GRAVEL OR AGGREGATE.

GEOTEXTILE FABRIC: HEAVY-DUTY, NEEDLE-PUNCHED, NON-WOVEN FILTER CLOTH ('BIDIM' A24 OR EQUIVALENT).

INSTALLATION

1. REFER TO APPROVED PLANS FOR LOCATION AND DIMENSIONAL DETAILS. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION, DIMENSIONS, OR METHOD OF INSTALLATION, CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.

2. CLEAR THE LOCATION OF THE ROCK PAD, REMOVING STUMPS, ROOTS AND OTHER VEGETATION TO PROVIDE A FIRM FOUNDATION SO THAT THE ROCK IS NOT PRESSED INTO SOFT GROUND. CLEAR SUFFICIENT WIDTH TO ALLOW PASSAGE OF LARGE VEHICLES, BUT CLEAR ONLY THAT NECESSARY FOR THE EXIT. DO NOT CLEAR ADJACENT AREAS UNTIL THE REQUIRED EROSION AND SEDIMENT CONTROL DEVICES ARE IN PLACE.

3. IF THE EXPOSED SOIL IS SOFT, PLASTIC OR CLAYEY, PLACE A SUB-BASE OF CRUSHED ROCK OR A LAYER OF HEAVY-DUTY FILTER CLOTH TO PROVIDE A FIRM FOUNDATION.

4. PLACE THE ROCK PAD FORMING A MINIMUM 200mm THICK LAYER OF CLEAN, OPEN-VOID ROCK.

5. IF THE ASSOCIATED CONSTRUCTION SITE IS UP-SLOPE OF THE ROCK PAD, THUS CAUSING STORMWATER RUNOFF TO FLOW TOWARDS THE ROCK PAD, THEN FORM A MINIMUM 300mm HIGH FLOW CONTROL BERM ACROSS THE ROCK PAD TO DIVERT SUCH RUNOFF TO A SUITABLE SEDIMENT TRAP.

6. THE LENGTH OF THE ROCK PAD SHOULD BE AT LEAST 15m WHERE PRACTICABLE, AND AS WIDE AS THE FULL WIDTH OF THE ENTRY OR EXIT AND AT LEAST 3m. THE ROCK PAD SHOULD COMMENCE AT THE EDGE OF THE OFF-SITE SEALED ROAD OR PAVEMENT.

7. FLARE THE END OF THE ROCK PAD WHERE IT MEETS THE PAVEMENT SO THAT THE WHEELS OF TURNING VEHICLES DO NOT TRAVEL OVER UNPROTECTED SOIL.

8. IF THE FOOTPATH IS OPEN TO PEDESTRIAN MOVEMENT, THEN COVER THE COARSE ROCK WITH FINE AGGREGATE OR GRAVEL, OR OTHERWISE TAKE WHATEVER MEASURES ARE NEEDED TO MAKE THE AREA SAFE.

MAINTENANCE

1. INSPECT ALL SITE ENTRY AND EXIT POINTS PRIOR TO FORECAST RAIN, DAILY DURING EXTENDED PERIODS OF RAINFALL, AFTER RUNOFF-PRODUCING RAINFALL, OR OTHERWISE AT FORTNIGHTLY INTERVALS.

2. IF SAND, SOIL, SEDIMENT OR MUD IS TRACKED OR WASHED ONTO THE ADJACENT SEALED ROADWAY, THEN SUCH MATERIAL MUST BE PHYSICALLY REMOVED, FIRST USING A SQUARE-EDGED SHOVEL, AND THEN A STIFF-BRISTLED BROOM, AND THEN BY A MECHANICAL VACUUM UNIT, IF AVAILABLE.

3. IF NECESSARY FOR SAFETY REASONS, THE ROADWAY SHALL ONLY BE WASHED CLEAN AFTER ALL REASONABLE EFFORTS HAVE BEEN TAKEN TO SHOVEL AND SWEEP THE MATERIAL FROM THE ROADWAY.

4. WHEN THE VOIDS BETWEEN THE ROCK BECOMES FILLED WITH MATERIAL AND THE EFFECTIVENESS OF THE ROCK PAD IS REDUCED TO A POINT WHERE SEDIMENT IS BEING TRACKED OFF THE SITE, A NEW 100mm LAYER OF ROCK MUST BE ADDED AND/OR THE ROCK PAD MUST BE EXTENDED.

5. ENSURE ANY ASSOCIATED DRAINAGE CONTROL MEASURES (e.g. FLOW CONTROL BERM) ARE MAINTAINED IN ACCORDANCE WITH THEIR DESIRED OPERATIONAL CONDITIONS.

6. DISPOSE OF SEDIMENT AND DEBRIS IN A MANNER THAT WILL NOT CREATE AN EROSION OR POLLUTION HAZARD.

REMOVAL

1. THE ROCK PAD SHOULD BE REMOVED ONLY AFTER IT IS NO LONGER NEEDED AS A SEDIMENT TRAP.

2. REMOVE MATERIALS AND COLLECTED SEDIMENT AND DISPOSE OF IN A SUITABLE MANNER THAT WILL NOT CAUSE AN EROSION OR POLLUTION HAZARD.
3. RE-GRADE AND STABILISE THE DISTURBED GROUND AS NECESSARY TO MINIMISE THE EROSION HAZARD.

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Drawn:	Date:		
GMW	Apr-10	Construction Exit - Rock Pad (construction sites only)	Exit-02

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APPLICATION

1. REFER TO APPROVED PLANS FOR LOCATION, EXTENT, AND APPLICATION DETAILS. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION, EXTENT, OR METHOD OF APPLICATION CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.

2. FILL OR SUITABLY CONTOUR ANY EXISTING RUTTING, RILLING OR GULLIES.

3. SUITABLY DIVERT UP-SLOPE STORMWATER RUNOFF AROUND TREATED AREA AS DIRECTED WITHIN THE APPROVED PLANS, OR OTHERWISE AS DIRECTED BY THE SITE ENGINEER.

4. APPLY TREATMENT TO THE AREA TO THE DEPTH AND FREQUENCY (SPACING) SPECIFIED ON THE APPROVED PLANS, OR OTHERWISE AS DIRECTED BY THE SITE ENGINEER.

5. IMMEDIATELY SEED AND MULCH ROUGHENED AREAS TO OPTIMISE SEED GERMINATION AND GROWING CONDITIONS.

MAINTENANCE

1. DURING THE CONSTRUCTION PERIOD, INSPECT THE TREATED AREA PRIOR TO FORECAST RAINFALL, DAILY DURING EXTENDED PERIODS OF RAINFALL, AFTER SIGNIFICANT RUNOFF PRODUCING RAINFALL, OR OTHERWISE ON A WEEKLY BASIS.

2. FILL EROSION RILLS SLIGHTLY ABOVE THE ORIGINAL GRADE, OR REGRADE THE SLOPE AS DIRECTED TO REMOVE THE RILLS.

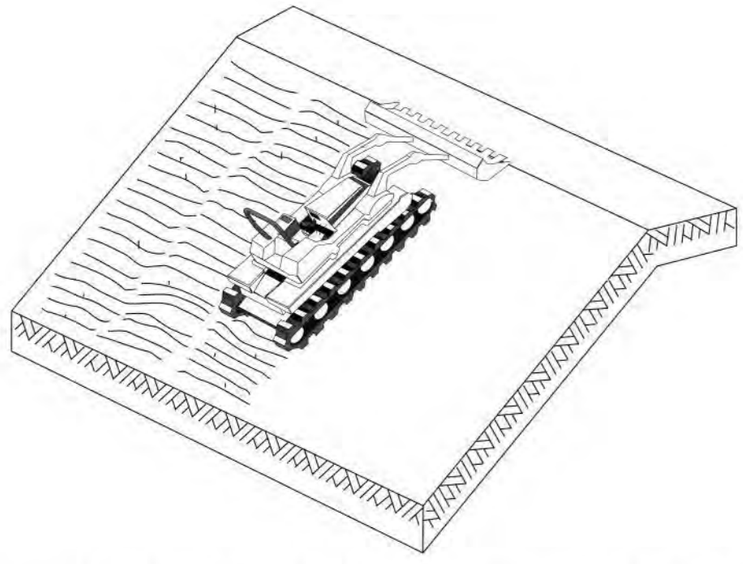

Figure 1 - Application of surface roughening on slope

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Drawn:	Date:		
GMW	Dec-09	Surface Roughening	SR-01

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Appendix E Methane Emission Management Plan

MEMP

NT-2050-MP-15- 030

BEETALOO EXPLORATION PROGRAM

Methane Emission Management Plan

Review record

Rev	Date	Reason for issue	Reviewer/s	Consolidator	Approver
0	15/04/2019	Released for use	MK	LF	MH

Review due: 18/05/2021

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1. Purpose

This Methane Emissions Management Plan (MEMP) is designed to outline the measures as to how the risks of methane emissions associated with Origin Energy's Beetaloo Basin exploration activities will be managed. This Plan has been developed in accordance with the Code of Practice for Petroleum Activities in the Northern Territory.

2. Key Legislation

Key legislation and documents consulted in the development of this plan are provided below. A full list of applicable legislation is provided in the corresponding management plans.

- **Code of Practice for Petroleum activities in the Northern Territory:** Mandatory code of practice legislating the management of chemicals and wastewater onsite, including the use of secondary containment, lined tanks and spill management plan,
- **National Greenhouse and Energy Reporting Act 2007:** Regulates the reporting of greenhouse gas emissions, energy production and energy consumption associated with company activities. Data to be supplied annually to the regulator in accordance with emission/energy use guidance manuals.

3. Activity description

The activities undertaken as a part of this MEMP are summarised in Table 1. These activities are restricted to the drilling, stimulation, well testing and ongoing operation of exploration wells. They do not cover any production, compression or pipeline activities as these are currently not proposed.

Table 1 Activity and emission description summary

Activity	Emission Description	Controls	Emission monitoring
Drilling	Methane emissions are small (<1 tonne) and restricted to outgassing of hydrocarbon within intersected shales brought to surface.	•Drilling is overbalanced, preventing gas influx into well bore •Shale formations have negligible permeability with limited influx of gas from target formations	•Due to low emission level, gas is qualitatively monitored in mud stream as a concentration (not flow rate). •Gas desorption data is collected from target reservoir allowing emission estimates.
Stimulation	During stimulation, the well will be overbalanced restricting the flow of hydrocarbons to surface.	•Well is kept overbalanced to prevent gas influx during and after stimulation. •Flowback kept within the formation after each stage.	N/A
Well Testing	Well is unloaded to allow hydrocarbons and fluid to flow to surface. All fluids and hydrocarbons diverted to a separator and then a flare onsite Small emissions (<1 tonne) of methane may be released prior to the onsite of flaring, as the hydrocarbon production rate may not be enough to sustain a flare initially. Small volumes (kg's/day) of methane is entrained within liquid hydrocarbons and flowback fluid and will be released to atmosphere	Well heads are designed in accordance with the NT Code of Practice and API standards to minimise loss of methane containment. methane A reduced emission completion will be utilised- where all gas is sent to a separator and then flared. Personal Gas Detector during all operational visits	•Personal Gas Detector during well testing activities •All flared gas measured using flow meters
Ongoing Well Operations/ suspension	Methane emissions restricted to unplanned leaks from well heads, including surface casing vents.	•Operation staff to carry personal calibrated gas detectors during every routine operational visit to well sites.	•Personal Gas Detector during well testing activities •6 monthly leak detection

Activity	Emission Description	Controls	Emission monitoring
		•Routine wellhead maintenance as per well Integrity Management System •Each well and equipment on a well pad to be inspected every 6 months for leaks using a US EPA Method 21 compliance technique	

4. Equipment Selection and Activity Design

The uncontrolled emissions of natural gas during drilling, stimulation and well testing activities represents a potential hazard to workers and the environment. All equipment will be selected to minimise the emissions during production activities.

- Exploration wells and associated surface infrastructure shall be designed to mitigate leaks in accordance with the relevant standards. These Standards include:
  - ISO 16530-1-2017 Petroleum and natural gas industries- Well Integrity - Life cycle governance
  - API SPEC 5CT 2016 Casing and Tubing
  - API SPEC 16D 2013 Control Systems for Drilling Well Control Equipment and Control Systems for Diverter Equipment
  - API RP 59 2012 Well control operations
  - API SPEC 6A 2016 Wellhead and Christmas Tree equipment
  - NORSOK Standard D-010, Well integrity in drilling and well operations
- Leak detection implemented consistent with Codes of Practice.
- Ongoing well maintenance as per the Well Operations Management Plan.

5. Flowback Activities

5.1 Reduced emission Completion

- A Reduced Emission completions (REC) shall be used to minimise the amount of venting
- A REC for the purpose of the Beetaloo Exploration Project is a separator equipped with a flare.
- Venting shall only be used where the capture or flaring is not possible.
- The recovery or gas and hydrocarbons for sale will be prioritised (where practicable) to minimise flaring.

6. Leak Detection Inspections.

The leak inspection programs will be implemented in accordance with Table 2.

Table 2 Leak detection program

Monitoring Program	Monitoring methodology	Frequency
Routine operational Inspections	Calibrated personal gas detector	During each operational visit
Mandatory inspection	US EPA Method 21	6-monthly

7. Monitoring Methodology

- Mandatory inspections will be completed on all surface infrastructure (vents, flanges, valves, connections, drains, pressure relief vents, etc.) of the exploration well in accordance with the USEPA Method 21 requirements or a vehicle mounted cavity ring-down spectrometer (CRDS).

7.1 Instrument Selection

- A Method 21 detector must be able to detect methane at the minimum detection range of 10 Parts Per Million (PPM), with an +/- accuracy of 50PPM.

- A vehicle mounted CRDS detectors shall have a 10 Parts Per Billion (PPB) minimum detection accuracy with an accuracy of +/- 10PPB
- The instrument shall be intrinsically safe (where used within hazardous areas) and equipped with an electrically driven pump, to ensure that a sample is provided to the detector at a constant flow rate.

7.2 Qualifications

- Inspections must be carried out by a suitably qualified person
- A suitably qualified person is defined as a person that has been specifically trained in leak detection or has at least 3 years industry experience in conducting leak detection activities.

7.3 Calibrations

- Gas detectors must be maintained and calibrated in accordance with the manufacturers instructions. Records of instrument calibration shall be retained.
- A two stage calibration shall be sued, with a Air calibration and a 10PPM by volume CH^4 calibration gas used.
- The instrument response time shall be less than 30 seconds.

7.4 Testing procedure

7.4.1 Method 21

Method 21 inspections are used to survey individual pieces of equipment. These types of inspections require access to the surface of the equipment and are extremely effective at pinpointing leaks. The following procedure is to be followed when conducting method 21 inspections:

1. Ensure gas detector is calibrated and functioning properly
2. Ensure the appropriate permitting is obtained before entry into a hazardous area
3. Place the probe inlet at the surface of the component interface where leakage could occur.
4. Move the probe along the interface periphery while observing the instrument readout. If an increased meter reading is observed, slowly sample the interface where leakage is indicated until the maximum meter reading is obtained.
5. Leave the probe inlet at this maximum reading location for approximately two times the instrument response time (i.e. at least a minute).
6. If the maximum observed meter reading is greater than 500PPM at the surface of a piece of infrastructure, the leak is to be measured again at 150mm immediately above (and downwind) of the leak in an open-air environment
7. The leak shall be classified in accordance with section 7
8. The location of the leak shall be clearly documented and photographs taken (if safe to do so)
9. Any liquid petroleum leaks should also be identified, along with estimates of leak rate and volume released.

7.4.2 Vehicle mounted CRDS

Vehicle mounted CSRDS uses highly sensitive, PPB level detectors to screen clumps of infrastructure for leaks. They are extremely effective at providing a rapid assessment and are used in combination of method 21 assessment to pin point leaks. The following procedure shall be followed when conducting vehicle mounted CRDS inspections:

1. The vehicle shall be driven within 20m up and downwind of the infrastructure at a speed below 20km/hour: it is advisable to drive around a piece of infrastructure in a circular motion to obtain up and down wind in the same pass.
2. where a survey cannot be made within 20m downwind of a piece of infrastructure, a method 21 inspection shall be undertaken.
3. Downwind methane concentrations shall be compared to upwind (background) concentration.
4. Where an emission is identified at 5PPM above background, a method 21 inspection shall be undertaken
5. Where enrichment is recorded below 5PPM, the infrastructure has no material leaks present.

7.5 Leak Classification, Repair and Notification

Each leak shall be classified, repaired and reported in accordance with Table 3. It should be noted, that classification of leaks is only undertaken using a method 21 approach outlined in 7.4.1.

Table 3 Leak classification and remediation summary

Classification	Threshold	Response	Notification	Comments
Minor Leak	>500ppm measured at the surface of the component in accordance with section 6.4.1	All minor leaks must be documented and repaired as soon as practicable, but within 30 days. Where 30 days in unachievable, the reason for the delay and target date for completion must be submitted.	All minor leaks must be documented	A minor leak is an unplanned release that does not occur during commissioning or bringing equipment back into service. These leaks should be corrected immediately as a part of commissioning
Significant Leak	>5000ppm (or 10%of the Lower Explosive Limit) when measured at 150mm above the leak source. Or A Liquid Petroleum (condensate/oil) loss of containment that exceeds 200L. Or The leak is too large or not safe to measure.	1. The activities safety management plan, risk assessment and emergency response requirements must be followed. 2. Remediation work must only commence after a suitable risk assessment has been undertaken (at a level appropriate to the nature of the leak) and the relevant safety procedures are followed including the consideration of all the required Personal Protective Equipment and emergency response material. 3. If safe to do so, the leak source should be isolated and repaired immediately. The response priority must be to make the site safe above all other actions. 4. The leak shall be repaired or made safe as soon as practicable, as follows: i) the leak must be isolated, repaired if possible, contained or otherwise made safe within 72 hours. ii) Where isolation and repair is not possible, an exclusion zone must be established around the leak and appropriate restrictions to on access to the exclusion zone imposed. iii) in the event the 72 hour deadline is unachievable, the reason for the delay and the target date for repair shall be submitted to DPIR before the deadline ahs passed.	In the case of an emergency situation, DPIR must be notified within 24 hours via the emergency response hotline number 1300 935 250. Notification must include the date of identification, nature and level of the leak, infrastructure name, number and location as well as the initial actions to minimise the risk. The land owner or occupier of the property in which these leaks are occurring must be notified in the following circumstances: i) if the leak cannot be repaired immediately; and ii) if the leak is likely to affect any of the land owner's or occupiers facilities or activities. A written close-out report must be submitted within 5 business days of the remediation of the leak, specifying the date of identification, nature and level of leak, location and name of the operating plant, and the rectification actions taken.	A significant leak is an unplanned release that does not occur during commissioning or bringing equipment back into service. These leaks should be corrected immediately as a part of commissioning

Classification	Threshold	Response	Notification	Comments
		5. If it is contended that the risk of immediately repairing the leak exceeds the risk posed by the leak, an extension of the 72-hour deadline may be sought provided that other measures to mitigate the risk are undertaken (eg. ensuring an appropriate exclusion zone has been implemented) 6. For leaks identified on well equipment, higher order controls such as containment by repair must be implemented wherever possible. 7. For leaks identified on well casings or adjacent to the well casing (where a work over rig is necessary to effect repair) it must be determined whether the leak requires immediate repair, or whether the risk can be adequately managed via other control measures until a work over of the well is scheduled for normal operational reasons. The risk assessment to determine the above shall consider the location of the well, likely access to the well from landholders or the general public, and landholder/community concerns in relation to the leak.	If finalising the remediation is delayed more than 7 business days from the identification of the leak an update must be submitted on that day. The final close out report shall be provided when all work is completed.	

8. Reporting

8.1 Flaring and Venting Emissions

- Where natural gas is vented or flared during exploration activities, these emissions shall be measured or estimated using methods consistent with those outline under the National Greenhouse and Energy Reporting (Measurement) Determination 2008. This include:
    - Leaks, venting and flaring during flowback activities
    - Equipment blowdowns, system upsets and accidental releases

8.2 Annual reporting

An annual report will be provided to the Northern Territory Government summarising the following:

1. The records of the stages of flowback activities including:

i. the date and time of the onset of flowback;
ii. the date and time of each attempt to route flowback fluid to the separator;
iii. the date and time of each occurrence in which the operator reverted to the initial flowback stage;
iv. the date and time of well shut in or connected into adjacent gathering lines;
v. the date and time that temporary flowback equipment is disconnected.
vi. the total duration of venting, combustion and flaring over the flowback period.

2. The results of leak detection surveys (in the annual report under the Act) outlining:

i. the extent of compliance with the leak management plan;
ii. a summary of monitoring undertaken during the period;
iii. a summary of minor and significant leaks identified during the reporting period,
iv. including the date of identification and repair for each leak and those leaks that
v. could not be repaired; and
vi. iv. an explanation of why any component could not be repaired and what actions will
vii. be taken to either decommission the component or otherwise remedy the problem.

Appendix F Beetaloo W-1 Activity Risk Assessment

Risk Matrix

CONSEQUENCE	IMPACT ON ORIGIN OPERATIONS – Conduct Business with Due Care: People	IMPACT ON ORIGIN OPERATIONS – Conduct Business with Due Care: Environment and Community	IMPACT ON ORIGIN OPERATIONS – Create Value: EBIT	IMPACT ON ORIGIN OPERATIONS – Create Value: Cash flow	IMPACT ON ORIGIN OPERATIONS – Create Value: NPV	EXTERNAL RESPONSE – Decisions are Subject to Scrutiny: Stakeholder Perceptions	EXTERNAL RESPONSE – Decisions are Subject to Scrutiny: Laws, regulation and civil actions
6 CATASTROPHIC	Multiple fatalities ≥4 or life threatening illness or total permanent disability to a large exposed group (10 or more people)	Extensive permanent damage to endangered species, habitats, ecosystems or area/s of cultural significance Extensive irreversible loss of community livelihood. Long-term social unrest and outrage	>$200m	>$1b	>$1.5b	Multiple stakeholder groups confirming coordinated action, as reflected in media channels with significant reach and influence (eg. scheduled blockade or boycott covered in media for more than 1 week).	Criminal charges against any director or senior executive involving jail or loss of right to manage the company. Public inquiry – requiring considerable resources and Executive Management time. Loss of licence to operate an asset
5 CRITICAL	1 – 3 fatalities or life threatening illness or total permanent disability to a small exposed group (<10 people)	Extensive long term partially reversible damage to vulnerable species, unique habitats, ecosystems or area/s of cultural significance Extensive reversible loss of community livelihood. Prolonged community outrage.	>$50m - $200m	>$250m - $1b	>$375m - $1.5b	Multiple stakeholder groups mobilising and encouraging others to take action, as reflected in media channels with significant reach and influence (eg. social media campaign calling for protest, escalating over several days).	Criminal charges against any director, senior executive or senior manager not involving jail or loss of right to manage the company. Prolonged major litigation – exposure to significant damages / fines / costs. Suspension / restriction to operate an asset.
4 MAJOR	Injury or illness to one or more persons, resulting in permanent partial disability	Long term reversible impacts to listed species, habitats, ecosystems or area of cultural significance Significant impacts to community cost of living, business viability or social wellbeing. High levels of community tension.	>$20m - $50m	>$100m - $250m	>$150m - $375m	More than one stakeholder group's opinion or view influencing other stakeholders, reported through media channels with some reach and influence (eg. government comments in national media or in Parliament).	Criminal charges against any employee (not described above) Major litigation – exposure to damages / fines / costs.
3 SERIOUS	Injury or illness to one or more persons resulting in hospitalisation, 5 or more days lost time or alternative / restricted duties for 1 month or more	Serious medium term reversible impacts to low risk species, habitats, ecosystems or area/s of cultural significance Moderate impacts to community cost of living, business viability or social wellbeing. Moderate levels of community tension.	>$5m - $20m	>$25m - $100m	>$37.5m - $150m	More than one stakeholder group offering an opinion or view, reported through media channels with some reach and influence (eg. state based commentary lasting one 24 hour media cycle across internet, print, television, radio).	Non-compliance with conditions of licence to operate an asset or to conduct an activity. Litigation – exposure to damages / fines / costs.
2 MODERATE	Injury or illness to 1 or more persons resulting in medical treatment, up to 5 days lost time or alternative / restricted duties for up to 1 month	Moderate short term impacts to common regional species, habitats, ecosystems or area of cultural significance Small scale impacts to cost of living, business viability or social wellbeing. Isolated examples of community tension.	>$1m - $5m	>$500k - $25m	>$750k - $37.5m	A single stakeholder group drawing attention to an incident, issue or approach, conveyed though media channels with potential reach and influence (eg. some social media complaints or local media reports).	Moderate non-compliance with external mandatory obligations or breach of contractual or other legal obligations (not described above). Litigation possible.
1 MINOR	Injury or illness requiring first aid to 1 or more persons, or no treatment (record only)	Minor environmental or community impact - readily dealt with	>$100k - $1m	<$500k	<$750k	A person or organisation within stakeholder group signaling an interest in an incident, event or approach, using channels with limited reach or influence (eg. letter of complaint/commendation).	Minor non-compliance with external mandatory obligations or breach of contractual or other legal obligations.

CONSEQUENCE	LIKELIHOOD – 1 REMOTE <1% chance of occurring within the next year. Only occurs as a '100 year event' or less frequent.	2 HIGHLY UNLIKELY <10% chance of occurring within the next year. Could occur within decades.	3 UNLIKELY <30% chance of occurring within the next year. Could occur within the next few years.	4 POSSIBLE <60% chance of occurring within the next year. Could occur within months to years.	5 LIKELY <90% chance of occurring within the next year. Could occur within weeks to months.	6 HIGHLY LIKELY Likely to happen multiple times a year
6 CATASTROPHIC	HIGH	HIGH	VERY HIGH	VERY HIGH	VERY HIGH	VERY HIGH
5 CRITICAL	MEDIUM	MEDIUM	HIGH	VERY HIGH	VERY HIGH	VERY HIGH
4 MAJOR	MEDIUM	MEDIUM	MEDIUM	HIGH	VERY HIGH	VERY HIGH
3 SERIOUS	LOW	MEDIUM	MEDIUM	MEDIUM	HIGH	HIGH
2 MODERATE	LOW	LOW	MEDIUM	MEDIUM	MEDIUM	MEDIUM
1 MINOR	LOW	LOW	LOW	MEDIUM	MEDIUM	MEDIUM

* Cash Flow - change from expectation over the life of the exposure. EBIT change from expectation over 12 – 18 month period.

Ref	Environmental Factor	Risk scenario description	Risk Source	Code of Practice	Unmitigated (no CoP implemented) Risk Rating			Risk mitigation Measures			Residual Risk Rating			ALARP criteria achieved?	Residual risk ALARP and Acceptable Statement	Acceptable criteria achieved?	Scientific Uncertainty Ranking
					Consequence	Likelihood	Risk Rating	Prevent	Detect	Recover	Consequence	Likelihood	Risk Rating				
1	**Groundwater**	Changes in aquifer quality from complete failure of well integrity (groundwater user or Groundwater Dependent Ecosystem).	Cross flow of formation through inadequate well barrier maintenance.	B.4.3 Well design and barriers B.4.2 Aquifer Isolation B.4.7 Primary cementing	3	2	M	•the formation is not simulated, with limited flow between formations likely to occur limiting the potential impact •CBL and pressure test to be completed on well prior to commencement of DFIT operations to confirm cement integrity.. Cement or casing remediation to be completed as required. •The Beetaloo W-1well is existing, which was designed and constructed with 4 casing barriers and specifically-engineered cement in place to protect aquifers- this includes the 16" Conductor casing, 10.75" surface casing, 7.625" intermediate casing and 4.5" production casing. •Well Barrier Integrity Validated through casing pressure tests and leak off tests. •A well completion report was submitted to DITT post exploration program. located in the base of each aquifer unit, with cement returned to surface •A Well Operations Management Plan (WOMP) will be developed and approved by DITT prior to commencement of activities. •No pastoralist bores within 12km. (Elimination).	•Monthly well integrity verification confirms aquifer remains protected from well barriers. •Ongoing well integrity verification (surface casing vent pressure testing) during operations/ •Annual groundwater monitoring of onsite extraction and control monitoring bores installed to detect and trigger response in the case of contamination.	•Well maintenance and repair to be performed if well integrity issue suspected. •Any contamination event to be characterised and have remediation plans developed and executed in accordance with the process outlined in schedule A of the National Environmental Protection (Assessment of site Contamination) Measures (Engineering)	2	1	L	Yes	The Beetaloo W-1 well is an existing well designed and constructed with multiple barriers protecting the underlying aquifers. The risk of cross formation flow is managed through the COP which provides specific well barrier design and validation requirements to mitigate the risk of aquifer interconnectivity. The well barrier design is submitted to DITT as a part of the WOMP, with the final Well barrier integrity verification report submitted to DITT post well completion. The consequence of an interconnectivity event is likely to be "moderate", with spatially restricted (to the vicinity of the well), medium term reversible impacts. The Likelihood of all casing and cement failures occurring without intervention during operation is considered remote, with a probability lower than 1%. This is confirmed by the NT inquiry that estimated the likely well failure rate (total failure of all barriers) to be less than 0.1%.	Yes	Low
2		Changes in aquifer quality from DFIT activities impacting a receptor (groundwater user or Groundwater Dependent Ecosystem).	Cross flow of formation through connection created through DFIT operations	B.4.1 Well Integrity Management B.4.2 Aquifer Isolation B.4.3 Well design and barriers B.4.15 Well suspension and decommissioning D.5.5 Leak Remediation and Notification	2	2	L	•Geomechanical properties of the formation an separation between the shales and aquifer reduce the potential to remote. •the formation is not simulated, with limited flow between formations likely to occur limiting the potential impact •CBL and pressure test to be completed on well prior to commencement of DFIT operations to confirm cement integrity.. Cement or casing remediation to be completed as required. •The Beetaloo W-1 well is existing, which was designed and constructed with 4 casing barriers and specifically-engineered cement in place to protect aquifers- this includes the 16" Conductor casing, 10.75" surface casing, 7.625" intermediate casing and 4.5" production casing. •Casing shoe for the conductor and surface casing section to be located in the base of each aquifer unit, with cement returned to surface (Engineering) • Well Barrier Integrity Validation reports submitted to DITT post well construction in 2016). (Administration) •Any impacted area likely to be localised, around the immediate vicinity of the E&A wells. (Elimination) •No pastoralist bores within 7.5km. (Elimination) •No major GDE linked to CLA within 25km of extraction point	•A Well completion report submitted to DITT upon completion of exploration program in 2016. Well Operations Management Plan (WOMP) to be authorised by DEPWS (Administration) •Routine (6 monthly) monitoring of well integrity in accordance with code of Practice (Engineering) •Routine (6 monthly) well leak detection on all wells.	• any potential cement or casing defects to be remedied prior to undertaking a DFIT. •Any contamination event to be characterised and have remediation plans developed and executed immediately in accordance with the process outlined in schedule A of the National Environmental Protection (Assessment of site Contamination) Measures (Engineering)	2	1	L	Yes	The Beetaloo W-1 well is an existing well designed and constructed with multiple barriers protecting the underlying aquifers. The risk of creating potential cross flow is primarily reduced through the geomechanical properties of the shale reservoir , separation distance to closest aquifer, the stringent well barrier construction and verification requirements outlined in the COP. A CBL and casing pressure test will be completed prior to undertaking the proposed DFIT, with any integrity issues remedied. The well has multiple casing and cement strings meaning the failure of a well barrier would be contained within the inner casing strings significantly reducing the consequence and likelihood of an event. A contamination event is likely to result in "moderate", reversible impacts (months to years) restricted to the vicinity of the lease pad. The likelihood is reduced by the separation distance to aquifers, geomechanical properties of the well , presence of multiple casing strings, likely low leakage rate as the well hasn't been stimulated and rapid dilution of any contamination. The NT Inquiry concluding the likelihood of this scenario being very low, typically less than 0.1%. This likelihood	Yes	Low
3		Unsustainable groundwater extraction impacts landholders and groundwater dependent ecosystems.	Over extraction of groundwater for the regulated activities.	B.4.17 Groundwater monitoring	1	1	L	•Groundwater extraction for activities to be restricted to the minimum water required, with total take <1ML/year. (Elimination) •All water take licenced in accordance with NT Water Act under Water Extraction Licence (WEL) GRF 10285 (Administration) •Drawdown from activity and other users assessed by DEPWS as a part of WEL; impacts to closest receptor not anticipated (Administration/ Elimination) Karst system is under allocated, with sufficient available capacity to support proposed water extraction requirements. (Elimination) •Closest receptor (homestead) is ~7.5km from extraction point (Elimination) No Major GDE linked to CLA within 25km of extraction point.	•Continuous flow meters to monitor take and water balance implemented to ensure compliance with WEL (Administration) •Annual groundwater monitoring completed to identify impacts associated with water extraction (Engineering)	•Groundwater extraction to cease where sustained drawdown post pumping exceeds 1 m (Administration)	1	1	L	Yes	1ML of water is required for the ongoing data collection and maintenance activities. There is significant water capacity in the Karst System for the water extraction requirements for the proposed activities. The risk consequence is determined to be "minor"- given the lack of extraction volume is unlikely to cause long term impacts.. The likelihood of such a consequence from occurring is considered remote (probability <1%) due to the quality of the Cambrian limestone aquifer, separation distance from surrounding users and under utilisation of the targeting aquifer.	Yes	Low
4		Contamination of aquifer from surface activities (chemical and waste storage, handling and spills) impacting a receptor (groundwater user or GDE).	Surface spills from storage, handling and transportation of waste.	A.4.7 Containment of Contaminants C.8.2 Spill Management Plan C.8.1 Wastewater Management Plan	2	1	L	•No material volumes of wastewater anticipated to be generated, with no drilling or flowback wastewater produced or stored onsite (elimination) •Chemical storage and handling areas to have secondary containment, with an impermeable membrane with coefficient of permeability of less than 10-9 m/s . (engineering) •Licenced waste transporters to be used for all listed waste transportation •Separation between chemical storages and closest aquifer over 80m. •No pastoralist bores within 7.5km. (Elimination) •No major GDE linked to CLA within 25km of extraction point	•Daily monitoring of tank levels during operations and wet season - weekly at all other times •Weekly tank integrity inspections and level monitoring to identify any potential structural defects	•Potential tank leaks to be investigated and repaired as soon as practicable •Spills and leaks to be cleaned up and rectified immediately •Any contamination event to be characterised and have remediation plans developed and executed in accordance with the process outlined in schedule A of the National Environmental Protection (Assessment of site Contamination) Measures (Engineering)	2	1	L	Yes	The consequence and likelihood of groundwater contamination are reduced by the duration of the activity, separation of underlying aquifer units for the surface, absence of wastewater or material chemcial storage volumes and mandated use of secondary containment . Any spill onsite is therefore likely to be small, restricted to the chemical storage areas or onsite steel storage tanks . The potential consequence of ground water contamination event is likely to be "moderate", with potential spill consequences likely to be locally restricted, moderate-short term and reversible. The likelihood is reduced down to remote with a probability of less than 1%. This is primarily influenced by the lack of spill sources, short duration of the proposed activities, separation distance between aquifers and the surface and spill management plan that will rapidly detect any spills.	Yes	Low
5	**Surface Water**	Contamination of surface water bodiesfrom surface activities.	Transportation accident releasing chemical (Completion fluid or Fit fluid).	A.4.7 Containment of Contaminants C.8.2 Spill Management Plan	2	1	L	•Limited chemical transportation activities proposed. •Risk assessment completed for all wet season transportation of chemicals and wastes •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. •Transportation route to avoid major urban areas •All drivers to be appropriately licenced •Fatigue management plan implemented, requiring journey management plans and drivers to rest every 2 hours •Strict drug and alcohol policy implemented, with routine testing and 0 zero tolerance policy to alcohol (0.00% limit) and drugs •Area is remote with major urban centres to be avoided. •Risk to any receptor is identical to that of normal diesel or petroleum tankers. •Training of Origin supervisors regarding chain of responsibility requirements to minimise the risk of driver fatigue •Origin has completed 100,000's of chemical and wastewater trucking movements in QLD without significant incident causing material environmental harm •The transportation of waste and chemicals across Australia is a standard practice with mature codes and legislation in place. the transportation of fuels, chemicals and wastes occurs every year in the NT to support existing industry's during the wet season.	•Transport incident statistics collected and monitored. •Onsite assurances and fit for work assessments completed periodically on transport companies.	•Spill Management Plan and Emergency Response Plan implemented to prevent, detect and respond to spills. •Contractor performance reviews completed where breaches in requirements are escalated and actions implemented to rectify defects.	2	1	L	Yes	Limited volume of chemicals or wastewater will be transported during the activities. The transportation of wastes and chemicals is a tightly controlled industry with mature practices designed to prevent, detect and respond to transportation spills. Any accident is likely to be restricted to road corridors and result in "moderate", short term (days-weeks) reversible impacts. All contractors must be appropriately licenced, with National uniform legislation in place to offer a high level of regulatory protection. This risk is considered identical to that of bulk diesel and other dangerous goods transportation- a common activity throughout Australia. Fuel and chemical transport accidents are rare given the number of transportation movements in Australia. The likelihood of an event occurring is therefore considered "remote", what a probability of less than 1%.	Yes	Low

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6			Storage and handling of chemicals and fuel.	A.4.7 Containment of Contaminants C.8.2 Spill Management Plan	2	2	L	• Limited volumes of chemicals and fuels will only be stored onsite temporarily to support exploration activities (elimination). •All areas where chemicals and fuels are stored will have secondary containment with a coefficient of permeability of less than 10-9 m/s • Secondary containment to be maintained in a good working order •Spill Management Plan implemented to prevent, detect and respond to spills. implemented. •Area is remote with closest water course receptor approximately 8.5km away.	•Daily inspections will be implemented for secondary containment areas during the wet season and spills rectified immediately	•All spills to be cleaned up as soon as practicable (within the shift that spill was observed) •Any contamination event to be characterised and have remediation plans developed and executed in accordance with the process outlined in schedule A of the National Environmental Protection (Assessment of site Contamination) Measures (Engineering)	2	1	L	Yes	Limited storage of chemicals and fuels will be required to support the exploration activities. The storage, handling and management of chemicals is a standard activity that is managed through a mature regulatory setting. The COP further reduces the likelihood and consequence of chemical spills and contamination, through the mandated use of secondary containment, a spill management plan and groundwater monitoring. A spill event is likely to result in moderate, short term reversible impacts restricted to the existing lease pad. The likelihood is further reduced down to remote (<1% probability of occurring) based on the 8.5km separation distance to the closest watercourse.	Yes	Low
7			Release of contaminated (sediment and chemical) stormwater from activities to surface water.	A.4.1 Site selection and planning A.4.3 Erosion and sediment control and hydrology	2	2	L	•Iwastewater not anticipated to be stored onsite. •existing site which has been stabilised with erosion and sediment controls implemented around the site to minimise erosion and sediment releases (Engineering) •Stockpiled debris to be used to discourage water concentration. (Engineering) •Sites to be maintained, with vegetation cover on exposed bunds/ stockpiles established and erosion and sediment controls kept in working order (Elimination) •any stormwater collected in onsite chemical bunds will be tested prior to release. •A sediment sock to be used to reduce sediment levels within stormwater releases where undertaken. (Engineering) •Lease pad located away from watercourses or regional flow paths. (Elimination) •Area is remote with closest watercourse approximately 8.5km away.(Elimination)	•Pre-wet season site assessment completed to identify any maintenance requirements (Administration) • Site inspections and assurances completed to detect potential spills or contaminant sources	•Maintenance to be undertaken on erosion and sediment controls to ensure ongoing functionality (Engineering)	2	2	L	Yes	The proposed activities will have no wastewater produced or stored. All stormwater collected in chemical storage areas will be tested prior to release with any contaminated water disposed of in accordance with the WMPCA . The risk of contaminated stormwater being released is considered to be more likely to be associated with sediment releases from disturbed surfaces.. Given the lack of surface water bodies and sources of contamination, the potential consequence is considered "moderate", with impacts considered short term. The likelihood of an impact to a surface water body is reduced by the absence of a close receptor, use of secondary containment, use and ongoing maintenance of erosion and sediment controls. The likelihood is reduced from an "unlikely" to "highly unlikely" (<10% probability of occurring) .	Yes	Low
8			Runoff from sewage treatment irrigation areas.	A.4.1 Site selection and planning	1	2	L	•Camp activities are expected to be temporary and of limited extent, with large workforce not required. •Irrigation areas located away from watercourses (Elimination) •Where irrigation of sewage wastewater exceeds the triggers in the DoH Code of Practice for On-site Waste Water Management, a wastewater works approval will be sought. (Engineering) •Wastewater irrigation to comply with DOH requirement (Engineering) •Areas appropriately sized to accommodate irrigation volume (Engineering) •Area is remote with closest watercourse approximately 8.5km away (Elimination)	•Wastewater system performance to be monitored in accordance with the manufacturers requirements (Administration)	•Where wastewater specifications are exceeded, corrective actions will be implemented to ensure wastewater is returned back into specification (Engineering)	1	1	L	Yes	The management of sewerage and greywater is mature with various NT wastewater management guidelines. Due to the temporary nature of the activity, the maximum contamination resulting from sewerage and grey water irrigation is likely to be minor, with any impacts locally restricted and temporary in nature. The closest watercourse is approximately 8.5km, with the potential contamination of these features considered remote (probability <1%).	Yes	Low
9	**Soils**	Loss in long-term soil productivity and viability.	Soil compaction from access tracks and leases.	A.4.1 Site selection and planning	2	3	M	•No Land Clearing proposed (Elimination) •Lease pad is built and topsoil has been stockpiled for future rehabilitation (Elimination) •rehabilitation plan developed and rehabilitation security held 9administration) •The current disturbance area is small (less than 0.005% of total tenure area) (Elimination)	•Rehabilitation monitoring to assess soil productivity impacts (Administration)	•Areas with poor rehabilitation will be maintained to reduce impact (Engineering)	2	2	L	Yes	During the operation of lease pads, access tracks , camp pads etc., these sites will be compacted. Long term impacts of this compaction will be addressed during the rehabilitation of the sites. A loss of productivity is anticipated in the earlier stages of rehabilitation, returning back to pre-disturbed state within ~10 years. This will be accelerated through removal of hard stand areas, ripping and scarifying compacted surface. the consequences is likely to be "moderate", being locally restricted, with a moderate- long (years) recovery time. The likelihood of long term productivity impairment is considered "highly unlikely" (probability <10%), given the observed rehabilitation from previous disturbance activities.	Yes	Low
10			Soil erosion from cleared areas impacting sensitive receptor (access tracks, lease pads, gravel pits and camp pads).	A.4.3 Erosion and sediment control and hydrology	1	4	M	•No Land Clearing proposed (Elimination) •Existing site with established Erosion and Sediment Control Plan in place and maintained in functioning condition (Engineering) •Sites to be maintained, with erosion and sediment controls kept in working order (Engineering) •Stockpiled debris to be used to discourage water concentration. (Engineering) •Absence of sensitive receptors in the vicinity of the exploration site	•Pre and post wet season erosion and sediment control inspections. •Rehabilitation monitoring to assess soil productivity impacts (Administration)	•Maintenance completed on areas where erosion is occurring or where the controls are defective (Engineering) •Areas with poor rehabilitation will be maintained to reduce impact (Engineering)	1	3	L	Yes	The erosion and sediment release from cleared area is a well document impact. The consequences of erosion from disturbed areas are likely to be minor, a function of the low risk nature of the site soils types, slope of the area, design of infrastructure and ongoing inspection and maintenance programs. Based on the nature of the wet season and associated high intensity storm events, the likelihood of these minor locally restricted erosion events is considered possible (Possible 60%) .	Yes	Low
11		Soil contamination due to spills and leaks of chemicals or wastes .	Spills/leaks from the on-site storing and handling of fuels, completion chemicals, oils, and other wastes	A.4.7 Containment of Contaminants C.8.2 Spill Management Plan	2	3	M	•Limited volume of chemicals or fuels proposed to be stored onsite to support operations. •All chemical, fuel and waste storage and high risk spill handling areas are to have secondary containment, with an impermeable liner with coefficient of permeability of less than 10-9 m/s •Licenced waste transporters to be used to transport listed wastes. •Chemicals to be transported in accordance with the Australian Dangerous Goods Code and NT Dangerous Goods Act. •No chemical or wastewater transportation during wet season, unless a risk assessment determined the activity is safe and low risk •All transportation of listed wastes and dangerous goods to be undertaken via licenced contractors. •Area is remote with major urban areas to be avoided during the transportation of dangerous goods and wastes in accordance with the NT Dangerous Goods Act. •Origin has completed 100,000's of chemical and wastewater trucking movements in QLD without significant incident causing material environmental harm	• No chemical storage areas to be left onsite unattended over the wet season	•Chemical storage bund liner leaks to be investigated and liners repaired as soon as practicable •Spills and leaks to be cleaned up and rectified immediately •Any contamination event to be characterised and have remediation plans developed and executed in accordance with the process outlined in schedule A of the National Environmental Protection (Assessment of site Contamination) Measures (Engineering)	2	2	L	Yes	The storage, handling and management of chemicals is a standard activity that is managed through a mature regulatory setting. The COP further reduces the likelihood and consequence of chemical spills and contamination, through the mandated use of secondary containment, a spill management plan and groundwater monitoring. A spill event is likely to result in moderate, short term reversible impacts restricted to the existing lease pad. The likelihood is further reduced down to highly unlikely(<10% probability of occurring) based on the use of secondary containment, rapid spill detection and rehabilitation requirements..	Yes	Low

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12			Chemical and waste transportation accident.	A.4.7 Containment of Contaminants C.8.2 Spill Management Plan	3	2	M	•Limited volumes of chemicals or wastes likely to be utilised/ generated which reduces transportation risk •Risk assessment completed for all wet season transportation of chemicals and wastes (Administration) •All wastes to be transported in accordance with the NT Waste Management and Pollution Control Act. (Administration) •All dangerous goods to be transported in accordance with the NT Dangerous Goods Act and Australian Dangerous Goods Code.(Administration) •Transportation route to avoid major urban areas •All drivers to be approximately licenced (Administration) • Fatigue management plan implemented, requiring journey management plans and drivers to rest every 2 hours (Administration) •Access track maintained to allow periodic wet weather access •Strict drug and alcohol policy implemented, with routine testing and 0 zero tolerance policy to alcohol (0.00% limit) and drugs (Administration) •Area is remote with major urban centres to be avoided. (Elimination) •Risk to any receptor is identical to that of normal diesel or petroleum tankers. •Training of Origin supervisors regarding chain of responsibility requirements to minimise the risk of driver fatigue (Administration) •Origin has completed 100,000's of chemical and wastewater trucking movements in QLD without significant incident causing material environmental harm (elimination) •The transportation of waste and chemicals across Australia is a standard practice with mature codes and legislation in place. the transportation of fuels, chemicals and wastes occurs every year in the NT to support existing industry's during the wet season. (Engineering)	•Transport incident statistics collected and monitored. (Administration) •Onsite assurances and fit for work assessments completed periodically on transport companies (Administration)	•All transport spills to be cleaned up immediately (engineering) •Contractor performance reviews completed where breaches in requirements are escalated and actions implemented to rectify defects. (administration)	3	1	L	Yes	The transportation of wastes and chemicals is a tightly controlled industry with mature practices designed to prevent, detect and respond to transportation spills. Any accident is likely to be restricted to road corridors and result in "serious", short term (days-weeks) reversible impacts. All contractors must be appropriately licenced, with National uniform legislation in place to offer a high level of regulatory protection. This risk is considered identical to that of bulk diesel and other dangerous goods transportation- a common activity throughout Australia. Fuel and chemical transport accidents are rare given the number of transportation movements in Australia. Origin has completed 100,000's of chemical and wastewater trucking movements in QLD without significant incident causing material environmental harm The likelihood of an event occurring is therefore considered "remote", what a probability of less than 1%.	Yes	Low
13		Soil contamination from the disposal of greywater and sewerage from camp activities.	Greywater and sewerage disposal (camps).		1	2	L	•Sewerage wastewater irrigated as per Department of Health code of Practice for On-site Wastewater Management (July 2014) (Engineering)(Elimination) •Where irrigation of sewage wastewater exceeds the triggers in the DoH Code of Practice for On-site Waste Water Management, a wastewater works approval will be sought. (Engineering) •Areas appropriately sized to accommodate irrigation volume (Engineering) •Area is remote with closest watercourse approximately 8.5km away (Elimination)	•Wastewater system performance to be monitored in accordance with the manufacturers requirements (Administration)	•Where wastewater specifications are exceeded, corrective actions will be implemented to ensure wastewater is returned back into specification (Engineering)	1	2	L	Yes	The management of sewerage and greywater is mature with various NT wastewater management guidelines. Due to the temporary nature of the activity, the maximum contamination resulting from sewerage and grey water irrigation is likely to be minor, with any impacts locally restricted and temporary in nature. The closest watercourse is approximately 20km, with the potential contamination of these features considered remote (probability <1%).	Yes	Low
14	**Flora and fauna**	Impact to listed threatened habitats and listed threatened flora and fauna through exploration activities.	Activity (vehicle and machinery) noise and lighting on well pads and access tracks.	A.4.1 Site selection and planning A.4.2 Noise	1	3	L	•limited activities proposed, with all activities likely to be temporary (days to weeks) •No opens storage of chemicals proposed •Site location avoids areas of high conservation value as a priority (Elimination) •Areas are not considered high conservation value, are not threatened/endangered and not fragmented, with impacts unlikely to result in significant disturbance to threatened/endangered species. (Elimination) •Impacts likely to be temporal, with fauna able to move to adjacent areas to escape impacts. (Elimination) .	•A site inspections and assurance completed to detect any injured/impacted fauna	•Where impacts are identified, practices will be reviewed and modified to reduce impact on fauna (Administration/ engineering) .	1	3	L	Yes	Limited activities proposed, with all activities likely to be temporary (days to weeks). Fauna may be disturbed temporarily through transport movements along access tracks and well maintenance activities around the lease pad. The consequence of activity nuisance is anticipated to be minor, with localised, short term impacts to areas immediately adjacent to access tracks. The likelihood of the risk is reduced through the isolated location (lack of sensitive receptors), regionally extensive vegetation communities (good outside refuge away from access tracks and limited transport movements during the evenings . The impact to fauna is considered highly unlikely given the ability of fauna to move to other areas of refuge away from E&A activities	Yes	Low
15			Introduction and spread of weeds in the area.	A.4.5 Weed management	2	4	M	•Limited activities proposed under the EMP, with no land clearing or major exploration activities. •All equipment and vehicles to be washed-down and to have a Biosecurity Declaration Certificate prior to access to site (Elimination) •Areas of proposed exploration have been surveyed and are deemed to have low weed abundance (elimination) •Activity will be restricted to defined lease pads and camp pads (Elimination)	•6 monthly monitoring implemented around infrastructure to detect the spread/ introduction of weed species (administration) •Origin assurance activities to target equipment wash-down certificates to ensure standards are being met. (Administration)	•Where weed outbreaks are identified associated with Origin's activities, infestations will be treated in accordance with the Weed Management Plan. (elimination) •Corrective actions implemented where ongoing biosecurity breaches are identified.	2	2	L	Yes	Due to the low intensity nature of the proposed activities, the lack of vehicle and equipment movements will inherently reduce the risk of weed spread. The area in the vicinity of the exploration sites are generally free of weeds, with Parkonsonia previously detected. Ongoing inspection and management of weeds within exploration areas is underway. Weeds are also present across the broader property, particularly in the adjacent road corridor.. Any introduction of weeds is likely to result in localised impact, with weed management requirements likely to reduce the consequence down to "moderate, short term. Due to the limited nature of the proposed activities, the risk likelihood is considered highly unlikely, with a probability less than <10%	Yes	Low
16			Accidental ignition of fire from exploration activities (site preparation, slashing and general access).	A 4.6 Fire management	3	3	M	•Limited activities proposed, with no major civil work or flaring proposed (Elimination) •Bushfire management plan implemented to prevent and respond to bushfires including establishment of communication and fire response protocols with pastoralists (Administration) •Bushfire awareness included in site inductions. (Administration) •Designated smoking areas on-site (Elimination) •Firefighting equipment to be available to deal with fires (Engineering). •Fire breaks have been constructed around the exploration lease and camp pads (Engineering) •Ignition sources placed outside of the hazardous area. (Elimination) •Intrinsically safe equipment used in hazardous area. (Elimination) •Hazardous area drawing will provide classification of hazardous zones. (Elimination) •Activities will comply with landholder and regional bushfire management plans. (Elimination)	•Annual fire preparedness assurance activities completed where activities are proposed during high fire risk periods (administration) •Daily monitoring of bushfires in the region during periods of high fire danger (administration) •Annual fire frequency mapping using the Northern Australia Fire Information fire history database (administration)	•Fire hazard reduction strategies (such as back burning) to be implemented to reduce the risk of fire ignition/ impact as required (Elimination) •Where a bushfire is started and cannot be controlled, Origin to engage with pastoralist to coordinate response activities	3	1	L	Yes	Fire is a common occurrence within the Barkly Region. A fire is likely to have a serious impact, with moderate term reversible impacts (years). With the appropriate controls, such as separation distances, firebreaks, and adherence to total fire bans, the likelihood of causing a fire from the limited regulated activities proposed is anticipated to be remote, with a predicted occurrence of <1%	Yes	Low
17			Poor rehabilitation of the site reduces regional habitat and promotes weed invasions	A.4.8 Rehabilitation	2	3	M	•A site specific Rehabilitation Plan has been developed and will be implemented progressively Engineering) •Areas will have infrastructure and wastes removed, topsoil respread and vegetation re-introduced. (Engineering) •Rehabilitation timing will consider seasonal constraints, with rehab completed prior to the wet season to maximise revegetation chance (Engineering)	•Rehabilitation monitoring to be undertaken to track rehabilitation progress (Administration)	•Maintenance will be undertaken periodically to fix any defects (Engineering)	2	2	L	Yes	rehabilitation practices are well known, with observed rehabilitation level sin the Beetaloo indicating rapid re-establishment of vegetation. A loss of productivity is anticipated in the earlier stages of rehabilitation, returning back to pre-disturbed state within ~10 years. This will be accelerated through removal of hard stand areas, ripping and scarifying compacted surface. the consequences is likely to be "moderate", being locally restricted, with a moderate- long (years) recovery time. The likelihood of long term productivity impairment is considered "highly unlikely" (probability <10%), given the observed rehabilitation from previous disturbance activities.	Yes	Low

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18			Contaminants in water and soil pass through the food chain and bioaccumulate in fauna causing detrimental impacts to local species and communities	A.4.7 Containment of Contaminants C.8.2 Spill Management Plan	2	2	L	•Chemical, and fuel volumes utilised, generated or stored onsite are likely to be minimal. •All chemicals stored in designated areas with secondary containment (Engineering)	•Routine weekly inspections to identify poor chemical handling storage practices (engineering)	•Where ongoing fauna interactions with chemicals are identified through monitoring, additional controls shall be implemented as appropriate to reduce the potential for exposure (such as additional fencing, deterrents etc.) (Engineering)	1	1	L	Yes	Minimal chemical storage activities are proposed onsite, which reduces both the potential consequence of exposure to fauna (i.e. limiting numbers) and likelihood. No open wastewater storage or long term chemical storage is proposed. The consequence is anticipated to be restricted to fauna individuals, with consequences of exposure considered "minor" -i.e. no broader ecological impacts. given the lack of exposure sources, the likelihood of impacts to an individual fauna is considered "remote"	Yes	Low
19			Vehicle collisions with fauna – fauna mortality results in a localised impact to listed threatened species	A.4.4 Biodiversity protection	1	1	L	•Vehicle speed limited to 40km/hr to be reduced around areas of high risk of fauna collision (Administration) •Vehicle movements to avoid driving at night (Elimination) •Fauna collisions observed during the previous 2015- 2021 exploration program have been minimal, with collision restricted to several wallabies along access track (elimination) • Absence of listed threatened species identified in the vicinity of the Lease pad and access tracks.	•Fauna mortality data is collected as part of Origin's incident and observation management procedures (Administration)	•Where ongoing fauna collisions are reported, additional controls shall be investigated, such as reduced speed limits in high risk areas will be implemented.(Administration)	1	1	L	Yes	Fauna collisions with vehicles are a commonly associated with roads. It is anticipated that a small number of fauna collisions will be experienced during the activity (1-2 animals per month), with minor, short term, reversible impacts to local fauna species. The likelihood of causing a localised decline in species abundance is considered remote.	Yes	Low
20			Encouragement of feral animals and other pest species increases leading to competition with native species. This includes the introduction of cane toads.	A.4.4 Biodiversity protection	1	2	L	• camp temporary and to require limited capacity. •Camp wastes to be storage to be animal proof (Engineering) •All food scraps to be removed from site and disposed of at a licenced facility (Elimination) •Food scraps to be frozen and stored within freezer during wet season (Elimination) •Experience from previous exploration activities conducted across the basin from 2015 to 2021 has not detected increased feral animal prevalence, with only 1 feral dog identified in 6 months of camp operations. (Elimination)	•Feral fauna observation data is collected as part of Origin's incident and observation management procedures (Administration)	•Where ongoing feral animal presence is detected, additional controls will be investigated in consultation with the pastoralist (such as fencing, removal of water sources etc.) (Engineering)	1	2	L	Yes	Feral animals may be increased through the provision of access to water, food (camps) and hunting habitat (such as road corridors). The use of the existing site and access tracks limits the additional risk associated with provision of additional hunting habitat. Food scraps and waste will be frozen and disposed of offsite which will reduce the food availability for pests. Wastewater is too saline for cane toads to survive, with the design of the tanks likely to restrict toad habitat. The anticipated consequence is minor, with the potential pest species increase anticipated to be small. The likelihood is determined to be highly unlikely, with a probability of less than 30%.	Yes	Low
21	**Cultural Heritage and Sacred Sites**	Exploration activities cause a disturbance of sacred site or culturally sensitive area and decline in environmental value of area used for hunting, foraging and enjoyment.	Sites disturbed directly by exploration activities	A.4.1 Site selection and planning	3	2	M	•Exploration Agreements with Determined Traditional owners covering all proposed exploration activities. •All areas of the proposed activity to be cleared by NLC. (Elimination) •AAPA certificates for proposed work program have been granted (Elimination) •The location of infrastructure has considered proximity to sacred sites (Elimination) •Areas of cultural heritage to be avoided during construction (Elimination) •Areas of cultural significance are not within 8km of the proposed area of activity (Elimination) •Implementation of the unexpected finds protocol (Administration).	•Origin completes 6 monthly assurance programs to confirm access to sacred sites has not occurred.	•N/A- no access to sacred sites anticipated. (Elimination)	3	1	L	Yes	All sites of the proposed activity must have Traditional Owner clearance via the NLC. AAPA certificates are required for all activities to ensure sacred sites are not impacted by activities. The remote location of the activity, compliance (and supervision)with restricted work area requirements for access track maintenance and contractual requirements prohibiting access reduce the likelihood down to "Remote", with a probability lower than 10%.	Yes	Low
22			Accidental ignition by site activities (site preparation, slashing, grinding etc.)	A 4.6 Fire management	3	2	M	•Bushfire management plan implemented to prevent and respond to bushfires including establishment of communication and fire response protocols with pastoralists (Administration) •Bushfire awareness included in site inductions. (Administration) •Designated smoking areas on-site (Elimination) •Firefighting equipment to be available to deal with fires (Engineering). •Fire breaks have been constructed around the exploration well lease and camp pads (Engineering) •Ignition sources placed outside of the hazardous area. (Elimination) •Intrinsically safe equipment used in hazardous area. (Elimination) •Hazardous area drawing will provide classification of hazardous zones. (Elimination) •Activities will comply with landholder and regional bushfire management plans. (Elimination)	•Annual fire preparedness assurance activities completed where activities are proposed during high fire risk periods (administration) •Daily monitoring of bushfires in the region during periods of high fire danger (administration) •Annual fire frequency mapping using the Northern Australia Fire Information fire history database (administration)	•Fire hazard reduction strategies (such as back burning) to be implemented to reduce the risk of fire ignition/ impact as required (Elimination) •Where a bushfire is started and cannot be controlled, Origin to engage with pastoralist to coordinate response activities	3	1	L	Yes	Fire is a common occurrence within the Barkly Region. A fire is likely to have a serious impact, with moderate term reversible impacts (years). With the appropriate controls, such as separation distances, firebreaks, and adherence to total fire bans, the likelihood of causing a fire from the regulated activities is anticipated to be highly unlikely, with a predicted occurrence of <10%	Yes	Low
23			Personnel unauthorised access to sacred site or performing work within a Restricted work Area	A.4.1 Site selection and planning	2	2	L	•Restricted work areas have been identified along access tracks, with no activities proposed for these areas (other than access and maintenance) (administration/ elimination)) •All staff to be inducted covering restricted work areas and cultural heritage (Administration) •Access off lease not permitted. (Elimination)	•Origin completes 6 monthly assurance programs to confirm access to sacred sites has not occurred.	• N/A- no access to sacred sites anticipated. (Elimination)	2	2	L	Yes	All sites of the proposed activity must have Traditional Owner clearance via the NLC.. AAPA certificates are required for all activities to ensure sacred sites are not impacted by activities. The remote location of the activity, lack of sacred sites in the vicinity of the Beetaloo W-1 lease pad and contractual requirements prohibiting access reduce the likelihood down to "highly unlikely", with a probability lower than 10%.	Yes	Low
24	**Community impact**	Loss of visual amenity, experience and sense of place for landholder, community members and tourists.	Industrialisation of landscape.	A.4.1 Site selection and planning A.4.1.1 Well pad specific site selection	1	1	L	•Existing location use •Site is located away from major roads and not clearly visible: (Elimination) •Progressive rehabilitation to occur when sites are no longer required for future operations (engineering) •Activity intensity is restricted to specific periods, with most activity restricted to the lease pad (elimination). •Workers are flown in and out of Daly waters from Darwin. Busses are used to limit vehicle transport movements between the Daly Waters airport and remote camps- there is limited Drive In/Drive Out workers into the Beetaloo- except where local or regional contractors are utilised. •Camps utilised where staff numbers are high to minimise impact on local accommodation and tourism.	•Ongoing community engagement to monitor performance and identify potential impacts from activity on local amenity.	•N/A- site location and activity intensity is unable to be changed.	1	1	L	Yes	The proposed exploration activities are located away from major transport routes, homesteads and communities. The consequences of activities are not anticipated to result in changes to aesthetics through visibility of exploration activities due to the remote location. The probability that the activity will result in an industrialisation of the landscape is considered remote, with a probability less than 1%.	Yes	Low
25			Increased traffic from exploration activities	A.4.1 Site selection and planning	1	2	L	•Traffic impact assessment completed assessing the increased traffic levels as negligible: reflective of limited size and scope of activity. •Traffic impacts are expected to small and temporary . •Access route is away from the main homestead of Beetaloo Station. •Capacity of road and level of service will not be impacted materially. •Workers are flown in and out of Daly waters from Darwin. Busses are used to limit vehicle transport movements between the Daly Waters airport and remote camps- there is limited Drive In/Drive Out workers into the Beetaloo- except where local or regional contractors are utilised. •Traffic issues were not identified during the previous Beetaloo W-1 drilling and stimulation program or the Kyalla 117 N2-1 well drilling and stimulation campaign.	•Ongoing community engagement to monitor performance and identify potential impacts from activity on traffic.	•Complaints regarding traffic will be dealt through Origins complaint resolution process. Where valid complaints are received, additional controls will be implemented to address community complaints (such as changes to vehicle load movements etc.)	1	2	L	Yes	The increased traffic from the activity is likely to be minimum, short term and within the Level of service of the existing roads. Increases in traffic are anticipated to have a "minor" consequence (increase in traffic observable, but temporary). The likelihood of causing a loss of experience from the E&A activities is considered "Highly unlikely", with an anticipated probability of less than 10%.	Yes	Low
26			Light emissions impact on sensitive receptor (such as pastoralist)	A.4.1 Site selection and planning	1	2	L	•Site is located in a remote location 34km away from the Stuart Highway and ~12km the nearest homestead. (elimination) •No flaring or night-time work proposed.. (Elimination) No pastoralist complaints received from the previous Beetaloo W-1 activities	•Ongoing pastoralist engagement to monitor performance and identify potential impacts from activity on local amenity. (Administration)	•Complaints regarding light emissions will be dealt through Origins complaint resolution process. Where valid complaints are received, additional controls will be implemented to address community complaints	1	1	L	Yes	The limited nature of activities (no flaring), remote location and separation distances between receptors is likely to result in minor light emissions. The likelihood of impacts is a function of separation distance and is therefore predicted to be highly unlikely, with a probability less than 1%	Yes	Low

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27			Influx of workers to region		1	1	L	•Work temporary in nature and utilises existing regional contractors where available (elimination) •Engagement with the pastoralists and directly affected community completed to communicate scope of work (administration) •Site camps utilised where worker numbers are high to minimise workers within local community (elimination)	•Ongoing community engagement to monitor performance and identify potential impacts from activity on local communities.	•Complaints regarding work influx are unlikely and will be dealt through Origins complaint resolution process. Where valid complaints are received, additional controls will be implemented to address community complaints.	1	1	L	Yes	The limited scope and duration of activities reduces the risk and uncertainty associated with risk to a minor impact, remote likelihood.. Most workers will be located away from communities, meaning there is unlikely to be a major increase in people.	Yes	Low
28			Noise emissions from activities.	A.4.1 Site selection and planning A.4.2 Noise	1	1	L	•Site is located off the Stuart Highway and the closest homesteads is approximately 12km. Noise impacts will not reach sensitive receptors, with QLD experience on rig and stimulation noise indicating noise levels approaching background levels approximately<2km from the activity. (Elimination) •Noise limits have been adopted form the Northern Territory Noise Management Framework Guidelines . The adopted project specific noise level has been determined at 45_{LaAeq} dB (during the day and 35_{LAeq} dB during the night), which assumes a rural background noise of 40_{LAeq} dB and a target intrusive noise level increase of 5 dB. Given no sensitive receptors within the vicinity of the activity, the activity will be compliant with this limit under all activity and environmental condition. •No valid complaints from pastoralists received from the previous Beetaloo W-1 activities	•Ongoing pastoralist engagement to monitor performance and identify potential impacts from activity on local amenity. (Administration)	•Complaints regarding noise emissions will be dealt through Origins complaint resolution process. Where valid complaints are received, additional controls will be implemented to address community complaints	1	1	L	Yes	The limited nature of exploration activities and remote location and separation distances between receptors is likely to result in "minor" noise impacts. The likelihood of impacts is a function of separation distance and is therefore predicted to be remote, with a probability less than 1%	Yes	Low
29		Reduction in land productivity.	Introduction and spread of weeds in the area.	A.4.5 Weed management	3	4	M	•Limited activity proposed, with lease site free of weeds (elimination) •All equipment and vehicles to be washed-down and to have a Biosecurity Declaration Certificate prior to access to site (Elimination) •Areas of proposed exploration have been surveyed and are deemed to have low weed abundance- Parkonsonia (WONS) has been identified in the vicinity of the access track and will be managed. (elimination) •Activity will be restricted to defined lease pads and camp pads (Elimination)	•6 monthly monitoring implemented around infrastructure to detect the spread/ introduction of weed species (administration) •Origin assurance activities to target equipment wash-down certificates to ensure standards are being met. (Administration)	•Where weed outbreaks are identified associated with Origin's activities, infestations will be treated in accordance with the Weed Management Plan	2	2	L	Yes	Limited activities are proposed under this EMP, limiting the potential for weed introduction or spread. The area in the vicinity of the Beetaloo W-1 site is generally free of weeds, with Parkonsonia (a WONS) previously identified on the access track. Weed monitoring and management will continue to mitigate the impacts of these weeds. Weeds are present across the broader property, particularly in the adjacent Stuart Highway road corridor. Any introduction of weeds is likely to result in localised impact, with weed management requirements likely to reduce the consequence down to "moderate, short term. Due to the limited nature of the activities the risk likelihood is considered highly unlikely, with a probability less than <10%	Yes	Low
30		Reduction in the availability of groundwater for pastoral uses	Over extraction of groundwater.	A.4.1.1 Well pad specific site selection requirements	1	1	L	•Groundwater extraction for activities to be restricted to the minimum water required. (Elimination) •Groundwater bores are metered for groundwater take. (Engineering) •All water take licenced in accordance with NT Water Act under Water Extraction Licence (WEL) GRF 10285 (Administration) •Drawdown from activity and other users assessed by DEPWS as a part of WEL; impacts to closest receptor not anticipated (Administration/ Elimination) •Karst system is under allocated, with sufficient available capacity to support proposed water extraction requirements. (Elimination) •Closest pastoralist receptor is ~12km from extraction point (Elimination)	•Continuous flow meters to monitor take and water balance implemented to ensure compliance with WEL (Administration) • Groundwater monitoring completed to identify impacts associated with water extraction (Engineering)	•Groundwater extraction to cease where sustained drawdown post pumping exceeds 1 m (Administration)	1	1	L	Yes	The extraction of groundwater for hydraulic fracturing activities requires all take to be licenced. The proposed take is minor and is assessed as a part of the licence application, with the assessment considering current and future water take levels. Based on this assessment, it was determined that the extraction rate would not impact upon adjacent users. The risk consequence is determined to be "minor"- given the lack of water take proposed and proximity to pastoralist bores. The likelihood of such a consequence from occurring is considered remote (probability <1%) due to the quality of the Cambrian limestone aquifer, separation distance from surrounding users and under utilisation of aquifer.	Yes	Low
31		Reduction in land productivity.	Bushfire from accidental ignition by site activities (site preparation, grinding etc.) or personnel.	A 4.6 Fire management	3	2	M	•Bushfire management plan implemented to prevent and respond to bushfires including establishment of communication and fire response protocols with pastoralists (Administration) •Bushfire awareness included in site inductions. (Administration) •Designated smoking areas on-site (Elimination) •Firefighting equipment to be available to deal with fires (Engineering). •Fire breaks have been constructed around the exploration well lease and camp pads (Engineering) •No flaring proposed (Engineering) •Ignition sources placed outside of the hazardous area. (Elimination) •Intrinsically safe equipment used in hazardous area. (Elimination) •Hazardous area drawing will provide classification of hazardous zones. (Elimination) •No grinding or hot works during periods of total fire ban (Elimination) •Activities will comply with landholder and regional bushfire management plans. (Elimination)	•Annual fire preparedness assurance activities completed where activities are proposed during high fire risk periods (administration) •Daily monitoring of bushfires in the region during periods of high fire danger (administration) •Annual fire frequency mapping using the Northern Australia Fire Information fire history database (administration)	•Fire hazard reduction strategies (such as back burning) to be implemented to reduce the risk of fire ignition/ impact as required (Elimination) •Where a bushfire is started and cannot be controlled, Origin to engage with pastoralist to coordinate response activities	3	1	L	Yes	Fire is a common occurrence within the Barkly Region. A fire is likely to have a serious impact, with moderate term reversible impacts (years). With the lack of activity combined with the appropriate controls, such as separation distances, firebreaks, and adherence to total fire bans, the likelihood of causing a fire from the regulated activities is anticipated to be remote, with a predicted occurrence of <1%	Yes	Low
32			Poor rehabilitation of exploration infrastructure.	A.4.8 Rehabilitation	2	2	L	•A site specific Rehabilitation Plan has been developed and will be implemented progressively (Engineering) •Areas will have infrastructure and wastes removed, topsoil respread and vegetation re-introduced. (Engineering) •Rehabilitation timing will consider seasonal constraints, with rehab completed prior to the wet season to maximise revegetation chance (Engineering)	•Rehabilitation monitoring to be undertaken to track rehabilitation progress (Administration)	•Maintenance will be undertaken periodically to fix any defects (Engineering)	2	2	L	Yes	Rehabilitation success will be determined through the timing of rehabilitation, with rehab activities undertaken before the wet season to maximise success. Ongoing monitoring and maintenance of rehabilitated areas will be critical to identify and repair areas where rehabilitated success is poor, Consequences are likely to be moderate, with impacts likely to have moderate, locally restricted and medium to long term (1-5 years). The likelihood is influenced by the requirement for security provisions, rehabilitation plan requirements, ongoing monitoring and management and COP conditions. The likelihood is anticipated to be highly unlikely, with a probability below 10%.	Yes	Low
33			Disruption of agricultural operations due to ongoing access, traffic, helicopter movements etc.	A.4.1 Site selection and planning A.4.2 Noise	1	3	L	•All activities require engagement with pastoralists (Administration) •Lease site has been located to avoid disruption to agriculture operations and infrastructure (Elimination) •Engagement will be undertaken in accordance with NT Petroleum (Environment) Regulations (Administration) •Traffic levels are anticipated to be small- as per Traffic Impact Assessment.(Elimination) •Helicopter movements to be restricted to wet season when landholder activities are minimal (Elimination) •Helicopter movements to be undertaken in consultation with leaseholder to avoid impacts to livestock, cattle yards, watering points, homesteads and other sensitive areas as advised by leaseholder. (Elimination)	•Ongoing pastoralist engagement to monitor performance and identify potential impacts from activity on local amenity. (Administration)	•Complaints regarding Origin's activities will be dealt through Origins complaint resolution process. Where complaints are received, Origin will investigate if additional controls are needed and implement to address the complaint	1	2	L	Yes	This site is an existing site with limited activities proposed. Origin has extensive experience in co-existing its activities with agricultural users. Consultation with pastoralists is undertaken to ensure impacts on their activities are mitigated. These impacts are addressed in the compensation agreements and access guidelines. It is noted that there is an impact on stakeholder in regards to working with proponents to plan E&A activities. This is unavoidable, albeit of minor impost, and required to ensure the activities can be designed to accommodate the activities of both parties. Consequences are anticipated to be minor for E&A activities, with the likelihood highly unlikely. The likelihood is reduced through compensation agreements which consider the pastoralist time when negotiating agreements.	Yes	Low

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34		Safety hazard to pastoralists, community and tourists from increased traffic levels	Increased risk of vehicle accident	A.4.1 Site selection and Planning	3	1	L	•Traffic impact assessment completed, with traffic levels are anticipated to be small (Elimination) •Fatigue management policy implemented for transport companies, with breaks required every two hours (Administration) •Alcohol and drug policy implemented with zero tolerance (0.00% BAC and no illicit substances) (Elimination) •Workers are flown in and out of Daly waters from Darwin. Busses are used to limit vehicle transport movements between the Daly Waters airport and site- there is limited Drive In/Drive Out workers into the Beetaloo- except where local or regional contractors are utilised. (Elimination) • Camps to be sued where worker numbers are high to limit traffic and accommodation issues (eliminating) •Origin has completed 100,000's of transport movements each in QLD with transports incidents extremely rare. (Elimination)	•Ongoing community engagement to monitor performance and identify potential impacts from activity on local amenity. (Administration)	•Complaints regarding Origin's activities will be dealt through Origins complaint resolution process. Where valid complaints are received, additional controls will be implemented to address community complaint (Administration)	3	1	L	Yes	E&A activities will increase traffic levels up to 16 vehicles per day during the peak. This traffic volume is well below the Level of Service for the highway, which is estimated to be above 700 vehicles per hour. Accidents from truck turning into access tracks or from general vehicle accidents are anticipated to have a serious consequence, with an injury to community members/ tourist requiring hospitalisation. Given Origin completed 100,000's of heavy vehicle movements each year with serious incidents extremely rare, smaller volume of traffic required for Beetaloo, the lack of road users, traffic management plan for the access track turn in, Zero tolerance for alcohol and drugs and use of trained drivers, the likelihood is considered Remote, with a probability less than 1%	Yes	Low
35		Labour competition with local businesses and agricultural procedures.	Exploration activities compete with agricultural industry for resources.		1	1	L	•Proposed activity is temporary with no major labour requirements- stakeholders engaged to ensure they know the temporal nature of work (Administration) •Local and regional contractors will be utilised where available (Elimination) •All work to be short-term with predominantly skilled workforce sourced regionally/interstate. •Contracts will be structured to reduce 'boom and bust' cycle (clear understanding of limited scope of work).	•Ongoing community engagement to monitor performance and identify potential impacts from activity on local amenity. (Administration)	•Complaints regarding Origin's activities will be dealt through Origins complaint resolution process. Where valid complaints are received, additional controls will be implemented to address community complaint (Administration)	1	1	L	Yes	Labour competition is a consequence that may occur in a full scale shale development and is not anticipated to have a major impact during exploration. Exploration activities are generally short term campaigns and are completed similar to most small infrastructure projects (such as road upgrades). Local contractors are to be used where available, with a priority on using Tn businesses. The consequence of labour competition during E&A is minor, with a likelihood of remote (<1% probability)	Yes	Low
36		Reduction in air quality associated with the regulated activities (DFIT, maintenance etc.)	Emissions from the combustion of diesel.	A.4.1 Site selection and planning D.5.1 Baseline assessment	1	1	L	• low intensity activity proposed •Low emission equipment to be utilised (Engineering) •All equipment to be maintained in accordance with the manufacturer's recommendations (Engineering) •No sensitive receptors (homestead) within 12km (Elimination)	•Equipment condition and maintenance to be built into contract (Administration) •Routine site inspections and assurance undertaken to ensure equipment is maintained and operated as per manufacturers requirements. (Engineering)	•All equipment defects identified by site inspection and assurances to be rectified promptly.(Engineering)	1	1	L	Yes	Impacts to sensitive receptors are not anticipated, with the closest receptor over 12km away. No flaring or other intensive activities proposed.. The potential consequence from E&A activities is predicted to be minor. The likelihood is a function of source (lack of) and separation distance between receptors. the likelihood of a sensitive receptor being exposed to emissions from E&A activities above the NEPM guidelines are remote (<1%).	Yes	Low
37	**Air Quality and greenhouse gas emissions**	Increased nuisance from dust and particulate emissions associated with exploration activities caused impacts to regional ecosystems and fauna	Operational nuisance from DFIT or well maintenance. [Dust emissions from truck movements and civil works on unsealed areas]	A.4.1 Site selection and planning	1	2	L	•Water trucks will be used to decrease dust emissions. (Engineering) •Roads maintained to prevent bull dust generation (Engineering) •No sensitive receptors (homestead) within 12km (Elimination)	•Routine site inspections and assurance undertaken to identify and rectify high dust emissions (Administration)	•Dust control to be implemented where unacceptable dust from transport activities occur (Engineering)	1	2	L	Yes	Dust will be generated through transport movements along access tracks and around lease pads. The consequence of dust is anticipated to be moderate, with localised, short term impacts to areas immediately adjacent to access tracks. The likelihood of the risk is reduced through the isolated location (lack of sensitive receptors), regionally extensive vegetation communities (good outside refuge away from access tracks and use of dust suppression . As dust generation has been observed, and is commonly associated with dirt tracks, the likelihood of an impact is considered highly unlikely .	Yes	Low
38		Bushfire from accidental ignition by site activities (site preparation, grinding) or personnel.	A 4.6 Fire management		3	2	M	•no flaring proposed. (elimination) •Bushfire management plan implemented to prevent and respond to bushfires including establishment of communication and fire response protocols with pastoralists (Administration) •Bushfire awareness included in site inductions. (Administration) •Designated smoking areas on-site (Elimination) •Firefighting equipment to be available to deal with fires (Engineering). •Fire breaks have been constructed around the Beetaloo w-1 lease and camp pads (Engineering) •Ignition sources placed outside of the hazardous area. (Elimination) •Intrinsically safe equipment used in hazardous area. (Elimination) •Hazardous area drawing will provide classification of hazardous zones. (Elimination) •Activities will comply with landholder and regional bushfire management plans. (Elimination)	•Annual fire preparedness assurance activities completed where activities are proposed during high fire risk periods (administration) •Daily monitoring of bushfires in the region during periods of high fire danger (administration) •Annual fire frequency mapping using the Northern Australia Fire Information fire history database (administration)	•Fire hazard reduction strategies (such as back burning) to be implemented to reduce the risk of fire ignition/ impact as required (Elimination) •Where a bushfire is started and cannot be controlled, Origin to engage with pastoralist to coordinate response activities (Administration/ engineering)	3	1	L	Yes	Fire is a common occurrence within the Barkly Region. A fire is likely to have a serious impact, with moderate term reversible impacts (years). With the appropriate controls, such as separation distances, firebreaks, and adherence to total fire bans, the likelihood of causing a fire from the regulated activities is anticipated to be remote, with a predicted occurrence of <1%	Yes	Low
39		Unsustainable Greenhouse Gas emissions from the activity.	Combustion of diesel for exploration activities.	A.4.1 Site selection and planning	2	1	L	•Australian emission standards for equipment ensures minimum operating efficiency (Engineering) •All equipment to be maintained in accordance with the manufacturer's recommendations (Engineering) •No sensitive receptors (homestead) within 12km (Elimination)	•Equipment condition and maintenance to be built into contract (Administration) •Routine site inspections and assurance undertaken to ensure equipment is maintained and operated as per manufacturers requirements. (Engineering)	•All equipment defects identified by site inspection and assurances to be rectified promptly.(Engineering)	2	1	L	Yes	The risks associated with Greenhouse Gas generation through diesel combustion are well documented in literature and domestic/international greenhouse policy (such as NGERS and IPCC). The consequences of GHG generation from exploration activities is moderate, with less than 1% of the NT emissions generated. The likelihood of the level of GHG production being unsustainable is considered remote, with a probability less than 1%	Yes	Low
40			Uncontrolled release of gas encountered during DFIT or maintenance from operator error or vehicle collision	B.4.1 Well integrity management B.4.3 Well design and barriers D.5.8 Venting and flaring	2	2	L	•CBL and pressure test to be completed on well prior to commencement of DFIT operations to confirm cement integrity.. Cement or casing remediation to be completed as required. •All equipment will be API compliant to handle expected conditions (Engineering) •Site manned during well intervention, unmanned during wastewater storage with daily/ weekly inspections (depending on season)(engineering/ Administration) •Well suspended with multiple cement and casing barriers in place- with 4 casing section utilised (conductor, surface, intermediate and production).(Engineering) •Barricading to be used to protect each exploration well from vehicle collision. (Engineering)	•Process monitoring to detect events that could potentially result in a uncontrolled release of gas (such as fluid balances, well head pressure etc.) (Engineering) •Routine (monthly) well inspections (Administration	•Contracts in place with emergency well intervention specialists (such as Boots and Cootes) (administration) •Emergency response plan implemented (administration)	2	1	L	Yes	The COP and standard well integrity controls are designed to prevent the uncontrolled release of hydrocarbons. No flaring is proposed. The consequence are anticipated to be moderate, with impacts likely to be moderate, restricted in duration (minutes to hours). The likelihood is considered highly remote with a occurrence probability less than 1%, based on the well designed, construction and operations requirements mandated by the COP.	Yes	Low
41			Uncontrolled release of gas from well due to sabotage.	D.5.8 Venting and flaring	2	1	L	•well has not been stimulated, with limited free gas production potential (elimination) •well located 34km from public road on a private access track. •Multiple barriers used during well suspension/operation- including downhole suspension plugs, suspension fluid and surface valves (Engineering) •Sites manned during operation (during well interventions) (Administration) •Security cameras located on sites (Engineering) •Sites locked (Engineering) •Valves locked (Engineering)	•Routine (monthly) well inspections (Engineering)	•Contracts in place with emergency well intervention specialists (such as Boots and Cootes) Administration) •Emergency response plan implemented (Administration)	2	1	L	Yes	The risks associated with Greenhouse Gas generation through well sabotage is anticipated to be moderate, with impacts likely to b restricted in duration (hours to days). The likelihood is considered highly unlikely (probability <10%), with the site remoted and multiple valves locked on the well to prevent tampering	Yes	Low

Ref	Environmental Factor	Risk scenario description	Risk Source	Code of Practice	Unmitigated (no CoP implemented) Risk Rating			Risk mitigation Measures			Residual Risk Rating			ALARP criteria achieved?	Residual risk ALARP and Acceptable Statement	Acceptable criteria achieved?	Scientific Uncertainty Ranking
					Consequence	Likelihood	Risk Rating	Prevent	Detect	Recover	Consequence	Likelihood	Risk Rating				
42			Leak of gas from wells.	B.4.1 Well integrity management B.4.3 Well design and barriers D.5.4 Emission detection and management D.5.5 Leak remediation and notification	2	2	L	•well has not been stimulated, with limited free gas production potential. •Well constructed with multiple (4) specifically-engineered cement and steel casing barriers in place between hydrocarbon-bearing zone and surface. This includes conductor casing, surface casing, intermediate casing and production casing intervals (Engineering) • Well design and Well Barrier Integrity Validation reports submitted to DITT as part of Well Operations Management Plan (WOMP). (Administration/ engineering) •Wells constructed and suspended with barriers in place and verified as per code (engineering)	•Routine 6 monthly well leak detection (Engineering) •Routine (monthly) well inspections (Administration)	•Any leaking wells to be reported and remediated at a frequency consistent with the COP depending on severity (Engineering)	2	2	L	Yes	The consequence of a well leak are anticipated to be minor with impacts likely to be small (<1000L/hour) and restricted in duration (days to weeks). The likelihood is considered highly unlikely with a occurrence probability less than 10%, based on the well designed, construction and operations requirements mandated by the COP. Leak detection and reporting requirements are also controls to ensure any leaks are promptly identified and fixed.	Yes	Low
43	**Cumulative risk**	Cumulative impacts on groundwater quantify.	Groundwater take from surrounding land users exceeds the natural recharge rate of the Basin.	Water extraction licences under the NT Water Act	1	1	L	•Groundwater take volumes very small, <1ML •Groundwater extraction volumes to be monitored and kept below WEL (Elimination) •Groundwater extraction assessments include an estimate of current extraction levels at a regional scale. •No intensive users of groundwater within the region, with stock and domestic being the major usage. (elimination) •Cumulative impacts considered in the water extraction licence under the NT Water Act. (Elimination) •Strategic Regional Environmental Baseline Assessment (SREBA) completed to collected baseline environmental data, with Environmental Impact Assessments completed to address cumulative impacts from industry (Administration/ Engineering/ elimination)	•Regional groudnwater monitoring program and control/ impact groudnwater monitoring bores adjacent to extraciton point are likely to detect reductions in groudnwater levels at extraction points(Engineering)	•Where sustained groundwater depletion is observed in regional aquifers, alternative water supplies may be required, such as deeper aquifers with limited extraction (Elimination) •Water Act make good provisions to ensure any impacts on users from exploration activities are "made good"	1	1	L	Yes	The regional understanding of the CLA is sufficient to understand the risks associated with groundwater extraction. The absence of users and small exploration take reduces the uncertainty of the activity. This risk has been assessed as a part of the WEL application and approval. Due to the small water take proposed, lack of receptors, the consequence is considered moderate (i.e. 1 user within 12km) and likelihood remote (probability less than 1%	Yes	Low
44		Cumulative impacts on terrestrial ecology.	Impacts from exploration activities and existing agricultural activities results in impacts to vegetation communities, fragmentation and poses a threat to protected flora and fauna.	A.4.1 Site selection and planning A.4.1.1 Well pad specific site selection A.4.4 Biodiversity Protection	1	1	L	•Existing site with no new clearing proposed. •Area has limited development with no widespread land clearing or other pressures from agriculture or other users. (elimination) •Petroleum activity is limited in scale and will not material decrease availability of habitat across the region (Elimination) •Strategic Regional Environmental Baseline Assessment (SREBA) completed to collected baseline environmental data, with Environmental Impact Assessments completed to address cumulative impacts from industry (Administration/ Engineering/ elimination)	•N/A- No increased risk to cumulative regional impacts.	N/A.	1	1	L	Yes	The region has low land clearing pressure with no applications for large scale land clearing present. The level of disturbance proposed is small, with field ecological scouting confirming ecological communities present.	Yes	Low
45		Cumulative impacts on amenity.	Exploration activities further reduces amenity (visual, noise, traffic and lighting) through additional landscape modification, dust, noise, light and traffic.	A.4.1 Site selection and planning A.4.1.1 Well pad specific site selection	1	2	L	•Activity is located on an existing site and of limited duration. Activity may will not be visible from roads . (Elimination) •Traffic volumes are anticipated to be small and well below existing industries. (Elimination) •Low level of development activity within the region, with activity unlikely to cause declines in amenity. (Elimination) •absence of other industries in the region mitigating cumulative noise impacts (elimination).	•Community complaints regarding nuisance (including dust, traffic etc.) to be used to detect cumulative impacts (Administration)	•Complaints are to be investigated and additional controls implemented where appropriate. (Administration/ engineering)	1	1	L	Yes	The region is underdeveloped with the activity located away from major transportation routes, homesteads and communities. The activity is of a small size and unlikely to result in any loss of amenity. Any loss of amenity is therefore likely to be minor, with a likelihood of highly unlikely.	Yes	Low
46		Cumulative impacts on surface water quality.	Exploration activities in addition to existing surrounding land use (agriculture) reduces surface water quality.	A.4.1 Site selection and planning A.4.1.1 Well pad specific site selection A.4.3 Erosion and sediment control and hydrology	1	1	L	•Area has limited development with no widespread land clearing pressures from agriculture or other users likely to reduce water quality. (Elimination) •Activity will occur on existing disturbed areas with limited additional clearing. (Elimination) •No surface water take or wastewater releases permitted. (Elimination) •Strategic Regional Environmental Baseline Assessment (SREBA) completed to collected baseline environmental data, with Environmental Impact Assessments completed to address cumulative impacts from industry (Administration/ Engineering/ elimination)	N/A- no increased impact to surface waters anticipated	N/A- no increased impact o surface waters anticipated	1	1	L	Yes	The region is underdeveloped with the activity located away from major flow pathways with limited topographic variation.. The activity is of a small size and unlikely to result in any material increase in sediment loads to surface waters.	Yes	Low
47		Cumulative impacts-greenhouse gas emissions	Exploration activities materially increase Northern Territory's and Australia Greenhouse Gas emissions	B.4.1 Well integrity management B.4.3 Well design and barriers D.5.8 Venting and flaring	1	1	L	•No flaring proposed. •Full development (if technically and commercially viable) likely to provide a viable transition fuel with up to 50% emissions of coal (Engineering) •Total greenhouse gas emissions for the Beetaloo Sub-basin are low compared to total NT and Broader Australia Greenhouse gas emissions. •Strategic Regional Environmental Baseline Assessment (SREBA) completed to collected baseline environmental data, with Environmental Impact Assessments completed to address cumulative impacts from industry (Administration/ Engineering/ elimination)	N/A- Greenhouse gas emissions are approved prior to commencement of activity	N/A- Greenhouse gas emissions are approved prior to commencement of activity	1	1	L	Yes	The role natural gas plays as a low carbon intensity transition fuel to support renewable energy use is well known. Broad adoption of natural gas within the US has replaced coal in energy production and has been responsible for a continued decline in carbon emissions. The use of natural gas is one of the low carbon intensity fuels required to reduce carbon emissions.	Yes	Low

Appendix G Stakeholder engagement

Part A- Stakeholder Engagement Log Summary

Date	Originator of communication	Contact point	Contact type	Summary of contact	A statement of the interest holders response to stakeholder	Does it trigger merit review?	Change to EMP required ?	Details of changes the interest holder has made as a result of the stakeholder engagement
02/07/2021	Origin-David Armstrong	Beetaloo Pastoralist - Jane and Scott Armstrong	Email	Email from confirming stakeholder engagement under the PER's has been finalised, with no comments received on the stakeholder engagement pack after 35 days review (28 days was nominated in the stakeholder engagement pack as a reasonable review period consistent with eh public comment period of EMP's under the PER). Origin confirmed that even though stakeholder engagement as a part of the EMP has been finalised, ongoing stakeholder engagement will continue to address any comments/ concerns raised by the stakeholder engagement pack.	N/A	N/A	N/A	N/A
16/06/2021	Beetaloo Pastoralist - Jane Armstrong	Origin-David Armstrong	Email	Email from pastoralist confirming they would seek feedback from their legal representatives regarding comments on the stakeholder engagement pack.	N/A	N/A	N/A	N/A
16/06/21	Origin-David Armstrong	Beetaloo Pastoralist - Jane and Scott Armstrong	Email	Email from Origin inquiring as to whether the pastoralist legal representatives would likely provide comment on the stakeholder engagement pack	N/A	N/A	N/A	N/A
16/06/2021	Beetaloo Pastoralist - Jane Armstrong	Origin-David Armstrong	Email	Email from pastoralist confirming the stakeholder engagement pack submitted to lawyers for review	N/A	N/A	N/A	N/A
15/06/21	Origin-David Armstrong	Beetaloo Pastoralist - Jane and Scott Armstrong	Email	Email from Origin to Pastoralist asking if they have had a chance to review the Stakeholder Engagement Pack and have any feedback or questions.	N/A	N/A	N/A	N/A

Date	Originator of communication	Contact point	Contact type	Summary of contact	A statement of the interest holders response to stakeholder	Does it trigger merit review?	Change to EMP required ?	Details of changes the interest holder has made as a result of the stakeholder engagement
26/05/21	Beetaloo Pastoralist - Jane Armstrong	Origin-David Armstrong	Email	Email acknowledging receipt of stakeholder engagement pack	N/A	N/A	N/A	N/A
26/05/2021	Origin-David Armstrong	Beetaloo Pastoralist - Jane and Scott Armstrong	Email	Submission of Stakeholder Engagement Pack which covers the material required under the Petroleum (Environment) Regulations	N/A	no	N/A	N/A
21/04/2021	Origin- David Armstrong	Beetaloo Pastoralist - Jane Armstrong	Telephone	Discussion on proposed work program and submission of stakeholder engagement plan.	N/A	No	No	N/A
28-30/3/2021	Origin Energy- Russell Jeffrey, Cory Giefer, David Armstrong	NLC and Traditional Owners	Face to face	On Country meetings with Native Title Holders and NLC	Origin Energy provided an overview of work completed during CY2020 and discussed the CY21 work program approved by TOs and addressed any questions about our activities.	No	No	NA
4/3/21 (am)	Origin Energy- Russell Jeffrey/ Steph Stonier	NLC	Face to face	Meeting to map out the logistics for the on-country meetings with Native Title holders being held at the end of March and early April	N/A	No	No	NA
5/11/2020	Origin Energy- Simon Nish	Northern Land Council (NLC)	Face to Face Meeting	Meeting to provide an update on Origin's Beetaloo Exploration Project and planning discussions for future activities (2021 and 2022). Agenda items included; results from 2020 activities; 2021 and 2022 work programme; Sacred Site Clearance and Avoidance Surveys; site visit to Kyalla 117; on-country meetings with Native Title holders; compliance to existing agreement and timing of future production agreement	Record of the meeting taken by both parties	No	No	n/a
27/10/2020	Origin Energy- Russel Jeffrey	NLC	Face to Face	Ongoing meeting to discuss sacred site clearances and exploration activities.	Origin discussed a range of potential future exploration activities and provided a summary of the relevant site and environmental constraints	No	No	N/A

Date	Originator of communication	Contact point	Contact type	Summary of contact	A statement of the interest holders response to stakeholder	Does it trigger merit review?	Change to EMP required ?	Details of changes the interest holder has made as a result of the stakeholder engagement
22/09/2020	Origin Energy - Russell Jeffrey/ Steph Stonier	NLC/ TO's	Face to Face	Site visit to the Kyalla 117 N2 site to inspect the Kyalla 117 N2-1H site during stimulation. The Origin operations team walked the TO's through the site and provided them an overview of the processes and various environmental controls.	Origin fielded various questions regarding the processes	No	No	N/A
29/06/2020	Origin Energy	NLC	Face to Face	Meeting to provide an update of the Beetaloo exploration project and discuss sacred sites clearances.	Ongoing consultation/engagement with NLC regarding Origins current and future activities.	No	No	N/A
3/09/2019	Origin Energy	NLC -Greg Macdonald	Meeting	Meeting to discuss upcoming site clearances and scope amendment by Origin. Additional information on lease pad layout and revised site list include.	NA	No	NA	NA
03/04/2019-10/04/2019	Origin Energy	NLC/TO	Meeting	x6 on country meetings in Elliot with Native Title family groups regarding NLC Cleared Areas CA3 (Amungee NW1H (existing well site location), CA5 (Kyalla 117) and CA10 (Velkerri 76). Wednesday 8 May 2019, X1 meeting in Darwin with Native Title family for NLC Cleared Areas from Sacred Site Clearance and Avoidance Survey in response to Origin's WPS - All meeting included overview of the proposed work program and the environmental controls to address environmental risks. Origin used Story boards to present and discuss key aspects regarding the environment and its protection	NA	No	NA	NA
23/01/2019	Origin Energy	AAPA	Written	Electronic application AAPA to Amend AAPA Certificate 2018/103 to include drilling, well testing and hydraulic fracturing activities	NA	No	NA	NA
16/11/2018	Stakeholder	NLC -Greg Macdonald	Written	Letter and report for EP 98 work program and sacred site avoidance survey received. Information sent to AAPA via NLC to inform the authority Certificate application.	N/A	No	N/A	N/A

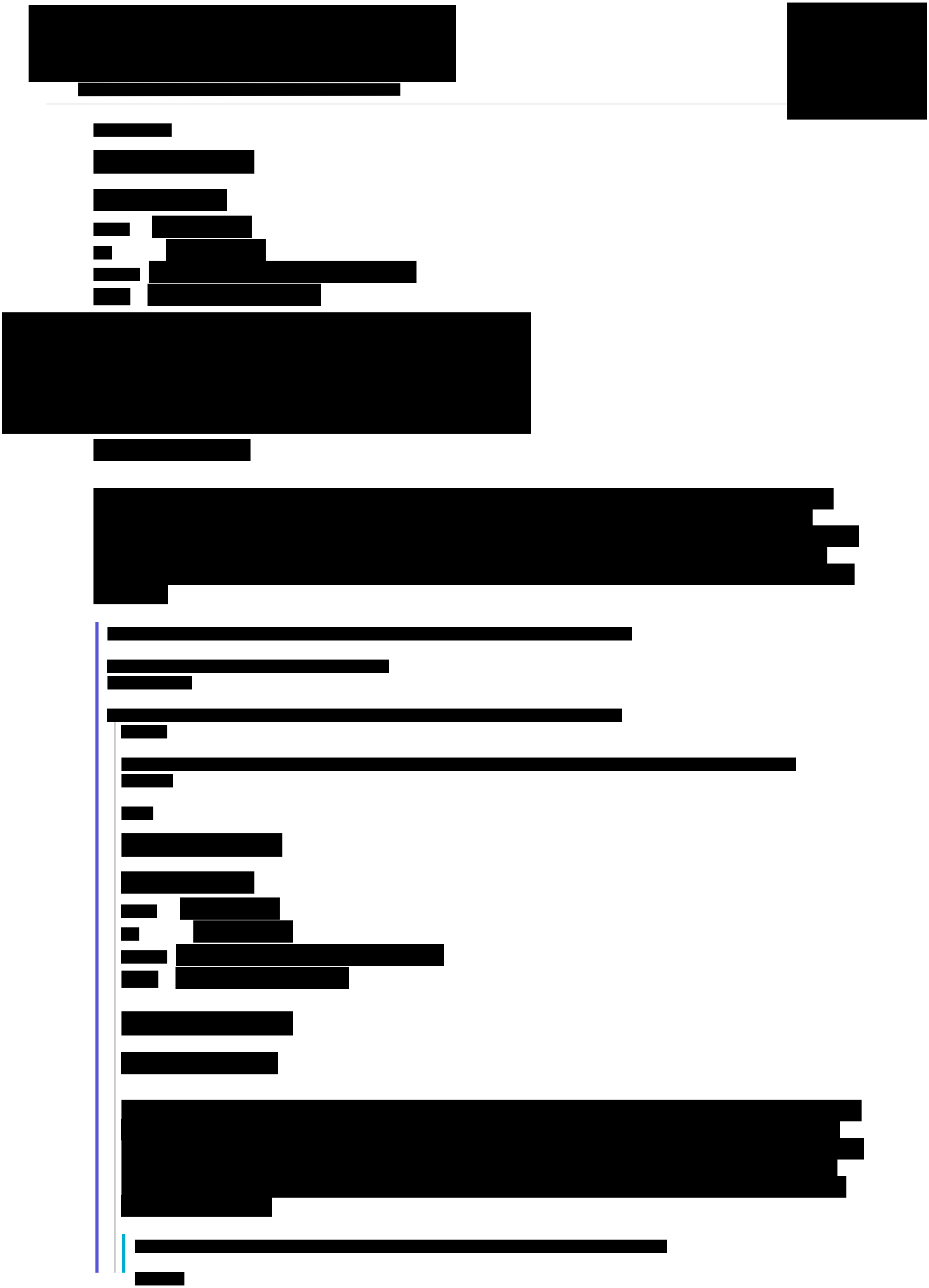
Date	Originator of communication	Contact point	Contact type	Summary of contact	A statement of the interest holders response to stakeholder	Does it trigger merit review?	Change to EMP required ?	Details of changes the interest holder has made as a result of the stakeholder engagement
03/09/2018- 04/09/2018	Origin Energy	NLC- Greg Macdonald	Meeting	Revised work program spatial information sent to NLC outlining variation to site clearance scope. Additional information on lease pad layout and revised site list included	No	No	Yes	Location in proximity to Jingaloo community Kyalla W2-1 removed from broader scope of Origin's exploration area
17/07/2018	Origin Energy	NLC -Greg Macdonald	Written	Origin provided additional information regarding maps and proposed site locations.	NA	No	NA	NA
10/07/2018	Origin Energy	NLC -Greg Macdonald	Written	Origin request to obtain site clearances for its proposed 2018/19/20 exploration program. This request included a description of the proposed activities (including up to 10 wells at each location, estimated duration and summary of key environmental considerations and risk controls.	NA	No	NA	NA

PART B Assessment against section 7 (2) of the Petroleum (Environment) Regulation stakeholder engagement requirements

Section 7(2)(a)	Document and Content	Date Provided
(i) "the regulated activity the interest holder proposes to carry out"	**Stakeholder Engagement Pack**: Email from Origin to Beetaloo station representative. Email included a stakeholder engagement pack which summarised the activity to be undertaken on the Beetaloo W1 site, access tracks, gravel pits and camp pad. Details of the regulated activity were provided in section "5 Description of the regulated activities".	26/05/2021
(ii) "the location (or locations) where it is proposed to carry out the activity"	**Stakeholder Engagement Pack**: Email from Origin to Beetaloo station representative. Email included a stakeholder engagement pack which summarised the location of the activity to be undertaken on the Beetaloo W1 site, access tracks, gravel pits and camp pad. Details of the regulated activity were provided in section "4 Location of regulated activities".	
(iii) "the anticipated environmental impacts and environmental risks of the activity's	**Stakeholder Engagement Pack** : Email from Origin to Beetaloo station representative. Email included a stakeholder engagement pack which summarised the environmental impacts and risks of the activity to be undertaken on the Beetaloo W1 site, access tracks, gravel pits and camp pad. Details of the regulated activity were provided in section "6 environmental outcomes, impacts and risks".	
(iv) "the proposed environmental outcomes in relation to the activity"	**Stakeholder Engagement Pack** : Email from Origin to Beetaloo station representative. Email included a stakeholder engagement pack which summarised the environmental outcomes of the activity to be undertaken on the Beetaloo W1 site, access tracks, gravel pits and camp pad. Details of the regulated activity were provided in section "6 environmental outcomes, impacts and risks".	
(v) "the possible consequences of carrying out the activity to the stakeholder's rights or activities"	**Stakeholder Engagement Pack**: Email from Origin to Beetaloo station representative. Email included a stakeholder engagement pack which summarised the consequences of carrying out the activity on the stakeholder's rights or activities. Details of the regulated activity were provided in section "7 consequences for stakeholder rights and activities".	

PART C Evidence of stakeholder engagement

Please note, detailed records of stakeholder engagement between the stakeholders has been provided in a separate file to DEPWS to protect the confidentiality and privacy of the stakeholder and Origin Energy. The stakeholder engagement pack provided to the Pastoralist is included below.



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Beetaloo Station

Petroleum (Environment) Regulations

Stakeholder Engagement Pack

Stakeholder Engagement Pack

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Stakeholder Engagement Pack

1 Introduction

Origin Energy B2 Pty Ltd (Origin) is a registered holder and the operator of exploration permit (EP) 117, which is located in the Beetaloo Sub-basin. Origin has an existing petroleum exploration well, Beetaloo W-1 located on the Beetaloo Pastoral Station.

Origin is required to revise/replace the approved Beetaloo Sub-basin, EP98 and EP 117 exploration drilling Environmental Management Plan (EMP) NT-2050-15-MP-0010 to cover all forward proposed activities associated with the existing Beetaloo W-1 petroleum exploration well. These forward activities are associated with the ongoing maintenance and collection of data from the existing well site (including the exploration well). No exploration well drilling, hydraulic fracture stimulation or well testing are proposed under this EMP.

In accordance with Section 6 (2) of the *Northern Territory (NT) Petroleum (Environment) Regulations 2016* (***PER***), the revised EMP can only be submitted for approval to the Minister after the interest holder (Origin) has carried out stakeholder engagement in relation to the regulated activity to which the plan relates. The requirements of stakeholder engagement are outlined in section 7 of the PER. Specifically, the interest holders are required to provide the following information:

- the regulated activity the interest holder proposes to carry out; and
- the location (or locations) where it is proposed to carry out the activity; and
- the potential environmental impacts the activity; and
- the proposed environmental outcomes in relation to the activity; and
- the possible consequences of carrying out the activity to the stakeholder's rights or activities.

This Stakeholder Engagement Pack (SEP) is designed to fulfill the stakeholder engagement requirements as defined under the PER.

Origin proposes that any questions or feedback to the information provided in this pack is formalised via the form included in Appendix A within 28 days of receipt of the SEP. This review timeframe is consistent with the EMP public comment timeframe provided by the Northern Territory Government under the PER for EMP's involving drilling and hydraulic fracture stimulation. Given the nature of the proposed activities, this is considered a reasonable period for the stakeholder to respond to the information provided.

Origin will ensure that all responses are reviewed, and feedback provided as appropriate. Origin also offers a face to face or virtual meeting with the Stakeholder where subject matter experts can present the information in this pack and answer any questions. These meetings should be arranged within 14 days of receipt of the pack so this engagement can be scheduled within the allocated engagement period. It should be noted that Origin is committed to ongoing stakeholder engagement beyond the legislated minimum requirements, with ongoing stakeholder engagement throughout the duration of the proposed activities.

2 Scope

The scope of this SEP is to satisfy the stakeholder engagement requirements defined in section 7 of the PER prior to the submission of the revised Beetaloo Sub-basin, EP98 and EP 117 exploration drilling EMP NT-2050-15-MP-0010.

These activities covered in this EMP are associated with the ongoing maintenance and collection of data from the existing petroleum exploration infrastructure (including the exploration well) for the next 5 years (the maximum duration of an EMP in accordance with the PER). No exploration well drilling, hydraulic fracture stimulation or well testing are proposed under this SEP and are therefore out of scope.

This SEP is restricted to the development and submission of the activities within the revised/new maintenance and monitoring EMP. Other approvals, such as land access and compensation agreements (LACA), are also required to be obtained prior to the activities proposed in this SEP. This SEP is specifically designed to address the requirements of the PER and does not cover other approvals such as the LACA. The requirements for compensation and access agreements for proposed regulated activities are covered under the *Northern Territory Petroleum Act 1984* and *Petroleum Regulations 2020* and will occur under a separate engagement process. To avoid any confusion, any comments received relating to the LACA or other approval not subject to this SEP, will be addressed by origin separately from this stakeholder engagement process.

3 Background

Origin holds three petroleum exploration permits in the Barkly region under the Beetaloo Joint Venture with Falcon Oil and Gas. These permits consist of EP76, EP98 and EP117 which cover 18,512 square kilometres (km^2) of largely pastoral leases on the Sturt Plateau, part of the Barkly Tableland, within the Northern Territory (Figure 1). These tenures were originally granted by the NT Minister for Mines and Energy under the NT *Petroleum Act 1984*.

The Beetaloo W-1 appraisal well was drilled in 2016 under executed (16th September, 2015) Land Access and

Compensation Agreement Beetaloo Station. The E&A well has been suspended since the completion of drilling activities, with routine maintenance and monitoring conducted since this time.

This revised EMP covers the proposed 2021-2026 forward regulated activities associated with the existing Beetaloo W1 petroleum exploration well. These include activities required to maintain the stability and safety of the existing infrastructure, as well as allow for future monitoring and data collection and final site rehabilitation works.

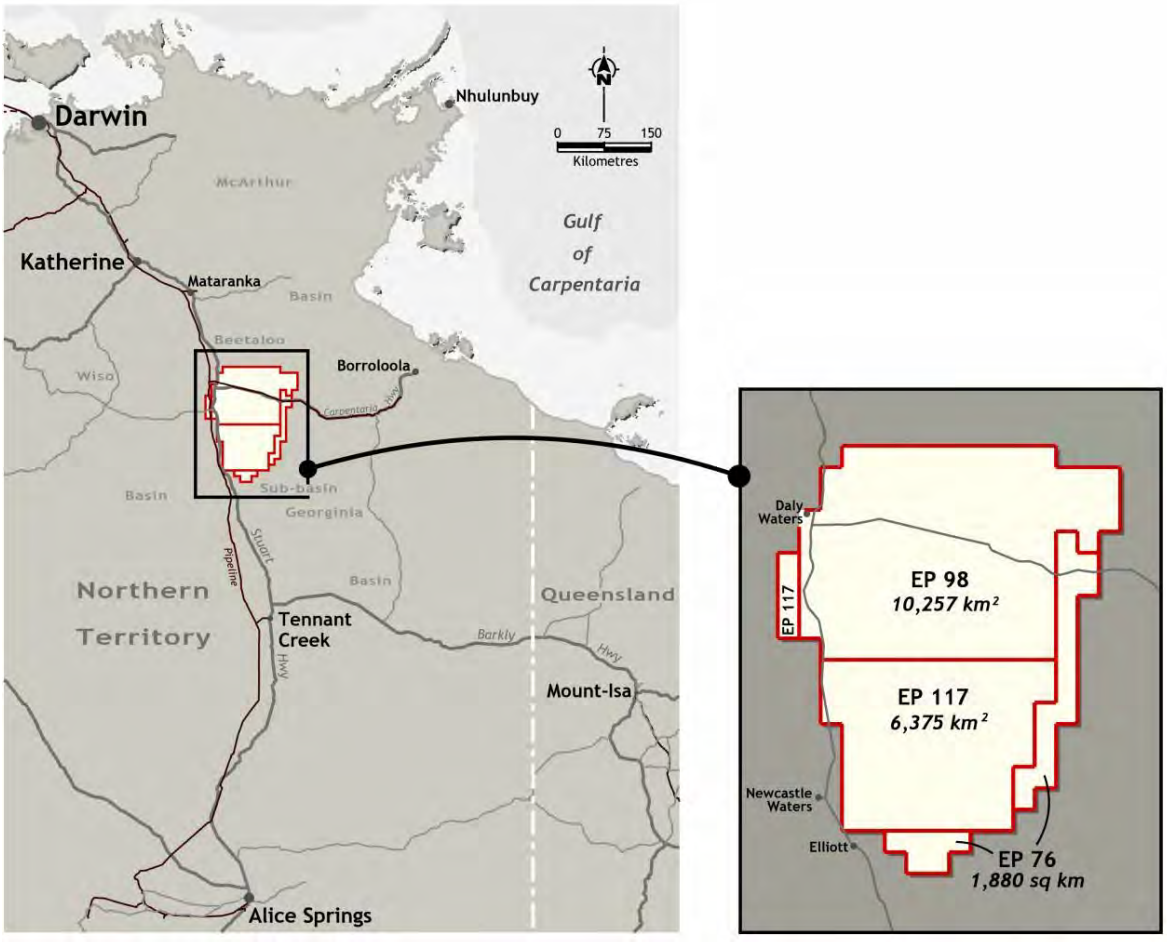


Figure 1 Location of Origin Permit Area.

4 Location of the Regulated Activities

The proposed activities will remain inside the current disturbance area at Beetaloo W1 site. The Beetaloo W-1 site is located on the Beetaloo Pastoral station, approximately 100km South-west of Daly Wasters. Access to the site is via a 34km access track connecting the Stuart highway to the Beetaloo W-1 lease pad.

The location of the activities are provided in Table 1 and Figure 4 . Images of the existing lease pad and exploration well are provided in Figure *2* and Figure 3.

Table 1 Existing infrastructure location.

Exploration Permit	Infrastructure Name	Station	Zone*	Approx Easting	Approx Northing	Approximate area
EP117	Beetaloo W1 Lease Pad	Beetaloo	53	368312	8106695	~3.5ha
EP117	Beetaloo W1 Camp Pad and sewer spray field	Beetaloo	53	367863	8106777	~0.9ha

EP117	Existing 35km Access track	Beetaloo	53	368082 335845	8106705 8106352	~34km
EP117	Gravel Pit 1	Beetaloo	53	341177.31	8106350	0.5ha
EP117	Gravel Pit 1	Beetaloo	53	348615.28	8106403.9	0.5ha
EP117	Gravel Pit 1	Beetaloo	53	355401.19	8106540.91	0.25ha

** Universal Transverse Mercator (UTM) geographic coordinate system is Geocentric Datum of Australia (GDA) 94.*

*

Figure 2 Aerial image of the Beetaloo W-1 site

Figure 3 Beetaloo W-1 exploration well

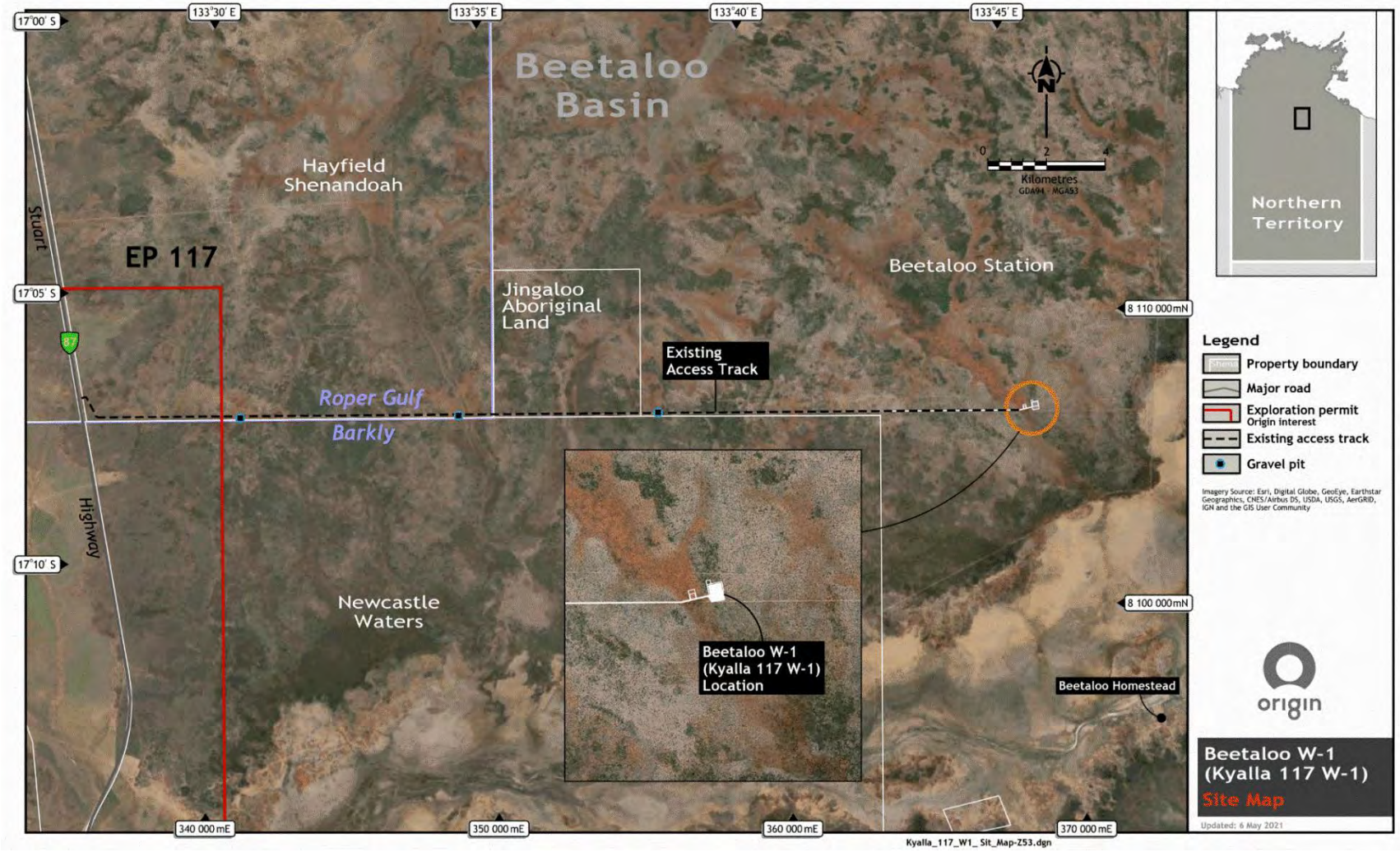


Figure 4 Beetaloo W-1 location map

5 Description of the Regulated activity

The core activities covered under this SEP can be summarised as:

- Routine site (surface) monitoring and maintenance
- Routine exploration well inspection, monitoring and maintenance
- Collection of reservoir data (including the execution of a Diagnostic Fracture Injection Test (DFIT))
- Suspension and/or abandonment of the exploration well
- Rehabilitation of disturbed exploration areas (lease pad, camp pad and access tracks)

A detailed description of the activities, their timing and typical duration is provided in Table 2. Pictures of selected activties have also been provided to assist in understanding the size and nature of the activties. Additional information on each of the activties can be provided upon request.

Stakeholder Engagement Pack

Table 2 Description of proposed regulated activity details

Activity description	Typical vehicles/ equipment numbers	Timing	Duration	Activity example pictures
Site monitoring and inspections consisting of the following: • **Site and exploration well monitoring-** an operator or contractor will access the site to perform checks on the exploration well and stability of the site. Checks include pressure readings and visual checks of valve integrity. In some cases, a helicopter may be utilised to complete the inspections. Surveys are completed fortnightly. • **Weed inspections-** Access to the site by several contractors/ Origin personnel in light vehicles to identify weeds. In some cases, a helicopter may be utilised. Contractors may perform spot sprays with a NTG recommended weed treatment. Surveys are completed pre and post wet season. • **Erosion and sediment control inspections-** Access to the site by several contractors/ origin personnel in light vehicles to identify erosion or stability issues. Inspection will be used to schedule maintenance to repair	2 light vehicles	Fortnightly/ 6 monthly (depending on activity)	1 day per inspection	

Stakeholder Engagement Pack

Activity description	Typical vehicles/ equipment numbers	Timing	Duration	Activity example pictures
any defects identified. In some cases, a helicopter may be utilised to complete the inspections. Surveys are completed pre and post wet season. • **Gas leak detection surveys-** Access to the site by 2- 3 contractors/ origin personnel in light vehicles to perform mandatory gas testing using handheld gas meters. Surveys are completed 6 monthly.				
Site maintenance (**lease pad, camp pad and access track)-** includes grading, erosion and sediment control repair, vegetation management, firebreak management, weed management, fence repair and all other ancillary activities required to maintain a site and associated access tracks. Gravel will be extracted from the 3 existing pits located on the access track. This will be undertaken by civil maintenance contractors and Origin personnel.	Subject to the level of maintenance required- < 6 light vehicles, tractors, graders, water truck, generators and temporary office.	6 monthly- pre and post wet season maintenance	<7 days per activity depending on the nature of the activity.	

Stakeholder Engagement Pack

Activity description	Typical vehicles/ equipment numbers	Timing	Duration	Activity example pictures
Beetaloo W1 well head maintenance- maintenance is completed annually on each well. Maintenance primarily includes valve checking, testing, greasing and (in some cases) replacement, as well as any other activities required to maintain the integrity of the well**.**	2 light vehicles, service truck, crane, generator and other support vehicles depending on the type of maintenance required.	annually	< 7 days per activity- depending on nature of maintenance.	

Stakeholder Engagement Pack

Activity description	Typical vehicles/ equipment numbers	Timing	Duration	Activity example pictures
Beetaloo W1 well intervention- cement and casing remediation activity (if required during the life of the well),,setting downhole mechanical plugs ,casing perforation, subsurface barrier maintenance/ installation.	Coil tubing unit or completions rig/ wireline unit/ cementing unit, 6 light vehicles, temporary offices, crane, service trucks, pump trucks, generators and support vehicles.	Ad hoc requests- typically 1 interventions within the next 10 years	<10 days per activity	
Beetaloo W1 well intervention- data acquisition- This includes performing cement bond logs, casing pressure tests, and setting downhole mechanical plugs. This generally involves the use of a wireline unit to run special tools down the exploration well to collect data on the reservoir.	Wireline unit, 6 light vehicles, temporary offices, crane, service trucks, pump trucks, generators and support vehicles.	Ad hoc requests- typically 2 interventions within the next 5 years	<10 days per activity	

Stakeholder Engagement Pack

Activity description	Typical vehicles/ equipment numbers	Timing	Duration	Activity example pictures
Beetaloo W1 diagnostic fracture injection test (DFIT)- Diagnostic Fracture Injection Tests (DFITs) may be conducted to evaluate the geo-mechanical and reservoir properties of the targeted formation to determine the suitability and capacity of these formations for potential gas extraction activities. Prior to a DFIT, a cement bond log and casing pressure test is completed to ensure the integrity of the cement and steel casing. A DFIT involves the injecting of small volumes of a water (approximately 30 barrels (5,000L) per DFIT) at low pumping rates to create a small fracture in the target interval. The well is shut-in and the pressure allowed to fall-off naturally. Monitoring the fall-off pressure over time allows information to be derived about the reservoir. The fluid does not contain proppant so that the fracture closes naturally when the fluid leaks off into formation. The analysis of pressure, during injection and after shut-in, provide powerful tools for understanding and subsequently informing the design for a future hydraulic fracturing process (not in this scope). Any returned fluid will be stored within double lined tanks and disposed of offsite at a licenced facility.	Pumping unit/ wireline unit, 6 light vehicles, temporary offices, crane, service trucks, generators and support vehicles.	1 DFIT potentially within the 5-year frequency	<10 days per activity	

Stakeholder Engagement Pack

Activity description	Typical vehicles/ equipment numbers	Timing	Duration	Activity example pictures
Beetaloo W1 Groundwater monitoring bore installation- installation of up to 4 control and impact groundwater monitoring bores within the underlying aquifers. Activity will utilise a water bore drilling rig to construct the bores in accordance with the Minimum Construction Requirements for Water Bores in Australia. Activity will only be required where they are needed to support future exploration activities. Bores will often be drilled to target both the Anthony Lagoon formation (if present and saturated) or the Gum Ridge formation,	Typically involves several light vehicles, a water bore drilling rig, light truck, generators and service/ support vehicles.	The drilling of water bores is a contingent activity that would be undertaken to support future exploration activities.	<4 weeks	
Beetaloo W1 well plugging and decommissioning. Involves the permanent removal of the well through the placement of cement plugs to isolate the target reservoir from overlying aquifers in accordance with the Code of Practice: Onshore Petroleum Activities within the Northern Territory (Code of Practice). Once plugs are installed, they are pressure tested to confirm the underlying formations have been adequately sealed off. The well head is then removed. A permanent marker is added to indicate the location of the plugged and abandoned well. (note activity looks similar to a DFIT with a wireline unit and cement truck unit	< 6 light vehicles, coil tubing unit/ completion rig, cement unit, light trucks, water truck, generators and other support equipment	End of well life	<10 days	

Stakeholder Engagement Pack

Activity description	Typical vehicles/ equipment numbers	Timing	Duration	Activity example pictures
utilised)				
Temporary camp activities to support exploration activities. The temporary camp may be constructed onsite to support exploration activities, with a kitchen, offices and accommodation. A camp includes onsite sewage treatment and irrigation in accordance with the NT Department of Health guidelines for waste treatment and irrigation.	<30 person camp, <12 dongas/ temporary building, 3 camp support vehicles, generators, water tanks, sewage wastewater treatment plant and irrigation area.	Activity to coincide with any well intervention or maintenance which requires onsite camp support (most work will be run out of Daly Waters to avoid the use of a camp).	As required to support exploration activities.	

Stakeholder Engagement Pack

Activity description	Typical vehicles/ equipment numbers	Timing	Duration	Activity example pictures
Chemical and fuel storage- All chemicals and fuels (diesel) required to support exploration activities will be stored within secondary containment (bunding) onsite. Chemicals and fuels will be stored in accordance with the Code of Practice, including requirements for routine inception and spill management. Chemical and fuel volumes are anticipated to be small, with no drilling or stimulation proposed.	Chemicals and fuels will be stored within double lined tanks or secondary containment, as per the relevant Australian Standards.	During exploration activities	During exploration activities.	

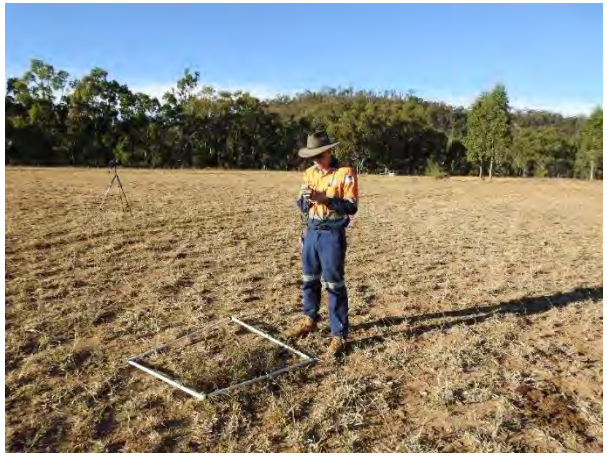
Stakeholder Engagement Pack

Activity description	Typical vehicles/ equipment numbers	Timing	Duration	Activity example pictures
Waste management: Any waste generated during exploration activities will be stored onsite in accordance with the Waste Management and Pollution Control Act and Code of Practice and transported offsite to a licenced waste management facility.	Secondary containment/ skips/ bins	During explorations activities	During explorations activities	
Groundwater extraction: Groundwater extractions from the existing groundwater extraction bore (RN038492) or another approved extraction bore (which may include trucking water from adjacent properties) will be completed periodically to support exploration activities.	Bore pump and genset.	Ongoing to support exploration activities.	During exploration activities	

Stakeholder Engagement Pack

Activity description	Typical vehicles/ equipment numbers	Timing	Duration	Activity example pictures
Groundwater monitoring Ongoing monitoring of the Beetaloo W-1 groundwater extraction bore (RN038492) and selected pastoralist bores. Monitoring includes collection of groundwater samples and levels.	<6 light vehicles, drilling rig, 2-3 support trucks, telehandler, water truck and bobcat/ front end loader	Monitoring bores may be installed to collected baseline groundwater quality data prior to future exploration activities on the site. The timing will be based upon future work programs.	< 7 days per monitoring bore	

Stakeholder Engagement Pack

Activity description	Typical vehicles/ equipment numbers	Timing	Duration	Activity example pictures
Beetaloo W1 site rehabilitation- within 6 months of the Beetaloo W1 well being plugged and decommissioned, the site will be rehabilitated. This involves a) the removal of all surface facilities (well heads, fencing, water bores, tanks etc.) b) deep ripping of compacted surfaces c) recontouring landforms d) respreading of topsoil from the topsoil stockpiles, e) re-seeding (if required) and f) ongoing monitoring and maintenance of the rehabilitation.	<10 light vehicles and civil equipment (graders, excavators, front end loader etc.) required to bring the infrastructure back to a natural state to allow regeneration.	Within 6 months of the plugging and abandonment of the Beetaloo W-1 exploration well.	<14 days, with ongoing monitoring and maintenance	

6 Environmental outcomes, impacts and risk

The environmental outcomes, potential impacts and risks associated with the ongoing exploration activities are summarised in Table 3.

A comprehensive assessment of the proposed regulated activity and all associated environmental impacts and risks will be submitted to the Department of Environment, Parks and Water Security (DEPWS) for formal assessment and approval.

Table 3 Environmental risks and controls of proposed variation

Aspect	Environmental Outcomes	Potential Impact and risk	Controls
Groundwater use and quality	• To manage exploration activities to prevent unsustainable depletion of groundwater resources • Preserve groundwater quantity and quality for livestock supplies (the surrounding water use)	• No material risk or impact to groundwater quality as activities are restricted in nature with no material volumes of groundwater utilised. • Existing exploration well constructed with multiple barriers preventing aquifer contamination.	• All water take covered by an existing Water Extraction Licence WEL GRF 10285 • All water take to be metered and reported quarterly to the regulator • Routine monitoring of groundwater bores in the vicinity of the exploration site. • All chemicals and fuels to be stored with secondary containment • No flowback or drilling wastewater storage proposed.
Traffic	• Minimise the impact of traffic on pastoralist amenity and tourism	• Minor Increases in traffic associated with Origin's activities- with peak vehicle movements anticipated to be below 10 vehicles per day • Due to the location of the activity, the nuisance and/or impact to pastoral activities/homesteads, cattle and/ or fauna is anticipated to be minimal. Given the limited nature of activities, impacts from traffic are considered a low risk	• Site is located away from pastoralist main access points • Maximum peak traffic during mobilisation and demobilisation is likely to be typically less than<10 vehicle movements per day for 2 weeks. • Speed limit restricted on the access tracks to <60km/hr • Dust suppression to be utilised to minimise dust emissions
Emissions	• Avoid environmental nuisance at sensitive receptors • Minimise greenhouse gas emissions	• Due to the location of the activity, the nuisance and/or impact to pastoral activities/homesteads, cattle and/ or fauna from the activity dust is anticipated to be minimal. Given the limited nature of activities, impacts from dust are considered a low risk • Material levels of greenhouse gasses are not anticipated to be generated.	• Exploration wells have not been hydraulically fractured, with material volumes of gas not likely to be produced from suspended exploration wells. • Venting of raw gas is tightly controlled under the Code of Practice, with no material volume of gas proposed. • Site located away from sensitive receptors, such as homesteads
Noise and visual amenity	• Minimise impacts to pastoralists and sensitive receptors	• Localised creation of noise and light emissions anticipated to be minor with limited to no works proposed at night.	• Existing site • Activities are located away from sensitive receptor, such as homesteads.

Aspect	Environmental Outcomes	Potential Impact and risk	Controls
	from noise	• Due to the location of the activity, the nuisance and/or impact to pastoral amenity as anticipated to be low	• Activities are unlikely to be visible and audible from Stuart highway or Beetaloo Station homestead during certain conditions (such as night time)
Dust	• Minimise impacts to pastoralists and surrounding ecological communities from dust	• Localised dust impacts on surrounding vegetation are anticipated to be minimal and in line with existing impacts from pastoralist access tracks	• Dust suppression to be used on access tracks and adjacent sites to minimise dust emissions • Dust levels consistent with standard pastoral activities
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 • Prevent the contamination of soil to maintain the viability of soil resources	• Impact from erosion reducing soil productivity/ stability anticipated to be low, with no major civils works proposed and maintenance activities proposed in this EMP designed to reduce the risk. • Impact from chemical/ diesel leaks contaminating soils anticipated to be low, given the Code of Practice requirements mandating spill management plans and secondary containment.	• Sites (including gravel pits) maintained to minimise sediment releases, with erosion and sediment control plan in place • No vegetation clearing or major civil works proposed • No flowback or drilling wastewater storage proposed. • All chemicals and fuels to be stored with secondary containment as per code of Practice. • Site to be rehabilitated back to pre-existing/ agreed state with pastoralist input
Bushfire	• Minimise the risk of causing bushfires from Origin's activities • Avoid impacts on pastoral infrastructure, environmental habitat and fauna, impacts on culturally-significant sites, public infrastructure and community lands	• Site works causes a uncontrolled bushfire	• No flaring to be undertaken • Fire breaks to be utilised • Bushfire management plan to be implemented outlining fire response strategies and emergency contact protocols.
Weeds	• Avoid the introduction of weeds • Avoid the spread of existing	• Risk and impact associated with the introduction or spread of weed species is considered moderate given the existing	• All equipment and loads to be inspected and certified weed free prior to entry • 6 monthly weed inspections to be completed

Aspect	Environmental Outcomes	Potential Impact and risk	Controls
	weeds	presence of weeds at the site and in the vicinity of the Stuart Highway	with all identified weeds treated. • Weeds sprayed periodically to restrict weed numbers.
Surface Water	• Avoid and minimise the potential contamination caused by the discharge of sediment or contaminated storm water to waterways or established drainage systems. • Contain any potential contaminants for treatment or disposal.	• Risk/ impact of offsite releases of sediment or contaminants on surface water bodies considered low risk based upon use of erosion and sediment control, secondary containment, no offsite discharges of wastewater and lack of watercourses in the immediate vicinity of the proposed activity.	• No take of surface water permitted or proposed • Site maintained to minimise sediment releases, with erosion and sediment control plan in place • No offsite releases of wastewater proposed or permitted • No storage of hydraulic fracture flowback or drilling wastewater proposed.
Flora and Fauna	• Minimise disturbance to flora and fauna • No disturbance to high conservation areas	• Existing site, with no proposed vegetation clearing proposed – risks and impacts to fauna and flora limited • Traffic volumes anticipated to be low, with lease not located in close proximity to Stuart Highway • The risk of rehabilitated areas no longer supporting pastoral activities/ environmental values is considered low based upon observed vegetation re-establishment in the area and rehabilitation requirements.	• Vehicle speed limit restricted to 60km/hr • No clearing proposed • Dust suppression used to limit dust impacts to vegetation • Limited night-time activities proposed. • Site to be rehabilitated back to pre-existing/ agreed state with pastoralist input • Rehabilitation plan to be developed and implemented through the EMP process.

.

7 Consequences for Stakeholder Rights and Activities

7.1 Stakeholders Rights

Pastoral Lessees within the Northern Territory have non-exclusive rights to conduct their pastoral activities on the land granted under the Northern Territory Pastoral Lands Act (2016). Origin respects these legal rights and seeks a sustainable relationship with Pastoral Lessees so that both parties' can co-exist on the land. Origin proposes to achieve this via the following key principles:

1. Formal stakeholder engagement aligned with the requirements of Section 7.2 (a) of the Northern Territory Petroleum (Environment) regulations 2016
2. Structured and timely process for the execution of an access agreement and associated compensation under the *Northern Territory Petroleum regulations 2020*
3. Mutually agreed ongoing, regular engagement and communications

Origin's impacts to stakeholder rights are limited to accessing and utilisation of defined sections of the pastoral lease for authorised petroleum exploration activities. Impacts to rights are restricted to a loss of pastoral productivity over the areas for which Origin has established infrastructure, such as lease pads, camp pads and access tracks. Access to demarcated zones around the well pad is also restricted, to ensure stakeholder and community safety.

7.2 Stakeholders Activities

In accordance with S7.2 of the PER, Origin is required to provide the pastoralists information on the potential consequences of undertaking the regulated activities on a stakeholders rights.

The proposed additional activities at Beetaloo W1 site are located in existing disturbed areas operated by Origin. The proposed additional activity will be consistent to the activities undertaken at the site since drilling of the exploration well in 2015 and will not directly interfere with existing pastoral infrastructure.

A summary of the potential consequences of the activity and mitigation controls are summarised in Table 3 Potential consequences and control measures

Table 3 Potential consequences of the activity on stakeholders' activities

Pastoralist Activity	Potential Consequence to Activities	Mitigations for Consequence
Pastoralist site access	• Vehicles along access track interacts with pastoralist activities- mustering and pastoralist vehicles • Restricted access to exploration well fenced area	• existing disturbance area and access track utilised. • pastoralist engaged during planning of proposed activity to reduce pastoral impacts • limited duration of activities and limited traffic volumes anticipated. • Restricted areas restricted to current approved sites, fenced and signed
Pastoral activities- grazing and mustering	• Minor elevated levels of noise in the immediate vicinity of the well pad during exploration activities (no noise at all other times) • Disturbance of cattle in the immediate vicinity of the activity when works are undertaken • Dust impacts on adjacent vegetation reduces yield • Reduction in pastoral productivity through poor	• existing disturbance area utilised. • full fencing of well pad to restrict cattle • speed limits restricted to 60km/hr • dust control utilised to reduce dust emissions • Weed management plan implemented, including requirements for weed hygiene inspections and certificates on all equipment and vehicles. • 6 monthly weed monitoring and spraying of weeds using a NT Government approved treatment

Pastoralist Activity	Potential Consequence to Activities	Mitigations for Consequence
	rehabilitation • Potential introduction or spread of weeds	
Pastoral activities- ongoing productivity of area post rehabilitation	• Reduction in productivity due to erosion and sediment control • Reduction in productivity due to chemical/fuel spills • Reduction in pastoral productivity through poor rehabilitation • Potential introduction or spread of weeds	• Routine site maintenance completed to ensure functioning of erosion and sediment control • All fuels and chemicals to be stored within secondary containment, with no storage of hydraulic fracture stimulation flowback work drilling wastewater. • All spills remediated as required in the EMP/spill management plan • End of life rehabilitation to return land back to pre-existing state or as agreed to with pastoralist • Rehabilitation security with NTG retained. • Weed management plan implemented, including requirements for weed hygiene inspections and certificates on all equipment and vehicles. • 6 monthly weed monitoring and spraying of weeds using a NT Government approved treatment
Pastoral access to groundwater	• No anticipated impacts	• All take to be authorised under a Water Extraction Licence • Water extraction from pastoralist bores not proposed.
Pastoral access to surface water	• No anticipated impacts.	• No surface water proposed to be taken • No hydraulic fracture stimulation flowback or drilling wastewater to be generated or stored onsite
Pastoralists amenity	• Minor elevated levels of noise in the immediate vicinity of the well pad during activities consistent with the 2016 drilling campaign • Visual presence of infrastructure within pastoralist lease	• Existing site located away from main pastoralist entry points and homestead. • Short duration of activities • No flaring proposed.

8

9 Ongoing Stakeholder Engagement

To keep the Beetaloo Pastoral representatives informed of the status of the regulated activities, the following ongoing engagement is proposed:

- Quarterly engagement on the status of exploration activities
- Fortnightly engagement prior to the commencement of activities under this SEP
- Adhoc engagement as requested by the Beetaloo Pastoral Representative
- Future engagement on additional petroleum exploration activities (If and when proposed) which are not covered under this EMP

Alternative engagement frequencies can be accommodated at the request of the nominated representative.

Origin would also like to extend an invitation to the Pastoral lessees to attend any of the proposed exploration activities to further seek comfort in their understanding and to highlight the nature in which operations are conducted.

10 Stakeholder Engagement Plan Feedback

All feedback on the proposed activities and their potential impacts, risks and proposed controls should be provided to Origin via the feedback form in Appendix A within the 28-day time period. Where no comments on contents relating to the requirements of the PER are received within the 28 day period, the PER Stakeholder Engagement requirements will be considered fulfilled. Ongoing stakeholder engagement will then proceed.

All lessee comments and associated Origin responses will be documented and provided to DEPWS as a part of the EMP approval process.

11 Commonly used Acronyms & Abbreviations

Acronym	Meaning
AAPA	Aboriginal Areas Protection Authority
ALARP	As Low As Reasonably Practicable
BMP	Bushfire Management Plan
Code of Practice	Code of Practice: Onshore Petroleum Activities within the Northern Territory
DEPWS	Department of Environment, Parks and Water Security
DFIT	Diagnostic Fracture Injection Test
EC	Electrical Conductivity
EPA	Environment Protection Authority (NT)
EP	Exploration Permit (e.g. EP76, EP98 and EP117)
EMP	Environmental Management Plan
ERP	Emergency Response Plan
ESCP	Erosion and Sediment Control Plan
GHG	Greenhouse Gas
Ha	hectare
HFS	Hydraulic Fracture Stimulation
JV	Joint Venture
Km	Kilometre
m	metre
NT	Northern Territory
NTG	Northern Territory Government
RWA	Restricted Work Area
SPMP	Spill Management Plan
TO	Traditional Owner

WEL	Water Extraction Licence
WMP	Weed management Plan
WWMP	Wastewater Management Plan

Appendix A – Stakeholder Feedback Form

From: **David Armstrong** david@terrabos.com.au
Subject: Re: Beetaloo W1 -Origin Proposed Work.
Date: 16 June 2021 at 1:13 pm
To: Jane Armstrong janearmstrong1008@gmail.com

Thanks Jane

DAVID ARMSTRONG

Managing Director

MOBILE 0400 567 401
FAX 08 8984 9125
ADDRESS PO Box 2427, Humpty Doo, NT 0836
EMAIL david@terrabos.com.au

www.terrabos.com.au

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> On 16 Jun 2021, at 1:09 pm, Jane Armstrong <janearmstrong1008@gmail.com> wrote:
>
> I will make contact with Nick today Dave to see
> Regards Jane
>
> On Wed, Jun 16, 2021 at 1:17 PM David Armstrong <david@terrabos.com.au> wrote:
> > Hi Jane
> >
> > Yes you had emailed that you had received it but just wondering when Barry and Nick will respond with feedback
> > Regards
> >
> > Dave
> >
> > **DAVID ARMSTRONG**
> >
> > Managing Director
> >
> > MOBILE 0400 567 401
> > FAX 08 8984 9125
> > ADDRESS PO Box 2427, Humpty Doo, NT 0836
> > EMAIL david@terrabos.com.au
> >
> > <PastedGraphic-3.tiff>
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> > www.terrabos.com.au
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> >
> > > On 16 Jun 2021, at 12:41 pm, Jane Armstrong <janearmstrong1008@gmail.com> wrote:

Hi Dave
Yes all recieved regards the SEP , apologies I thought I had sent you a message that it had been received on my end. Have sent it on to Barry and Nick Taylor to peruse .
Regards Jane

On Tue, Jun 15, 2021 at 2:42 PM David Armstrong <david@terrabos.com.au> wrote:

> Hi Jane
>
> Just touching base to see if you have reviewed the SEP sent out on the 26/5/2021via email and have any feed back for Origin regarding it. If you don't have any feed back thats fine however if you have questions please let me know so they can be answered.
>
> Shortly Origin will issue a land access agreement for your consideration in relation to the Beetaloo W1 site for the work listed in the SEP. I don't have a date when this will be sent but I will keep you informed
>
> Regards
>
> Dave
>
> **DAVID ARMSTRONG**
>
> Managing Director
>
> MOBILE 0400 567 401
> FAX 08 8984 9125
> ADDRESS PO Box 2427, Humpty Doo, NT 0836
> EMAIL david@terrabos.com.au
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>
> On 26 May 2021, at 8:28 pm, Jane Armstrong <janearmstrong1008@gmail.com> wrote:
>
> Thanks Dave
> Sorry I haven't been back
> Been busy here but will get to this .
> Regards Jane
>
> Sent from my iPhone
>
> > On 26 May 2021, at 3:19 pm, David Armstrong <david@terrabos.com.au> wrote:
> >
> > Hi Jane and Scotty, hope your well.
> >
> > As discussed with you on the 21/4/2021 regarding the potential of Origin wishing to undertake further work on the Beetaloo W1 site, this has now materialised. Attached for your consideration and review is a Stakeholder Engagement Pack (SEP) that contains all relevant information regarding what Origin propose to undertake. This information pack is to fully inform you of any proposed site operations including potential environmental outcomes, impacts and risks in accordance with the current regulations. Its detailed to comprehensively cover what is proposed and therefore - if you need - Origin offer appropriate people within the organisation that you may wish to speak with to better understand what is proposed. Outside of Origin I'm happy to introduce you to people within the NT Government who are involved with the on-shore gas industry and can explain what Origin propose or answer other questions you may have. This has been done with other station owners.
> >
> > Origin request that you read through the SEP and response with any questions you may have. If you read through it and are happy could you please respond accordingly. Your assessment and potential approval of the SEP has no bearing on access. An access agreement will need to be negotiated for Origin to undertake this work. Therefore when appropriate, Origin will send you a proposed Land Access and Compensation Agreement (LACA) for you to consider.
> >
> > I will not go into any detail within this email as to what the SEP contains as I will allow you to read through it. However please feel free to call me at any time to discuss any aspect of this information.
> >
> > Regards

Regards

Dave

DAVID ARMSTRONG

Managing Director

MOBILE 0400 567 401
FAX 08 8984 9125
ADDRESS PO Box 2427, Humpty Doo, NT 0836
EMAIL david@terrabos.com.au

<Stakeholder Engagement Pack- Beetaloo.pdf>

Stakeholder Feedback Form NT-2050-95-AQ-0003

Stakeholder:	
Document Referenced:	
Controlled Doc Number:	

#	Ref	Comment	Date	Origin Feedback	Date

Appendix H Wastewater Management Plan

THE BEETALOO EXPLORATION PROJECT

Wastewater Management Plan

Review record

Rev	Date	Reason for issue	Author	Reviewer	Approver
1.5	15/05/2021	Minor update to address DEPWS comments			MK
1.6	01/07/2021	Minor updates to included Beetaloo W-1 activities			MK
1.7	25/08/2021	Minor update to address DEPWS comments	MK		MK

Review due: 18/05/2023

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Beetaloo Exploration WWMP

NT-2050-15-MP-028

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Beetaloo Exploration WWMP

NT-2050-15-MP-028

1. Introduction

This Wastewater Management Plan (WWMP) has been prepared to support Origin's Beetaloo exploration program. The WWMP is a mandatory requirement prepared in accordance with the Code of Practice for Petroleum Activities in the Northern Territory (the CoP).

This plan is designed to provide the strategy for how wastewater will be managed across Origin's Beetaloo exploration activities.

The current Environmental Management Plan's (EMPs) covered by this plan are:

- NT-2050-15-MP-025 Origin Energy Beetaloo Kyalla 117 N2 Drilling, Stimulation and Well Testing EMP
- NT-2050-15-MP-032 Origin Energy Beetaloo Velkerri 76 S2 Drilling, Stimulation and Well Testing EMP
- NT-2050-15-MP-038 Origin Beetaloo Sub-Basin Kyalla 117 N2 Multiwell Drilling, Stimulation and Well Testing EMP
- CDN/ID NT-2050-35-PH-0018 Origin Beetaloo Sub-Basin Amungee NW-1H EMP
- NT-2050-MP-039- Beetaloo W-1 Environmental Management Plan

This plan will reference the related sections within each of the various EMPs to avoid duplication. Appendix A provides this WWMP as a poster to be displayed at offices/worksites where the plan is to be implemented.

2. Description of Activity

Wastewater, as defined in the CoP, includes the following:

- Drilling fluid, drill cuttings and cement returns
- Flowback fluid, generated during the well testing phase
- Completion fluids, kill fluids and well suspension fluids.

Wastewater is produced through the following activities:

- **Drilling**: waste drilling fluids are generated as a result of drilling activities. Drilling fluids primary objective is to provide primary well barrier during well construction (unless underbalance drilling is preferred drilling technique) where bottom hole hydrostatic pressure exerted by drilling fluids is used to overbalance formation pore pressure. Drilling fluids are also used to cool the bit and assist in transporting formation cuttings to surface (rock such as shale, mudstone, siltstone etc.). Excess cement when cementing a casing string and waste drill fluids and cuttings are stored in a lined mud sump, tested and either disposed of on-site or disposed of off-site at a licensed waste facility.
- **Stimulation 'flow back' water:** After the completion of hydraulic fracture stimulation, the exploration well is "flowed back" to remove all recoverable injected fluid from the formation. Flowback wastewater is stored in on-site tanks, evaporated and then disposed of off-site at a licenced facility.
- **Well production test:** During production testing the well flows gas and water to the surface. The water coming to surface is defined as 'production water' and is separated from the gas stream and is stored in the on-site tanks, evaporated and then disposed of at a licenced facility. The production water is the same quality as the flow back water from stimulation.

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- **Completion activities:** Completion fluids, such as kill fluids or well suspension fluids, are used to supress the formation pressure within the reservoir. The use of these fluids is a form of well control and may need to be removed from the well and disposed of where well interventions are required (i.e. the well may be suspended with fluid post drilling, with the fluid removed prior to completion and stimulation activities).

The wastewater generating activities within the scope of each EMP covered by this plan is presented in Table 1.

Table 1: Wastewater generating activities per Beetaloo Exploration EMP

EMP	Drilling	Stimulation	Well production test	Completions
NT-2050-15-MP-025 Kyalla 117 N2	x	x	x	x
NT-2050-15-MP-032 Velkerri 76 S2	x	x	x	x
NT-2050-15-MP-038 Kyalla 117 N2 Multiwell	x	x	x	x
CDN/ID NT-2050-35-PH-0018 Amungee NW-1H	N/A	N/A	x	x
NT-2050-15-MP-039 Beetaloo W-1 EMP	N/A	N/A	N/A	Not anticipated- with incidental volumes possible

3. Waste management framework

Wastewater will be managed with the objective of achieving optimal environmental outcomes and in accordance with the following hierarchy principals:

1. **Avoid:** eliminate the generation of waste through design modification
2. **Reduce:** reduce unnecessary resource use or substitute a less resource intensive product or service
3. **Re-use:** re-use a waste without further processing
4. **Recycle:** recover resources from a waste
5. **Treatment:** treat the waste to reduce the hazard of the waste prior to disposal
6. **Disposal:** disposal of waste if there is no viable alternative.

It is recognised that the options for avoiding, reducing or re-using wastewater generated during exploration are limited. This is largely restricted to:

- Maximising the re-use and recycling of drilling fluids during operations

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- Minimising the use of suspension fluids by minimising re-entry activities (i.e. multiple entries into a well requiring fluid to be unloaded)
- Minimise the off-site transportation of flowback through maximisation of evaporation within the designated treatment tanks.

The amount of cuttings produced during the drilling activity is dictated by the regional stratigraphy (target zone depth) and lateral length of the horizontal well, whereas the volume of the flowback is a function of stimulation design and number of stages completed during stimulation. There is however an ability to minimise the volume of waste disposed of off-site, through careful waste management and treatment.

4. Wastewater risk assessment

The risks associated with wastewater are covered in the risk assessments within each of the EMPs.

Detailed assessments of the site-specific risk associated with the disposal of drilling fluids and muds as per condition C.4.1.2 of the CoP, will be undertaken upon completion of drilling activities.

Geogenic chemical composition of flowback water was sampled as a part of the Amungee NW-1H, Kyalla 117 N2-1H and Shenandoah 1 a hydraulic fracture activity. This data indicates the risk associated with flowback are largely to do with salts—specifically chlorides. The presence of other compounds, such as hydrocarbons and heavy metals are also likely.

The hazards associated with flowback management have been addressed by the CoP and within specific EMPs. Specific controls covered by the CoP and EMP's preventing environmental harm include:

- Well operations management plan designed to ensure the risk of the well to surrounding aquifers is mitigated; including the requirement for multiple, verified well barriers containing steel and cement
- Use of enclosed tanks
- Use of double lined tanks with leak detection
- Secondary containment requirements for all pumps and high-risk spill locations
- Prohibition of wastewater discharges and reinjection
- Groundwater monitoring bores
- Spill management plan
- Freeboard requirements to accommodate a 1:1000 ARI total wet season.

5. Wastewater management overview

A summary of how each wastewater stream is managed to optimise the environmental outcomes is provided in Table 2. An individual description of each wastewater stream is provided in the following section.

5.1 Drilling fluid and cuttings

Approximately 750 m3 of solid drilling muds and cuttings and 1ML of drilling fluids will be generated as a result of drilling of each exploration well. Drilling fluids and wastes are saline, polymer/bentonite

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based material which are stored in line sumps on-site. The primary contaminants associated with drilling fluids and wastes are likely to be from chlorides. All drilling fluids are water-based muds (WBM).

Drilling fluids and muds will be managed in accordance with the following:

- All fluids, muds and cuttings stored in engineered lined Coletanche sumps
- Sumps will be designed with a 1:1000 ARI freeboard calculated in accordance with the methodology outlined in Appendix C
- The Maximum Water Level (1.3M wet season and 0.3M dry season freeboard) will be clearly marked on the side of the sump
- All lease pads will be fenced to prevent livestock and fauna ingress into open sumps
- Supernatant liquids will be transferred to lined wastewater storage tanks from the sump upon completion of activity to allow the muds and cuttings contained in lined sump to dry out with liquids evaporated in lined wastewater storage tanks
- Drilling cuttings and muds may be removed from the sump between wells, or as required, to maintain the safe operating level of the sump. Drilling waste material will be stored in pit/sump (in compliance with the CoP) with an impermeable liner, with any free water removed to the sump or wastewater tanks. During the wet season, dried drilling muds and cuttings will be covered to prevent rain ingress into the stored area
- Any residual liquids will be transported to a licenced interstate disposal facility (Westrex, Jackson, Queensland) with the appropriate interstate waste transport consignment authority as per the *National Environmental Protection (Movement of Controlled Waste between States and Territories) Measure 1998* (NEPM) as implemented under the NT *Waste Management and Pollution Control Act 1998* and Queensland *Environmental Protection Act 1994*
- Leachability testing of drill cuttings and muds will be undertaken in accordance with Table 10 of the CoP
- A disposal option assessment will be completed by a suitably qualified person (as outlined in section C.4.1.2 of the CoP), with on-site disposal to land only undertaken where environmental harm will not result from the disposal activities.

5.2 Produced water and flowback management

All produced water and flowback fluids will be stored in accordance with the CoP.

The volume of flowback generated from the activity is dependent on the number of stages of stimulation, with approximately 20% to 80% fluid recovery expected (based on US ranges). For Origin Stage 2 activities, it is anticipated that approximately 3-9ML of flowback from stimulation activities will be generated from each exploration well, with a final off-site disposal figure of approximately 1–2ML per E&A well (post treatment). Flowback and production water will be highly saline, with a summary of the anticipated quality provided in Appendix B—Table 5 and Table 7 Further details on the wastewater generated and stored on-site is found in the water balance section of each EMP.

Management controls for flowback implemented during the program include:

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- No disposal of flowback wastewater to surface water
- Wastewater stored in above ground tanks
- Tanks to be double lined with built in leak detection
- All wastewater to be stored in enclosed tanks
- The site will have enough enclosed storage to deal with the total volume of wastewater stored at any time
- Appropriate venting of enclosed tanks to prevent the build-up of explosive gasses
- Tank design, construction and operation will consider environmental factors, such as wind loading, temperature bushfires and structural integrity
- All working evaporation tanks will have a minimum freeboard to allow for a 1 in 1000-year average recurrence intensity wet or dry season (depending on which season operations are undertaken in) as calculated in Appendix C
- Off-site wastewater disposal will be minimised through the treatment of wastewater through evaporation. Evaporation tanks will be used to treat wastewater all times, except during periods of significant rainfall
- Mechanical evaporators will be used in each tank to increase evaporation to reduce the volume of flowback. Evaporators will be positioned in a manner to avoid off-site drift and have automated wind direction and speed cut-offs
- When wastewater storage volumes have been reduced on-site and enclosed tank availability permits, enclosed tanks may be converted to open evaporation treatment tanks (noting the requirement to have enough enclosed storage to manage all wastewater on-site at any time)
- Wastewater may be transferred between approved sites to maximise the efficient use of tank capacity.
- The freeboard requirements will be clearly marked on each of the tanks as the Maximum Water Level (MWL)
- All wastewater on location must be able to be transferred into enclosed tanks within 72-hours of becoming aware of a significant rainfall event. This transfer must be completed at least 8-hours prior to the predicted commencement of the significant rainfall event. The determination of a significant rainfall event is provided in section 7.1
- Pumping infrastructure must be available to transfer all wastewater into enclosed storage within 24-hours (noting all wastewater must be transferred 8-hours prior to the onset of the rainfall event). Sufficient pumping redundancy must be available to accommodate pump failures
- Storage tanks that are connected will be designed to prevent uncontrolled release from multiple tanks
- Tanks are to be designed and constructed to the relevant Australian Standard (including AS1554.1 and AS3990) with a quality assurance and quality control (QA/QC) plan and installation procedures implemented by the contractor
- Tanks will be designed to prevent the ingress of stock and fauna, with each exploration site fenced to prevent stock and public access

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- Where drilling sumps are left open with drilling waste and are unattended, fencing will be installed to prevent fauna
- Monitoring of pond levels will be undertaken daily, with management response criteria implemented to prevent tank overtopping. This includes shutting in operations where freeboard requirements cannot be met
- Residual flowback liquids will be evaporated and transported to a licenced interstate disposal facility (such as Westrex, Jackson, Queensland) with the appropriate interstate waste transport consignment authority as per the NEPM as implemented under the NT *Waste Management and Pollution Control Act 1998* and Queensland *Environmental Protection Act 1994*
- When the tanks are decommissioned the associated residual solids, brines and liners are removed and disposed of at an appropriately licensed waste disposal facility by a licenced contractor as per NT *Waste Management and Pollution Control Act*
- Daily inspections of all wastewater storages will be implemented during operations (active well testing), with continuous level logging and leak detection implemented when sites are unmanned.

5.3 Drilling and completion fluids (suspension and kill fluids)

Drilling and completion fluids (suspension and kill fluids) may be used to maintain bit lubrication and circulation and for well control/suppress formation pressure. Drilling and completion fluids are likely to have an elevated salinity, with sodium and potassium-based salts being the main compounds.

It is anticipated that up to 0.5–1ML of drilling and completion fluids could be produced per well, with fluids stored in the drill sump or tanks (depending on whether tanks have been installed on-site at the stage). The fluids will be evaporated, and any residual transported off-site for final disposal at a licenced facility.

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Table 2: Wastewater management summary and implementation plan

Wastewater	Quantity produced	Properties	Hazards	Implementation plan					Final management	Final disposal volume[1]	Alternative management options considered
				Storage	Handling	Operational controls	Routine inspections	Monitoring			
Flowback / production water	Up to 9 ML per well-depending on stimulation volume	Composition influenced by chemical composition of shale formation. Geogenic sourced contaminants include: Salinity (Electrical Conductivity 50,000us/cm-250,000us/cm) with elevated, sodium, chloride, boron, barium and hydrocarbons as per Appendix A	High salinity wastewater representing a hazard to groundwater, surface water and soils from chloride dominated salts if released into the environment	• Stored on-site in double lined above ground enclosed tanks and double lined working evaporation Tanks with leak detection • All tanks have been sized with regards to the 1:1000 average recurrence interval rainfall event as per Appendix C • Maximum water levels (MWL) to be clearly marked on each tank	• Transferred to storage facilities from on-site separators or directly from the well as required under B.4.13.2 (k) of the CoP • Secondary containment used under all pumps and connections	• Storage volumes of ponds to be monitored daily through visual inspections or telemetry during wastewater storage • Evaporators to be strategically located on or within the boundaries of the pond with drift prevention controls (automated wind direction and speed cut offs) • All wastewater to be transferred into enclosed storage when a significant rainfall event is predicted as per section 7	• Storage facilities and handling areas inspected daily during operations via electronic or manual means • Visual inspections of tanks completed weekly	As per section 6	Evaporated on-site using fractionating evaporators to reduce final volumes. Potentially onsite treatment using brine crystallisation to create solid salt. Then trucked off-site to a licenced waste disposal facility (where locally available or Westrex in QLD) in accordance with *NT Waste Management and Pollution Control Act* waste consignment authority approval	Up to 2ML/well	• Due to the saline nature of the material, limited re-use or recycling options exist during exploration • Treatment using Reverse Osmosis or other mechanical filtration has been considered; salinity and scaling constraint posed by wastewater restricted the use of conventional water treatment • Request for proposal (RFP) has been released to identify additional technologies for a potential future trial
Drilling muds, cuttings and fluids	750m3/well	Saline (KCL and NaCl) polymer/bentonite based drilling fluids with formation cuttings	KCL and NaCL may represent a hazard in residual drilling muds and cuttings if not segregated prior to disposal. Formation cuttings may contain low level of hydrocarbons, which are likely to be degraded	• Stored on-site in lined drilling sumps with sufficient freeboard to accommodate a 1:1000 average recurrence interval rainfall event as per Appendix C	• Transferred directly from rig via the shakers into the sump • Fluid stored in lined tanks as per CoP	• Storage volumes of sumps to be monitored daily • Material to be dried out after completion of activity, with supernatant fluids evaporated in a separate tank (CoP compliant storage) • Material to be	• Sump level to be monitored daily during operations via electronic or manual means • Sump liner and embankments to be inspected	As per section 6	• Supernatant fluids will be segregated from muds upon completion of activity and evaporated (in a CoP compliant tank) • Fluids to be transported to a licenced waste disposal facility (where available locally or Westrex in QLD) in accordance	750m3/well	There are no other viable options currently available in addition to what has currently been considered (off-site and on-site disposal)

[1] Note these values are indicative and the final values are outlined in the respective EMP.

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Wastewater	Quantity produced	Properties	Hazards	Implementation plan					Final management	Final disposal volume[1]	Alternative management options considered
				Storage	Handling	Operational controls	Routine inspections	Monitoring			
			quickly in the open sump.	• Maximum water levels (MWL) to be clearly marked on each tank and sump		tested prior to determining final disposal requirements	weekly during operations		with *NT Waste Management and Pollution Control Act* and related interstate waste consignment authority approval • Final disposal solution of muds and cuttings to be determine through on-site characterisation and risk assessment by third party • For on-site disposal, muds and cuttings to be mixed, buried and covered on-site • For off-site disposal, material will be transported to a licenced waste disposal facility (where available locally or Westrex in QLD) in accordance with *NT Waste Management and Pollution Control Act* and related interstate waste consignment authority approval		

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Wastewater	Quantity produced	Properties	Hazards	Implementation plan					Final management	Final disposal volume[1]	Alternative management options considered
				Storage	Handling	Operational controls	Routine inspections	Monitoring			
Drilling, completion, suspension and kill fluids	0.5-1ML/well (or incidental volumes during maintenance)	KCL or NaCl based fluids with a TDS >50,000us/cm	High salinity wastewater representing a hazard to groundwater, surface water and soils from chloride dominated salts if released into the environment	• Stored on-site in the sump and transferred (as required) to the double lined above ground enclosed tanks and evaporation tanks with leak detection • All tanks have been sized with regards to the 1:1000 average recurrence interval rainfall event as per Appendix C • Maximum water levels (MWL) to be clearly marked on each tank and sump	• Transferred to flowback storage facilities directly from well • Secondary containment used under all pumps and connections	• Storage volumes of ponds to be monitored daily during operations • Evaporators to be strategically located on or within the boundaries of the pond with drift prevention controls (automated wind direction and speed cut offs) • All wastewater to be transferred into enclosed storage when a significant rainfall event is predicted as per section 7.1	• Storage facilities and handling areas inspected daily during operations • Visual inspections of tanks completed weekly	As per section 6	Stored in flowback tanks. Evaporated on-site using fractionating evaporators to reduce final volumes. Potentially onsite treatment using brine crystallisation to create solid salt. Then trucked off-site (if required) to a licenced waste disposal facility (Westrex in QLD) in accordance with *NT Waste Management and Pollution Control Act* waste consignment authority approval. Currently, it is assumed all drilling wastewater will be evaporated with limited water removed from site.	0–0.5ML	• Due to the saline nature of the material, limited re-use or recycling options exist during exploration • Treatment using reverse osmosis or other mechanical filtration has been considered; salinity and scaling constrain the use of conventional water treatment • Request for proposal (RFP) has been released to identify additional technologies for a potential future trial

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6. Wastewater monitoring program

A wastewater sampling program will be implemented to characterise the quality of the wastewater during flowback activities. The monitoring program is summarised in Table 3 below.

Table 3: Minimum monitoring requirements

Monitoring Program	Location	Monitoring Requirements	Frequency
Significant rainfall event detection	Each site	Daily review of 8-day total rain forecast as per section 7.1	Daily during wastewater storage
Flowback characterisation	Post separator— prior to entering storage tanks	Electrical conductivity, pH, temperature and volume of flowback	Daily for the first 30-days, and weekly thereafter
		Testing samples of flowback for analytes listed in Appendix C	Weekly until the EC level stabilises (<10% change over 4 weeks) and then monthly until practical completion of flowback activities
Stimulation fluid— pre-injection	Post blender— prior to injection	Testing sample of stimulation fluid for analytes listed in Appendix C	1 sample pre-injection for each stimulation fluid utilised
Flowback storage tanks	Each storage tank	Testing samples of flowback for analytes listed in Appendix C	6-monthly
	Each storage tank	Level— estimated evaporation rates	Daily - through either visual inspections or telemetered meter.
Drilling material	Determined by suitably qualified person	Testing samples of drilling cuttings for analytes listed in Table 10 of the Codes of Practice, Naturally Occurring Radiation Material (NORMs) and volume	Prior to disposal
Fauna interactions	Wastewater tanks and surrounding lease area	1. Ad hoc bird and fauna observations and photos to be taken around wastewater tanks	1. Continuous 2. Daily 3. Weekly 4. During final decommissioning

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Monitoring Program	Location	Monitoring Requirements	Frequency
		2. Wastewater tank inspection for bird carcasses 3. Inspections around area adjacent to lease (within 50m of boundary) 4. Carcasses present during tank emptying	

6.1 Sampling methodology

- Water samples will be collected in accordance with the methodology outlined in Table 4
- All samples will be collected by appropriately qualified personnel, with all meters calibrated in accordance with the manufacturer's instructions
- Samples will be collected in laboratory supplied sampling containers and placed in chilled eskies and transported under chain of custody (COC) procedures
- Analysis will be performed by laboratories with National Association of Testing Authorities (NATA) accredited analysis methodology
- Each sample will have a unique identifier that would be cross referenced to the monitoring location and time of sampling. Due to the remote location, samples will be couriered to the laboratory to minimise sample holding time violations.
- In accordance with of C.5.1 (d) in the Code of Practice, where there are no NATA accredited laboratories for a specific analyte or substance, then duplicate samples must be sent to at least two separate laboratories for independent testing or evaluation.

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Table 4: Monitoring program methodologies

Program	Sampling methodology
Drilling sump characterisation	• National Environment Protection (Assessment of Site Contamination) Measure • AS4482.1-2005 guide to the investigation and sampling of sites with potentially contaminated soil
Flowback and drilling fluid monitoring	• Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2000 (ANZECC Guidelines) • AS/NZ5667.1: 1998. Water Quality Sampling Part 1: Guidance on the design of sampling programs, sampling techniques and the preservation and handling of samples

7. Wastewater storage management response criteria

To minimise the risk of overtopping a tank or sump, the criteria outlined in Table 5 will be implemented when hydraulic fracturing wastewater is stored on-site.

Table 5: Wastewater storage management response criteria

Monitoring program	Criteria Description	Criteria	Criteria Response
Significant rainfall event	Significant rainfall event predicted	The 4-day total rainfall exceeds 300mm within the 8-day forecast	All flowback fluid must be transferred to enclosed storage at least 8-hours prior to the predicted commencement of the significant rainfall event
Wastewater tank level monitoring	Enclosed storage level exceedance	The total volume of hydraulic fracturing wastewater stored on-site exceeds the available closed/covered tank storage capacity	Flowback activities to cease, unless authorised by DEPWS to continue operations. Origin to provide written notification to DEPWS within 48-hours of exceedance, along with the proposed plan

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			to return back into compliance.
Drilling sump level monitoring	Drilling sump storage level exceedance	The total volume of drilling wastewater exceeds the freeboard capacity of the drilling sump, with no additional storage available within other on-site tanks	Drilling wastewater disposal activities to cease, unless authorised by DEPWS to continue operations. Origin to provide written notification to DEPWS within 48-hours of exceedance, along with the proposed plan to return back into compliance.

7.1 Significant rainfall events

The 8-day Bureau of Meteorology 4-day total rain forecast (http://www.bom.gov.au/jsp/watl/rainfall/pme.jsp) shall be reviewed daily to identify periods of significant rainfall. Significant rainfall is defined in this WWMP as an event where greater than 300mm of total rainfall is predicted over a 4-day period. This type of rainfall level is consistent with that from a significant rainfall event; such as a monsoonal trough, tropical low or a cyclone.

Commencement time to transfer the flowback fluid will be selected to ensure that it is completed at least 8-hours prior to the predicted commencement of the significant rainfall event.

8. Waste transportation and disposal

All wastewater transport providers will be licenced under the NT *Waste Management and Pollution Control Act.*

All wastewater will be transported interstate to a licenced waste storage and treatment facility. Westrex, at Jackson, Queensland is the current default option for wastewater disposal, with other interstate disposal locations available. The transportation of wastewater between states/territories, will require an Interstate waste transport consignment authority as per the NEPM as implemented under the *NT Waste Management and Pollution Control Act 1998* and relevant accepting state/territory (such as the Queensland *Environmental Protection Act 1994*).

All wastewater storage and treatment facilities will be licenced as per the relevant accepting state/territory (such as the Queensland *Environmental Protection Act 1994*).

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9. Waste tracking and reporting

The movement of wastewater will be tracked in accordance with the following:

i. Volumes of wastewater produced from the well

ii. Volumes of wastewater transferred into each tank

iii. Estimates for evaporation rates from each tank updated weekly

iv. Volumes of wastewater reused

vi. Volumes of water removed from site (whether by vehicle or pipeline).

- Wastewater tracking will be documented and available upon request
- Off-site wastewater tracking must be in accordance with tracking requirements of listed wastes as per the *Waste Management and Pollution Control Act*, NEPM and (where relevant) the *Radiation Protection Act*
- Wastewater tracking documentation must be reported to the Minister at least annually in the annual environment performance report for the relevant EMP.

The following measurement criteria have been developed to demonstrate the risks associated with wastewater storage are reduced as low as reasonably practicable:

- Zero wastewater tank overtopping events
- No off-site releases of wastewater
- No reportable spills of wastewater

10. Incident reporting

The reporting of incidents shall comply with the *Petroleum (Environment) Regulations* and the *Waste Management and Pollution Control Act.*

10.1 Reportable environmental incident reporting

The *Petroleum (Environment) Regulations* define a reportable incident as an incident arising from a regulated activity that has caused, or has the potential to cause, material environmental harm or serious environmental harm as defined under the *Petroleum Act*.

An interest holder must notify (this may be oral or in writing) DEPWS of a reportable incident as soon as practicable but no later than two-hours after the first occurrence of the incident or after the time the interest holder becomes aware of the incident.

DEPWS can be notified through the DEPWS Onshore gas non-compliance hotline on 1800 413 567.

Any verbal report to DEPWS must be followed up by a written report from the Project Manager within three days in accordance with the *Petroleum (Environment) Regulations.*

10.2 Recordable incidents

The *Petroleum (Environment) Regulations* define a recordable incident as an incident arising from a regulated activity that:

I. Has resulted in an environmental impact or environmental risk not specified in the current plan for the activity; or

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II. Has resulted in a contravention of an environmental performance standard specified in the current plan for the activity; or

III. Is inconsistent with an environmental outcome specified in the current plan for the activity; and

IV. Is not a reportable incident.

An interest holder must notify (this may be oral or in writing) DEPWS of a recordable incident as soon as practicable but no later than 15-days after the reporting period (agreed period or each 90-day period after the day on which the EMP is approved).

10.3 *Waste Management and Pollution Control Act* incident reporting

In accordance with the *Waste Management Pollution Control Act*, where contaminants or waste is not confined within the land on which the petroleum activities are undertaken (i.e. the approved disturbance areas where the petroleum activity is occurring), Origin will notify the regulator of incidents causing or threatening to cause pollution as soon as practicable, but no later than 24-hours after becoming aware of the incident.

A notifiable incident is defined as an incident that causes, or is threatening or may threaten to cause, pollution resulting in material environmental harm or serious environmental harm.

A notification must include:

(a) the incident causing or threatening to cause pollution
(b) the place where the incident occurred
(c) the date and time of the incident
(d) how the pollution has occurred, is occurring or may occur
(e) the attempts made to prevent, reduce, control, rectify or clean up the pollution or resultant environmental harm caused or threatening to be caused by the incident
(f) the identity of the person notifying.

The notification shall be made to the NT EPA Pollution Hotline 1800 064 567.

11. Emergency response

An Emergency Response Plan (NT-2050-15-MP019) has been developed covering the proposed activities within the EMP. The ERP provides a broad framework for managing potential emergency incidents to minimise the potential risk to human safety and the environment. The ERP should be referenced for any emergency response activities.

Spills must be reported to the Minister in accordance with the requirements of spill management plan (NT-2050-15-MP-027) and reportable and recordable incidents of the *Petroleum (Environment) Regulations.*

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Beetaloo Exploration WWMP

NT-2050-15-MP-028

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Appendix A Amungee NW-1H flowback characteristic summary

Table 6: Anticipated flowback quality of the Velkerri formation based on Amungee NW -1H flowback results

Parameter	Flow back levels
BTEX compounds	BTEX levels are anticipated to be low ranging between 2 and 15 µg/L
Total nitrogen (as N)	Maximum value of 62.1mg/l observed within flowback
Salinity (TDS)	Saline with total dissolved solids level exceeding 49,000mg/L
pH	Slightly acidic with a median value of 6.74
Major ions	Predominantly Na and Cl dominated. Bicarbonate present at levels consistent with stimulation fluid
Dissolved metals	Barium and Boron are the main metal elements anticipated to be present at elevated levels. Maximum levels of 80.1 mg/L for Barium and 54.5mg/l for Boron were recorded during the Amungee NW 1 flowback. Lower level of other metals such ash Arsenic and Manganese were observed, with maximum concentration of 0.084mg/l and 3.09 mg/L respectively
Polycyclic Aromatic Hydrocarbons	Expected to be below detection level
Petroleum Hydrocarbons	All fractions of TPH are anticipated to be elevated
Phenolic Compounds	Low level of phenolic compounds expected, with only Phenol (max 4µg/L) and 3-&4- methylphenol (max 11.3ug/L)
Radionuclides	Maximum Gross Alpha Activity and Gross Beta Activity of 12.4Bq/L and 18.3Bq/L were recorded in the flowback of offset wells. The primary component being Radium-226

Table 7: Flowback quality based on Kyalla 117 N2-1 flowback results

Parameter	Flow back levels
BTEX compounds	Total BTEX levels in the flowback ranged between 63 and 190 µg/L
Total nitrogen (as N)	Maximum value of 180mg/l observed within flowback
Salinity (TDS)	Saline with total dissolved solids level from 120,000–290,000mg/L

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Parameter	Flow back levels
pH	Slightly acidic with a median value of 6.54
Major ions	Flowback predominantly Na and Cl dominated, with elevated levels of calcium and magnesium
Dissolved metals	All detected dissolved metal concentrations within the flowback were low, with the exception of Barium (1029mg/L), Gallium (290mg/l) and Strontium (279mg/l)
Polycyclic Aromatic Hydrocarbons	All values in the flowback below laboratory Limit of Reporting (LOR),
Petroleum Hydrocarbons	All fractions of TPH are anticipated to be elevated, with Total Petroleum Hydrocarbon levels likely to range from 25mg/l–150 mg/l
Phenolic Compounds	Low level of phenolic compounds detected in flowback with phenol and phenol compounds <3ug/
Radionuclides	Maximum Gross Alpha Activity and Gross Beta Activity of 36.2Bq/L and 97Bq/L encountered in the flowback, the anticipated source is likely to be Radium-226

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Appendix B Wastewater monitoring analyte list

Parameter	Reporting units	Limit of reporting	Method
Physical Parameters			
Electrical Conductivity (EC)	us/cm	1	Field
Total Dissolved Solids (TDS)	mg/L	10	APHA 2540C
Total Suspended Solids (TSS)	mg/L	5	APHA 2540C
pH		0.1	Field
Sodium Adsorption Ratio	ratio	0.01	APHA 4500 Ca, Mg, Ca, NA
Temperature	°C	0.1	Field
Nutrients			
Nitrate	mg/L	0.01	APHA VC13
Nitrite	mg/L	0.01	APHA 4500 NO2
Total Nitrogen	mg/L	0.1	APHA 4500 NORG
Total Kjeldahl Nitrogen	mg/L	0.1	APHA NORG/TKN
Ammonia	mg/L	0.01	APHA NH4
Reactive Phosphorous	mg/L	0.01	APHA 4500P
Total Phosphorous	mg/L	0.01	APHA 4500P
Anions			
Sulfate	mg/L	1	APHA 4500-SO4-C
Chloride	mg/L	1	APHA 4500-Cl-C
Carbonate	mg/L	1	APHA 2320 B
Bicarbonate (as CaCO3 equivalent)	mg/L	1	APHA 2310 B
Bicarbonate Alkalanity (as CaCO3 equivalent)	mg/L	1	APHA 2320 B
Hydroxide Alkalinity (as CaCO3 equivalent)	mg/L	0.01	APHA 2320 B
Total Alkalinity (as CaCO3 equivalent)	mg/L	0.01	APHA 2320 B
Fluoride	mg/L	0.1	APHA 4500 F-C
Bromide	mg/L	0.01	APHA 4110B
Major Cations			
Sodium	mg/L	1	APHA 4500 Na
Magnesium	mg/L	1	APHA 4500 Mg
Potassium	mg/L	1	APHA 4500 K
Calcium	mg/L	1	APHA 4500 Ca

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Parameter	Reporting units	Limit of reporting	Method
Metals and Metalloids (total and dissolved)			
Aluminium	mg/L	0.001	USEPA 6010 ICP/AES
Antimony	mg/L	0.001	USEPA 6010 ICP/AES
Arsenic	mg/L	0.001	USEPA 6010 ICP/AES
Barium	mg/L	0.001	USEPA 6010 ICP/AES
Beryllium	mg/L	0.001	USEPA 6010 ICP/AES
Boron	mg/L	0.001	USEPA 6010 ICP/AES
Bromide	mg/L	0.001	USEPA 6010 ICP/AES
Cadmium	mg/L	0.001	USEPA 6010 ICP/AES
Chromium	mg/L	0.001	USEPA 6010 ICP/AES
copper	mg/L	0.001	USEPA 6010 ICP/AES
iron	mg/L	0.001	USEPA 6010 ICP/AES
Lead	mg/L	0.001	USEPA 6010 ICP/AES
Manganese	mg/L	0.001	USEPA 6010 ICP/AES
Mercury	mg/L	0.001	USEPA 6010 ICP/AES
Molybdenum	mg/L	0.001	USEPA 6010 ICP/AES
nickel	mg/L	0.001	USEPA 6010 ICP/AES
Selenium	mg/L	0.001	USEPA 6010 ICP/AES
Silica	mg/L	0.1	USEPA 6010 ICP/AES
Silver	mg/L	0.001	USEPA 6010 ICP/AES
Strontium	mg/L	0.001	USEPA 6010 ICP/AES
Thorium	mg/L	0.001	USEPA 6010 ICP/AES
Tin	mg/L	0.001	USEPA 6010 ICP/AES
Uranium	mg/L	0.001	USEPA 6010 ICP/AES
Vanadium	mg/L	0.001	USEPA 6010 ICP/AES
Zinc	mg/L	0.001	USEPA 6010 ICP/AES
Naturally Occuring Radioactive Material (NORM)			
alpha radiation	Bq/L	0.05	ASTM D7283-06
beta radiation	Bq/L	0.05	ASTM D7283-06
BTEX			
Benzene	µg/L	1	USEPA 5030/8260 HS or P&T/GC/MS
Toluene	µg/L	2	USEPA 5030/8260 HS or P&T/GC/MS
Ethylbenzene	µg/L	2	USEPA 5030/8260 HS or P&T/GC/MS
M and P Xylene	µg/L	2	USEPA 5030/8260 HS or P&T/GC/MS

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Parameter	Reporting units	Limit of reporting	Method
O Xylene	µg/L	2	USEPA 5030/8260 HS or P&T/GC/MS
Total Xylene	µg/L	2	USEPA 5030/8260 HS or P&T/GC/MS
Hydrocarbons			
TRH C6 - C10	µg/L	20	USEPA 5030/8260 HS or P&T/GC/MS
TRH C6 - C10 less BTEX	µg/L	20	USEPA 5030/8260 HS or P&T/GC/MS
TRH >C10 - C16	µg/L	100	USEPA 5030/8260 HS or P&T/GC/MS
TRH >C10 - C16 less Napthalene	µg/L	100	USEPA 5030/8260 HS or P&T/GC/MS
TRH >C16 - C34	µg/L	100	USEPA 5030/8260 HS or P&T/GC/MS
TRH >C34 - C40	µg/L	100	USEPA 5030/8260 HS or P&T/GC/MS
Total TRH C6 - C40	µg/L	100	USEPA 5030/8260 HS or P&T/GC/MS
Polycyclic Aromatic Hydrocarbons			
3-Methylcholanthrene	mg/L	0.001	USEPA 3510/8270 GC/MS
7, 12-Dimethylbenz(a)anthracene	mg/L	0.001	USEPA 3510/8270 GC/MS
Acenaphthene	mg/L	0.001	USEPA 3510/8270 GC/MS
Acenaphthylene	mg/L	0.001	USEPA 3510/8270 GC/MS
Anthracene	mg/L	0.001	USEPA 3510/8270 GC/MS
Benzo (a) pyrene	mg/L	0.0005	USEPA 3510/8270 GC/MS
Benzo (b) fluoranthene	mg/L	0.001	USEPA 3510/8270 GC/MS
Benzo (ghi) perylene	mg/L	0.001	USEPA 3510/8270 GC/MS
Benzo (k) fluoranthene	mg/L	0.001	USEPA 3510/8270 GC/MS
Benzo (a) anthracene	mg/L	0.001	USEPA 3510/8270 GC/MS
Chrysene	mg/L	0.001	USEPA 3510/8270 GC/MS
Dibenz (ah) anthracene	mg/L	0.001	USEPA 3510/8270 GC/MS
Fluoranthene	mg/L	0.001	USEPA 3510/8270 GC/MS
Fluorene	mg/L	0.001	USEPA 3510/8270 GC/MS
Indeno (1,2,3-cd) pyrene	mg/L	0.001	USEPA 3510/8270 GC/MS
Napthalene	mg/L	0.001	USEPA 3510/8270 GC/MS
Phenanthrene	mg/L	0.001	USEPA 3510/8270 GC/MS
Pyrene	mg/L	0.001	USEPA 3510/8270 GC/MS

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Parameter	Reporting units	Limit of reporting	Method
Carcinogenic PAHs (benzo[a}pyrene equivalents	mg/L	0.001	USEPA 3510/8270 GC/MS
Total PAH	mg/L	0.0005	USEPA 3510/8270 GC/MS
Volatile Organic Compounds			
2,3,4,6-Tetrachlorophenol	µg/L	1	USEPA 3510/8270 GC/MS
2,4,5-Trichlorophenol	µg/L	1	USEPA 3510/8270 GC/MS
2,4,6-Trichlorophenol	µg/L	1	USEPA 3510/8270 GC/MS
2,4-Dichlorophenol	µg/L	1	USEPA 3510/8270 GC/MS
2,4-Dimethylphenol	µg/L	1	USEPA 3510/8270 GC/MS
2,4-Dinitrophenol	µg/L	1	USEPA 3510/8270 GC/MS
2,6-Dichlorophenol	µg/L	1	USEPA 3510/8270 GC/MS
2-Chlorophenol	µg/L	1	USEPA 3510/8270 GC/MS
2-Methyl-4,6-dinitrophenol	µg/L	1	USEPA 3510/8270 GC/MS
2-Nitrophenol	µg/L	1	USEPA 3510/8270 GC/MS
4-Chloro-3-methylphenol	µg/L	1	USEPA 3510/8270 GC/MS
4-Nitrophenol	µg/L	1	USEPA 3510/8270 GC/MS
Dinoseb	µg/L	1	USEPA 3510/8270 GC/MS
Formaldehyde	µg/L	1	USEPA 3510/8270 GC/MS
Hexachlorophene	µg/L	1	USEPA 3510/8270 GC/MS
m- and p-Cresol	µg/L	1	USEPA 3510/8270 GC/MS
Pentachlorophenol	µg/L	1	USEPA 3510/8270 GC/MS
Phenol	µg/L	1	USEPA 3510/8270 GC/MS
Organic Carbon			
Dissolved Organic Carbon	mg/L	1	APHA 5310 B
Total Organic Carbon	mg/L	1	APHA 5310 B

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Beetaloo Exploration WWMP

NT-2050-15-MP-028

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Appendix C 1:1000 ARI Calculation

Monthly rainfall totals were analysed from the Scientific Information for Land Owners (SILO) data for to interpolate rainfall data from 1900 to the present day. Consistent with industry accepted methodology associated with practices (such as dam risk assessments which calculates the wet season based on your geographical location) a 3-month time period was determined applicable.

The highest 3-month rainfall period during the wet and dry seasons was predicted for every year from 1900 till 2018. These values were then used to fit a Log Pearson III distribution to the data to allow us to extrapolate to the 1000-year, 3-month duration wet season (1) and 3 month dry season (figure 2). This method is consistent with the *Australian Rainfall & Runoff* methodologies. The median 1 in 1000-year 3-month wet season is 1,289mm and 3-month dry season is 300mm. These figure does not include any evaporation and are therefore considered extremely conservative.

Based on the assessment, a 1,300mm wet season and 300mm dry season freeboard will be applied to all open sumps and tanks.

Figure 1: Log Pearson determination of 1:1000 Wet Season ARI

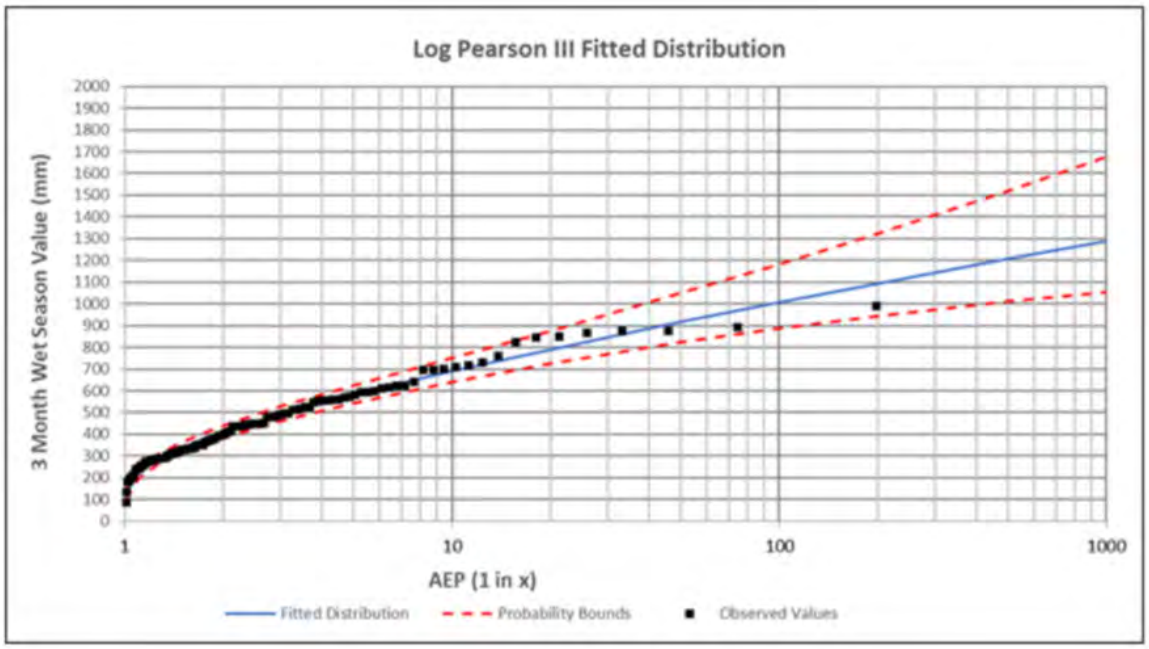

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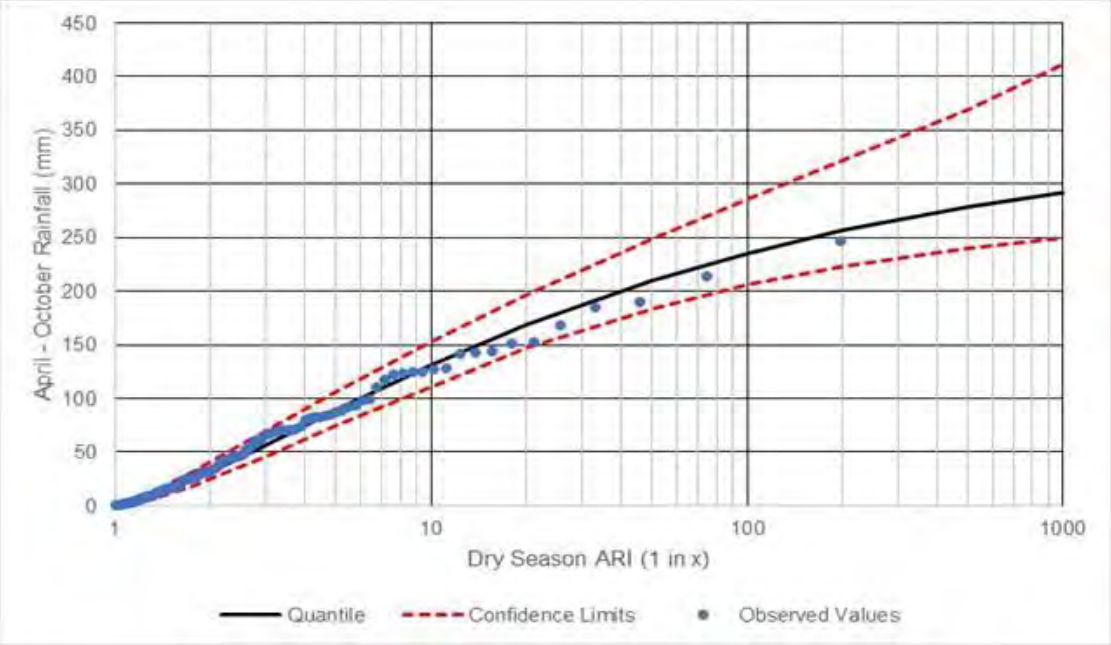
Figure 2: Log Pearson determination of 1:1000 Dry Season ARI



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Appendix I Spill Management Plan

THE BEETALOO EXPLORATION PROJECT

Spill Management Plan

Review record

Rev	Date	Reason for issue	Authors	Consolidator	Approver
0	18/04/2019	Issued for review	MK	LF	EW
1	26/07/2019	Updated to meet final CoP	Mk	SM	EW
1.1	14/11/2019	Minor update to incident notification	MK		LF
1.2	03/12/2019	Minor update to address DENR comments	MK		LF
1.3	02/11/2020	Minor update to include additional wells	RU		MK
1.4	29/03/2021	Minor update to include Amungee NW-1H	RU		MK
1.5	01/07/2021	Minor update to include Amungee Beetaloo W-1			MK
1.6	25/08/2021	Minor update to address DEPWS comments			MK

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Spill Management Plan

NT-2050-15-027

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1. Purpose

This Spill Management Plan (SMP) has been prepared to support Origin's Beetaloo exploration program. The SMP is a mandatory requirement prepared in accordance with the Code of Practice for Petroleum Activities in the Northern Territory (the Code of Practice). This SMP is designed to provide the strategy for the management of spills across Origin's Beetaloo exploration activities.

The Environmental Management Plans (EMPs) covered by this plan are:

- NT-2050-15-MP-025 Origin Energy Beetaloo Kyalla 117 N2 Drilling, Stimulation and Well Testing EMP
- NT-2050-15-MP-032 Origin Energy Beetaloo Velkerri 76 S2 Drilling, Stimulation and Well Testing EMP
- NT-2050-15-MP-038 Origin Beetaloo Sub-Basin Kyalla 117 N2 Multiwell Drilling, Stimulation and Well Testing EMP
- CDN/ID NT-2050-35-PH-0018 Origin Beetaloo Sub-Basin Amungee NW-1H EMP.
- NT-2050-15-MP-039 Beetaloo W-1 EMP

This plan will reference the relevant sections within each of the various EMPs to avoid duplication.
Key legislation

Key legislation and documents consulted in the development of this plan are provided below (a full list of applicable legislation is provided in the corresponding management plans):

- **Code of Practice: Onshore Petroleum Activities in the Northern Territory:** Mandatory code of practice legislating the management of chemicals and wastewater onsite, including the use of secondary containment, lined tanks and spill management plan,
- ***Transport of Dangerous Goods by Road and Rail (National Uniform Legislation) Act 2010:*** Covers the transportation of goods by road in the NT. This also covers licences for vehicles and drivers carrying dangerous goods.
- ***Workplace Health and Safety (National Uniform Legislation) Act 2011:*** Covers the storage and handling of chemicals on site.
- ***Waste Management and Pollution Control Act 1998:*** Covers the requirements for the transportation and disposal of waste within the NT. This includes the requirements for contractors, vehicles and facilities managing listed wastes to be licenced.

2. Chemicals and wastewater description

The chemicals and wastewater typically stored onsite includes:

- Chemicals used for drilling
- Waste drilling fluids
- Chemicals used for stimulation
- Flowback wastewater
- Completions and well suspension fluids
- General use chemicals such as condensate and oil, diesel and fuels, general equipment maintenance chemicals (hydraulic oils, degreasers etc.)

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Table 1: Types of chemicals and wastewater relevant to each EMP

EMP	Drilling chemicals and waste fluids	Stimulation chemicals	Flowback wastewater	Completion and well suspension fluids	General use
NT-2050-15-MP-025 Kyalla 117 N2	x	x	x	x	x
NT-2050-15-MP-032 Velkerri 76 S2	x	x	x	x	x
NT-2050-15-MP-038 Kyalla 117 N2 Multiwell	x	x	x	x	x
CDN/ID NT-2050-35-PH-0018 Amungee NW-1H	N/A	N/A	x	x	x
NT-2050-15-MP-039 Beetaloo W-1 EMP	N/A	N/A	N/A	Incidental volumes may be generated	X

The full list of chemicals and wastewater that may be stored onsite, including their maximum volumes and location are provided in the relevant EMP.

3. Spill failure scenarios

Potential spill scenarios associated with exploration activities are summarised in Table 2. These scenarios include:

- Spills from chemical and wastewater handling and storage activities onsite
- Spills from chemical and wastewater during transportation (offsite)
- Tank, drilling sump and containment vessel overflows and structural failures

The loss of containment due to the failure of well barriers is covered under the Well Operations Management Plan (WOMP).

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Table 2: Spill scenario summary table

Spill scenario	Activity duration	Mechanisms	Location	Quality	Quant-ity	Key management controls	Monitoring	Receptors
Spills from chemical and wastewater handling and storage activities onsite	• Drilling–45 days • Stimulation–15-30 days • Well testing 30–180 days	Container rupture Spill during chemical handling and mixing	• Chemicals storage area •Drilling rig • Stimulation spread • Drilling sumps • Flowback storage tanks • Well testing equipment	• Saline drilling fluids Saline flowback • Chemicals listed in EMP	<1,000L <1,000L <100L	• Designated storage areas with appropriate segregation of incompatible chemicals • Secondary containment to be deployed under high-risk spill/leak storage and handling areas • Spill kits available • Routine inspection of chemical stores • Sites are manned during operations, with continuous leak detection and level monitoring at all other times	Routine inspection of chemical stores, sumps and tanks during operations Tank leak detection	Retained on-site

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Spill scenario	Activity duration	Mechanisms	Location	Quality	Quant-ity	Key management controls	Monitoring	Receptors
						• Wastewater management plan		
Loss of containment during transfer onsite (leakage from pipes, hoses, fittings etc)	• Drilling–45 days • Stimulation– 15-30 days • Well testing 30–180 days	Coupling, valve, hosing and equipment failure	Chemical mixing and transfer areas on the drill rig, mixing hoppers and wastewater storages	• Saline drilling fluids and wastewater • Chemicals listed in EMP	<5,000L	• Secondary containment to be deployed under high-risk spill/leak storage and handling areas • Spill kits available • Routine inspection of chemical stores • Sites are manned during operations, with continuous leak detection and level monitoring at all other times • Wastewater management plan	Routine inspection of all chemical handling areas, including wastewater transfer points and chemical mixing areas	Retained on-site
Spills from chemical and wastewater during	• Drilling chemical transfer—1–5 days of bulk chemical transfer	Transport spill	Off-site along highway	• Various chemicals as listed in EMP	<1,000L	• All transport companies to be appropriately licenced to	Performance of contractors to be monitored as	• Chemical transport between Darwin/South

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Spill scenario	Activity duration	Mechanisms	Location	Quality	Quant-ity	Key management controls	Monitoring	Receptors
transportation (off-site)	generally pre-drilling • Stimulation chemical transfer 2–3 truckloads of chemicals per week for ~6 weeks • Wastewater disposal over 3 weeks—up to ~22 truck movements total over the duration	Traffic accident (total or partial release)		• Saline wastewater	for transport spill <50,000L for total loss of B-triple carrying flowback	transport chemicals and waste *(Dangerous goods and Waste Management and Pollution Control Act)* including the requirement to detect and respond to spills • Wastewater management plan	a part of transportation contractors	Australia and Queensland/ and Daly Waters • Wastewater transportation between Daly Waters and Queensland Via Tennant Creek
Tank, drilling sump and containment vessel overflows and structural failures	• Duration of all activities plus ongoing wastewater storage which may be extended beyond 12-months to allow for ongoing evaporation of fluids	Overfilling of a sump and flowback tank Structural failure of embankment or tank wall	Sumps and Tanks on lease	Saline wastewater with TDS >50,000mg/l	>10,000L	• Lease pads bunded during the storage of flowback • Enclosed tanks used during wet seasons operations Open tanks with 1:1000ARI freeboard	Routine tank and sump level and structural integrity (visual) inspections	Retained on lease pad within bund

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Spill scenario	Activity duration	Mechanisms	Location	Quality	Quant-ity	Key management controls	Monitoring	Receptors
						• Tanks constructed to Australian Standards Routine tank and sump inspections		

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4. Potential receptors

The location of Origin's Beetaloo exploration activities is remote. A description of the environment, including environmental and cultural sensitivities, with the potential to be impacted by a spill is provided in each of the EMPs. Figure 1 illustrates the separation distance from sensitive receptors such as:

- Watercourses
- Communities
- Homesteads
- Heritage places
- Vegetation communities
- Protected areas

Maps regarding Sacred Sites and restricted work areas are also applicable and will be provided to work crews to ensure awareness of these features.

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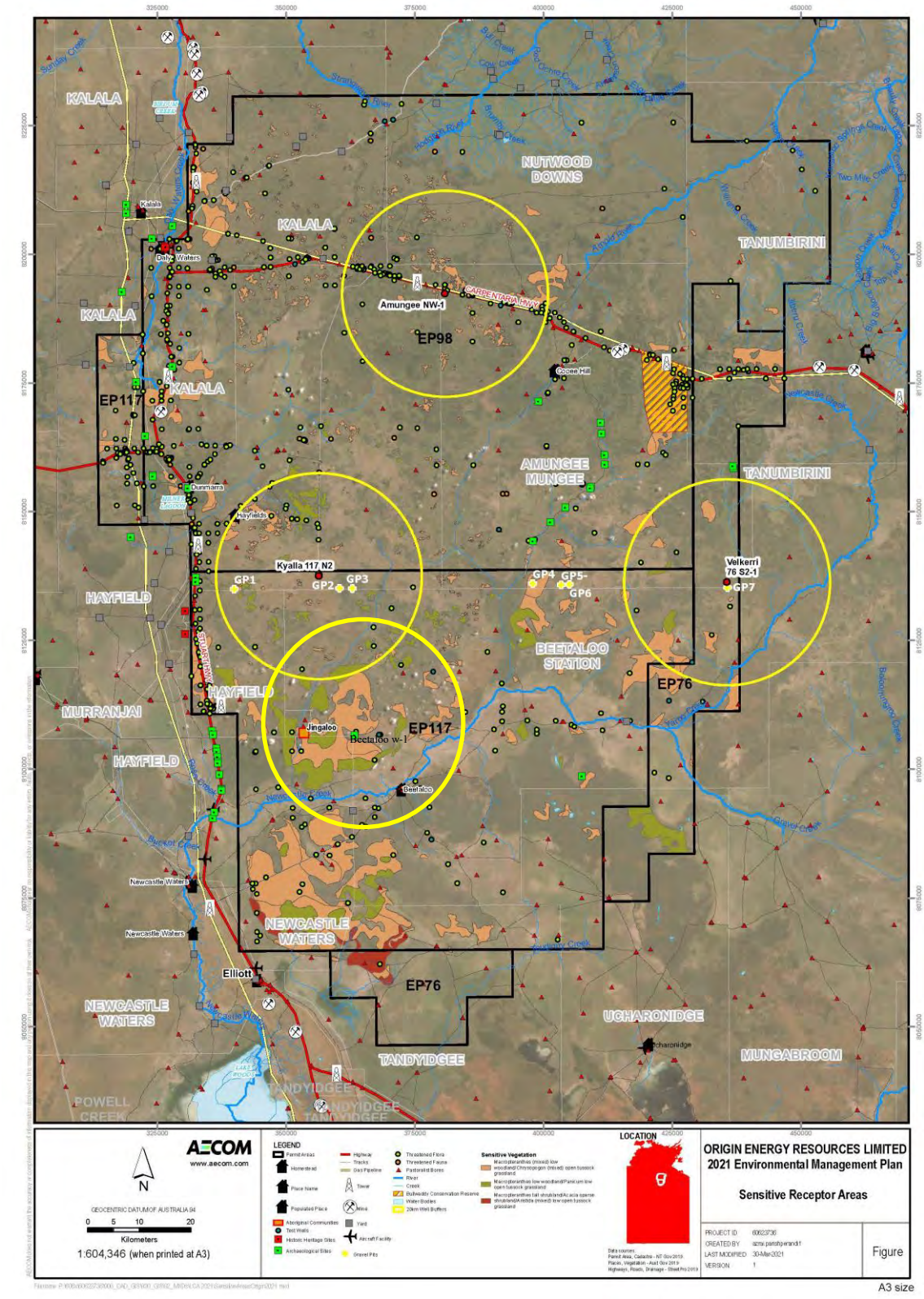

Figure 1 Location of activities and potential receptors

Review due: 18/05/2023

5. Risk assessment

The risk of spills associated with all drilling, stimulation and well testing activities is covered under the EMPs.

6. Control measures

Controls measures to manage spills associated with exploration activities are provided in the EMPs and summarised in Table 2. The key management controls include:

- Contractors are required to develop spill management procedures to comply with the requirements of this plan
- All flowback, completion fluids, chemicals, oil and fuel storage will be equipped with secondary containment (or dual liners), as per the codes of practice
- Drilling will be lined, with enough freeboard to manage a 1:1000ARI wet season (~1300mm)
- Flare pits will be designed to manage a 1:1000ARI 24-hour storm event (377mm)
- Tanks will be designed, installed and operated as per the manufacturer's specifications and COP
- Where flowback is being stored on a lease pad, the wastewater tanks shall be earthen bunded to prevent release to surrounding areas in the case of a catastrophic failure.
- The earthen bund shall be designed to hold 110% of the volume of the largest wastewater tank onsite
- The earthen bund shall be constructed to withstand a failure event, with the bund appropriately compacted and stabilised
- Well sites are designed and constructed to prevent spills of hazardous chemicals; this includes
  - compacting the lease pad surface to 100kpa prevent infiltration
  - provision of bunded (lined) chemical segregation areas
- Monitoring to detect spills will be undertaken in accordance with Section 9
- Procedures will be developed by contractors designed to detect, remediate and report any spills. This includes:
  - Chemical handling procedures
  - Chemical storage and handling inspection procedures
  - Spill prevention, detection and response procedures
- The transport of hydraulic fracturing chemicals and wastewater during the wet season will be avoided, unless a site-specific risk assessment indicates the risk is equal to or below a moderate
- Effective spill clean-up material readily available at each work site and on all mobile service trucks or vehicles, where hydrocarbons and chemicals are stored and/or used
- Inspection reports and maintenance records of secondary containment shall be kept and available for review upon request
- Spill response mock-up drills to be completed as a part of routine emergency response.

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7. Spill response and management

The following section provides an overview of the response to spills during drilling, stimulation and well testing activities. Where the spill is the result of an emergency situation that is still active, the Beetaloo Exploration Emergency Response Plan (NT-2050-15-MP-024) will take precedence over this plan.

7.1 Rapid spill assessment

When a spill occurs, the on-site Supervisor will carry out a rapid assessment to determine the potential hazards and the type and location of emergency assistance required. This assessment shall include the following:

- Determine the physical (volume and state) and location of the spill
- Determine the appropriate spill category and type of response as per section 12.1.
- Assess the hazard of the material spilled, including any potential hazards associated with chemical mixing (such as oxidising and reducing agents)
- Determine the safety hazard to immediate response personnel and whether additional resources (such as emergency services or specialised equipment or advice) are required to manage the spill safely
- Determine spill movement, factors affecting the movement (i.e. impending weather, topography, drainage lines etc.) and spill response priorities as per Table 3.

Table 4: Spill response priorities

Spill priority	Response considerations
People and communities	• Evacuate and muster (if deemed necessary) • Account for all people and determine missing persons • Stop unauthorised access • Provide a technical resource to the Emergency Services (if required) • Protect community and pastoralists
Environment and sacred sites	• For emergencies that are safe to manage, onsite personnel will respond with available resources to limit the extent of the impact to the environment or a protected site • For larger incidents, or where it is unsafe for onsite personnel to respond, trained people will be mobilised to control and contain the emergency to minimise the impact to the environment or protected site
Regulators	• Notify Regulators as per incident reporting requirements
Assets	• Monitor automatic shutdown of the equipment or part thereof, or initiate manual shutdowns where it is safe to do so • Mobilise emergency services to intervene
Reputation	• Notify neighbours (if required)

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7.2 Spill containment and clean up procedures

Generic spill containment clean up procedures must be developed and implemented by each drilling, stimulation and well testing contractor aligning with the requirements of this plan. These procedures shall be adapted (where appropriate) to consider the site and chemical specific hazards associated with each spill event.

The procedures shall consider the following generic spill containment and response procedure:

- Move all people out of harm's way
- Alert others nearby
- Assess the situation—determine what substances are involved, the potential receptors (people and the environment) and if additional support is required. The substance must be known prior to taking any action (refer to SDS)
- If applicable; remove any possible risk escalating factors (e.g. ignition hazards in case of flammable/combustible spills); approach from up-wind to reduce fume risks, isolate the spill source (close containment valve, similar). Ensure appropriate controls requirements are met, e.g. PPE, first aid support, etc., prior to conducting spill clean up
- If it is safe to do so; stop the source of the leak (if possible) and contain the spill using onsite equipment to
- Prevent from leaving site or entering a waterway or sensitive feature
- Recover free liquid and contaminated material as soon as practicable (i.e. immediately) to mitigate infiltration. Material recovery should consider the benefit of recovery versus the additional impact that recovery of all contaminated material could cause as per the National Environment Protection (Assessment of Site Contamination) Measure
- Prevent people, livestock and wildlife access to hazardous material through fencing or other barriers
- Store contaminated material in a manner to minimise the risk of additional contamination
- For Level 2 spills and higher, the Project Manager shall be notified as soon as it is safe to do so, but within 2-hours
- Project Manager to ensure appropriate external incident reporting requirements are actioned in accordance with the impact of the spill
- For Level 2 spills and higher, Origin Project Manager to seek expertise as to whether additional testing and remediation is required upon completion of the initial containment and clean up. This consideration will be undertaken in in accordance with the National Environment Protection (Assessment of Site Contamination) Measure
- Upon rectification of a reportable spill, an incident investigation shall be completed as per the Petroleum (Environment) Regulations. This shall include the root cause of the incident, actions taken to mitigate the impact and ongoing monitoring and maintenance required to ensure the site is stable and non-polluting.

7.3 Contaminated material disposal

Contaminated material disposal will be undertaken in consideration of the following:

- During a spill clean up, the storage of contaminated material must be undertaken in a manner that minimises additional contamination
- Offsite disposal must be undertaken in accordance with the NT *Waste Management and Pollution Control Act 1998*
- All listed waste transportation shall be undertaken by licenced contractors, be tracked and disposed of at approved waste management facilities.

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8. Monitoring and inspections

The monitoring and inspection programs to identify spills is summarised in Table 4.

Table 5: Spill monitoring and inspections

Monitoring Program	Frequency	Methodology	Purpose	Minimum volume of leak
Tank and sump level monitoring (when wastewater is stored on-site)	During operations: Daily All other times: • Weekly during the dry season • Daily during the wet season	Instrument Or Level dip/ visual assessment	Prevent the overtopping of tanks	10's of litres
Tank leak detection (when wastewater is stored on-site)	Continuous	Instrument	Detect the migration of fluid through primary containment	10's of litres
Chemical storage areas (when chemical stored On-site)	During operations: Daily All other times: Weekly	Visual (a camera may be utilised where sites are umanned)	Detection of leaks	Litres
Tank structural integrity (when wastewater is stored onsite)	Weekly	Visual inspection	Detect potential structural weakness	N/A

9. Roles and responsibilities

The critical roles and responsibilities set out in Table 6 are for the main members of the Spill Response Group. This team represents the core group of resources that will lead a spill response with the support of the broader Origin Energy Team.

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Table 6: Roles and responsibilities

Position	Role and responsibility
Project Manager	Ultimately accountable for the implementation of the spill management plan (SMP). Role, or delegate, will liaise with Origin Environment Specialists to determine remediation requirements and external reporting obligations.
On-site Supervisor	Responsible for the initial response to a spill. This role will be delegated to the well site representative or nominated contractor in charge of a work program. Role will undertake the initial spill assessment, engage emergency services (if required) and co-ordinate immediate spill clean up operations associations to minimise the potential impacts to people, places and the environment.
Environment/HSE Lead	Report Spill to Regulatory Authorities. Provide expertise on clean up requirements and ongoing monitoring and management requirements. Interface with government and regulatory bodies for communication and consents.
Emergency Response Lead	Provide specialist technical advice (Emergency Response) to support spill management activities.

10. Waste transportation and disposal

All contractors engaged to perform drilling, stimulation and well testing will be required to comply with this plan. A bridging SPMP will be developed be each contractor summarising the activities to be undertaken to comply with this plan and the CoP.

11. Spill reporting

11.1 Spill rating

Table 7 provides a summary of the spill classification based upon the volume and location of spill. The hazards of the potential spill to people and the environment should be assessed independently, to ensure incident specific hazards are considered in the spill response. This table provides guidance as to the likely spill scenarios that may trigger the different incident reporting requirements.

When classifying spills and determining the reporting requirements, Ministerial conditions and environmental performance objectives and criteria should also be considered when determining the whether the event is a recordable or reportable event.

The spill tiers include:

- **Level 1:** Spills that can be contained within the well site and can be cleaned up by the operator without involvement of external organisations. Most Tier 1 spills are likely to be less than 2,500L and would include diesel spills during fuel transfer, oil spillage during routine maintenance or small wastewater spills during well testing. Clean up time is

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generally less than 1-day. These spills will most likely be classified as recordable incidents as per Section 12.

- **Level 2:** Spills that have not been completely contained within the site boundary and/or may require additional resources to clean up. Clean up time is generally less than a week. Level 2 spills are typically reportable incidents as defined in section 12 and may also require notification under the *Waste Management and Pollution Control Act.*
- **Level 3:** Severe spills that cannot be contained by the operator and requires substantial additional resources to manage the spill. Clean up time is generally greater than a week. Level 3 spills are reportable incidents.

Table 7: Spill tier levels

		Spill (L)		
		20-200L	200-2,500 L	>2,500 L
Receiving environment	Bund or contained impervious area	**Not reportable***	**Level 1**	**Level 1**
	Onsite *(lease pad, camp pad, hardstand, road or work area)* compacted or sealed surface**	**Not reportable***	**Level 1**	**Level 2**
	Offsite permeable surfaces- areas adjacent to lease pads, camp pads, roads where spills have moved beyond the approved activity area. **	**Level 1**	**Level 2**	**Level 3**
	Sensitive environmental or cultural feature (such as a waterway, drainage lines, wetland, high valued habitat and sacred site) or where the spill has, or has the potential to, cause material or serious environmental harm **	**Level 2**	**Level 2**	**Level 3**

Notes: * *Non-reportable spills must be recorded in Origin's OCIS (and made available for review by Contractor), with monthly reviews. For certain substances, such as flowback, there may be site specific requirements outlined int eh approval notice. The approvals notice should be reviewed. ** spills of Dangerous goods or wastes offsite may need to be reported under NT Dangerous Goods Act or Waste Management and Pollution control Act 1998.*

11.2 Incident reporting

Incidents may require reporting under the *Petroleum (Environment) Regulations and Waste Management Pollution Control Act.*

11.2.1 *Petroleum (Environment) Act* incident reporting

11.2.1.1 Reportable environmental incident reporting

The Petroleum (Environment) Regulations define a reportable incident as an incident arising from a regulated activity that has caused, or has the potential to cause, material environmental harm or serious environmental harm as defined under the *Petroleum Act.*

An interest holder must notify (this may be oral or in writing) DEPWS of a reportable incident as soon as practicable but no later than two-hours after the first occurrence of the incident or after the time the interest holder becomes aware of the incident.

DEPWS can be notified through the DEPWS Onshore gas non-compliance hotline on 1800 413 567.

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Any verbal report to DEPWS must be followed up by a written report from the Project Manager within three days in accordance with the *Petroleum (Environment) Regulations.*

11.2.1.2 Recordable incidents

The *Petroleum (Environment) Regulations* define a recordable incident as an incident arising from a regulated activity that:

I. Has resulted in an environmental impact or environmental risk not specified in the current plan for the activity; or
II. Has resulted in a contravention of an environmental performance standard specified in the current plan for the activity; or
III. Is inconsistent with an environmental outcome specified in the current plan for the activity; and
IV. Is not a reportable incident.

These types of spills are typically a Level 1 type spill as defined in Table 7.

An interest holder must notify (this may be oral or in writing) DEPWS of a recordable incident as soon as practicable but no later than 15-days after the reporting period (agreed period or each 90-day period after the day on which the EMP is approved).

11.2.2 *Waste Management and Pollution Control Act* incident reporting

In accordance with the *Waste Management and Pollution Control Act,* where contaminants or waste is not confined within the land on which the petroleum activities are undertaken (i.e. the approved disturbance areas where the petroleum activity is occurring), Origin will notify the EPA of any incident causing or threatening to cause pollution as soon as practicable, but no less than 24 hours after becoming aware of the incident.

A notifiable incident is defined as an incident that causes, or is threatening or may threaten to cause, pollution resulting in material environmental harm or serious environmental harm.

A notification must include:

a) the incident causing or threatening to cause pollution;
b) the place where the incident occurred;
c) the date and time of the incident;
d) how the pollution has occurred, is occurring or may occur;
e) the attempts made to prevent, reduce, control, rectify or clean up the pollution or resultant environmental harm caused or threatening to be caused by the incident; and
f) the identity of the person notifying.

The notification shall be made to the NT EPA Pollution Hotline 1800 064 567.

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Appendix K Emergency Response Plan

Integrated Gas

EMERGENCY RESPONSE PLAN
Beetaloo Asset (Northern Territory)

This document details the Emergency Response Plan for the Beetaloo Asset in a manned and unmanned status.

Revision	Date	Description	Originator	Checked	Approved
0	29/04/2019	Issued for use	L Fulford	B Baldwin M Hanson Ed Wong	T Boyes
1	19/07/2019	Update based on DENR feedback	L Fulford	M Hanson	T Boyes
2	03/12/2019	Update based on DENR feedback	L Fulford	M Kernke	L Fulford
3	18/02/2020	Stage 3 update	L Fulford	E Wong	L Fulford
4	17/01/2021	Updated with DEPWS comments	G. Bertini		M. Kernke

Review due: 18/02/2021

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THE THREE WHATS

What can go wrong?
What could cause it to go wrong?
What can I do to prevent it?

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1. Site Emergency Response Plan (SERP) activation immediate actions

When a site level emergency is declared, this plan will be activated and escalated where appropriate.

Table 1: Activation immediate actions

Triggers for Activation			
Site Emergency Response Team activations (actual or potential) for impacts of any of the following and/or at the discretion of the Person in Charge (PIC).			
People	Serious temporary injury/illness or worse to any person		☐
Environment	Moderate effects on biological physical environment and serious short term effect to eco-system functions		☐
Asset	Serious damage or loss to production, property and/or infrastructure		☐
Reputation	Serious impact to community or cultural heritage		☐
Liability	Serious breach of law or regulation		☐
1 – Isolate and Evacuate			
Muster	Account for all personnel (upwind) whilst assessing the situation		☐
Isolate	Either through Emergency Shutdown Devices (ESD's) or remotely		☐
Evacuate	If required evacuate to designated evacuation points either upwind or at a safe distance as determined by event type or respective response guideline		☐
Control	Establish control points to coordinate response and restrict access		☐
Meeting Points	Nominate predetermined Emergency Services meeting points or establish meeting points near known landmarks or road intersections and establish sentry to meet Emergency Services upon their arrival		☐
2 – Communicate and Escalate			
Confirm	Confirm details of the emergency (type of emergency, injuries, contained or uncontained etc.) and response required.		☐
Activate	Activate ERT, SEMT, brief GEMT-L, contact Emergency Services, communicate with other Stakeholders		☐
Escalate	Consider likely impacts		☐
Impacts (actual & potential)	Most likely	What is realistically likely to happen and who / what is impacted?	☐
	Worst case	How bad could it really get and then who / what is impacted?	
SEMT-Leader: Brief On-Call GEMT Leader **0477 755 369** on situation, response and triggers for further activation.			☐
3 – Respond			
• Continually reassess situation		• Appoint OSC	☐
• Designate communication channels		• Establish exclusion zones	☐
• Activate appropriate resources		• Develop SMEACS briefing	☐
• Apply Incident Response Guidelines		• Provide regular updates	☐
4 – Response Management			
Personnel	Appropriate personnel in the ERT, SEMT and from outside resources		☐
Resources	Appropriate resources available to manage the incident		☐
Tools	Appropriate tools available for the ERT, SEMT, OSC and other responders		☐

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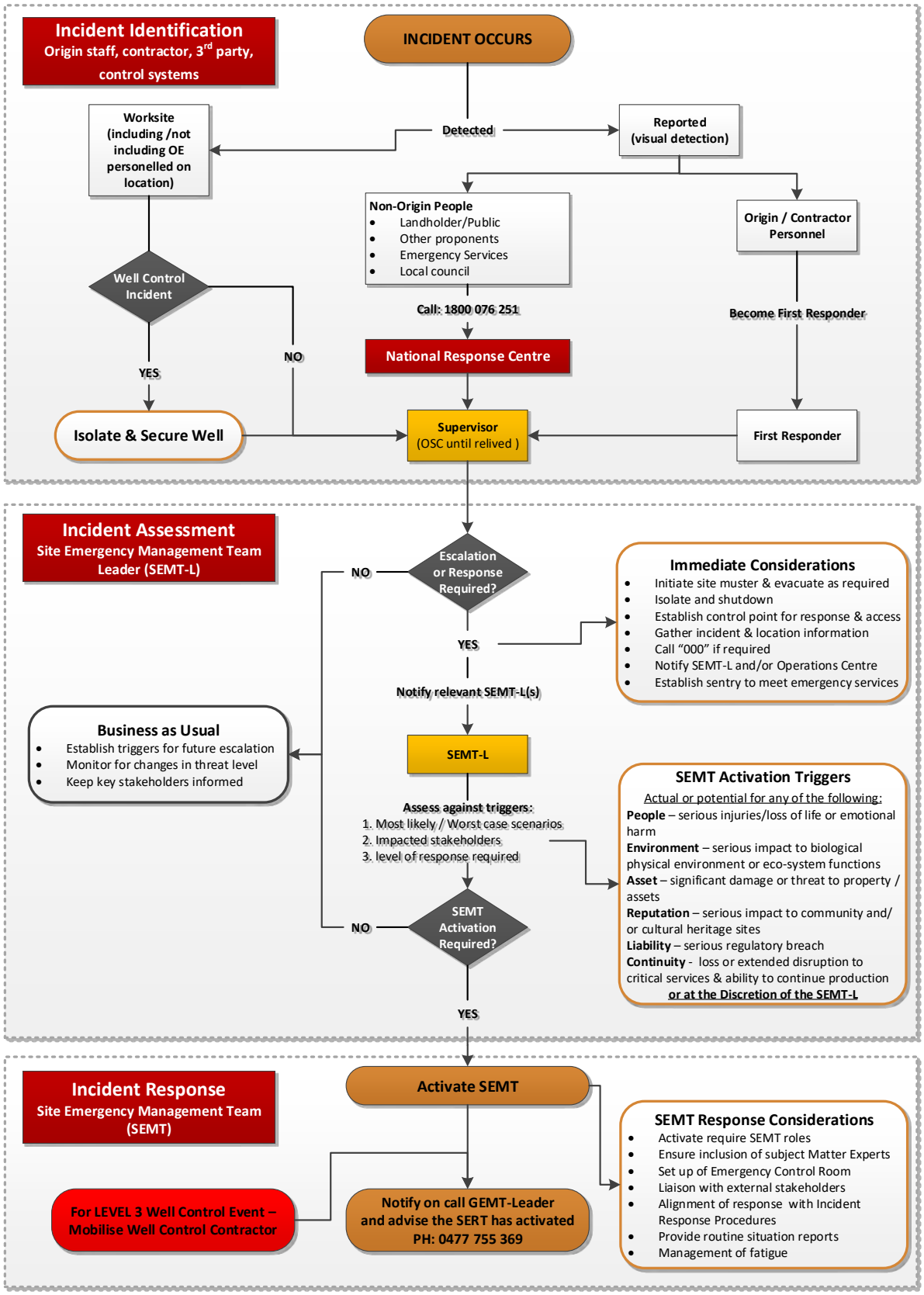
Figure 1: Detection, Assessment, Response Flowchart



2. Introduction

This Emergency Response Plan (ERP) encompasses all Growth Asset's activities within the Beetaloo Asset and will be activated to manage emergency events at site.

Locations / site specific information may be recorded either in a contractors emergency response plan (ERP), bridging document, or through another means of providing emergency information, e.g Emergency Response Notification (ERN) form.

The Site Emergency Response Plan (SERP) is designed to direct and guide the On Scene Commander (OSC) and Emergency Response Team (ERT) (if nominated) to respond effectively to site level emergencies and return the site to normal operations.

Further support is provided through the Origin Emergency Response Framework via the Group Emergency Management Plan (GEMP 6522903) and Crisis Management Plan (CMP ORG-RMS-PLA-001).

2.1 Purpose

The purpose of this plan is to describe how to effectively manage site emergencies for the Beetaloo Asset whilst in a manned and unmanned condition.

The plan will:

- Briefly describe the Origin emergency response structure
- Explain the notification and escalation paths for an emergency
- Identify key people and explain what they will do during an emergency
- Describe important information about site infrastructure including:
  - Location
  - Geographic area
  - Isolation points (if applicable)
  - Exclusion zones (if applicable)
  - Other technical information
- Provide tools and templates to use during an emergency.

2.2 Scope

This Plan supports normal manned operations and response to unmanned locations. Unmanned relates to periodic contractor service visits and occasional small team visits.

This plan applies to all employees, contractors and visitors to the following Beetaloo Asset locations and activities:

- Asset Locations details as described in Section 3.
- Activities included in scope are:
  - General travel activities (Walking, Land transport).
  - Non/minimum risk activities such as visual inspections, routine low risk maintenance and monitoring tasks.
  - Accompanying or guiding contractors who are engaged in the above mentioned activities.
  - Laydown yards within tenure.
  - Construction Work (such as access tracks, lease builds, site earthworks, remediation)
  - Drilling, well completion, intervention or abandonment activities.
  - Transport to and from work areas (not including chartered flights to Airfield)

This plan excludes:

- Chartered flights to airfield and commercial flights to Darwin
- Third Line Logistics Freight and Haulage from Depots to Laydown Yards
- Accommodation in commercial establishments outside of the work areas identified in Section 3.

2.3 Compliance with Civil Legislation and Australian Standards

This plan meets the requirements as identified by legislation for emergency response plans including:

Australian Standards, Codes, Guidelines and Commonwealth Legislation

- Work Health and Safety Act 2011.
- Work Health and Safety Regulations 2011.
- Environment Protection and Biodiversity Conservation Act 1999.
- Australian Dangerous Goods Code.
- National Environment Protection (Assessment of Site Contamination) Measure (NEPM) 1999 as amended 2013.

Northern Territory

- Work Health and Safety (National Uniform Legislation) Act 2016.
- Work Health and Safety (National Uniform Legislation) Regulations 2017.
- Petroleum Act 2018.
- Petroleum Regulations 2013.
- Petroleum (Environment) Regulations 2018.
- Code of Practice for Petroleum Activities in the Northern Territory
- Bushfire Management Act 2016.
- Bushfire Management (General) Regulations 2018.
- Dangerous Goods Act 2012.
- Dangerous Goods Regulations 2018.
- Transport of Dangerous Goods by Road and Rail (National Uniform Legislation) Act and Regulations.
- Waste Management and Pollution Control Act 2016.
- Northern Territory Contaminated Land Guideline (June 2017).

2.4 Operator Details

Origin Energy B2 Limited (“Origin”)

Level 25

180 Ann Street, Brisbane, QLD, 4000

2.5 Definition of a Site Emergency

An emergency is defined as an unplanned event within a specific site, facility, field or area, accidentally or deliberately caused, which requires a response to normalise the activity and which may result in an incident such as:

- Injury to people
- A near miss

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- Loss of control of any health, safety environment or community related incident as part of the operation
- Damage to the environment
- An uncontrolled release of a substance to air, land and water
- Loss of reputation
- Loss of business
- Loss or damage to product or assets
- Loss of production
- The potential for any of the above

2.6 Project, Construction and Mobile Work Group ER Philosophy.

These teams will have the ability to provide a basic response to: incipient fires, minor spills and basic medical emergencies, in order to preserve life, contain incidents (if able) and reduce the impact on our people, the community, environment and assets.

Section 4, Appendix B and Appendix G identify where increased response capability has been introduced to mitigate the consequences of specific incident types, e,g, Loss of Well Control. Depending on the magnitude of the scenario event, escalation could also include emergency services.

2.7 Site Emergency Management Team Activation/Escalation

This Site Emergency Response Plan (SERP) is activated for emergencies that cause or have the potential to cause SERIOUS or greater consequences. Consequence classification is based on Origins Risk Management Directive ORG- RMS-DIR-001

The Site Emergency Management Team Leader (SEMT-L) or On Scene Commander (OSC) has the authority to activate this SERP. Notification must occur to the Group Emergency Management Team (GEMT) Leader, however escalation and activation of the GEMT is determined by the GEMT on call leader. Escalation to the GEMT is conducted by ringing the GEMT-L on call phone **0477 755 369**. The Origin Emergency Management Structure Escalation Chart shows the different escalation levels between the SERT, GEMT and Crisis Management Team (CMT).

Under certain circumstances the GEMT may be activated without the activation of the SERP / SERT. If required the GEMT-L may then require the activation of SERP's / SERT's to manage an incident/s.

2.8 Document Hierarchy

The Document Hierarchy for Origin Emergency response is identified in Figure 2 below.

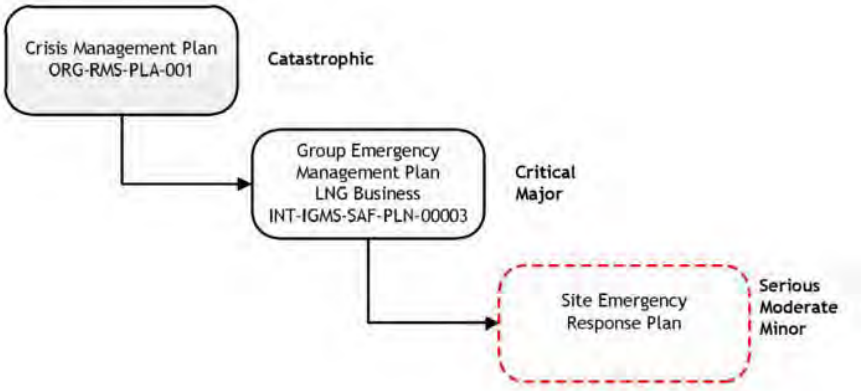

Figure 2 Hierarchy of Emergency Response documentation

2.8.1 Document Hierarchy for Principal Contractors

The relationship of Origin Emergency Response documentation for the Beetaloo Project, in conjunction with Contractor Emergency Response documentation is demonstrated in Figure 3 below.

Emergency Management - Overview

Emergency Response System Framework – Activity Specific

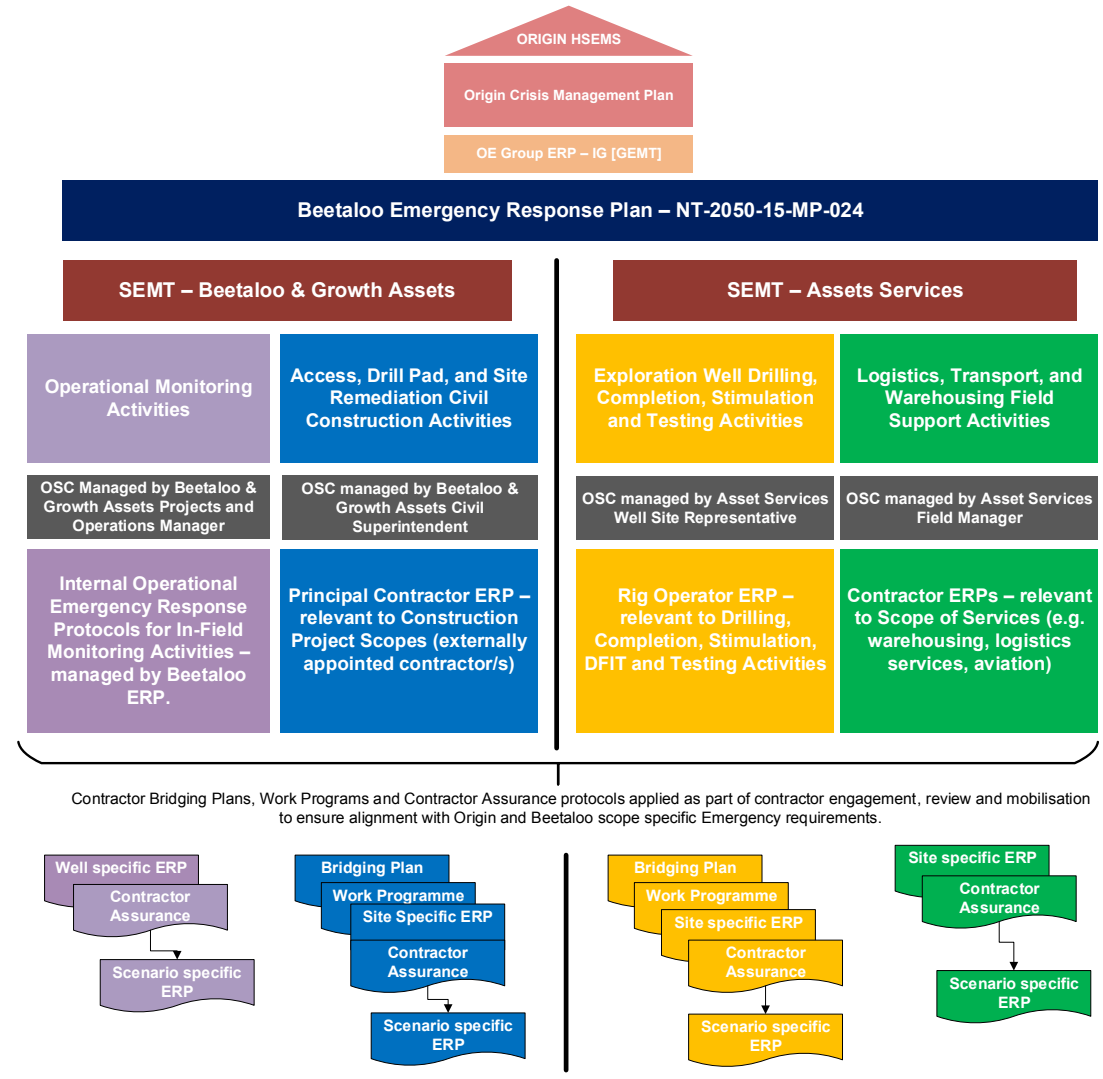

Figure 3 – Hierarchy of Emergency Response documentation

2.8.2 Emergency Management Structure

Figure 4 below identifies the Command and Control and escalation pathway for emergencies. Figure 3 identifies the escalation pathways for each component in Beetaloo & Growth Assets including Asset Services.

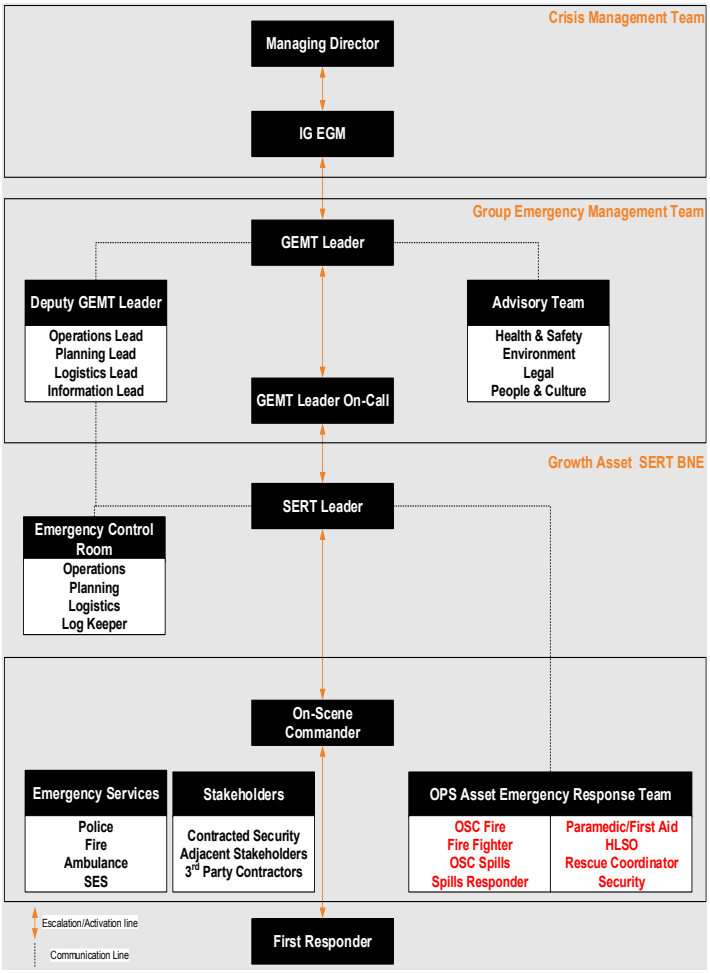

Figure 4 – Emergency Management Structure

3. Beetaloo Asset Locations and Field Activities

The Integrated Gas Growth Asset Business conducts operations in the Northern Territory (NT) at Beetaloo. The activities conducted in this scope include the following areas:

3.1.1 Drilling, Hydraulic Fracturing Stimulation (HFS), Completion and Well Testing Activities

Works are executed by Rig contractors, and are supervised by an Origin Wellsite Representative (company representative) who at times may additionally undertake rigless operations. Contractors undertaking these scopes of work operate under their own Safety Management System and Emergency Response Plans at designated locations identified within this Emergency Response Plan.

Additionally, these activities are supported by the IG Asset Services Emergency Response Plan CDN/ID 19601361 (where deemed applicable).

IG Field Management is executed through the Asset Services Field Managers located within project areas during project duration, details of these are provided within Contacts list within Appendix A.

3.1.2 Civil construction and related activities

Works such as establishing lay down areas, construction of access tracks, are usually executed by contractors operating under their own Safety Management System and Emergency Response Plans at various Beetaloo locations which are bridged to Origin Energy requirements. Beetaloo Field Management is executed through the Beetaloo & Growth Assets Projects & Operations Manager and the Beetaloo & Growth Assets Civil Superintendent whom is located within the project areas during project duration.

3.1.3 Commissioning

Works relating to commissioning of infrastructure are executed by contractors for electrical facilities and Rig Contractors for hydrocarbons as per Contractor Safe Systems of Work.

3.1.4 Projects

Works may be executed at varying locations to expand or support capability improvement to Origin Assets at Beetaloo including water monitoring bores, helicopter landing sites, or communication equipment. These Projects are usually delivered by contractors operating under their own Safety Management System and Emergency Response Plans bridged to Origin Energy requirements.

3.1.5 Field Support (logistics)

Where applicable, mobile camps will be executed by Principal Contractors. Warehousing and laydown activities will be managed by specific location ERP for the activity.

3.1.6 Existing well inspection monitoring

Well inspection monitoring activities are undertaken by local contractors working directly for Origin, these contractors report through the Beetaloo & Growth Assets Projects & Operations Manager and Beetaloo & Growth Assets Civil Superintendent located within project areas during project duration. The process undertaken for existing wells is detailed within Appendix B.

3.2 Field Sites / Locations

Site specific details, include location, proximity to emergency services and townships can be found within Appendix C. The maps below identify the location of the Beetaloo Project as well as specific Site locations referenced within this plan.

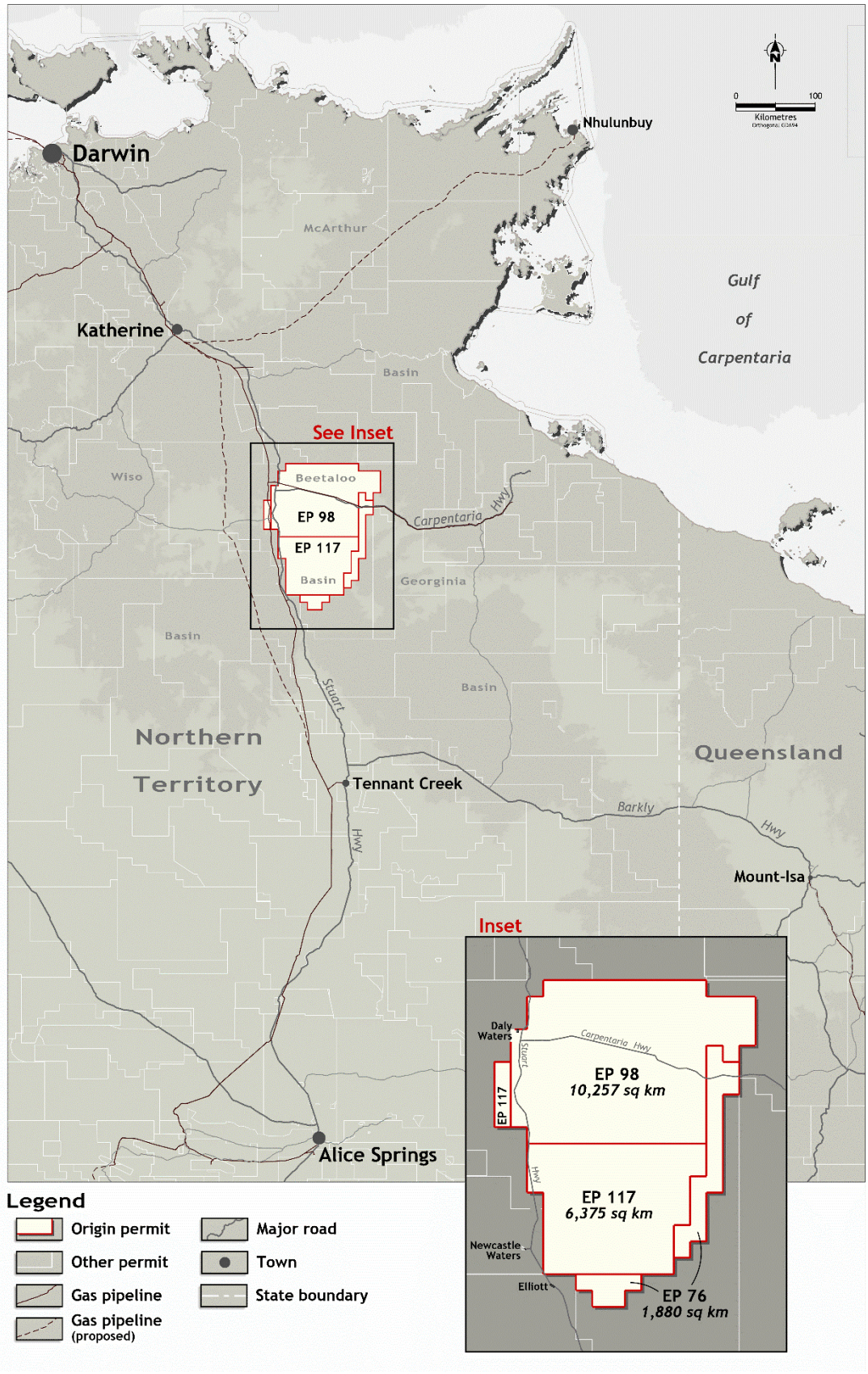

Figure 5: Location of Beetaloo Asset within Northern Territory

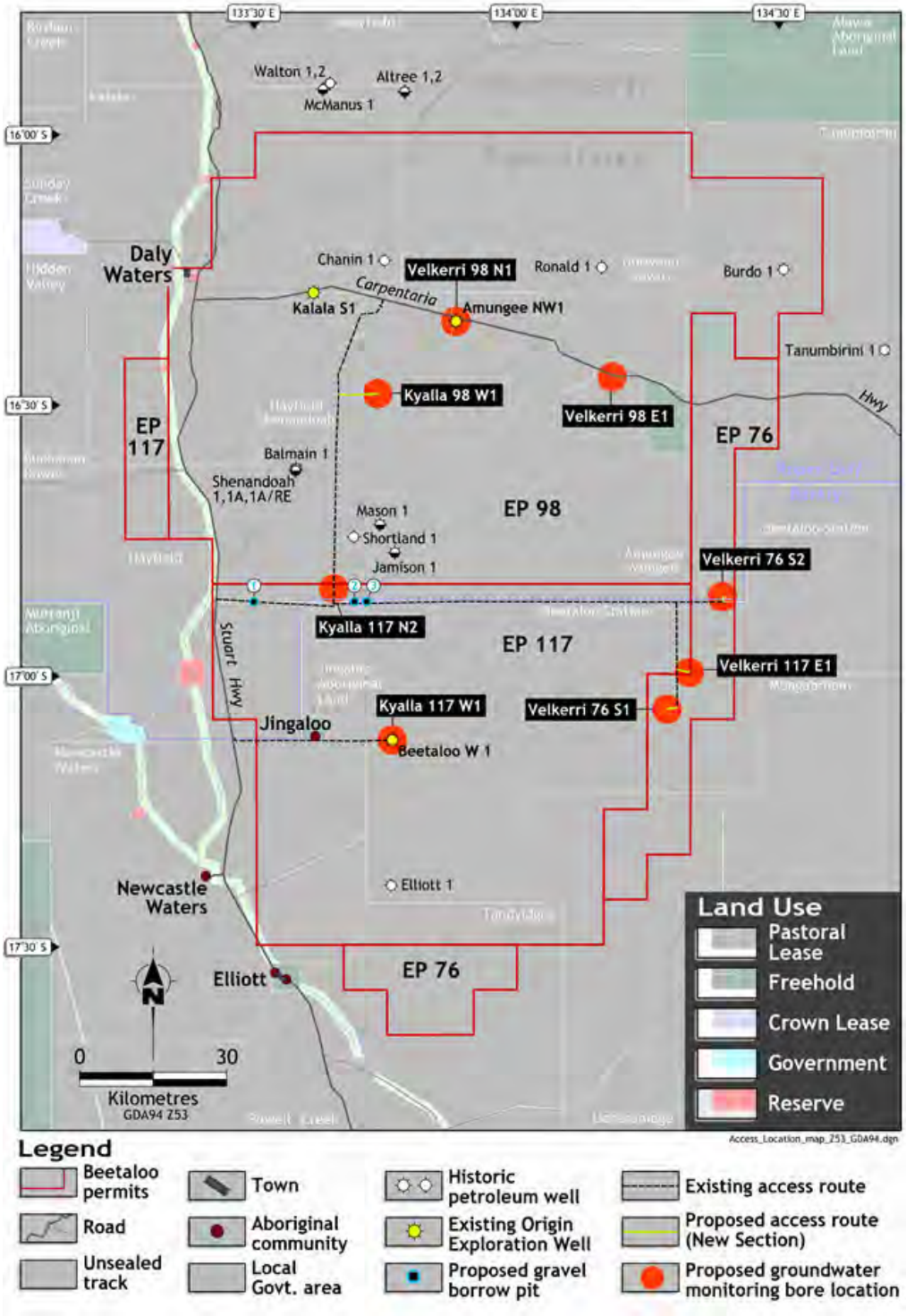

Figure 6 – Current Drilled and proposed wells locations

4. Emergency Scenario Responses

If an incident occurs, the designated Person in Charge as determined by the Beetaloo Safety Management Plan – NT-2050-15-MP-001 (Field Supervisor) will nominate an OSC and also which Origin business unit SEMT-L will be initiated. These aspect is indicated within Figure 3.

The designated SEMT-L will liaise with the Associated contractor (and Contract Owner) and notify the On-Call GEMT Leader (if deemed required). If an emergency event exceeds the contractors capability, i.e. Loss of well control, then Origin Beetaloo Asset will assume management of the incident and delegate management to internal Origin expertise, i.e Asset Services, Drilling & Completions team. The Integrated Gas Asset Services team will then determine if external support is required.

Category	Response Procedures
GENERAL	▪ Evacuation and Alarms ▪ First Responder – Immediate Action Checklist ▪ Activate Emergency Shutdown Device ▪ Shift Change Over Checklist ▪ Termination of Emergency
FIRE	▪ Fire – (Plant, Building/Storage / Accommodation (Including mobile camps), Electrical) ▪ Bushfire
PERSONAL SAFETY	▪ Medical Emergency ▪ Vehicle Accident ▪ Missing Overdue worker ▪ Lone Worker ▪ Snakebite ▪ Rescue from Height ▪ Rescue from Confined space ▪ Rescue from Heights ▪ Communicable Disease ▪ Electrical Shock ▪ Man Down ▪ Aviation
ENVIRONMENT	▪ Environment Related Incident (Earthquake) ▪ Environment – Weather Related Incident – Storm and Lightning ▪ Loss of Containment / Spill ▪ Flood
FACILITY & EQUIPMENT	▪ Major Structural / Mechanical Damage ▪ HV / LV Electrical Fault
HAZMAT	▪ Diesel ▪ Nitrogen ▪ Loss of Well Control level 1 or 2
SECURITY	▪ Protest / Trespass ▪ Bomb Threat ▪ Armed Intruder ▪ Lockdown

4.1 Scenario Flip Charts

The Emergency Scenario Flip Charts (CDN 3676134) provide an easy to understand detailed response to identified emergency situations and also provide additional scenarios that may not be mentioned. Appendix H contains four main responses from the Flip Charts for ease of reference being: 1.) Bushfire 2.) Flood 3.) Spill and 4.) Loss of Well Control.

4.2 Contractor Scenarios

For some undertakings, for example a Well control event, Origin will delegate its responsibility to a Contractor, or Sub-Contractor with suitable emergency response capability as Origin will have limited/if any field presence at times.

It will be the responsibility of the contractor to provide an initial emergency response and coordinate the emergency event. If an Origin employee is involved in an emergency event at a site under the control of a contractor it is expected that the Origin employee will conform to the contractors response requirements and support the contractor if willing and competent to do so.

Notification of the event will follow normal reporting processes within the business unit. The activation of the GEMT may be required for an incident involving the contractor. While an Origin SEMT-L may be required to coordinate Origin aspects at the incident site, in support of the contractor, contractor management will more likely occur through a nominated Origin contact (i.e.Contract Owner) who will liaise with the contractor emergency management team.

Depending on location of works the contractor may be able to call upon other nearby parties or State Emergency Services for assistance in responding or handling the incident; however the contractor retains responsibility for managing the emergency event.

4.3 Well Monitoring and Control

Appendix B and Appendix C contain all information pertaining to the monitoring of remote wells, well control and classification of well control incidents.

A loss of Well Control is considered a Major Accident Event (MAE) which, while rare, requires additional controls and engineering assessments to mitigate potential consequences.

4.3.1 Potential Major Accident Events

A Major Accident Event is an *uncontrolled incident, including fire, explosion or release of dangerous substance with the potential to lead to multiple fatalities or major environmental damage* (potential for critical or catastrophic consequence as per Origin Risk Matrix).

If the Business Unit undertaking the work has the potential for a Major Accident Event to occur these will be identified in the Business Unit Safety Management Plan (SMP) or Safety Case.

For more information refer to MAE hazard assessment and risk reduction (ALARP & SFAIRP requirements) procedure (CDN/ID: 7983063) or contact the Process Safety Advisor at Origin (details in contact list).

5. Campaign specific ERP arrangements

5.1 Roles

The following roles and responsibilities are essential to ensure effective communication within Beetaloo Asset when responding to emergency events.

- First Responder (FR), located at the incident scene and may be a Contractor
- On Scene Commander (OSC) located at the incident scene
- Site Emergency Management Team Leader (SEMT-L), located at either:
  - the Field Emergency Control Room (ECR) ; or
  - The Brisbane ECR, 180 Ann Street, Level 29, Room 29:12

Individuals may undertake multiple roles depending on the nature of the emergency, its duration and complexity. The functional roles that will assist the SEMT-L are listed below and known as the Site Emergency Management Team (SEMT).

- Operations
- Planning
- Logistics
- Log Keeper

Additional roles such as Technical Engineering, Travel and Accommodation Services may supplement the SEMT depending on the type of incident.

If the SEMT-L is unable to undertake their responsibilities a competent alternate or delegate SEMT-L must be appointed to ensure the SEMT continues to function.

If required, depending on the nature and severity of the incident, the Group Emergency Management Team (GEMT) may be activated to support the response. The GEMT can be called upon to support

such issues as Regulatory notifications, provide additional manning to site, or source assets required to support the site, such as Aviation.

For in-depth information regarding the above positions refer to the Duty cards in the OSC/SEMT toolkits

SEMT and OSC Toolkit (AUS-IGMS-SAF-GDL CDN 6893451)
http://im.originenergy.com.au/otcs/cs.exe/Open/6893451

5.2 Responsibilities

A summary of responsibilities are located below, with contractors found in the PC ERP.

Roles and responsibilities	
Contractor work parties / First Responder	• Respond to the situation as per the contractors emergency response plan. • Actively participate in the risk management process to assist in the development of emergency action plans; • Check the notice boards for any recent updates to information; • Maintain a high level of awareness of actions to be taken in the event of an emergency situation; • Follow instructions from Emergency Controller, Emergency Services personnel, Fire Wardens, First Aiders and other designated emergency personnel as appropriate; and • Prior to commencing any work or entering a work area, sign on to prestart or JRA for the associated activity.
First Aiders	• Ensure their first aid competencies (minimum *Apply First Aid and CPR*) are maintained and advise the PM prior to the expiry; • Provide first aid treatment or assessment as needed, working within their skill level; • Determine need for medical assistance and provide information to Medical personnel or Emergency services as required; • Ensure that first aid kits are maintained and complete and items are in-date; and • Ensure that all treatments provided, regardless of the type or complexities are recorded.
Site Paramedic / Nurse Practioner	• Provide care on site available during the 12 hr work day (on call 24/7 whilst on location) • Ensures that medical response emergency equipment is suitable and located appropriately; • Checks that Emergency action plans are appropriate for the activity/hazards identified; • Test communication and advises of any changes;
Origin work /travel team supervisor **(Person in Charge)** **On Scene Commander**	• Escalate to the Person in Charge, for Beetaloo & Growth Assets managed activities whom is the Beetaloo & Growth Assets Civil Superintendent or delegate, • For Integrated Gas Asset Services (IGAS) managed activities (identified in Figure 3) to the designated Field Manager. • Maintain a log of events • Escalate to Emergency Services, if required. • Act as On Scene Commander (OSC) and manage first response at site level • Ensure that emergency action plans are discussed on a regular basis at Pre-Start / Toolbox meetings, so that all persons under their control are aware of the project emergency procedures; • Ensure that emergency equipment is maintained in good working order (complete, clean and available for immediate use);

	• Advise the HSE Representative or Person in Charge (e.g Operations/Project Manager/Field Manager) of any operational issues that may impact with or affect the emergency action plans; • Ensure that emergency action plans are prominently displayed and available for use by all workers; and • Take role of on-scene commander especially in first response to an emergency incident. During first response, ensure safety of other team members and ensure that emergency situation is communicated to the Emergency Controller.
For Civil and existing infrastructure (exploration wells) activities managed by Beetaloo & Growth Assets Team. **Operations Manager Growth Assets**	• Act as Site Emergency Management Team Leader (SEMT-L) (with respect to taking call from OSC and escalating to Project Manager Provide well monitoring trend analysis as required • Act as journey contact for field teams. • Escalate to GEMT-L as required. • Support field team with emergency service direction/calls as requested
For D&C activities managed by Integrated Gas Asset Services **Asset Services – D&C Field Manager**	• Act as Site Emergency Management Team Leader (SEMT-L) (with respect to taking call from OSC and escalating to D&C Beetaloo Project Manager • Provide well monitoring trend analysis as required • Act as journey contact for field teams. • Escalate to GEMT-L as required. • Support field team with emergency service direction/calls as requested
General Manager Beetaloo & Growth Assets	• Receive call from PIC and support where required. • Participate in Group Emergency Management Team if activated.
General Manager Asset Services	• Receive call from PIC and support where required. • Participate in Group Emergency Management Team if activated.

5.3 Communications

The communication flow between contractors (rig), external services and Origin is demonstrated in the flow chart below:

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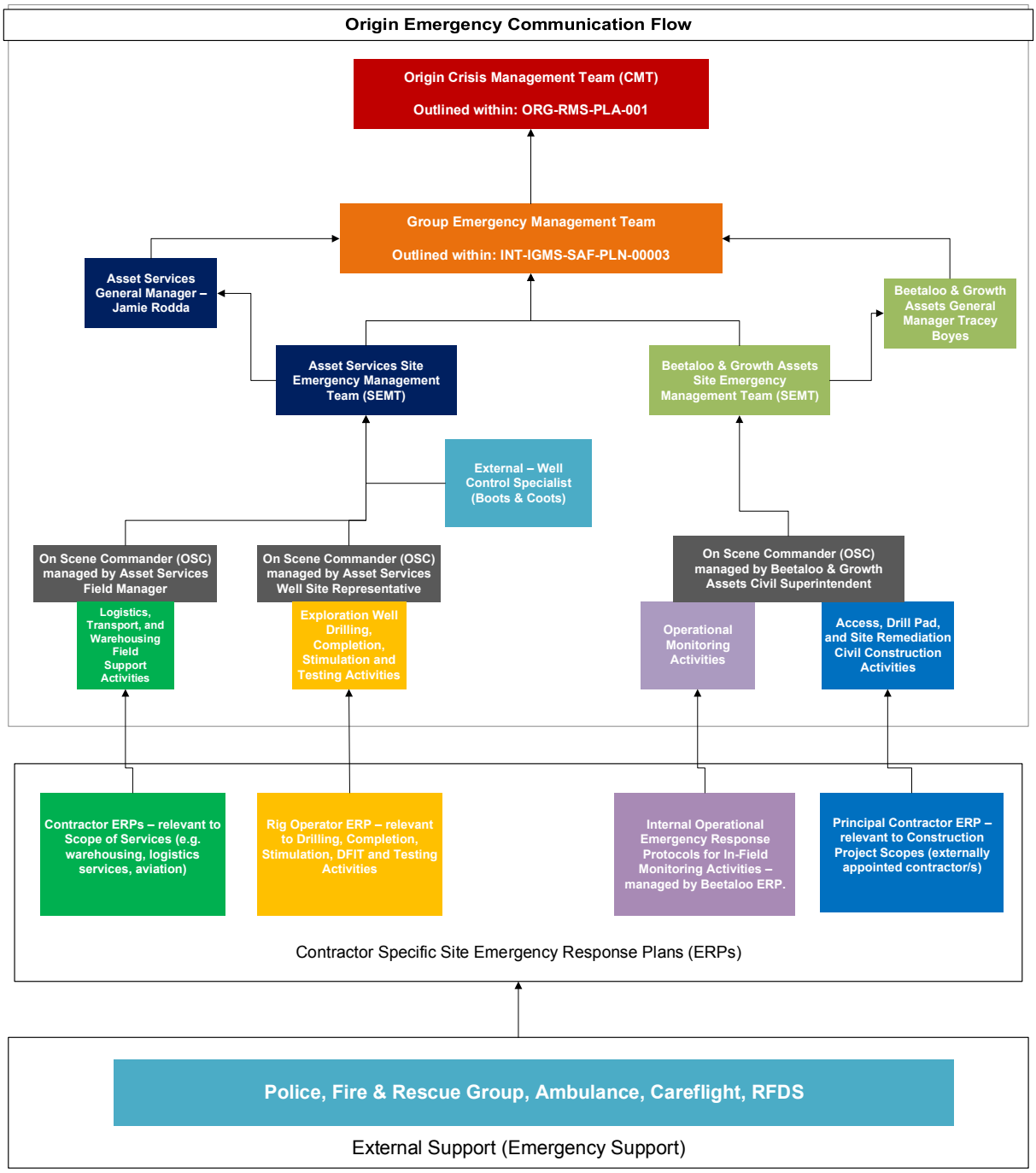

Figure 6: Communication flow

6. Emergency Management and Control

After an emergency is detected, the following emergency management stages will be used to control and contain the incident and return to business as usual.

- Raise the alarm
- Isolate and secure
- Communicate and Escalate
- Respond and Recover

6.1 Raise the alarm

One or more of the following methods can be used to raise the alarm:

- in person
- radio (Digital, UHF, VHF etc)
- phone (mobile, satellite or landline)
- Emergency alarm

6.2 Isolate and Evacuate

- Stop all work and make sure the worksite is safe
  - Secure the well, or impacted area
  - stop vehicle and mobile plant operations
- If you need to abandon vehicles and mobile plant
  - pull over and park in a safe area
  - ensure access and egress to the site is not impeded
  - switch off and leave the keys in the ignition
- Plan a safe route to the muster point and avoid movement through unsafe areas
- Account for all people
- Stand by at the muster point until stood-down or instructed to evacuate

6.3 Communicate and Escalate

- Gather information – where is the emergency, what has happened, who is affected, is anyone missing, where are the safe areas etc
- Advise and update the Site Safety Manager
- Call Emergency Services (police, fire, ambulance) if required
- Identify meeting points for responders (Origin Medical Providers, ERT etc) and Emergency Services
- SEMT activates if required

6.4 Respond and Recover

- Apply first aid to injured people (if safe to do so)
- Activate ERT
- Consider Simultaneous Operations (SIMOPS), advise nearby work groups and if on an IG Asset, the Asset SEMT-L
- Assist Emergency Services
- Follow response procedures

6.5 Meeting Emergency Services

Where Emergency Services such as Ambulance, Police and Fire Services dispatched by road or air, an Origin employee or contractor, whenever possible, will meet the Emergency Service at a designated location and direct them to the incident site.

Meeting points with Emergency Services should be pre-identified if practicable and communicated to the Emergency Services on call out.

6.6 Hazard awareness

Any person arriving at the emergency site (Origin responders, Origin medical providers, Emergency Services) will be made familiar with:

- Hazards generated by the incident (fire, heat radiation, chemical exposure etc)

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- Known hazardous areas
- Known safe locations and distances
- Appropriate PPE (if known)

6.7 Shift changeover during an emergency

Shift changeovers are required for continuity of emergency management. The SEMT-L is responsible for change over of personnel involved in the emergency. Effective changeover will be achieved by:

- Staggering changeover times
- Avoiding changeovers during critical periods
- Having changeovers in daylight, where possible
- Briefing incoming personnel

6.8 Termination of emergency and recovery actions

The SEMT-L will declare when the response phase will stop and determine the recovery strategy and resources required in consultation with the GEMT-L if GEMT is activated.

All activities required to terminate an emergency and conduct recovery operations are located in Paragraph 8 of this document.

7. Post Emergency Actions

The following post emergency actions must occur in order to ensure the Asset, and Business as a whole, successfully learns from the incident and returns to pre-incident state operations.

7.1 After Action Review

A debrief or After Action Review (AAR) is to be held after each emergency in accordance with the After Action Review Procedure CDN 8189619 and using the After Action Review Form CDN 13853829. An AAR is designed to discuss strengths and weaknesses and necessary improvements for this plan and related procedures. All AAR's shall be entered into OCIS along with any action items identified within the corresponding Incident tab.

7.2 Incident investigation

All incident investigations should be conducted in accordance with the Integrated Gas Manage Incidents and Learning Core Process found within ProMapp. The following steps should also be considered:

- Secure the incident site, restrict access and do not disturb anything until investigators have finished and handed back control of the site.
- Gather any evidence that may assist the investigations (list of people involved, response logs, situation boards, photographs etc).

The incident reporting system 'Origin Collective Intelligence System' (OCIS) will be used to record all incidents and actions arising from the emergency.

7.3 Recovery Actions

Prior to resuming work, develop a recovery plan that considers the following:

- Check plant and equipment for structural, physical and electrical/instrumentation integrity
- Ensure all active detection and protection systems are restored
- Replenish emergency response equipment as required
- Replace or return any third party emergency equipment

In addition, consider the following points:

- People who were involved may require counselling, depending on the nature of the incident
- People should be debriefed, with all relevant information captured for a 'lessons learnt'
- Conduct a tool box talk on specific start up activities before restarting work

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- Consider the potential for loss of confidence or potential IR issues following the incident or the response to that incident
- Emergency response plans and training may need to be revised before resuming normal activities.

7.4 Post Incident Clean-Up

Post incident clean up must be done using the following guidelines:

- Conduct an initial inspection to identify the extent of equipment and plant damage
- Assess potential decontamination needs (removal of chemicals/oil/foam from plant/equipment, contaminated soil etc.)
- Store all contaminated material in proper containers, pending offsite disposal by licensed hazardous waste contractors
- Repair or replace damaged equipment and plant
- Inspect and test affected equipment
- Attend to commissioning and site reinstatement

8. Training and Capability

IG emergency response competency-based training is managed by Organisational Capability. Training is captured in People Central on the Origin Intranet (Source). Managers and supervisors are responsible for identifying and organising training for people required to perform emergency response roles. All personnel must be given specific instructions and training on how to respond to emergencies and in the correct use of emergency equipment available.

Emergency training may be in the form of:

- Competency based training
- Simulated exercises
- Desktop exercises
- Toolboxes
- Practical drills
- Resource and equipment checks

8.1 Drills and Exercises

The Emergency Exercise Planning and Reporting Procedure AUS-1000-SAF-PRO-00010 CDN/ID 3674898 details the minimum requirements for the planning and conduct of exercises.

All drills and exercises require an After Action Review to determine what worked well and what requires improvement. All actions are to be recorded in OCIS and reviewed until close out.

Figure 7 details the Beetaloo Assets annual exercise program.

In addition to this schedule the IG Well Control Standard (INT-1000-35-TS-001) mandates emergency response exercises to be conducted as follows:

- For continuous operations, IG D&C related activities shall conduct two Well Control Emergency response exercises per year to evaluate the effectiveness of the response of all stakeholders
- For projects that are campaign based, a Well Control Emergency Response Exercise shall be held at the start of the campaign involving all stakeholders. Subsequent exercises shall be conducted on a minimum twice annual basis if applicable.

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		Jan	Feb	Mar	Apr	May	Jun
		1st Qtr			2nd Qtr		
Shift 1 and 2	Primary	Environmental	Fire	Environmental	Personnel safety	Structural failure	Personnel safety
	Secondary	Personnel safety	Personnel safety	HAZMAT	Security	Personnel safety	Personnel safety

		Jul	Aug	Sep	Oct	Nov	Dec
		3rd Qtr			4th Qtr		
Shift 1 and 2	Primary	Personnel safety	Personnel safety	Security	Structural / Equipment failure - Water	Fire	Personnel safety
	Secondary	Security	Personnel safety	Personnel safety	Environmental	Personnel safety	HAZMAT

Figure 7 – Exercise Schedule

8.2 Training Requirements

The Site ER job task analysis and Site Supervisor/Wellsite Representative job task analysis identifies the minimum requirements for trained personnel for specific roles that comprise the ERT and SEMT. It is the Contractor / Site Manager responsibility to maintain minimum levels of trained staff to meet their sites requirements.

8.3 Training and Competency

- All parties must be familiarised with the contents of this ERP.
- All personnel identified to fulfil emergency response roles within this ERP must be competent
- Minimum one remote first aid trained person per work party or travelling team.

9. Response Resources

The following response resources may aid in the preparation for, and management of, emergencies by the Beetaloo Asset.

9.1 Planning and Preparation

Enabling activities, such as ensuring minimum training and ensuring hardware maintenance, which are required to be carried out to support this plan are detailed in the:

- Beetaloo Basin Groundwater Monitoring Bore Installation Environmental Management Plan,
- Bushfire Management Plan
- Spill Contingency Management Plan
- Civil Construction Environmental Management Plans, and the
- Drilling, Completion, Hydraulic Fracture Stimulation and Well Testing Environmental Management Plan, in conjunction with the requirements of the Origin Integrated Gas HSEMS.

Dependent on workscope the relevant Person in charge (Field Supervisor) is responsible for ensuring that any staff mobilised to conduct work for OE in the Beetaloo Basin have been appropriately briefed, completed appropriate inductions and completed the nominated minimum training as applicable to the work conducted.

9.2 Equipment and Unmanned Phase

During operations, emergency response equipment available at each Site, and their layout, will be detailed and provided within contractor specific ERPs.

Emergency response assistance will be provided by Triple P Contracting within an unmanned aspect, this will only involve monitoring the location from a distance to ensure appropriate escalation can occur if required.

9.3 Incident Response Procedures Flip Charts

Emergency Scenario Flip Charts CDN 3676134 are intended to provide further assistance to each role in dealing with various pre–defined emergency scenarios. The charts define the key roles and

responsibilities to ensure essential response actions are undertaken. The flip charts can be found in Core Process Manage Incidents and Learning.

9.4 Spill Response

The Beetaloo Spill Management Plan (NT-2050-15-MP-030) provides specific information on how to manage and handle spill response within the Beetaloo Asset (included spills located off tenure). This document should be referenced for all non emergency spill response scenarios. For managing spills, Emergency Scenario Flip Charts CDN 3676134 and Appendix H should be utilised to manage Spills.

9.5 Chemical Response & Risk

The Chemical Response guidelines (QLD-1000-SAF-PRO CDN 4411922) provide specific information for specific chemicals that are used on Origin sites. The guidelines provide information on:

- PPE requirements
- Chemical details and description
- First Aid requirements
- Evacuation considerations
- Fire and spill management

Whilst this document was developed for QLD based Integrated gas sites it can be used on other sites if the same chemicals are present and the SDS lists the same response requirements. Any differences between the Chemical Response Procedures and the SDS must be risk assessed with appropriate controls adopted.

Additionally, an Hydraulic Fracturing Chemical Risk Assessments were completed for the activities. The fluid systems reviewed were:

- Hydraluic fracture stimulation fluids;
- Hydraulic fracture chemical tracers; and
- Drilling fluids

As part of the Chemical Risk Assessment an hazard assessment was undertaken with the 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).

Chemical Response Procedures (CDN 4411922)
Beetaloo Chemical Risk Assessment (NT-2050-15-AR-0003)

9.6 SEMT and OSC Toolkit

The link below identifies forms and procedures that can be used to help the OSC or SEMT in an emergency situation. These include:

SEMT and OSC Toolkit	
Duty Cards	SEMT Duty Cards
Initial Emergency Response Actions for All Incidents	Checklists
OSC Forms	SEMT Forms
OSC Worksheets	SEMT Worksheets
Checklists	ECR Equipment and Layout
Landing of Careflight Helicopter in The Field	ECR Status Boards

SEMT and OSC Toolkit (AUS-IGMS-SAF-GDL- CDN 6893451)

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9.7 Bushfire Management

Specific wellsite Bushfire Managements Plans (BMPs) have been prepared for each wellsite location as per Code of Practice for Petroleum Activities requirements, these BMPs can be found in **Appendix D4.**

The following link can provide technical advice in developing Bushfire Management processes as it provides access to Prevention and Response resources such as:

- IG Bushfire Standard
- Bushfire Preparedness Tool
- Generic Bushfire Asset Protection Zone (APZ) Guide
- Beetaloo Bushfire Management Plan
- https://www.pfes.nt.gov.au/incidentmap

Bushfire Management Source Bushfire Page Link

9.8 Flood Management

In the preparation and response to a flood event, the following resources have been developed to help the site prepare for and manage a flood response

- Camp Isolation Readiness Check sheet (Appendix I).
- Flood Mapping via OLIMAPS (where available)

Betaloo Assets teams can use the above tools to develop site Specific Flood Plans. The plan should take into consideration:

- Sources of flooding i.e. rivers, dam over flows etc.
- Fixed and temporary assets affected by flooding
- Access roads that are cut off and at what levels.
- Seasonal Preparedness – Activities at a minimum to prepare site for a flood
- Flood Warning or Watch
- Need to isolate equipment affected by flooding
- Flood Recovery requirements

9.9 Security Toolkits

In addition to the Emergency Response Flip Charts (CDN 6893451) the following documentation supports response to different security scenarios:

- IG Security Management Plan CDN 8278592
- Wellsite Safety and Security Level Classification Procedure
- Regional Protest Plan - CDN 7654911
- Beetaloo Security Plan – NT-2050-95-MN-001

Security Toolkits Source Security Page

9.10 Aviation Resources

Specific aviation resources can be sourced for use during an emergency. The IG Aviation Management Plan INT-1000-SAF-PLN-00007 can help to develop site specific aviation appropriate emergency response actions for the business unit's area.

Additionally, the Beetaloo Aviation Management plan provides further guidance for specific aviation practices within the Asset.

Further tools can be found at the IG Transport and Aviation Source Page

The plan identifies

- Aviation Tasking Process
- Aviation Bookings (fixed and rotary winged aircraft)
- Landing Site Management including approved Airfields and Helicopter landing site requirements.

Aviation Management Plan
Integrated Gas Aviation Management Plan

In addition to the aviation management plan the below link provides details on the following:

- Helicopter Landing Sites technical inspection report form
- Helicopter Landing site design plate
- Helicopter Landing Site Officers
- Approved Helicopter Landing Site Register and requirements
- Aerial Firefighting
- Helicopter Landing Site Officer operators manual

Aviation Resources
http://source.originenergy.com.au/Business/Gas/hse/risk/Pages/Transport.aspx

9.10.1 Helicopter Landing Site Officer (HLSO)

If a helicopter is required for an emergency situation a designated / trained Helicopter Landing Site Officer (HLSO) should be sourced (where available) to support ground activities. It is the responsibility of the HLSO to ensure that they are familiar with the landing locations and the requirements associated with the Helicopter Landing Site Officer Operations Procedure – Integrated Gas (CDN/ID 7983075) .

Landing Site Coordinates should be identified in either the Emergency Response Notification (ERN) document that is prefilled by the rig when moving to a new well location or if conducting a Campaign then nominated in the campaign specific bridging document.

9.11 Emergency Control Room

The Emergency Control Room (ECR), manned by the Growth Assets SEMT, is the coordination centre and “communication hub” for Beetaloo Asset based emergency incidents. The ECR must be activated to help assist the affected site oversee the operational emergency response and well-being of personnel involved in, or affected by, the emergency. The Beetaloo Asset ECR is located in 180 Ann Street in room 29:12 and contains appropriate tools, documents and stationery to support a response.

Emergency Control Room ECR Tools

9.12 Emergency Equipment

A detailed list of Beetaloo major ER equipment is located in Appendix G.

10. Stakeholder Management

An emergency will be coordinated and supported by the SEMT at the ECR and SEMT at site. The bridging document or the ERN will contain site specific contacts that can be contacted in an emergency.

10.1 Group Emergency Management Team (GEMT)

The GEMT provides support to an emergency situation and manages the higher level requirements to assist the SEMT whilst dealing with regulators, media, legal and industry partners. For every activation of the SEMT, the SEMT-L must contact the on call GEMT-L and advise of the situation. The GEMT-L will determine whether the GEMT will be activated. The SEMTL and GEMTL must be familiar with the levels of incident management categories located within the Emergency response Assessment and Escalation procedure (CDN 8629094)

When an incident has escalated to include the GEMT, the SEMT-L, having consulted with the OSC, will communicate regularly with the GEMT Operations Lead to provide updates and make requests for support.

Group Emergency Management Plan (INT-IGMS-SAF-PLN CDN 6522903)

10.2 Emergency Services

First Responders must notify the OSC and in turn the SEMT-L if they call Emergency Services. Once notified, the OSC is responsible for all communications back to the SEMT.

Upon arrival, Emergency Services may take control of the emergency or leave the control to Origin to manage, depending on the type of emergency and the assistance that is required. In most circumstances Emergency Services will require assistance from Origin for local and technical knowledge and for additional resources to manage the incident.

Where Emergency Services take control of the incident it must be remembered that they are not able to command Origin personnel or resources, this command must still be managed by an Origin representative such as the OSC. This same control over the Emergency Services personnel and resources must be managed by the Emergency Services representative, such as the Incident Controller or senior officer.

10.2.1 Emergency Manifest

A hard copy Emergency Manifest, identifying notifiable quantities of hazardous substances, should be located on arrival at permanent field locations in an easily accessible and identifiable place. An Emergency Service Manifest template found in Open Text Templates (and CDN 5362370) can be used to develop the Emergency Manifest.

10.3 Next of Kin

In the event of a death, serious injury or other emergency, involving Origin personnel, advice to relatives about the condition of a person or about the incident will be coordinated by People and Culture (P&C) through the GEMT.

During or after an emergency, the SEMT-L will refer any queries or concerns from relatives to People and Culture. P&C may also activate Employee Assistance Program (EAP) providers to support site personnel or relatives affected by an incident.

Principal Contractors and Contractor companies are responsible for management of next of kin communication in consultation with Police services, and EAP management in accordance with their emergency response plans and relevant State obligations. Where Contractors do not maintain their own EAP provider, P&C may extend EAP services as determined by the GEMT-L and P&C GEMT representative.

10.4 Landowners / Pastoralists

Contact with local landowners can be initiated by the SEMT-L in extreme circumstances; however Land Relations Advisors are to be used in the first instance. When activated, stakeholder communications will be handled by the GEMT and are addressed in the Group Emergency Management Plan (INT-IGMS-SAF-PLN-00004). Refer to Appendix A for contact details.

10.5 Regulatory Notification

A regulatory notifiable incident is an incident or non-compliance with an External Mandatory Obligation or External Voluntary Obligation that requires notification or reporting to a Regulator as prescribed by applicable Laws and Regulations. HSE regulatory notifiable incidents required to be reported to a regulator are listed in Appendix A.1.

Any regulatory incident notification to joint venture parties must follow the contractual arrangements specified in the joint venture agreement.

The Origin Energy joint venture representative must be consulted to determine Origin Energy's contractual obligations for incident notification and reporting.

Any correspondence between Origin Energy and joint venture partners must be conducted through the joint venture representative unless other arrangements have been agreed.

Verbal Notification	**Written Notification**

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Risk Assurance Compliance and Process Safety Team On-call number 0475 813 986	IntegratedGasCompliance@upstream.originenergy.com.au

Integrated Gas management of Regulatory Notifiable Incidents (INT-IGMS-BUS-PRO-00001 CDN/ID 5814101)

10.6 Dealing with Media Enquires

During an emergency event, media attention may occur at the affected site. All communications with the media must be in accordance with the Origin Media Policy (ORG-CGOV-POL-005). If personnel receive an enquiry from a journalist or reporter, whether in person or by phone and are asked about Origin, they should say:

"I am not in a position to comment but if you give me your name and telephone number I will organise for the most appropriate person to call you."

Always ask for:

- the journalist / reporter's name;
- publication / media outlet;
- contact phone number and / or email, and
- publication deadline.

The SEMT-L will advise the GEMT-L on call and External Affairs managers at the earliest opportunity of any media contact or enquiry. Refer to Appendix A – Table 3 for External Affairs contact details.

It is important to remember that there is no such thing as "off the record". Even if you are speaking informally, you could be quoted at any time.

11. Review and update

The ERP will be reviewed and updated as necessary in response to one or more of the following:

- annually
- when major changes have occurred, which may affect the Emergency Response coordination or capabilities
- following routine testing of the plan
- after an actual emergency or
- before installing and commissioning new plant and equipment.

During the review, the following aspects are also to be considered:

- lessons learned from an emergency
- changes in legal requirements
- improvements to effectiveness in terms of response strategy, management and communication
- developments in the latest techniques and technology in handling an emergency
- changes to, or movement of people within our organisation
- changes to contact numbers of internal and external organisations

revisions to existing, or availability of, emergency management tools and equipment and resource suppliers and contractors.

12. Associated Documents

Document	Document Reference
Incident Response Procedures	QLD-1000-SAF-PRO-00041

Document	Document Reference
Chemical Response Procedures	QLD-1000-SAF-PRO-00095
SEMT Toolkit	AUS-IGMS-SAF-GDL-00002
Emergency Response Exercise Planning Form	AUS-1000-SAF-FRM-00012
IG Group Emergency Management Plan (GEMP)	INT-IGMS-SAF-PLN-00004
Crisis Management Plan	ORG-RMS-PLA-001
Emergency Response Exercise Planning and Reporting Procedure	AUS-1000-SAF-PRO-00010
Risk Management Policy	ORG-RISK-POL-001
Origin Risk Toolkit	ORG-RSK-TOOL-001

13. Document information and history

DOCUMENT CUSTODIAN GROUP

Title	Name/s
General Manager – Beetaloo & Growth Assets	Tracey Boyes

DOCUMENT AUTHOR

Position	Name
HSE Lead – Growth Assets	Lucas Fulford

STAKEHOLDERS AND OTHER CONTRIBUTORS

Position	Name
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Operations & Projects Manager – Growth Assets	Matthew Hanson
D&C Project Manager – Growth Assets	Ed Wong
Field Manager – Asset Services (Beetaloo)	Troy Beetson
Logistics Manager – Asset Services	Peter Runge
Environmental Specialist – Growth Assets	Matt Kernke

DOCUMENT HISTORY

Rev	Date	Changes made in document	Reviewer/s	Consolidator	Approver

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A	25/03/2019	Consolidation of previous Beetaloo campaign ER plans, unmanned ERP to align with Integrated Gas ERP requirements to form Asset ERP.	B Baldwin	L Fulford	
0	29/04/2019	Issued for Use	B Baldwin M Hanson Ed Wong	L Fulford	T Boyes
1	21/06/2019	- Update references around regulatory reporting requirements based on NT regulator DNER feedback. - Update from NT police comments. - Combined wells and lease pad locations into one location in Appendix C for ease of reference.	M Kernke	L Fulford	T Boyes
2	03/12/2019	Police contact details updated in Appendix A1.	M Kernke	L Fulford	L Fulford
3	08/01/2020	Update to Appendix C – Well control information, addition of Boots & Coots information. Addition of Appendix D – Bushfire Management Plans	E Wong	L Fulford	L Fulford
4	17/1/2021	Updated with DEPWS comments	G Bertini		M Kernke

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Appendix A Contact lists

External Agencies		
Role	**Name**	**Primary**
Local Emergency Services	Police, Fire, Ambulance	000 (or 112 from mobile)
Hospital	Katherine Hospital	(08) 8973 9211 Kintore Clinic Katherine (08) 8972 1677
Field response contractor / initial inspections	Triple P Contracting (PPP)	Gordon Jackson 0456 618 367 Susey Jackson 0487 120 819 Sat Phone 0147157201 Email: triplepcontracting@outlook.com
Remote Well Monitoring Assistance	Vincent James Operations Support Manager MPC Kinetic	+61 419 822 992
Bushfires NT	Fire control officer	Katherine (08) 8973 8871
Volunteer Bushfire brigade		(08) 8975 9936
Regional Shire Council	Roper Gulf Shire	08 8972 9000 or 1300 366 208
Regional Shire Council	Barkley Shire	
Police (non-emergency)	Police Link	131 444 Elliott - (08) 8969 2010 Katherine – (08) 8973 8000
Poisons Information Centre	n/a	13 11 26
Bureau of Meteorology	Cyclone Warnings Forecasts & Warnings	1300 659 211 08 8920 3826
NT DPIR's Petroleum Operations Team	after-hours	+61 1300 935 250
NT DNER		08 8973 8871 or 08 8973 8872 or 08 8973 8870 **DENR** Note, also required to notify landholder
NT EPA Pollution Hotline	n/a	1800 064 567
NT WorkSafe	n/a	1800 019 115 ntworksafe@nt.gov.au
Department of Main roads	n/a	1300 654 628
NT power and water	n/a	1800 245 090
Well Control supplier (for lev3)	Boots & Coots Services Well Control and Prevention	24 hr. hotline 1 800 BLOWOUT or + 1 281 931 8884

Origin Beetaloo contacts		
Role	**Name**	**Primary**
Group Emergency Management Team (GEMT) Leader On-Call	[redacted]	+61 477 755 369
Origin IG Compliance	[redacted]	+61 475 813 986 IntegratedGasCompliance@origin.com.au
General Manager – Beetaloo & Growth Assets	Tracey Boyes	+61 475 949 668 Tracey.boyes@origin.com.au
Construction Supervisor – Beetaloo & Growth Assets [Weeds officer]	Robert Wear	+61 467 679 003 sat phone 0450 942 082 robert.wear@origin.com.au
Operations & Projects Manager – Beetaloo & Growth Assets	Matthew Hanson	+61 477 748 843 Matthew.hanson@origin.com.au
Ed Wong – D&C Project Manager – Beetaloo & Growth Assets	Ed Wong	+61 467 791 931 Ed.wong@origin.com.au
HSE Lead – Beetaloo & Growth Assets	Gabrielle Bertini	+61 0477 723 282 Gabrielle.Bertini@origin.com.au
Environmental Specialist – Beetaloo & Growth Assets	Matt Kernke	+61 467 700 565 Matt.kernke@origin.com.au
Corporate Affairs - Beetaloo & Growth Assets	Stephanie Stonier	+61 475 940 931 Stephanie.stonier@origin.com.au
Senior Petroleum Engineer – Beetaloo & Growth Assets	Alex Cote	+61 408 612 889 Alexander.Cote@origin.com.au
Senior Project Engineer - Beetaloo & Growth Assets	Mitch Roll	+61 423 929 661 Mitchell.roll@origin.com.au
Rig Superintendent – Asset Services	James Boorman	+61 436 617 346 James.boorman1@origin.com.au
Field Manager – Asset Services (Beetaloo Stage 2 campaign)	Troy Beetson / Josh Fisher	+61 475 977 156 (Troy) Troy.beetson@origin.com.au +61 459 022 252 (Josh) Josh.fisher@origin.com.au
Field HSE Advisor – Asset Services (Beetaloo Stage 2 campaign)	Zeak Cheney / Shaun McGrath	+61 477 390 119 (Zeak) Zeak.cheney@origin.com.au +61 477 357 045 (Shaun) Shaun.mcgrath@origin.com.au
External Affairs Manager - IG → direct media enquires	Chris Zipf Or Tony Hancox	(Chris) +61 429 078 331 Christopher.Zipf@origin.com.au (Tony) +61 477 394 576 Tony.Hancox@origin.com.au
Process Safety SME – HSE RAC - Origin	Liana Bonnette	+61 455 092 572 Liana.bonnette@origin.com.au
Emergency Response and Security Specialist – HSE RAC - Origin	Bruce Baldwin	+61 467 802 482 Bruce.baldwin@origin.com.au

For contacting neighbouring properties/pastoralists, all escalation is to be undertaken by the Beetaloo & Growth Assets Project and Operations Manager – Matthew Hanson (or delegate).

Neighbouring Properties			
Property Name	**Contact Name**	**Phone**	**Direct Neighbouring Properties**
Amungee Mungee	Adrian Brown (owner)	(08) 89 711293 Katherine office +61 427 825159 Adrian (08) 89 759 599 Amungee homestead UHF 18 VHF 123600	Nutwood Downs –North Tanunbirini – East Hayfield – West Beetaloo – South
Beetaloo	Scotty & Jane Armstrong (son-in-law/ manager)	(08) 89 644 613 Office (08) 89 644 711 UHF 16 VHF 123850	Amungee Mungee – North Hayfield/Shenandoah – N/W NCW – West NCW – South (Tandi/Uchar)
Sturt Plains Hayfield/Shenandoah	Brad & Lisa Dyer Justin & Sally Dyer (son/policy)	+61 429 806 477 Brad (08) 89 759 920 Hayfield +61 408 802 741 Justin +61 417 836 551 Val UHF 17 VHF 123900	Buchannan – West Kalala – North Amungee Mungee – East Beetaloo – East NCW – South
Hidden Valley	David & Jenny James	(08) 89 759 999 (08) 89 759 622 Kitchen	Sunday Creek – North Kalala – East Buchannan – South
Kalala	Ray & Pam Murphy Tosser Murphy (son)	(08) 89 759 936 Office +61 427 759 938 Ray +61 488 759 944 Tosser	Sunday Creek – West Maryfield – North Nutwood Downs – East Hayfield/Shenan – South Hidden Valley - West
Newcastle Waters	Jak Andrews	(08) 89 644 527 (08) 89 644 571 + 61 428 525 895 Jak	Hayfield – North Beetaloo – North
Nutwood Downs	Rod & Rayna Dunbar	(08) 89 759 954	Kalala – West Amungee Mungee – South
Tanunbirini	Mick Tasker (Manager)	(08) 89 759 929	Amungee Mungee - West

A.1. Incident Notification Matrix – Northern Territory

As detailed in the IG Management of HSE Regulatory Notifiable Incidents procedure, incidents that may potentially be notifiable will be escalated via the various field team, through their functional lead (Field Manager / Operations and Projects Manager) and through to the IG RAC & Process Safety team who will provide guidance in interpreting notification requirements and guiding the external authority notification.

Integrated Gas Regulatory Incident Notification Guideline (NT regulatory notification matrix)				
Legislation	**Incident**	**Way report must be given**	**When report must be given**	**Contact Details**
Work Health and Safety (National Uniform Legislation) Act 2011 ***Sections 35 - 39***	A PCBU must notify the regulator as soon as they become aware of a death, serious injury or illness or dangerous incident that arises out of the conduct of the business or undertaking. A *dangerous incident* includes: • Uncontrolled escape, spillage or leakage of a substance, gas or pressurised substance • Uncontrolled implosion, explosion or fire • Electric shock • Fall or release from height of plant, substance or thing • Collapse, overturning, failure or malfunction of, or damage to, any plant/equipment/structure/excavation • In-rush of water, mud or gas in an underground excavation tunnel or interruption of ventilation in said tunnel A serious injury or illness means that results in: • work related injury • immediate hospital treatment as an in-patient • immediate treatment for serious injuries (for example amputation, scalping, a spinal injury, loss of a bodily function or a serious laceration, burn, head injury or eye injury), or • medical treatment within 48 hours of exposure to a substance.	By telephone	Immediately after becoming aware	1800 019 115 Worksafe ntworksafe@nt.gov.au
Schedule of Onshore Petroleum Exploration and Production Requirements 2019	An incident involving death or serious injury (reports shall be in addition to, and not take precedence over reports required by NT WorkSafe) A serious injury is one which requires immediate attention by a medical practitioner	by telephone AND in writing	immediately As soon as practicable	1300 935 250 DPIR Petroleum.Operations@nt.gov.au
	An incident involving serious damage (other than Environmental Harm) including loss, destruction or damage to property exceeding $50k or when any person dies or suffers serious injury	by telephone AND in writing	immediately As soon as practicable	1300 935 250 DPIR Petroleum.Operations@nt.gov.au
	An incident involving or could potentially involve the injury to a person or serious damage to property that is professionally considered to have been caused by an event that is not in the normal or ordinary course of an operation (Potentially Hazardous event)	by telephone AND in writing	immediately As soon as practicable	1300 935 250 DPIR Petroleum.Operations@nt.gov.au
	An incident where damage to property occurs (<$50k) that is not serious damage to property, but which results in a significant loss of structural integrity or load bearing capacity in the property damaged or results in some other significant unsafe condition	by telephone AND in writing	immediately As soon as practicable	1300 935 250 DPIR Petroleum.Operations@nt.gov.au
	An incident that is considered to be an emergency	by telephone	Immediately (after 000)	1300 935 250 DPIR Petroleum.Operations@nt.gov.au

Integrated Gas Regulatory Incident Notification Guideline (NT regulatory notification matrix)				
Legislation	**Incident**	**Way report must be given**	**When report must be given**	**Contact Details**
Petroleum Act 1984 and associated Regulations	**Reportable Incident:** An incident, arising from a regulated activity, that has caused or has the potential to cause material environmental harm or serious environmental harm. *Material environmental harm* means harm that: (a) Is not trivial or negligible in nature; (b) Consists of an environmental nuisance of a high impact or on a wide scale; (c) Results, or is likely to result, in not more than $50k or the prescribed amount (whichever is greater) being spent in taking appropriate action to prevent or minimise the environmental harm or rehabilitate the environment; or (d) Results in actual or potential loss or damage to the value of not more than $50k or the prescribed amount (whichever is greater). *Serious environmental harm* means environmental harm that is more serious than material environmental harm and includes environmental harm that: (a) Is irreversible or otherwise of a high impact or on a wide scale; (b) Damages an aspect of the environment that is of a high conservation value, high cultural value or high community value or is of special significance; (c) Results or is likely to result in more than $50k or the prescribed amount (whichever is greater) being spent in taking appropriate action to prevent or minimise the environmental harm or rehabilitate the environment; or (d) Results in actual or potential loss or damage to the value of more than $50k or the prescribed amount (whichever is greater). **[Note: Applicable for on tenure Spills]**	by telephone OR in writing AND in writing	As soon as practicable (not later than 2 hours after the incident) <24 hours after oral notice (written notification) 3 days after the incident (initial report) 90 days intervals from the date of the initial report (interim reports) 30 days after clean up or rehabilitation (final)	1300 935 250 DPIR Petroleum.Operations@nt.gov.au
	Recordable Incident: An incident that has resulted in an environmental impact or environmental risk not specified in the current plant for the activity; or has resulted in the contravention of an environmental performance standard specified in the current plan for the activity; or is inconsistent with an environmental outcome specified in the current plan for the activity; and is not a reportable incident.	In writing	15 days after each 90 day period after then day on which the environmental management plan is approved.	1300 935 250 DPIR Petroleum.Operations@nt.gov.au
Environmental Protection Biodiversity Conservation Act 1999	Incidents considered to have an impact to Matters of National Environmental Significance	in writing	within 5 business days of becoming aware	Compliance@environment.gov.au
Energy Pipelines Act 1981 and associated Regulations	A reportable incident that involves: • Death or serious injury (or the potential to cause) • Significant damage to a pipeline (or potential to cause) • Immediate investigation	By telephone AND In writing	As soon as practicable As soon as practicable	1300 935 250 DPIR Petroleum.Operations@nt.gov.au
	A significant pipeline accident event that: • Is connected with work carried out on or in relation to a pipeline • Causes, or has the potential to cause human death	By telephone AND in writing	As soon as practicable As soon as practicable	1300 935 250 DPIR Petroleum.Operations@nt.gov.au
Environmental Assessment Act 1982 and associated Regulations	Alteration of action in such a manner that the environmental significance of the proposed action may be changed	in writing	As soon as practicable after the alteration	08 8924 4218 **NT EPA** ntepa@nt.gov.au
Bushfires Management Act 2016 and associated Regulations	Unable to control a fire on the land	All reasonable steps	Following the fact	08 8973 8871 or 08 8973 8872 or 08 8973 8870 **DENR** Note, also required to notify landholder

Integrated Gas Regulatory Incident Notification Guideline (NT regulatory notification matrix)				
Legislation	**Incident**	**Way report must be given**	**When report must be given**	**Contact Details**
Waste Management and Pollution Control Act 1998 and associated Regulations	An incident that causes, or is threatening or may threaten to cause, pollution resulting in material environmental harm or serious environmental harm. This includes road transport incidents and spills that may occur off the lease (spill response). Refer to the definition of *material* and *serious environmental harm* provided in *Petroleum Act* section above. *Pollution* means: (a) A contaminant or waste that is emitted, discharged, deposited or disturbed or that escapes, or (b) A contaminant, effect or phenomenon, that is present in the environment as a consequence of an emission, discharge, deposition, escape or disturbance of a contaminant or waste. Note: does not apply to incidents confined within petroleum activities land (including air and water above or below) – see the EMP for the area of petroleum activities land **[Note: Applicable for off tenure Spills]**	by telephone	Within 24 hours of becoming aware	1800 064 567 **NT EPA** Pollution@nt.gov.au
Heritage Act 2011 and associated Regulations	Discovery of archaeological places and objects	In writing	As soon as practicable (within 7 days of discovery)	08 8999 5039 **DTC - Heritage Branch** heritage@nt.gov.au
Weeds Management Act 2001	First becoming aware of a declared weed that has not previously been, or known to have been, present on the land.	Not specified	14 days of becoming aware	08 8999 4567 **DENR** weedinfo@nt.gov.au
Dangerous Goods Act 1998 and associated Regulations	Becoming aware of theft, loss of, or unauthorised interference with explosives.	Not specified	Immediately after becoming aware	Police Assistance Line 131 444

Internal Contacts	
The on-call phone number is 0475 813 986 and is monitored 24/7 by the Integrated Gas Regulatory Compliance Team	*integratedgascompliance@upstream.originenergy.com.au*
a. *Work Health & Safety Incident Notification form*	*http://www.worksafe.nt.gov.au/LawsAndCompliance/Pages/incident-reporting.aspx*
b. *Pollution Report Form*	*https://ntepa.nt.gov.au/waste-pollution/hotline/pollution-report-form* *http://im.originenergy.com.au/otcs/cs.exe/properties/7486053*
c. *Aviation Accident or Incident Notification Form*	*https://www.atsb.gov.au/mandatory/asair-form.aspx?*

Appendix B Well Inspection and Monitoring Protocol

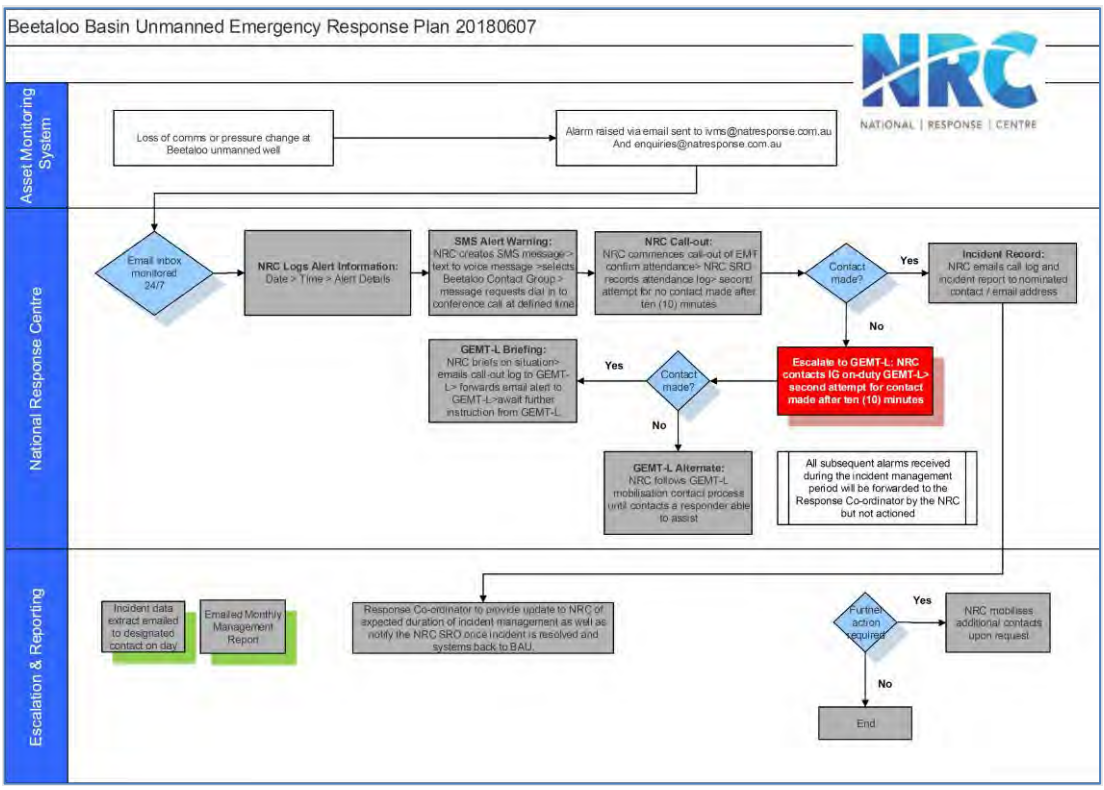
B.1. Well Pressure Remote Monitoring

The Amungee NW-1H well is suspended at surface for monitoring and recording of the reservoir pressure buildup. Real time pressure monitoring exists and a pressure anomaly or loss of communications to site will trigger an email alarm to a minimum of 7 people (listed below) and to a 24/7 monitored email at the Origin's National Response (NRC) centre. The NRC will send a further SMS and text to voice message to the notification list to alert the team of the alarm. The SMS will include time details to call into a conference call number at a set time (nominally 10 minutes time – but to be stated in the message). NRC will start the the conference call however if NRC was unable to contact any one on the list by phone before the call, and no one joins the conference call they escalate to GEMT.

The group on the conference call can then decide if the site requires inspection and agrees on the person (the nominated SERT-L) to deploy Triple P or other services to site. NRC will continue on the conference call maintaining notes of discussions. NRC will follow the below process flow when activated from an alarm.

Conference call number to be used.

1800 062 923
Host PIN 6700 4855 4873
Guest PIN 6700 4855 3024



Current list of people receiving notifications. All people on this list should have this list of people in their contacts to facilitate quick communications.

Role	Name	Primary
Construction Superintendent – Beetaloo & Growth Assets	Robert Wear	+61 467 679 003 sat phone 0147162733
Operations & Project Manager – Beetaloo & Growth Assets	Matthew Hanson	+61 477 748 843

General Manager – Beetaloo & Growth Assets	Tracey Boyes	+61 475 949 668
D&C Project Manager – Asset Services	Ed Wong	+61 475 836 554
Senior Petroleum Engineer – Beetaloo & Growth Assets	Alex Cote	+61 408 612 889
Senior Project Engineer - Beetaloo & Growth Assets	Mitch Roll	+61 423 929 661
HSE Lead – Beetaloo & Growth Assets	Lucas Fulford	+61 477 749 524

If it is determined there is an unexplained pressure change in the well or unrecoverable communications issue then Triple P is deployed to site to assess the situation. The site person shall only deploy to site if it is possible to do so and travel in daylight hours. The requirement is to be at site within 6 hours. This in practice means that they should only be deployed to site if the event occurs before noon. If the event occurs after noon they should notified so as to be on site as early as possible the next morning. Triple P will follow the procedure detailed in the "Well Control" Section B3.

Once on site Triple P will use the satellite phone to call back the person that deployed them to report the situation on site and received further instructions. If the information received from Triple P is that the situation on site is not normal then this triggers an emergency event and Triple P becomes the On Scene Command (OSC) and the Beetaloo & Growth Assets Operations and Project Manager (or the senior person in the group which has responded to the alarm) will be the SERT-L and notifies the General Manager Growth Assets (Tracey Boyes 0475949668).

Other key stakeholders, specifically Stephanie Stonier (0475940931) and any of the alarm monitoring team not already invovled, should then be notified as soon as possilble.

- Triple P
  - o Gordon Jackson 0456 618 367
  - o Susey Jackson 0487 120 819
  - o Sat Phone 0147157201
  - o Email triplepcontracting@outlook.com

Well control incidents may require the mobilisation of specialised response contractors information on this is listed within Appendix C4.

Appendix C Well Control

C.1. Unmanned

A specific standard operating procedure has been undertaken for well inspection monitoring where detailed instructions are provided to the worker undertaken the well inspection.

In the event of an uncontrolled release from a wellhead (being observed in the field):

- Move out of harm's way. Find safe upwind location (at least 50 metres away).

  Considerations:

  - Determine wind direction.
  - Always pay attention to Fire, fumes, electrical, ignition and Health Risks.
  - What is the type of Leak and source?
  - Monitor situation visually from distance.
  - Secure site and keep all non-essential personnel and ignition sources away from the hazardous area. (secure location)
- Alert others near-by
- Assess the situation – determine the level of the immediate threat.

If a report is received from any source (for instance tourists travelling along highway see the well on fire) that an incident has occurred then the response for a pressure change in the well, exaclation is to be immediately initiated.

If the responding group are reasonably certain that loss of containment has occurred then Triple P should be sent to site to secure access from the highway and confirm the situation on site and escalation through General Manager – Beetaloo & Growth Assets to GEMT should occur with the recommendation to notify Asset Services to arrange third party Well Control Services to prepare to deploy, or deploy if the report is very credible (information on this process is located in Appendix C4).

If there is a high level of doubt about the information, Triple P contracting should be deployed to obtained reliable information from site (keeping a safe distance away with any potential ignition source).

Note: After consultation with the Project Manager and/or Well Integrity team representative - and you if are competent, confident – and i**f it is safe** to do so; **contain the incident** by shutting in the well – if flow is through wellbore; then activation of the self actuation UMV may be appropriate; of if escape is evident to be from an annular space, it may be possible to isolate via a manually operated valve.

Caution: Well control incidents may require the mobilisaiton of specialised response contractors.

Please refer to Appendix B for Well Inspection and alarm flow chart or NT-2050-35-MN-0001 Amungee NW-1H Remote Pressure Monitoring trouble shooting manual for well integrity monitoring and data transmission details.

C.2. Well Control Incident Classification

In the event that a Well Control Incident exceeds level 1 and 2, the Person in Charge (Wellsite Representative) will activate the SEMT who in turns, notifies the GEMT-L and the involvement of a contracted third party specialist to handle the well control integrity event.

The Well Control specific incident response plan is detailed the Origin Well Control Standard – INT-1000-35-TS-001 and the Asset Services Emergency Response Plan – QLD 1000 SAF PLN CDN/ID 19601361; for well control events these documents are to be followed. The following information is guidance on different levels of well control. Additionally, Appendix G4 gives an basic overview on how Well Control events are managed.

Level 1 (an uncomplicated kick or a low risk production / well integrity event)	Level 2 (a kick with some complications or a low - moderate risk well integrity event)	Level 3 (complete loss of well control or a moderate - high risk well integrity event)
Generally, these are events that commonly occur during drilling and workover operations. Additionally covers low risk well integrity events during the production phase. Emergency interfacing is limited due to pressure and flow containment. Personnel and equipment are not threatened, and there are no injuries or fire involved. Thus, the situation can be handled using resources and procedures available on-site (or readily mobilisable in the case of a well integrity event). The situation is managed immediately by the Driller who will keep the rig manager informed of the situation. Caution: Level 1 incidents can escalate quickly to a more serious and threatening level if not handled properly.	A Level 2 event can be defined as an abnormal well control event during drilling and workover operations involving some sort of complication in which: • Well control has NOT been lost at the surface • Resources beyond the normal capabilities of the rig crew or production operations staff may be required • Outside well control consultation, materials, equipment or personnel may be required Includes low - moderate risk production events (e.g. noticeable leak or significant annular pressure). There are no injuries or fires associated with this incident level since control has not been totally lost. The situation is typically managed by the Rig with the OSC liaising. The SEMT is on Standby but not activated. The incident is generally not sufficiently threatening to activate the GEMT to deal with the situation.	A Level 3 emergency denotes a complete loss of well control at surface during drilling and workover operations with no opportunity to restore it using all the resources available on-site. Includes moderate – high risk well integrity events during the production phase. Level 3 Incidents require the SEMT to activate including notification to the GEMT to effectively deal with the situation. External Well Control support (i.e. Boots & Coots, Wild Well Control, Cudd, etc.) must be activated upon confirming that the well is out of control at surface and measures must be immediately taken to protect people, the environment and material assets. These emergencies, although serious at the outset, have the potential to escalate further during control attempts. Such escalation may cause serious structural damage or total loss of the facility, rig, BOP stack and wellhead due to explosion, fire, loss of buoyancy or location subsidence and could affect nearby wells & infrastructure.

In conjunction with the Well Control contractor, three levels of well control event have been defined in the Wellsite ERP and are mirrored in the Well Control Standard (INT-1000-35-TS-001).

Each level defines the level of escalation required including potential mobilisation of the Well Control contractor.

Well Control Incident Level 1 - Uncomplicated Kick	
Situation managed by:	WSR in consultation with Field Manager or Drilling Superintendent, Drilling/Completion Engineer
Support:	Usually none required
Communication:	Field Manager/Drilling Superintendent to liaise with Brisbane based D&C operations lead as required
Example situation:	Influx while drilling

Well Control Incident Level 2 – Kick with Complication	
Situation managed by:	WSR in consultation with Field Manager or Drilling Superintendent, Drilling/Completion Engineer SERT on standby
Support:	Technical Team as required

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	Well control specialist as required
Communication:	WSR/Field Manager or Drilling Superintendent to liaise with Technical Team Technical team to liaise with IG D&C management as required
Example situation:	• Severe lost circulation combined with influx into wellbore • Kick taken with pipe out of hole • Leak or mechanical failure of well control equipment • Gain and loss situations • Plugged workstring • Influx taken while running casing or pumping cement • Loss of casing shoe integrity • Any complication experienced during live well operations

Well Control Incident Level 3 – Loss of Containment	
Situation managed by:	Onsite: SERT Office: GEMT
Support:	Technical Team to support SERT and GEMT as required Well control specialist onsite and in office as required
Communication:	SERT-L to liaise with GEMT-L Support functions to report to SERT-L or GEMT-L as required
Example situation:	• Severe lost circulation combined with influx into wellbore • Kick taken with pipe out of hole • Leak or mechanical failure of well control equipment • Gain and loss situations • Plugged workstring • Influx taken while running casing or pumping cement • Loss of casing shoe integrity • Any complication experienced during live well operations

C.3. Response to Level 3 Well Control Event

Human safety shall always be the highest priority in a Well Control event. Untrained personnel should never attempt to conduct well intervention activities due to the extreme risk for significant injury, fatality or event escalation. The primary focus immediately following a Level 3 well control event should consist of rig evacuation and care for injured parties. During drilling/completion operations the rig contractors rig evacuation procedures shall be the prevailing document(s). The senior drilling contractor representative (Rig Manager) shall serve as the On Scene Commander (OSC) during evacuation and Search and Rescue operations. Upon completion and confirmation of a full muster, the Rig Manager shall be relieved of OSC duties by the ranking Origin Energy representative.

Initial procedures as defined in the Wellsite ERP include, but are not limited to, the following:

- Evacuate and make sure everybody is safe and all personnel accounted for
- Isolate the area and restrict access
- Notify applicable groups (including well control specialists if required)
- Conduct initial assessments

C.3.1 Initial Assessment

In the event of a well control event, factually correct information is essential to aid in decision making. Once the site has been secured, personnel accounted for and appropriate notifications made, information should be gathered which aids the response to the incident. **Appendix C8 & C9** C.8include templates to aid in gathering the information necessary in such an event.

C.3.2 Further Considerations for Initial Response

The response to a Well Control event will depend on situation. Hence, a specific plan would be made after the initial assessments are completed. For a loss of containment event where fire is an issue, then a suitable water source and storage capacity onsite will be one of the main issues with the response. This should be addressed as a matter of urgency. Calculation of water requirements are outlined in **Appendix C13.**

Once the site has been secured, some hazards and potential solutions are outlined in **Appendix C10.** Information in this Appendix should be used to identify the site specific issues relevant to the event and mobilise services and materials that may be required to respond.

C.4. Well Control Contractor Mobilisation

The current primary well control contractor is Boots & Cootsfor Origin Energy's Northern Territory operations.

Although it will always be impossible to establish a plan that will be perfectly suited to a given loss of containment event, a well control package has been contracted to cover commonly required equipment for such occasions. To deal with a loss of containment event, regardless of the technical solution employed, requires mobilization of specific equipment and personnel, and more importantly proper engineering of any envisaged solution.

The Coalition Well Control Package shall only be mobilized upon request of the operator following declaration of a Level 3 type event. Dispatch of the equipment shall only be authorized by the following Origin Energy representatives:

Position	Incumbent
General Manager Drilling and Completions	Jamie Rodda
Drilling & Completions Manager	Ben Corbett

Table 2 - Origin Personnel Authorised to Mobilise Well Control Package

C.5. Well Control Contractor Contact details:

Alan Vick | Eastern Hemisphere – Technical Support - BD Manager

Well Control and Prevention| Boot and Coots

avick@boots-coots.com

G-Tower 199 Jalan Tun Razak, Kuala Lumpur Malaysia 50450

| Office - +603-2182-4346 | M: +6012 647-2692 | VOIP 886034346

USA Mobile +1 281 352 9737

24 Hr. Emergency Hotline 1 800 BLOWOUT (USA) or +1 281 931-8884 (International)

Appendix C9 has a well condition data sheet which should be completed and sent to Boots and Coots for their initial assessment of the situation.

C.6. Well Control Equipment Mobilisation

In addition to mobilising Boots and Coots personnel, preparation should commence to mobilise the Coalition Well Control package. The well control equipment package is stored and maintained at **Halliburton offices situated at 9 Roma Downs Road, Roma, Queensland Australia,4455**. The package consists of a total of eight (8) enclosed DMV type steel containers. An evaluation shall be conducted based on the scale of incident and a determination made as to the need to mobilize the full or partial equipment package.

The actual package would get mobilised to site once it was checked over by Boots and Coots personnel, but the trucks required to mobilise it site should be organised. Boots and Coots estimates that two road trains with a total of eight flatdeck trainers will be required to transport the well control

equipment to site, along with a 25T crane to load and unload the trucks. **Appendix C11** provides information on the Boots and Coots Well Control Package.

In addition to the Boots and Coots well control package, a range of equipment and services may be required depending on actual event in question. Origin has existing contracts in place for the services that may be required. Primary contractors will be updated to ascertain equipment requirements, these are listed in **Appendix C12** and a list of equipment and services that may be required to respond to a situation.

C.7. Level 3 Well Control Emergency Response Exercises

It is recommended that a Level 3 loss of containment event be simulated yearly as minimum to test the Emergency Management structure (SERT, GEMT, CMT) in line with the requirements set out in the Wellsite ERP. Scenarios should progress from level 1 to level 3 (blowout stage) to ensure that all Emergency Management leaders are provided an opportunity to participate. In addition, the drills should include the primary well control contractor and support contractors to test their state of readiness. The aim of the exercise is to simulate the loss containment event, test personnel's response to the event, test the mobilisation and function of the Emergency Management structures, and test the mobilisation of the contractors required to respond to the well control event. Any lessons learned from the exercise should be incorporated when appropriate to continually improve Origin's response to such an event.

C.8. Well Control Incident Questionnaire

Initial information to be obtained following well control incident.

Question	Answer
Are there any injuries and is immediate assistance required for evacuation of personnel?	
What assistance is currently underway for injured personnel?	
Has the rig been abandoned/evacuated?	
What are the weather conditions?	
Has the location been secured?	
When were applicable contingency plans put into effect?	
Determine the current status of the emergency:	
Is there a fire? If not, should ignition be considered?	
Is there any pollution?	
Can source of pollution be stopped?	
Are toxic gases present?	
What is the condition of the drilling/workover rig?	
Is the rig still on location?	
Should rig, or can rig, be moved off location?	
Are the BOP's operable?	
What is the current status of the well?	
Is the wellhead/tree intact?	
Pressure readings (annulus and drill pipe)?	
Previous casing size and depth?	
What is the well depth?	
Mud weight?	
Where is the drill pipe/tubing?	

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Is an attempt to shut in the well feasible if not already done?	

C.9. Well Control Incident Call In Form

Date and time of incident:		Location:	
Contact name:		Contact number:	
Rig:		WC Incident Level:	

Injured parties:

	Name	Company	Type of Injury
1.			
2.			
3.			
4.			

Brief Summary (facts only):

What has been done so far to secure the site:

Who has been contacted so far:

Government/Regulatory Bodies Notified and Media Coverage:

Once printed, this is an uncontrolled document unless issued
and stamped Controlled Copy or issued under a transmittal.

Initial well conditions			
Shut In Drill pipe pressure (psi):		Shut In Casing pressure (psi):	
Pit gain volume (bbl):		Mud weight (ppg):	
Well depth (mMDRT): (mTVDRT if required)		Casing shoe depth (mMDRT): (mTVDRT if required)	
Last casing size (in):		Last FIT/LOT (ppg):	
Hole size (in):		Bit depth (mMDRT): (mTVDRT if required)	
Float in drill string: Ported?		If yes, drill pipe pressure to open float (psi):	
Operation in progress at time of kick:			
Actions since time of kick:			
Current conditions (if different from initial conditions reported above):			
Shut In Drill pipe pressure (psi):		Shut In Casing pressure (psi):	
BOPs closed (Y/N):			
Current operation and plans:			

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C.10. Further Considerations for Initial Response – Possible Hazards and Solutions

Hazard	Services/Materials	Task
Security		
Visitors entering dangerous site	Self powered site office with toilet and fridge.	Secure entry to site (ie lock gate) Contact security contractor to mobilise personnel/equipment as required
Lack of communication	Digital radios	Supply digital radios for working party
Visibility at night	Light plants	Contact primary contractor to mobilise equipment as required
Landowner not informed of situation	N/A	Contact landholder access team to discuss how landholder is to be informed
People		
Fatigue	Additional SERT personnel	Ensure sufficient personnel at site location to man SERT 24hrs
Lease Preparation		
Fire – overgrown with grass	Slasher	Contact primary contractor to mobilise equipment as required
Uneven ground	Grader	Contact primary contractor to mobilise equipment as required Seek approval and blade fire break if safe to do so.
Removal ground soil	Excavator	Contact primary contractor to mobilise equipment as required
Ignition	N/A	Ensure any possibly ignition sources present at the wellsite are removed/disabled if safe to do so
Movement around well	Bobcat & Backhoe	Contact primary contractor to mobilise equipment as required Tentatively confirm work to remove fence around well pending well controls specialist advice upon arrival
Water used in well kill operations causing contamination	Bobcat and/or backhoe	Consider if application(s) of permits required to construct any in earth holding basin or water recovery trenches Contact primary contractor to mobilise equipment as required
Housekeeping – equipment on wellpad/lease	Crane/Forklift Truck	Contact primary contractor to mobilise equipment as required Clear lease as much as safely possible to allow access to wellhead considering equipment which may be required to solve well control situation
Loss of containment effecting nearby wells	Operations coordination	If other wells are nearby (ie on production pad), check wells are secure and check annuli on wells to ensure pressures haven't significantly changed
Water		
Insufficient water to respond to event - fire control and well kill	Water	Confirm an adequate water source close by See Appendix G for method to estimate water requirements
Inability to deliver sufficient water to site	Water trucks	Determine volume of water required for event See Appendix G for method to estimate water requirements Contact primary contractor to mobilise equipment as required
Inability to pump water required	Water pump(s) w/- suction & discharge hose	Contact primary contractor to mobilise equipment as required
Inability to store sufficient water at site	Onsite fluid storage tanks	Determine volume of water required for event See Appendix G for method to estimate water requirements Contract primary contractor to mobilise equipment as required

Logistics		
Inability to move heavy equipment around well	100 t Crane(s)	Contact primary contractor to mobilise equipment as required
Delay due to lack of road transport	Road transport	Contact primary contractor to mobilise equipment as required Sufficient road transport available to move required equipment (may need 24hr coverage)
Wellbore Fluids		
Gas	SCUF vent tank with generator to run same	Contact primary contractor to mobilise equipment as required
Return fluids	Storage tank	Contact primary contractor to mobilise equipment as required
Storage tank overflow	Vac trucks to remove fluid	Contact primary contractor to mobilise equipment as required
Well Kill/Isolation		
Inability to kill well	Mud or cementing pump with sufficient hard lines	Contact primary contractor to mobilise equipment as required
Inability to kill well	Fluid Storage/Mud Tank(s) with sufficient hard lines	Contact primary contractor to mobilise equipment as required
Hydrocarbon zone isolation	Cement unit, cement, additives and associated equipment	Contact primary contractor to mobilise equipment as required
Wellhead Equipment		
Isolation of well before side outlet valve removal	VR plug lubricator	Contact primary contractor to mobilise equipment as required
Surface facility isolations not in place	Origin Operator	Contact production operations to discuss situation
Specialised Services		
Inable to fabricate equipment	Machine shop	Contact primary contractor to mobilise equipment as required
Removal of equipment/fabrication	Welding services	Contact primary contractor to mobilise equipment as required
HSE		
HSE – hydrocarbon spill, uncontrolled release of well fluids into the air	Evaluate if any specialist HSE services are required (ie air sampling, radiation assessment, noise assessment)	Contact primary contractor to mobilise equipment as required

C.11. Boots & Coots Well Control Package Specifications

The Boots & Coots Well Control Equipment package consists of eight (8) standardized and certified DMV steel containers. All containers are of the same standard size with a maximum weight of not more than 10,000 kg. The containers have been specially modified to meet the needs of the well control specialists and the equipment necessary to mitigate a reasonably forseeable well control event. Specifically the package consists of the following individual units.

The containers include the following equipment:

Container 1	**Workshop**
Container 2	**4000 gpm Water Pump #1**
Container 3	**4000 gpm Water Pump #2**
Container 4	**Pump Suction Piping**
Container 5	**Pump Discharge Piping/Nozzles**
Container 6	**Generator/ Casing Cutters**
Container 7	**Water Monitor Stands/ Tin**
Container 8	**Tool Shed**

Below are some photos of the equipment

C.12. Sample Equipment List & Primary Support Contractors

Description	Qty	Contractor
Logistics support		
Trucking to transport 8 sea containers & support operation	8	
Crane, 25T to load/unload above sea containers	1	
D-8 or D-9 Caterpillar bulldozer w/ hydraulic winch	1	

D-8 or D-9 Caterpillar bulldozer w/ rippers	2	
Front end loader, large capacity rough terrain	1	
Track hoe, 235 Caterpillar or equivalent	1	
Bobcat	1	
Slasher	1	
Forklift	1	
150 ton Crawler crane w/ minimum of 100' boom (capping crane)	1	
40 – 60 ton hydraulic crane (for rigging up firefighting equipment)	2	
Tandem Rig up Truck/ Pole Truck	1	
Vacuum trucks (for hauling firewater or discharge from well)		
Water tankers	Calculate	
Refuelling/Lube truck (for refuelling heavy equipment, fire pumps)	1	
Road grader, Maintainer	1	
Transportation for workforce	1	
Self powered site office with toilet and fridge	1-2	
Digital radios	6	
Rental Equipment		
185 cfm air compressor	1	
Light plants, trailer mounted	4	
Generator	1	
Pressure washers	2	
4 wheelers, Kawasaki mules or alternative all-terrain vehicles		
Metal for Fabricating Support Equipment		
3' x 8' sheets corrugated tin	250	
Large diameter pipe for fire water supply line (12"-16")	1000 ft	
2" steel plate	1	
1" steel plate	2	
½" –5/8" steel plate	2	
2" x 2" x ¼" angle iron (Heat shields for bulldozers)	1500 ft	
3/16" or ¼" diamond plate, expanded metal or floor grating (flooring for monitor sheds, cutting sheds, etc.)	50	
2 3/8" or 2 7/8" junk tubing (structural for building monitor sheds, sheds, and heat shield)	2000 ft	
Casing for diverter lines	1	
General Oilfield Supplies		
8" Figure 100 hammer unions	6	
6" figure 100 hammer unions	6	
4" figure 100 hammer unions	12	
8" x12" pipe nipples, threaded both ends & collars	6	

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6” x 12” pipe nipples, threaded both ends & collars	12	
4” x 12” pipe nipples, threaded both ends & collars	12	
4”wafer type butterfly valves	6	
4” 150# R.F. threaded flange	12	
5/8” x 6 ¼” studs w/ nuts both ends	50	
Tie wire	10 rolls	
3/8” x 15’ high test chain w/ grab hooks (Crosby Brand & Load Binders)	20	
2” shackles, pinned	40	
1 ¾” shackles, pinned	40	
1 ½” shackles, pinned	40	
1 ¼” shackles, pinned	40	
1” shackles, pinned	40	
¾” shackles, pinned	40	
½” manila rope	1 roll	
¾” manila rope	1 roll	
200-psi liquid filled gauges	4	
600-psi liquid filled gauges	4	
1,000-psi liquid filled gauges	4	
3,000-psi liquid filled gauges	4	
5,000-psi liquid filled gauges	4	
10,000-psi liquid filled gauges	4	
Shop rags, Cotton Only (No Synthetic)	2 boxes	
Snatch blocks for 1 1/8” cable, shackled not hooked	2	
Heavy duty boards (to support pumps on water levy, scaffolding, etc.)	25	
Structural lumber (2 x 4’s) for heat shields, road blocks, etc.		
Awning	1	
Specialised Oilfield Supplies		
Pit liner for fuel tank containment and potential water pits if utilized	1	
Tanks for water storage (frac tanks or the like), 450 bbl	Calculate	
Water pump with suction/discharge hose (one or two 4,000 gpm pumps)		
Mud or cementing pump(s) with hard lines		
SCUF vent tank with generator		
Tanks to store hydrocarbons		
VR plug lubricator		
500 ton travelling blocks (Used for rig removal)	2	
Mud charging pumps (to feed pump truck from frac tanks)	2	
Mud system, complete with mixing and circulating capabilities	1	

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Cement		
Board mats	1	
High Pressure tubing, for pumping or cutting operation (to maintain good distance between well and pump trucks) size to be determined per requirement	1000 ft	
6” or 8” Drill Collars (Dead man to skid rig)	20	
Coil Tubing unit	1	
Snubbing Unit	1	
Cables, Slings & Clamps		
1 1/8” - 6 x 36-softlay cable (for rig removal)	2000 ft	
¾” - 6 x 36-softlay cable (slings for debris removal)	1000 ft	
5/8” - 6 x 36-softlay cable (slings for debris removal)	1000 ft	
1 1/8” cable clamps	100	
¾” cable clamps	100	
5/8” cable clamps	100	
1 ½” x 10’ wire rope slings, 6 x 36 soft lay cable	10	
1 ¼” x 10’ wire rope slings, 6 x 36 soft lay cable	20	
1 ¼” x 20’ wire rope slings, 6 x 36 soft lay cable	20	
1” x 10’ wire rope slings, 6 x 36 soft lay cable	20	
1” x 20’ wire rope slings, 6 x 36 soft lay cable	20	
¾” x 10’ wire rope slings, 6 x 36 soft lay cable	40	
¾” x 20’ wire rope slings, 6 x 36 soft lay cable	40	
5/8” x 10’ wire rope slings, 6 x 36 soft lay cable	40	
5/8” x 20’ wire rope slings, 6 x 36 soft lay cable	40	
Welders, Machining and Associated Equipment		
Structural welders with helper and equipment	6	
Certified Welder with Helper and equipment	1	
Cutting torch complete with large supply of oxygen, acetylene and accessories, 250 ft. of hose per torch, strikers, tip cleaners and spare tips	4	
Long reach cutting torch, complete with large supply of oxygen, acetylene and accessories, 250 ft. of hose per torch, strikers, tip cleaners and spare tips	2	
Machine shop services for fabrication		
HSE		
HSE services (air sampling, heat radiation monitoring, noise monitoring)		

C.13. Water Requirements

The most important step when controlling a level 3 incident is establishing a water supply which is plentiful and consistent. Surface intervention of a blowout requires massive volumes of water. Well Control specialists will determine pumping, volume of water required onsite and ongoing water requirements.

If water cannot be stored in ground pits, water shall be stored on location utilizing multiple manifolded 450 barrel portable frac tank containers. Combined storage capacity up to 2,000,000 million gallons may be required (subject to confirmation). Origin shall consider the requirements for application(s) of any permits required to construct any in earth holding basin or water recovery trenches. It is critical to the safety of the well control crews and ultimate success of the well control mitigation that water supply remain uninterrupted. Water from the storage tanks will be piped to the fire pump(s) and distributed to fire monitor stands and hand lines as deemed appropriate by the well control specialist.

Water volume requirements vary from one blowout to another. For example, only one pump would be required for a minor fire (with backup pump circulating water as a redundant system) for a minor fire, whereas two or more pumps would be required for a major rig fire, thus doubling the water volume required. Typically, a benchmark of 2,000,000 gallons per day (48,000 bbls per day) is used in the Well Control Contingency Plan (WCCP) calculations.

A well on fire requires a tremendous volume of water. For example, the following calculations show how fast 1,000,000 gallon (24,000 bbls) pit would be emptied using various capacity fire pumps:

- 1,000,000 gallons/(4,000 gpm + 4,000 gpm) = 125 minutes

Water Supply Calculations – Using Tankers Only

Before mobilising water storage tanks and water to site, liaise with Boots and Coots to determine likely water requirements. Below are sample calculations only based on a worst case scenario.

The following calculations gives the number of tanker loads needed to replenish the pit with water:

- $1m^3$= 6.29 bbls
- $24m^3$ tanker capacity x 6.29 bbls/m^3=150 bbls
- 24,000 bbls/150 bbls per load= 160 tanker loads

The following calculation factors in a water recovery rate of 30%:

160 tanker loads x (1.0-.3) = 112 tanker loads.

Using the two minimum 4,000 gpm fire pumps, it would require 61 tanker loads per hour to maintain operations.

With a remote pit containing an additional 1,000,000 gallon capacity for a total of a 2,000,000 gallon capacity (48,000 bbls), operations could be maintained for four (4) hours using two 4,000 gpm pumps. The flowing calculations gives tanker load totals for 10 hours of winter time daylight operations:

- (10 hours operations) – (4 hours water supply on hand) = 6 hours additional water supply needed
- (6 hours) x (61 tanker loads per hour) = 366 tanker loads
- (366 tanker loads) / (10 hours) = 37 tanker loads per hour

37 tanker loads per hour, although cumbersome, is far more manageable than 61 tanker loads per hour. However, using the above calculation, at the end of 10 hours the pits will be dry. The following calculation gives the tanker loads per hour to overnight replenish the 2,000,000 gallons (48,000 bbls):

- 48,000 bbls / 150 per load = 320 tanker loads
- 24 hours – 10 hours daylight operations = 14 hours to refill pits

320 tanker loads / 14 hours = 23 tanker loads per hour overnight

C.14. Site Safety/Site Control

If a severe level 3 well control incident occurs, the OSC, SERT-L, HSE and Well Control Specialist will develop a Site Safety Plan and enforce it immediately.

The plan will identify the hazards present on site and will define Site Control boundaries, including SAFE AREA and HOT ZONE boundaries, and control access to the incident site. Common hazards to health and safety on a blowout include:

- Radiant Heat
- Explosive and/or toxic gas concentrations
- Explosive materials (perforating charges, prima cord, etc.)
- Compressed substances (acetylene, oxygen, aerosols, etc.)
- Hazardous chemicals

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- Dangerous noise levels
- Structural damage
- Leaking gas or fluids

Such a plan would only be developed for Level 3 well control incidents where deemed necessary.

Appendix D Site Specific Lease Pads with associated wells

D.1. Location data – Existing Exploration Wells / Lease pads

Permit Area(s)	EP98
Exploration Well name	Kalala South – 1 (Drilled & Suspended Well)
Associated Water Bores	N/A
Well/Lease location (Lat/Long)	-16° 17' 37.7" S / 133° 36' 44.3" E -16.2941, 133.6124 (GDA94) E: 351740, N: 8198023 (MGA Zone 53)
Nearest Town by Vehicle	Daly Waters
Nearest Major Road	Carpentaria Highway
Nearest Airports by Vehicle	Daly Waters: 25 min/25km Elliot: 2hrs / 165 km
Nearest Hospital by Vehicle	Katherine Hospital 3hrs drive (299km)
Permit Area(s)	EP117
Exploration Well name/s	Beetaloo West - 1 (Drilled & Suspended Well) (Kyalla 117 W1) (proposed second well on same lease)
Associated Wells on location	N/A
Well/Lease location (Lat/Long)	-17° 7'13.82"S / 133°45'43.63"E -17.12051, 133.7621 (GDA94) E: 368312, N: 8106689 (MGA Zone 53)
Nearest Town	Elliot
Nearest Major Road	Stuart Highway
Nearest Airport by Vehicle	Daly Waters: 1.5hrs/100km Elliot: 1.75hrs,110km
Nearest Hospital by Vehicle	Katherine Hospital: 4hrs drive (399km)
Permit Area(s)	EP98
Exploration Well name/s	Amungee North West-1H (Drilled & Suspended Well) Velkerri 98 N1 (Proposed second well on same lease)
Associated wells	VEL 98 N1 – CMB-G (RN40894)
Well/Lease location (Lat/Long)	-16°20'51.034"S / 133°53'4.403"E -16.34751, 133.8846 (GDA94) E: 380859, N: 8192292 (MGA Zone 53)
Nearest Town by Vehicle	Daly Waters
Nearest Major Road	Carptentaria Highway
Nearest Airport by Vehicle	Daly Waters: 1hr /61km Elliot 2.5hrs /202km
Nearest Hospital by Vehicle	Katherine Hospital: 3.5hrs drive (329km)
Permit Area(s)	EP117
Exploration Well name	Kyalla 117 N2 1H
	Kyalla 117 N2-2H and 3H- Proposed.
Associated Wells	KYA 117 N2 – CMB - (RN40895)

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	KYA 117 N2 - CMB - AL (RN40896) KYA 117 N2 – CMB - G (RN41132) KYA 117 N2 – IMB - AL (RNxxxxx) - TBC KYA 117 N2 – IMB - G (RNxxxxx) - TBC
Well/Lease location (Lat/Long)	-16°50' 29.01”S; 133°39' 0.16”E -16.84141, 133.6501 (GDA94) E: 356183, N: 8137492 (MGA Zone 53)
Nearest Town by Vehicle	Daly Waters
Nearest Major Road	Stuart Highway
Nearest Airport by Vehicle	Daly Waters: 1hr /92 km Elliot: 1.5hrs /117 km
Nearest Hospital by Vehicle	Katherine Hospital: 4.5hrs drive (365km)

D.2. Location data – Proposed Exploration Wells / Lease pads

Permit Area(s)	EP76
Exploration Well name	Velkerri 76 S2
Associated Wells	VEL76 - S2 – CMB – AL (RN41133) VEL76 – S2 – CMB – G (RN41134) VEL76 - S2 – IMB – AL (RNxxxxx) - TBC VEL76 – S2 – IMB – G (RNxxxxx) - TBC
Well/Lease location (Lat/Long)	-16°51' 20.13”S; 134°23' 39.85”E -16.85571, 134.3939 (GDA94) E: 435432, N: 8136301 (MGA Zone 53)
Nearest Town by Vehicle	Daly Waters
Nearest Major Road	Stuart Highway
Nearest Airports by Vehicle	Daly Waters: 2.5 hr /190 km Elliot: 3.0 hrs /198 km
Nearest Hospital by Vehicle	Katherine Hospital: 5.5 hrs drive (442km)
Permit Area(s)	EP117
Exploration Well name	Velkerri 117 E1
Associated Wells	TBD
Well/Lease location (Lat/Long)	-16°59' 35.50” S, 134°19' 26.21” E -16.993194, 134.323948 (GDA94) E: 428034.8, N: 8121074 (MGA Zone 53)
Nearest Town by Vehicle	Daly Waters
Nearest Major Road	Stuart Highway
Nearest Airports by Vehicle	Daly Waters: 3 hr / 190 km Elliot: 3.0 hrs /194 km
Nearest Hospital by Vehicle	Katherine Hospital: 5.5 hrs drive (452km)
Permit Area(s)	EP 76
Exploration Well name	Velkerri 76 S1

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Associated Wells	TBD
Well/Lease location (Lat/Long)	-17°3' 48.91" S, 134°17' 21.05" E -17.063587, 134.28918 (GDA94) E: 424362, N: 8113273 (MGA Zone 53)
Nearest Town by Vehicle	Daly Waters
Nearest Major Road	Stuart Highway
Nearest Airports by Vehicle	Daly Waters: 3.15 hr / 194 km Elliot: 3.15 hrs /204 km
Nearest Hospital by Vehicle	Katherine Hospital: 6 hr drive (462km)

D.3. Campaign specific information

Exploration campaigns have the following specific information, this information is approximate only and should be utilised to provide guidance on approximate personnel data per exploration campaign activity:

D.3.1 Civil activity

Civil	Various Civil construction activities (Road/track upgrades, lease builds)
Average Personnel #	1-20
Fuel Capacity	Dual walled, self bunded diesel 26.4m3 tank

D.3.2 Drilling activity

Rig	Rig to be contracted for each campaign
Average Personnel #	8-14
Fuel Capacity	Dual walled, self bunded diesel 26.4m3 tank

D.3.3 Hydraulic Fracture Stimulation spread (Fracspread)

Rig name	Fracspread
Average Personnel #	40-60
Fuel Capacity	Dual walled, self bunded diesel 26.4m3 tank

D.3.4 Completion activity specific data

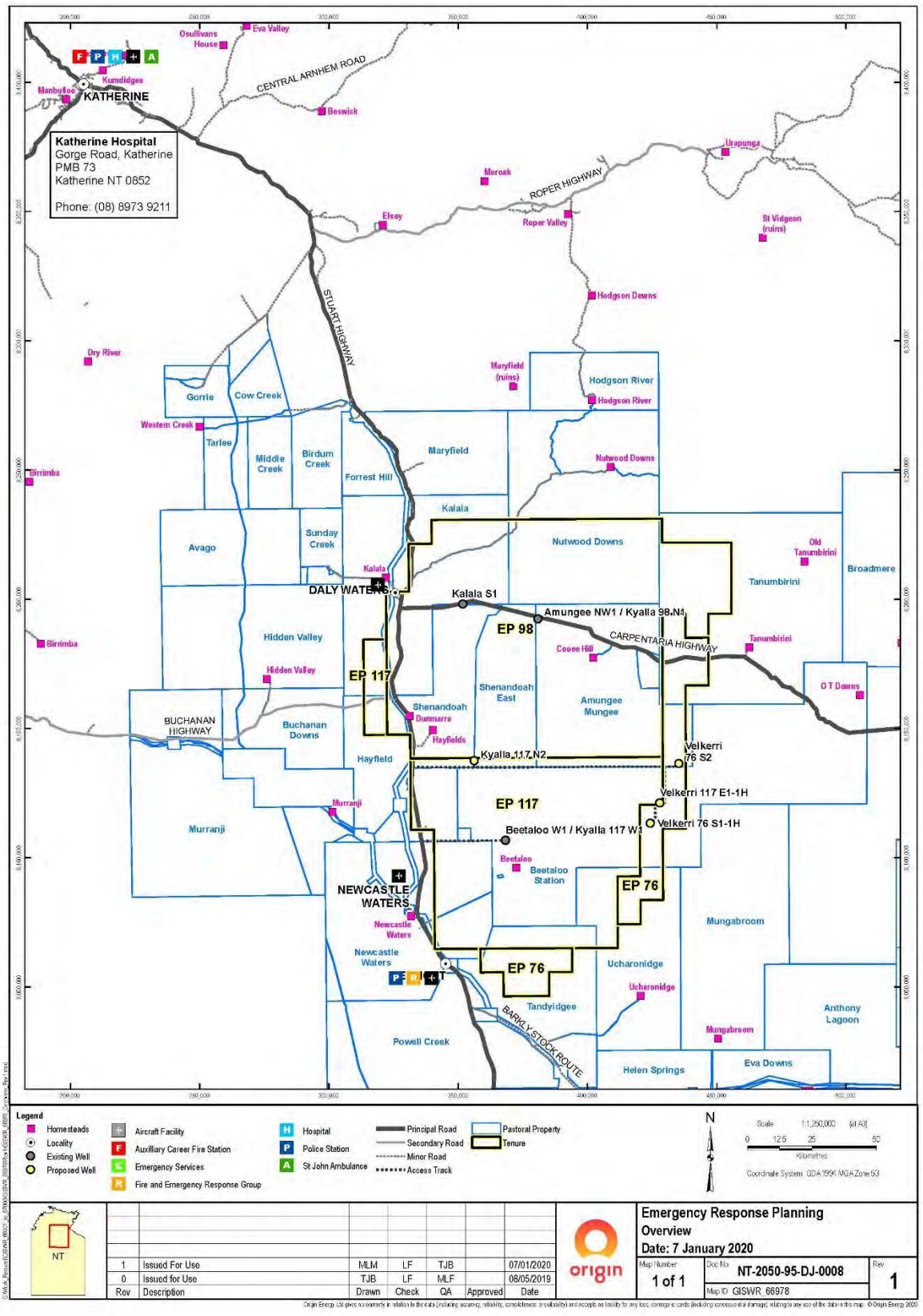
Rig name	Rig to be contracted for each campaign
Average Personnel #	8-12
Fuel Capacity	Dual walled, self bunded diesel 26.4m3 tank

D.3.5 Well Testing spread specific data

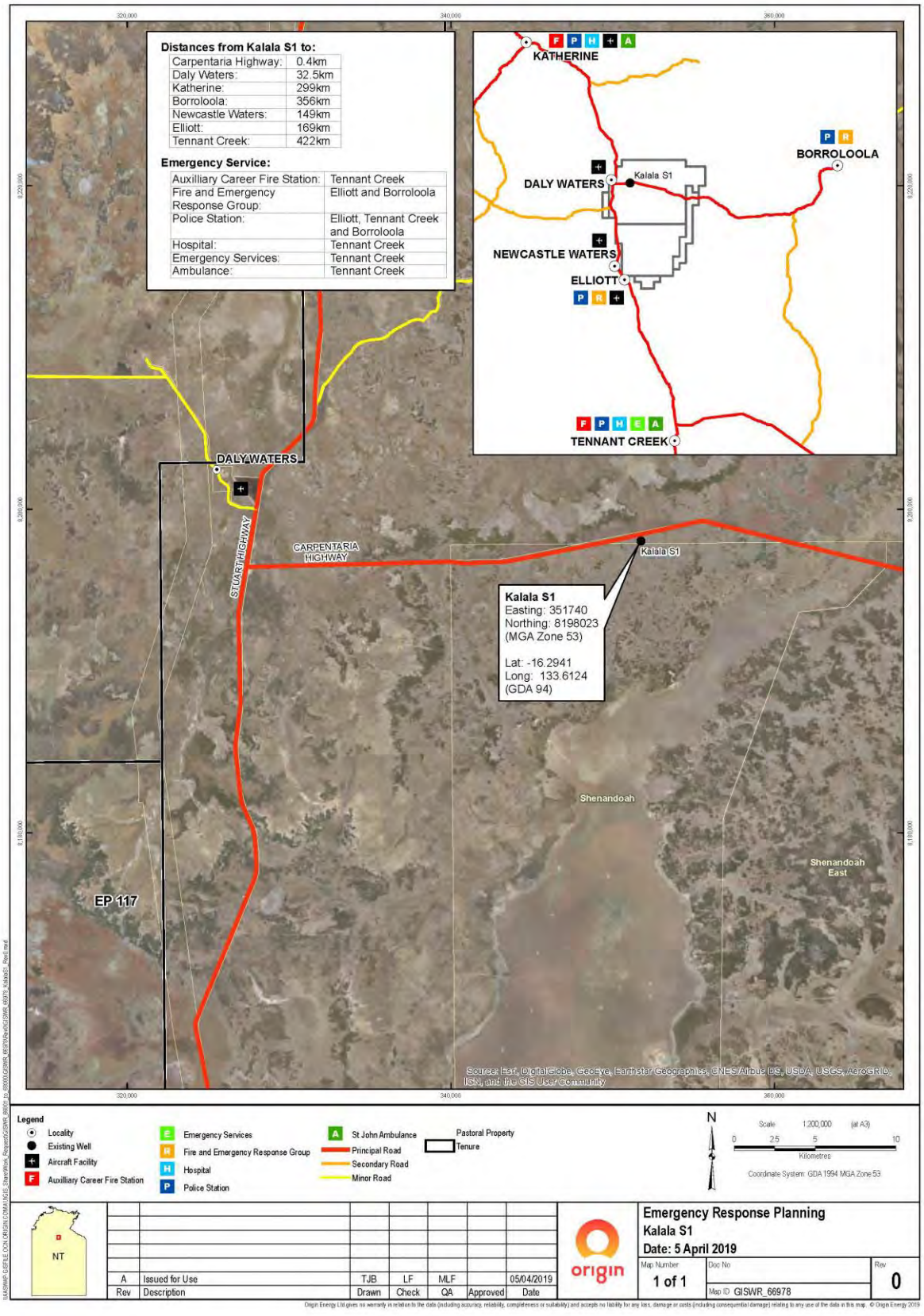
Rig name	Extended Production Test – EPT (Well Test)
Average Personnel #	2-6
Fuel Capacity	Dual walled, self bunded diesel 26.4m3 tank

D.4. Emergency Response Locality maps

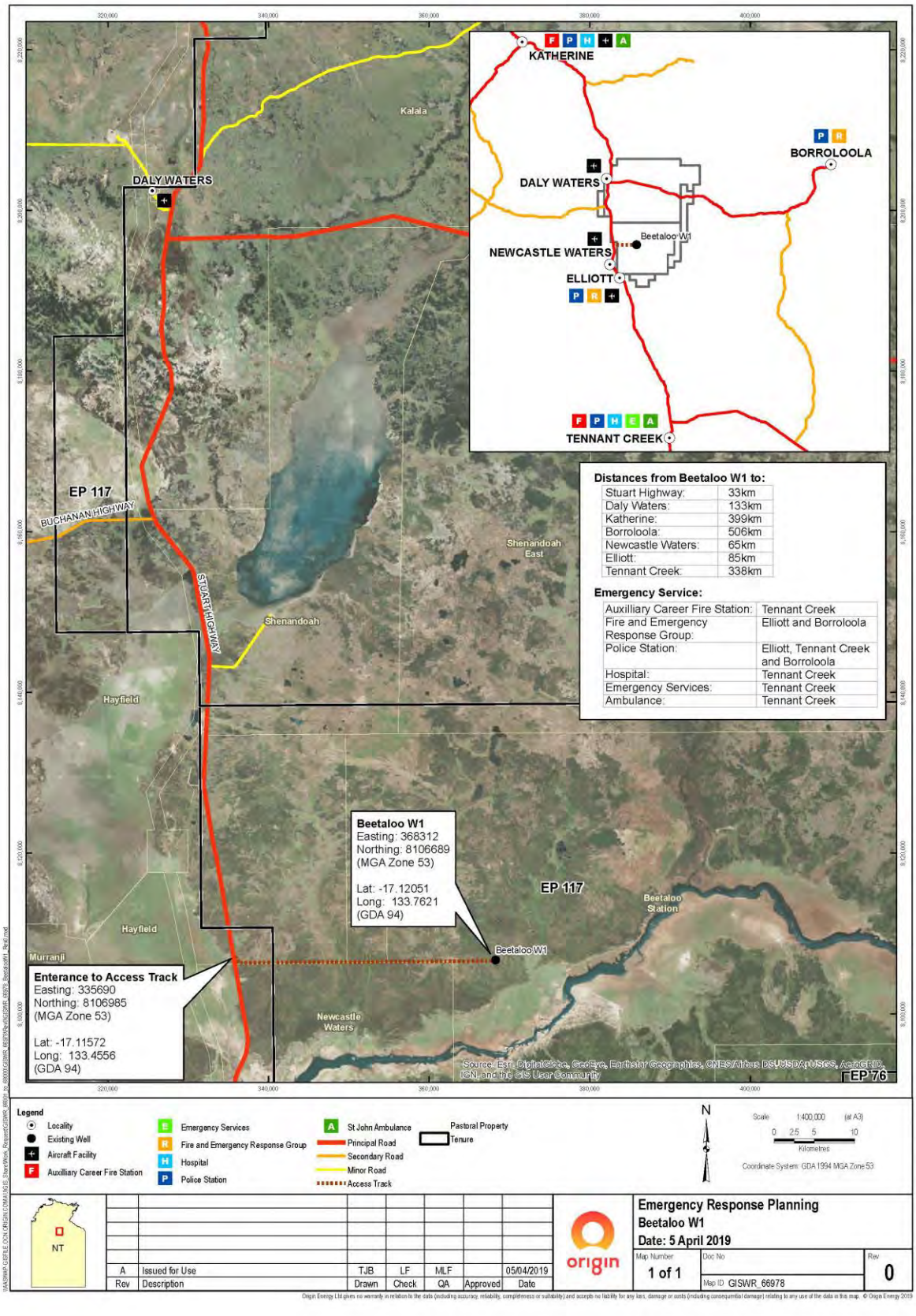
Overview maps for all existing and proposed Petroleum Wells



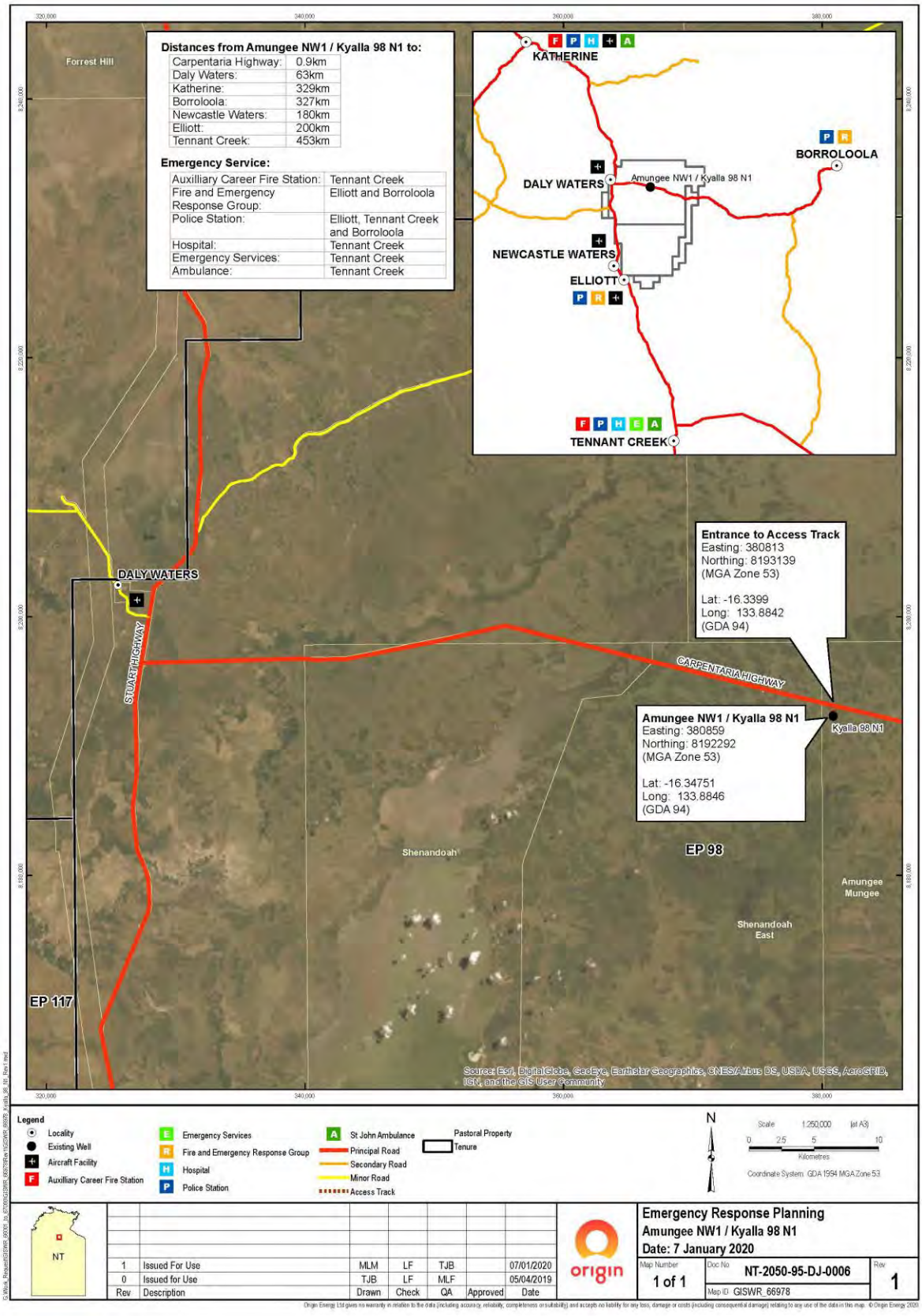
D.4.1 Kalala S1 – Emergency Response Planning Map



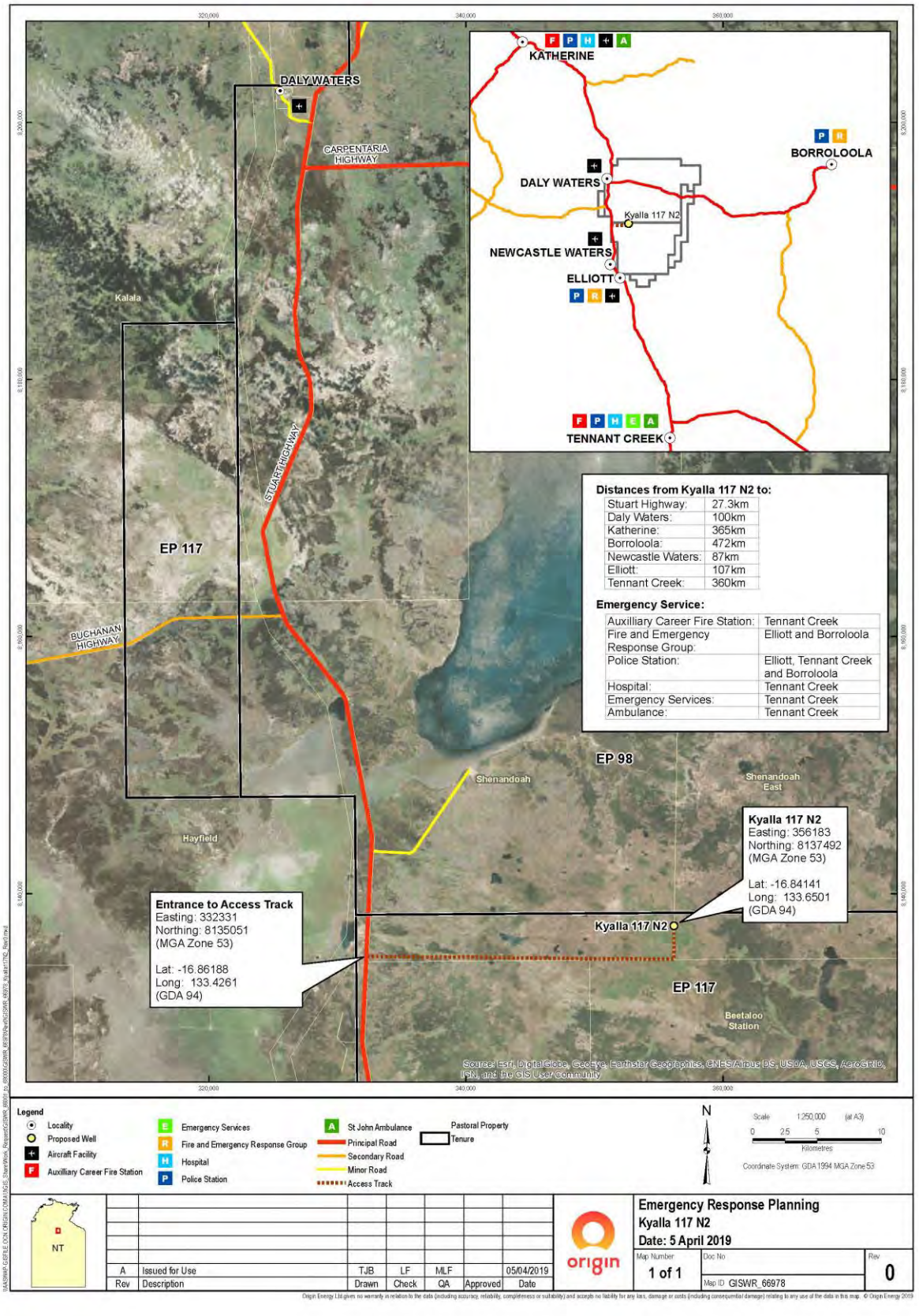
D.4.2 Beetaloo W1 / Kyalla W1 – Emergency Response Planning Map



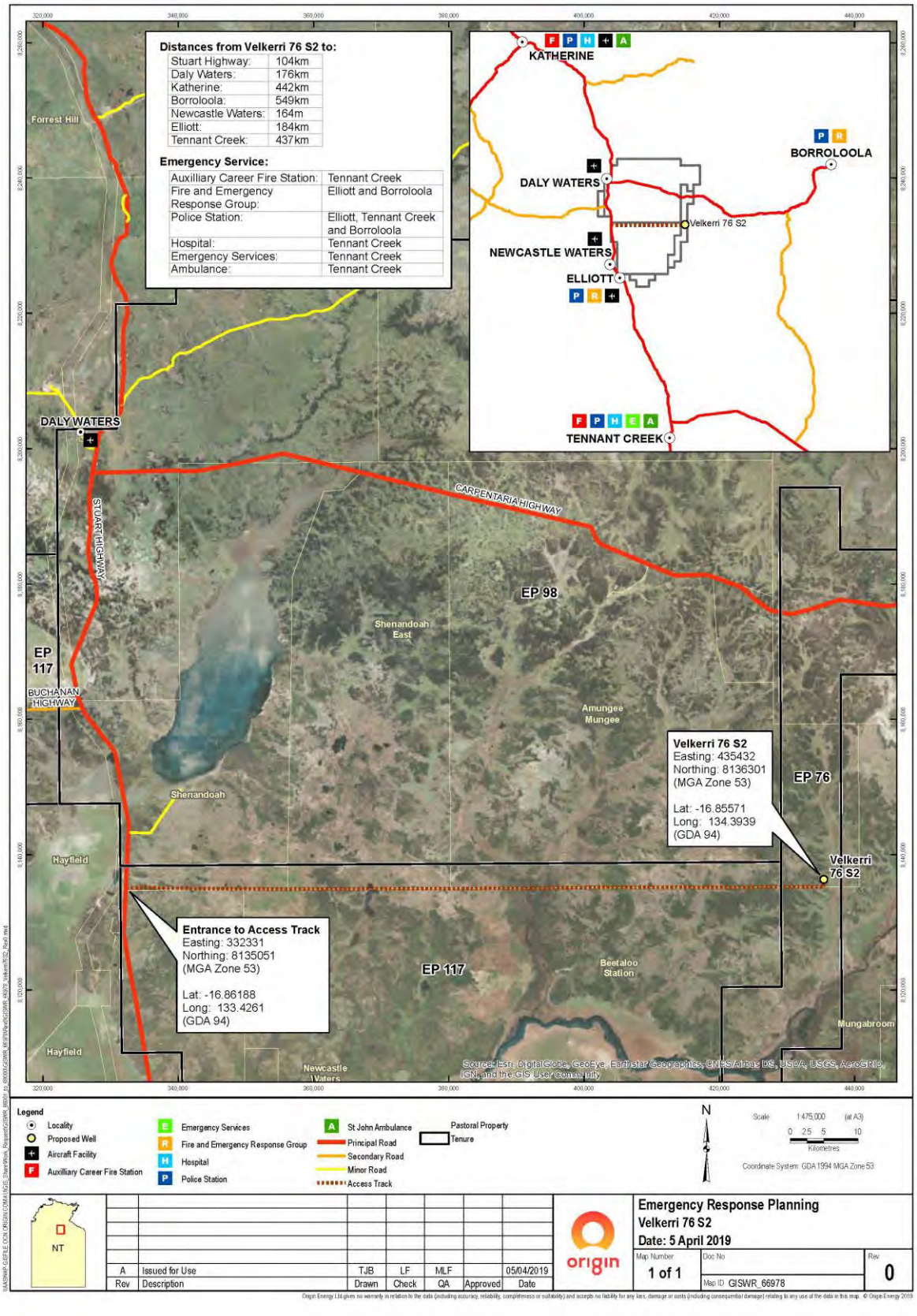
D.4.3 Amungee NW 1H / Kyalla 98 N1 – Emergency Response Planning Map



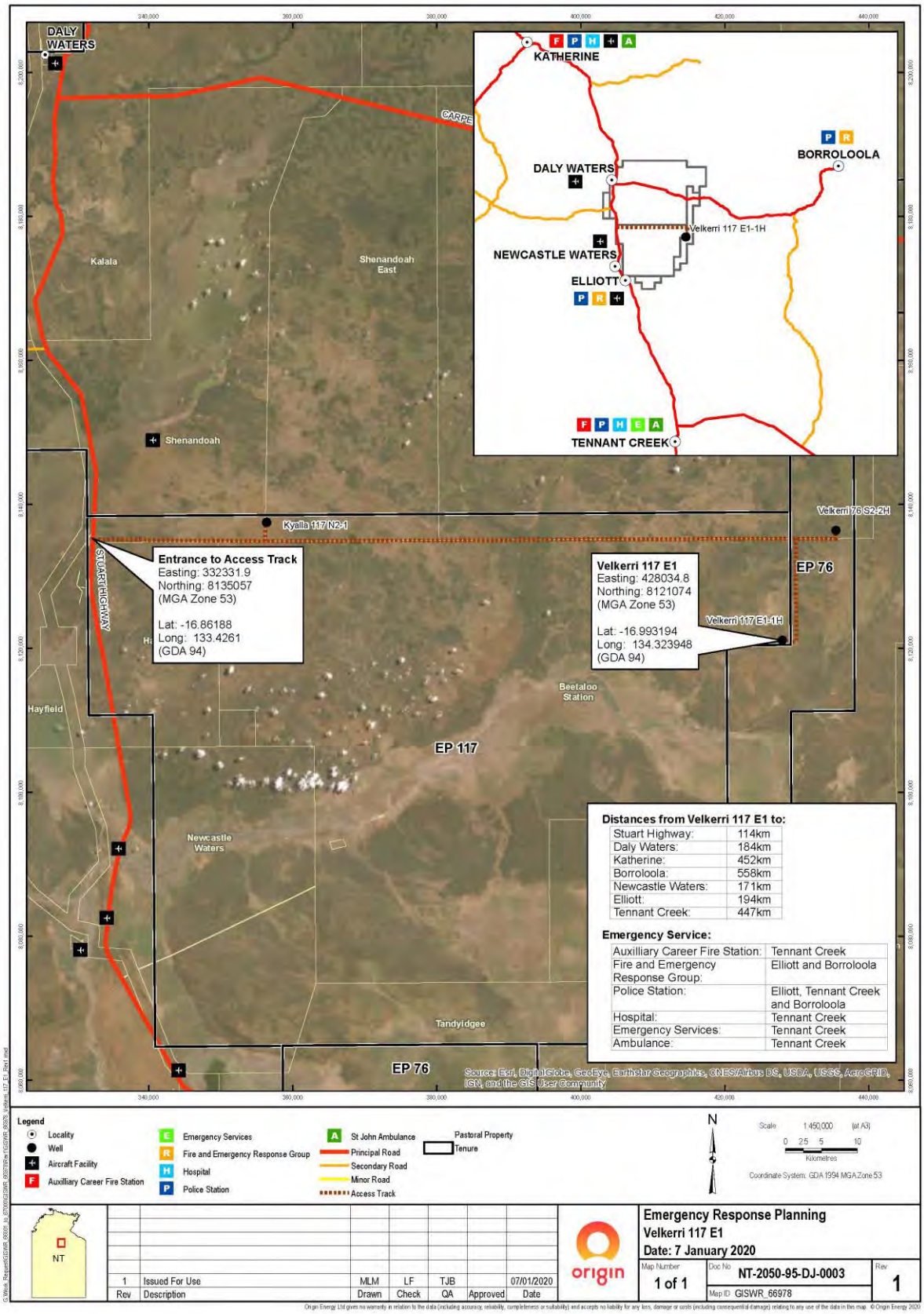
D.4.4 Kyalla 117 N2 – Emergency Response Planning Map



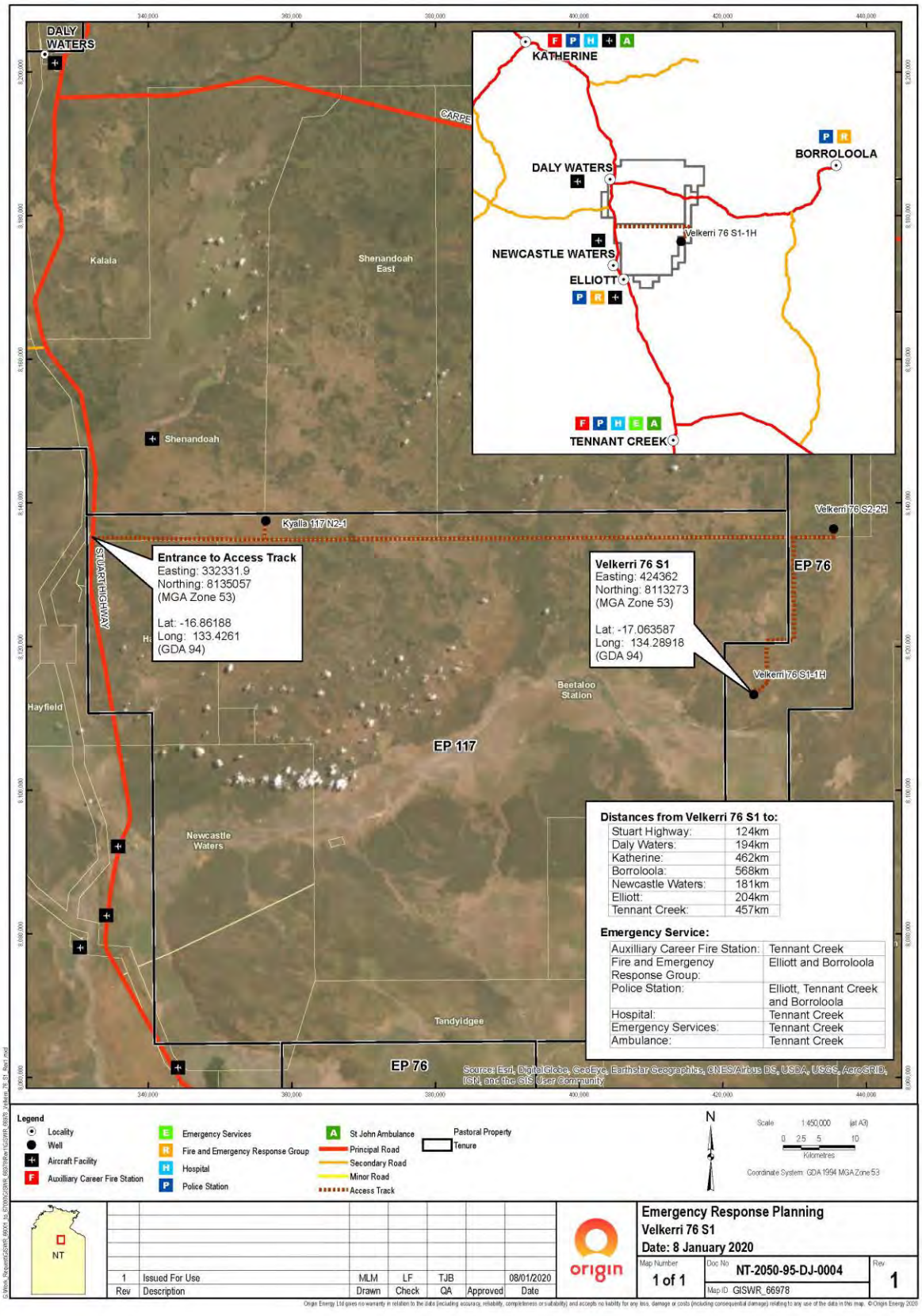
D.4.5 Velkerri 76 S2 – Emergency Response Planning Map



D.4.6 Velkerri 117 E1 – Emergency Response Planning Map



D.4.7 Velkerri 76 S1 – Emergency Response Planning Map



Appendix E Bushfire Management Plans (BMP) – Wellsites

E.1. Kyalla 117 N2 – Bushfire Management Plan

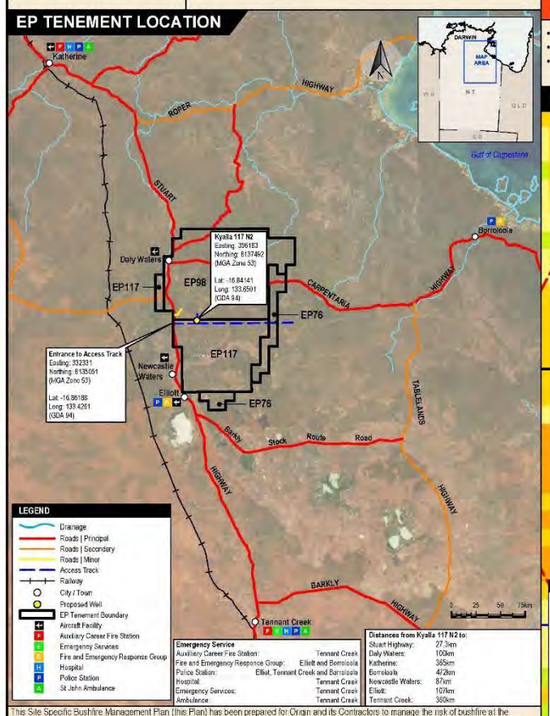
Exploration Permit 117

Bushfire Management Plan 2019/2020

Kyalla 117 N2 Lease

Location of Kyalla 117 N2	
Property land uses	Gas exploration and cattle grazing
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 Origin's people, assets and operations and neighbouring land uses.

EP TENEMENT LOCATION



This Site Specific Bushfire Management Plan (this Plan) has been prepared for Origin and its Contractors to manage the risk of bushfire at the Kyalla 117 N2 exploration lease area. This Plan should be read in conjunction with the overarching *Environmental Management Plan* and *Emergency Response Plans* for Origin's operations in the Beetaloo Basin.

Appendix A Site Specific Bushfire Management Plan (this plan) / Version 1/ 5 December 2019

Origin Fire Officer	Contact Details	Name
	mobile : 0467 679 003 Satellite phone : 0147 612 733 Robert.Wear@upstream.originenergy.com.au	Robert Wear

Properties	Contact Details		Name
Amungee Mungee Station	08 8971 1293 Katherine office 0427 825 159 Adrian 08 8975 9599 Amungee homestead	UHF 18 VHF 123600	Adrian Brown
Kalala Station	08 8975 9936 Office		Andrew Scott
Hayfield Station	08 8975 9920 Hayfield 0408 802 741 Justin 0417 836 551 Val	UHF 17 VHF 123900	Justin & Sally Dyer
Beetaloo Station	08 8964 4613 Office 08 8964 4711	UHF 16 VHF 123850	Scotty & Jane Armstrong

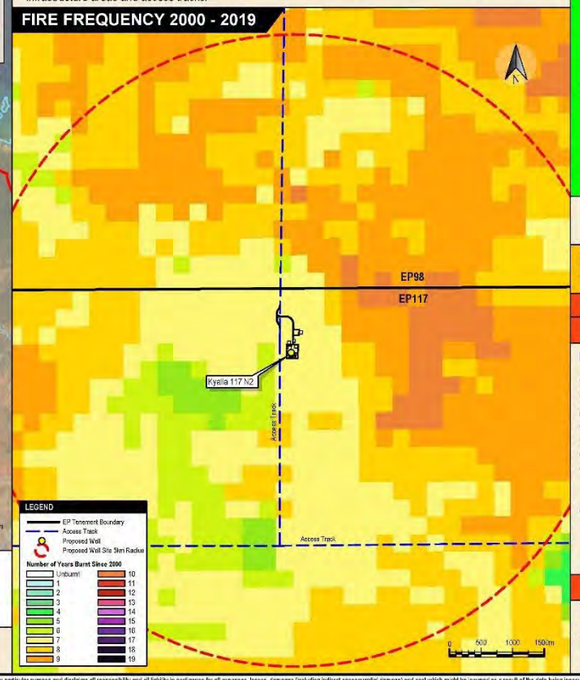
Offsite Stakeholders	Contact Details	Name
Volunteer Bushfire Brigades	08 8975 9936	
National Response Centre	1800 076 251	24/7 contract line
Emergency	000 or 112 mobile	
Bushfire NT Katherine office	08 8973 8873 08 8973 8871	Troy Munckton
Bushfire NT Head office	08 8922 0840 bushfires.nt@nt.gov.au 08 8922 0844	Mark Gardner
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/	

Fire Frequency 2000-2019

Fire management risks

- Ignitions (humans and lightening) on or off site resulting in harm to workers and loss of equipment.
- Fire scar mapping indicates the exploration area burns approximately every 3 years.
- Spread of high fuel load grassy weeds could increase fire intensity, eg gamba, grader and buffel grass, adjacent infrastructure areas and access tracks.

FIRE FREQUENCY 2000 - 2019



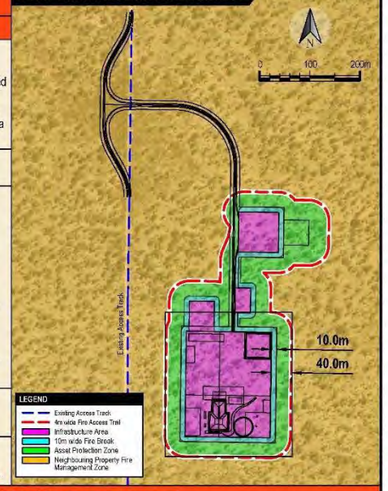
Annual Works Calendar

Month	Bushfire Risk	Action	Month	Bushfire Risk	Action
Jan	Low	• No fire management activity.	July	High	• Monitor NAFI and visual scan horizon for smoke. • Liaise with neighbour regarding bushfires. • IG bushfire preparedness tool to be utilised daily during periods of fire danger of severe or greater.
Feb	Low	• Manage vegetation onsite including weeds.	Aug	High	• Monitor NAFI and visual scan horizon for smoke. • Liaise with neighbour regarding bushfires. • IG bushfire preparedness tool to be utilised daily during periods of fire danger of severe or greater.
Mar	Low	• Planning meeting with neighbour. • Manage vegetation onsite including weeds. • Manage fire break and fire access trail.	Sept	High	• Monitor NAFI and visual scan horizon for smoke. • Liaise with neighbour regarding bushfires. • IG bushfire preparedness tool to be utilised daily during periods of fire danger of severe or greater.
Apr	Low	• Manage vegetation onsite including weeds.	Oct	High	• Monitor NAFI and visual scan horizon for smoke. • Liaise with neighbour regarding bushfires. • IG bushfire preparedness tool to be utilised daily during periods of fire danger of severe or greater.
May	Low	• Manage vegetation onsite including weeds.	Nov	Medium	• Monitor NAFI and visual scan horizon for smoke. • Liaise with neighbour regarding bushfires. • IG bushfire preparedness tool to be utilised daily during periods of fire danger of severe or greater.
June	Medium	• Monitor NAFI and visual scan horizon for smoke. • Liaise with neighbour regarding bushfires. • IG bushfire preparedness tool to be utilised daily during periods of fire danger of severe or greater.	Dec	Low	• No fire management activity.

Kyalla 117 N2 Fire Management Zones

Bushfire Management Actions	
Infrastructure area	• Remove all vegetation. • Treat emerging vegetation with herbicide. • A permit for open flaring and hot works is required during a declared fire danger period. • Open flaring and hot works are not permitted on total fire ban days without written approval from a fire control officer or fire warden.
Fire management break	• Maintain a 10 m wide bare earth loop road around the infrastructure area.
Asset Protection Zone (APZ)	• During operations, establish a 40 m wide APZ around the infrastructure area by removing woody understorey vegetation and achieving a grass height of < 100 mm using the methods prescribed in the *Origin Generic bushfire asset protection zone guide*. • Maintain grass cover to a height < 100 mm. • Remove vegetation from the 10 m wide fire break around the infrastructure area. Monitor for grassy weeds and control where appropriate. • Ensure a 4m wide fire access trail around the perimeter of the asset protection zone is trafficable by fire fighting appliances. Monitor for grassy weeds and control where appropriate.
Fire access trails	• Create and maintain a 4m wide access trail around the perimeter of the asset protection zone by grading or spraying.
Neighbouring Property Fire Management Zone	• Annual fire management planning meeting with neighbouring properties. • Neighbour to advise proponent of planned burns.

FIRE MANAGEMENT ZONES



Bushfire Preparedness - refer to *IG Bushfire preparedness tool*

Preparedness 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 risk (fire in the area), 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' (Community or Origin permanent sites).

Monitoring Routine

- 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, eg roads and Origin infrastructure such as well numbers).
   - **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 (Origin, Landowners or Emergency Services).
   - **Response required** - Origin and / or Emergency Services.
   - **Access** - Safe access and egress routes.
4. **Notify Origin** - Fire officer / Supervisor.
5. **Notify Pastoralists** - Refer to Property Contacts.
6. **Notify Emergency Services** - Call "000" or "112" (some mobiles) if Origin and Pastoralists unable to manage situation.
7. **Respond** - if safe to do so in consultation with Pastoralist.
8. **Handover** - to the Origin On-Scene Commander / Pastoralist of Emergency Services on arrival.
9. **Support** - provide ongoing support to the response as appropriate.

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E.2. Beetaloo W1 / Kyalla 117 W1 – Bushfire Management Plan

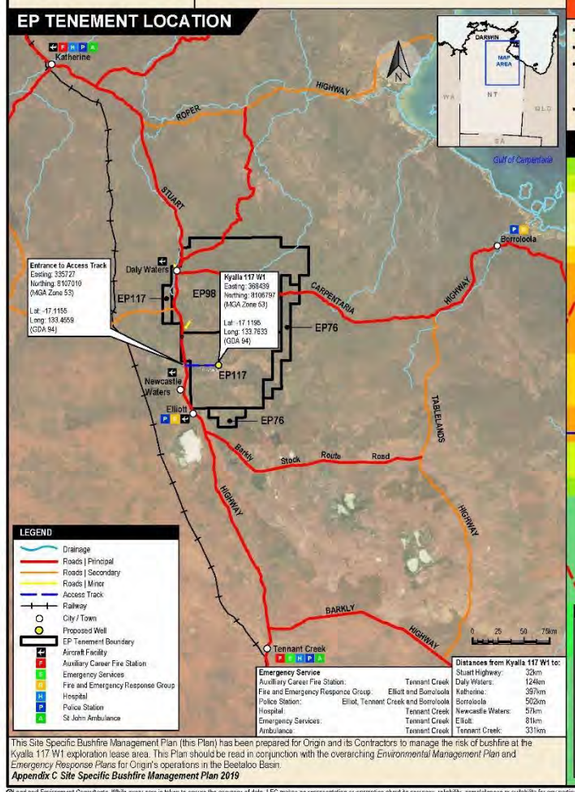
Exploration Permit 117

Bushfire Management Plan 2019/2020

Kyalla 117 W1 Lease

Location of Kyalla 117 W1	
Property land uses	Gas exploration and cattle grazing
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 Origin's people, assets and operations and neighbouring land uses.

EP TENEMENT LOCATION



This Site Specific Bushfire Management Plan (this Plan) has been prepared for Origin and its Contractors to manage the risk of bushfire at the Kyalla 117 W1 exploration lease area. This Plan should be read in conjunction with the overarching *Environmental Management Plan* and *Emergency Response Plans* for Origin's operations in the Beetaloo Basin.

Appendix C Site Specific Bushfire Management Plan 2019

Origin Fire Officer	Contact Details	Name
	mobile : 0467 679 003 Satellite phone : 0147 612 733 Robert.Wear@upstream.originenergy.com.au	Robert Wear

Properties	Contact Details		Name
Amungee Mungee Station	08 8971 1293 Katherine office 0427 825 159 Adrian 08 8975 9599 Amungee homestead	UHF 18 VHF 123600	Adrian Brown
Kalala Station	08 8975 9936 Office		Andrew Scott
Hayfield Station	08 8975 9920 Hayfield 0408 802 741 Justin 0417 836 551 Val	UHF 17 VHF 123900	Justin & Sally Dyer
Beetaloo Station	08 8964 4613 Office 08 8964 4711	UHF 16 VHF 123850	Scotty & Jane Armstrong

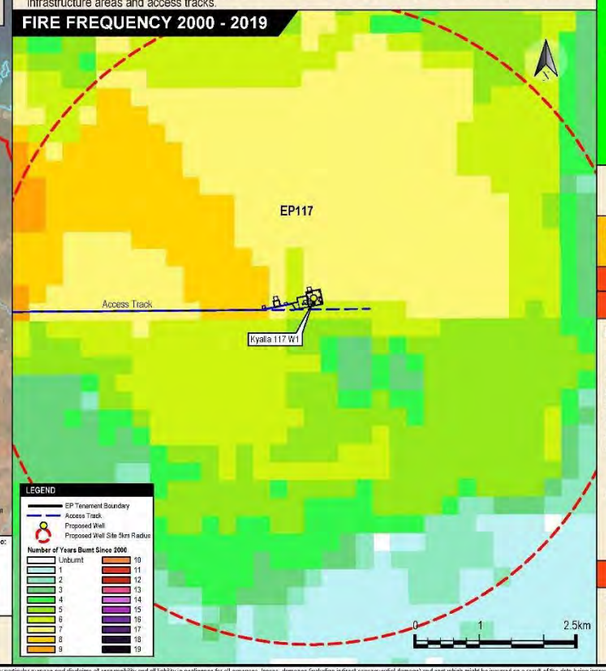
Offsite Stakeholders	Contact Details	Name
Volunteer Bushfire Brigades	08 8975 9936	
National Response Centre	1800 076 251	24/7 contract line
Emergency	000 or 112 mobile	
Bushfire NT Katherine office	08 8973 8873 08 8973 8871	Troy Munckton
Bushfire NT Head office	08 8922 0840 bushfires.nt@nt.gov.au 08 8922 0844	Mark Gardner
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/	

Fire Frequency 2000-2019

Fire management risks

- Ignitions (humans and lightening) on or off site resulting in harm to workers and loss of equipment.
- Fire scar mapping indicates the exploration area burns approximately every 3 years.
- Bullwaddy and Lancewood vegetation communities occur within the vicinity of the infrastructure area and are fire sensitive. Hot fires have the ability to reduce habitat quality for both flora and fauna species which utilise these vegetation communities.
- Spread of high fuel load grassy weeds could increase fire intensity, eg gamba, grader and buffel grass, adjacent infrastructure areas and access tracks.

FIRE FREQUENCY 2000 - 2019



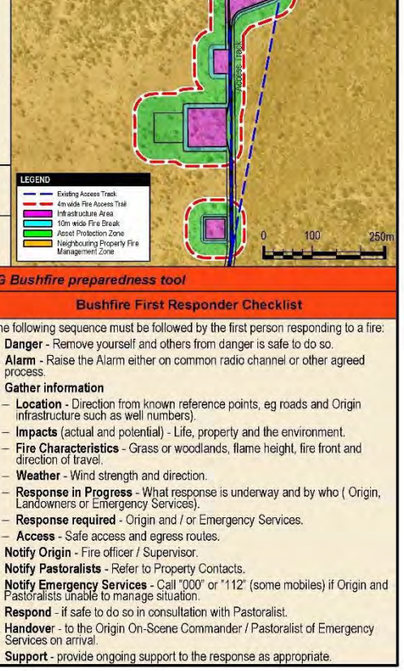
Annual Works Calendar

Month	Bushfire Risk	Action	Month	Bushfire Risk	Action
Jan	Low	• No fire management activity.	July	High	• Monitor NAFI and visual scan horizon for smoke. • Liaise with neighbour regarding bushfires. • IG bushfire preparedness tool to be utilised daily during periods of fire danger of severe or greater.
Feb	Low	• Manage vegetation onsite including weeds.	Aug	High	• Monitor NAFI and visual scan horizon for smoke. • Liaise with neighbour regarding bushfires. • IG bushfire preparedness tool to be utilised daily during periods of fire danger of severe or greater.
Mar	Low	• Planning meeting with neighbour. • Manage vegetation onsite including weeds. • Manage fire break and fire access trail.	Sept	High	• Monitor NAFI and visual scan horizon for smoke. • Liaise with neighbour regarding bushfires. • IG bushfire preparedness tool to be utilised daily during periods of fire danger of severe or greater.
Apr	Low	• Manage vegetation onsite including weeds.	Oct	High	• Monitor NAFI and visual scan horizon for smoke. • Liaise with neighbour regarding bushfires. • IG bushfire preparedness tool to be utilised daily during periods of fire danger of severe or greater.
May	Low	• Manage vegetation onsite including weeds.	Nov	Medium	• Monitor NAFI and visual scan horizon for smoke. • Liaise with neighbour regarding bushfires. • IG bushfire preparedness tool to be utilised daily during periods of fire danger of severe or greater.
June	Medium	• Monitor NAFI and visual scan horizon for smoke. • Liaise with neighbour regarding bushfires. • IG bushfire preparedness tool to be utilised daily during periods of fire danger of severe or greater.	Dec	Low	• No fire management activity.

Kyalla 117 W1 Fire Management Zones

Bushfire Management Actions	
Infrastructure area	• Remove all vegetation. • Treat emerging vegetation with herbicide. • A permit for open flaring and hot works is required during a declared fire danger period. • Open flaring and hot works are not permitted on total fire ban days without written approval from a fire control officer or fire warden.
Fire management break	• Maintain a 10 m wide bare earth loop road around the infrastructure area.
Asset Protection Zone (APZ)	• During operations, establish a 40 m wide APZ around the infrastructure area by removing woody understorey vegetation and achieving a grass height of < 100 mm using the methods prescribed in the *Origin Generic bushfire asset protection zone guide*. • Maintain grass cover to a height < 100 mm. • Remove vegetation from the 10 m wide fire break around the infrastructure area. Monitor for grassy weeds and control where appropriate. • Ensure a 4m wide fire access trail around the perimeter of the asset protection zone is trafficable by fire fighting appliances. Monitor for grassy weeds and control where appropriate.
Fire access trails	• Create and maintain a 4m wide access trail around the perimeter of the asset protection zone by grading or spraying.
Neighbouring Property Fire Management Zone	• Annual fire management planning meeting with neighbouring properties. • Neighbour to advise proponent of planned burns.

FIRE MANAGEMENT ZONES



Bushfire Preparedness - refer to *IG Bushfire preparedness tool*

Preparedness 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 risk (fire in the area), 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' (Community or Origin permanent sites).

Monitoring Routine

- 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, eg roads and Origin infrastructure such as well numbers).
   - **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 (Origin, Landowners or Emergency Services).
   - **Response required** - Origin and / or Emergency Services.
   - **Access** - Safe access and egress routes.
4. **Notify Origin** - Fire officer / Supervisor.
5. **Notify Pastoralists** - Refer to Property Contacts.
6. **Notify Emergency Services** - Call "000" or "112" (some mobiles) if Origin and Pastoralists unable to manage situation.
7. **Respond** - if safe to do so in consultation with Pastoralist.
8. **Handover** - to the Origin On-Scene Commander / Pastoralist of Emergency Services on arrival.
9. **Support** - provide ongoing support to the response as appropriate.

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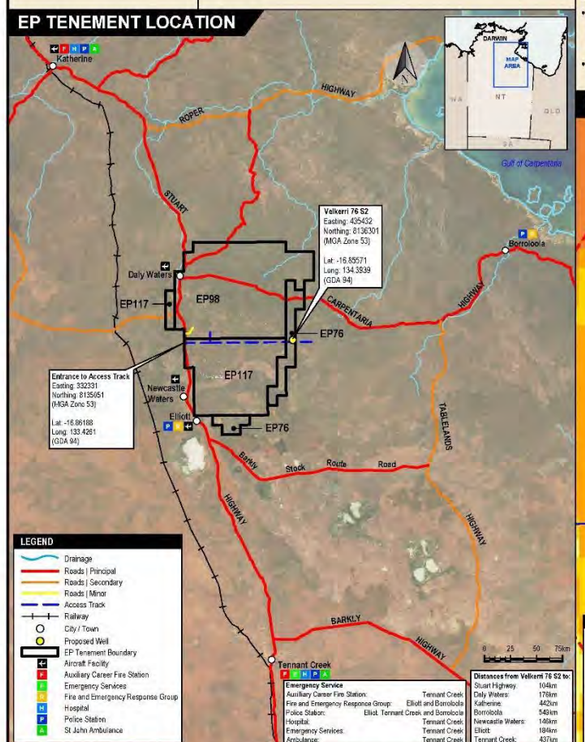
E.3. Velkerri 76 S2 – Bushfire Management Plan

Exploration Permit 76
Bushfire Management Plan 2019/2020
Velkerri 76 S2 Lease

Location of Velkerri 76 S2	
Property land uses	Gas exploration and cattle grazing
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 Origin's people, assets and operations and neighbouring land uses.

EP TENEMENT LOCATION



This Site Specific Bushfire Management Plan (this Plan) has been prepared for Origin and its Contractors to manage the risk of bushfire at the Velkerri 76 S2 exploration lease area. This Plan should be read in conjunction with the overarching *Environmental Management Plan* and *Emergency Response Plans* for Origin's operations in the Beetaloo Basin.

Appendix B Site Specific Bushfire Management Plan (this plan) / Version 1/ 5 December 2019

Origin Fire Officer	Contact Details		Name
	mobile : 0467 679 003 Satellite phone : 0147 612 733 Robert.Wear@upstream.originenergy.com.au		Robert Wear

Properties	Contact Details		Name
Amungee Mungee Station	08 8971 1293 Katherine office 0427 825 159 Adrian 08 8975 9599 Amungee homestead	UHF 18 VHF 123600	Adrian Brown
Tanunbirini Station	08 8975 9929		Mick Tasker
Beetaloo Station	08 89 644 613 Office 08 89 644 711	UHF 16 VHF 123850	Scotty & Jane Armstrong

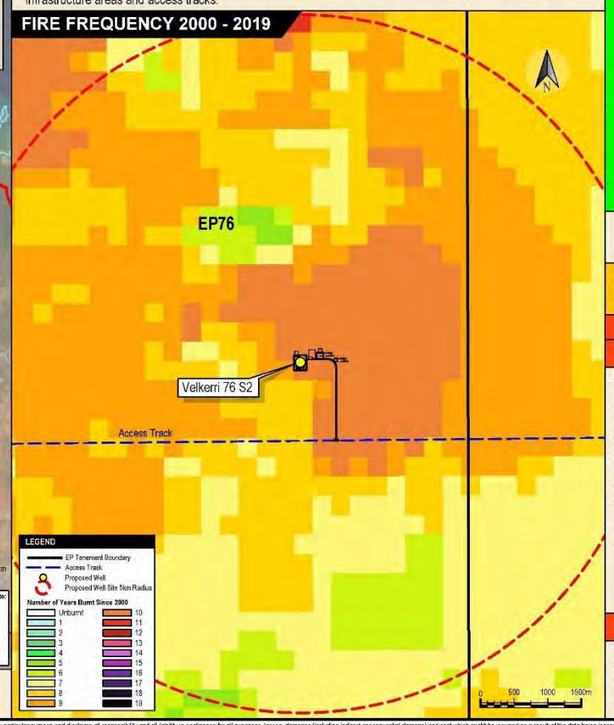
Offsite Stakeholders	Contact Details	Name
Volunteer Bushfire Brigades	08 8975 9936	
National Response Centre	1800 076 251	24/7 contract line
Emergency	000 or 112 mobile	
Bushfire NT Katherine office	08 8973 8873 08 8973 8871	Troy Munckton
Bushfire NT Head office	08 8922 0840 bushfires.nt@nt.gov.au 08 8922 0844	Mark Gardner
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/	

Fire Frequency 2000-2019

Fire management risks

- Ignitions (humans and lightening) on or off site resulting in harm to workers and loss of equipment.
- Fire scar mapping indicates the exploration area burns approximately every 2 years.
- Bullwaddy and Lancewood vegetation communities occur to the south and west of the infrastructure area and are fire sensitive. Hot fires have the ability to reduce habitat quality for both flora and fauna species which utilise these vegetation communities.
- Spread of high fuel load grassy weeds could increase fire intensity, eg gamba, grader and buffel grass, adjacent infrastructure areas and access tracks.

FIRE FREQUENCY 2000 - 2019



Annual Works Calendar

Month	Bushfire Risk	Action	Month	Bushfire Risk	Action
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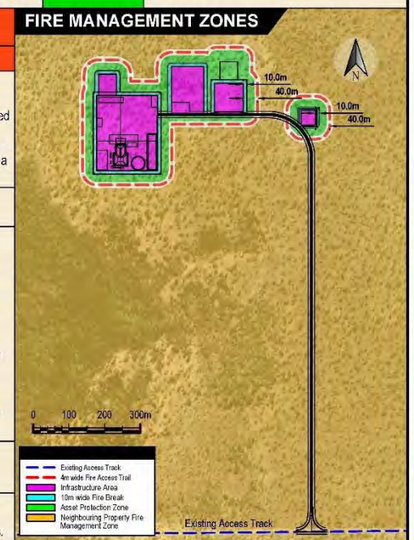
Mar	Low	• Planning meeting with neighbour. • Manage vegetation onsite including weeds. • Manage fire break and fire access trail.	Sept	High	• Monitor NAFI and visual scan horizon for smoke. • Liaise with neighbour regarding bushfires. • IG bushfire preparedness tool to be utilised daily during periods of fire danger of severe or greater.
Apr	Low	• Manage vegetation onsite including weeds.	Oct	High	• Monitor NAFI and visual scan horizon for smoke. • Liaise with neighbour regarding bushfires. • IG bushfire preparedness tool to be utilised daily during periods of fire danger of severe or greater.
May	Low	• Manage vegetation onsite including weeds.	Nov	Medium	• Monitor NAFI and visual scan horizon for smoke. • Liaise with neighbour regarding bushfires. • IG bushfire preparedness tool to be utilised daily during periods of fire danger of severe or greater.
June	Medium	• Monitor NAFI and visual scan horizon for smoke. • Liaise with neighbour regarding bushfires. • IG bushfire preparedness tool to be utilised daily during periods of fire danger of severe or greater.	Dec	Low	• No fire management activity.

Velkerri 76 S2 Fire Management Zones

Bushfire Management Actions

Infrastructure area	• Remove all vegetation. • Treat emerging vegetation with herbicide. • A permit for open flaring and hot works is required during a declared fire danger period. • Open flaring and hot works are not permitted on total fire ban days without written approval from a fire control officer or fire warden.
Fire management break	• Maintain a 10 m wide bare earth loop road around the infrastructure area.
Asset Protection Zone (APZ)	• During operations, establish a 40 m wide APZ around the infrastructure area by removing woody understorey vegetation and achieving a grass height of < 100 mm using the methods prescribed in the *Origin Generic bushfire asset protection zone guide*. • Maintain grass cover to a height < 100 mm. • Remove vegetation from the 10 m wide fire break around the infrastructure area. Monitor for grassy weeds and control where appropriate. • Ensure a 4m wide fire access trail around the perimeter of the asset protection zone is trafficable by fire fighting appliances. Monitor for grassy weeds and control where appropriate.
Fire access trails	• Create and maintain a 4m wide access trail around the perimeter of the asset protection zone by grading or spraying.
Neighbouring Property Fire Management Zone	• Annual fire management planning meeting with neighbouring properties. • Neighbour to advise proponent of planned burns.

FIRE MANAGEMENT ZONES



Bushfire Preparedness - refer to *IG Bushfire preparedness tool*

Preparedness 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 risk (fire in the area), 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' (Community or Origin permanent sites).

Monitoring Routine

- 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.
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3. **Gather information**
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   - **Response required** - Origin and / or Emergency Services.
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E.4. Velkerri 76 S1 – Bushfire Management Plan

Exploration Permit 76

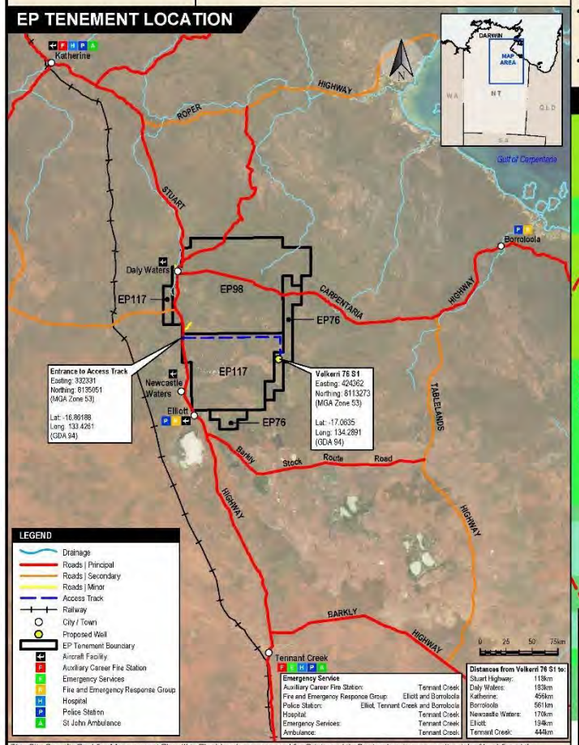
Bushfire Management Plan 2019/2020

Velkerri 76 S1 Lease

Location of Velkerri 76 S1

Property land uses	Gas exploration and cattle grazing
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 Origin's people, assets and operations and neighbouring land uses.

EP TENEMENT LOCATION



This Site Specific Bushfire Management Plan (this Plan) has been prepared for Origin and its Contractors to manage the risk of bushfire at the Velkerri 76 S1 exploration lease area. This Plan should be read in conjunction with the overarching *Environmental Management Plan* and *Emergency Response Plans* for Origin's operations in the Beetaloo Basin.

Appendix A Site Specific Bushfire Management Plan 2019

Origin Fire Officer	Contact Details	Name
	mobile : 0467 679 003 Satellite phone : 0147 612 733 Robert.Wear@upstream.originenergy.com.au	Robert Wear

Properties	Contact Details		Name
Amungee Mungee Station	08 8971 1293 Katherine office 0427 825 159 Adrian 08 8975 9599 Amungee homestead	UHF 18 VHF 123600	Adrian Brown
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Offsite Stakeholders	Contact Details	Name
Volunteer Bushfire Brigades	08 8975 9936	
National Response Centre	1800 076 251	24/7 contract line
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Bushfire NT Head office	08 8922 0840 bushfires.nt@nt.gov.au 08 8922 0844	Mark Gardner
NAFI North	https://www.firenorth.org.au/nafi3/	
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Fire incident map	https://www.pfes.nt.gov.au/incidentmap/	

Fire Frequency 2000-2019

Fire management risks

- Ignitions (humans and lightening) on or off site resulting in harm to workers and loss of equipment.
- Fire scar mapping indicates the exploration area burns approximately every 3 years.
- Bullwaddy and Lancewood vegetation communities occur within the vicinity of the infrastructure area and are fire sensitive. Hot fires have the ability to reduce habitat quality for both flora and fauna species which utilise these vegetation communities.
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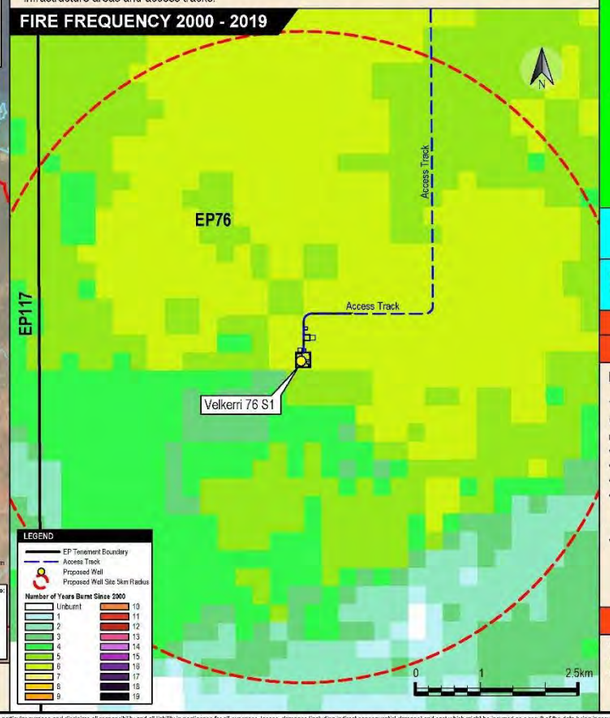
FIRE FREQUENCY 2000 - 2019



Annual Works Calendar

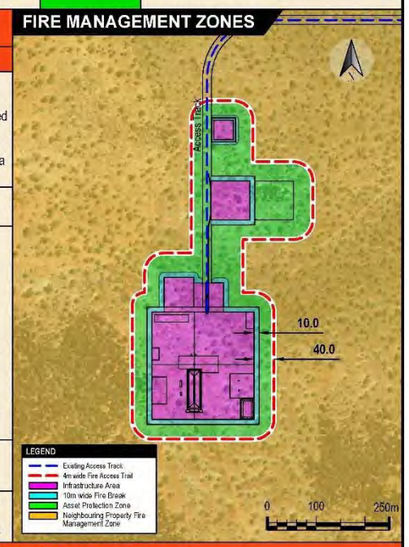
Month	Bushfire Risk	Action	Month	Bushfire Risk	Action
Jan	Low	• No fire management activity.	July	High	• Monitor NAFI and visual scan horizon for smoke. • Liaise with neighbour regarding bushfires. • IG bushfire preparedness tool to be utilised daily during periods of fire danger of severe or greater.
Feb	Low	• Manage vegetation onsite including weeds.	Aug	High	• Monitor NAFI and visual scan horizon for smoke. • Liaise with neighbour regarding bushfires. • IG bushfire preparedness tool to be utilised daily during periods of fire danger of severe or greater.
Mar	Low	• Planning meeting with neighbour. • Manage vegetation onsite including weeds. • Manage fire break and fire access trail.	Sept	High	• Monitor NAFI and visual scan horizon for smoke. • Liaise with neighbour regarding bushfires. • IG bushfire preparedness tool to be utilised daily during periods of fire danger of severe or greater.
Apr	Low	• Manage vegetation onsite including weeds.	Oct	High	• Monitor NAFI and visual scan horizon for smoke. • Liaise with neighbour regarding bushfires. • IG bushfire preparedness tool to be utilised daily during periods of fire danger of severe or greater.
May	Low	• Manage vegetation onsite including weeds.	Nov	Medium	• Monitor NAFI and visual scan horizon for smoke. • Liaise with neighbour regarding bushfires. • IG bushfire preparedness tool to be utilised daily during periods of fire danger of severe or greater.
June	Medium	• Monitor NAFI and visual scan horizon for smoke. • Liaise with neighbour regarding bushfires. • IG bushfire preparedness tool to be utilised daily during periods of fire danger of severe or greater.	Dec	Low	• No fire management activity.

Velkerri 76 S1 Fire Management Zones

Bushfire Management Actions

Infrastructure area	• Remove all vegetation. • Treat emerging vegetation with herbicide. • A permit for open flaring and hot works is required during a declared fire danger period. • Open flaring and hot works are not permitted on total fire ban days without written approval from a fire control officer or fire warden.
Fire management break	• Maintain a 10 m wide bare earth loop road around the infrastructure area.
Asset Protection Zone (APZ)	• During operations, establish a 40 m wide APZ around the infrastructure area by removing woody understorey vegetation and achieving a grass height of < 100 mm using the methods prescribed in the *Origin Generic bushfire asset protection zone guide*. • Maintain grass cover to a height < 100 mm. • Remove vegetation from the 10 m wide fire break around the infrastructure area. Monitor for grassy weeds and control where appropriate. • Ensure a 4m wide fire access trail around the perimeter of the asset protection zone is trafficable by fire fighting appliances. Monitor for grassy weeds and control where appropriate.
Fire access trails	• Create and maintain a 4m wide access trail around the perimeter of the asset protection zone by grading or spraying.
Neighbouring Property Fire Management Zone	• Annual fire management planning meeting with neighbouring properties. • Neighbour to advise proponent of planned burns.

FIRE MANAGEMENT ZONES



Bushfire Preparedness - refer to *IG Bushfire preparedness tool*

Preparedness 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 risk (fire in the area), 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' (Community or Origin permanent sites).

Monitoring Routine

- 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, eg roads and Origin infrastructure such as well numbers).
   - **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 (Origin, Landowners or Emergency Services).
   - **Response required** - Origin and / or Emergency Services.
   - **Access** - Safe access and egress routes.
4. **Notify Origin** - Fire officer / Supervisor.
5. **Notify Pastoralists** - Refer to Property Contacts.
6. **Notify Emergency Services** - Call "000" or "112" (some mobiles) if Origin and Pastoralists unable to manage situation.
7. **Respond** - if safe to do so in consultation with Pastoralist.
8. **Handover** - to the Origin On-Scene Commander / Pastoralist of Emergency Services on arrival.
9. **Support** - provide ongoing support to the response as appropriate.

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E.5. Velkerri 117 E1 – Bushfire Management Plan

Exploration Permit 117

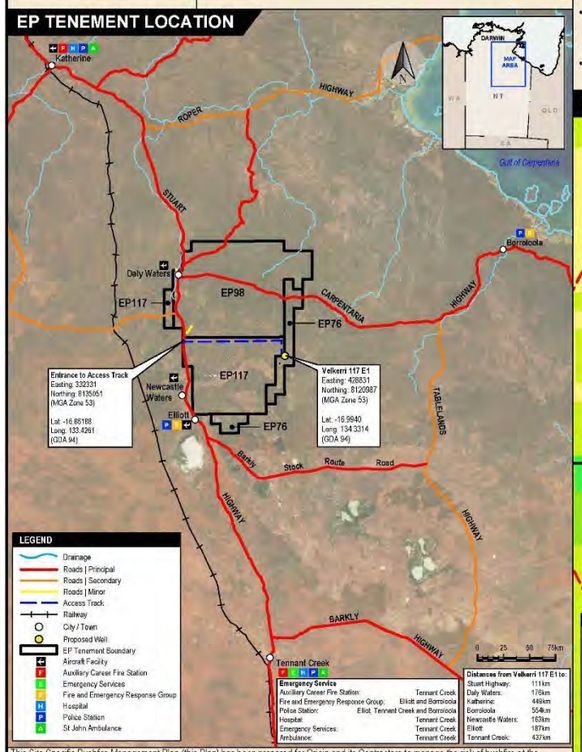
Bushfire Management Plan 2019/2020

Velkerri 117 E1 Lease

Location of Velkerri 117 E1

Property land uses	Gas exploration and cattle grazing
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 Origin's people, assets and operations and neighbouring land uses.

EP TENEMENT LOCATION



This Site Specific Bushfire Management Plan (this Plan) has been prepared for Origin and its Contractors to manage the risk of bushfire at the Velkerri 117 E1 exploration lease area. This Plan should be read in conjunction with the overarching *Environmental Management Plan* and *Emergency Response Plan* for Origin's operations in the Beetaloo Basin.

Appendix B Site Specific Bushfire Management Plan 2019

Origin Fire Officer	Contact Details	Name
	mobile : 0467 679 003 Satellite phone : 0147 612 733 Robert.Wear@upstream.originenergy.com.au	Robert Wear

Properties	Contact Details		Name
Amungee Mungee Station	08 8971 1293 Katherine office 0427 825 159 Adrian 08 8975 9599 Amungee homestead	UHF 18 VHF 123600	Adrian Brown
Tanunbirini Station	08 8975 9929		Mick Tasker
Beetaloo Station	08 89 644 613 Office 08 89 644 711	UHF 16 VHF 123850	Scotty & Jane Armstrong

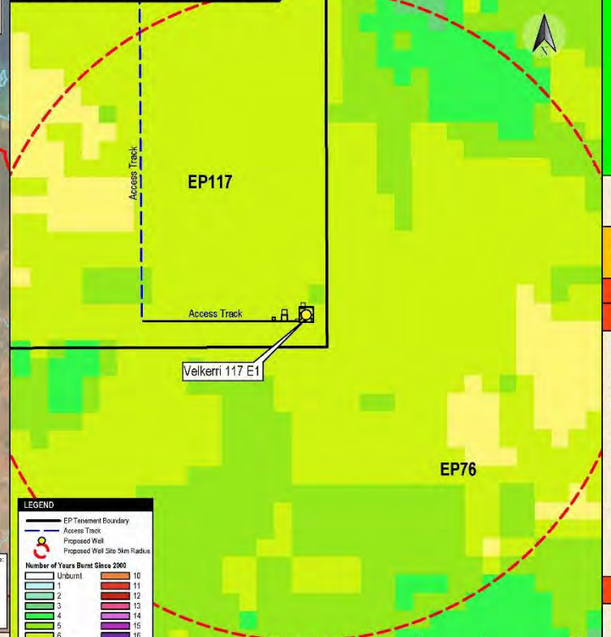
Offsite Stakeholders	Contact Details	Name
Volunteer Bushfire Brigades	08 8975 9936	
National Response Centre	1800 076 251	24/7 contract line
Emergency	000 or 112 mobile	
Bushfire NT Katherine office	08 8973 8873 08 8973 8871	Troy Munckton
Bushfire NT Head office	08 8922 0840 bushfires.nt@nt.gov.au 08 8922 0844	Mark Gardner
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/	

Fire Frequency 2000-2019

Fire management risks

- Ignitions (humans and lightening) on or off site resulting in harm to workers and loss of equipment.
- Fire scar mapping indicates the exploration area burns approximately every 3 years.
- Bullwaddy and Lancewood vegetation communities occur within the vicinity of the infrastructure area and are fire sensitive. Hot fires have the ability to reduce habitat quality for both flora and fauna species which utilise these vegetation communities.
- Spread of high fuel load grassy weeds could increase fire intensity, eg gamba, grader and buffel grass, adjacent infrastructure areas and access tracks.

FIRE FREQUENCY 2000 - 2019



Annual Works Calendar

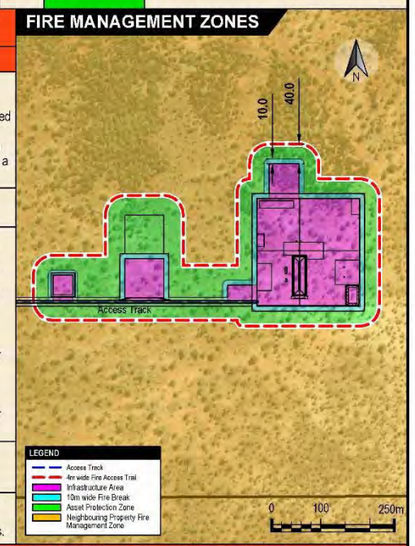
Month	Bushfire Risk	Action	Month	Bushfire Risk	Action
Jan	Low	• No fire management activity.	July	High	• Monitor NAFI and visual scan horizon for smoke. • Liaise with neighbour regarding bushfires. • IG bushfire preparedness tool to be utilised daily during periods of fire danger of severe or greater.
Feb	Low	• Manage vegetation onsite including weeds.	Aug	High	• Monitor NAFI and visual scan horizon for smoke. • Liaise with neighbour regarding bushfires. • IG bushfire preparedness tool to be utilised daily during periods of fire danger of severe or greater.
Mar	Low	• Planning meeting with neighbour. • Manage vegetation onsite including weeds. • Manage fire break and fire access trail.	Sept	High	• Monitor NAFI and visual scan horizon for smoke. • Liaise with neighbour regarding bushfires. • IG bushfire preparedness tool to be utilised daily during periods of fire danger of severe or greater.
Apr	Low	• Manage vegetation onsite including weeds.	Oct	High	• Monitor NAFI and visual scan horizon for smoke. • Liaise with neighbour regarding bushfires. • IG bushfire preparedness tool to be utilised daily during periods of fire danger of severe or greater.
May	Low	• Manage vegetation onsite including weeds.	Nov	Medium	• Monitor NAFI and visual scan horizon for smoke. • Liaise with neighbour regarding bushfires. • IG bushfire preparedness tool to be utilised daily during periods of fire danger of severe or greater.
June	Medium	• Monitor NAFI and visual scan horizon for smoke. • Liaise with neighbour regarding bushfires. • IG bushfire preparedness tool to be utilised daily during periods of fire danger of severe or greater.	Dec	Low	• No fire management activity.

Velkerri 117 E1 Fire Management Zones

Bushfire Management Actions

Infrastructure area	• Remove all vegetation. • Treat emerging vegetation with herbicide. • A permit for open flaring and hot works is required during a declared fire danger period. • Open flaring and hot works are not permitted on total fire ban days without written approval from a fire control officer or fire warden.
Fire management break	• Maintain a 10 m wide bare earth loop road around the infrastructure area.
Asset Protection Zone (APZ)	• During operations, establish a 40 m wide APZ around the infrastructure area by removing woody understorey vegetation and achieving a grass height of < 100 mm using the methods prescribed in the *Origin Generic bushfire asset protection zone guide*. • Maintain grass cover to a height < 100 mm. • Remove vegetation from the 10 m wide fire break around the infrastructure area. Monitor for grassy weeds and control where appropriate. • Ensure a 4m wide fire access trail around the perimeter of the asset protection zone is trafficable by fire fighting appliances. Monitor for grassy weeds and control where appropriate.
Fire access trails	• Create and maintain a 4m wide access trail around the perimeter of the asset protection zone by grading or spraying.
Neighbouring Property Fire Management Zone	• Annual fire management planning meeting with neighbouring properties. • Neighbour to advise proponent of planned burns.

FIRE MANAGEMENT ZONES



Bushfire Preparedness - refer to *IG Bushfire preparedness tool*

Preparedness 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 risk (fire in the area), 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' (Community or Origin permanent sites).

Monitoring Routine

- 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, eg roads and Origin infrastructure such as well numbers).
   - **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 (Origin, Landowners or Emergency Services).
   - **Response required** - Origin and / or Emergency Services.
   - **Access** - Safe access and egress routes.
4. **Notify Origin** - Fire officer / Supervisor.
5. **Notify Pastoralists** - Refer to Property Contacts.
6. **Notify Emergency Services** - Call "000" or "112" (some mobiles) if Origin and Pastoralists unable to manage situation.
7. **Respond** - if safe to do so in consultation with Pastoralist.
8. **Handover** - to the Origin On-Scene Commander / Pastoralist of Emergency Services on arrival.
9. **Support** - provide ongoing support to the response as appropriate.

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Exploration Permit 98

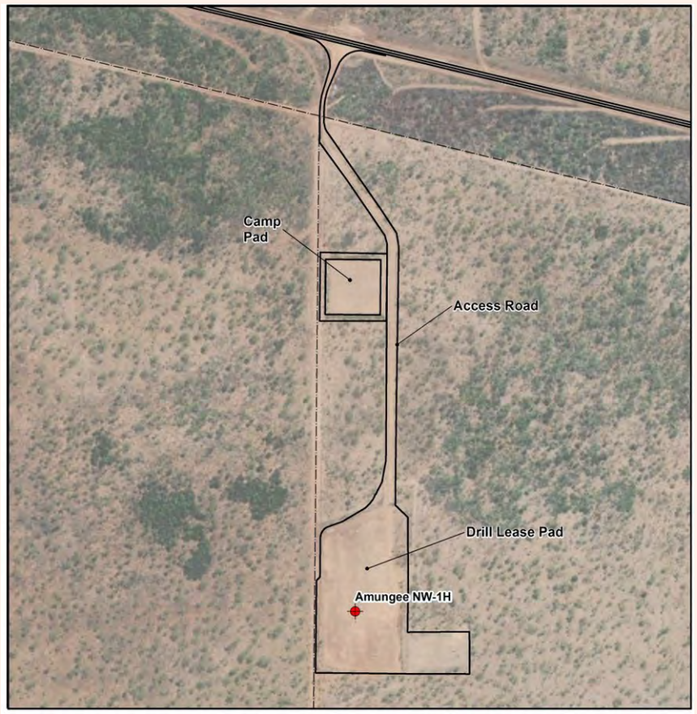
Bushfire Management Plan Rev 1.0

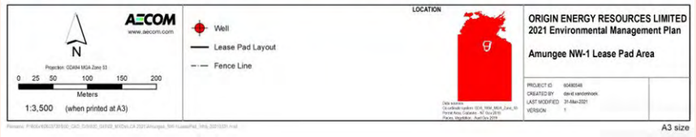
Amungee NW-1H Lease

Location of Amungee NW-1H Lease	
Property land uses	Gas exploration and cattle grazing
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 Origin's people, assets and operations and neighbouring land uses.

Fire Management Risks

- Ignitions (humans and lightening) on or off site resulting in harm to workers and loss of equipment.
- Fire scar mapping indicates the exploration area burns approximately every 3 to 5 years.
- Bullwaddy and Lancewood vegetation communities occur in areas across the permit and are fire sensitive. Hot fires have the ability to reduce habitat quality for both flora and fauna species which utilise 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.





This Site Specific Bushfire Management Plan has been prepared for Origin to manage the risk from bushfire within the Amungee NW-1 lease area. This Plan should be read in conjunction with the Overarching *Environmental Management Plan and Emergency Response Plans* for Origins operations in the Beetaloo Basin. ***Site Specific Management Plan | Version 1.0 | 01 April 2021***

Bushfire Officer	Contact Details	Name
	Mobile : 0467 679 003 Satellite phone : 0147 612 733 Robert.Wear@upstream.originenergy.com.au	**Robert Wear**

Properties	Contact Details		Name
Amungee Mungee Station	(08) 89 711293 Katherine +61 427 825159 Direct (08) 89 759 599 Homestead	UHF 18 VHF 123600	Adrian Brown
Beetaloo Station	(08) 89 644 613 Office (08) 89 644 711	UHF 16 VHF 123850	Scotty & Jane Armstrong

Offsite Stakeholders	Contact Details	Name
National Response Centre	1800 076 251	24/7 contract line
Emergency	000 or 112 mobile	
Bushfire NT Katherine office (Savanna)	(08) 8973 8876	
Bushfire NT Alice Springs office (Barkly)	(08) 8952 3066	
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/	

Origins's Amungee NW-1 Lease Area Management Zones—Bushfire Management Actions

Well Pads and Tank Pads	• Remove all vegetation within the lease pad area and implement erosion and sediment control plan. • Treat emerging vegetation with herbicide. • A permit for open flaring and hot works is required during a declared fire danger period. • Hot works are not permitted on total fire ban days without written approval from a fire control officer or fire warden.
Fire management break	• Maintain a 10 m wide bare earth loop road around the infrastructure area.
Fire access trails	• Create and maintain 4 m wide access trail by grading or spraying
Asset Protection Zone (APZ)	• Site Manager to assess fuel load prior to camp establishment and again at end of wet season if infrastructure is still in place. • Establish a 20 m low fuel zone around well pads and lease pads. • 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 fire fighting appliances. Monitor for grassy weeds and control where appropriate.
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.

Bushfire Preparedness—refer to IG Bushfire Preparedness Tool

Preparedness 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 know risk (fire in the area), 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' (Community or Origin permanent Sites).

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 Origin's infrastructure such as lease 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 (Origin, Pastoralist or Emergency Services).
- ☐ **Response required** – Origin Contractors and / or Pastoralist and / or Emergency Services.
- ☐ **Access** – Safe access and egress routes.

4. Notify Origin – Fire Officer/Supervisor

5. Notify Pastoralists – Refer to Property Contacts

6. Notify Emergency Services – Call "000" or "112" (for mobiles) if Origin and Pastorlist unable to manage situation

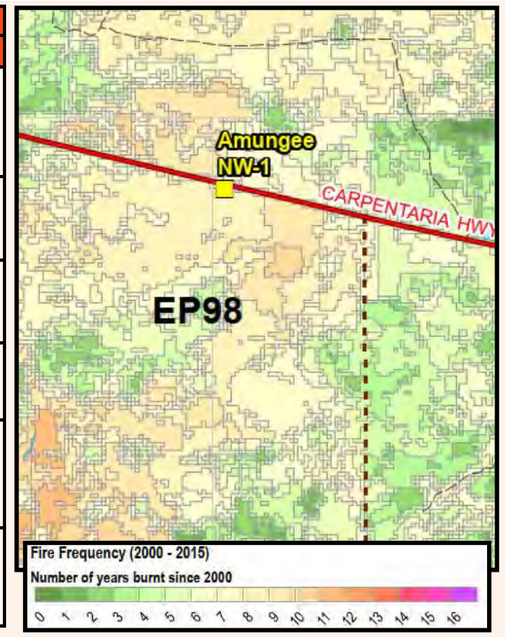
7. Respond – If safe to do so in consultation with Pastoralists.

8. Handover – To the Origin On-Scene Commander (ODC) / Pastoralist / Emergency Services on arrival.

9. Support – Provide ongoing support to the response as required.

Annual Works Calendar

Month	Bushfire Risk	Action	Month	Bushfire Risk	Action
Jan	Low	• No fire management activity	July	Medium	• Manage vegetation onsite including weeds • Manage fire break and fire access trail • Monitor NAFI • Liaise with neighbour regarding bushfires
Feb	Low	• No fire management activity	Aug	High	• Monitor NAFI and visual scan horizon for smoke • Liaise with neighbour regarding bushfires • Review the preparedness planning requirements
Mar	Low	• Weed survey • Planning meeting with neighbour • Annual fire mapping to monitor changes to fire frequency in the relevant area.	Sept	High	• Monitor NAFI and visual scan horizon for smoke • Liaise with neighbour regarding bushfires • Review the preparedness planning requirements
Apr	Low	• No fire management activity	Oct	High	• Monitor NAFI and visual scan horizon for smoke • Liaise with neighbour regarding bushfires • Review the preparedness planning requirements
May	Medium	• Manage vegetation onsite including weeds • Manage fire break and fire access trail • Monitor NAFI • Liaise with neighbour regarding bushfires	Nov	High	• Monitor NAFI and visual scan horizon for smoke • Liaise with neighbour regarding bushfires • Review the preparedness planning requirements
June	Medium	• Manage vegetation onsite including weeds • Manage fire break and fire access trail • Monitor NAFI • Liaise with neighbour regarding bushfires	Dec	Medium	• Manage vegetation onsite including weeds • Manage fire break and fire access trail • Monitor NAFI • Liaise with neighbour regarding bushfires



Appendix F Definitions

Term	Definition
CMP / T	Crisis Management Plan / Team
DPIR	Department of Primary Industry and Resources
DENR	Department of Environment and Natural Resources
EPA	Environmental Protection Agency
SEMT	Site Emergency Management Team
ER/P/T	Emergency Response / Plan / Team
GEMP/T	Group Emergency Management Plan / Team
GEMT-L	Group Emergency Management Team Leader
SEMT-L	Site Emergency Management Team – Leader
OE BU	Origin Energy Business Unit
DA	Development Area
D&C	Drilling and Completions
ECR	Emergency Control Room
ER&S	Emergency Response and Security, Senior Advisor
PC ERT	Primary Contractor Emergency Response Team
PC IMT	Primary Contractor Incident Management Team
FR	First Responder
OE	Origin Energy
OSC	On scene Commander
PC	Primary Contractor

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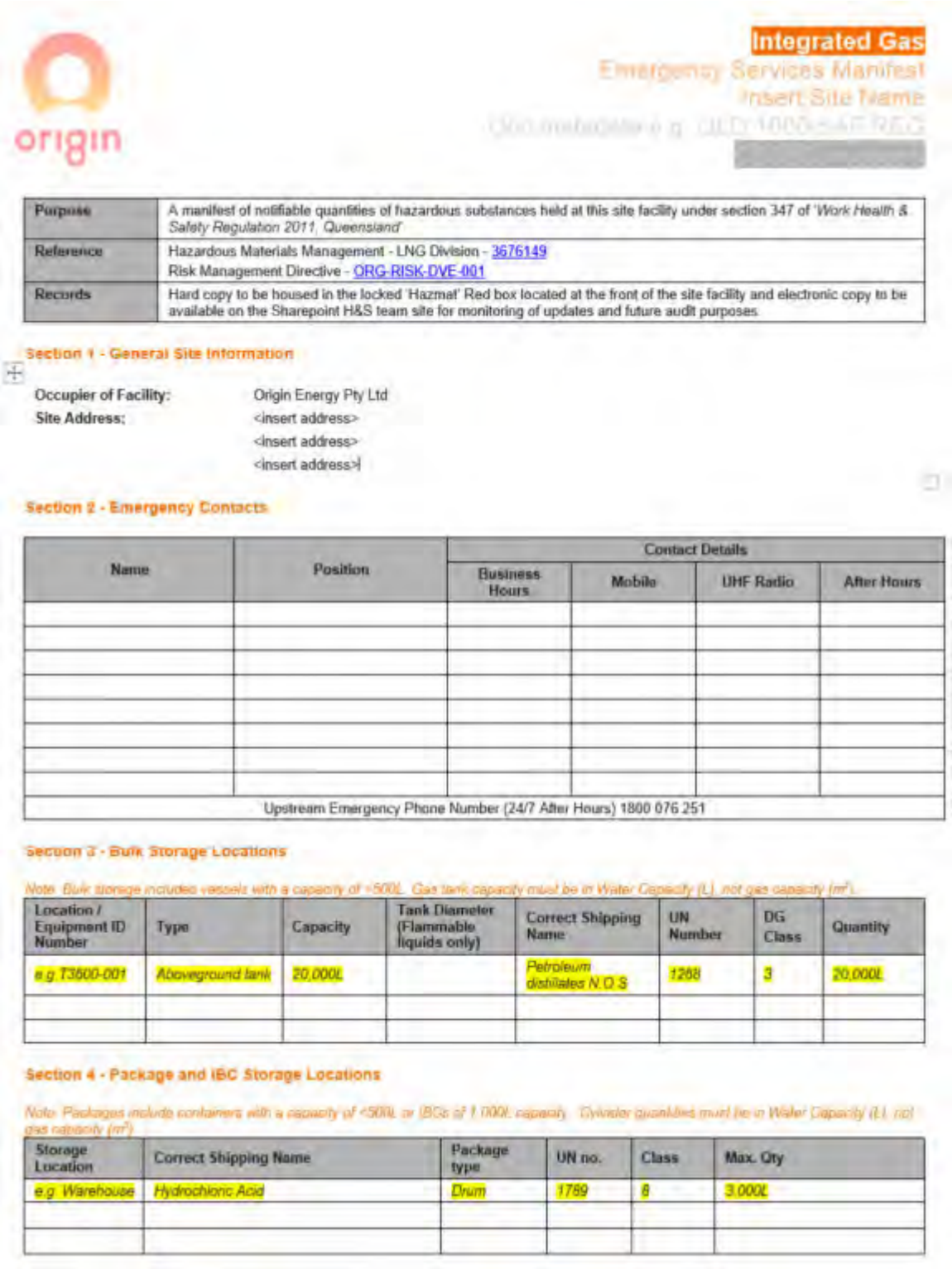
Appendix G Emergency Services Manifest

To be completed within 2 weeks of occupation of Site.

Screen shot of example: Emergency Services Manifest Template.



origin

Integrated Gas
Emergency Services Manifest
Insert Site Name

Purpose	A manifest of notifiable quantities of hazardous substances held at this site facility under section 347 of *'Work Health & Safety Regulation 2011, Queensland'*
Reference	Hazardous Materials Management - LNG Division - 3676149 Risk Management Directive - ORG-RISK-DVE-001
Records	Hard copy to be housed in the locked 'Hazmat' Red box located at the front of the site facility and electronic copy to be available on the Sharepoint H&S team site for monitoring of updates and future audit purposes

Section 1 - General Site Information

Occupier of Facility:	Origin Energy Pty Ltd
Site Address:	<insert address> <insert address> <insert address>

Section 2 - Emergency Contacts

Name	Position	Contact Details			
		Business Hours	Mobile	UHF Radio	After Hours
Upstream Emergency Phone Number (24/7 After Hours) 1800 076 251					

Section 3 - Bulk Storage Locations

Note: Bulk storage includes vessels with a capacity of >500L. Gas tank capacity must be in Water Capacity (L), not gas capacity (m^3).

Location / Equipment ID Number	Type	Capacity	Tank Diameter (Flammable liquids only)	Correct Shipping Name	UN Number	DG Class	Quantity
e.g T3600-001	*Aboveground tank*	*20,000L*		*Petroleum distillates N.O.S*	*1268*	*3*	*20,000L*

Section 4 - Package and IBC Storage Locations

Note: Packages include containers with a capacity of <500L or IBCs of 1,000L capacity. Cylinder quantities must be in Water Capacity (L), not gas capacity (m^3).

Storage Location	Correct Shipping Name	Package type	UN no.	Class	Max. Qty
e.g Warehouse	*Hydrochloric Acid*	*Drum*	*1789*	*8*	*3,000L*

Appendix H Site Specific Emergency Response Equipment

To be developed within 2 weeks of site occupation to display the following areas:

- Person in Charge (PIC)
- Muster Areas
- First Aid Treatment Areas
- First Aid Kit locations
- Fixed Fire Extinguishers and Blankets
- Evacuation Routes
- Helicopter Landing Sites
- Emergency Services Meeting Points
- Hazardous / Restricted Areas
- Emergency event PPE Locations
- Spill Kit

Northern Territory – Daly Waters

- Daly Waters Airport

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Appendix I Emergency Response Flipcharts

The following scenario responses have been reproduced from the Origin Incident Response Procedures CDN 3676134

Appendix G1 – Bushfire

Appendix G2 – Flood

Appendix G3 – Spill

Appendix G4 – Loss of Containment

I.1. Bushfire

Bushfire

Considerations

1. Is there a need to activate the Emergency Response Team (ERT).
2. Is there adequate fire fighting capability?
3. Is there an adequate water source available?
4. Bushfire - Is based on a region wide fire event where access roads will directly affect evacuation. Refer to Bush Fire Preparedness Tool for response actions, web links (i.e. BOM) and evacuation considerations.

First Responders

1. Raise the Alarm?
2. If there is a casualty provide First Aid (DRSABCD). Continue until either physically unable to do so, relieved or the patient is pronounced deceased by a doctor or paramedic.
3. Refer to the Bush Fire Preparedness Tool.
4. Be vigilant. Watch for flying embers and small fires starting on site.

On Scene Commander (OSC)

1. Mitigate Hazards to ensure personnel safety.
2. Contact the Site Emergency Management Team Leader (SEMT-L).
3. Activate Emergency Response Team (ERT) response.
4. Muster personnel and evacuate as required.
5. Contact Emergency Services if required.
6. Prepare for the arrival and briefing of Emergency Services.

Site Emergency Management Team Leader (SEMT-L)

1. Notify Origin Site Representative of emergency in the region.
2. Australia - Call 000 or 112 Mob or Fire Agencies (if available).
3. Identify available fire fighting assets (aerial, ground, mutual aid).
4. Conduct planning for evacuation and determine triggers.
5. Coordinate whole of site actions.
    1. Give preparatory orders for securing the site against the bushfire.
    2. Isolate hazardous energy and make equipment safe.
    3. Provide support to the OSC.
    4. Coordinate Emergency Services.
    5. Ensure isolation of hazardous energy and make safe (e.g. Central Control Room).
    6. Consider mobilization of Civil Maintenance to assist with fire break preparation, asset protection/earthen barriers.
6. Notify Group Emergency Management Team Leader (GEMT-L)?
7. Confirm incident terminated – use Incident Termination Checklist
8. Confirm incident investigation and gathering of facts initiated
9. Mobilise counselling services and support by the Employer Assistance Program (EAP) if required.
10. Don't return to work until all facilities and damage have been declared as safe.

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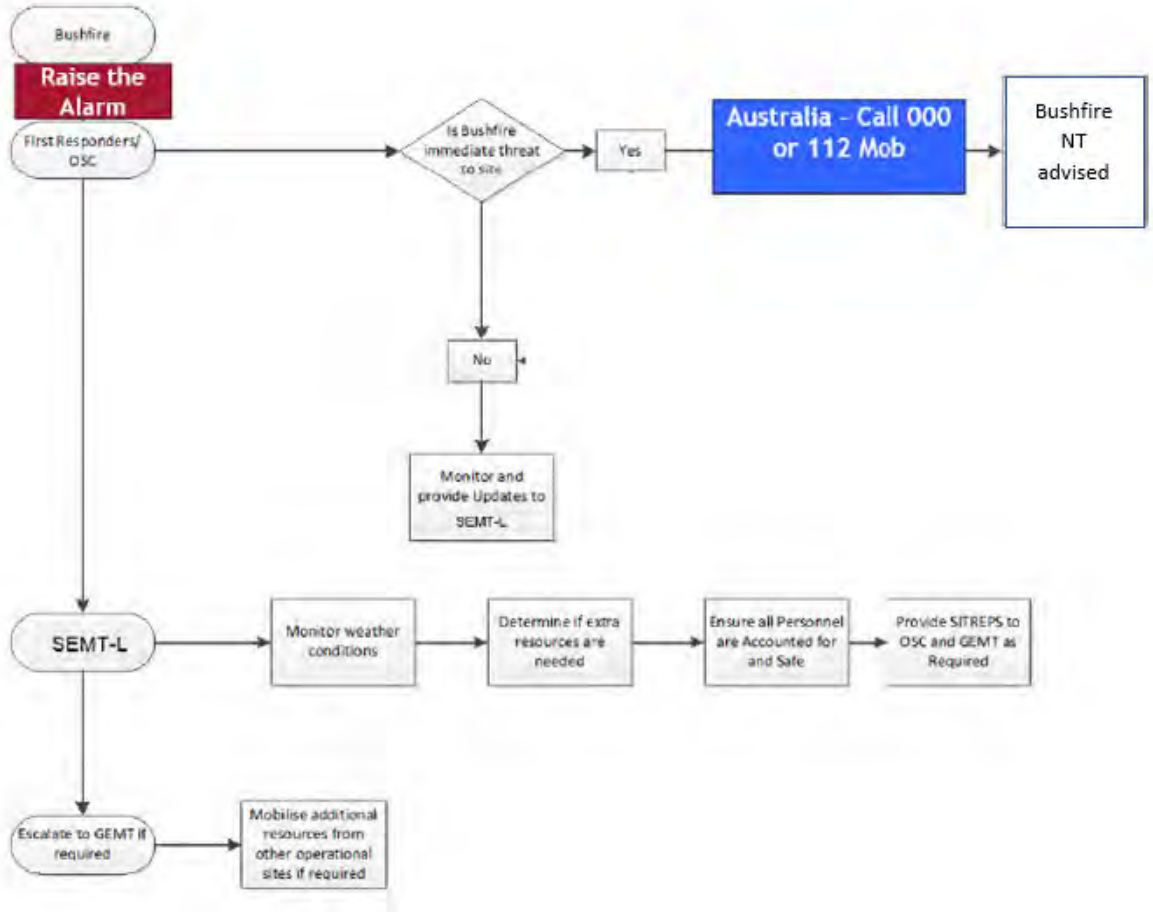
Bushfire
Raise the Alarm
First Responders/ OSC
Is Bushfire immediate threat to site
Yes
Australia - Call 000 or 112 Mob
Bushfire NT advised
No
Monitor and provide Updates to SEMT-L
SEMT-L
Monitor weather conditions
Determine if extra resources are needed
Ensure all Personnel are Accounted for and Safe
Provide SITREPS to OSC and GEMT as Required
Escalate to GEMT if required
Mobilise additional resources from other operational sites if required

I.2. Flood

Flood

Notification
Level 1
- Once a creek starts to flow over any of the access roads.

Level 2 (Consider Evacuation)
- Creek level reaches 100mm for unsealed roads, or
- Creek level reaches 200mm for sealed roads.

Level 3 (Consider Evacuation and/or Demobilising)
- Creek level reaches 300mm for unsealed roads, or
- Creek level reaches 400mm for sealed roads.
- Consider duration of weather event and prolonged effects on site.

Considerations
Level 1
- Commence prep of site for shut down and evacuation.
- Secure chemicals and toxins.
- Check supplies of food and water.

Level 2
- Non-essential personnel evacuated.
- Track personnel movements and account for all staff at all times.
- Prepare to secure / isolate infrastructure.
- Maintain communications at all times.
- Ensure sufficient food and water available on site if personnel are stranded.

Level 3
- Shut down, secure and evacuate.
- Track personnel movements and account for all staff at all times.

Don't put yourself at risk.

AVOID DRIVING OVER ROADS THAT HAVE MORE THAN 100mm OF WATER OVER THEM.

Driving over flooded roads in an emergency must be risk assessed by the Site Emergency Management Team Leader (SEMT-L).

Prior to Flood Waters Reaching Site:

1. Refer to these tools to identify assets and roads that will flood to certain levels:
   a. Flood Plan,
   b. Flood Mapping, and
   c. Hazard visualiser.
2. Closely monitor weather reports and flood predictions from the Bureau Of Meteorology (BOM).
3. Confirm triggers, evacuation plans and routes. What preparatory actions are required at site? Construction of protective banks takes time and may require additional equipment (plant) to be transported and deployed.
4. Whenever possible, mitigate environmental damage by undertaking appropriate action.
5. Evacuate mobile worksites as early as practicable?.

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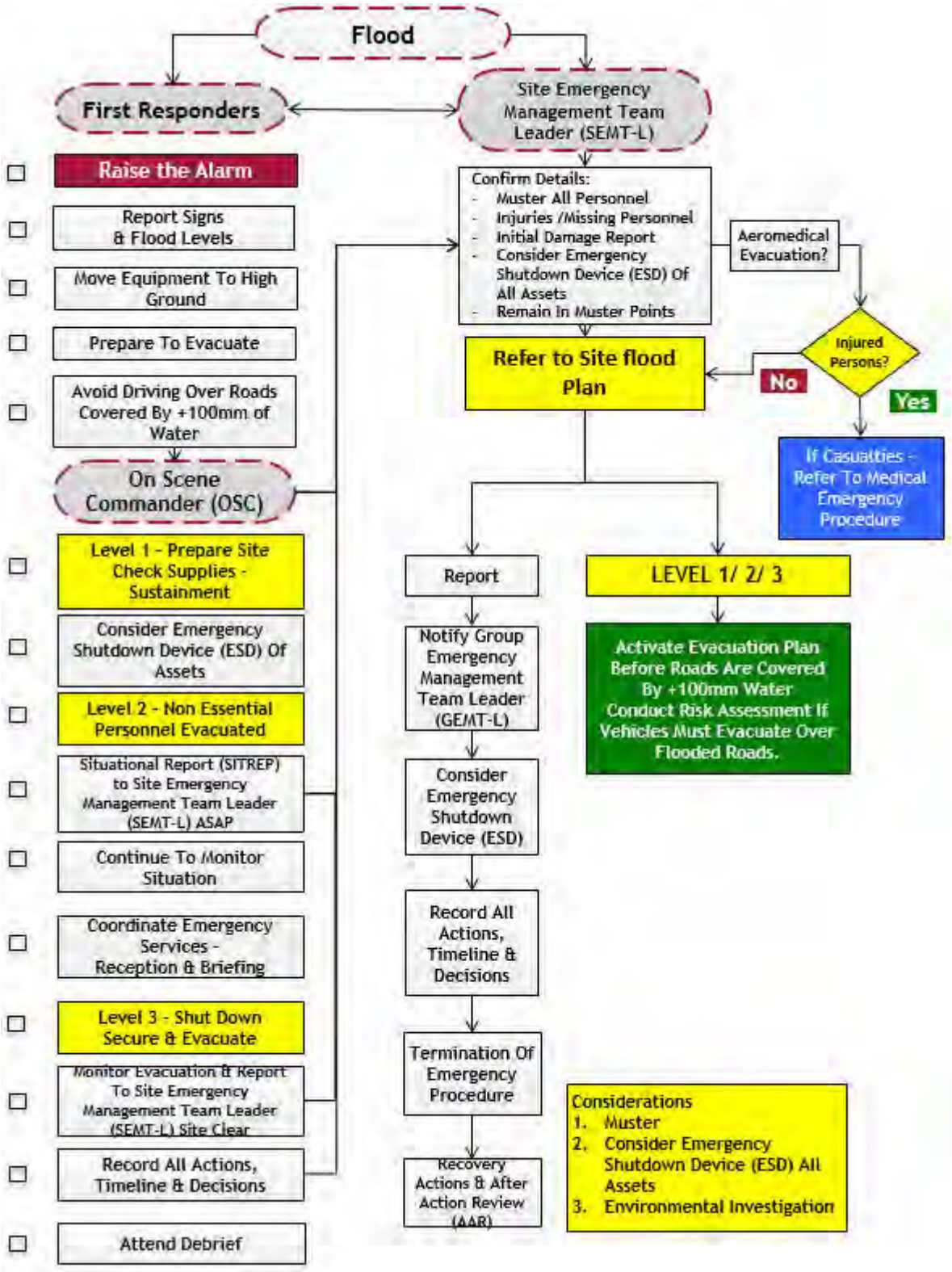

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I.3. Spill

Spill

Considerations

1. Activate the Emergency Response Team (ERT).
2. A pollutant spill may be on permeable ground and encompass a wide array of substances, some of which will be toxic and very harmful to the environment.

First Responder

1. Raise the Alarm?
2. Is there a need to activate the Emergency Response Team (ERT)?
3. Always pay attention to fire, fumes, electrical, ignition and other health risks.
4. Activate containment operations immediately to prevent spill from reaching a surface watercourse or ground water.
5. Do not flush the spill down clean drains or other inlets.

On Scene Commander (OSC)

1. Mitigate Hazards to ensure personnel safety.
2. Consider the effects of toxic spills – refer to Safety Data Sheets (SDS).
3. Use appropriate spill kits.
4. Consider type of spill, type of ground and what is the most effective method of containing with the minimum impact on personnel and the environment.
5. Consider how to prevent entry to area and spread of contamination.
6. Engage the Origin Site Representative to help assess the impact and determine appropriate actions for complex or remote incidents.
7. Some chemicals are incompatible and have the potential to increase or alter the hazard – refer to the Chemical Compatibility Chart in the Hazmat section of the site Emergency Response Plan (ERP).
8. For Water Treatment Facilities only - Disposal of diluted material to the ponds is permissible in an emergency but must be approved by the Water Treatment Facility (WTF) Supervisor.

Site Emergency Management Team Leader (SEMT-L)

1. Consider use of Civil Maintenance team for installation of earthen bunds / diversion systems.
2. Consider early engagement with the Origin Site Representative and external agencies through Compliance Team.
3. Consider nature of spill and any decontamination requirements to personnel and or equipment.
4. Consider any logistics that will be required for rapid clean up and /or remediation.
5. Consider advising local land owners and councils as appropriate.
6. Ensure all spills are managed and that environmental impacts are reported correctly within mandated time frames.
7. Consider future prevention measures and better clean up practices.

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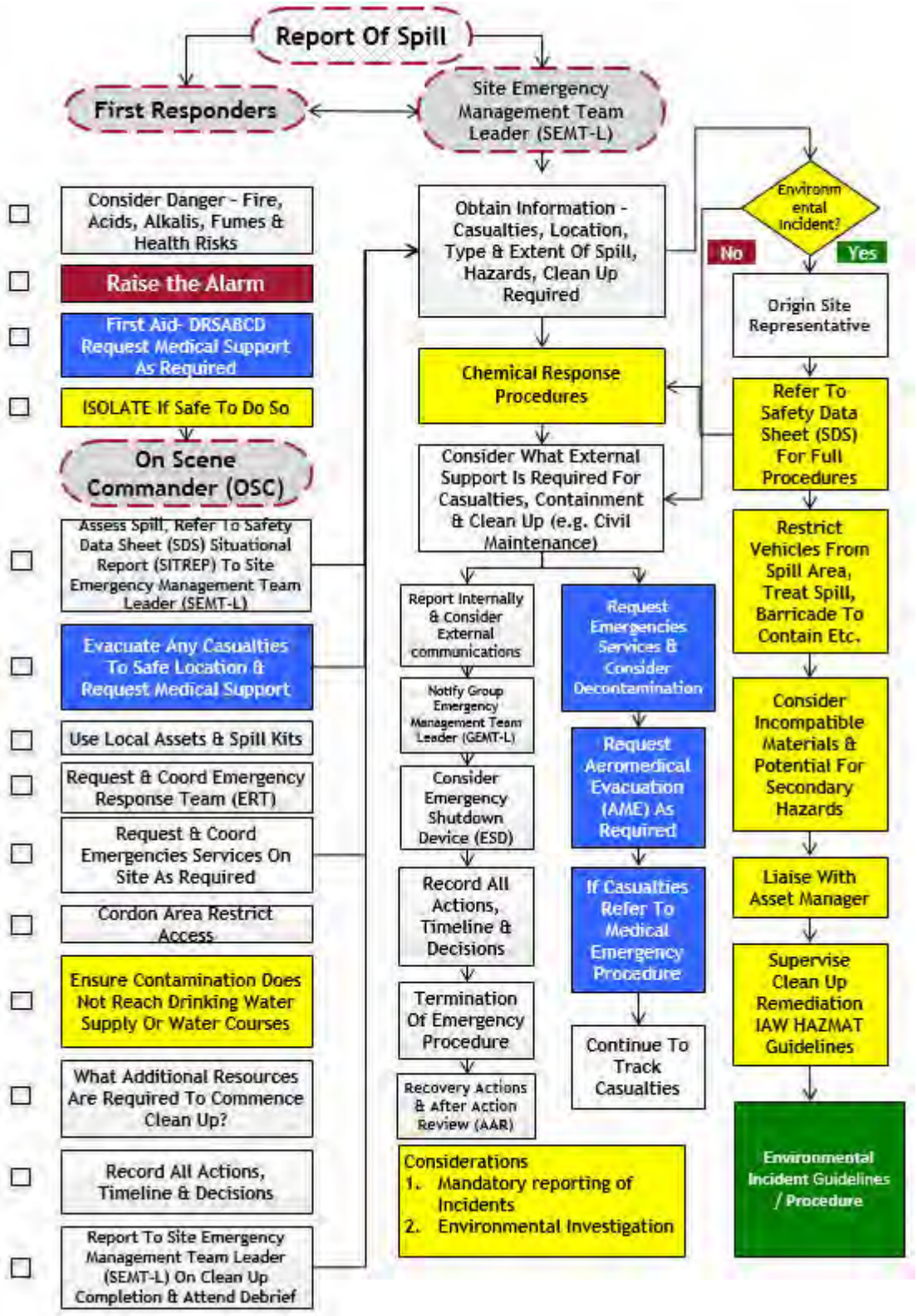
Report Of Spill
First Responders
Site Emergency Management Team Leader (SEMT-L)
Consider Danger - Fire, Acids, Alkalis, Fumes & Health Risks
Raise the Alarm
First Aid- DRSABCD Request Medical Support As Required
ISOLATE If Safe To Do So
On Scene Commander (OSC)
Assess Spill, Refer To Safety Data Sheet (SDS) Situational Report (SITREP) To Site Emergency Management Team Leader (SEMT-L)
Evacuate Any Casualties To Safe Location & Request Medical Support
Use Local Assets & Spill Kits
Request & Coord Emergency Response Team (ERT)
Request & Coord Emergencies Services On Site As Required
Cordon Area Restrict Access
Ensure Contamination Does Not Reach Drinking Water Supply Or Water Courses
What Additional Resources Are Required To Commence Clean Up?
Record All Actions, Timeline & Decisions
Report To Site Emergency Management Team Leader (SEMT-L) On Clean Up Completion & Attend Debrief
Obtain Information - Casualties, Location, Type & Extent Of Spill, Hazards, Clean Up Required
Chemical Response Procedures
Consider What External Support Is Required For Casualties, Containment & Clean Up (e.g. Civil Maintenance)
Report Internally & Consider External communications
Notify Group Emergency Management Team Leader (GEMT-L)
Consider Emergency Shutdown Device (ESD)
Record All Actions, Timeline & Decisions
Termination Of Emergency Procedure
Recovery Actions & After Action Review (AAR)
Request Emergencies Services & Consider Decontamination
Request Aeromedical Evacuation (AME) As Required
If Casualties Refer To Medical Emergency Procedure
Continue To Track Casualties
Considerations
1. Mandatory reporting of Incidents
2. Environmental Investigation
Environmental Incident?
No
Yes
Origin Site Representative
Refer To Safety Data Sheet (SDS) For Full Procedures
Restrict Vehicles From Spill Area, Treat Spill, Barricade To Contain Etc.
Consider Incompatible Materials & Potential For Secondary Hazards
Liaise With Asset Manager
Supervise Clean Up Remediation IAW HAZMAT Guidelines
Environmental Incident Guidelines / Procedure

I.4. Loss of Well Control

Loss of Well Control

Considerations

1. Activate the Emergency Response Team (ERT).
2. Determine wind direction.
3. Determine leak location; subsurface and and type.
4. Well Control Contractor requirement.
5. Consider Emergency Shutdown Device (ESD) (e.g. Central Control Room (CCR)).

First Responder

1. Raise the Alarm?
2. Always pay attention to Fire, fumes, electrical, ignition and Health Risks.
3. Muster and evacuate.
4. Secure the scene / Cordon off area.
5. Provide full details to On Scene Commander (OSC) and Site Emergency Management Team Leader (SEMT-L) – particularly:
   - Where is it originating from?; and
   - What is the wind direction?
5. Consider ignition sources as vapour could be flammable.

On Scene Commander (OSC)

1. Mitigate Hazards to ensure personnel safety.
2. What is the type of Leak and source? What is the wind direction?
3. Shutdown all potential ignition sources (liaise with Central Control Room (CCR)).
4. Monitor bleed down of leak and keep all non-essential personnel and ignition sources away from the hazardous area.
5. Make a decision whether a full site evacuation is required.

Site Emergency Management Team Leader (SEMT-L)

1. Consider environmental impacts and reporting requirements.
2. Consider early engagement with the Origin Site Representative.
3. Activate and monitor Well Control Contractor deployment and progress.
4. Consider nature of incident and method of repair and recovery to personnel and or equipment.
5. Consider any logistics that will be required for rapid clean up and or remediation.

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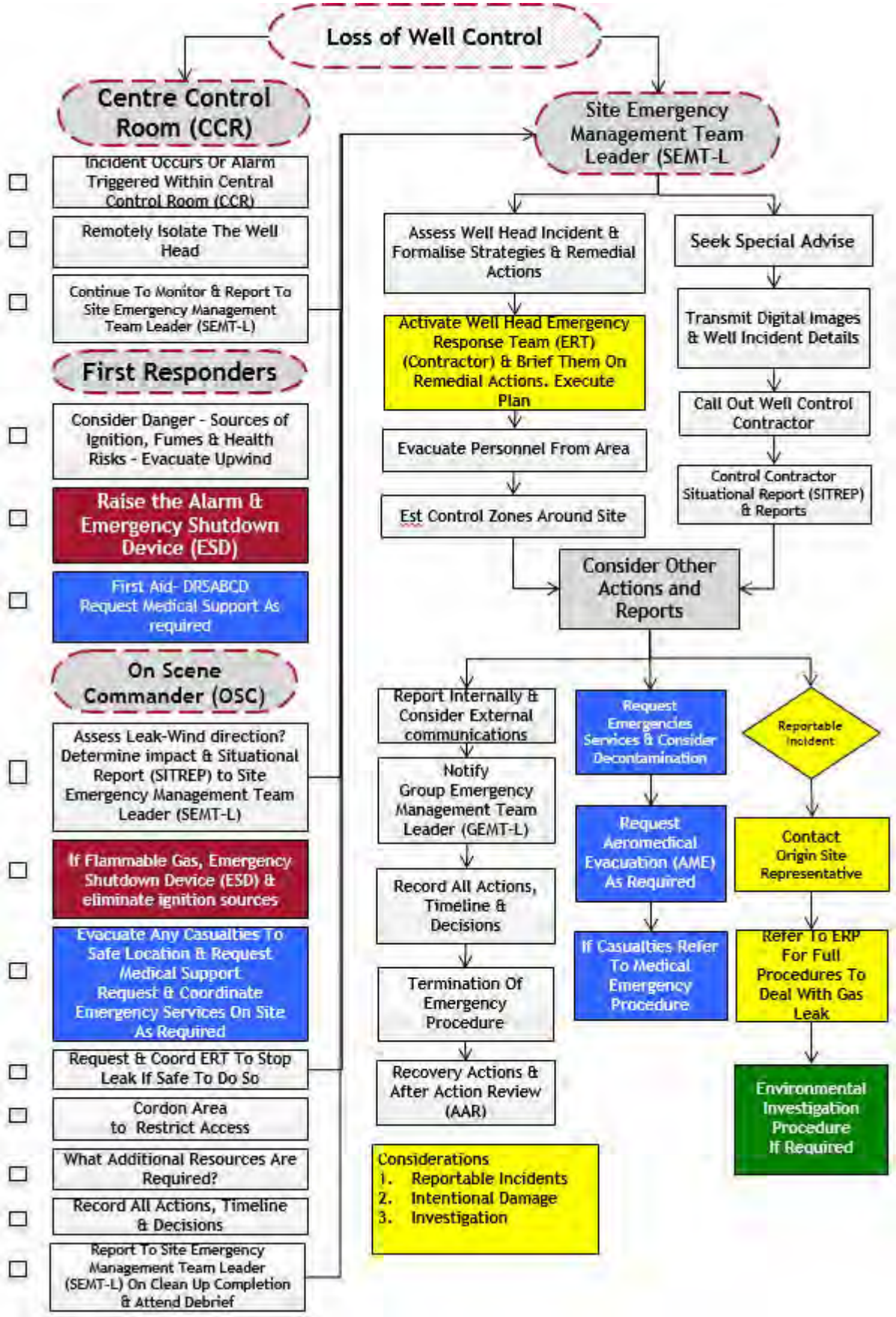

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Appendix J Camp Isolation Checklist

Screen shot of Camp Isolation Readiness Checklist. For original version go to: [the IG ER&S Flood Source Page]

Purpose	This checklist to be used to verify sustainability of camps in preparation for emergency events such as floods.
Reference	Area Flood Preparedness and Response Plans - http://source.originenergy.com.au/Business/lng/safety/emergency/Pages/FloodMgmt.aspx
Records	This checklist will be completed in October each year in preparation for the flood season. Additional requirements for completion will include forecasted severe storm or flood conditions.
Notes for use:	1. To be completed by the Camp Manager. 2. Additional sections critical supply items can be added in Sections 3 & 4 as required.

Date Checklist Completed	Click here to enter a date.	Prepared by	
Camp Name			
Location			
Type of Access	e.g. Dirt/Sealed Road Access or Single Point of access		
Camp Size	e.g. No of beds at full capacity		
Planning Assumptions	e.g. No of beds as the basis for determining supply/sustainment levels		
Camp Fire Fighting System	Choose an item.		

Section 1 - Food

Non Perishable		Perishables	
Current Holdings	Choose an item.	Current Holdings	Choose an item.
Frequency of Delivery	e.g. Twice Weekly - Mon & Thu	Frequency of Delivery	

Section 2 - Water & Waste Water

Water	Days' Supply	Storage Capacity	Current Holdings	Frequency of Delivery
		e.g. 90,000 Lt	Choose an item.	e.g. 2 Weekly - Mon/Thu
Waste Water	Days' Supply	Storage Capacity	Current Holdings	Frequency of Delivery
			Choose an item.	

Section 3 - Fuels & Chemicals

Diesel	Days' Supply	Storage Capacity	Current Holdings	Frequency of Delivery
			Choose an item.	
Other...	Days' Supply	Storage Capacity	Current Holdings	Frequency of Delivery
			Choose an item.	

Section 4 - Other

Linen	Days' Supply	Storage Capacity	Current Holdings	Frequency of Delivery
			Choose an item.	
Other...	Days' Supply	Storage Capacity	Current Holdings	Frequency of Delivery
			Choose an item.	

Section 5 - Exceptions/Comments

Appendix L Archaeological Survey Report

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11 September 2018

Matthew Hanson
Beetaloo Project Manager
Origin
339 Coronation Drive
Milton QLD 4064

Dear Matthew

Aboriginal & Historic Heritage Assessment: 2018 Exploration Lease Areas

1.0 Introduction

AECOM Australia Pty Ltd (AECOM) was commissioned by Origin Energy Resources Limited (Origin) to conduct a heritage assessment of eight proposed groundwater bore drill locations (Velkerri 98 E1-1, Kyalla 98 W1-1, Velkerri 76 S1-1, Velkerri 76 S2-1, Kyalla 117 N2-1, Velkerri 117 E1-1, Kyalla 117 W1-2 (also known as Beetaloo W-1) and Kyalla 117 W2-1) within the Beetaloo Basin covering exploration permit areas EP76. EP98, EP117 located west of Daly Waters, Northern Territory. This assessment included the associated access tracks.

The assessment involved a field inspection for the area of proposed works (study area).

2.0 Proposed Activities

Origin are proposing to undertake a series of low impact activities required to establish a comprehensive baseline groundwater monitoring program in preparation for its' 2019 exploration program. The groundwater monitoring program will involve the installation of up to four groundwater monitoring bores from eight (8) proposed lease sites within the Origin Beetaloo Exploration Area.

The project boundaries for the heritage assessment was defined as the area which may be affected by the groundwater monitoring bore installation program and the potential future exploration activities. Including:

- The eight (8) proposed 4 hectare lease area with an additional 500 m buffer, which encompassed the 50 x 50 m groundwater monitoring bore lease sites.
- The upgrade of approximately 205 km of existing access tracks and boundary fence tracks to allow the groundwater bore drilling rig access; and
- The installation of approximately 15km of new access tracks to connect the groundwater monitoring sites to the existing access tracks.
- Potential establishment of three 50m x 50 m gravel pits

It is noted that the heritage assessment allowed for a 250 m buffer either side of an existing access track to allow for locating camps, gravel pits and water supply bores in the future. Where the access track is located on a property boundary, the buffer will be 500 m out into the property the road is located on.

It is noted that not all of the nominated areas for the monitoring bore lease and/or access tracks will be affected by site activities, but sufficient size has been allowed to provide flexibility in the siting of infrastructure, which in turn can be used to minimise environmental and heritage impacts (e.g. significant tree or habitat avoidance, Sacred Site/archaeological artefact avoidance).

3.0 Existing Data Sources

Information on the location of heritage sites within the study area was obtained from:

- a review of Native Title claims and Indigenous Land Use Agreements over the proposed activity areas
- a review of existing Northern Territory Heritage Register managed by the NT Heritage Branch

- a review of the Sacred Sites Register maintained by the Aboriginal Areas Protection Authority
- a review of past archaeological survey reports and assessments undertaken within the local area.

3.1 Native Title

Three Native Title claims have been determined as non-exclusive and one Indigenous Land Use Agreement (ILUA) are current over the permit areas (see Table 1).

Table 1 Native Title & ILUA Agreements

Type	Bore	Name	Summary
Native Title	Kyalla 98 W1-1	NTD21/2010 Shenandoah Pastoral Lease	Native Title exists in parts of the determination area and is held by the Kinbininggu and Bamarrngganja groups
	Kyalla 117 N2-1	NTD21/2010 Shenandoah Pastoral Lease	Native Title exists in parts of the determination area and is held by the Kinbininggu and Bamarrngganja groups
	Kyalla 117 W2-1	NTD27/2010 Beetaloo Pastoral Lease	Native Title exists in parts of the determination area and is held by the Karranjini group; the Bamarrnganja group; the Warranangku group; the Pinda (OT Downs) group; and the Lija/Muwartpi group
	Kyalla 117 W1-2 (Beetaloo W-1)	NTD27/2010 Beetaloo Pastoral Lease	Native Title exists in parts of the determination area and is held by the Karranjini group; the Bamarrnganja group; the Warranangku group; the Pinda (OT Downs) group; and the Lija/Muwartpi group
	Velkerri 98 E1-1	NTD17/2010 Amungee Mungee Pastoral Lease	Native title exists in parts of the determination area and is held by The Karranjini group; the Bamarrnganja group
	Velkerri 76 S2-1	NTD17/2010 Amungee Mungee Pastoral Lease	Native title exists in parts of the determination area and is held by The Karranjini group; the Bamarrnganja group
	Velkerri 76 S1-1	NTD27/2010 Beetaloo Pastoral Lease	Native Title exists in parts of the determination area and is held by the Karranjini group; the Bamarrnganja group; the Warranangku group; the Pinda (OT Downs) group; and the Lija/Muwartpi group
	Kyalla 117 E1-1	NTD27/2010 Beetaloo Pastoral Lease	Native Title exists in parts of the determination area and is held by the Karranjini group; the Bamarrnganja group; the Warranangku group; the Pinda (OT Downs) group; and the Lija/Muwartpi group
Indigenous Land Use Agreement	All Sites	D12004/014 Jingaloo CLA ILUA	Registered for Community Living Area and Tenure resolution

The Native Title Petroleum Exploration Agreement between Permit Holder and the NLC includes clauses for the protection of Sacred Sites, objects and sensitive areas related to Aboriginal activities in the area, including cultural, hunting and foraging activities. Site clearance will occur prior to any on ground activities. The Native Title Agreement also includes clauses for the protection of the environment and rehabilitation.

3.2 Australian Heritage Database

A search of the Australia Heritage Database identified that no statutory listed heritage places within the proposed impact areas.

3.3 NT Heritage Register

A search of the Northern Territory Heritage Register identified two artefact scatters located adjacent to the Stuart Highway (Table 2). Goochegoochena Creek Site 1 and Goochegoochena Creek Site 2 are recorded within 600 m and 350 m respectively of the proposed access track entrance. These sites will not be directly affected by the proposed works.

Table 2 NT Heritage Register - Aboriginal Heritage Sites

Site Name	Zone	Easting	Northing	Site Type
Goochegoochena Creek Site 1	53	335612	8107484	Stone artefact scatter
Goochegoochena Creek Site 2	53	335812	8106684	Stone artefact scatter

3.4 Aboriginal Areas Protection Authority

AAPA clearance surveys by AAPA anthropologist and traditional owners are currently being undertaken and will be finalised prior to commencement of activities. Previous clearances have previously been completed for the Origin exploration permit areas. The most current clearance certifciates issued for Origin exploration program including:

- AAPA 2014/1021 (C2014/183) – EP117 for Beetaloo W-1 (Kyalla 117 W1-2)
- AAPA 2014/1022 (C2014/184) – EP98 for Kalala S-1 and Amungee NW-1
- AAPA 2015/550 (C2015/212) – EP98 for Kalala NE-1 and Nutwood Downs SW-1. AAPA 2015/550 was reviewed to update a change of exploration sites on EP98 for the CY2016 program.

Based on previous clearance certificates the only area restricted work area for the current clearance AAPA 2014/1021 (C2014/183) which lists AAPA #5663-45. This area is described as *open country surrounded by dense vegetation on the road to Jingaloo – no access and no work permitted on south side of Beetaloo access track within a radius of 300 m*.

Other restricted works areas are identified across the entire permit area. Refer to Appendix E for the available AAPA Clearance Certificates. Origin have committed to comply with conditions as prescribed by AAPA for the duration of the program.

3.5 Previous Archaeological Investigations

The majority of archaeological investigations near the study area have been predominately associated with either linear infrastructure in an alignment parallel to the Stuart Highway or natural gas exploration activities associated with the Beetaloo Basin. Of the assessments of relevance to the study area, the majority of sites identified are artefact scatters composed of raw material commonly found in the immediate area (quartz, silcrete and quartzite).

Table 3 provides a summary of previous archaeological investigations undertaken in the local area.

Table 3 Previous Archaeological Assessments in the Local Area

Researchers	Assessment Type	Locality	Key Findings
Smith, 1986	Excavation	Lake Woods	Insitu artefacts dated to 6,000 years.
Hermes, 1986	Survey	Amadeus Basin to Katherine	Large scale survey for a proposed natural gas pipeline targeting areas of major cultural sensitivity from Daly Waters to Katherine. Thirty-two sites were identified with the majority being artefact scatters associated with watercourses.

Researchers	Assessment Type	Locality	Key Findings
Quaternary Archaeological Surveys, 1998	Survey	Stuart Highway to Mataranka Homestead	Large scale survey for a fibre optic cable corridor. Three isolated artefacts and one historic heritage site identified.
Heritage Surveys, 1999	Survey	Daly Waters to McArthur River	Nine archaeological sites identified including rockshelters and artefact scatters.
HLA-Envirosciences Pty Ltd, 2006a, 2006b, 2006c, 2006d, 2007	Survey	Beetaloo Basin	Several archaeological sites identified across the exploration permits including artefact scatters, isolated artefacts and stone cairns.
AECOM Australia Pty Ltd, n.d., 2011, 2012a, 2012b	Survey	Beetaloo Basin	Several archaeological sites identified as part of seismic line clearance including large artefact scatters (>1 km), quarry sites and isolated artefacts.
AECOM Australia Pty Ltd, 2014	Survey	Beetaloo Basin	One isolated artefact identified as part of an exploration drilling program clearance.
AECOM Australia Pty Ltd, 2016	Survey	Beetaloo Basin	One isolated artefact identified on Newcastle Waters firebreak

4.0 Heritage Assessment

A heritage assessment involving field survey was undertaken by AECOM archaeologist, Luke Kirkwood for the proposal area on 28 to 29 August 2017. The archaeological inspection involved helicopter and pedestrian survey of the proposed water bore lease area and access tracks.

During the inspection notes were taken on landform, ground surface visibility and areas of exposure. The aim of the inspection was to identify any surface expressions of Aboriginal archaeological and cultural heritage values within the proposal area. Photographic records were taken at each proposed disturbance location.

Results of the inspection are provided in Table 4. Appendix B provides details on ground surface visibility classes and subsurface archaeological potential assessment. Plate 1 to Plate 8 present the general context shot of the proposed monitoring bore lease area.

Table 4 Monitoring Bore Inspection Results

Location	Easting (mE)[a]	Northing (mN)[a]	GSV[b]	GSI[c]	Surface Archaeology	Subsurface Potential	Impact Potential
Kyalla 98 W1-1	364955	8177458	Very good	High	None identified	Low	Low to No Impact
Kyalla 117 N2-1	356175	8137500	Fair	High	None identified	Low	Low to No Impact
Kyalla 117 W1-2 (Beetaloo W-1)	368079	8106696	Fair	Moderate	None identified	Low	Low to No Impact
Kyalla 117 W2-1	358321	8108680	Good	High	BT-18-IA1	Low	Low to No Impact
Velkerri 76 S2-1	435488	8136321	Good	High	None identified	Low	Low to No Impact
Velkerri 76 S1-1	424362	8113273	Very good	High	None identified	Low	Low to No Impact
Velkerri 98 E1-1	415515	8180683	Very poor	High	None identified	Low	Low to No Impact
Velkerri 117 E1-1	428861	8120782	Very good	High	None identified	Low	Low to No Impact

a GDA94 Zone 53; b GSV = Ground Surface Visibility; c GSI = Ground Surface Integrity

Plate 1 Kyalla 98 W1-1 general context shot

Plate 2 Kyalla 117 N2-1 general context shot

Plate 3 Kyalla 117 W1-2 general context shot

Plate 4 Kyalla 117 W2-1 general context shot

Plate 5 Velkerri 76 S1-1 general context shot

Plate 6 Velkerri 76 S2-1 general context shot

Plate 7 Velkerri 98 E1-1 general context shot

Plate 8 Velkerri 117 E1-1 general context shot

5.0 Identified Archaeological Heritage

No culturally sensitive landforms were identified during the survey of the proposed lease sites. One Aboriginal isolated artefact (BT-18-IA1, a silcrete unifacial point) was identified 100 m north west of the proposed Kyalla 117 W2-1 lease. Details of the find are provided below:

Site Name: BT-18-IA1

Co-ordinates: 358243mE 8108739mN GDA94 Zone 53

Site Description: Isolated silcrete unifacial point. Retouch is present along all margins of the artefact with the platform also removed. Extreme tip of point shows evidence of impact damage. No other obvious signs of usewear or residues. Darkening on ventral surface of tool, may be from exposure to soil.

Site is located on the boundary of two ecotones: Spinifex and laterite rich lower slopes. Soil is light grey/yellow sandy matrix typical of spinfex suitable habitats. Immediately adjacent is a very gently inclined slope composed on ironstone nodules. No evidence of archaeology was identified in the ironstone rich areas. Nearest wetland is 400m to the southeast

Ground Surface Visibility: 80%. Generally GSV is considered to be extremely good in this area due to low grass cover. Despite intensive survey of the immediate area (50m) no further archaeological finds were identified.

Ground Surface Integrity: 100%.

Site Interpretation: Site is an isolated discard event and likely represents small groups/individuals moving across the landscape for hunting purposes. Points are thought to be a late Holocene technology that was developed in response to increasingly marginal environments. The popularity of points is thought to be a response to reducing foraging risk by developing a highly maintainable technology that allowed for greater adaptation to these new conditions.

Table 5 Artefacts Identified in Disturbance Area

Archaeological Site	Artefact Type	Raw Material	Length (mm)	Width (mm)	Breadth (mm)
BT-18-IA1	Isolated unifacial point	Silcrete	38	22	5

Plate 9 **BT-18-IA1 (dorsal)**

Plate 10 **Kyalla 117 W2-1 ground cover context shot showing surface visibility. Artefact in foreground**

6.0 Key Findings and Recommendations

The key findings of this heritage assessment are:

- A review of existing heritage data and reports for the study area indicate that no previously recorded heritage sites will be impacted by the proposed works.
- One isolated artefact, BT-18-IA1, was identified. This artefact was found on the surface and has likely been moved by hydrological processes common across this area during the wet season.
- AAPA clearance surveys by AAPA anthropologist and traditional owners are currently being undertaken and will be finalised prior to commencement of activities.

On the basis of the above findings, the following recommendations are made:

- Heritage specialist to report site to NT Heritage Branch
- Avoid impact to the site by temporarily fencing a 10 m buffer around its location during construction works.
- If impact cannot be avoided:
  - Consult with the NT Heritage Branch and traditional owners and identify a suitable relocation area. Under law, the NT Heritage Branch are the determining body with respect to impacts to Indigenous heritage, but generally default to the wishes of community.
  - Update site details to the NT Heritage Branch. Relocation of isolated artefacts is allowed under the NT Heritage Act provided, the site is extensively documented prior to relocation.
- An unexpected heritage finds stop works procedure is to be implemented for the duration of the project.
- Induction of staff on site is to include reference to the wider area having Indigenous heritage values and the stop works procedure.

7.0 References

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Yours faithfully

Luke Kirkwood
Principal Archaeologist
[redacted]

Appendix A - Legislation

Commonwealth Legislation

Environment Protection and Biodiversity Conservation Act

The Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) took effect on the 16 July 2000 (NSW Department of Urban Affairs and Planning, 2000). Under section 26 of the EPBC Act it is stated that:

> *A person must not take on Commonwealth land an action that has, will have or is likely to have a significant impact on the environment.*

Under section 28 of the EPBC Act it is stated that:

> *The Commonwealth or a Commonwealth agency must not take inside or outside the Australian jurisdiction an action that has, will have or is likely to have a significant impact on the environment inside or outside the Australian jurisdiction.*

An action is defined as a project, development, undertaking, activity, series of activities, or alteration. An action will also require approval if:

> *It is undertaken on Commonwealth land and will have or is likely to have a significant impact;*
>
> *It is undertaken outside Commonwealth land and will have or is likely to have a significant impact on the environment on Commonwealth land; and*
>
> *It is undertaken by the Commonwealth and will have or is likely to have a significant impact.*

The EPBC Act defines 'environment' as both natural and cultural environments and therefore includes Aboriginal and historic heritage items. Under the Act, protected heritage items are listed on the National Heritage List (items of significance to the nation) or the Commonwealth Heritage List (items belonging to the Commonwealth or its agencies). These two lists replaced the Register of the National Estate (RNE) which is no longer a statutory list.

Aboriginal and Torres Strait Islander Heritage Protection Act 1984

The Aboriginal and Torres Strait Islander Heritage Protection Act 1984 (the ATSIHP Act) provides for the preservation and protection of places, areas and objects of particular significance to Indigenous Australians. The stated purpose of the ATSIHP Act is the 'preservation and protection from injury or desecration of areas and objects in Australia and in Australian waters, being areas and objects that are of particular significance to Aboriginals in accordance with Aboriginal tradition' (section 4).

Under the Act, 'Aboriginal tradition' is defined as "the body of traditions, observances, customs and beliefs of Aboriginals generally or of a particular community or group of Aboriginals, and includes any such traditions, observances, customs or beliefs relating to particular persons, areas, objects or relationships" (Section 3). A 'significant Aboriginal area' is an area of land or water in Australia that is of 'particular significance to Aboriginals in accordance with Aboriginal tradition' (Section 3). A 'significant Aboriginal object', on the other hand, refers to an object (including Aboriginal remains) of like significance.

For the purposes of the Act, an area or object is considered to be injured or desecrated if:

- In the case of an area:
  - it is used or treated in a manner inconsistent with Aboriginal tradition;
  - the use or significance of the area in accordance with Aboriginal tradition is adversely affected;
  - passage through, or over, or entry upon, the area by any person occurs in a manner inconsistent with
  - Aboriginal tradition;
- In the case of an object:
  - it is used or treated in a manner inconsistent with Aboriginal tradition.

The ATSIHP Act can override state and territory laws in situations where a state or territory has approved an activity, but the Commonwealth Minister prevents the activity from occurring by making a declaration to protect an area or object. However, the Minister can only make a decision after receiving a legally valid application under the ATSIHP Act and, in the case of long term protection, after considering a report on the matter. Before making a declaration to protect an area or object in a state or territory, the Commonwealth Minister must consult the appropriate Minister of that state or territory (section 13).

Northern Territory Legislation

Northern Territory Aboriginal Sacred Sites Act

Provides for the protection of Aboriginal sacred sites through the establishment of different categories of site based on land tenure, including sites on Aboriginal Freehold land. The Act also establishes the Aboriginal Areas Protection Authority (AAPA) as the central administering body which supports Aboriginal custodians in achieving the objectives of the Act. Consultation with the NLC and TO's required and the issue of the AAPA clearance certificates.

The Act establishes a duty-of-care to notify the AAPA of any potential disturbance to Aboriginal sacred sites. It is an offence to desecrate or disturb a site without the approval of the relevant custodians. A register of known sites exists to assist in identifying the likelihood of disturbance and potential need to obtain approval.

Heritage Act

Protects both natural and cultural heritage, including Aboriginal, historic and Macassan heritage. The Act establishes the Heritage Council (consisting of eleven members) and the NT Heritage Register. It sets the process by which places become heritage places and allows for interim protection of places.

It is an offence to remove or damage heritage places or objects or to mislead or obstruct heritage officers regarding the provision of requested information or entry to works, vehicles or premises that are likely to have been involved in an offence against the Heritage Act. Compliance with the requirements of the Act must be adhered to at all times.

Appendix B – Archaeological Assessment Criteria

Table B1 Ground Surface Visibility (GSV) Rating Scheme

GSV rating	Percentage GSV
No ground surface visibility	0%
Very poor	1-10%
Poor	11-30%
Fair	31-50%
Good	51-70%
Very good	71-90%
Excellent	91-100%

Table B2 Ground Surface Integrity (GSI) Rating Scheme

GSI rating	Definition
Low	Ground surface has been subjected to significant disturbance (e.g. earthworks, excavation). Little to no integrity remains.
Moderate	Ground surface has been subject to moderate disturbance (e.g. native vegetation clearance) but retains a reasonable degree of integrity.
High	An unmodified or minimally modified ground surface.

Table B3 Definitions for Subsurface Archaeological Potential

Subsurface Archaeological Potential	Definition
Low	Areas in which subsurface archaeological materials are unlikely to occur. This may be due to unfavourable environmental conditions and/or prior disturbance(s).
Moderate	Areas in which subsurface archaeological materials may occur. Reasonable environmental conditions exist though high artefact counts/densities are unlikely. Subsurface evidence likely to be the product of random discard events as opposed to repeated or extensive activity by Aboriginal people in antiquity.
High	Areas known or highly likely to contain subsurface archaeological materials. Presence of archaeological materials typically reflects optimal environmental conditions and little to no prior landscape disturbance. High artefact counts/densities are likely.

Table B4 Impact Potential Ranking for Aboriginal Objects

Impact Potential	Definition	Management Action
No Impact	Aboriginal objects will not be affected by the proposed activity.	No action required
Low Impact	The proposed activity is unlikely to disturb, destroy, damage or deface an Aboriginal object or objects.	No action required
Moderate Impact	The proposed activity has reasonable potential to disturb, destroy, damage or deface an Aboriginal object or objects.	Avoid area if possible. If avoidance not an option, test excavate area to determine nature and extent of potential archaeological deposits

Impact Potential	Definition	Management Action
High Impact	The proposed activity will, or is highly likely to, disturb, destroy, damage or deface an Aboriginal object or objects.	Avoid area if possible. If avoidance not an option, test excavate area to determine nature and extent of potential archaeological deposits