Beetaloo Basin Shenandoah South E&A Program

Environment Management Plan (TAM1-3)

EP 117 and EP 98

REV	DATE	REASON FOR ISSUE	COMPILER	APPROVER
0	16/11/2023	Issued for assessment	L Pugh	M Kernke
1	27/11/2023	Minor edits for EMP assessment Reissued for assessment	L Pugh	M Kernke
2	28/03/2024	Addresses regulation 10 and regulation 11 feedback from DEPWS, 29-Feb-2024	L Pugh	M Kernke
3	26 April 2024	Addresses regulation 10 and regulation 11 feedback from DEPWS, 19 Apr-2024	L Pugh	M Kernke

Table of Contents

Figures

Tables

Appendices

APPENDICES A – D:

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

Appendix B Bushfire Management Plans

Appendix C Weed Management Plan

Appendix D Engineering Drawings, Layouts and Specifications

APPENDIX E – Chemical risk assessments:

- Appendix E Chemical Risk Assessment – AECOM (2024). *Beetaloo Exploration and Appraisal Program - Hydraulic Fracturing Chemical Risk Assessment,* dated 20 March 2024
- Appendix E.1 Chemical Risk Assessment – EHS Support (2023) *Hydraulic Stimulation Chemical Risk Assessment Tamboran Resources Northern Territory Tenements*, dated 12 January 2023

APPENDICES F – K:

Appendix F Spill Management Plan

Appendix G Wastewater Management Plan

Appendix H Erosion and Sediment Control Plan

Appendix I Methane Emissions Management Plan

Appendix J Water Monitoring Suites

Appendix K Land Condition Assessment Report

APPENDICES L – M:

Appendix L Heritage Assessment Report

Appendix M Risk Assessment

APPENDIX N – Stakeholder engagement:

- Part A Stakeholder engagement log summary & Part B Stakeholder summary of information provided and the relevant sections of the Petroleum (Environment) Regulations 2016
- Appendix N.1.1 Pastoral stakeholder engagement
- Appendix N.1.2 NLC stakeholder engagement
- Appendix N.1.3 Historic engagement – under approved EMPs
    - Historic Kyalla 117 N2 stakeholder engagement

APPENDICES O – Q:

Appendix O Rehabilitation Management Plans

Appendix P Environmental Commitments Register

Appendix Q Emergency Response Plan

Executive Summary

Tamboran B2 Pty Ltd (Tamboran) is the registered holder and operator of exploration permits (EP) 98 and 117, located in the Beetaloo Sub-basin. This Environment Management Plan (EMP) represents Tamboran's application to the Northern Territory (NT) Minister for Environment for a series of exploration and appraisal (E&A) activities proposed under the Shenandoah South E&A program over 5 years.

The Shenandoah South E&A program EMP is designed to collect appraisal data to determine the future technical and commercial viability of the underlying shales within EP 98 and 117. This EMP is restricted to E&A activities and does not cover production as defined in the NT *Petroleum Act 1984*. Activities proposed in this EMP include:

- **Civil construction of 4 new E&A locations – Shenandoah S2, Shenandoah S B, Shenandoah S C, Shenandoah N A:** Civil construction of up to 4 new E&A well sites and associated infrastructure (access tracks, camp pads, helipads, laydown yards, fence lines, firebreaks, water bore, and all other ancillary infrastructure).Includes the construction of a new 5-hectare (ha) gravel pit (SSGP3).
- **Civil construction to expand the existing Kyalla 117 N2 site:** Civil construction to expand the existing Kyalla 117 N2 site inside the firebreak / fenced well site[1] from 13.11 ha to 17.41 ha, including 0.50 ha contingency to expand the camp site.
- **Sealing of existing access track intersection with the Stuart Highway** to comply with the Department of Infrastructure, Planning and Logistics (DIPL) intersection requirements.
- **Drilling of** up to 15 horizontal E&A wells. This includes the approved Shenandoah S 2H on the Kyalla 117 N2 location.
- **Hydraulic fracture stimulation (HFS) and well testing of u**p to 15 horizontal E&A wells at four (4) exploration locations. This includes the approved the Shenandoah S 2H well on Kyalla 117 N2.
- **Drilling of a vertical stratigraphy well at Shenandoah N A.**
- **Construction of a gathering network connecting exploration sites** to allow for the transfer of wastewater (including raw water, flowback, completion and drilling wastewater) and hydrocarbons between Kyalla 117 N2 and Shenandoah S2 and Shenandoah S B and Shenandoah S C.
- **Drilling waste and flowback wastewater management** on each site, including the transfer between sites**.** This includes construction and operation of drilling sumps and wastewater storage tanks, as well as the operation of gathering networks connecting sites.
- **Seismic acquisition of a total of 77 km of 2D seismic (EP 98 and EP 117):**
    - Acquisition of 3 x 2D seismic surveys totalling approximately 38 km (19 ha disturbance) across EP 117 and 98.
    - Acquisition of an additional 39 km of 2D seismic along existing access tracks with no disturbance.
- **Operation and maintenance of the existing Kyalla 117 N2 E&A location, main access track(s), gravel pits and ancillary activities.** Includes the incorporation of all remaining / in force regulated activities from the following approved EMPs[2] (refer Appendix A) at the Kyalla 117 N2 sites:

[1] The terms "well pad(s)" and "well site(s)" may be used interchangeably with the terms "lease pad(s)" and "lease pad area(s)". As per the definition in the Code:

"A well pad is the area upon which the well is constructed … A well site refers to the area used for well construction activities and potentially includes the well pad, storage of equipment and materials associated with well construction and accommodation for well construction personnel. That is, the entire land area that has been cleared and used for the well construction activity."

[2] "Approved EMPs" includes Regulation 22 notifications made under each approved EMP.

- Beetaloo Basin Kyalla, civil construction EP 117 N2 EMP (ORI1-1), approved 6 June 2019.
- Beetaloo Basin Kyalla drilling hydraulic fracture stimulation and well testing program EP 117 N2 EMP (ORI3-2), approved 13 August 2019.
- Beetaloo Sub-basin Kyalla 117 N2 multi-well drilling, hydraulic fracturing and well testing program EMP (ORI6-3), approved 22 February 2021.

- **Decommissioning[3] of up to 18 wells**, including the 15 new E&A wells, 1 approved E&A well and 2 existing E&A wells; Kyalla 117 N2-1H and Shenandoah S-1H.
- **All ancillary activities on each site required to undertake E&A activities including:**
  - Power generation
  - Bulk chemical and fuel handling, storage and use
  - Material transport and storage
  - Gravel extraction
  - Helicopter operations
  - Flaring
  - Flowback wastewater management, recycling and treatment
  - Recycling of wastewater, including the recycling of waste drilling fluids, completion fluids and flowback into operational process (such as stimulation make up water)
  - Groundwater extraction and monitoring
  - Micro-seismic data acquisition and associated works
  - Induced seismic monitoring and associated works
  - Environmental monitoring for weeds, flora, fauna, soil, air quality and other environmental aspects
  - Inspection and maintenance
  - Office, workshop and laydown areas
  - Operations of camps at each location
  - Subsurface diagnostic tests and data collection on each petroleum exploration well
  - Maintenance and monitoring of each of the proposed petroleum exploration wells and infrastructure
  - Suspension and decommissioning[4] of the proposed petroleum exploration wells.
  - Rehabilitation of disturbance areas

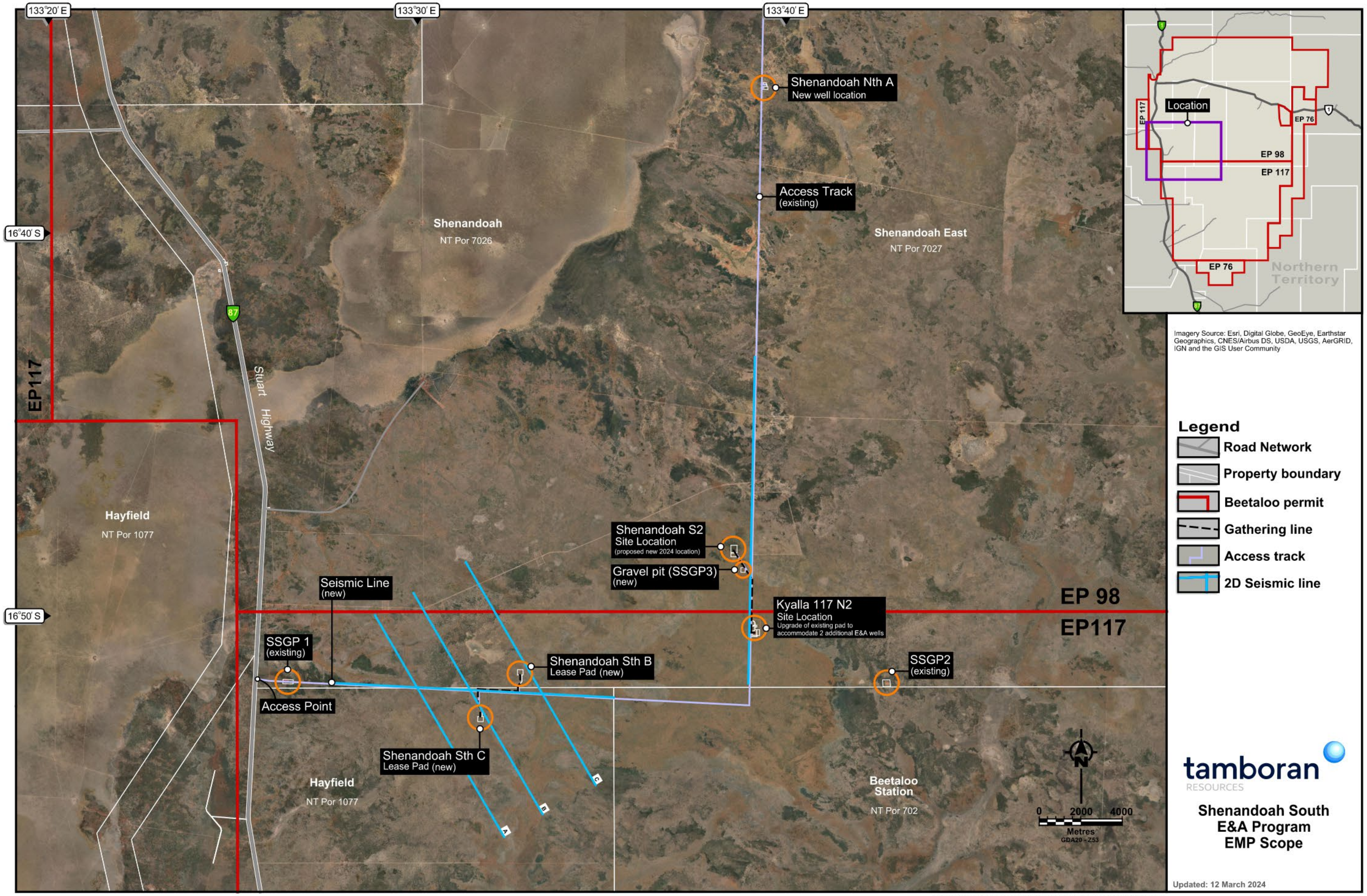
The EMP has been prepared in compliance with the NT Petroleum (Environment) Regulations 2016 (the "Regulations"), *Code of Practice: Onshore Petroleum Activities in the Northern Territory* (the "Code") and the Exploration Agreements between Tamboran, native title holders and the Northern Land Council (NLC). The EMP is designed to ensure that the proposed activities are carried out in such a manner that the environmental impacts and risks will be reduced to as low as reasonably practicable (ALARP) and acceptable.

[3] Decommissioning includes the permanent plugging, abandonment and/or remediation of wells.

[4] Ibid.

Location of the regulated activities

The Shenandoah South E&A program is located on the Shenandoah and Hayfield Pastoral stations within EP 117 and EP 98. The location of the proposed activities is provided in Figure 1.



Shen-Sth-EA-Prog_EMP-Scope-V3-REV-GDA20_Z53.dgn

Figure 1: Location of new well pads, gravel pit (SSGP3), proposed seismic and existing Kyalla 117 N2 infrastructure

Description of the activity

A summary of the proposed activities covered in the EMP is provided in Table 1. This includes the following regulated activities:

- Civil construction activities, including drilling of groundwater monitoring and extraction bores
- Drilling of E&A wells
- HFS and well testing of E&A wells
- Maintenance, monitoring and abandonment of E&A wells
- Collection of seismic information
- All ancillary activities on each site required to undertake E&A activities

Table 1: Description of the proposed new exploration and appraisal activities for the Shenandoah South E&A program, including 2D seismic acquisition

Activity	Parameter	Description
Exploration-on site civil construction	Expansion of existing Kyalla 117 N2 site-total disturbance increasing from 5.25 ha to 9.05 ha	• Operation and expansion of the existing Kyalla 117 N2 well pad from 5.25 ha to 9.05 ha
	Construction and ongoing maintenance of 4 new E&A sites- 34.5 ha total disturbance	• Construction of 4 new E&A locations: • Shenandoah S2- (12.0 ha) • Shenandoah S B- (12.0 ha) • Shenandoah S C- (7.5 ha) • Shenandoah N A-(3.0 ha)

Activity	Parameter	Description
	Access tracks – ~20.1 ha total	• Construction/ upgrade of access tracks to pastoral track type 2 (e.g. 14 m wide): • Bitumen sealing of the existing Kyalla 117 N2 access track intersection with the Stuart Highway (no new disturbance) • Use and maintenance of the existing 28 km of access connecting the Stuart Highway with the existing Kyalla 117 N2 site • Use and upgrade of approximately 2.5 km of existing pastoral access track from the Kyalla N2 access to the new Shenandoah S2 access – 4.5 ha • Construction of a new 2.0 km access track (including turn-ins, erosion and sediment controls, and passing bays) connecting the existing pastoral access track to the new Shenandoah S2 – 3.3 ha • Construction of a new 1.5 km access track from the existing Kyalla N2 access track (including turn-ins, erosion and sediment controls, and passing bays) connecting to the new Shenandoah S B location – 3.3 ha • Construction of a new 1.5 km access track from the existing Kyalla N2 access track (including turn-ins, erosion and sediment controls, and passing bays) connecting Shenandoah S C– 3.3 ha • Use and upgrade of existing ~26 km of existing pastoral track connecting the Shenandoah N A location to the Kyalla 117 N2 location – 4.0 ha of new disturbance • Construction of a 1.0 km access track from the existing pastoral access track (including turn-ins, erosion and sediment controls, and passing bays) to Shenandoah N A – 2.0 ha.
	Camp pads: ~3.5 ha	• Construction of 1.0 x 1.0 ha camp pad each at Shenandoah S2, S B and Shenandoah N A. The camp pads at these sites will only be constructed where the centralised camp at the existing Kyalla 117 N2 site is not used. • Expansion of the Kyalla 117 N2 camp from 1.0 ha to 1.50 ha (contingent).
	4 cellars per well pad (at least)	• Installation of at least 4 E&A well cellars and conductors on each well pad to accommodate the proposed wellheads and surface facilities.
	1 sump per well pad	• Construction of a drilling sump on each well pad to manage drilling fluids, muds and cuttings with a typical volume of 10,000 $m^{3.}$
	1 bund per well pad	• Construction of a site bund for wastewater storage to contain 110% of the volume of the largest tank.

Activity	Parameter	Description
	1 stormwater retention basin per well pad	• Construction of a sediment basin to manage stormwater during wastewater storage.
	37 new groundwater monitoring / extraction bores (total spread across all sites)	• Drilling of up to 10 new bores at each of the 3 proposed E&A sites in Shenandoah South. • 5 new bores at Kyalla 117 N2 • Up to 2 new bores at Shenandoah N A. Also, use of existing groundwater bores on Kyalla 117 N2.
	Laydown areas: ~10.00 ha total	• Construction of a 2.5 ha laydown area at Shenandoah S B and S C. • Construction of a 5.0 ha laydown area at Shenandoah S2.
	Helipad -~1.50 ha total	• Maintenance and operation of the existing Kyalla 117 N2 helipad (0.5 ha) • Construction of a helipad at Shenandoah S B and S C each (0.5 ha)
	~18.00 ha total	• Construction of a 20 m x 2 km fence line and firebreak around the Shenandoah S2, S B and S C sites (4.00 ha per site) • Construction of a 20 m x 1 km fence line and firebreak around the Shenandoah NA site (2.00 ha) • Existing firebreak and fence line around the Kyalla 117 N2 site (~4.00 ha)
	~13.75 ha total	• Operation and maintenance of the existing / approved Kyalla 117 N2 gravel pits SSGP1 (2.5ha) • Operation and maintenance of the existing / approved Kyalla 117 N2 gravel pits SSGP2 (6.25ha) • Construction, operation and maintenance of a new gravel pit in the vicinity of Shenandoah S2 [SSGP3] (5 ha).
Site set-up and mobilisation to support the E&A wells	Camps	• The existing Kyalla EP 117 camp pad may be used to establish a centralised camp to reduce camp mobilisations / new disturbance across the step-out locations and work program. • Where a centralised camp is not used, a temporary main camp will be located on the newly constructed camp pad at Shenandoah S2, Shenandoah S B and Shenandoah N A. • Each main camp will typically have a ~75-person capacity. • A drilling mini-camp will also be located on the well pad during drilling to accommodate 24-hour operations (~8-person capacity).

Activity	Parameter	Description
	Chemical storage areas	• Set-up of chemical and material storage areas at each site.
	Material transportation	• Transportation, handling and storage of bulk chemicals, fuels and wastes.
	Drilling rig and equipment	• Set-up of drilling rig, including blow-out preventors, fluid systems and associated equipment such as pipe racks, power generation, offices, ablution blocks and cementing units.
	Frack spread	• Set-up of HFS equipment, completions rig and equipment, well testing equipment, and other associated equipment at each site.
	Traffic	• Approximately 44 traffic movements per day, per site during site demobilisation.
Camp operation	~75-person camp	• Operation of a main camp – either centralised (existing Kyalla 117 N2 site) and/or at Shenandoah S2, Shenandoah S B and Shenandoah N A. • Operation of drilling camp on each well pad during drilling.
E&A well drilling	15 horizontal E&A wells	• Drilling of 15 horizontal E&A wells across the Shenandoah S2, Shenandoah S B, Shenandoah S C and Kyalla 117 N2 sites, including the vertical pilot well (where required) and collection of reservoir quality data during drilling. This includes the approved drilling of the Shenandoah S 2H.
	1 vertical stratigraphic E&A well	• Drilling of 1 stratigraphic E&A well at Shenandoah NA, and collection of reservoir quality data during drilling.
Hydraulic fracturing	15 horizontal E&A wells	• HFS of 15 horizontal E&A wells across 4 sites – including the approved Shenandoah S 2H. • 10 – 60 stages per well depending on horizontal length (typically 30 stages). • Recycling of flowback wastewater for stimulation fluid makeup to reduce raw water use.
Well completion	15 E&A wells total	• Completion of 15 E&A wells across 4 E&A sites.
Well testing	Typically less than 90 days per well, up to 300 days	• Extended production testing of 16 wells across 4 sites (including the existing Shenandoah S 1H [5]); average well test duration is anticipated to be less than 90 days, with a maximum of 300 days well testing.

[5] The Kyalla 117 N2-Shenandoah S-1H as spudded on 1 August 2023 under the *Beetaloo Sub-basin Kyalla 117 N2 Multi-well Drilling, Hydraulic Fracturing and Well Testing Program EMP (ORI6-3)*, 22 February 2021.

Activity	Parameter	Description
		● Gas flaring in accordance with Code requirements and as per United States Environmental Protection Agency(US EPA) 40 Code of Federal Regulations(CFR) 63.11, with a flare tip combustion efficiency of 98%.
Well maintenance and monitoring	18 E&A wells total	● Maintenance and monitoring works on 18 wells (including well workovers) in accordance with approved WOMP(s) covering: ● Existing Kyalla 17 N2-1HExisting Shenandoah S 1H ● 15 horizontal E&A wells under this EMP ● Shenandoah NA
Build up testing	17 E&A wells total	● Build up testing to monitor the pressure build-up within each E&A well, including the existing Shenandoah S-1H, Kyalla 117 N2-1H and 15 horizontal E&A wells.
Well suspension and decommissioning [6]	18 E&A wells total	● Suspension and decommissioning (if required) of all wells covered in this EMP in accordance with the *Code of Practice: Onshore Petroleum Activities in the Northern Territory* (Code). The breakdown across sites is as follows: ● Existing Kyalla 17 N2-1H ● Existing Shenandoah S-1H ● 15 horizontal E&A wells under this EMP ● Shenandoah NA
Groundwater extraction (average)	~375 ML/year (approximately)	● Groundwater extraction under existing groundwater extraction licence (WEL GRF 10285). ● Tamboran will seek amendment to the existing WEL / apply for a new WEL to supplement future groundwater take. ● Where practicable, Tamboran will recycle flowback to minimise extraction.
Groundwater monitoring / extraction bores	37 new bores 4 existing bores on Kyalla 117 N2	● Tamboran currently has 4 groundwater bores at Kyalla 117 N2 (RN040896, RN041132, RN041136 and RN041137). These will continue to be operated and monitored. ● Up to 10 new bores will be installed at each of the 3 Shenandoah South sites. ● 5 new bores at Kyalla 117 N2 ● Up to 2 new bores at Shenandoah NA.
Environmental monitoring	All sites	● Monitoring activities (including groundwater, stormwater, soils, leak detection, seismicity and all other low impact ancillary data collection programs).

[6] Refer Footnote 3

Activity	Parameter	Description
On-site wastewater management to support ongoing E&A program	5 well sites	• Peak flowback storage volume of approximately 34 ML • On-site wastewater storage and treatment in accordance with Code. • Use of the drilling sump, enclosed wastewater storage tanks and wastewater treatment tanks to manage drilling and flowback wastewater. • Drill cuttings and flowback fluid quality testing in accordance with the Code. • Drilling waste storage – including centralised storage of drilling waste from other approved locations. • Disposal of drill cuttings subject to the outcomes of chemical analysis in accordance with clause C.4.1.2 of the Code. • On-site treatment of wastewater through evaporation or other alternative methods (such as enhanced evaporation or other mechanical water treatment options). • Recycling of flowback wastewater for stimulation fluid makeup to reduce raw water use. • Off-site disposal of flowback wastewater in accordance with the Waste Management and Pollution Control Act.

Gathering lines	~8.61 km
	(8.61 ha)
		• Construction and operation of wastewater gathering lines to a centralised wastewater treatment infrastructure located a Shenandoah S B (~10 m wide):
		  • Shenandoah S B to/from Shenandoah S C: 4.11 km (4.11 ha)
		  • Shenandoah S2 to/from Kyalla 117 N2: 4.5 km (4.5 ha)

Site decommissioning	All sites and associated infrastructure (access tracks, gravel pits, seismic lines etc.)	• Decommissioning and removal of all surface infrastructure and wastes from site including the removal of drilling sump, wastewater tanks, cellars, equipment, non-drilling waste, wastewater and all ancillary equipment.
Site demobilisation	All sites	• Demobilisation of exploration equipment, including camps, drilling rigs, HFS equipment, completion rigs, well testing equipment, wastewater storage tanks and various service provider equipment.

Activity	Parameter	Description
Seismic acquisition	~ 38 km (19.0 ha disturbance) ~ 39 km along existing access tracks (no additional disturbance)	● Seismic program to use 2 energy sources to evaluate optimal energy source type: vibroseis and seismic charges ● Civil construction of 3 x 2D seismic lines: ● Clearing of approximately 38 km of seismic lines with a 5 m cleared track width. ● Seismic lines to be weaved through vegetation to a path of least resistance. Slashing can be utilised in otherwise untraversable vegetation. Deviations in lines must be constructed in a way that is accessible by equipment/vehicles such as heavy-rigid body trucks (minimum 15 m turning radius). ● A small turning circle to be constructed at the end of each seismic line to allow equipment and vehicles to exit. ● A 250 m buffer /deviation from either side of the centreline pre-plot data where required to avoid any unsuitable terrain or obstacles. ● Estimated maximum surface disturbance of 19.0 ha, noting that all efforts will be deployed to avoid clearing. ● Estimated groundwater use ~0.5 – 1.0 ML. ● Construction of 2 fenced areas 12 m(L) x 9 m (W) for explosive storage magazines (AS2187) along cleared lines: ● Fenced areas to be constructed as per AS1725. ● Gates minimum 4 m opening. ● Surface within the magazine storage area to be smooth and free of debris, loose zones and soft spots. ● Surface compaction ≥ 100 kPa. ● Shot hole drilling for 400 x 20 m depth holes @ 80 mm – 100 mm outer diameter at a shot hole interval of 60 m. ● Low disturbance node deployment. ● Seismic acquisition, including vibroseis deployment, charge detonation and data collection. ● Rehabilitation of cleared lines and shot holes by respreading any windrowed soil and reinstating vegetation from stockpiled area back across the seismic line.
Total disturbance and rehabilitation (approx.)	139.66 ha	Final rehabilitation activities to return all sites back to a safe, stable and non-polluting form consistent with pre-disturbed condition: ● 119.26 ha new clearing across all sites, including seismic. ● 20.40 ha approved clearing across Kyalla 117 N2site.

Description of the existing environment

The Shenandoah South E&A program is located on EP 117 and EP 98, which encompasses the Shenandoah, Shenandoah East, Hayfield and Beetaloo pastoral stations.

The existing Kyalla 117 N2 site was constructed in 2019 under the approved *Beetaloo Sub-basin Kyalla 117 N2 Civil Construction EMP*. The existing Kyalla 117 N2 disturbance footprint including well pad is shown in Figure 2. Included in the proposed regulated activities is an expansion of the exploration site to accommodate 2 new E&A wells.

Land condition assessments across the Kyalla 117 N2 site and Shenandoah South E&A program, include data from previous baseline assessments completed in 2004, 2006 (HLA, 2006; 2006c), 2010, 2014, 2016, 2018, 2021 and the most recent March-April 2023 survey (AECOM, 2011; 2014; 2016, 2018, 2021 and 2023). These assessments include a review of the physical, natural and cultural heritage environment.

The Shenandoah South E&A program falls within the Sturt Plateau Bioregion. The bioregion is characterised by undulating plains on sandstone with predominantly neutral sandy red and yellow earth soils. Dominant vegetation is eucalypt woodland, which include 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.

A description of the existing environment for the new sites (e.g. Shenandoah S2, Shenandoah S B, Shenandoah S C, and Shenandoah N A) is provided in section 4 and Appendix K. Figure 3 provides an overview of vegetation communities that occur along the seismic lines and within the disturbance areas of the Shenandoah S B and Shenandoah S C Shenandoah S2 and Shenandoah N A well pad areas. [7]

A summary of the existing environment in which the 4 new well pads and 2D seismic acquisition will be located is provided in Table 2, Table 3, Table 4 and Table 5.

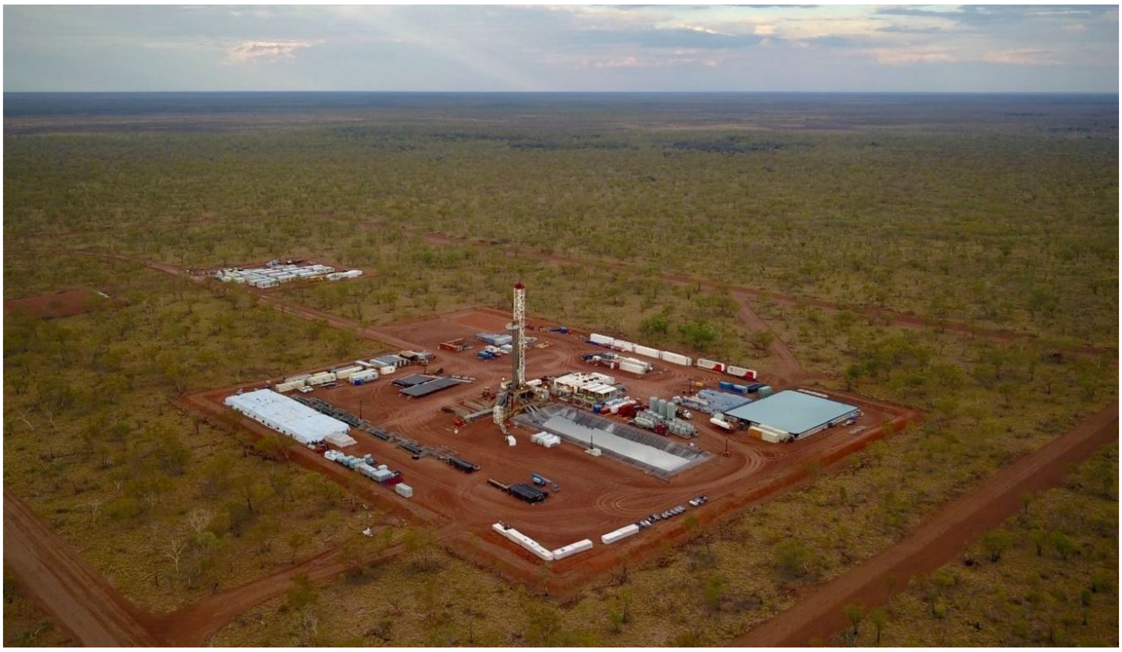


Figure 2: Existing Kyalla 117 N2 disturbance footprint includingwell pad upon which the approved 3 approved E&A wells and 2 new E&A wells and associated activities will be located (image taken during drilling of Kyalla 117 N2-1H)

[7] Includes surveyed areas not covered by this EMP.

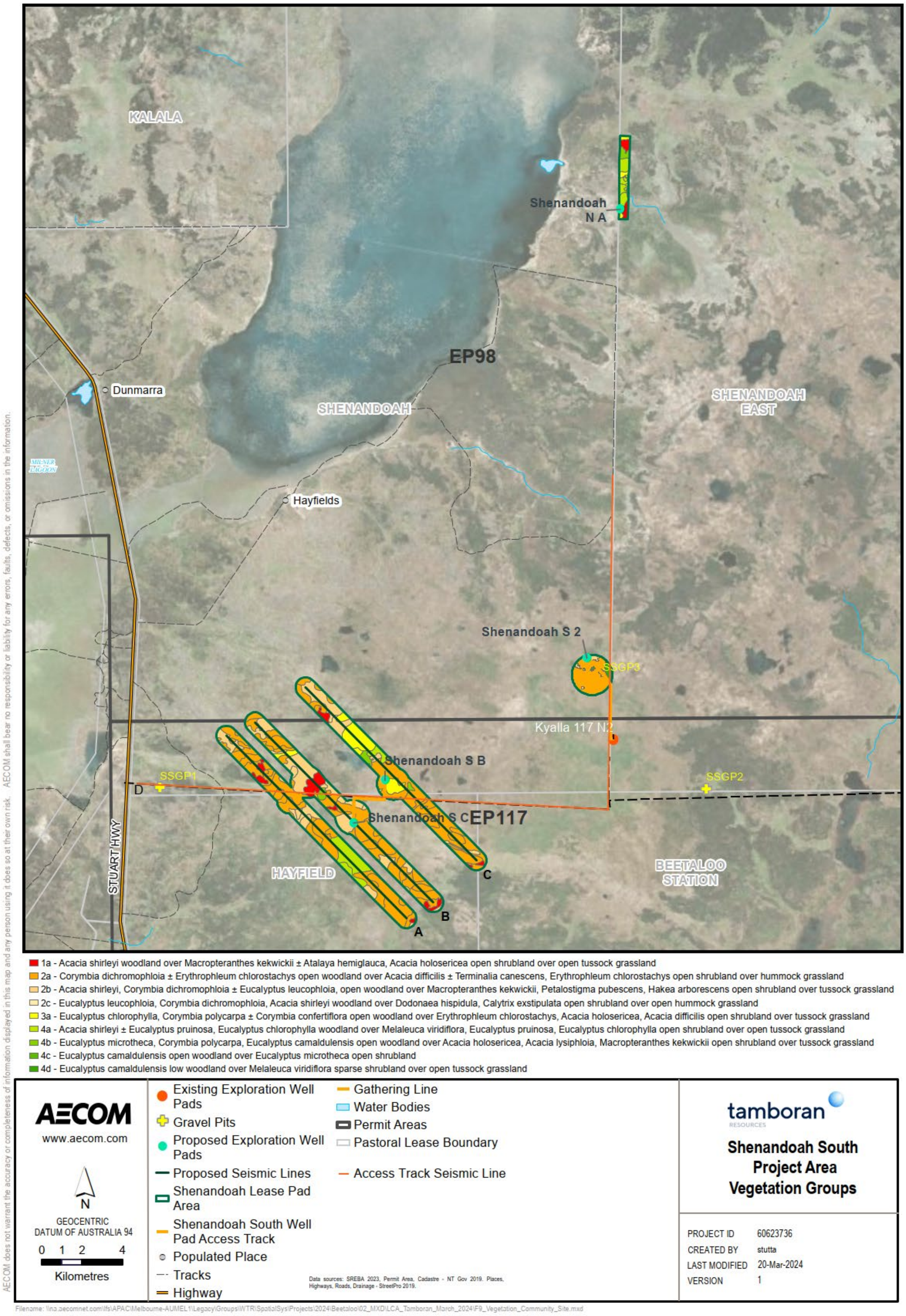


Figure 3: Vegetation communities for new sites

Table 2: Summary of existing environment and surrounds Shenandoah S2

<table>
<tr><th colspan="2">Shenandoah S2</th><th colspan="2">Survey photos of the vegetation/habitat of the surrounding environment</th></tr>
<tr><td>Location</td><td>GDA94, Zone 53, 355291E, 8140676N</td><td rowspan="4"></td><td rowspan="4"></td></tr>
<tr><td>Landform and soil</td><td>5YR 3/4 dark reddish brown (upper) to 5YR 3/3 dark reddish brown clay loam, sandy. Well drained on flat surface, no slope (0%).</td></tr>
<tr><td>Vegetation community</td><td>2a: Corymbia dichromophloia ± Erythrophleum chlorostachys open woodland over Acacia difficilis ± Terminalia canescens, Erythrophleum chlorostachys open shrubland over hummock grassland</td></tr>
<tr><td>Vegetation description</td><td>Corymbia dichromophloia ± Erythrophleum chlorostachys mid high open woodland, over Acacia difficilis ± Terminalia canescens, Erythrophleum chlorostachys mid high open shrubland, over Triodia bitextura, Aristida hygrometrica, Chrysopogon fallax mid high hummock grassland</td></tr>
<tr><td>Dominant flora species</td><td>Corymbia dichromophloia, Erythrophleum chlorostachys
Erythrophleum chlorostachys, Acacia difficilis, Terminalia canescens
Triodia bitextura</td><td rowspan="2"></td><td rowspan="2"></td></tr>
<tr><td>Habitat condition</td><td>Moderate - Common tree hollows and falling logs. Mistletoe and flowering plants absent. Shallow leaf litter. Termite mounds: Nil. Fire damage > 2 years ago. No erosion. Minor cattle impacts. Ground cover: 55% vegetation, 2% leaf litter, 43% bare.</td></tr>
<tr><td>Weeds</td><td colspan="3">No Weeds of National Significance present.</td></tr>
<tr><td>Potential listed threatened species (Strategic Regional Environmental and</td><td colspan="3">Northern Shrike-tit (Falcunculus frontatus whitei), Gouldian Finch (Erythrura gouldiae), Plains Death Adder (Acanthophis hawkei), Yellow Spotted Monitor (Varanus panoptes), Grey Falcon (Falco hypoleucos), Common Brushtail Possum (Trichosurus vulpecula arnhemensis), Mertens' Water Monitor (Varanus mertensi)</td></tr>
</table>

Shenandoah S2	**Survey photos of the vegetation/habitat of the surrounding environment**
Baseline Assessment(SREBA) 2023)	
Hydrogeology	Groundwater resources and use is primarily from the Cambrian Limestone Aquifers (the Anthony Lagoon Formation and Gum Ridge Formation) with the shallower undifferentiated Cretaceous or perched alluvium systems being unsaturated.

Table 3:Summary of existing environment and surrounds Shenandoah S B

Shenandoah S B		**Survey photos of the vegetation/habitat of the surrounding environment**	
Location	GDA94, Zone 53, 345579E, 8135469N		
Landform and soil	Dark grey; clay loam sandy in upper 0.5 m. Light medium clay to 0.7 m. No surface gravels. Well drained, potential for standing water following rainfall on a simple slope <1%.		
Vegetation community	**3a:** *Corymbia polycarpa, Eucalyptus chlorophylla, Acacia shirleyi* mid-high open woodland.		
Vegetation description	*Corymbia polycarpa, Eucalyptus chlorophylla, Acacia shirleyi* mid high open woodland over *Acacia difficilis, Acacia gonoclada, Macropteranthes kekwickii* mid high open shrubland over *Aristida contorta, Aristida hygrometrica* mid high open tussock grassland.		
Dominant flora species	*Corymbia polycarpa, Eucalyptus chlorophylla, Acacia shirleyi* *Acacia difficilis, Acacia gonoclada, Macropteranthes kekwickii* *Aristida contorta, Aristida hygrometrica*		
Habitat condition	Moderate -Scattered tree hollows, fallen logs and flowering plants common. Mistletoe and leaf litter absent. Fire damage low > 2 years ago. No erosion. Minor cattle impacts. Termite mounds sparse.Ground cover: 15% vegetation, 10% litter, 25% bare soil, 50% gravel.		
Weeds	No Weeds of National Significance present.		
Potential listed threatened species (SREBA 2023)	Northern Shrike-tit (*Falcunculus frontatus whitei*), Gouldian Finch (*Erythrura gouldiae*), Plains Death Adder (*Acanthophis hawkei*), Yellow Spotted Monitor (*Varanus panoptes*), Grey Falcon (*Falco hypoleucos*), Common Brushtail Possum (*Trichosurus vulpecula arnhemensis*), Mertens' Water Monitor (*Varanus mertensi*)		
Hydrogeology	Groundwater resources and use is primarily from the Cambrian Limestone Aquifers (the Anthony Lagoon Formation and Gum Ridge Formation) with the shallower undifferentiated Cretaceous or perched alluvium systems being unsaturated.		

Table 4: Summary of existing environment and surrounds Shenandoah S C

Shenandoah S C		**Survey photos of the vegetation/habitat of the surrounding environment**
Location	GDA94, Zone 53, 343472E, 8133331N	 
Landform and soil	Dark reddish brown silty clay loam in upper 0.3 m. Progressing to clay. No surface gravels. Well drained on a simple slope <1%.	
Vegetation community	**2b:** *Acacia shirleyi, Corymbia dichromophloia ± Eucalyptus leucophloia, C. polycarpa* mid-high open woodland	
Vegetation description	*Acacia shirleyi, Ventilago viminalis* mid high open woodland over *Macropteranthes kekwickii, Terminalia volucris, Eucalyptus chlorophylla* mid high open shrubland over *Sorghum intrans, Eulalia aurea, Chrysopogon fallax* mid high tussock grassland.	
Dominant flora species	*Acacia shirleyi*, *Ventilago viminalis* *Macropteranthes kekwickii*, *Terminalia volucris*, *Eucalyptus chlorophylla* *Sorghum intrans*, *Eulalia aurea*, *Chrysopogon fallax*	 
Habitat condition	Moderate - Tree hollows, Mistletoe and leaf litter absent. Fallen logs and flowering plants common. Fire damage moderate > 2 years ago. No erosion. Minor cattle impacts. Termite mounds spares. Ground cover: 40% vegetation, 25% litter, 25% bare soil, 10% gravel.	
Weeds	No Weeds of National Significance present.	
Potential listed threatened species (SREBA 2023)	Northern Shrike-tit (*Falcunculus frontatus whitei*), Gouldian Finch (*Erythrura gouldiae*), Plains Death Adder (*Acanthophis hawkei*), Yellow Spotted Monitor (*Varanus panoptes*), Grey Falcon (*Falco hypoleucos*), Common Brushtail Possum (*Trichosurus vulpecula arnhemensis*), Mertens' Water Monitor (*Varanus mertensi*)	
Hydrogeology	Groundwater resources and use is primarily from the Cambrian Limestone Aquifers (the Anthony Lagoon Formation and Gum Ridge Formation) with the shallower undifferentiated Cretaceous or perched alluvium systems being unsaturated.	

Table 5: Summary of existing environment and surrounds Shenandoah N A

Shenandoah N A		**Survey photos of the vegetation/habitat of the surrounding environment**
Location	GDA94, Zone 53, 356697E, 8163759N	 
Landform and soil	5YR 4/1. dark grey sandy loam in upper 0.4 m. No surface gravels. Well drained, on a simple slope <1%.	
Vegetation community	**1a:** *Acacia shirleyi* mid high woodland	
Vegetation description	*Acacia shirleyi* mid high woodland over *Macropteranthes kekwickii, Atalaya hemiglauca, Acacia holosericea* mid high open shrubland over *Fimbristylis sp., Brachyachne convergens, Aristida contorta* mid high open tussock grassland.	
Dominant flora species	*Acacia shirleyi* *Macropteranthes kekwickii, Atalaya hemiglauca, Acacia holosericea* *Fimbristylis sp., Brachyachne convergens, Aristida contorta*	 
Habitat condition	Moderate - tree hollows, Mistletoe and leaf litter absent, fallen logs and flowering plants common. Fire damage moderate >2years ago. No erosion. Moderate cattle impacts. Termite mounds sparse. Ground cover: 70% vegetation, 5% litter, 10% bare soil, 15% gravel.	
Weeds	No Weeds of National Significance present.	
Potential listed threatened species (SREBA 2023)	Northern Shrike-tit (*Falcunculus frontatus whitei*), Gouldian Finch (*Erythrura gouldiae*), Plains Death Adder (*Acanthophis hawkei*), Yellow Spotted Monitor (*Varanus panoptes*), Grey Falcon (*Falco hypoleucos*), Common Brushtail Possum (*Trichosurus vulpecula arnhemensis*), Mertens' Water Monitor (*Varanus mertensi*)	
Hydrogeology	Groundwater resources and use is primarily from the Cambrian Limestone Aquifers (the Anthony Lagoon Formation and Gum Ridge Formation) with the shallower undifferentiated Cretaceous or perched alluvium systems being unsaturated.	

Chemical risk assessment

Chemical risk assessments have been completed for all chemicals to be used in drilling and HFS. All chemicals were considered low concern when standard chemical handling, storage and disposal practices were applied (Appendix E and Appendix E.1). The chemicals and estimated quantities that may be added to the HFS proppant (sand) are also shown in Table 6.

Table 6: Chemicals that may be added to the proppant during stimulation activities and held on each well pad, based on 3 wells per pad

Material name	Typical volume	Maximum volume	Unit	Storage area	Chemical composition	CAS Number	Chemical risk assessment report
Acetic acid - 60% pH control	3,000	9,000	L	Stimulation chemical storage area	Acetic acid	64-19-7	AECOM, 2024 – Appendix E EHS Support, (2023) – Appendix E.1
BE-9 biocide	17,000	17,000	L	Stimulation chemical storage area	Tributyl tetradecyl phosphonium chloride	81741-28-8	AECOM, 2024 – Appendix
Caustic soda liquid pH control/ buffer	15,000	45,000	L	Stimulation chemical storage area	Sodium hydroxide	1310-73-2	AECOM, 2024 – Appendix E EHS Support, (2023) – Appendix E.1
DCA-11001 breaker activator	5,000	15,000	L	Stimulation chemical storage area	Diethanolamine	111-42-2	AECOM, 2024 – Appendix E
DCA-13002 breaker	300	900	kg	Stimulation chemical storage area	Sodium persulfate	7775-27-1	AECOM, 2024 – Appendix E
DCA-13003 breaker	10,000	30,000	L	Stimulation chemical storage area	Chlorous acid, sodium salt Sodium chloride	7758-19-2 7647-14-5	AECOM, 2024 – Appendix E
DCA-16001 clay stabiliser	42,000	126,000	L	Stimulation chemical storage area	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	Proprietary	AECOM, 2024 – Appendix E
DCA-17001 corrosion inhibitor	1,000	3,000	L	Stimulation chemical storage area	Diethylene glycol Cinnamaldehyde Amine oxides, cocoalkyldimethyl Methanol Benzaldehyde Alcohols, C12-16, ethoxylated	111-46-6 104-55-2 61788-90-7 67-56-1 100-52-7 68551-12-2 7681-82-5	AECOM, 2024 – Appendix E

Material name	Typical volume	Maximum volume	Unit	Storage area	Chemical composition	CAS Number	Chemical risk assessment report
					Sodium iodide		
DCA-19001 crosslinker	600	1,800	kg	Stimulation chemical storage area	Disodium octaborate tetrahydrate	12008-41-2	AECOM, 2024 – Appendix E
DCA-19002 crosslinker	10,000	30,000	L	Stimulation chemical storage area	Ulexite Ethylene glycol Crystalline silica, quartz	1319-33-1 107-21-1 14808-60-7	AECOM, 2024 – Appendix E
DCA-23001 friction reducer	5,000	15,000	kg	Stimulation chemical storage area	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	Proprietary	AECOM, 2024 – Appendix E
DCA-23003 friction reducer	18,000	54,000	L	Stimulation chemical storage area	Hydrotreated light petroleum distillate Ethoxylated branched C13 alcohol Sodium diacetate	64742-47-8 78330-21-9 126-96-5	AECOM, 2024 – Appendix E
DCA-25005 gelling agent	35,000	105,00	kg	Stimulation chemical storage area	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	Proprietary	AECOM, 2024 – Appendix E
DCA-30001 scale Inhibitor	15,000	45,000	L	Stimulation chemical storage area	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	Proprietary	AECOM, 2024 – Appendix E

Material name	Typical volume	Maximum volume	Unit	Storage area	Chemical composition	CAS Number	Chemical risk assessment report
DCA-32002 surfactant	15,000	45,000	L	Stimulation chemical storage area	Alcohols, C6-C12, ethoxylated propoxylated Alcohols, C10-C16, ethoxylated propoxylated	68937-66-6 69227-22-1	AECOM, 2024 – Appendix E
DCA-32014 surfactant	200	600	L	Stimulation chemical storage area	Hydrotreated light petroleum distillate Ethanol Fatty acids, tall-oil, ethoxylated C12-C15 Ethoxylated alcohols Amides, tall-oil fatty, N,N-bis(hydroxyethyl) Butyl alcohol Methanol	64742-47-8 64-17-5 61791-00-2 68131-39-5 68155-20-4 71-36-3 67-56-1	AECOM, 2024 – Appendix E
FE-2 buffer	200	600	kg	Stimulation chemical storage area	Citric acid	77-92-9	AECOM, 2024 – Appendix E
Hydrochloric acid - 32%	50,000	150,000	L	Stimulation chemical storage area	Hydrochloric acid (32%)	7647-01-0	AECOM, 2024 – Appendix E
Alcohols, C11-14-iso-, C13-rich, ethoxylated- surfactant	5,285	15,855	L	Stimulation chemical storage area	Alcohols, C11-14-iso-, C13-rich, ethoxylated	78330-21-9	AECOM, 2024 – Appendix E EHS Support, (2023) – Appendix E.1
Sodium (C14-16) olefin sulfonate - surfactant	4,658	13,974	L	Stimulation chemical storage area	Sodium (C14-16) olefin sulfonate	68439-57-6	EHS Support, (2023) – Appendix E.1
Diisobutyl glutarate - plasticiser	627	1,881	L	Stimulation chemical storage area	Diisobutyl glutarate	71195-64-7	EHS Support, (2023) – Appendix E.1
Diisobutyl succinate - plasticiser	209	627	L	Stimulation chemical storage area	Diisobutyl succinate	925-06-4	EHS Support, (2023) – Appendix E.1

Material name	Typical volume	Maximum volume	Unit	Storage area	Chemical composition	CAS Number	Chemical risk assessment report
Diisobutyl adipate- plasticiser	179	537	L	Stimulation chemical storage area	Diisobutyl adipate	141-04-8	EHS Support, (2023) – Appendix E.1
Sodium thiosulphate- stabilising agent	4,763	14,289	L	Stimulation chemical storage area	Sodium thiosulphate	7772-98-7	EHS Support, (2023) – Appendix E.1
Sodium sulphate stabilising agent	913	2,739	L	Stimulation chemical storage area	Sodium sulphate	7757-82-6	AECOM, 2024 – Appendix E EHS Support, (2023) – Appendix E.1
Sodium sulphite stabilising agent	794	2,382	L	Stimulation chemical storage area	Sodium sulphite	7757-83-7	AECOM, 2024 – Appendix E EHS Support, (2023) – Appendix E.1
Ethylene glycol- crosslinker	5,112	15,336	L	Stimulation chemical storage area	Ethylene glycol	107-21-1	AECOM, 2024 – Appendix E EHS Support, (2023) – Appendix E.1
Choline chloride- clay stabiliser	10,301	30,903	L	Stimulation chemical storage area	Choline chloride	67-48-1	AECOM, 2024 – Appendix E EHS Support, (2023) – Appendix E.1
Glutaraldehyde- biocide	14,930	44,790	L	Stimulation chemical storage area	Glutaraldehyde	111-30-8	AECOM, 2024 – Appendix E EHS Support, (2023) – Appendix E.1
Ammonium sulphate- breaker	4,479	13,491	L	Stimulation chemical storage area	Ammonium sulphate	7783-20-2	AECOM, 2024 – Appendix E EHS Support, (2023) – Appendix E.1
Polyacrylamide- friction reducer	4,479	13,491	L	Stimulation chemical storage area	Polyacrylamide	25085-02-3	AECOM, 2024 – Appendix E EHS Support, (2023) – Appendix E.1
Sodium polyacrylate- gelling agent	746	2,238	L	Stimulation chemical storage area	Sodium polyacrylate	9003-04-7	AECOM, 2024 – Appendix E EHS Support, (2023) – Appendix E.1

Material name	Typical volume	Maximum volume	Unit	Storage area	Chemical composition	CAS Number	Chemical risk assessment report
Sodium bisulfite- stabiliser	149	447	L	Stimulation chemical storage area	Sodium bisulfite	7631-90-5	AECOM, 2024 – Appendix E EHS Support, (2023) – Appendix E.1
Alkyl alcohol- surfactant	149	447	L	Stimulation chemical storage area	Alkyl alcohol	56-81-5	EHS Support, (2023) – Appendix E.1
2-Propenoic acid, homopolymer, ammonium salt- biocide	149	447	L	Stimulation chemical storage area	2-Propenoic acid, homopolymer, ammonium salt	9003-03-6	AECOM, 2024 – Appendix E EHS Support, (2023) – Appendix E.1
Potassium persulfate-braker	149	447	L	Stimulation chemical storage area	Potassium persulfate	7727-21-1	AECOM, 2024 – Appendix E EHS Support, (2023) – Appendix E.1
2-Ethoxy-naphthalene- surfactant	149	447	L	Stimulation chemical storage area	2-Ethoxy-naphthalene	93-18-5	EHS Support, (2023) – Appendix E.1
Sodium gluconate- stabiliser	8,576	25,728	L	Stimulation chemical storage area	Sodium gluconate	527-07-1	EHS Support, (2023) – Appendix E.1
Boric acid- crosslinker	4,288	12,864	L	Stimulation chemical storage area	Boric acid	10043-35-3	EHS Support, (2023) – Appendix E.1
Potassium hydroxide- pH control	10,745	32,235	L	Stimulation chemical storage area	Potassium hydroxide	1310-58-3	AECOM, 2024 – Appendix E EHS Support, (2023) – Appendix E.1
Mannanase- crosslinker	2	6	L	Stimulation chemical storage area	Mannanase	37288-54-3	EHS Support, (2023) – Appendix E.1
Ammonium persulphate- breaker	7,451	22,353	L	Stimulation chemical storage area	Ammonium persulphate	7727-54-0	AECOM, 2024 – Appendix E EHS Support, (2023) – Appendix E.1
Talc- buffer	384	1,152	L	Stimulation chemical storage area	Talc	14807-96-6	AECOM, 2024 – Appendix E EHS Support, (2023) – Appendix E.1

Material name	Typical volume	Maximum volume	Unit	Storage area	Chemical composition	CAS Number	Chemical risk assessment report
Sodium bromate- breaker	50,441	151,323	L	Stimulation chemical storage area	Sodium bromate	7789-38-0	AECOM, 2024 – Appendix E EHS Support, (2023) – Appendix E.1
Hepta sodium phosphonate- Emulsifier	3,176	9,528	L	Stimulation chemical storage area	Hepta sodium phosphonate	22042-96-2	AECOM, 2024 – Appendix E EHS Support, (2023) – Appendix E.1
Distillates, hydrotreated light- friction reducer	54,231	162,693	L	Stimulation chemical storage area	Distillates, hydrotreated light	64742-47-8	AECOM, 2024 – Appendix E EHS Support, (2023) – Appendix E.1
Guar gum- viscosity regulator	15,141	45,423	L	Stimulation chemical storage area	Guar gum	9000-30-0	AECOM, 2024 – Appendix E EHS Support, (2023) – Appendix E.1
Poly-oxyethylene nonylphenol ether- surfactant	4,466	13,398	L	Stimulation chemical storage area	Poly-oxyethylene nonylphenol ether	9016-45-9	EHS Support, (2023) – Appendix E.1
Quaternary ammonium compounds, bis(hydrogenated tallow alkyl)dimethyl, salts with bentonite- biocide	4,466	13,398	L	Stimulation chemical storage area	Quaternary ammonium compounds, bis(hydrogenated tallow alkyl)dimethyl, salts with bentonite	68953-58-2	AECOM, 2024 – Appendix E EHS Support, (2023) – Appendix E.1
1,6-Hexanediol- cross linker	447	1,341	L	Stimulation chemical storage area	1,6-Hexanediol	629-11-8	EHS Support, (2023) – Appendix E.1
Hydrochloric acid- pH control	44,715	134,145	L	Stimulation chemical storage area	Hydrochloric acid	7647-01-0	AECOM, 2024 – Appendix E EHS Support, (2023) – Appendix E.1
N-Benzyl-alkylpyridinium chloride- pH control	28	84	L	Stimulation chemical storage area	N-Benzyl-alkylpyridinium chloride	68909-18-2	EHS Support, (2023) – Appendix E.1

Material name	Typical volume	Maximum volume	Unit	Storage area	Chemical composition	CAS Number	Chemical risk assessment report
Formic acid- corrosion inhibitor	38	114	L	Stimulation chemical storage area	Formic acid	64-18-6	EHS Support, (2023) – Appendix E.1
Sodium erythorbate- scaler prohibitor	334	1,002	L	Stimulation chemical storage area	Sodium erythorbate	6381-77-7	AECOM, 2024 – Appendix E EHS Support, (2023) – Appendix E.1
Citric acid- pH control	15,878	47,634	L	Stimulation chemical storage area	Citric acid	77-92-9	AECOM, 2024 – Appendix E EHS Support, (2023) – Appendix E.1
Acetic acid- pH control	15,878	47,634	L	Stimulation chemical storage area	Acetic acid	64-19-7	AECOM, 2024 – Appendix E EHS Support, (2023) – Appendix E.1
Isopropanol- clay management	83	249	L	Stimulation chemical storage area	Isopropanol	67-63-0	AECOM, 2024 – Appendix E EHS Support, (2023) – Appendix E.1
Ethoxylated C12-C16 alcohol - surfactant	57	171	L	Stimulation chemical storage area	Ethoxylated C12-C16 alcohol	68551-12-2	AECOM, 2024 – Appendix E EHS Support, (2023) – Appendix E.1
Ethoxylated decanol - surfactant	19	57	L	Stimulation chemical storage area	Ethoxylated decanol	26183-52-8	AECOM, 2024 – Appendix E EHS Support, (2023) – Appendix E.1
Cinnamaldehyde- biocide	57	171	L	Stimulation chemical storage area	Cinnamaldehyde	104-55-2	AECOM, 2024 – Appendix E EHS Support, (2023) – Appendix E.1
Ethoxylated tallow alkyl amine - surfactant	9	27	L	Stimulation chemical storage area	Ethoxylated tallow alkyl amine	61791-26-2	EHS Support, (2023) – Appendix E.1
Methanol- corrosion inhibitor	2	6	L	Stimulation chemical storage area	Methanol	67-56-1	AECOM, 2024 – Appendix E EHS Support, (2023) – Appendix E.1

Material name	Typical volume	Maximum volume	Unit	Storage area	Chemical composition	CAS Number	Chemical risk assessment report
Polyacrylamide - friction reducer	49,093	147,279	L	Stimulation chemical storage area	Polyacrylamide	9003-05-08	AECOM, 2024 – Appendix E EHS Support, (2023) – Appendix E.1
Polyethylene glycol trimethylnonyl ether - clay manager	87	261	L	Stimulation chemical storage area	Polyethylene glycol trimethylnonyl ether	127087-87-0	EHS Support, (2023) – Appendix E.1
Water in additive- stabiliser	66,804	200,412	L	Stimulation chemical storage area	Water in additive	7732-18-5	EHS Support, (2023) – Appendix E.1
Potassium sorbate food grade- corrosion inhibitor	14	42	L	Stimulation chemical storage area	Potassium sorbate	24634-61-5	EHS Support, (2023) – Appendix E.1
Mannanase (Mannan endo-1,4-beta-mannosidase)- cross linker	2	6	L	Stimulation chemical storage area	Mannanase (Mannan endo-1,4-beta-mannosidase)	37288-54-3	EHS Support, (2023) – Appendix E.1
Nonoxynol-9- surfactant	9	27	L	Stimulation chemical storage area	Nonoxynol-9	26571-11-9	EHS Support, (2023) – Appendix E.1
2-Ethylhexanol PO/EO polymer- stabiliser	9	27	L	Stimulation chemical storage area	2-Ethylhexanol PO/EO polymer	64366-70-7	EHS Support, (2023) – Appendix E.1
Corn oil- friction reducer	662	1,986	L	Stimulation chemical storage area	Corn oil	8001-30-7	EHS Support, (2023) – Appendix E.1
Sodium chloride- weighting agent	15,000	45,000	kg	Completion chemical storage area	Sodium chloride	7647-14-5	AECOM, 2024 – Appendix E
ALDACIDE G biocide	500	1,500	L	Completion chemical storage area	Glutaraldehyde Methanol	111-30-8 67-56-1	AECOM, 2024 – Appendix E
OXYGON Oxygen scavenger	100	300	kg	Completion chemical storage area	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	Proprietary	AECOM, 2024 – Appendix E

Material name	Typical volume	Maximum volume	Unit	Storage area	Chemical composition	CAS Number	Chemical risk assessment report
BARACOR 100 corrosion inhibitor	2,000	6,000	L	Completion chemical storage area	Ethanol, 2,2'-oxybis-, reaction products with ammonia, morpholine derivatives residues Methanol Nitrilotriacetic acid, trisodium salt monohydrate	68909-77-3 67-56-1 5064-31-3	AECOM, 2024 – Appendix E
Sodium Hypochlorite 10 – 30% cleaner	10,000	30,000	L	Completion chemical storage area	Sodium hypchlorite Sodium Hydroxide Water	7681-52-9 1310-73-2 7732-18-5	AECOM, 2024 – Appendix E
CON-DET wetting agent	50	150	kg	Drilling chemical storage area	Amides, coco, N,N-bis (hydroxyethyl) Benzenesulfonic acid, dimethyl-, sodium salt Isopropanol Potassium pyrophosphate Potassium hydroxide	68603-42-9 1300-72-7 67-63-0 7320-34-5 1310-58-3	AECOM, 2024 – Appendix E
SAPP- sodium acid phosphate cement treatment	50	150	kg	Drilling chemical storage area	DISODIUM PYROPHOSPHATE	7758-16-9	AECOM, 2024 – Appendix E
Bentonite- lubricant	3,000	9,000	kg	Drilling chemical storage area	Crystalline silica, quartz Crystalline silica, cristobalite Crystalline silica, tridymite	14808-60-7 14464-46-1 15468-32-3	AECOM, 2024 – Appendix E
Caustic Soda-pH control	1,400	4,200	kg	Drilling chemical storage area	Sodium hydroxide	1310-73-2	AECOM, 2024 – Appendix E

Material name	Typical volume	Maximum volume	Unit	Storage area	Chemical composition	CAS Number	Chemical risk assessment report
EZ MUD DP or EZ MUD Liquid- drilling mud	2000	6,000	kg	Drilling chemical storage area	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	Proprietary	AECOM, 2024 – Appendix E
ALDACIDE G biocide	336	1,008	kg	Drilling chemical storage area	Glutaraldehyde Methanol	111-30-8 67-56-1	AECOM, 2024 – Appendix E
STOPPIT loss of circulation material	1,000	3,000	kg	Drilling chemical storage area	Crystalline silica, quartz	14808-60-7	AECOM, 2024 – Appendix E
Soda Ash- drill mud conditioner	350	1,050	kg	Drilling chemical storage area	Sodium carbonate	497-19-8	AECOM, 2024 – Appendix E
BARACOR 100 corrosion inhibitor	250	750	kg	Drilling chemical storage area	Ethanol, 2,2'-oxybis-, reaction products with ammonia, morpholine derivatives residues Methanol Nitrilotriacetic acid, trisodium salt monohydrate	68909-77-3 67-56-1 5064-31-3	AECOM, 2024 – Appendix E
Sodium chloride (flossy salt)- weighting agent and formation inhibitor	96,000	288,000	kg	Drilling chemical storage area	Sodium chloride	7647-14-5	AECOM, 2024 – Appendix E
Barite- weighting agent	500	1,500	kg	Drilling chemical storage area	Crystalline silica	14808-60-7	AECOM, 2024 – Appendix E
BARACARB loss of circulation material	500	1,500	kg	Drilling chemical storage area	Crystalline silica, quartz	14808-60-7	AECOM, 2024 – Appendix E
Citric acid- pH control	500	1,500	kg	Drilling chemical storage area	Citric acid	5949-29-1	AECOM, 2024 – Appendix E

Material name	Typical volume	Maximum volume	Unit	Storage area	Chemical composition	CAS Number	Chemical risk assessment report
BARADEFOAM HP drilling fluid/foam	500	1,500	kg	Drilling chemical storage area	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	Proprietary	AECOM, 2024 – Appendix E
Sodium bicarbonate- pH buffer	500	1,500	kg	Drilling chemical storage area	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	Proprietary	AECOM, 2024 – Appendix E
PERFORMATROL- polymer fluid system	500	1,500	kg	Drilling chemical storage area	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	Proprietary	AECOM, 2024 – Appendix E
SOURSCAV- mud additive treat H2S contamination	500	1,500	kg	Drilling chemical storage area	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	Proprietary	AECOM, 2024 – Appendix E
DRIL-N-SLIDE- casing lubricant	500	1,500	kg	Drilling chemical storage area	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	Proprietary	AECOM, 2024 – Appendix E

Material name	Typical volume	Maximum volume	Unit	Storage area	Chemical composition	CAS Number	Chemical risk assessment report
STEELSEAL- corrosion inhibitor	500	1,500	kg	Drilling chemical storage area	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	Proprietary	AECOM, 2024 – Appendix E
BARAZAN D or BARAZAN D PLUS- viscosity increaser	4,150	12,450	kg	Drilling chemical storage area	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	Proprietary	AECOM, 2024 – Appendix E
PAC L loss of circulation material	2,300	6,900	kg	Drilling chemical storage area	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	Proprietary	AECOM, 2024 – Appendix E
Potassium chloride- weighting agent and formation inhibitor	22,500	67,500	kg	Drilling chemical storage area	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	Proprietary	AECOM, 2024 – Appendix E
QUIK-FREE – drilling additive	500	1,500	kg	Drilling chemical storage area	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	Proprietary	AECOM, 2024 – Appendix E

Material name	Typical volume	Maximum volume	Unit	Storage area	Chemical composition	CAS Number	Chemical risk assessment report
BAROFIBRE, BAROFIBRE super fine and BAROFIBRE coarse loss of circulation material	500	1,500	kg	Drilling chemical storage area	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	Proprietary	AECOM, 2024 – Appendix E
BaraBlend-657 Loss of circulation material	500	1,500	kg	Drilling chemical storage area	Crystalline silica, quartz	14808-60-7	AECOM, 2024 – Appendix E
N-DRIL HT PLUS filtration control additive	500	1,500	kg	Drilling chemical storage area	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	Proprietary	AECOM, 2024 – Appendix E
DEXTRID LTE filtration control additive	4,600	13,800	kg	Drilling chemical storage area	Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	AECOM, 2024 – Appendix E
BARABUF pH buffer	500	1,500	kg	Drilling chemical storage area	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	Proprietary	AECOM, 2024 – Appendix E
BDF 933 or BaraLube W-933 drilling lubricant	864	2,592	kg	Drilling chemical storage area	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	Proprietary	AECOM, 2024 – Appendix E

Material name	Typical volume	Maximum volume	Unit	Storage area	Chemical composition	CAS Number	Chemical risk assessment report
BAROLIFT sweeping agent	500	1,500	kg	Drilling chemical storage area	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	Proprietary	AECOM, 2024 – Appendix E
OXYGON oxygen scavenger	500	1,500	kg	Drilling chemical storage area	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	Proprietary	AECOM, 2024 – Appendix E
ENVIRO-THIN filtration control additive	500	1,500	kg	Drilling chemical storage area	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	Proprietary	AECOM, 2024 – Appendix E
Lime pH buffer	500	1,500	kg	Drilling chemical storage area	Calcium hydroxide	1305-62-0	AECOM, 2024 – Appendix E
Calcium chloride	37,000	111,000	kg	Drilling chemical storage area	Calcium chloride	10043-52-4	AECOM, 2024 – Appendix E
Sodium bromide	8,160	24,480	kg	Drilling chemical storage area	Sodium bromide	7647-15-6	AECOM, 2024 – Appendix E
Evolube TR	14,500	43,500	L	Drilling chemical storage area	Triethylene glycol, monobutyl ether 2-Butoxyethanol Diethanolamine	143-22-6 111-76-2 111-42-2	AECOM, 2024 – Appendix E
Radiagreen EME	4,800	14,400	L	Drilling chemical storage area	Fatty esters Specialities	Proprietary	AECOM, 2024 – Appendix E
Radiagreen EBL	4,800	14,400	L	Drilling chemical storage area	Fatty esters	Proprietary	AECOM, 2024 – Appendix E

Material name	Typical volume	Maximum volume	Unit	Storage area	Chemical composition	CAS Number	Chemical risk assessment report
					Specialities		
Polydrill	7,500	22,500	kg	Drilling chemical storage area	SULPHONATED ORGANIC POLYMER	Proprietary	AECOM, 2024 – Appendix E
Alpine spotting beads	1,000	3,000	kg	Drilling chemical storage area	Styrene	100-42-5	AECOM, 2024 – Appendix E
Proppants*							
100 mesh sand- proppant	91,000	273,000	kg	Stimulation chemical storage area	Sand	14808-60-7	AECOM, 2024 – Appendix E EHS Support, (2023) – Appendix E.1
Quartz or organophilic phyllosilicate- proppant	1,084	3,252	L	Stimulation chemical storage area	Quartz or organophilic phyllosilicate	14808-60-7	AECOM, 2024 – Appendix E EHS Support, (2023) – Appendix E.1
40/70 sand- proppant	1,650,000	4,950,000	kg	Stimulation chemical storage area	Sand	14808-60-7	AECOM, 2024 – Appendix E EHS Support, (2023) – Appendix E.1
30/50 sand- proppant	610,000	1,830,000	kg	Stimulation chemical storage area	Sand	14808-60-7	AECOM, 2024 – Appendix E EHS Support, (2023) – Appendix E.1 as 20/40
* Proppants are sand which is inert. They do not require special chemical bunding but are co-located in the stimulation chemical storage area, within the well pad bund. Residual proppant from a stimulation campaign is often used to assist with chemical spills on the well pad, where contaminated spill material is removed.							

Key environmental risks

The environmental, heritage and social risks associated with the activities have been assessed using the Tamboran risk assessment framework. The risk assessment presents the range of potential impacts, corresponding mitigation measures and risk ratings based on their assessed worst-case consequence and likelihood of occurrence. Key risks assessed under this EMP include:

- protection of groundwater through sustainable groundwater use and zonal isolation
- loss of containment:
  - assessment and management of chemicals
  - generation and management of wastewater, including prevention of spills
  - well integrity
- generation and management of waste, associated with drilling and hydraulic fracturing
- managing cultural heritage finds
- managing of erosion and sediment control
- managing traffic
- managing the risk of bushfire in the area
- mitigating the introduction and spread of weeds
- exceedance of greenhouse gas (GHG) emissions above 100,000 t/CO_2e per financial year.

It was considered that with the appropriate controls implemented to mitigate the impacts there were no residual risks above a rating of medium (Table 7).

Table 7: Summary of risk ratings with environmental controls applied

	Environmental risk rating with applied controls			
	Low	Medium	High	Very high
Total 90	87	12	0	0

The medium risks identified were consistent with standard project and pastoral activities completed across the NT, and are related to soil erosion, spread of weeds, accidental ignition of fire/bushfires and nuisance dust generation.

The medium residual risks sources assessed under this EMP include:

a. Loss in long-term soil productivity and viability due to soil erosion from cleared areas (existing access tracks, well pads, camp pads and 2D seismic) – risk ID 28
b. Impact to listed threatened habitats and listed threatened flora and fauna, including non-listed fauna and livestock through surface activities – risk ID 45, risk ID 46, risk ID 53, risk ID 54 and risk ID 55
c. Disturbance of a sacred site or culturally sensitive area and decline in environmental value of area used for cultural purposes through the accidental ignition of fire by site activities – risk ID 59 and risk ID 64
d. Reduction in agriculture productivity through the introduction and spread of weeds in the area or accidental ignition from surface activities – risk ID 73 and risk ID 76
e. Increased nuisance from dust emissions associated with the activities – risk ID 88 and risk ID 89

The assessment demonstrates that the risks associated with drilling and stimulation activities, often referred to as "high consequence, low likelihood" risks, such as contamination of potable groundwater from onshore gas activities, have been assessed as a "low" risk rating. The rating is achieved through the application of multiple mandatory well integrity safeguards, including isolation barriers to protect against contamination of groundwater aquifers,[8] which reduces the risk rating to ALARP and 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, including the offsetting of residual GHG emissions.
- The protection and enhancement of community and cultural values, places and amenity.

At completion of E&A activities, the sites will be returned to a safe, stable and non-polluting form consistent with pre-disturbed conditions.

Stakeholder engagement

Stakeholder engagement for Tamboran's E&A project has focused on the host traditional owners (facilitated by the NLC) and host pastoralists directly affected by the proposed activity. Contact details are as follows:

NLC [redacted]	Various	[redacted]	[redacted]
Hayfield / Shenandoah Pastoral Station [redacted]	Val Dyer	[redacted]	[redacted]
Beetaloo Station[9] [redacted]	Jane and Scott Armstrong	[redacted]	[redacted]

Detailed community and stakeholder engagement is ongoing and covers Tamboran's activities on a broader level and includes the information required under the Regulations. This includes providing the stakeholders of the activity description, location, impacts, potential risk, proposed environmental controls and potential impacts to the stakeholders' rights.

Further information on stakeholder engagement is provided in section 5.

Key objectives of this EMP

The scope covered in this EMP is considered an important step in confirming the technical and commercial feasibility of the underlying shale resources. In other unconventional plays, such as Queensland Coal Seam Gas (CSG) fields, typically 5 well pilots are/were utilised at multiple locations within a field to demonstrate the commerciality of an area. This EMP anticipated 4 wells will be utilised per location to achieve the appraisal objectives. Key objectives of the program will be to collect information the following:

[8] Mandatory standards and processes applied to the regulated activities are described in the Code, which is designed to ensure that the risk to public, workers and the environment are reduced to a level that is ALARP and acceptable (Cl 1).

[9] As per previous engagement covering approved Beetaloo W regulated activities and EMPs.

- Estimates of gas volumes and gas production curves to calculate the estimated ultimate recovery and wells required to be drilled to maintain production from the target shales. This will be utilised to determine the likely amount of gas able to be produced from each well and underpins resource estimates.
- Understanding of resource continuity and variability, to underpin the design of future resource development. This will be utilised to assist in understanding the size of the resource, which will provide estimates of the potential size of a development and production profiles.
  - Optimisation of drilling techniques, HFS design and well spacing to suit the underlying shale resources. Adjacent horizontal wells in a multi-well pad operation are critical in collecting data points to determine well interference (and therefore horizontal separation distances) and well productivity improvements (i.e. using different stimulation fluid systems or other variables to see if positive production results are achieved).
  - Optimise multi-well pad layout of surface operations for a potential future development scenario with the core objective of minimising the environmental footprint, including minimising land clearance, maximising wastewater re-use and reducing GHG emissions.
  - Demonstrate design requirements and operability of multi-well pad operations across all seasons in the Beetaloo Sub-basin.
  - Assess the financial competitiveness in multi-well pad development scenario to inform the final investment decision for future development scenarios.
  - Demonstrate no impact on groundwater quality at a well site in a multi-well pad operation.
  - Collect additional data on flowback quality and quantity during a multi-well pad operation to assess options for minimising off-site wastewater disposal through future treatment and re-use.
  - Provide key data as input into future production approvals, including footprint optimisation, flowback characterisation, GHG emission intensity, and solid and liquid waste management and recycling options.

1 Introduction

1.1 Purpose

Tamboran B2 Pty Ltd (Tamboran) is a registered holder and the operator of Exploration Permit (EP) 117, 98 and 76, located in the Beetaloo Sub-basin. This Environment Management Plan (EMP) forms the basis of Tamboran's application to the Northern Territory (NT) Minister for Environment for a series of exploration activities proposed in the Shenandoah South area on EPs 117 and 98 over a period of 5 years.

The Shenandoah South E&A program EMP is designed to collect appraisal data to determine the future technical and commercial viability of the underlying shales within EP 98 and 117. This EMP is restricted to E&A activities and does not cover production as defined in the NT Petroleum Act (1984). Additional approvals are required to be sought with information collected from this E&A program. Activities proposed in this EMP include:

- **Civil construction of 4 new E&A locations – Shenandoah S2, Shenandoah S B, Shenandoah S C, Shenandoah N A:** Civil construction of up to 4 new E&A well sites and associated infrastructure (access tracks, camp pads, helipads, laydown yards, fence lines, firebreaks, water bore, and all other ancillary infrastructure as relevant). Includes the construction of a new 5-ha gravel pit (SSGP3).
- **Civil construction to expand the existing Kyalla 117 N2 site:** Civil construction to expand the existing Kyalla 117 N2 site inside the firebreak / fenced well pad[10] area from 13.11 ha to 17.41 ha, including 0.50 ha contingency to expand the camp site.
- **Sealing of existing access track intersection with the Stuart Highway** to comply with the DIPL intersection requirements.
- **Drilling** of up to 15 horizontal E&A wells, including the approved Shenandoah S 2H on the Kyalla 117 N2 location.
- **Hydraulic fracture stimulation (HFS) and well testing of u**p to 15 E&A wells at four (4) exploration locations, including the approved Shenandoah S 2H well on Kyalla 117 N2.
- **Drilling of a vertical stratigraphy well at Shenandoah N A**.
- **Construction of a gathering network connecting exploration sites** to allow for the transfer of wastewater (including raw water, flowback, completion and drilling wastewater) and hydrocarbons between: Kyalla 117 N2 and Shenandoah S2; and Shenandoah S B and Shenandoah S C.
- **Drilling waste and flowback wastewater management** on each site, including the transfer between sites**.** This includes construction and operation of drilling sumps and wastewater storage tanks, as well as the operation of gathering networks connecting sites.
- **Seismic acquisition of a total of 77 km of 2D seismic (EP 98 and EP 117):**
  - Acquisition of 3 x 2D seismic surveys totalling approximately 38 km (19 ha disturbance) across EP 117 and 98.
  - Acquisition of an additional 39 km of 2D seismic along existing access tracks with no disturbance.
- **Operation and maintenance of the existing Kyalla 117 N2 E&A location, main access track(s), gravel pits and ancillary activities**. Includes the incorporation of all remaining / in force regulated activities from the following approved EMPs[11] (refer Appendix A) at the Kyalla 117 N2 sites:
  - Beetaloo Basin Kyalla, civil construction EP 117 N2 EMP (ORI1-1), approved 6 June 2019.

[10] Refer Footnote 1.

[11] "Approved EMPs" includes Regulation 22 notifications made under each approved EMP.

  - Beetaloo Basin Kyalla drilling hydraulic fracture stimulation and well testing program EP 117 N2 EMP (ORI3-2), approved 13 August 2019.
  - Beetaloo Sub-basin Kyalla 117 N2 multi-well drilling, hydraulic fracturing and well testing program EMP (ORI6-3), approved 22 February 2021.
- **Decommissioning[12] of up to 18 wells**, including the 15 new E&A wells, 1 approved E&A well and 2 existing E&A wells (Kyalla 117 N2-1H and Shenandoah S-1H).
- **All ancillary activities on each site required to undertake E&A activities** including:
  - Power generation
  - Bulk chemical and fuel handling, storage and use
  - Material transport and storage
  - Gravel extraction
  - Helicopter operations
  - Flaring
  - Flowback wastewater management, recycling and treatment
  - Recycling of wastewater, including the recycling of waste drilling fluids, completion fluids and flowback into operational process (such as stimulation make up water)
  - Groundwater extraction and monitoring
  - Micro-seismic data acquisition and associated works
  - Induced seismic monitoring and associated works
  - Environmental monitoring for weeds, flora, fauna, soil, air quality and other environmental aspects
  - Inspection and maintenance
  - Office, workshop and laydown areas
  - Operations of camps at each location
  - Subsurface diagnostic tests and data collection on each petroleum exploration well
  - Maintenance and monitoring of each of the proposed petroleum exploration wells and infrastructure
  - Suspension and decommissioning of the proposed petroleum exploration wells.
  - Rehabilitation of disturbance areas

This EMP has been prepared in compliance with the Petroleum (Environment) Regulations 2016 (the Regulations), the Code and the Exploration Agreement(s) between Tamboran, native title holders and the NLC.

The overall objective of the EMP is to ensure that the proposed activities are carried out in such a manner that the environmental impacts and risks will be reduced to a level that is ALARP and acceptable.

[12] Refer Footnote 3.

Specifically, this EMP aims to:

- Address regulatory requirements.
- Provide site-specific impact management strategies to assist Tamboran in maintaining a positive position in the local community throughout its program.
- Align with the principles of Ecological Sustainable Development (ESD) through the adoption of responsible development practices that are designed to maximise social benefit, while minimising the level of impact on the surrounding ecosystems.
- Provide a description of site-specific aspects of the existing environment (physical, biological, social and cultural).
- Provide site-specific plans for monitoring and rehabilitation.

Be a practical and usable document, with environmental management principles that are easily implemented and effective. While every effort has been made to ensure current and accurate information in this EMP, it is intended to be adaptive by design while fulfilling the need for sufficient controls. However, it must remain responsive to fluctuations and alterations in field conditions.

1.2 Proponent

Attribute	**Details**
Name:	Matt Kernke
Position:	Manager
Company:	Tamboran B2 Pty Ltd
Address:	C/- Tower One, International Towers, Suite 1, Level 39, 100 Barangaroo Avenue, Barangaroo NSW 2000 Australia
Contact details:	Tamboran.contact@tamboran.com +61 2 8330 6626
Non-operating proponent	
Name:	Philip O'Quigley
Position:	Director
Company:	Falcon Oil & Gas Australia Limited
Address:	C/- 17 Phoenix Street, Nightcliff, Northern Territory 0814 Australia
Contact details:	poquigley@falconoilandgas.com +35 38 7814 7042

1.3 Current EMPs in force superseded by this EMP

All regulated activities described in the five (5) EMPs listed in section 1.1, are incorporated into this EMP: *Shenandoah South E&A Program EMP EP 117 and EP 98 (TAM1)*.

A breakdown of the regulated activities; activity status; and environmental performance standards, outcomes and obligations is provided in Appendix A. Upon approval of this EMP, Tamboran will submit a regulation 14 letter to Department of Environment, Parks and Water Security (DEPWS) to close-out the above EMPs in accordance with the Regulations.

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 8. This EMP has been prepared in relation to these requirements.

Table 8: Key legislation

Legislation	Requirement	How Tamboran 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 authorising Petroleum activities.	Department of Industry, Tourism and Trade (DITT) [13] DEPWS [14] Department of Treasury and Finance [15]
	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') [16], covers key regulatory requirements for operational management of well activities in conjunction with the Code.	Requirements addressed in the Well Operations Management Plan (WOMP).	
	Prescribes the provisions of the Financial Assurance Framework, which introduces mandatory environmental remediation and petroleum infrastructure decommissioning securities as well as mandatory insurance requirements for all petroleum interests.	Environmental security is assessed by the DEPWS and paid to DITT. Petroleum infrastructure decommissioning securities is assessed by DITT and paid to DITT	DEPWS and DITT
	Outlines the framework for the fees and levies prescribed in the Petroleum Regulations 2020 (below), including publication.	Fees are paid to DITT but in some cases assessment of the fees is undertaken by DEPWS	DEPWS and DITT
	Ensuring all regulated activities have an approved EMP.	This EMP has been developed to satisfy this requirement.	DEPWS

[13] Except provisions about royalties, provisions relating to environmental regulation of exploration and production of petroleum and Part V, Division 2.

[14] Part V, Division 2 and provisions relating to environmental regulation of exploration and production of petroleum.

[15] Provisions about royalties.

[16] NOTE: The Schedule is only valid under the Petroleum (Transitional) Regulations 2023, if a WOMP was submitted to DITT prior to 22 June 2023.

Legislation	Requirement	How Tamboran meets the requirement	Administered by
NT Petroleum (Environment) Regulations 2016	That the EMP is developed in accordance with the NT Petroleum (Environment) Regulations 2016 (the Regulations).	Tamboran has developed this EMP in accordance with the Regulations.	
	That stakeholder engagement for the regulated activities is undertaken.	Tamboran has completed stakeholder engagement in accordance with the Regulations, as summarised in section Appendix N of this EMP.	
	That activities are conducted in accordance with the Code.	The EMP outlines how the activities will be conducted in accordance with the Code.	
	Reporting requirements for incidents and hydraulic fracturing.	The EMP summarises how incidents and flowback monitoring results will be reported.	
Petroleum (Transitional) Regulations 2023	Provides clarity around how and when new arrangements will apply to existing titles, applications, approvals and requirements, including a current insurance policy, new fees, levies and securities.	Fees are paid to DITT. Copy of insurance policy is submitted to DITT.	DITT
Petroleum Regulations 2020	Provides for land access agreements between interest holders and owners or occupiers of the land.	Land access agreements in place for the regulated activities described in this EMP.	DITT
	Prescribes the fees relating to the general administration of petroleum titles, including those for the grant, renewal and variation of exploration permits, retention licences and production licences (Schedule 1).	Fees are paid to DITT for the administration of all titles, permits and licences.	DITT
	Prescribes the fees for resource management, activity and infrastructure plans (Schedule 1A).	Fees are paid to DITT.	
	Describes fees and calculation processes for EMPs based on complexity of the regulated activity described in an EMP (Schedule 1B).	Fees are paid to DEPWS for all regulated activities proposed under this EMP.	DEPWS
	Prescribes the monitoring and compliance levy intended to recover the costs of a range of DITT and DEPWS monitoring and compliance activities (Schedule 4A).	A calculation tool is submitted to DEPWS, then approved and invoiced by the Energy Development Branch, DITT on the advice of DEPWS.	DEPWS and DITT

Legislation	Requirement	How Tamboran meets the requirement	Administered by
	That the WOMP must be developed in accordance with Regulation 66AA Schedule 4B.	Requirements addressed in the Well Operations Management Plan (WOMP).	DITT
	That the field management plan must be developed in accordance with Regulation 66AAB and Schedule 4C.	Requirements addressed in the field management plan.	
	Prescribes the information that must be included in a petroleum surface infrastructure plan in accordance with Regulation 66AAD and Schedule 4D.	Requirements addressed in the surface infrastructure plan.	
	Reporting requirements prescribed under Regulation 66AAN (Schedule 4E) to Regulation 66AAX(2) (Schedule 4R).	Requirements addressed through various reports provided to the regulator that a relevant to the regulated activities described in this EMP.	
Induced Seismicity Management Guideline 2022	Pursuant to section 71 of the *Petroleum Act 1984* a permittee must submit an induced seismicity management plan with the WOMP for approval by the Minister of Mining and Industry.	Requirements addressed in the WOMP.	DITT
Bushfires Management Act 2016 and Regulations	Compliance with total fire bans and fire permitting.	Tamboran will not undertake flaring or the lighting of fires during periods of total fire bans and will obtain a permit where flaring occurs during declared fire danger periods.	Bushfires NT
	Requirements for occupiers to prevent and control fires.	Addressed through Tamboran's Bushfire Management Plan **(**Appendix B) which includes bushfire preventative and response measures.	
	Aerial burning permits.	Tamboran will acquire permits where aerial burning to manage fuel loads is proposed as a part of its ongoing bushfire management activities. Tamboran 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 NT road network, including traffic, operation, management, capacity or safety, or result in the construction or installation of new infrastructure within the Northern Territory Government	Tamboran will continue to engage with the Department of Infrastructure, Planning and Logistics (DIPL) regarding proposed and ongoing traffic management.	Department of Infrastructure, Planning and Logistics (DIPL)

Legislation	Requirement	How Tamboran meets the requirement	Administered by
	(NTG) road network, requires assessment and Road Agency Approval.		
Emergency Management Act 2013	Establishes the requirements for local, regional and Territory emergency management plans. Describes the functions and powers of the NTPFES, Territory Emergency Controller, Territory Recovery Controller and Territory Emergency Management Committee.	Tamboran complies with the Act through the development of an emergency response plan and the identification of NTPFES as a stakeholder.	Northern Territory Emergency Service
Environment Protection Act 2019	Activities which have the potential to cause a significant impact to the environment are required to be referred to the NT Environment Protection Authority (NT EPA) for assessment under the *Environment Protection Act 2019*.	Tamboran has completed a self-assessment. The level of potential environmental impact is not considered significant.	NT EPA DEPWS
Heritage Act 2011	Requirements to avoid impacts to heritage places and objects.	Tamboran 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
Medicines, Poisons and Therapeutic Goods Act 2012	Establishes the requirements for minimising harm from scheduled substances and therapeutic goods. Regulates the possession, supply or administration of drugs and poisons.	Tamboran will abide by the limitations of use of any potent medicines, drugs and poisons to ensure their save and effective use and protection of humans and the environment.	Department of Health
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 Tamboran's proposed activities have had sacred site clearances completed by custodians. Aboriginal Areas Protection Authority (AAPA) certificates for all exploration activities proposed in the EMP will be obtained prior to commencement.	AAPA
Public and Environmental Health Act 2011	Requirements for camp kitchens and wastewater (sewage and greywater) management and permitting in the NT.	Tamboran'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

Legislation	Requirement	How Tamboran meets the requirement	Administered by
Radiation Protection Act 2004	Requirements for the management of radiation for the health and safety of community and protection of the environment.	Tamboran complies with the Act through proper handling of and disposal of drill cuttings.	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.	Tamboran 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 and Wildlife DEPWS
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 drilling and stimulation 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 Control Act 1998 (WMPCA)	Requirements covering general environmental duty, waste management, including waste management hierarchy, waste transportation and waste disposal requirements.	The storage, transportation and disposal of wastes will comply with 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.	NT EPA
	S12 General environmental duty: Applies to activities outside of the well site, or if a spill or leak occurs that leaves the well site, or 1 km from the centreline of a pipeline.	Tamboran will conduct all activities outside the approved disturbance well site (camp area, well 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 well site, or 1 km from the centreline of a pipeline, that causes or threatens to cause material or serious environmental harm.	Tamboran will report all incidents that causes or threatens to cause pollution beyond the boundary of the authorised activity (beyond the well site or camp pad), in accordance with Section 14 of the WMPCA.	

Legislation	Requirement	How Tamboran meets the requirement	Administered by
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).	Tamboran has obtained a WEL GRF 10285 (175 ML/year) covering previous water usage for exploration activities. WELs are renewed periodically to support operational activities. The WEL will be increased to cover the future proposed exploration activities. This application is covered under the Water Act and is separate to this EMP.	DEPWS
	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.	
	The Act requires an interest holder to obtain a permit if activities undertaken under the Act all result in interference with a waterway.	The proposed activities occur on existing EPs with additional clearing to occur on EP 117 and EP 98 to construct and operate 4 new well pads and one existing well pad. No new or approved activities will result in interference with a waterway.	
	The Act requires an interest holder to obtain a bore work permit for any new groundwater bores.	Tamboran will obtain a bore work permit for any new groundwater bores as required.	
Weeds Management Act 2001	Requires the occupier of the land (in this case Tamboran) 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.	Tamboran 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 C).	DEPWS

Legislation	Requirement	How Tamboran meets the requirement	Administered by
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.	Tamboran 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 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 Conservation Act 1999	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 the proposed activities within this EMP. Impacts to MNES are not expected to occur.	Department of Climate Change, Energy, the Environment and Water (DCCEEW)
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. The Act also introduces a Safeguard Mechanism aimed to reducing emission from large industrial facilities. It sets legislated limits—known as baselines—on the greenhouse gas emissions of these facilities. The Safeguard Mechanism applies to industrial facilities emitting more than 100,000 tonnes of carbon dioxide equivalent (CO_2-e) per year The safeguard requires that all emissions form the Beetaloo basin be offset with Australian Carbon Credit Units (ACCU) once the 100,000 tonnes CO_2- trigger is exceeded.	All energy consumption and greenhouse gas data used/generated form this activity will be reported in accordance with this Act. Upon exceeding the 100,000 tonnes CO_2- trigger in a given financial year, all emissions in that financial year and subsequent financial years will require to be offset.	DCCEEW

Legislation	Requirement	How Tamboran meets the requirement	Administered by
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.	Tamboran uses the NEPM to assess risk of contamination and for the assessment of the drilling fluids for disposal.	DCCEEW
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 Tamboran's exploration activities.	The Right to Negotiate process was applied to the grant of Tamboran's permits, resulting in Section 31 Agreements and Exploration (Ancillary) Agreements covering Tamboran's permits. The traditional owners were and continue to be represented by the NLC. Tamboran continues to implement the Exploration Agreements, in collaboration with the NLC, with all work programs being reviewed and approved by traditional owners. Tamboran has engaged with traditional owners on the activities proposed in this EMP, evidenced by the Section 31 Agreements and the implementation of the relevant Exploration Agreement.	Prime Minister and Cabinet (Divisions 6 and 7 of Part 2, and Part 11) Attorney-General's Department (except to the extent administered by the Minister responsible for Indigenous Affairs)

2.1 Ecologically Sustainable Development (ESD)

The EMP is consistent with the principles of ESD, through the adoption of responsible practices that are designed to maximise social benefit, while minimising the level of impact on the surrounding ecosystems. [17]

Tamboran'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, 2, 3 and 5).
- Complying with the Code 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 ESD 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 2, 4, 6 and 7).This has been confirmed through various inquiries/ research programs including the independent Scientific Inquiry into Hydraulic Fracturing of Onshore Unconventional Reservoirs in the Northern Territory and Commonwealth Geological and Bioregional Assessment Program.
- 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), Tamboran 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 NLC and 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 Tamboran to complete a series of E&A activities within over 5 years, as summarised in Table 9. These activities include:

- Drilling of Up to 15 horizontal E&A wells at four (4) exploration locations, including the approved Shenandoah S 2H on the Kyalla 117 N2 location.
- Hydraulic fracture stimulation (HFS) and well testing of up to 15 E&A wells at four (4) exploration locations, including the approved Shenandoah S 2H well on Kyalla 117 N2.
- Drilling of a vertical stratigraphy well at Shenandoah N A.
- Operation, maintenance and decommissioning[18] of the existing Kyalla 117 N2 1H E&A well under the *Beetaloo Basin Kyalla drilling hydraulic fracture stimulation and well testing program EP117 N2 EMP (ORI3-2)*, approved 13 August 2019.

[17] Referred to in the NT Petroleum (Environment) Regulations 2016 and the *Petroleum Act 1984* and set out in sections 18 to 24 of the *Environment Protection Act 2019*.

[18] Refer Footnote 3.

- Operation, testing, maintenance and decommissioning[19] of the existing Shenandoah S-1-1H E&A well, which was spudded at Kyalla 117 N2 on 1 August 2023, under the *Beetaloo Sub-basin Kyalla 117 N2 Multi-well Drilling, Hydraulic Fracturing and Well Testing Program EMP (ORI6-3)*, approved 22 February 2021.
- Collection of approximately 77 km (19 ha disturbance) of 2D seismic survey on EP 98 and EP 117 to support the evaluation of the underlying shale resources in the vicinity of the proposed exploration sites (Figure 5).

3.1 Activity summary

The activities proposed under this EMP are summarised in Table 9. Some figures, such as water use, stimulation stages and proppant usage, are estimates based on previous experience and may be higher or lower depending on operational requirements.

Table 9: Site activity summary

Activity	Parameter	Description
Exploration-on site civil construction	Expansion of existing Kyalla 117 N2 site- total disturbance increasing from 5.25 ha to 9.05 ha	• Operation and expansion of the existing Kyalla 117 N2 well pad from 5.25 ha to 9.05 ha
	Construction and ongoing maintenance of 4 new E&A sites- 34.5 ha total disturbance	• Construction of 4 new E&A locations: - Shenandoah S2- (12.0 ha) - Shenandoah S B- (12.0 ha) - Shenandoah S C- (7.5 ha) - Shenandoah N A-(3.0 ha)
	Access tracks – ~20.1 ha total	• Construction/ upgrade of access tracks to pastoral track type 2 (e.g. 14 m wide): • Bitumen sealing of the existing Kyalla 117 N2 access track intersection with the Stuart Highway (no new disturbance) • Use and maintenance of the existing 28 km of access connecting the Stuart Highway with the existing Kyalla 117 N2 site • Use and upgrade of approximately 2.5 km of existing pastoral access track from the Kyalla N2 access to the new Shenandoah S2 access – 4.5 ha • Construction of a new 2.0 km access track (including turn-ins, erosion and sediment controls, and passing bays) connecting the existing pastoral access track to the new Shenandoah S2 – 3.3 ha • Construction of a new 1.5 km access track from the existing Kyalla N2 access track (including turn-ins, erosion and sediment controls, and passing bays) connecting to the new Shenandoah S B location – 3.3 ha • Construction of a new 1.5 km access track from the existing Kyalla N2 access track (including turn-ins, erosion and sediment controls, and passing bays) connecting Shenandoah S C– 3.3 ha

[19] Refer Footnote 3.

Activity	Parameter	Description
		• Use and upgrade of existing ~26 km of existing pastoral track connecting the Shenandoah N A location to the Kyalla 117 N2 location – 4.0 ha of new disturbance • Construction of a 1.0 km access track from the existing pastoral access track (including turn-ins, erosion and sediment controls, and passing bays) to Shenandoah N A – 2.0 ha.
	Camp pads: ~3.5 ha	• Construction of 1.0 x 1.0 ha camp pad each at Shenandoah S2, S B and Shenandoah N A. The camp pads at these sites will only be constructed where the centralised camp at the existing Kyalla 117 N2 site is not used. • Expansion of the Kyalla 117 N2 camp from 1.0 ha to 1.50 ha (contingent).
	4 cellars per well pad (at least)	• Installation of at least 4 E&A well cellars and conductors on each well pad to accommodate the proposed wellheads and surface facilities.
	1 sump per well pad	• Construction of a drilling sump on each well pad to manage drilling fluids, muds and cuttings with a typical volume of 10,000 $m^{3.}$
	1 bund per well pad	• Construction of a site bund for wastewater storage to contain 110% of the volume of the largest tank.
	1 stormwater retention basin per well pad	• Construction of a sediment basin to manage stormwater during wastewater storage.
	37 new groundwater monitoring / extraction bores (total spread across all sites)	• Drilling of up to 10 new bores at each of the 3 proposed E&A sites in Shenandoah South. • 5 new bores at Kyalla 117 N2 • Up to 2 new bores at Shenandoah N A. Also, use of existing groundwater bores on Kyalla 117 N2.
	Laydown areas: ~10.00 ha total	• Construction of a 2.5 ha laydown area at Shenandoah S B and S C. • Construction of a 5.0 ha laydown area at Shenandoah S2.
	Helipad -~1.50 ha total	• Maintenance and operation of the existing Kyalla 117 N2 helipad (0.5 ha) • Construction of a helipad at Shenandoah S B and S C each (0.5 ha)
	~18.00 ha total	• Construction of a 20 m x 2 km fence line and firebreak around the Shenandoah S2, S B and S C sites (4 .00 ha per site) • Construction of a 20 m x 1 km fence line and firebreak around the Shenandoah NA site (2.00 ha) • Existing firebreak and fence line around the Kyalla 117 N2 site (~4.00 ha)
	~13.75 ha total	• Operation and maintenance of the existing / approved Kyalla 117 N2 gravel pits SSGP1 (2.5ha) • Operation and maintenance of the existing / approved Kyalla 117 N2 gravel pits SSGP2 (6.25ha) • Construction, operation and maintenance of a new gravel pit in the vicinity of Shenandoah S2 [SSGP3] (5 ha).

Activity	Parameter	Description
Site set-up and mobilisation to support the E&A wells	Camps	• The existing Kyalla EP 117 camp pad may be used to establish a centralised camp to reduce camp mobilisations / new disturbance across the step-out locations and work program. • Where a centralised camp is not used, a temporary main camp will be located on the newly constructed camp pad at Shenandoah S2, Shenandoah S B and Shenandoah N A. • Each main camp will typically have a ~75-person capacity. • A drilling mini-camp will also be located on the well pad during drilling to accommodate 24-hour operations (~8-person capacity).
	Chemical storage areas	• Set-up of chemical and material storage areas at each site.
	Material transportation	• Transportation, handling and storage of bulk chemicals, fuels and wastes.
	Drilling rig and equipment	• Set-up of drilling rig, including blow-out preventors, fluid systems and associated equipment such as pipe racks, power generation, offices, ablution blocks and cementing units.
	Frack spread	• Set-up of HFS equipment, completions rig and equipment, well testing equipment, and other associated equipment at each site.
	Traffic	• Approximately 44 traffic movements per day, per site during site demobilisation.
Camp operation	~75-person camp	• Operation of a main camp – either centralised (existing Kyalla 117 N2 site) and/or at Shenandoah S2, Shenandoah S B and Shenandoah N A. • Operation of drilling camp on each well pad during drilling.
E&A well drilling	15 horizontal E&A wells	• Drilling of 15 horizontal E&A wells across the Shenandoah S2, Shenandoah S B, Shenandoah S C and Kyalla 117 N2 sites, including the vertical pilot well (where required) and collection of reservoir quality data during drilling. This includes the approved drilling of the Shenandoah S 2H.
	1 vertical stratigraphic E&A well	• Drilling of 1 stratigraphic E&A well at Shenandoah NA, and collection of reservoir quality data during drilling.
Hydraulic fracturing	15 horizontal E&A wells	• HFS of 15 horizontal E&A wells across 4 sites – including the approved Shenandoah S 2H. • 10 – 60 stages per well depending on horizontal length (typically 30 stages). • Recycling of flowback wastewater for stimulation fluid makeup to reduce raw water use.
Well completion	15 E&A wells total	• Completion of 15 E&A wells across 4 E&A sites.

Activity	Parameter	Description
Well testing	Typically less than 90 days per well, up to 300 days	• Extended production testing of 16 wells across 4 sites (including the existing Shenandoah S-1H1F1F[20]); average well test duration is anticipated to be less than 90 days, with a maximum of 300 days well testing.
		• Gas flaring in accordance with Code requirements and as per United States Environmental Protection Agency (US EPA) 40 Code of Federal Regulations (CFR) 63.11, with a flare tip combustion efficiency of 98%.
Well maintenance and monitoring	18 E&A wells total	• Maintenance and monitoring works on 18 wells (including well workovers) in accordance with approved WOMP(s) covering: - Existing Kyalla 17 N2-1HExisting Shenandoah S 1H - 15 horizontal E&A wells under this EMP - Shenandoah NA
Build up testing	17 E&A wells total	• Build up testing to monitor the pressure build-up within each E&A well, including the existing Shenandoah S-1H, Kyalla 117 N2-1H and 15 horizontal E&A wells.
Well suspension and decommissioning[21]	18 E&A wells total	• Suspension and decommissioning (if required) of all wells covered in this EMP in accordance with the *Code of Practice: Onshore Petroleum Activities in the Northern Territory* (Code). The breakdown across sites is as follows: - Existing Kyalla 17 N2-1H - Existing Shenandoah S-1H - 15 horizontal E&A wells under this EMP - Shenandoah NA
Groundwater extraction (average)	~375 ML/year (approximately)	• Groundwater extraction under existing groundwater extraction licence (WEL GRF 10285). • Tamboran will seek amendment to the existing WEL / apply for a new WEL to supplement future groundwater take. • Where practicable, Tamboran will recycle flowback to minimise extraction.
Groundwater monitoring / extraction bores	37 new bores 4 existing bores on Kyalla 117 N2	• Tamboran currently has 4 groundwater bores at Kyalla 117 N2 (RN040896, RN041132, RN041136 and RN041137). These will continue to be operated and monitored. • Up to 10 new bores will be installed at each of the 3 Shenandoah South sites. • 5 new bores at Kyalla 117 N2 • Up to 2 new bores at Shenandoah NA.
Environmental monitoring	All sites	• Monitoring activities (including groundwater, stormwater, soils, leak detection, seismicity and all other low impact ancillary data collection programs).

[20] The Kyalla 117 N2-Shenandoah S-1H as spudded on 1 August 2023 under the *Beetaloo Sub-basin Kyalla 117 N2 Multi-well Drilling, Hydraulic Fracturing and Well Testing Program EMP (ORI6-3)*, 22 February 2021.

[21] Refer Footnote 3

Activity	Parameter	Description
On-site wastewater management to support ongoing E&A program	5 well sites	• Peak flowback storage volume of approximately 34 ML • On-site wastewater storage and treatment in accordance with Code. • Use of the drilling sump, enclosed wastewater storage tanks and wastewater treatment tanks to manage drilling and flowback wastewater. • Drill cuttings and flowback fluid quality testing in accordance with the Code. • Drilling waste storage – including centralised storage of drilling waste from other approved locations. • Disposal of drill cuttings subject to the outcomes of chemical analysis in accordance with clause C.4.1.2 of the Code. • On-site treatment of wastewater through evaporation or other alternative methods (such as enhanced evaporation or other mechanical water treatment options). • Recycling of flowback wastewater for stimulation fluid makeup to reduce raw water use. • Off-site disposal of flowback wastewater in accordance with the Waste Management and Pollution Control Act.
Gathering lines	~8.61 km (8.61 ha)	• Construction and operation of wastewater gathering lines to a centralised wastewater treatment infrastructure located a Shenandoah S B (~10 m wide): - Shenandoah S B to/from Shenandoah S C: 4.11 km (4.11 ha) - Shenandoah S2 to/from Kyalla 117 N2: 4.5 km (4.5 ha)
Site decommissioning	All sites and associated infrastructure (access tracks, gravel pits, seismic lines etc.)	• Decommissioning and removal of all surface infrastructure and wastes from site including the removal of drilling sump, wastewater tanks, cellars, equipment, non-drilling waste, wastewater and all ancillary equipment.
Site demobilisation	All sites	• Demobilisation of exploration equipment, including camps, drilling rigs, HFS equipment, completion rigs, well testing equipment, wastewater storage tanks and various service provider equipment.
Seismic acquisition	~ 38 km (19.0 ha disturbance) ~ 39 km along existing access tracks (no additional disturbance)	• Seismic program to use 2 energy sources to evaluate optimal energy source type: vibroseis and seismic charges • Civil construction of 3 x 2D seismic lines: • Clearing of approximately 38 km of seismic lines with a 5 m cleared track width. • Seismic lines to be weaved through vegetation to a path of least resistance. Slashing can be utilised in otherwise untraversable vegetation. Deviations in lines must be constructed in a way that is accessible by equipment/vehicles such as heavy-rigid body trucks (minimum 15 m turning radius). • A small turning circle to be constructed at the end of each seismic line to allow equipment and vehicles to exit.

Activity	Parameter	Description
		• A 250 m buffer /deviation from either side of the centreline pre-plot data where required to avoid any unsuitable terrain or obstacles. • Estimated maximum surface disturbance of 19.0 ha, noting that all efforts will be deployed to avoid clearing. • Estimated groundwater use ~0.5 – 1.0 ML. • Construction of 2 fenced areas 12 m(L) x 9 m (W) for explosive storage magazines (AS2187) along cleared lines: • Fenced areas to be constructed as per AS1725. • Gates minimum 4 m opening. • Surface within the magazine storage area to be smooth and free of debris, loose zones and soft spots. • Surface compaction ≥ 100 kPa. • Shot hole drilling for 400 x 20 m depth holes @ 80 mm – 100 mm outer diameter at a shot hole interval of 60 m. • Low disturbance node deployment. • Seismic acquisition, including vibroseis deployment, charge detonation and data collection. • Rehabilitation of cleared lines and shot holes by respreading any windrowed soil and reinstating vegetation from stockpiled area back across the seismic line.
Total disturbance and rehabilitation (approx.)	139.66 ha	Final rehabilitation activities to return all sites back to a safe, stable and non-polluting form consistent with pre-disturbed condition: • 119.26 ha new clearing across all sites, including seismic. • 20.40 ha approved clearing across Kyalla 117 N2site.

3.1.1 Workforce

The estimated workforce numbers across construction, drilling, hydraulic fracture stimulation, well completions and 2D seismic activities are provided below:

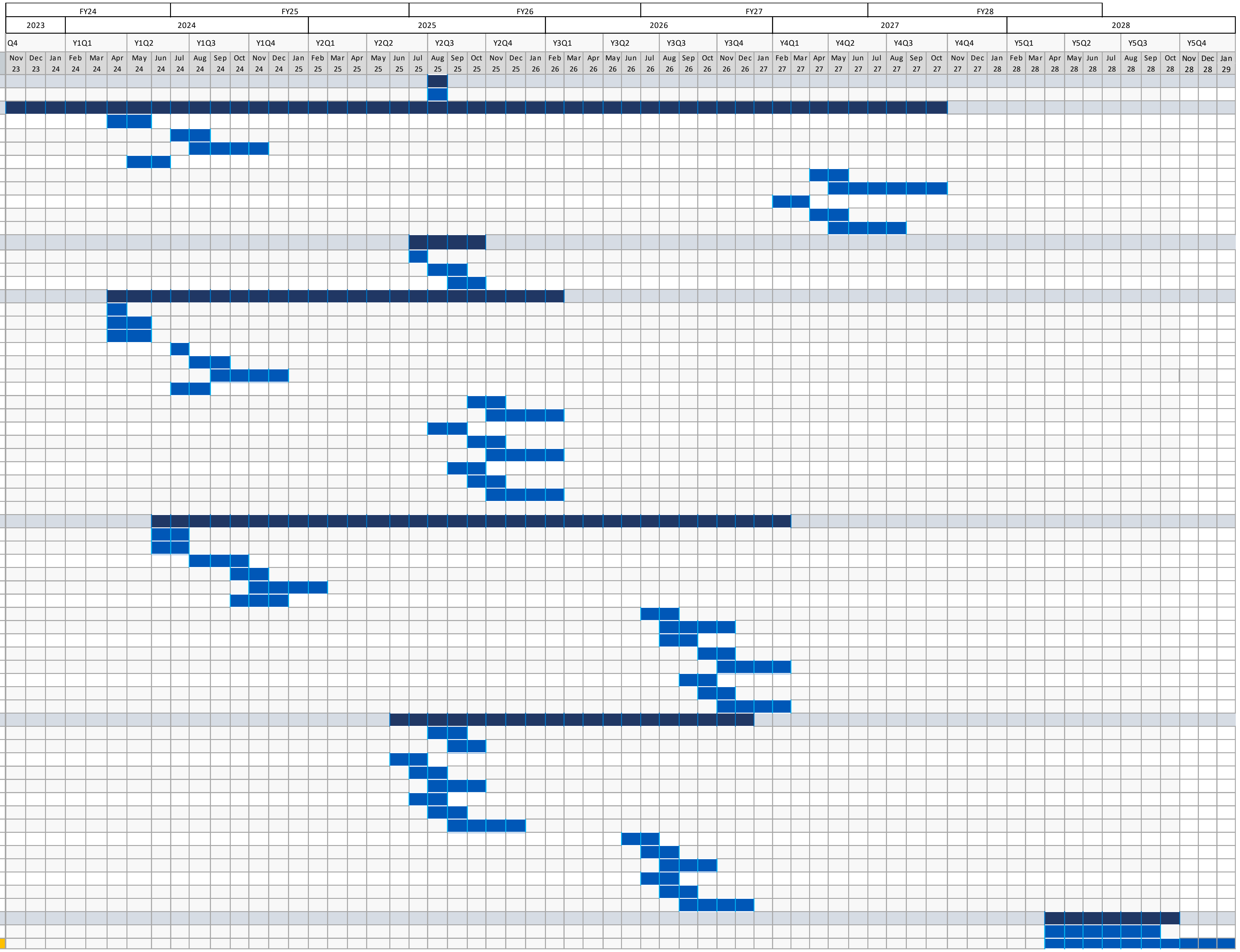
Activity	Workforce
Construction	8 - 12
Drilling	
Drilling set up	10 – 35
Well drilling	70
Rig stack	10 – 35
Stimulation, including mobilisation, stimulation and demobilisation	35 – 85
Completions and extended production testing (EPT)	85
2D seismic acquisition	3 – 11

Approximately 95% of drilling, hydraulic fracture stimulation and well completions workforce would be on a 3-week fly-in-fly-out (FIFO) roster with the balance being drive-in-drive-out (DIDO). The construction workforce will be sourced locally (e.g. 100%), compared with between 3 % - 5% local sourcing for the drilling, stimulation and completions workforce(s), which requires specialty expertise. The 2D seismic workforce will be a 60:40 split between interstate and local hire, respectively. A detailed breakdown of the workforce for the 2D seismic acquisition is provided in section 3.4.7.

3.2 Schedule

The key activity dates for the drilling, HFS and well testing program are provided in Figure 4. It should be noted that the below timeframes and order of activities are indicative, with final dates and decision to complete activities dependent on a range of additional considerations, including access, commercial and joint venture constraints. An update on the project will be provided to DEPWS monthly.

Tasks	Start date	End date
2D Seismic	**1/08/25**	**31/08/25**
Line preparation, acquisition & rehab	1/08/25	31/08/25
Kyalla 117 N2	**1/11/23**	**30/10/27**
x1 approved well - drilling Shenandoah South 2H*, incl mob/demob	1/04/24	31/05/24
x1 approved well - stimulation & clean-up Shenandoah South 2H*	14/07/24	13/08/24
x1 approved well - testing/flaring Shenandoah South 2H**	14/08/24	12/11/24
Well 3 - drilling, incl mob/demob	31/05/24	30/06/24
Well 3 - stimulation & clean-up	2/04/27	2/05/27
Well 3 - testing/flaring	3/05/27	30/10/27
Well 4 - drilling, incl mob/demob	16/02/27	8/03/27
Well 4 - stimulation & clean-up	2/04/27	2/05/27
Well 4 - testing/flaring	3/05/27	1/08/27
Shenandoah North A (SN A)	**14/07/25**	**5/10/25**
Groundwater monitoring/ extraction bores	14/07/25	28/07/25
Construction: Lease pad, camp, bore(s), all assoc infrastructure	27/08/25	17/09/25
Well 1 - E&A well drilling, incl logging, mob/demob & abandonment	17/09/25	5/10/25
Shenandoah South 2 (SS-2)	**1/04/24**	**13/02/26**
Groundwater monitoring/ extraction bores	1/04/24	15/04/24
Construction: Lease pad, camp, all assoc infrastructure	1/04/24	16/05/24
Construction: Gravel pit (SSGP3)	1/04/24	1/05/24
Well 1 - drilling, incl mob/demob	7/07/24	27/07/24
Well 1 -stimulation & clean-up	30/08/24	29/09/24
Well 1 -testing/flaring	29/09/24	28/12/24
Well 2 - drilling, incl mob/demob	27/07/24	16/08/24
Well 2 - stimulation & clean-up	16/10/25	15/11/25
Well 2 - testing/flaring	15/11/25	13/02/26
Well 3 - drilling, incl mob/demob	2/08/25	1/09/25
Well 3 - stimulation & clean-up	16/10/25	15/11/25
Well 3 - testing/flaring	15/11/25	13/02/26
Well 4 - drilling, incl mob/demob	2/09/25	2/10/25
Well 4 - stimulation & clean-up	16/10/25	15/11/25
Well 4 - testing/flaring	15/11/25	13/02/26
Appraisal gas sale		
Shenandoah South B (SS-B)	**24/06/24**	**14/02/27**
Groundwater monitoring/ extraction bores	24/06/24	8/07/24
Construction: Lease pad, camp, bore(s), all assoc infrastructure	24/06/24	24/07/24
Well 1 - drilling, incl mob/demob	23/08/24	22/10/24
Well 1 -stimulation & clean-up	23/10/24	22/11/24
Well 1 -testing/flaring	23/11/24	21/02/25
Well 2 - drilling, incl mob/demob	23/10/24	22/12/24
Well 2 - stimulation & clean-up	30/07/26	29/08/26
Well 2 - testing/flaring	30/08/26	28/11/26
Well 3 - drilling, incl mob/demob	2/08/26	1/09/26
Well 3 - stimulation & clean-up	16/10/26	15/11/26
Well 3 - testing/flaring	16/11/26	14/02/27
Well 4 - drilling, incl mob/demob	2/09/26	2/10/26
Well 4 - stimulation & clean-up	16/10/26	15/11/26
Well 4 - testing/flaring	16/11/26	14/02/27
Shenandoah South C (SS-C)	**1/06/25**	**1/12/26**
Groundwater monitoring/ extraction bores	18/08/25	1/09/25
Construction: Lease pad, camp, bore(s), all assoc infrastructure	1/09/25	1/10/25
Well 1 - drilling, incl mob/demob	1/06/25	1/07/25
Well 1 -stimulation & clean-up	2/07/25	1/08/25
Well 1 -testing/flaring	2/08/25	31/10/25
Well 2 - drilling, incl mob/demob	2/07/25	1/08/25
Well 2 - stimulation & clean-up	2/08/25	1/09/25
Well 2 - testing/flaring	2/09/25	1/12/25
Well 3 - drilling, incl mob/demob	1/06/26	1/07/26
Well 3 - stimulation & clean-up	2/07/26	1/08/26
Well 3 - testing/flaring	2/08/26	31/10/26
Well 4 - drilling, incl mob/demob	2/07/26	1/08/26
Well 4 - stimulation & clean-up	2/08/26	1/09/26
Well 4 - testing/flaring	2/09/26	1/12/26
Well Decommissioning	**1/04/28**	**1/04/33**
All wells (19)	1/04/28	30/09/28
Rehabilitation of site	1/04/28	1/04/33



NOTES:

Activity is not shown in full on the Gantt chart, as it extends past the 5 year life of the EMP and will require submission of an EMP revision. Only estimated timing of the activity is given.

* As per Ministerial approval 22 February 2021.

** Assumes 3 months per well worst case (maximum 6 months as per Ministerial approval, 22 February 2021).

Figure 4: Indicative schedule of activities

3.3 Site Settings

3.3.1 Site selection

Each of the existing and proposed exploration sites within the Shenandoah South E&A Program were 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 regional and local flow and flooding
- Areas of cultural significance
- Homesteads and communities
- Existing pastoralist groundwater extraction bores
- Major road(s).

All site selection and subsequent clearing will be undertaken in accordance with the NT Land Clearing Guidelines, with particular attention paid to the implementation of buffers to protect drainage lines, watercourses or sensitive vegetation communities and to improve public amenity (DEPWS 2021).

This approach also recognised that further changes to infrastructure location may be required at the request of the pastoralist, to avoid a cultural/ environmental find or due to operational requirements (i.e. changes in geological understanding or to satisfy permit work requirements). Where infrastructure is proposed to be relocated, Tamboran will follow the change management steps described in section 8.12.

A buffer of approximately 1 km has been applied to each exploration site as shown in Figure 5. The buffer zone is necessary to accommodate outcomes of ongoing pastoral engagement and reduce clearing in areas of environmental or cultural heritage sensitivity identified during construction (e.g. large trees, hollows, dense vegetation or cultural heritage finds). Any movement of well pads within the buffer will comply with the requirements of cl A.3.2.2(a) of the Code, and be completed in accordance with Tamboran's management of change protocols (refer section 8.12).

Approximate separation distances to the nearest environmental and community receptors from each site are shown in Figure 6 and summarised in the following sections.

3.3.2 Location and disturbance summary of activity

The Shenandoah South E&A program is located on the Shenandoah, Shenandoah East, Hayfield and Beetaloo pastoral stations, within EP 117 and EP 98.The location of the regulated activities are illustrated in Figure 5. The boundary of this EMP is defined as the area which may be affected by E&A regulated activities within the vicinity of the proposed Shenandoah South area as illustrated in Figure 5 and summarised in Table 10.

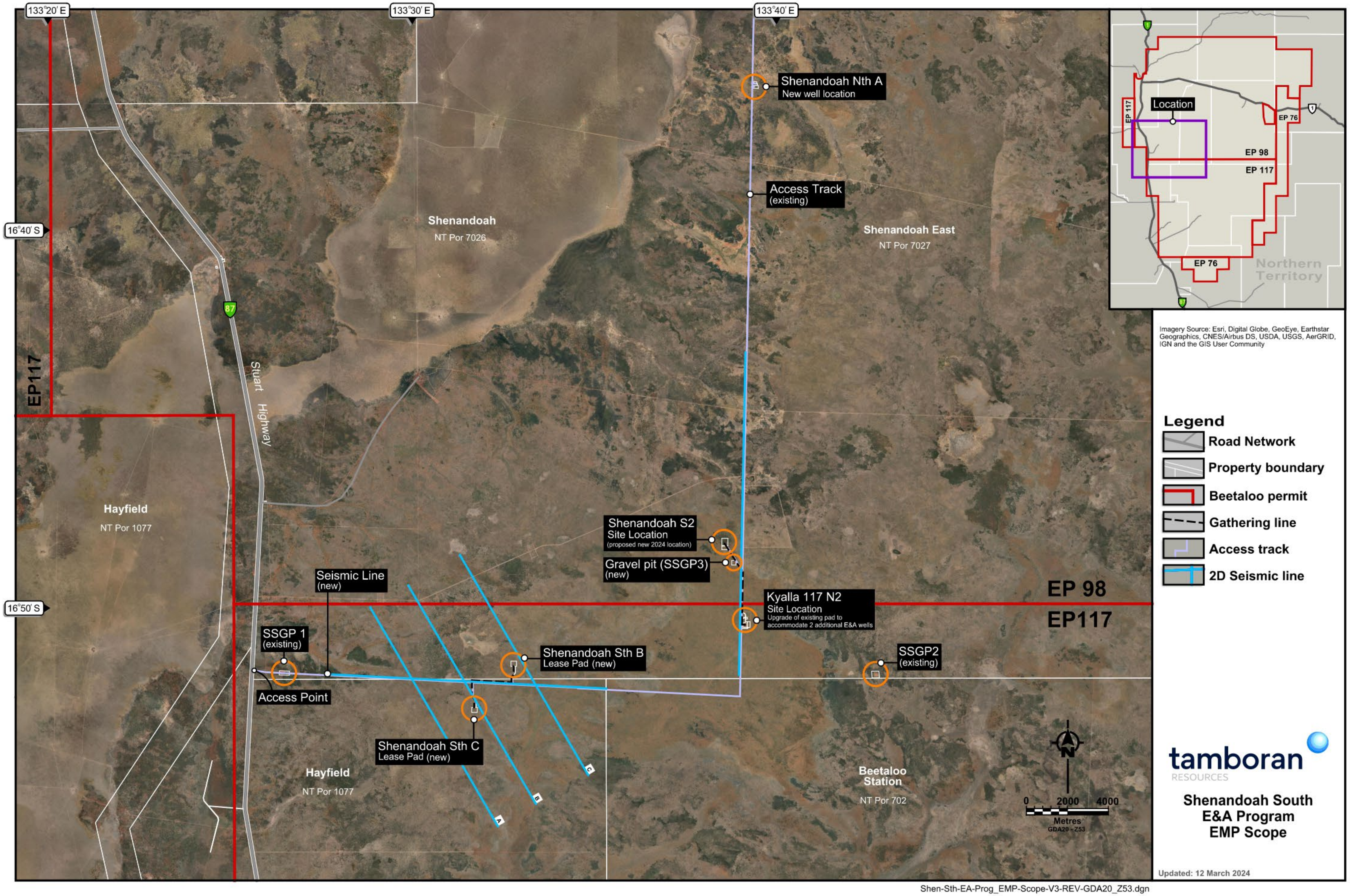


Figure 5: Location of all sites, associated infrastructure and the proposed 2D seismic program covered by this EMP

Table 10: Location and disturbance summary of infrastructure on EP 117 and EP 98

Infrastructure	EP	Zone*	Easting (approx.)	Northing (approx.)	Existing disturbance (ha)	New proposed disturbance (ha)	Total disturbance (ha)
Kyalla 117 N2: well pad, access track(s) and associated infrastructure [22]	117	53	356379.72	8137498.48	11.65	4.30	15.95
Kyalla 117: gravel pit SSGP1 (former gravel pit A)	117	52	333877.96	8135080.04	2.50	-	2.50
Kyalla 117: gravel pit SSGP2 (former gravel pit 3)	117	53	362753.93	8135089.25	6.25	-	6.25
Shenandoah S2: well pad, access track and associated infrastructure	98	53	355291	8140676	-	29.50	29.50
Shenandoah S2: gravel pit SSGP3	98	53	355823.97	8140510.08	-	5.00	5.00
Shenandoah S B: well pad, access track(s), laydown and associated infrastructure	117	53	345035	8135464	-	23.30	23.30
Shenandoah S C: well pad, access track(s) and associated infrastructure	117	53	343471	8133330	-	17.30	17.30
Gathering line: Kyalla 117 N2 to/from Shenandoah S2 (start to end)	117 & 98	53	356274 355060	8137505 8140071	-	4.50	4.50
Gathering line: Shenandoah S B to / from Shenandoah S C (start to end)	117	53	345035 343442	8135461 8133331	-	4.11	4.11
Shenandoah N A: well pad, camp pad, access track(s) and associated infrastructure	98	53	356687	8163762	-	12.00	12.00
Seismic: Shenandoah South Line A (13.00 km)**	117	53	337174.05 346089.96	337174.05 8128616.75	-	6.50	6.50
Seismic: Shenandoah South Line B (12.50 km)**	98 & 117	53	341094.69 349560.21	341094.69 8131483.21	-	6.50	6.50
Seismic: Shenandoah South Line C (12.50 km)**	98 & 117	53	338588.93 347420.93	338588.93 8129410.23	-	6.25	6.25

[22] The combined disturbance approved under the *Beetaloo Basin Kyalla 117 N2 Civil Construction EP117 EMP*, approved 6 June 2019 and *Beetaloo Basin groundwater monitoring bore installation program – Kyalla 117 EMP*, approved 10 December 2018, excluding gravel pit disturbance listed separately.

Infrastructure	EP	Zone*	Easting (approx.)	Northing (approx.)	Existing disturbance (ha)	New proposed disturbance (ha)	Total disturbance (ha)
Seismic: Shenandoah access track(s) seismic line(s) (39.00 km)**	98 & 117	53	332988 356365	332988 8150204	-	-	-
Total clearing (ha)					20.40	119.26	139.66
*Universal Transverse Mercator geographic coordinate system is Geocentric Datum of Australia 94. **Footprint area for 2D seismic based on 5 m wide seismic lines.							

3.3.2.1 Surface Disturbance – Regional Context

Including clearing proposed under this EMP, the combined land clearing on EP 117 and EP 98 from Tamboran's activities is ~320 ha, which represents ~0.019% of the combined surface area across the two EPs (16,675 km^2). Including new clearing proposed under this EMP (118.51 ha), the combined surface disturbance from all Tamboran activities is ~325 ha across 3 EPs (18,555 km^2), or ~0.018% of the total surface area.

Table 11 shows the estimated cumulative clearing across Tamboran's and neighbouring EPs by onshore petroleum operators. Onshore petroleum activities have a disturbance below <0.02% of the total surface area of all current operational EPs. This figure (~888 ha) is highly conservative, as it indicates approved clearing levels and not actual clearing levels. Compared to the approved clearing (2003 – 2023) on neighbouring pastoral stations within the Barkly/Gulf districts (~26,000 ha), land clearing for onshore petroleum activities is negligible. [23]

Table 11: Approximate cumulative surface disturbance (%) vs EPs (all interest holders)

Interest holder	EP	Exploration permit areas		Clearing	Land clearing
		km^2	ha	ha	%
Tamboran	117	6,375	637,500	144.76	0.0227
	98	10,300	1,030,000	172.50	0.0167
	76	1,880	188,000	7.65	0.0041
Sweetpea (a wholly owned subsidiary of Tamboran)	136	4,181	418,100	212.00	0.0507
Santos	161	13,350	1,335,000	99.20	0.0074
Imperial	187	2,998	299,800	252.00	0.0841
TOTAL		**39,084**	**3,908,400**	**888.11**	**0.0227**

3.3.3 Proximity to environmental and community receptors

3.3.3.1 Shenandoah S2, Shenandoah S B and Shenandoah S C

The Shenandoah S2, S B and S C sites are characterised as a mixture of eucalypt woodland, with extensive areas of Lancewood (*Acacia shirleyi*) / Bullwaddy (*Macropteranthes kekwickii*) vegetation (refer section Vegetation communities). Proximity of the proposed sites to environmental and community receptors and features of interest, including Tamboran's existing sites is provided in Figure 6 and Table 12. The closest receptors to these sites include: a pastoral bore (~9 km from Shenandoah S C), the Stuart Highway (~11 km from Shenandoah S B); and nearest major water course (i.e. stream order 3 or above), greater than 20 km from all three sites.

All three well pads are located outside the minimum riparian buffer requirement of 25 m (refer Table 19 of the NT Land Clearing Guidelines) (NTG, 2021). Surface water flows from the well pad areas will be low velocity sheet flows that only occur during rainfall events. The nearest drainage depression is located 1.5 km down gradient of the Shenandoah S B well pad to the south-east.

[23] See pastoral land clearing applications and permits: https://nt.gov.au/property/land-clearing/pastoral-land/pastoral-land-clearing-applications-and-permits.

3.3.3.2 Shenandoah N A

The Shenandoah N A site is characterised as predominantly *Acacia shirleyi* mid-high woodland within the Sturt Plateau (refer section 4.2.2). Lancewood is known to contain a sparse understorey of grasses and herbs. Lancewood stands are relatively species poor for both associated plants and vertebrates (Woinarski and Fisher, 1995). The nearest riparian surface water receptor is an intermittent stream (stream order 1), that is located over 450 m east of the Shenandoah N A well pad, which is well outside the NT Land Clearing Guideline for riparian areas of 25 m (NTG, 2021). The well pad is also situated east and adjacent to an AAPA restricted works area and AAPA recorded sacred sites extension area (see Appendix K and Appendix L).

Proximity of the proposed Shenandoah N A to environmental and community receptors and features of interest, including Tamboran's existing sites, is provided in Figure 6 and Table 12.

3.3.3.3 Kyalla 117 N2

Kyalla 117 N2 is an existing site, which was approved for construction by the Minister on 6 June 2019. The Kyalla 117 N2 site is characterised as *Corymbia* low woodland/*Terminalia* (mixed) sparse shrubland / Chrysopogon (mixed) low tussock grassland. This vegetation community is considered regionally extensive and not subjected to extensive clearing.

The site consists of a sump, groundwater bores, Kyalla 117 N2-1H well, wastewater tanks, camp pad, helipad (Figure 2). The site is currently active, with drilling of the Shenandoah S-1H well completed in September 2023 under the *Kyalla 117 N2 drilling, stimulation and well testing Multiwell EMP* (ORI 6-3) – see Table 1 and Appendix A. [24]

The total disturbance footprint of the well pad area and ancillary areas, including new clearing on the well pad and camp site (4.30 ha) will be ~15.95 ha, excluding gravel pits and gathering lines between the Kyalla 117 N2 site and the Shenandoah S2 site (Table 10). All clearing will occur within the existing site fencing.

Proximity of the existing Kyalla 117 N2 to environmental and community receptors and features of interest, including Tamboran's existing sites is illustrated in Figure 6and Table 12.

3.3.4 Seismic lines A, B and C

The seismic lines lie predominantly within *Corymbia dichromophloia* ± *Erythrophleum chlorostachys* open woodland over *Acacia difficilis* ± *Terminalia canescens*, *Erythrophleum chlorostachys* open shrubland over hummock grassland. Patches of Lancewood (*Acacia shirleyi*) also occur within the proposed transects.

A section of floodplain and drainage depressions intersect with current alignment of Seismic Line B and C. Measures to minimise impacts on floodplain and drainage depressions during seismic line preparation would be in the first instance to avoid clearing of trees on Palustrine Systems (depressions) or Floodplain systems where possible. Based on the description of interfering with a water way under the NT *Water Act* 1992 it is considered that the proposed seismic line activities will either not cause a material change or alteration (Not Material) or occur generally in lower stream order 1 (Low). Under this definition, it is unlikely a permit to interfere with a waterway would be required, although an application would be submitted to DEPWS Water Resources Branch should it be required.

The maximum total disturbance footprint is approximately 19 ha, however this should be significantly less, as existing cleared areas will be used where possible, and lines will be designed to avoid any large habitat trees, sensitive flora and drainage depressions. Line preparation is discussed further in section Line preparation.

Proximity of the seismic lines to environmental and community receptors and features of interest, including Tamboran's existing sites, is illustrated in Figure 6 and Table 12.

[24] The regulated activities currently being undertaken under the Kyalla multi-well EMP are incorporated into this EMP.

Table 12: Environmental and community receptors – approximate separation distances (km)

Receptor	Kyalla 117 N2 (km)	Shenandoah S2 (km)	Shenandoah S B (km)	Shenandoah S C (km)	Shenandoah N A (km)	Seismic Lines A, B, C (km)
Nearest pastoral bore	16	16	19	9	12	11 – 38
Nearest homestead	21	17	15	16	22	18 – 43
Nearest community	31 Dunmarra	28 Dunmarra	24 Dunmarra	25 Dunmarra	27 Dunmarra	19 Dunmarra
Nearest indigenous community (Jingaloo)	31	35	29	27	58	37 – 53
Stuart Highway	20	22	11	14	32	28 – 35
Carpentaria Highway	62	57	62	64	35	62 – 64
Bullwaddy Conservation Reserve	71	63	82	85	63	81 - 87
Frew Ponds	28	32	21	18	49	16 – 21
Lake Woods	92	100	93	91	122	91 – 93
Nearest mapped water course	13	7	22	21	9*	10 - 15
Archaeological site	No archaeological sites recorded	No archaeological sites recorded	No archaeological sites recorded	No archaeological sites recorded	No archaeological sites recorded**	No archaeological sites recorded
* NB: The closest intermittent creek (stream order 1), is located 450 m east of the proposed site. ** One Restricted Work Area (RWA) is identified to the west of the Shenandoah N A site (RWA3), parallel to a portion of the north-south pastoral access track leading to the site. Sacred sites within the RWA are over 3 km away from the Shenandoah N A.						

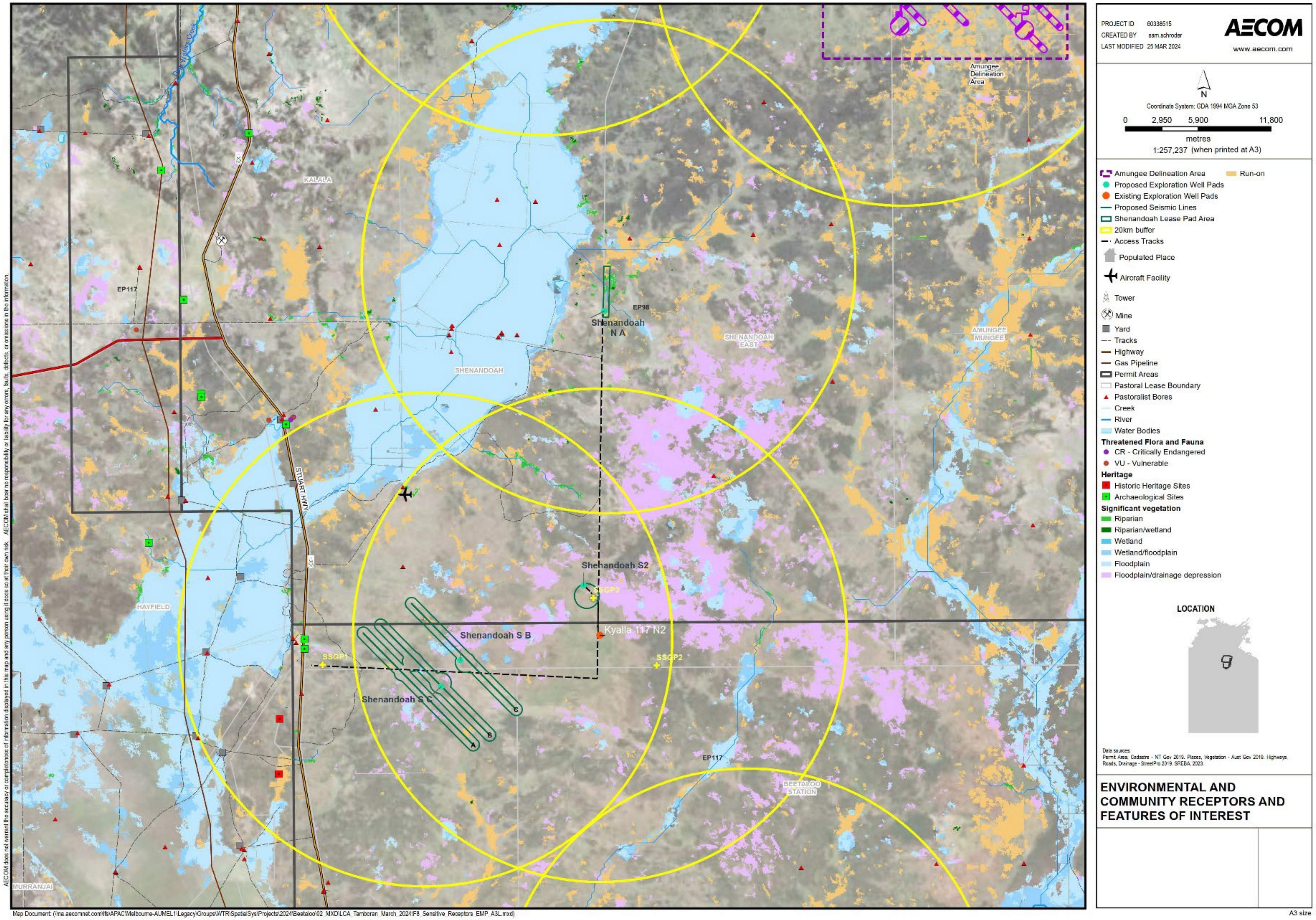


Figure 6: Proximity of environmental and community receptors and features of interest to all Tamboran's existing and proposed new exploration sites

3.4 Seismic survey

Approximately 77 km of 2D seismic acquisition will be completed (Figure 7)[25] comprising:

- 38 km of 2D seismic acquisition in the vicinity of the Shenandoah SB and SC well pads:
- Line A – 13.0 km (6.50 ha)
- Line B – 12.5 km (6.25 ha)
- Line C – 12.5 km (6.25 ha)
- 39 km of 2D seismic acquisition will occur along existing access tracks.

The seismic survey will involve a maximum ground disturbance of up to 19.0 ha (Table 10). The actual vegetation clearing level is likely to be significantly lower through the deployment of clearance avoidance measures. The cumulative impact of surface disturbance across EPs is discussed further in section 3.3.2.1.

Seismic surveys use a sound wave source from an energy source at the surface to propagate sound waves into the earth. The sound waves that reflect off underground rock formations are captured by recording sensors called geophones. Analysing the time sound waves take to return provides valuable information about rock types and an estimate of depth for rock formations. The returning reflections are recorded in a digital format and sent to a seismic data processing centre to produce a cross-section image of the layers of the earth's crust (process seismic image).

The proposed seismic survey will be undertaken with two different energy sources, seismic charges and vibroseis trucks. The two energy sources proposed for this survey, to determine the most suitable energy source method for future seismic surveys. Seismic charges are specifically being trialled against the use of the standard vibroseis methods, to evaluate whether this survey method could increase data quality, whilst lowering vegetation clearing requirements.

Estimated groundwater use during the seismic acquisition is approximately 0.5 – 1.0 ML.

3.4.1 Line preparation

Over 61% of the vegetation community in the vicinity of the proposed seismic lines A, B and C is characterised as mid-high open woodland dominated by *Corymbia dichromophloia* ± *Erythrophleum chlorostachys*.

Seismic line preparation will be required so that the vibroseis trucks can drive and operate over the survey area. Survey lines will be installed across the proposed survey area in a SE to NW direction. Seismic lines will be approximately 5 m wide with a small turning circle constructed at the end of each seismic line to allow equipment and vehicles to exit. To reduce disturbance, existing cleared areas will be used where possible.

Seismic lines will be situated to avoid any large habitat trees or sensitive flora through weaving a path of least resistance, with no material vegetation clearance to be undertaken in watercourses or associated riparian vegetation (included drainage depression). In areas with low vegetation density (such as *Corymbia / Erythrophleum* open woodland) ground disturbance will be restricted to running a dozer blade over the surface to remove rocks, fallen branches and shrubs to provide effective ground contact of the seismic vibro-source and minimise the risk of fire. Where vegetation clearance in unavoidable, such as within stands of lancewood (*Acacia shirleyi*) and Bullwaddy (*Macropteranthes kekwickii*), vegetation will be cleared with a D8 dozer and grader. Felled vegetation will be pushed to the edge of the line and will be pulled back across the line during rehabilitation. Slashing can be used in otherwise untraversable

[25] Seismic will only occur on access tracks that are adjacent to, or on NT Portions 1077, 7076 and 7027. Seismic will not occur along any access track that is adjacent to, or on NT Portion 702, Beetaloo Station.

vegetation. Deviations in lines must be constructed in a way that is accessible by equipment/vehicles such as heavy-rigid body trucks (minimum 15 m turning radius).

Cultural managers (Native Title holders) will be utilised to inspect all cleared areas prior to clearing/ access. Where artefacts/ areas of significance are identified, they will be avoided. Any finds will be documented (described, photographed and GPS located) and records sent the NT Heritage Branch and NLC.

A 250 m buffer /deviation from either side of the centreline pre-plot data where required to avoid any potential artefact finds, unsuitable terrain or obstacles.

To reduce the risk of bushfire, a spotter vehicle with a fire tender will also be used during clearing activities. Any fires detected will be promptly put out. To further reduce the risk of fire, no vegetation mulching is proposed.

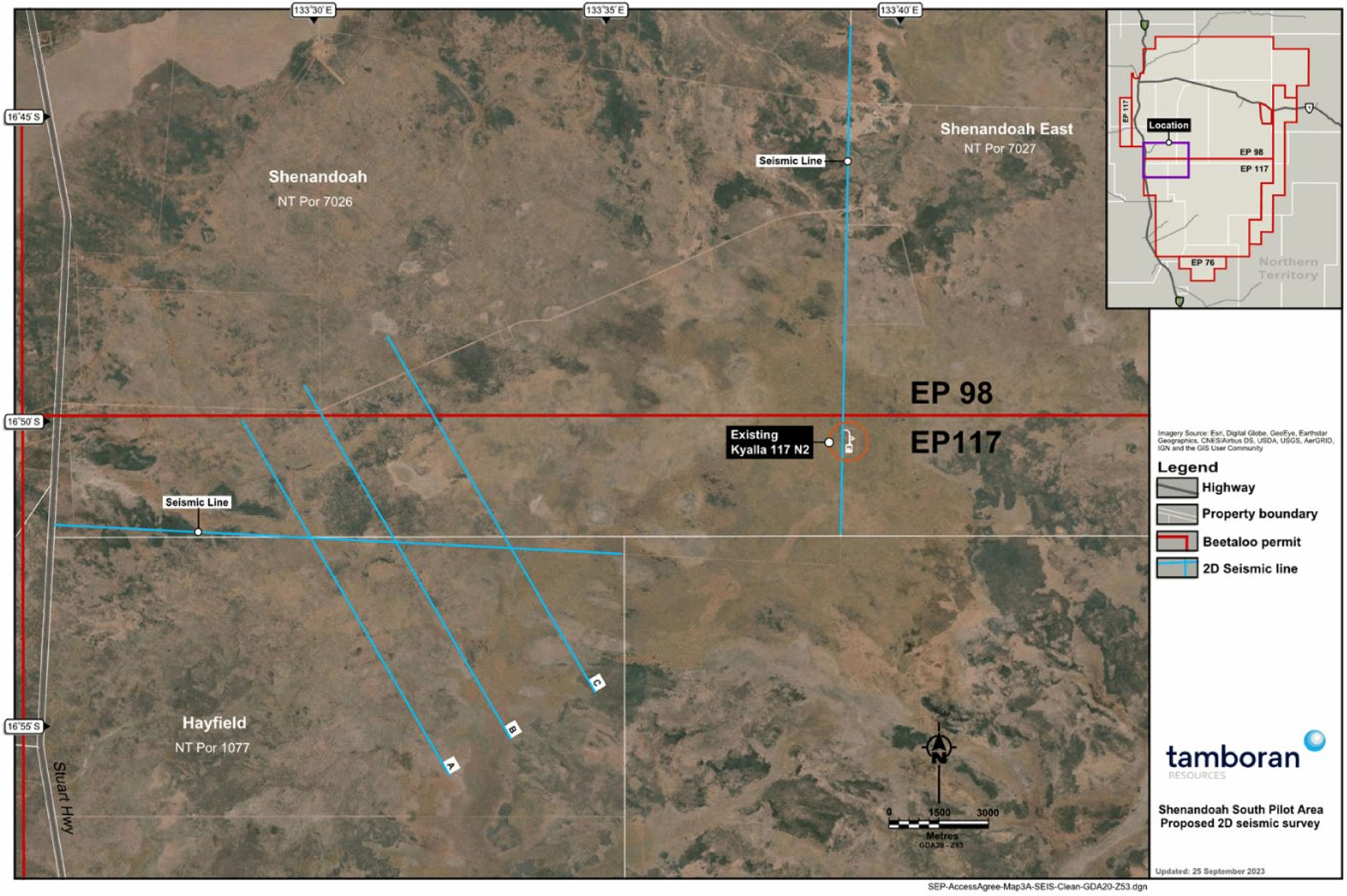


Figure 7: Proposed 2D seismic acquisition

3.4.2 Shot installation

Seismic acquisition using small dynamite charges reduces the required land clearing substantially (~90% less clearing). Small charges are placed at 15 – 20 m below the ground surface by light 4WD (four wheel drive) vehicle or equivalent (Figure 8), such as tractor mounted rigs or trailer mounted rigs towed with bobcats. Although not the preferred method, helicopters may also be used to move drilling rigs around. Explosives will be stored on site in a portable magazine which adheres to Australian Standards.

Figure 8: Example of a small rig that could be used for installing dynamite charges during a seismic survey

This approach reduces the need to clear vegetation, with the charges being able to be placed around vegetation to reduce clearing. Small amount of clearing may still be required to access extremely dense vegetation, but this should be minimal.

A 1 kg charge of Geoprime dBX high performance pentolite explosive will be utilised. This explosive is specifically designed for seismic surveying. The charges are packed in place within each shot hole, with the blast contained within the subsurface (i.e. no expulsion of earth from the surface). Shotholes consist of drilling for 400 x 20 m depth holes at an outside diameter of 80 mm – 100 mm. The shothole interval is approximately 60 m. Figure 9 is an example of a typical small seismic charge used during a New Zealand seismic shoot.

Figure 9: Example of loaded charge in hole ready for detonation and example of a charge used in dynamite seismic survey acquisition; charge length is approximately 400 – 500 mm

Misfires are considered rare and are likely to have a rate of less than 1%. In the event of a misfire, a drill rig will be on standby to drill and load a new charge offset at approximately 2 m. The detonation of a second charge within proximity usually causes a sympathetic detonation or at a minimum break the plastic seal to accelerate bioremediation of the charge. The success of sympathetic detonation is considered almost 100%- based on the service provider feedback on similar sized surveys. All misfires and the success of sympathetic detonations will be logged during the seismic survey, including Global Positioning System (GPS) coordinates and depth. Where sympathetic detonation cannot be validated, a small metal cattle proof marker shall be installed to inform the land users of the location of the hazard. These will be provided to DEPWS and the pastoralists.

Should the sympathetic detonation not occur, millions of freeze-dried microorganisms (along with nutrients for those microorganisms) are cast directly into the GEOPRIME dBX seismic booster during production. When these naturally occurring organisms are submerged in water, they become activated, as designed, and begin to slowly bio transform the undetonated GEOPRIME dBX. When the biotransformation is complete, the compounds are no longer explosive. In the remote chance biotransformation is not successful, the charge is located 15-20 m below ground level isolating it from potential existing and future land users in the area.

Charges will be offset from infrastructure (see Table 13). Offsetting distances from ecological features will be in accordance with Table 18 and Table 19 of the NT Land Clearing Guidelines (DEPWS, 2021), depending on the feature / sensitivity value. When detonation occurs all personnel under the instruction of the shot firer are to observe safe set back distances (20 – 25 m). A short sharp thud will be heard, and potential small level of vibration felt within 1 – 2 km of charge going off.

3.4.3 Geophone installation

The receivers (nodal geophones) will be hand carried along lines and put into the ground, usually deployed with a handheld drill and auger bit light 4WD vehicles or ATVs. The nodal geophones are autonomous units, containing the actual geophone as well as battery and data storage in one unit. These nodes are deployed at regular intervals along the non-cleared lines perpendicular to the source lines, these may be able to be carried through areas of riparian vegetation to avoid any damage to vegetation where access permits. The installation of nodes requires minimal disturbance (Figure 10).

Figure 10: Example of a deployed node

3.4.4 Survey execution and data collection

If the use of dynamite is not feasible, vibroseis trucks will be used for the seismic source. A vibroseis survey involves the establishment of cleared source lines for the vibroseis trucks to operate on. The survey is orientated NW to SE to align with the existing horizontal well Azimuths. Line clearing will be required so that the vibroseis trucks can drive and operate over the survey area (Figure 11). All source lines will be cleared with a dozer of reader to a width of 5 m. However, to reduce disturbance, existing cleared areas will be used where possible. The line position, plus tolerances for weaving the line around vegetation etc are pre-programmed into GPS units.

Seismic lines will be located to avoid any large habitat trees or sensitive flora, with minimal clearance to be undertaken in watercourses and associated riparian vegetation. In areas with low vegetation density (such as *Corymbia / Erythrophleum* open woodland) ground disturbance will be restricted to the removal of rocks and fallen branches and the slashing of grasses and shrubs to provide effective ground contact of the seismic vibro-source and the geophones and minimise the risk of fire (Figure 12).

Figure 11: Example of a vibroseis truck used during seismic acquisition

Figure 12: Data recording van used during seismic acquisition

In relation to potential impacts of seismic on livestock, cattle will be mustered away from the seismic area prior to commencement of the activity, in consultation with pastoralist. From a noise and vibration perspective, the vibroseis does not create an intrusive level of noise and vibration. The vibration is of less intensity than a cattle truck crossing a cattle grid. As discussed above, a short sharp thud will be heard, and potential small level of vibration felt within 1 km of charge going off; however, with cattle being mustered away from the activity, this should not result in any significant impact.

It is envisaged that the vibroseis truck will make 2 passes per seismic line.

3.4.5 Rehabilitation

Within 2 – 6 weeks of completion of seismic acquisition, the seismic acquisition area (lines and shot holes) will be rehabilitated immediately. The felled vegetation will be returned across the seismic line upon completion of seismic activities to aid in assist in erosion and sediment control. Root stocks are to be left in place as much as practicable to allow for rapid re-establishment of vegetation.

Drill holes will be progressively remediated after firing. Detonation wires will be pulled out and the hole and remaining cuttings will be returned down the hole. A cap will be emplaced 50 cm down the hole and the hole will be backfilled to ensure load bearing and no surface depression is left that might cause injury to cattle or native fauna.

Based on previous experience in the region, most areas will naturally regenerate following rehabilitation following the wet season. Rehabilitation monitoring will occur on an annual basis until the vegetation has become re-instated, with maintenance on rehabilitated area undertaken as required (refer Appendix O).

3.4.6 Infrastructure buffer zones

Buffer zones are applied around infrastructure to minimise the impacts from seismic surveys. These are summarised in Table 13. Tamboran will comply with these buffers and ensure activities are not completed within the stipulated buffer.

Table 13: Seismic survey buffer zones

Infrastructure type	Buffer (m)	
	Seismic charge	Vibroseis
Pipeline	100	50
Water bore	250	100
Active cattle holding yard	250	100

3.4.7 Vehicles and workforce

The estimated number of vehicles and workforce for the seismic campaign are provided in Table 14.

Table 14: Estimated number of vehicles and personnel for the 2D seismic acquisition

Vehicles	Quantity
Line preparation	
4x4 tray top light vehicle	1
Dozer	1
Grader	1
Support 4 x 4 vehicle	2
Total	6
Line restoration	
Grader	1
Excavator (20t)	1
4x4 vehicle	1
Total	3
Dynamite Drilling	
Drilling rig	1
4x4 Support vehicle	1
Total	2
Recording crew – layout and pickup	
4 x 4 dual cab vehicle	2
4 x 4 tray top – line manager	1
4 x 4 tray top – line crew	1
Total	4
Recording crew – vibroseis / weight drop	
Source controller truck	1
Vibroseis	1
Quality control and seismic processing field office truck	1
Generator trailer	1

Vehicles	**Quantity**
Technician service truck	1
Total	5
Recording crew – dynamite	
4x4 support vehicle	1
Total	1
Workforce	
Advance line preparation and survey crew	Quantity
Crew manager	1
Mechanic	1
Supply driver	1
Total	3
Line preparation crew	
Machine operator	2
Mechanical support	1
Line pointing surveyor	1
Water truck driver	1
Total	5
Dynamite Drilling	
Driller	1
Offsider	1
Loader	1
Total	3
Recording crew	
Crew manager*	1
Harvester operator	1
Line crew	6
Vibroseis technician/mechanic	1
Vibroseis operator	1
Supply driver*	2
Total	11
Line restoration crew – if required	
Machine operator (grader and excavator)*	2
Mechanical support*	1
Crew manager*	1
Surveyor*	1
Paramedic*	1
Total	6
* These positions are sourced from previous crew personnel	

3.5 Groundwater monitoring and extraction bores

New control and impact groundwater monitoring bores will be installed at each of the new exploration sites to satisfy condition B.4.17.2 of the Code. These bores are designed to monitor upgradient (control) and downgradient (impact) of exploration wells proposed to be stimulated. Sampling of the new bores will be initiated as soon as possible upon completion, to collect the required baseline data prior to drilling and stimulation as per Clause B.4.17.2(b) of the Code. Further information on the groundwater monitoring program is provided in section 3.27.1. These monitoring bores will also be utilised to supply groundwater to support exploration activities.

Up to 10 groundwater monitoring / extraction bores will be installed at each of the 3 Shenandoah South sites. Up to 2 new groundwater bores will also be drilled at Shenandoah N A and 5 new bores at the existing Kyalla 117 N2. Totalling 37 new bores (refer Table 9).

The groundwater monitoring bores will be installed on the proposed activity area (either on the well pad, camp pad or laydown area) at each site within the Anthony Lagoon and Gum Ridge Formation. The extraction bores will initially extract water from the Gum Ridge Formation, which corresponds to Tamboran's approved WEL GRF 10285. To meet future exploration activity requirements, Tamboran will seek to increase the WEL licence take from 175 ML and target the Anthony Lagoon Beds.

The groundwater bores will be drilled and constructed by a licenced water bore driller and in accordance with the current version of the *Minimum Construction Requirements for Water Bores in Australia* (National Uniform Drillers Licensing Committee ((NUDLC), 2020). A qualified hydrogeologist will supervise the drilling activities and will determine the appropriate screening depth of each bore. Each aquifer intersected will be isolated from overlying aquifers with a cemented casing string. Drilling will be undertaken with air or mud rotary techniques. If mud rotary techniques are employed, the circulation fluid will be water based and will use standard water bore drilling polymer or bentonite-based density and viscosity modifying additives.

Each bore will be completed with a self-draining concrete block centred on the bore casing constructed at the surface; 1 m^2 x 75 mm above the final ground surface and 25 mm below final ground surface. This provides further protection of the underlying aquifer from any surface spills.

A bore construction permit will be obtained for each bore, and they will be added to Tamboran's WEL GRF 10285 if additional production bores are required to meet the water requirements at each site.

A survey of each bore will be undertaken in Australian Height Datum to accurately determine depth to water table. Within 28 days of bore completion, the driller will provide a statement of bore (Form 21) with registered number, which will be provided to DEPWS. All cuttings and drilling mud will be disposed as per the *Minimum Construction Requirements for Water Bores in Australia* (NUDLC, 2020).

3.6 Civil construction and maintenance

3.6.1 Well pads, and associated infrastructure

The proposed civil construction activities are summarised in Table 9 include:

- Construction/ expansion of a well pads
- Construction of camp pads
- Construction of helipads
- Construction of a laydown
- Construction of fence line and firebreak
- Clearing, upgrading, forming and maintenance of access tracks, including bitumen sealing of Stuart Highway
- Civil maintenance of existing and new infrastructure

Equipment and machinery likely to be used during construction works include:

- Excavators
- Dozers
- Graders
- Rollers
- Water carts
- Haulage trucks
- Bob cats
- Light 4WD vehicles
- Bitumen spray and seal trucks (the access track intersection with the Stuart highway)
- Site offices and crib huts

Each proposed disturbance area will be cleared of vegetation. Prior to clearing, the areas will be walked down to identify the presence of fauna prior to clearing activities. Where fauna is encountered, clearing will cease in the immediate area until the fauna has moved on. Felled vegetation will be pushed up along the edges of the well pad to aid in erosion and sediment control.

Following vegetation clearing, the new disturbance areas will be stripped of up to 150 mm of topsoil, with the topsoil stockpiled around the edge of the well site or on the designated stockpile area. The stockpiled topsoil will be used a growth medium to support vegetation reinstatement. The topsoils will be allowed to germinate with native species from the area to maintain soil condition and seed bank.

The stockpile depth will typically to be less than 1.5 m (anticipated depth ~1m) to maximise viability of the topsoil for future use. Seed bank viability in the lower half of the stockpile may become compromised, however the upper levels are likely to continue to provide a valid seed bank. Furthermore, the vegetation community in the area are adapted to soils lacking in nutrients, there is low to no rainfall for over 8 months of the year and occur in free draining soils. The vegetation community is adapted to the harsh conditions that occur in a semi-arid area and likely to recover quickly post rehabilitation.

The proposed timeframe for the topsoil to be stockpiled around the well site could be up to 5 years, depending on whether the infrastructure will be required to support future exploration activities.

The topsoil stockpiles around the well pad will also be used to create a bund to prevent wastewater from leaving the site in the event of a tank failure and prevent overland flow entering the site in the event of a significant regional flood. The bund will be of an appropriate height and width (typically 1m x 3m) to contain 110% of the volume of the largest wastewater storage tank on site. Bunds will be constructed in accordance with the following:

- Sticks and roots will be raked from the topsoil
- Topsoil supplied in 300mm layers that are compacted prior the application of the next layer.
- Additional material, such as gravel or subsoils may be required in areas to increase the bund stability- determine by the field construction manager.
- Bunds to be watered within the first 2 weeks to enable vegetation establishment

This methodology of bund construction has been successfully utilised at sites such as Kyalla 117 N2, Velkerri 76 S2 and Amungee NW.

Once the site has been stripped of topsoil, the cleared areas will be grubbed to remove roots and rocks, levelled, compacted and sheeted with gravel to aid forming the working surface. The compacted surface will also minimise the infiltration of any spills and allow for material recovery. The well pad will be constructed with an approximate 0.2° fall, terminating at a purpose-built stormwater retention basin to manage rainfall that falls on the lease. The retention basin will only be in operation during stimulation and well testing activities, with the basin being removed at other times/ not operated. Any stormwater collected will be beneficially used on-site (for dust suppression within the activity area) or tested prior to release outside of the approved activity area (i.e. surrounding area). The sites will be fenced with a stock-proof fence to prevent livestock access.

A breakdown of civil constructions activities across the existing and new sites is provided in Table 15.

3.6.2 Access tracks

Most access tracks used to access the sites will be via existing pastoral tracks. New disturbance is predominantly for the construction of access tracks linking the existing access track to the new well pads and upgrading the intersection with the Stuart Highway. Estimated clearing for new access tracks and upgrades to existing pastoral tracks is 20.1 ha, with each track being cleared to a width of 14 m.

Access tracks will be constructed to NTG Pastoral Access Road 2 standards (refer Appendix D). A 2 m road shoulder will be installed to accommodate spoon drains. Land clearing will be undertaking in accordance with the NT Land Clearing Guidelines. The access tracks will be gravelled and regularly maintained to ensure continued access to each site.

The existing access track intersection with the Stuart Highway will also be upgraded and sealed to DIPL specifications. A road corridor permit and traffic control will mitigate the risk to road users.

A breakdown of civil constructions activities across the existing and new sites is provided in Table 15.

3.6.3 Gravel pits

Tamboran proposes to source gravel from a new gravel pit in the vicinity of Shenandoah S2 (SSGP3) on EP 98 and the existing approved gravel pits on EP 117 – SSGP1 (2.5 ha, ~100 m x 250 m) and SSGP2 (6.25 ha, ~250 m x 250 m). SSGP3 will be up to 5 ha in size (see Figure 5). A typical image of a gravel pit in the Beetaloo is provided in Figure 13.

SSGP3 will be cleared, with topsoil and subsoil stripped, segregated and stockpiled onsite for future revegetation. SSGP3 will be progressively constructed up to a final dimension of 200 m x 250 m, with a total depth of less than 3 m (typically 1.5 m). The final size and depth of a gravel pit is determined by the quantity of gravel present on the site and gravel requirements. The pit may be fenced where the pit batters represent a potential fall hazard to livestock and fauna, noting that to date, there have been no recorded fauna or livestock incidents occurring at existing gravel pits. Pit batters are typically 4:1.

Upon cessation of activities, all gravel pits will be recontoured back to a stable, safe and non-polluting form. Subsoils and topsoil will be reinstated across the gravel pit and natural revegetation used as the primary vegetation reinstatement measure. Gravel pit rehabilitation will commence within 12 months once there is no viable gravel left. However, if viable gravel remains, gravel pits may be transferred to the pastoralist subject to approval from DEPWS and the pastoralist.

A breakdown of civil constructions activities across the existing and new sites is provided in Table 15.

Figure 13: A typical operational gravel pit

Table 15: Summary of civil construction activities at all sites (ha)

Infrastructure	Existing (ha)	New (ha)
Kyalla 117 N2		
Well pad	5.25	3.80
Camp pad (increase of 0.50 ha is contingency)	1.00	0.50
Helipad	0.50	
Access track, including turn ins and passing bays	0.9	
Laydown/ storage/ contingent		
Fence line and firebreak	4.00	
Gathering lines: Kyalla 117 N2 to / from Shenandoah S2		4.50
Gravel pit(s): SSGP1 (2.50 ha) & SSGP2 (6.25 ha)	8.75	
Subtotal	~20.40	8.80
Shenandoah S2		
Well pad	-	12.00
Camp pad	-	1.00
Helipad	-	-
Access track, including turn ins and passing bays	-	7.50
Laydown/ storage/ contingent	-	5.00
Fence line and firebreak	-	4.00
Gathering lines: Kyalla 117 N2 to / from Shenandoah S2	Included under Kyalla 117 N2 totals	
Gravel pit(s): SSGP3	-	5.00
Subtotal	-	34.50
Shenandoah S B		

Infrastructure	Existing (ha)	New (ha)
Well pad	-	12.00
Camp pad	-	1.00
Helipad	-	0.50
Access track, including turn ins and passing bays	-	3.30
Laydown/ storage/ contingent	-	2.50
Fence line and firebreak	-	4.00
Gathering lines: Shenandoah S B to / from Shenandoah S C	-	4.11
Gravel pit(s)	-	-
Subtotal		27.41
Shenandoah S C		
Well pad	-	7.50
Camp pad	-	-
Helipad	-	0.50
Access track, including turn ins and passing bays	-	3.30
Laydown/ storage/ contingent	-	2.50
Fence line and firebreak	-	4.00
Gathering lines: Shenandoah S B to / from Shenandoah S C	Included under Shenandoah S B totals	
Gravel pit(s)	-	-
Subtotal		17.30
Shenandoah N A		
Well pad	-	3.00
Camp pad	-	1.00
Helipad	-	-
Access track, including turn ins and passing bays	-	6.00
Laydown/ storage/ contingent	-	-
Fence line and firebreak	-	2.00
Gathering lines	-	-
Gravel pit(s)	-	-
Subtotal	-	12.00
TOTAL	20.40	100.01

3.6.4 Drilling sump construction

To manage drilling waste cuttings and fluids, drilling sumps will be constructed. Depending on operational requirements, these sumps may either be built on each site, or a larger sump will be constructed to manage drilling wastes from multiple sites. Where required, multiple sumps may be installed on a site to assist in managing solids and fluids. Drilling waste will either be discharged directly into a sump from the shakers or stored in tanks/skips adjacent to the rig and transported to the drilling sump as required (typically daily during operations).

Each sump will be constructed with a capacity to manage up to 10,000 m^3 of drilling waste and fluids. The sump will either be installed adjacent to the proposed drilling rig or located at the edge of the well pad. Each sump will be excavated to the required depth, lined with an impermeable liner (such as Coletanche or equivalent). Each sump will be constructed with elevated berms to in a manner to divert overland flow. The liner will be "welded" in place using a heat gun, with joins tested periodically as per the manufacturers' recommended Quality Assurance requirements. An overview of the sump design is provided in Appendix D.

3.6.5 Cellar construction

Cellars will be constructed on each well pad to accommodate the wellhead equipment and blow-out preventer (BOP). Each of the cellars are each approximately 8 m^3, concrete lined and prefabricated off-site (Figure 14). The cellars are transported to the site in one piece and lowered into an excavated pit. A conductor casing (also referred to as a mouse hole) is installed within the cellar to approximately 20 m using an auger. The conductor casing is designed to prevent the upper sections of the exploration well from caving in when drilling through the unconsolidated sediments. The cellar itself will be fenced to exclude fauna.

Figure 14: A cellar prior to installation

3.6.6 Gathering network construction and abandonment

Gathering lines will be constructed as required to facilitate the transfer of high volumes of fluid and produced hydrocarbons safely and efficiently between well pads to a centralised storage area to enable centralised management and fluid recycling (Figure 15). The gathering lines will be constructed at the following locations:

- Shenandoah S B to / from Shenandoah S C: ~4.108 km (4.11 ha)
- Kyalla 117 N2 to / from Shenandoah S2: ~4.5 km (4.50 ha)

Gathering lines will be constructed, operated, maintained and abandoned in line with the *"Code of Practice Upstream Polyethylene Gathering Networks – CSG Industry Version 5.0"*, August 2019 (APGA 2019). Up to two (2) buried low-pressure (~1,500 kPag) 6-inch polyethylene gathering lines will be utilised; one managing water and one managing hydrocarbons. A single co-mingled gathering line may also be utilised where practicable.

The timing of installation will be dependent on positive well test results and the planned well testing schedule of each location. It is anticipated that Shenandoah S2 will be constructed first. As the project progresses Shenandoah S2 and/or Shenandoah S B will become centralised sites to manage produced hydrocarbons and wastewater. Two centralised sites provides greater flexibility for fluids recycling, storage and management.

Fluids transferred in the gathering network may include:

- Drilling and completion fluids
- Flowback fluid and produced water
- Groundwater for pipeline hydrotesting, purging and operational raw water supply (i.e. to reduce the amount of groundwater extraction bores drilled).

Beneficial outcomes of installing and operating a gathering network include:

- Ability to utilise existing installed wastewater containment and wastewater treatment capacity
- Reduced land clearing for storage tanks at each well site
- Reduction in potential environmental impacts and risk from contaminant spills / releases
- Increased capability and capacity for recycling and reuse of fluids between well sites reducing groundwater take
- Reduced wastewater disposal volumes and truck movements
- Reduced capital and operational costs
- Centralised flaring and hydrocarbon management to minimise light pollution from multiple sources.

Gathering lines will be located adjacent to access tracks within existing disturbed areas where practicable.

In some cases, an above-ground gathering line for fluid transfer may be utilised instead of a buried gathering lines. Above ground gathering lines will be temporary and typically used for several months before being purged and decommissioned. Where aboveground water gathering lines are used, these will be designed, constructed and maintained in accordance with *" Code of Practice Upstream Polyethylene Gathering Networks – CSG Industry Version 5.0"*, August 2019 (APGA 2019). This includes being designed to withstand the ambient temperature, have material that is fire resistant (such as High Density Polyethylene (HDPE)), be in cleared right of way, which are maintained to reduce woody vegetation and fuel load accumulation and will be stock proof.

Prior to operation, gathering lines will be hydrostatically tested to ensure they are not leaking and can operate at the required pressure.

The following methodology for gathering line installation is extracted from APGA, 2019.

3.6.6.1 Right of way clearing and grubbing

Gathering lines will be constructed in rights-of-way (ROW), which will be located adjacent to access tracks. Co-locating clearing requirements will be reduced to widening the access tracks by up to 6m, rather than clearing a dedicated 10 m wide gathering line route. The gathering lines will be constructed utilising the access track as a work area; they will be located to the access track's side and where buried, they will be marked to avoid trafficking directly above the buried gathering line. Having the access tracks and ROWs on a joint alignment will also allow easy visual inspection of the ROW without a dedicated access track.

Timber, vegetation and debris such as rocks etc., will be cleared and grubbed next to access track alignment for ROWs and will be stockpiled on the edge of the ROW for future rehabilitation activities.

Clearing and grubbing works will not be undertaken during the period from December to March to avoid the high-risk erosion potential periods.

3.6.6.2 Material selection and design

Materials used for the construction of the gathering network will comply with section 3 of the APGA Code of Practice for Upstream Polyethylene Gathering Networks (PEGN Code). HDPE 100 (or equivalent) will be used for all pipelines, due to their high toughness, excellent resistance to slow crack growth and rapid crack propagation. They also have an inherent resistance to water and chemicals. HDPE pipelines are the material of choice for many water, wastewater, gas and other applications as evidenced through their day to day use throughout society.

PE pipes shall be manufactured in accordance with AS/NZS 4130 and shall be third party certified by a JAS-ANZ accredited certifier under the StandardsMark, GasMark or WaterMark schemes or equivalent. Marking and product traceability shall be in accordance with the Standard. Appendix A of AS/NZS 4130 shall be used as the basis for demonstrating conformity. Pipes for Gathering Networks shall be Series 1 conforming to AS/NZS 4130. A design, risk assessment and testing regime, inline with the PEGN code, will ensure suitable material selection and selection of facility overpressure protection equipment to reduce the probability of leaks to ALARP.

3.6.6.3 Pipe stringing

The pipe will be either stick (~12 m lengths) or coils of up to 100 m. The pipe will be strung out on the ROW when clearing and grubbing for that section is complete. The pipe will not be strung across non-Tamboran access tracks or watercourse crossings until it is ready for installation on the same day. When the pipe is strung from end to end, adequate topographic and geomorphic provision shall allow for unimpeded overland flow/drainage, access by property owners, fauna and construction traffic.

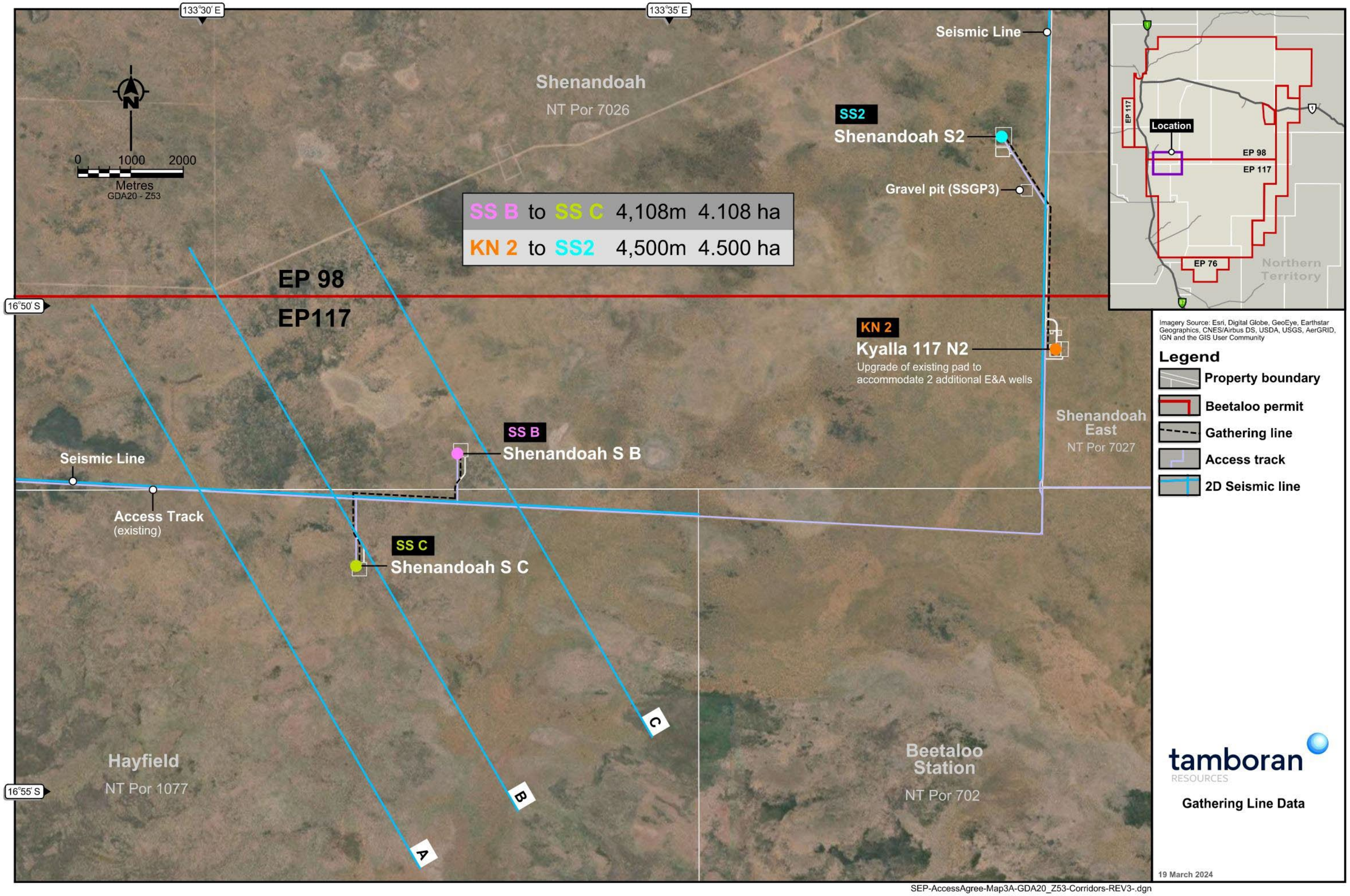


Figure 15: Gathering lines between the well sites

3.6.6.4 Pipe jointing

Polyethylene pipe or fittings can be joined only by heat fusion (welding) or mechanical fittings.

There are two types of heat fusion joints currently used - butt fusion welding and electrofusion welding. Pipe jointing is a skilled operation, with skilled service providers engaged to complete specific procedures necessary to achieve a successful joint. Tamboran will approve jointing procedures for the service provider before construction begins.

Data loggers will be used to verify conformance to the nominated welding parameters. A unique weld numbering system will be established to identify each production weld and tie-in for traceability records.

Butt welding

The most widely used method for joining individual lengths of polyethylene pipe is by heat fusion of the pipe butt ends (Figure 16).

Figure 16: Standard butt fusion join (source: APGA, 2019)

This technique, which precludes the need for specially modified pipe ends or couplings, produces a permanent, economical and flow-efficient connection. Welding parameters used will follow Plastics Industry Pipe Association of Australia Guideline POP 003, which provides guidelines for butt fusion welding parameters. The welding temperatures for polyethylene pipe used in constructing gathering lines are not high enough to be considered a potential cause for ignition.

The following procedures will be adopted to ensure the integrity of the fusion welds:

a) The welding contractor shall have:

- Demonstrated experience in fusion welding of polyethylene pipe
- Suitably sized equipment which has been maintained in good condition with calibration status documentation available
- Qualified operators who have a current log detailing project and welding experience

b) Assessment of the proposed welding procedures:

- Pre-qualified welding procedures for pipe class and diameters being proposed for the project and the welding machines or control box which will be used, and destructive weld testing data may be considered
- Carry out trial welds on the actual pipe to be used for the contract and have these destructively tested to meet the specified performance requirements (testing and minimum performance requirements are detailed in Section 7 – Inspection and Testing)
- Determine and document the agreed welding parameters, procedures, and welding equipment (this may also include the use of welding tents, pipe end covers etc.); and
- The agreed welding parameters, procedures and welding equipment become the contract requirements and should not be varied without additional evaluation and testing

c) Determine quality control and assurance requirements, including but not limited to:

- Inspection for wall thickness and welding zone preparation
- Internal inspection of pipe for obstruction and cleanliness. Including the removal of swarf after machining welding face for butt welding
- Maintaining a detailed welding log for each weld (including unique weld ID and GPS location record keeping)
- Destructive testing of a percentage of welds
- Visual and non-destructive assessment of each weld

d) Continuously review process and results.

- Butt fusion welding is a skilled operation; several very specific procedures need to be carried out to achieve a successful joint. All operators carrying out butt fusion welding will be trained by appropriately registered training organisations, meeting the prerequisite training requirements of PMBWELD 301.

Electrofusion welding

Electrofusion is the method by which the heat is applied. The electrofusion joint is heated internally by a conductor at the joint interface. Heat is created as an electric current that is applied to the conductive material in the fitting. Polyethylene pipe-to-pipe connections made using the electrofusion process requires electrofusion couplings.

Electrofusion fittings shall conform to Australian Standards (AS) / New Zealand Standards (NZS) 4129 and shall be third-party certified by a Joint Accreditation System of Australia and New Zealand accredited certifier under the StandardsMark, GasMark, WaterMark schemes, or equivalent.

To consistently make satisfactory electrofusion joints, it is essential to follow the jointing procedure, emphasising pipe surface preparation, cleanliness, joint restraint during the fusion and cooling cycles, and temperature control.

Electrofusion is a skilled operation; several very specific procedures need to be carried out to achieve a successful joint. Tamboran will approve welding procedures before construction begins. All operators carrying out electrofusion welding will be trained by appropriate RTOs, meeting the prerequisite training requirements of PMBWELD 302.

Mechanical joints

Where fusion joints are not appropriate, mechanical fittings can be used, particularly for the 50 mm and smaller polyethylene pipes. Three basic fittings can be used:

- Flanges
- Mechanical compression joints
- Mechanical couplings

When jointing of polyethylene pipe is required to other materials, a flanged joint is generally the most practical for field jointing. Otherwise, a material transition fitting can be considered and welded in.

Tamboran will preferentially use flanges for jointing to other materials, over other jointing methods, such as mechanical compression joints and mechanical couplings. A typical flange connection is shown in Figure 17.

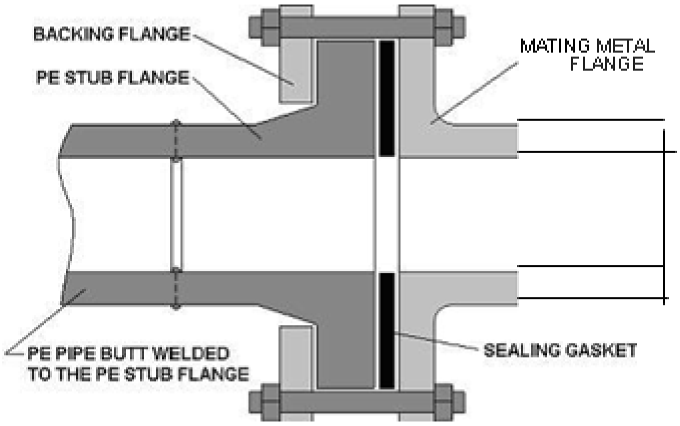


Figure 17: Typical flanged connection (source: APGA, 2019)

3.6.6.5 Buried pipeline trenching and bedding

For buried gathering lines, a trench will be excavated to a depth that will give 750 mm depth of cover (DOC) to gathering lines installed, except where the gathering line crosses an access track, where it will have a DOC of no less than 1200 mm. There are no gathering lines proposed to be constructed under waterways.

Trench excavation will be carried out using a trenching machine, excavator with an attachment or similar. In both instances, the objective is to achieve a trench bottom free of rocks, stones or other material with an angular profile that may cause damage to the pipe and a trench profile in continuous contact with the pipe. When such conditions are achieved, the pipe will be laid directly on the trench bed; if this is not achievable from the direct trenching operations, bedding will be applied into the trench to achieve the same.

Any trenches that are left open overnight will be:

- Fenced with electric fencing to exclude livestock
- Fitted with fauna ladders to allow fauna egress
- Checked before starting works the next day, and any fauna removed

Trenches will not be left open overnight across watercourses or access tracks.

Before any trenching is carried out in watercourses (of which there are no minor or major watercourse in the vicinity of the activity), Tamboran will check the 7-day weather forecast to ensure there is an adequate weather window for the trenching, installation, backfill, and stabilisation works to be carried out.

Records on the depth of buried gathering lines, including load bearing will be retained and provided to DEPWS.

3.6.6.6 Pipe placement in trench

The pipe will be lowered into the trench without excessive strain and laid with sufficient slack to allow for contraction caused by temperature changes.

Polyethylene pipe up to approximately 160 mm diameter can usually be placed in the trench manually. Heavier, larger diameter pipe will require handling equipment to lift, move, and carefully lower the pipe into the trench.

3.6.6.7 Backfilling and compaction

After the pipe is laid into the trench, backfilling will commence using excavated material.

- The initial material will be screened to ensure it is free of rocks, stones or other material with an angular profile that may cause damage to the pipe.

- The balance of the trench will be backfilled and compacted using excavated material.
- Compaction shall be performed to ensure the required compaction level is achieved while ensuring that any stress placed upon the pipe is acceptable.
- The standard of backfill and compaction shall minimise subsequent soil movement and prevent subsidence of the trenched area.
- The permeability of the backfilled and compacted trench shall be like that of the unexcavated material to minimise damage along the trench invert and potential "tunnel' erosion.
- Where scouring could occur in a trench, barriers shall be installed to prevent scouring. Barriers shall be built of non-degradable foam, sandbags or other approved material.

3.6.6.8 Road crossings

Where gathering lines are proposed to cross a road / access track, the following will be implemented:

- Buried pipelines: the line will be trenched across the road with the DOC increased from 750 mm to 1200 mm.
- Aboveground pipes: a culvert (concrete pipe or reinforced structure) will be constructed at bed level (level with the ground) to allow the pipeline to be laid within. The culvert will take the weight of any vehicle / equipment to protect the pipe.

3.6.6.9 Pressure/leak testing

All new components of the gathering line network and any part of an existing network that is diverted or altered in any way shall be subject to a pressure test to validate mechanical strength and detect leakage of the network before commissioning.

The polyethylene gathering networks' pressure testing will be broken into separate tests; a strength test and a leak test. The strength test proves the pipe's integrity and identifies any large leaks or defects in the network being tested. The leak test determines if there are any small leaks in the network. The leak test shall be undertaken after the successful completion of a strength test.

Due to the visco-elastic nature of polyethylene, it is not practical to conduct such tests in a manner that ensures no pressure change. Variations of atmospheric pressure, the temperature of the test fluid in the pipe, and material creep significantly affect the test pressure. Therefore, it is necessary to permit some drop in measured pressure over the test period.

All records of pressure, strength and leak testing shall be retained for each section of pipeline completed.

Pressure test safety

Pressure testing is considered one of the significant hazards in the development of a polyethylene network.

Pressure testing equipment will be fitted with regulators and pressure safety valves to ensure the gathering network is not over-pressured during testing. The primary safety control for pressure testing is quality assurance/quality control conformance, primarily in material selection and welding. The secondary safety control measure is the introduction and use of calculated exclusion zones.

Preliminary testing

Sections of the network in key areas may need to be preliminary tested or pre-tested separate from the main network section. Examples are roads, creek crossings, and sections near plants and houses where the impact of a pressure test failure is critical. The fabricated pipe sections to be installed will be preliminary tested where possible. These sections can later be tied into a long test section. The preliminary section's exclusion zone can be reduced in these cases as it has previously passed a strength test.

Test plan

A test plan will be developed for all pressure tests. This plan can be a general document to cover most cases. However, in all cases, the test's risks and hazards shall be understood and managed.

The testing plan shall be able to:

- Ensure the implementation of all risk controls.
- Ensure that ajob safety analysis is completed and all items identified are adhered to.
- Ensure that all relevant equipment has a current calibration certificate from a recognised and certified testing agency.
- Ensure that all measuring equipment is located at a suitable distance from the test section to conform with exclusion zone requirements.
- Ensure that the EMP is followed for the disposal of the test fluids and other wastes.
- The person or persons responsible for the preparation of the test plan shall have appropriate qualifications and experience.

Strength test

- The strength test intends to prove the pipe's integrity and identify any large leaks or defects in the network being tested. The pipe shall be considered to have passed the strength test if, at the end of the test period, the test section's pressure is above Maximum Allowable Operating Pressure (MAOP), and there is no evidence of a sudden pressure drop. After completing the strength test, the pipe shall then be subject to a leak test process.

The criteria for pneumatic strength testing is shown in Table 16.

Table 16: Strength test criteria (source: APGA, 2019)

Pneumatic strength test	Acceptance criteria
Starting pressure fp x MAOP Test pressure to remain between fp x MAOP and MAOP during the test.	Structural integrity maintained for 6 hours while pressure held between fp x MAOP and MAOP.

Leak test

The leak test intends to determine if there are any small leaks in the network. The 24-hour leak test shall be undertaken after successful completion of a strength test.

Exclusion zones are generally not required for leak tests as the network has been proven to have adequate structural integrity with no significant leaks. However, it is recommended that exclusion zones be maintained around above-ground pipe sections and testing equipment to keep unauthorised people out of the area during leak testing activities.

The minimum starting test pressure at which the leak test is performed shall be the nominated MAOP of the test network.

The leak test may be completed with compressed air or raw water sourced from the Gum Ridge. Where hydrotesting is completed, approximately 75,000 litres of water will be generated. The water will be managed in accordance with Section 3.8.3.1.

The criteria for strength testing is shown in Table 17.

Table 17: Leak test criteria (source: APGA, 2019)

Pneumatic leak test method	Acceptance criteria
Allowable pressure loss (Pneumatic pressure decay test) Details of this test method and calculations are described in CP-8-003 Leak Test Methods and Appendix B1 of the PEGN Code, respectively.	The acceptance volume loss is 1 litre/hour/actual m^3 volume of test fluid. NOTE: The word "fluid" in this context means air or another gaseous medium.

3.6.6.10 High point vents, Low point drains and infield valves

Water gathering lines in undulating areas are prone to air locking; high point vents (HPVs) are therefore utilised to release entrapped air and gasses. HPVs are designed to automatically release trapped air/ gasses with a water lock to prevent release of wastewater from the gathering lines. Given the flat topography and limited water transfers, HPVs are not expected to be used. High point drains will be inspected during routine pipeline inspections defined in the Methane Emission Management Plan (MEMP) (Appendix I).

Low point drains (LPDs) are located on gas gathering lines at low points in the gathering network to prevent water condensation building up in the pipeline. Water accumulating within LPDs is typically low electrical conductivity (EC <500 µs/cm), being essentially pure water vapour. LPDs will be manually tested and released to grade/ used for dust suppression where the quality of the water meets the standards within Table 24. Where the water does not meet the require specification, the water will be trucked to a wastewater tank for storage and management. Volumes of water removed from low point drain's will be tracked.

Infield valves will be installed approximately every 2 km and/or at pipeline juncture points to allow for the network to have appropriate isolation points. These isolation points will allow section of pipeline to be isolated for maintenance (such as pipe repair) or to respond to emergency events (such as pipeline failure or bushfire).

Any above-ground infrastructure outside of well pad fence lines will be barricaded to prevent livestock access. This is typically undertaken using concrete barricades. Erosion and sediment controls will be constructed as per the access track requirements of the Erosion and sediment control plan (ESCP) (Appendix H).

3.6.6.11 Pipe survey, location and signposting

Pipe survey

A survey will be made to locate the gathering network (and all related infrastructure) relative to permanent marks and benchmarks conforming to Mapping Grid of Australia 94 or other approved datum.

The survey will develop sufficient information on the constructed gathering network to satisfy the materials traceability requirements of the polyethylene.

Specific survey locations that will be captured occur at crossings (such as road, rail, creeks, rivers, third-party infrastructure) at changes of direction, fence lines, and boundaries.

The existence of services, structures, and other obstructions in or on the route shall be checked, identified and recorded before construction begins. The location of these shall be recorded in the as constructed survey record.

Pipe location

All buried gathering lines will have a detectable tracer wire installed, including bored sections. This detectable tracer wire enables the pipe location to be traced with a pipe locator, reducing the likelihood of damage during future excavations. Tracer wire will be metallic, electrically insulated and have a minimum diameter of 14 gauge. Tracer wire shall be resistant to corrosion damage either by using coated copper wire or by other means.

Marker signposting

Marker signs will be installed to alert people of the wastewater gathering network's presence and, if they plan to carry out work nearby, of the possible consequences of inflicting unintended damage.

Markers also instruct those intending to work near the gathering network to contact the nominated network operator and provide relevant contact details. Pipe marker signs shall conform to the requirements for safety signs per AS 1319 'Safety Signs for the Occupational Environment.'

Marker signs shall:

a. Indicate the approximate position of the pipe
b. Indicate that excavating near the pipe is hazardous
c. Include a direction to contact the gathering network operator before commencing excavation near the network

Signs shall be placed at the following locations and be inter-visible:

a. Both sides of public roads
b. Both sides of railways
c. At each property boundary (and at internal fence lines as appropriate)
d. Both sides of creeks and rivers
e. Both sides of vehicle tracks
f. Each change of direction
g. Utility crossings (buried or above ground)
h. At all network facilities

At all other places where signs marking the network location are considered to contribute to network safety by properly identifying its location.

3.6.6.12 Commissioning

Commissioning is broadly defined as the range of activities required between mechanical completion of the plant or network and its handover for operation; it involves introducing process fluids and the functional and performance testing of all related equipment and systems before handover.

Commissioning will always be preceded by acceptance pressure testing of the relevant network section. As this gathering network is very simple in design and operation, the commissioning plan will be equally simplistic.

Commissioning will ensure that both the polyethylene pipes and all associated facilities are checked and verified by a competent and qualified inspector to ensure that they are fit for the nominated operating envelopes for all gathering networks. Such facilities shall include valves, flanges, protective devices (pressure safety valves), electrical and instrumentation equipment where applicable.

The network shall not be considered ready to commence or recommence operation until, as a minimum, the following checklist has been completed:

a. The network safety management study has been reviewed, and the network determined as ready for operation
b. The strength and leak test requirements have been achieved and documented
c. The MAOP has been established and pressure protection implemented
d. If tie-in welds to existing facilities have not been subjected to b) above, then such welds have been subjected to the requirements of Section 7.5.1(including Appendix C), 7.7.1, 7.8 and 7.9 of the PEGN Code
e. All components have been tested for satisfactory operation
f. Sufficient operating, maintenance and emergency personnel have been trained and qualified as competent.

Records of the commissioning checklist for each gathering line shall be retained.

3.6.6.13 ROW reinstatement

After backfilling has been completed, construction tools, equipment, and debris will be removed.

Areas disturbed by the installation will be reinstated as soon as practicable, including pulling stockpiled timber back over the ROW.

Appropriate measures shall be taken to prevent erosion and minimise long-term degradation of the environment (e.g. the construction of contour banks or diversion banks).

Fences that have been removed to provide temporary access to the route will be re-erected.

3.6.6.14 Abandonment

The pipelines will be abandoned on according to the *Code of Practice: Upstream Polyethylene Gathering Networks- CSG industry* (APGA, 2019).

When a network is abandoned, it shall be disconnected from all wastewater sources present in other pipes and flushed clear of wastewater.

Durin the decommissioning of a pipeline, an adaptive process is proposed based on the level of contaminants encountered during decommissioning. The decommissioning of pipelines will be determined during a decommissioning plan, which will include the following:

- Flushing of wastewater from the pipe into an enclosed tank as per section 3.13.
- The pipe will be inspected to quantify the level of scale through either removal of a section or use of a downhole camera.
- Where clear evidence of material volumes of scale is detected, cleaning of the pipeline will be undertaken using a pipeline intervention gadget (PIG) to remove any residual scale or solid material.
- A sample of the final flush water will be analysed to confirm that the pipe has been sufficiently cleaned prior to abandonment. Should the analytes be greater than 125% of the source water utilised (125% has been utilised as it provides sufficient buffer against natural variability in groundwater), then the pipeline should be further cleaned until the results are consistent with the source water or a risk assessment shall be completed by an independent, qualified third party expert to determine why the abandonment is acceptable. This report shall be submitted to DEPWS.

It is anticipated that the cleaned pipework will be left in situ to avoid re-disturbing the underlying vegetation. This will reduce the impacts associated with vegetation clearance and subsidence caused by the removal of the pipework. Given the current land use and the inert nature of the pipework, this is considered ALARP as assessed in Appendix M. The following process shall be followed:

a. Pipeline cleaned and determined free of contaminants

b. The cutting and removal of all sections of buried pipes that come to the surface:
   i. at a minimum of 750 mm below the natural surface, or
   ii. at the pipe depth, whichever is the lesser
c. The removal of all surface equipment, including valve pits, vents and drains
d. The removal of all signage associated with the network on completion of the post abandonment maintenance period
e. Obtaining landowner releases for the completed abandonment

Upon completion, the records identifying and locating sections of the abandoned network shall be prepared as part of the relinquishment procedure. These records shall be provided to the pastoralist and DEPWS.

3.7 Exploration well drilling

3.7.1 Well design

The well design process is the first step in ensuring the integrity for each proposed well. Tamboran's sub-surface team, (geologists, geophysicists and petroleum engineers) summarise the key information and data required by the drilling engineers to design each E&A well. It forms the Basis of Well Design (BOWD).

Critical inputs into the BOWD:

- Existing geological data available for the site
- Downhole formations that need to be isolated (i.e. freshwater aquifers), hydrocarbon-bearing zones, aquifers and saline units that could be encountered during drilling operations
- The sub-surface well objective (production and/or reservoir evaluation)
- The fracture gradient, which describes how much pressure is required to fracture a specific formation
- The pore pressure, which is the in-situ fluid pressure within a reservoir
- The orientation and separation of each vertical and horizontal well
- Other conditions that may affect the integrity of the well (formation fluid composition, stress regime)

The BOWD is used in combination with the requirements outlined in the Code (including section B.4.3), the Regulations and Tamboran's internal standards to develop an appropriate well design that ensures well integrity is maintained throughout the life of the well and addresses all regulatory and risk management requirements.

The design process includes the definition of Well Acceptance Criteria (WAC). WAC are critical thresholds that are tested during well construction and typically form components of the well barrier envelope. The barrier envelope is the combination of one or more well barrier elements that are combined to prevent uncontrolled flow of fluids and hydrocarbons into another formation, or to escape at surface. The isolation and protection of aquifers is a critical component of the WAC. The WAC must be met or exceeded to confirm well integrity before proceeding to the next phase of well construction or operation. If a well WAC is not achieved, an approved remedy and/or risk assessment must be in place prior to moving forward with operations.

The well design and WAC form a critical part of the WOMP, which is a regulatory document that summarises how each well will comply with the required standards from the design to decommissioning of a well. This document is prepared and submitted to DITT for approval prior to the commencement of any drilling and stimulation activities. Where required, any deviation from the approved WOMP will need to be reviewed and approved by DITT prior to proceeding.

To accommodate multiple wells, each well is separated on surface by 10 – 15 m. This separation distance is calculated from the hole centre to hole centre and is selected to accommodate the rig package and future well interventions. Petroleum wells on a multi-well pad (both within Australia and internationally) are typically separated by 8 – 10 m but may be closer in proximity where safe to do so (e.g. coal seam gas wells are shallower, need smaller drilling rigs to drill and may be separated by 3 – 5 m). Well deviations from the vertical plane during drilling are monitored using standard survey tools as discussed in section 3.7.3.

Each lateral in a horizontal well on the same pad is drilled at a sub-surface separation distance of at least 200 – 400 m (with the final separation distance determined from the existing well test results and updated mechanical earth model) to ensure the stimulated zones between wells are not connected during stimulation. If two stimulation zones within the target reservoir were connected, this could reduce the productivity of each of the wells. It would not represent an environmental risk, as the stimulated zones are within the Velkerri shale formation.

Indicative well sections and sub-surface layout for the proposed wells sites are shown in Figure 18 and Figure 19. A conceptualisation of the Shenandoah N A stratigraphic well is provided in Figure 20. These figures show the use of the conductor casing string to isolate the Anthony Lagoon Formation and Surface Case string to isolate the Gum Ridge formation. The intermediate section then isolates all formations below these section until the production case point. This design ensures multiple string of casing and cement protect each aquifer.

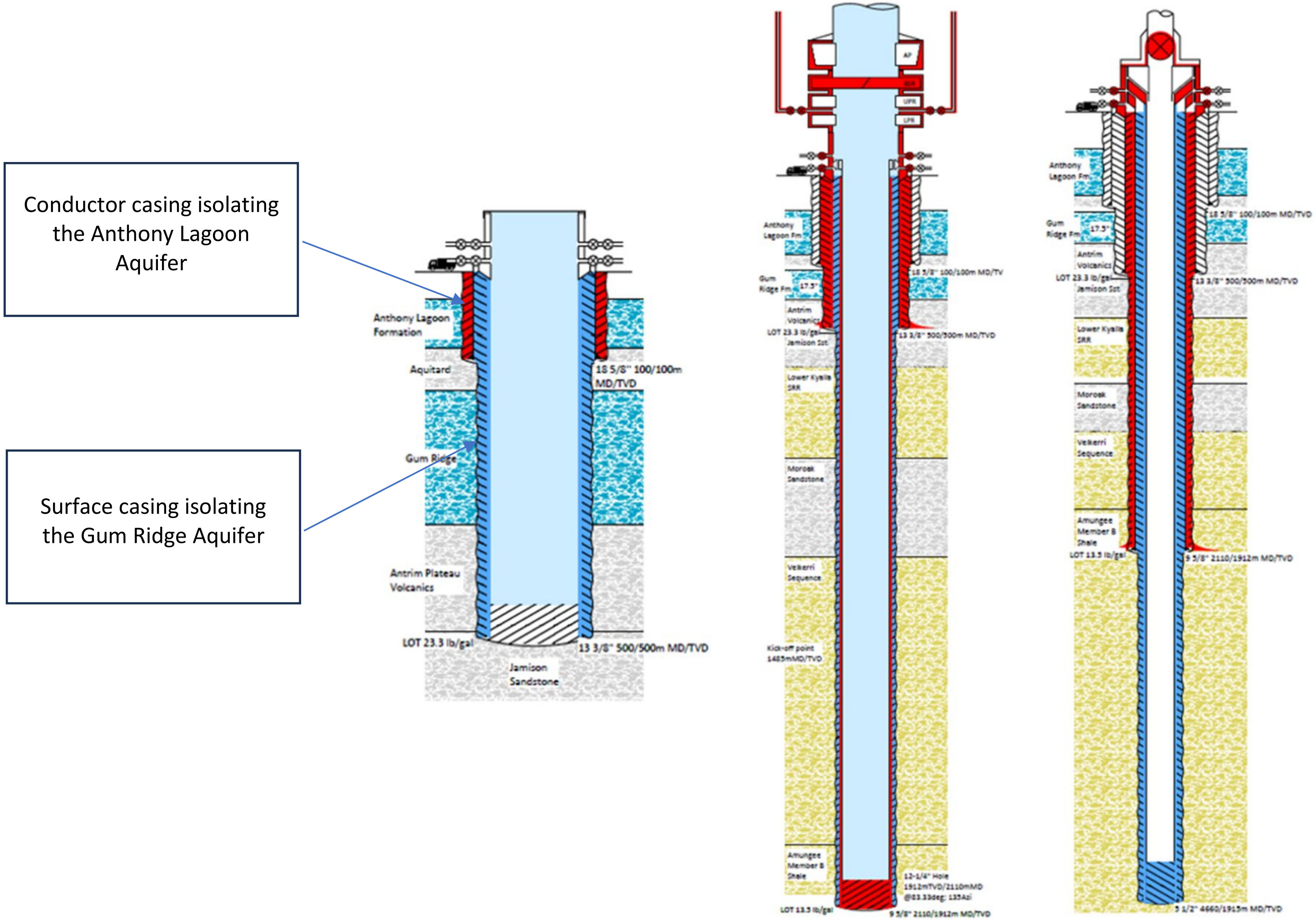


Figure 18: Typical well sections for the E&A wells – this includes the conductor and surface casing (left), intermediate (middle) and production casing (right) strings of each exploration well

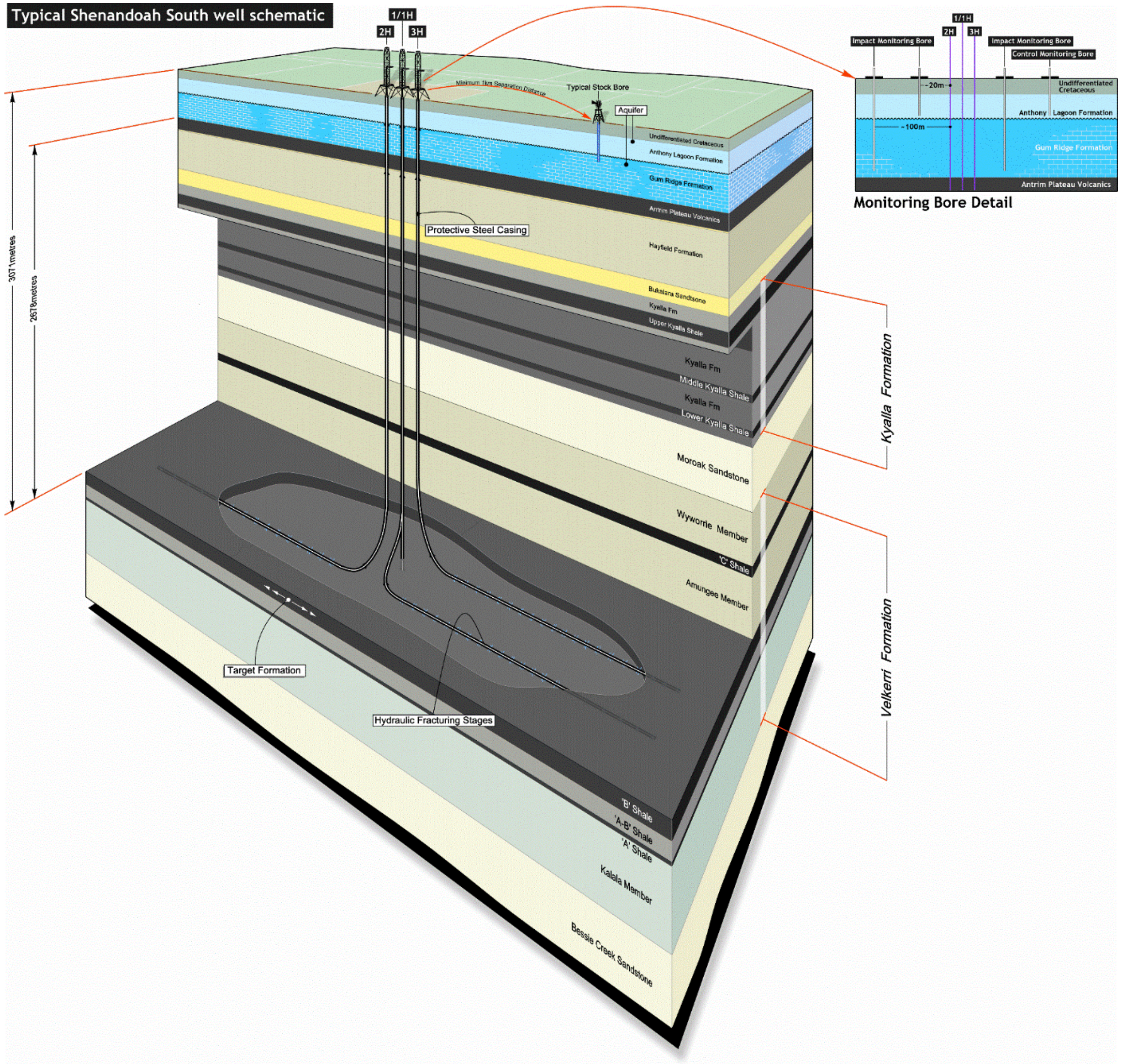


Figure 19: Example of a typical multi-well site

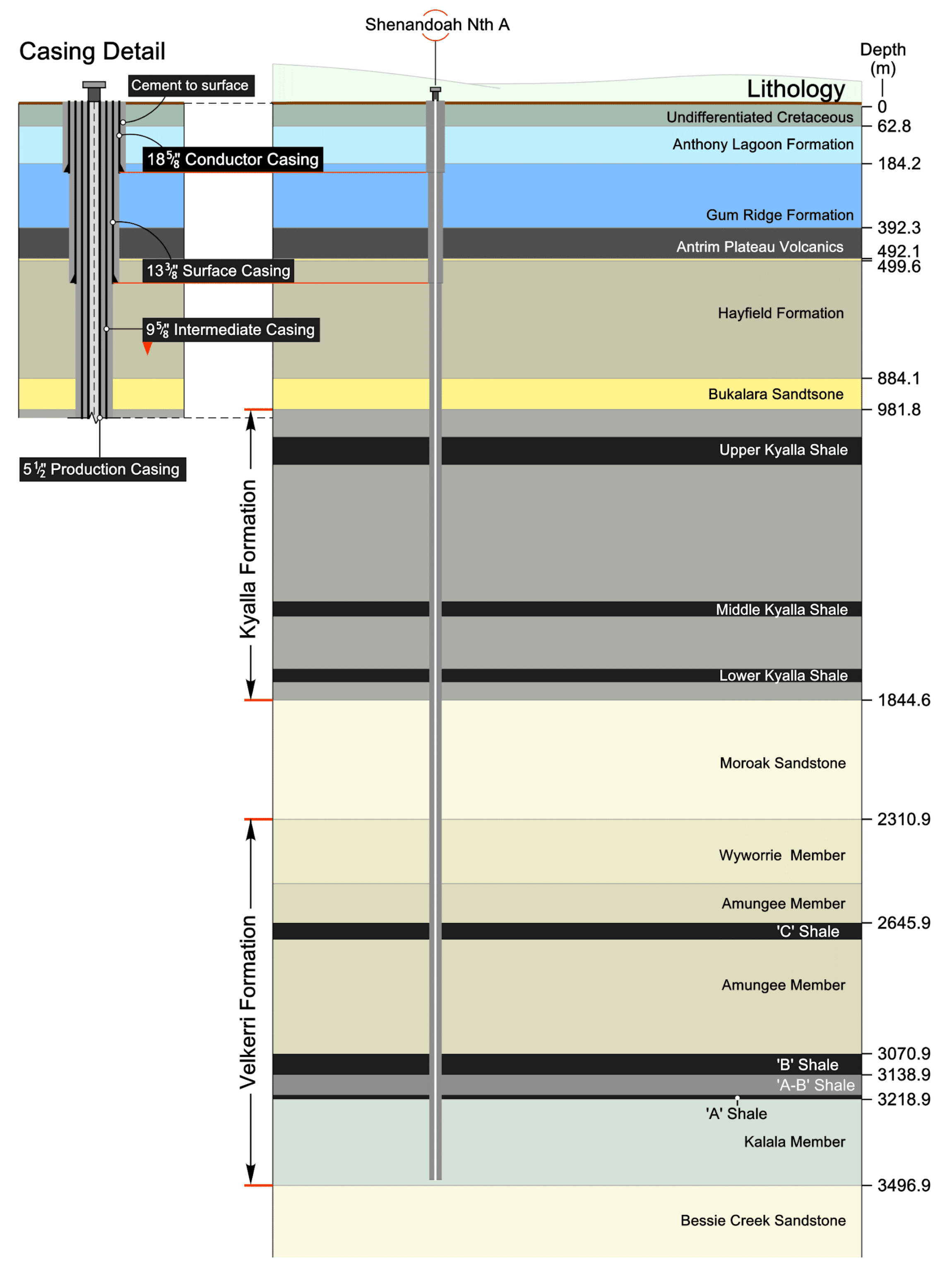


Figure 20: Stratigraphic conceptualisation of Shenandoah N A

3.7.2 Site preparation

A drilling rig package will be mobilised to site and constructed to prepare for the commencement of drilling activities. The rig package comprises the main rig, as well as the supporting vehicles, equipment and facilities outlined below:

- Rig mat, an impermeable liner containing all spills from the drilling rig.
- Drilling rig, comprising a rig floor, a mast or derrick, rig engine, BOP system and catwalk.
- Pipe rack for storing drill pipe and casing and potentially a pipe arm, which is a piece of equipment designed to bring the pipe and casing up to the drill floor.
- Rig fluid system, including tanks (water and mud), shakers, mud treatment system and pipes for storing and pumping fluids down the drill string.
- Storage trailers and racks for equipment.
- Bunded chemical storage areas for mud chemicals, diesel and wastes.
- Workshop.
- Portable on-site offices.
- Rig mini-camp, wastewater treatment system and irrigation area.
- Temporary accommodation for ~75 people.
- Diesel power generators.
- Third-party equipment such as cementing trucks, fuel trucks and wireline evaluation units.

Throughout drilling operations there will be ongoing vehicle movements, from the initial rig mobilisation to the interchange of drilling support services or delivery of equipment (a discussion of traffic is provided in section 3.25). Drilling operations are generally a 24-hour per day operation.

Examples of well pad layouts across the sites is provided in Figure 21, Figure 22 and Figure 23.

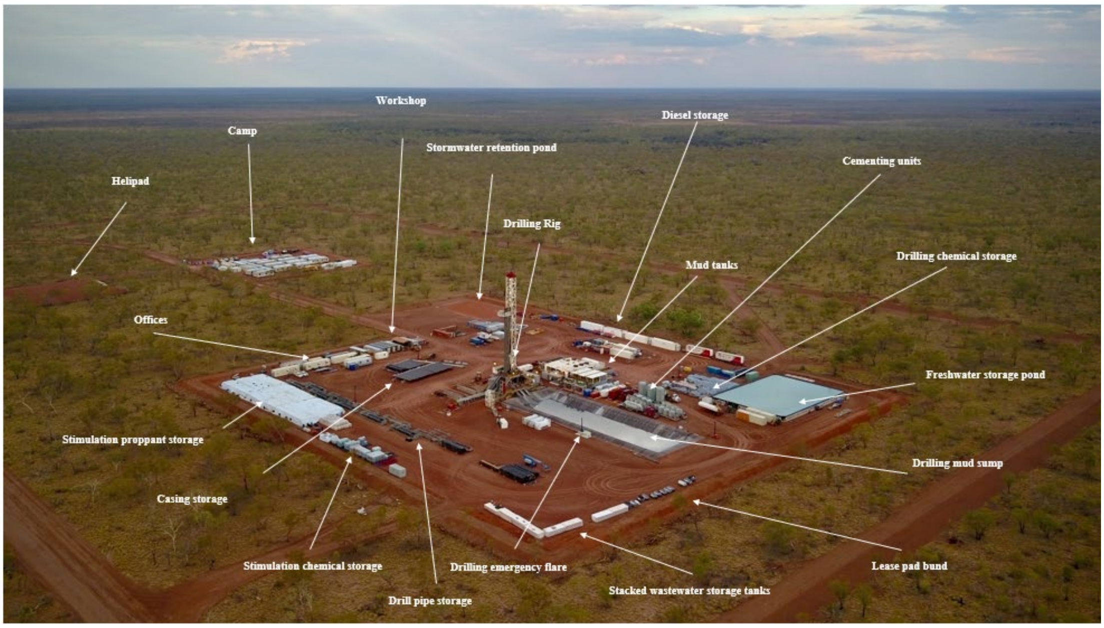


Figure 21: Example of a drilling operation at the Kyalla 117 N2-1H E&A well, November 2019; the new E&A well sites are likely to use a similar rig set-up

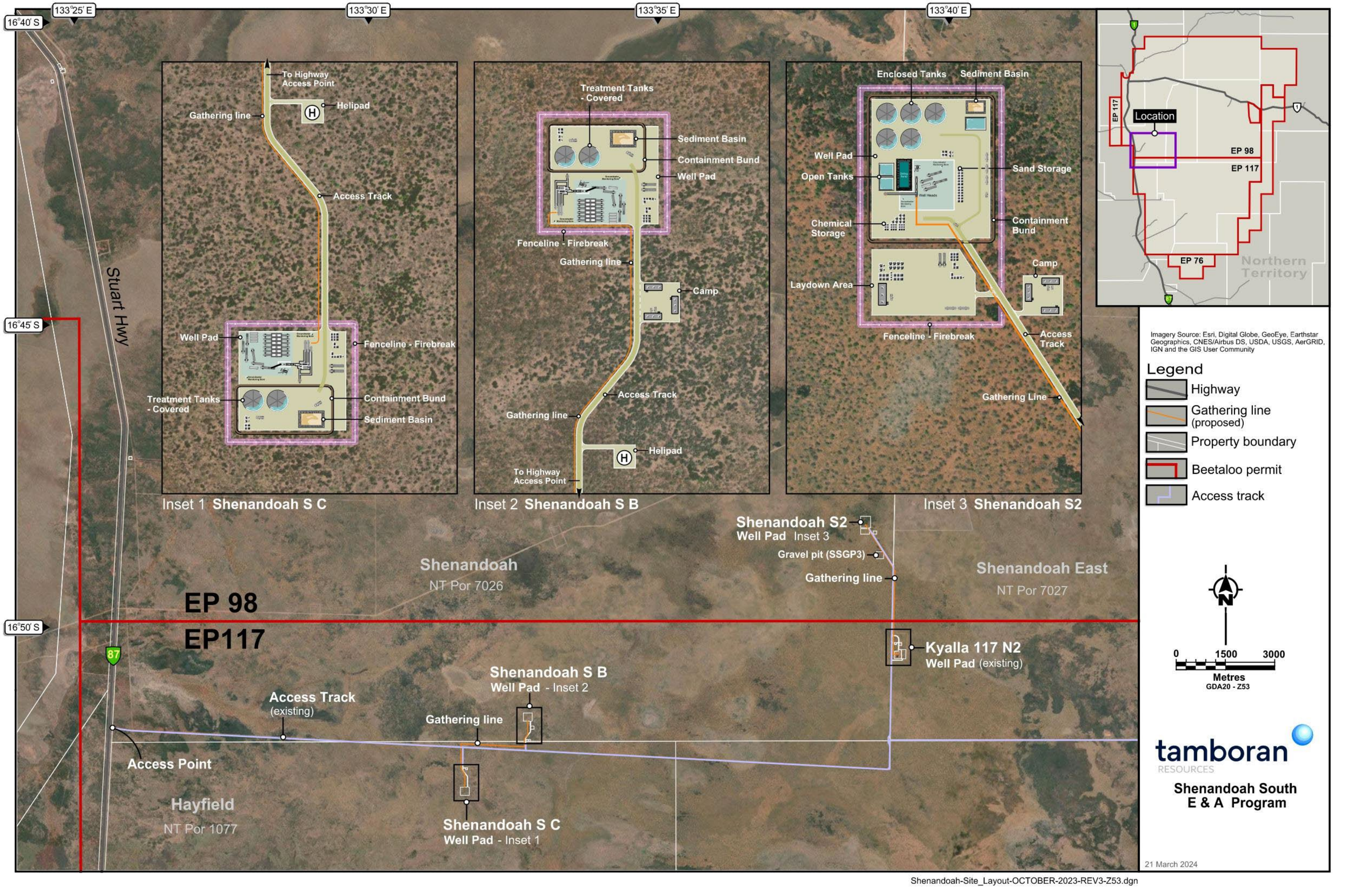


Figure 22: General site layout for new E&A well pads – Shenandoah S2, S B and S C

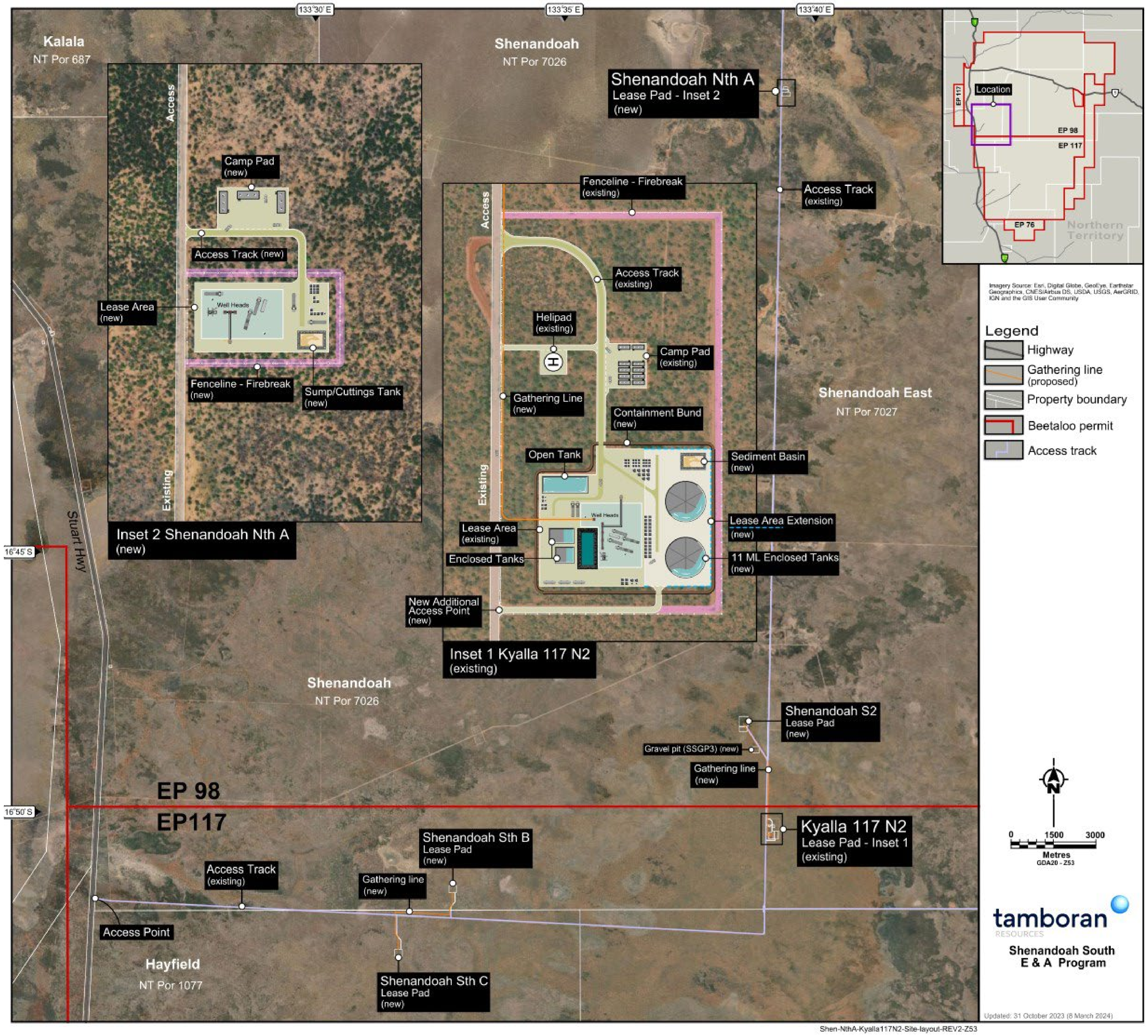


Figure 23: Generalised site layout for new E&A well pad Shenandoah N A and existing Kyalla 117 N2, including increased well pad

3.7.3 Drilling

Drilling of multiple wells on a pad requires specialised surveying tools to ensure the well path is constructed to design and to eliminate the risk of sub-surface collision with the existing wells on location. These survey tools use drill bit tracking to monitor the downhole position and trajectory of the well when drilling; this is called measurement while drilling. Safety envelopes are established around each existing well to detect when a well has begun to deviate into the proximity of the adjacent well. This reduces the likelihood of a subsurface collision, which represents a significant well integrity and economic risk to the project through loss of multiple assets. The use of measurement while drilling tools is a standard industry control that has been effectively used for multi-well pad drilling within Australia and internationally.

Once the rig is functional, the top-hole sections will be drilled, cased and cemented for each E&A well to depths which will enable isolation of the GRF and the Anthony Lagoon Formation. Each individual section will be cased and cemented (with specifically engineered cement) to seal the aquifer off from the rest of the wellbore to prevent fluid crossflow between formations. If an aquifer is discovered during drilling that was not identified prior to commencement of drilling, Tamboran will notify to the Minister as required under the Regulations and the Code.

Defining the contact between the GRF and adjacent formations is critical to ensure the appropriate casing setting points to isolate the two units. Data from the existing wells and control monitoring bores provides a high confidence that the casing setting point will effectively isolate each of the aquifer units.

Commonly during the drilling of the GRF, partial to total losses of drilling fluid have been observed due to high permeability conduits, fractures and cavernous zones expected in karstic formations. Loss of circulation material (LCM) is typically used to respond to fluid losses, with additives used to block fluid pathways to re-establish fluid circulation. LCM is often in the form of viscosity enhancers (such as bentonite and polymers), fibrous material (such as coconut coir, nut hulls etc.) or granular material (such as marble chips) with the type of LCM used dependent on the level of losses and formation type. Where drilling fluid losses cannot be stopped, the drilling fluid systems are reduced back to water to maintain dynamic well control (a continuous supply of water to overcome formation pressures) and to minimise drilling additive losses to the formation. Once the zone of high losses has been drilled through on water, the section is then cased-off to regain fluid circulation and allow drilling to continue unimpeded. In the event LCM is used and high loss zones are encountered, casing off will be deployed to manage fluid losses for the additional wells proposed under this EMP.

During cement operations, cement may also be lost to the formation resulting in cement slumping or 'patchy' cement sections. If cementing of either the conductor casing or the surface casing for a well is unsuccessful (i.e. the cement does not return to surface or slumping is observed) the following practices may be deployed depending on the casing section:

- For the conductor casing: a top up cement job will be undertaken – this process involves spotting cement from surface in the annulus of the conductor casing and formation
- Surface casing: the use of an external casing packer and a two-stage cement job will be utilised to provide hydraulic isolation between the casing and formation
- A cement evaluation log is performed to analyse the cement quality in the annulus and determine the appropriate corrective actions
- A Leak-Off Test (LOT) or Formation Integrity Test (FIT) is undertaken to confirm cement integrity.

Once the surface casing is cemented in place, the BOP is installed on top of the casing string. A BOP contains a series of rams and elements that may be closed to prevent a release of pressure and isolate the well at surface. Once installed, the BOP is function and pressure tested to confirm its integrity.

For a vertical stratigraphy well (such as Shenandoah N A) or where a vertical "pilot" hole is proposed to be drilled before the well is deviated into the horizontal, drilling will continue to below the target reservoir. The drilling of a vertical pilot/ stratigraphy well will enable coring of the formation and wireline logging analysis. Further testing may involve running a series of special tools to measure the various aspects of the reservoir fluids and rocks. For the stratigraphic wells (such as Shenandoah N A), this may then be cased and cemented awaiting for further testing (such as vertical stimulation after analysis of the rock properties are completed) or decommissioned. For a vertical pilot hole, the well will be plugged with cement at the ”kick off point" and a “whipstock” installed to allow the well to be deviate into the horizontal section. Not all wells will require a vertical “pilot” hole, with pilot holes only required where there is insufficient well control data to confidently pick the depth of target formation (i.e. areas where there is limited seismic control or other local geological well data).

Drilling will then progress down to the target ‘kick off’ point as part of the intermediate hole section, expected to be around 300 m – 500 m above the target shale formation. When the intermediate hole of each E&A well has reached its target depth, intermediate casing is installed and cemented in place (see Figure 18).

Prior to each new hole section of an exploration well being drilled, a FIT or LOT is performed to validate the integrity of each casing shoe and provide an operating envelope for drilling the next hole section. This ensures the casing string has sufficient integrity to protect aquifers from cross connection of deeper formations.

Once the kick-off point has been reached, the build section of each E&A well will be drilled into one of the selected Velkerri shale targets. Once in the targeted shale zone, the well will be drilled horizontally for up to 3000 m laterally, with each horizontal wellbore on the site location separated from each other in the horizontal plane by approximately 400 m.

An open hole Diagnostic Fracture Injection Test (DFIT) may be run to further investigate the local rock properties. This may be completed on the Stratigraphic well (Shenandoah North A), vertical pilot well section or from within the horizontal. This test involves injecting small volumes (<10,000 L) of water, with salts (NaCl or KCl) and biocide (assessed in the drilling chemical risk assessment Appendix E), into the formation to create small fractures, allowing the resulting pressure to fall naturally. The fluid contains no proppant; hence the fracture relaxes and closes naturally when the pressure is released. The pressure decline is monitored on-site, and data is analysed to assist reservoir characterisation. This hole section is again cased and cemented in place.

Where a well deviates from the required specification or WAC, a section may need to be plugged and abandoned as per section 3.16. The section of the well may be redrilled (either partially or completely) to ensure compliance with the Code and relevant well acceptance criteria.

Once drilling has been completed, the drill rig will be ‘walked’ to the next well or will be demobilised from site.

3.7.3.1 Drilling fluids, muds and cuttings

Drilling muds and fluids are made and stored in the fluid system, consisting of hoppers, mixing/storage tanks, chemical dosing units, pipework and pumps. Drilling fluids and muds are circulated down hole to keep the bit lubricated and assist in returning cuttings to the surface. Cuttings are removed from the muds via shakers, with the cuttings discharge directly to the sump or cuttings bins. The drilling fluids and muds are recycled until they are out of specification (such as specific gravity, quality etc.) and are then discharged to the drilling sump/ tanks onsite.

A low toxicity water-based drilling mud will be used as the base fluid for drilling through aquifers, to ensure there is no residual toxic effect as required in the Code of Practice. The chemical constituents safe to be used when drilling through aquifers is defined in the drilling management plan to ensure no unapproved chemicals are utilised. The fluid system primarily contain salts and polymers, which have a limited residual toxicity and bioaccumulation risk.

Drilling mud is required to maintain well control, provide formation stability, lubricate and control the temperature of the drill bit and lift cuttings to the surface. The fluid system consists of water with a sodium, calcium or potassium-based salt (to prevent formation swelling) and a viscosifying agent such as bentonite. Other low toxicity chemicals such as barite, citric acid, sodium bicarbonate and loss circulation material may also be used. The chemicals used for drilling are consistent with those used for water bore drilling. The details associated with the chemicals used during drilling have been included in the chemical risk assessment (Appendix E).

As per section B.5.1.1 of the Code, the benzene, toluene, ethylbenzene and xylene (BTEX) of all drilling fluids and muds will not increase the levels of the overall fluid above the BTEX content specified in Table 8 of the Code. Testing of the fluids systems will be carried out to validate BTEX levels.

Drilling fluids, cuttings and muds will be managed in the lined drilling sump on-site. The sump has been designed to support multiple E&A wells. All waste drilling fluids within the sump will be managed and disposed of in accordance with section 3.13.2.

3.8 Hydraulic fracture stimulation

Upon completion of drilling operations, each of the horizontal E&A wells will undergo HFS. The hydraulic fracturing process is a series of operations designed to increase the available surface contact area of the shale formation. This enhances the volume of hydrocarbons that migrate into the wellbore and flow to surface.

The process of a hydraulic fracturing completed on each exploration well is conducted in the following sequential stages:

- Well integrity verification
- Site set-up
- Stimulation activities

3.8.1 Well integrity validation

Prior to the stimulation of each E&A well, the wellbore will be assessed to ensure that sufficient well integrity is in place to withstand hydraulic fracturing pressures as per the Code (B.4.7.2 and B.4.13.2) and the Petroleum Regulations 2020.

The assessment will include the following completed for each exploration well:

- Cement evaluation logs are run to ensure that at a minimum 150 mTVD of good quality cement is present from the target reservoir to the nearest aquifer to ensure zonal isolation.
- Confirmation of geological barriers and assessment of geological hazards.
- Mechanical integrity evaluation of the production casing via a pressure test to the MAOP (typically 10,000 psi or another engineered level). The pressure test will consist of (a) 10-minute low pressure (300 psi) leak test and (b) 20-minute high (typically 10,000 psi) pressure strength test.
- Tamboran’s pressure test acceptance criteria is a 2% pressure drop per five (5) minutes over a stabilised test duration with a decreasing dP/dT trend.
- Pressure tests will be undertaken using fresh water which will be re-used.
- Well Barrier Integrity Verification Report certified by an independent and reputable validator must be completed and submitted to DITT before and after hydraulic fracturing.

3.8.2 Site set-up

The hydraulic fracturing operation of each E&A well requires various equipment as illustrated in Figure 24.

Stimulation equipment

- A data van, which is an on-site office to execute stimulation activities.

- Water storage – the wastewater tanks will be constructed on-site, capable of managing the total volume of both make-up water and flowback water. Tanks storing flowback will be double lined with leak detection capable of monitoring any leaks between the primary and secondary liner. Specific information on the wastewater tank construction is provided in section 3.8.3.
- Proppant trailer which is a large sand storage and delivery trailer that holds the proppant.
- Hydration unit which is used to add stimulation additives and viscosifying fluids.
- Blender unit which is used to mix proppant and fluid additives prior to its injection into the well.
- High pressure pumps which inject the hydraulic fracturing fluid mixtures from the blender unit down the well via the surface lines and hydraulic fracturing wellhead or coiled tubing unit.
- Coiled tubing unit – a large length of coiled steel pipe that can be temporarily installed in the well to perform various downhole operations.
- Wireline unit for plug and perforation deployment.
- Ancillary support buildings including offices, workshop, cranes, chemical storage area, equipment storage, laydowns and all other activities required to support stimulation activities.

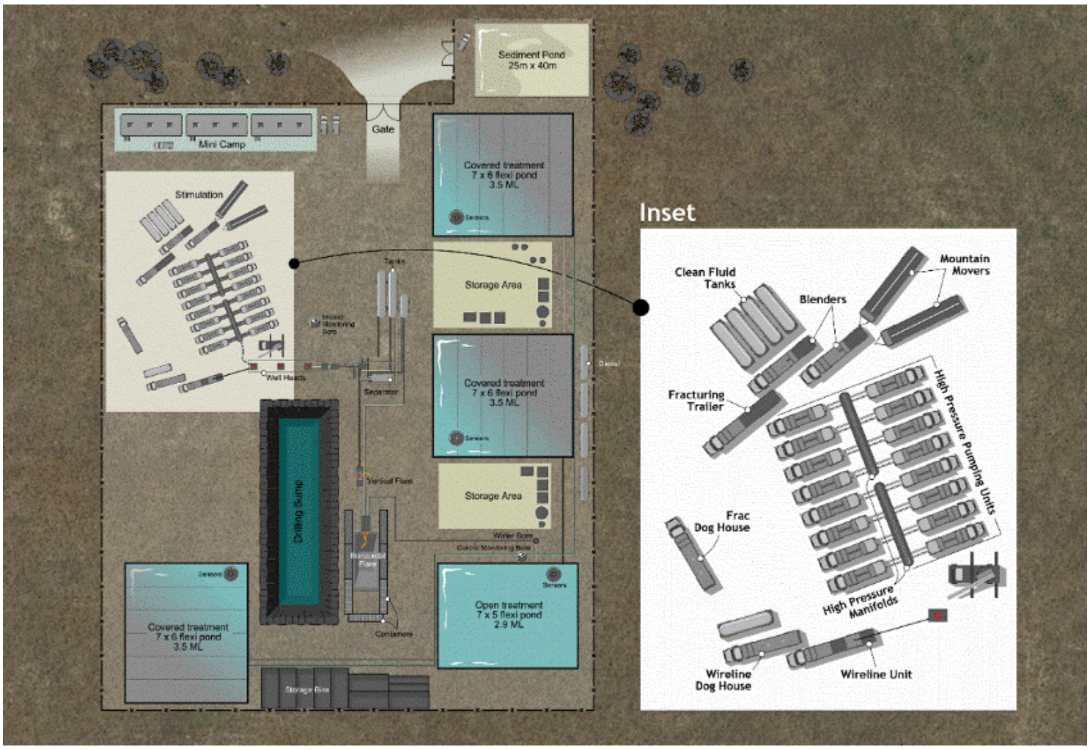


Figure 24: Indicative HFS spread used for each E&A well (NB: additional tanks will be installed where the frack spread is located during well test)

3.8.3 Wastewater tank set-up

In accordance with section C.4.2.2 of the Code, all flowback must be stored in enclosed tanks unless being treated for disposal or re-use. To comply with this requirement, a series of double lined enclosed and open wastewater tanks will be constructed on-site to store and treat flowback wastewater produced during well testing. The number of enclosed and open tanks used on-site will vary depending on the season, as summarised in section 3.13.3.3. Tanks will be periodically brought on and removed from operation to meet wastewater storage requirements. A combination of round (Riptide) and square (Flexiponds) will be constructed and used to managed wastewater on site (Figure 25).

Wastewater liners will be constructed of High Density Polyethylene (HDPE) which has an excellent chemical and physical resistance. The main hazard of flowback is salinity, with the concentration of metals and hydrocarbons not anticipated to represent a hazard to the liner. An overview of the physical and chemical properties of the HDPE liners are provided in Appendix E. All liners will comply with section 3.8 of the Code of Practice.

Liners will be welded together with a Quality Assurance and Quality Control (QA/QC) plan developed and executed to test seam welds. The QA/QC plan shall have acceptance criteria and will be in accordance with the liners manufacturers specifications.

Wastewater storage tanks have continuous level monitoring, with leak detection sensors located within the interstitial space between the primary and secondary liners.

It is anticipated that ~75 ML of tank storage may be installed onsite, with a combination of enclosed tanks and open treatment tanks. In accordance with the Code, sufficient enclosed tank capacity must be onsite to store all flowback wastewater. Flowback can only be stored within open tanks where undergoing treatment (such as evaporation). Open evaporation tanks must have a 1:1,000 annual re-occurrence Interval (ARI) wet or dry season freeboard (i.e., available tank space to accommodate rainfall), which is 1.3 m and 0.3 m, respectively.

The well pad or a specifically constructed wastewater storage areas will be bunded to contain 110% of the volume of the largest tank stored onsite.

Wastewater storage tanks may be deployed for extended periods of time to allow ongoing evaporation or treatment. Treatment of wastewater may also be undertaken onsite, with water treatment options such as submerged combustion units, enhanced evaporation units etc. utilises to reduce wastewater volume onsite. Wastewater from other sites across the basin may also be used to stored onsite, to assist in wastewater treatment / management.

Where excessive salt crystallisation is observed in evaporation tanks, higher density HDPE liners (i.e. 0.75 mmm) will be installed to prevent salt solids from puncturing liners.


Figure 25: Examples of covered wastewater tanks used across Tamboran's sites (Riptide left; Flexipond right)

3.8.3.1 Hydrotesting of wastewater tanks

Groundwater will be used to perform hydrotesting on each of the wastewater tanks to confirm the integrity of the primary liner and rectify any leaks prior to storing flowback wastewater. Hydrotesting involves the filling of each tank to approximately 75% capacity for a period of 24 hours. Records of hydrotesting of each tank shall be retained.

Once a tank has been hydrotested, the groundwater in the wastewater tank will be recycled to perform a hydrotest on the adjacent wastewater tank and will also be used for dust suppression. Most of the water will be re-used, with any unused groundwater released through a controlled discharge to the area surrounding the well pad. The quality of the hydrotest water is likely to be similar the groundwater, with a pH of between 6.5 to 9, and an electrical conductivity of less than 1,600 µs/cm. Where hydrotest water is proposed to be released from the site, it will be tested prior to discharge and records retained. The release limits are summarised in Table 18.

Table 18: Hydrotest discharge/ dust suppression quality release limits

Monitoring parameter	Release limit
Electrical conductivity	1,600 µs/cm
pH	6.5– 9
Volume	Record retained

To assess the potential impact of a stormwater release at the specific limit, modelling was completed to assess the changing soil salinities and the potential for impact on the receiving vegetation types. The model used the maximum observed Gum Ridge Salinity of 1,600 µs/cm (1,046 mg/L Total Dissolved Solids) released over a 5 year period . This included estimates of stormwater collected and discharged from the site over the period, as well as the periodic release of hydrotest water. This modelling is extremely conservative as it a) assumed all water ran off from the site and b) that all water was of a quality consistent with the Gum Ridge. In theory, the amount of water released from the site is likely to be significantly lower and of quality consistent with rainwater.

To understand the sensitive of the receiving vegetation to salinity, a literature review was completed. the receiving environment is characterised by Native grasses (including spinifex and tussock), with trees commonly found in the project area are moderately to highly tolerant to salinity. Eucalyptus species are known for their salt tolerance and can withstand salinity levels up to 8,000 µs/cm and greater. For example, *Eucalyptus camaldulensis* is present in the area (Table 19 of the Land Condition Report) is tolerant to salinity up to 8,000 µs/cm [26]. Several of the eucalyptus species in the area including *Eucalyptus microtheca* and *Eucalyptus camaldulensis* are specifically noted in the Salinity Management Handbook (Queensland Government) as suitable for saline discharge sites[27]. Acacian and Melaleuca species found in the area can tolerate at least 2,000 µs/cm and greater than 16,000 µs/cm. *Corymbia* (Bloodwood) generally exhibit moderate to low salinity tolerance compared to eucalypts- but still greater than 2,000 µs/cm and up to 4,000 µs/cm.

The modelling confirmed that the salinity of the receiving soils post release is within the anticipated range for the receiving vegetation species.

Releases will be undertaken in a manner that prevents erosion or the discharge of groundwater directly to surface waters.

3.9 Stimulation activities

HFS will be undertaken upon completion of the drilling of the E&A wells. HFS is generally conducted during daylight hours, with wireline and coiled tubing support activities operating on a 24-hour basis.

HFS involves the injection of a slurry, primarily consisting of water and sand (proppant), plus a small percentage of chemicals at high pressure into the target section of the horizontal wellbore. Typically, 95% or higher of the total volume in stimulation fluids is a combination of fresh water and sand, with the remainder as fluid-conditioning additives. Chemicals used in HFS are designed to optimise stimulation

[26] https://www.agric.wa.gov.au/soil-salinity/salinity-tolerance-plants-agriculture-and-revegetation-western-australia

[27] Table 43 Salinity Management Handbook, Queensland

outcomes and are commonly found in food and other household domestic products. The chemical composition of stimulation fluid is discussed further in section 3.11.

All fluid additives (water and chemicals) and sand are mixed on the surface in the frac spread mixer, which uses a portable containment bund. The mixture and pumping schedule (rates, volume and proppant) are based on modelling which determines the desired fracture attributes. The HFS model is completed prior to the commencement of stimulation activities and is underpinned by a Mechanical Earth Model (MEM). The MEM is generated from data collected during drilling, wireline logging, core analysis and DFIT tests. The stimulation fluid mixture and pumping schedule is continuously updated during and after each stage to ensure optimal outcomes are achieved. An example of the modelled fracture geometry for the Amungee NW-1H well is illustrated in Figure 26.

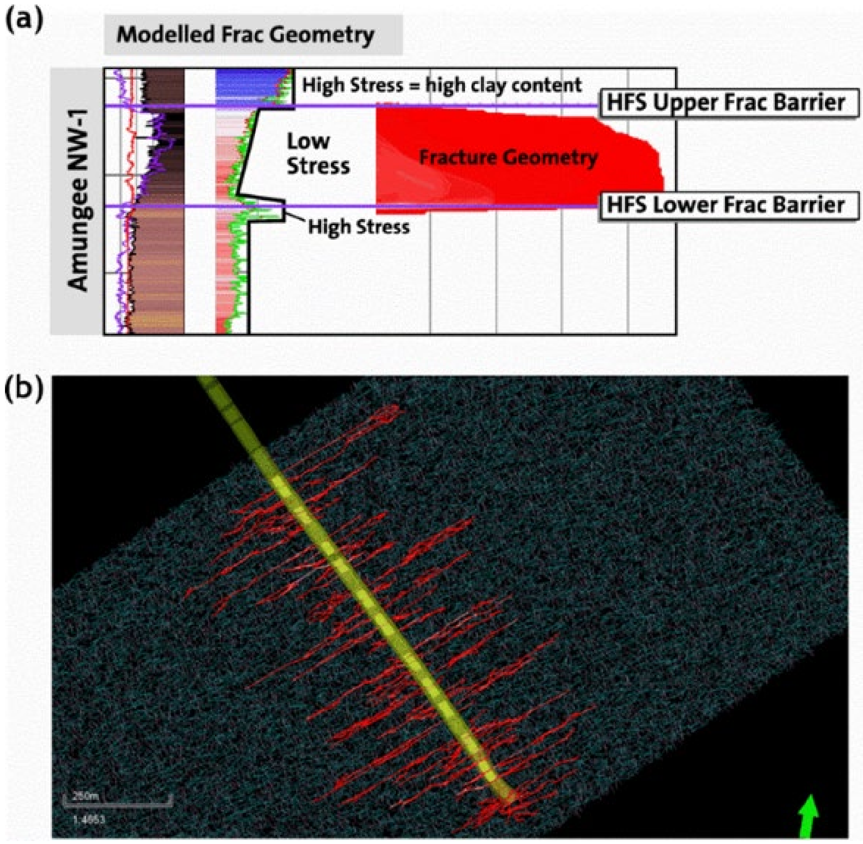


Figure 26: Example of visualised fracture geometry of Amungee NW-1

The stimulation fluid is pressurised by the high-pressure pumping units and directed downhole via a manifold to discrete target intervals along each of the horizontal wellbores (referred to as ‘stages’). Up to 20 stages per 1,000 m are proposed for each exploration well, with the final number of stages determined based upon the horizontal length of the well and commercial considerations. Each stage being isolated and perforated using a plug and perforation gun assembly deployed via wireline. As the pressure is sustained, the fractures propagate radially from the well, through the target rock. Once optimal fracture propagation has been achieved, the proppant (sand) is pumped down the well and into the open fractures. This process is repeated for each stage. The final number of stages pumped in each well is dependent on the useable length of the horizontal wellbore and in situ geological conditions. Once all stages are complete, the well is suspended awaiting completion and well testing activities.

Approximately 1- 1.5 ML(base case of 1.2ML) of water and 180 – 250 tonnes of proppant (sand) will be used for each stage. This equals an approximate volume of 72ML of water and between 15,000 tonnes of sand per E&A well. Water will be sourced in accordance with the WEL, as described in section 3.12. Proppant will be sourced from locations within Australia (such as South Australia) or imported from international sources.

Wellbore pressures of the E&A well which is being stimulated are monitored during each stimulation to ensure the operations have not compromised the integrity of the production casing or the cement barriers of the well. Pressure monitoring is also completed on each of the casing strings being stimulated and on the adjacent wells to ensure any interference is identified and corrective actions implemented. An example of the monitoring of applied stimulation fluid pressure and annulus pressure monitoring is provided in Figure 27. The risk of a stimulation migrating into an adjacent wellbore is considered low, with conservative well spacing designed to prevent connection. If the stimulation zone of an E&A well were to become connected, the design of each well is sufficient to withstand any likely pressures encountered.

A MAOP is an important parameter used to define the safe operating envelope of each E&A well. The Maximum Allowable Pumping Pressure (MAPP) is set below the MAOP to allow for uncertainty and provide an additional safety margin. The predicted MAPP is 9,200 psi and the MAOP is 10,000 psi.

Two additional safety measures are set in place to ensure treating pressures do not exceed the MAOP of the system:

1. Each HFS pumping unit has an automated high-pressure shut-off control set at the MAPP or lower, and
2. A pressure relief valve will be installed on the surface treating line to instantaneously bleed-down pressures if the pressure exceeds the MAPP.

A coiled tubing unit is on standby, on location, in the event of contingent wellbore intervention operations, such as a wellbore screen-out. A screen-out occurs when the proppant in the stimulation fluid blocks the perforations or fracture network, creating a sudden and significant restriction to fluid flow, resulting in a premature termination of the stimulation operation.

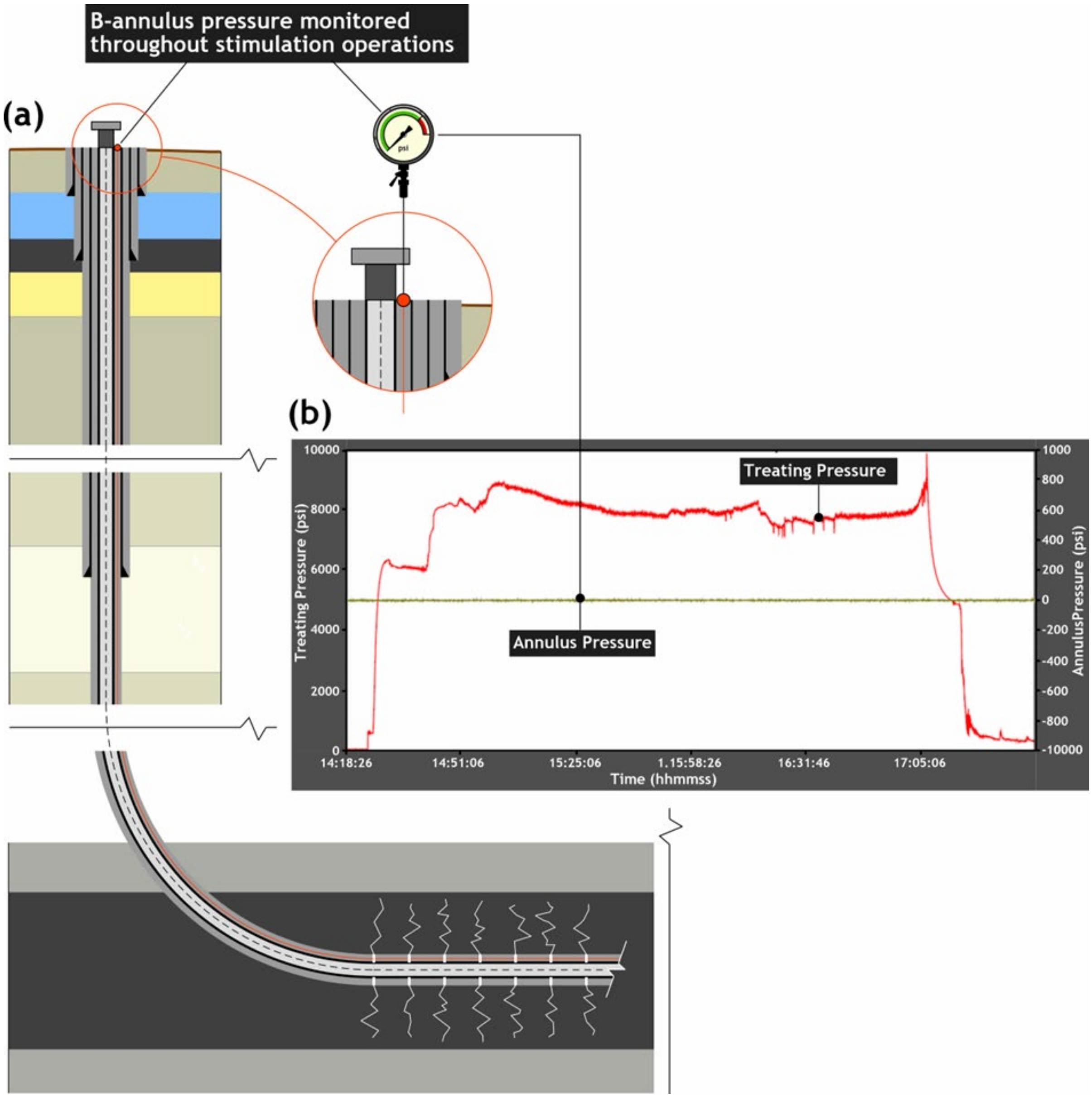


Figure 27: Well and wellhead schematic showing the "B Annulus" monitoring process, and an example from stage 1 of the observed pressure of the B Annulus (0 psi) while high-pressure HFS operations were underway

3.10 Well completion and test program

Upon finalisation of HFS activities, the wells at a site will be completed and well testing initiated. To initiate production, nitrogen lifting using a coil tubing rig is often undertaken to reduce bottom hole pressure and allow gas to flow to surface. As the volume of gas flow increases, the bottom hole pressure will decrease (due to the gas column reducing and hydrostatic head), allowing sustained production.

The well testing program is one of the most critical parts of the program, as information collected during this phase is used to understand the nature, quality, quantity and production performance of the resource. A key outcome of multi-well operations is to understand how the laterals interact with each other, to optimise lateral spacing and determine the number of wells that can be constructed on a development pad.

The well completion and testing program for each exploration well proposed under this EMP consists of:

- preparing for downhole completion equipment
- installation of a production packer and production tubing

- installation of production wellhead
- underbalance wellbore to initiate production of hydrocarbons

Well test activities include:

- flowback of fluids and hydrocarbons
- measurement and management of hydrocarbons
- ongoing sampling of flowback and hydrocarbons
- disposal of gaseous hydrocarbons via flare
- disposal of liquid hydrocarbons via flare or off-site transportation (including on-site temporary storage)

3.10.1 Completion and well testing

The site will consist of new and existing E&A wells and several associated, temporary facilities that will be brought on to assist with completion and testing activities. The Shenandoah South and Kyalla 117 N2 sites will have the following equipment and infrastructure:

- Completion rig and associated equipment (which installs the production tubing)
- Well testing package, including:
  - Test separator (separates hydrocarbons from flowback fluid).
  - Vertical gas flare, a safe and accepted disposal method of volatile hydrocarbons.
  - Surface pipe work and manifolds.
  - Emergency shut down valves.
  - Workshops and storerooms.
  - Communications and generator shacks.
  - Bunded diesel and oil storage areas.
  - Wastewater (flowback) fluid storage, open-top and covered.
  - Water transfer equipment.
  - A camp.

Each stimulated well will be completed to enable the flow of hydrocarbons and fluids. Completion activities involve the installation of downhole and surface completion equipment, including production packers and tubing and a wellhead.

To initiate the well testing phase, the well will be underbalanced to allow hydrocarbon and fluid production. To assist in under balancing the well, nitrogen lifting using a coil tube unit is often undertaken. Initially, the flowback will primarily contain HFS fluid. As the fluid and pressure within the reservoir is reduced, it is predicted that gas rates will increase. To obtain a comprehensive understanding of the fluid recovery and gas production potential of the target reservoir, well testing is expected to extend between one and six months for each well. The total time required to test each well will depend on several factors including the success of the well and observed depletion curve. Well testing activities may also be undertaken at multiple times during the activity to accommodate operational requirements (such as well maintenance, COVID-19 constraints or weather). For example, a well may be tested for three months in year one and then three months in year two. Additional time may be required to account for unexpected issues or operational requirements.

All flowback fluids and hydrocarbons will be directed through a fully contained separator on-site. The separator will separate out the gases, fluids and solids so that they can be measured and managed.

Due to the depth of the Velkerri shale and gas composition from the existing Shenandoah S1H well in the region, material volumes of liquid hydrocarbons are not anticipated. Any liquid hydrocarbons will be separated from the flowback fluid and either combusted in the on-site flare or transported off-site for disposal. The decision to flare versus remove off-site is based upon site access (with limited access in January and February). Where liquid hydrocarbons are stored, whether separated or mixed with other fluids at a concentration greater than 1% by volume, these will be stored in specialised enclosed condensate tanks compliant with section A.3.8(d) of the Code. Aboveground tanks used for storing or separating condensate during well completion will have vents that are directed to the onsite flare (or atmosphere where volumes are insufficient) to prevent vapours from exceeding the Lower Explosive Limit (LEL) outside of the tank. The condensate tanks will be double lined and grounded.

After the well test, the well may be shut-in to complete a pressure build-up test to further characterise the respective reservoirs for a period of up to 24 months. Upon finalisation of the build-up test, the well will be either suspended or plugged and rehabilitated.

An overview of the typical well testing equipment layout is provided in Figure 28 .

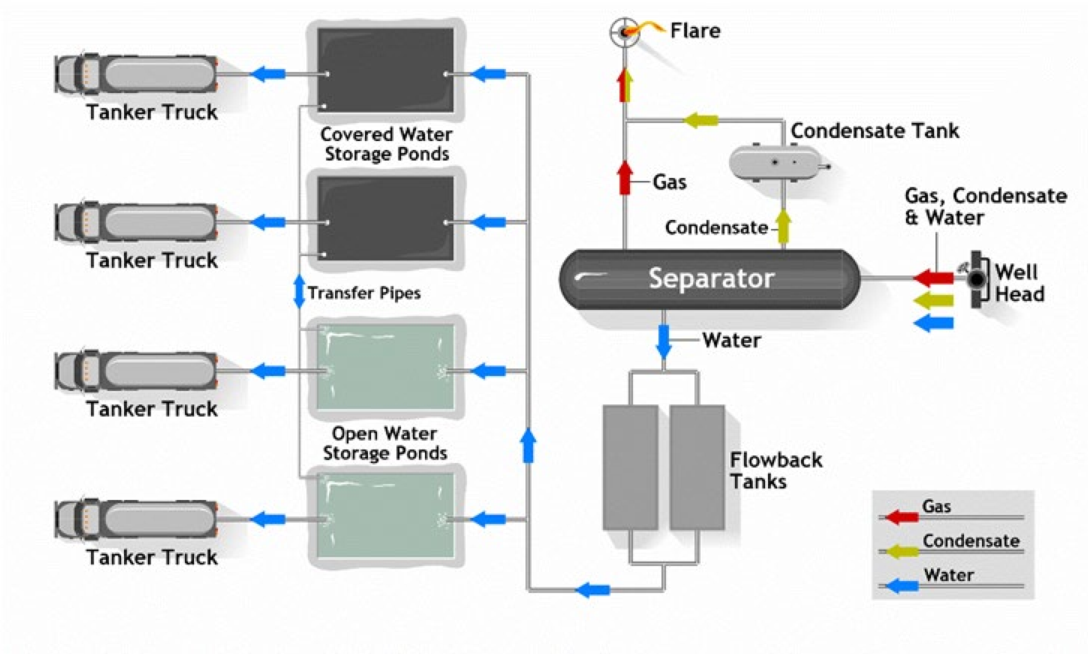


Figure 28: Sample well test schematic

3.10.2 Flaring

During well testing, produced gas and liquids will be separated to split out gas, condensate (if encountered) and flowback fluids. Flowback fluids will be sent to wastewater storage tanks for management as described in section Drilling waste composting/soil conditioner trial. Produced hydrocarbons (gas and condensate) will either be flared onsite or gathered to a centralised flare for management (such as Shenandoah S2). This will reduce the number of flares required to be operated and enable future appraisal gas sale (subject to a future EMP revision).

To minimise the potential GHG emissions and potential bushfire risk during operations, the following controls will be used:

- flares will be designed and will be operated in compliance with the US EPA 40 CFR § 63.11 control device and work practice requirements to achieve a 98% combustion efficiency.
- vertical flares will be designed to manage the maximum anticipated gas production rates likely to be encountered.

- The flare designs have capacity for the anticipated gas/liquid stream composition (net heating value) and maximum tip velocity (Vmax) to ensure the optimal flare efficiency. The flares have been installed with a constant pilot flame and an autoignition system that provides electrical impulses to a spark plug continuously. If the flare were to extinguish, the auto-ignition system has been designed to reignite the flare within 1.3 seconds.
- Flare efficiency shall be validated during the each well test in accordance with the US EPA 40 CFR § 60.18 to ensure the combustion efficiency is operating at 98%.Flares shall be used that have a diameter of 3 inches or greater, are non assisted, have a hydrogen content of 8.0 percent (by volume), or greater, and are designed for and operated with an exit velocity less than 37.2 m/sec (122 ft/sec) and less than the velocity, Vmax, as determined by the following equation:

  $V_{max} = (X_{H2} - K_1) * K_2$

  Where:

  V_{max} = Maximum permitted velocity, m/sec.

  K_1 = Constant, 6.0 volume-percent hydrogen.

  K_2 = Constant, 3.9(m/sec)/volume-percent hydrogen.

  X_{H2} = The volume-percent of hydrogen, on a wet basis, as calculated by using the American Society for Testing and Materials (ASTM) Method D1946–77. (Incorporated by reference as specified in § 60.17).
- The flares are located at least 45 m from the surrounding vegetation.
- A bushfire management plan implemented outlining the controls and communication requirements (Appendix B).
- Where a gas gathering line is used, pressure monitoring and 6 monthly pipeline inspections will be undertaken to detect pipeline leakage as described in the methane emission management plan (Appendix I).

Any residual condensate shall be stored in self-bunded waste oil tanks and disposed of as per section 3.22.

An example of a vertical flare is provided in Figure 29.

Figure 29: Vertical flare

3.11 Chemical and fuel management

Tamboran will use a range of chemicals and hydrocarbons to support drilling, stimulation and well testing operations. All chemicals used in Australia must be approved for use by the Federal Government Department of Health and be listed on the Australian Inventory of Chemical Substances which is maintained under the Australian Industrial Chemicals Introduction Scheme (formerly known as National Industrial Chemicals Notification and Assessment Scheme (NICNAS)). Tamboran is also required to disclose all chemicals that are proposed to be used prior to undertaking any drilling and stimulation activities. The Chemical Abstracts Services (CAS) numbers of all chemicals, including proprietary chemicals, are provided to the independent third-party consultant undertaking the chemical risk assessment to ensure all chemicals are fully assessed. However, the proprietary chemical CAS numbers are excluded from the public submission to protect the intellectual property of chemical manufacturers. This approach ensures that all chemicals can be appropriately assessed, while protecting chemical companies from releasing commercially sensitive information. The following factors were considered when deciding whether the chemicals were similar enough to be regarded as analogues for proprietary chemicals:

- Consideration of similar chemical structures.
- Consideration of the potential for the chemicals to have similar modes or mechanisms of action for their human health or environmental effects.

Benzoic acid and perfluorocarbons (group) were selected as the analogue chemicals for the chemical frac tracers (CFT) and gas frac tracers (GFT) respectively, due to their structural similarity and similar toxicological properties (where information was available) to the chemical tracers.

The final chemical risk assessments are provided as Appendix E (AECOM 2023) and Appendix E.1 (EHS Support 2023).

3.11.1 Chemical types and quantities

Bulk chemicals and hydrocarbons will be used/generated during the drilling, stimulation and well testing activities. The full suite of assessed chemicals are listed in Table 19 and include the following chemical types:

- Acids and bases: controls pH and are used to clear perforations of debris prior to stimulation
- Biocides: controls or eliminates bacteria growth in the stimulation fluid to prevent introduction to target formation
- Viscosity regulators: increases or reduces the thickness of a fluid
- Clay control: prevents clays from swelling
- Friction reducers: reduces friction between the stimulation fluid and piping allowing the fluid to be injected further without pressure drop
- Corrosion inhibiters: prevents equipment from rusting
- Chemical inhibitors: such as iron or scale prevention
- Surfactants: reduces surface tension of the hydraulic fracturing fluid
- Drilling muds and weighting agents: used to lubricate the drilling bit, return cuttings to surface, control clay swelling and inhibit formation inflows
- Bulk diesel: to fuel equipment and generate power
- Typical workshop and maintenance chemicals including hydraulic oil, coolant, greases, paints, solvents and engine oils
- Degreasers and domestic cleaning chemicals
- Wastewater (section 3.13)
- Condensate (incidental production)
- Camp wastewater (sewage) (section 3.22)

The chemical risk assessments

The maximum chemical storage volume is generally restricted to the materials required for drilling and stimulation of 3 exploration wells at a time at each site.

Chemical used (type and quantity) during drilling, completion and stimulation will be tracked and reported as a part of the daily drilling report and well completion report provided to DITT upon completion of the well.

Table 19: Estimated chemical volume and storage used in the drilling and stimulation process at each site

Material name	Typical volume	Maximum volume	Unit	Storage area	Chemical composition	CAS Number	Chemical risk assessment report
Acetic acid - 60% pH control	3,000	9,000	L	Stimulation chemical storage area	Acetic acid	64-19-7	AECOM, 2024 – Appendix E EHS Support, (2023) – Appendix E.1
BE-9 biocide	17,000	17,000	L	Stimulation chemical storage area	Tributyl tetradecyl phosphonium chloride	81741-28-8	AECOM, 2024 – Appendix
Caustic soda liquid pH control/ buffer	15,000	45,000	L	Stimulation chemical storage area	Sodium hydroxide	1310-73-2	AECOM, 2024 – Appendix E EHS Support, (2023) – Appendix E.1
DCA-11001 breaker activator	5,000	15,000	L	Stimulation chemical storage area	Diethanolamine	111-42-2	AECOM, 2024 – Appendix E
DCA-13002 breaker	300	900	kg	Stimulation chemical storage area	Sodium persulfate	7775-27-1	AECOM, 2024 – Appendix E
DCA-13003 breaker	10,000	30,000	L	Stimulation chemical storage area	Chlorous acid, sodium salt Sodium chloride	7758-19-2 7647-14-5	AECOM, 2024 – Appendix E
DCA-16001 clay stabiliser	42,000	126,000	L	Stimulation chemical storage area	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	Proprietary	AECOM, 2024 – Appendix E
DCA-17001 corrosion inhibitor	1,000	3,000	L	Stimulation chemical storage area	Diethylene glycol Cinnamaldehyde Amine oxides, cocoalkyldimethyl Methanol Benzaldehyde Alcohols, C12-16, ethoxylated	111-46-6 104-55-2 61788-90-7 67-56-1 100-52-7 68551-12-2 7681-82-5	AECOM, 2024 – Appendix E

Material name	Typical volume	Maximum volume	Unit	Storage area	Chemical composition	CAS Number	Chemical risk assessment report
					Sodium iodide		
DCA-19001 crosslinker	600	1,800	kg	Stimulation chemical storage area	Disodium octaborate tetrahydrate	12008-41-2	AECOM, 2024 – Appendix E
DCA-19002 crosslinker	10,000	30,000	L	Stimulation chemical storage area	Ulexite Ethylene glycol Crystalline silica, quartz	1319-33-1 107-21-1 14808-60-7	AECOM, 2024 – Appendix E
DCA-23001 friction reducer	5,000	15,000	kg	Stimulation chemical storage area	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	Proprietary	AECOM, 2024 – Appendix E
DCA-23003 friction reducer	18,000	54,000	L	Stimulation chemical storage area	Hydrotreated light petroleum distillate Ethoxylated branched C13 alcohol Sodium diacetate	64742-47-8 78330-21-9 126-96-5	AECOM, 2024 – Appendix E
DCA-25005 gelling agent	35,000	105,00	kg	Stimulation chemical storage area	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	Proprietary	AECOM, 2024 – Appendix E
DCA-30001 scale Inhibitor	15,000	45,000	L	Stimulation chemical storage area	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	Proprietary	AECOM, 2024 – Appendix E

Material name	Typical volume	Maximum volume	Unit	Storage area	Chemical composition	CAS Number	Chemical risk assessment report
DCA-32002 surfactant	15,000	45,000	L	Stimulation chemical storage area	Alcohols, C6-C12, ethoxylated propoxylated Alcohols, C10-C16, ethoxylated propoxylated	68937-66-6 69227-22-1	AECOM, 2024 – Appendix E
DCA-32014 surfactant	200	600	L	Stimulation chemical storage area	Hydrotreated light petroleum distillate Ethanol Fatty acids, tall-oil, ethoxylated C12-C15 Ethoxylated alcohols Amides, tall-oil fatty, N,N-bis(hydroxyethyl) Butyl alcohol Methanol	64742-47-8 64-17-5 61791-00-2 68131-39-5 68155-20-4 71-36-3 67-56-1	AECOM, 2024 – Appendix E
FE-2 buffer	200	600	kg	Stimulation chemical storage area	Citric acid	77-92-9	AECOM, 2024 – Appendix E
Hydrochloric acid - 32%	50,000	150,000	L	Stimulation chemical storage area	Hydrochloric acid (32%)	7647-01-0	AECOM, 2024 – Appendix E
Alcohols, C11-14-iso-, C13-rich, ethoxylated- surfactant	5,285	15,855	L	Stimulation chemical storage area	Alcohols, C11-14-iso-, C13-rich, ethoxylated	78330-21-9	AECOM, 2024 – Appendix E EHS Support, (2023) – Appendix E.1
Sodium (C14-16) olefin sulfonate - surfactant	4,658	13,974	L	Stimulation chemical storage area	Sodium (C14-16) olefin sulfonate	68439-57-6	EHS Support, (2023) – Appendix E.1
Diisobutyl glutarate - plasticiser	627	1,881	L	Stimulation chemical storage area	Diisobutyl glutarate	71195-64-7	EHS Support, (2023) – Appendix E.1
Diisobutyl succinate - plasticiser	209	627	L	Stimulation chemical storage area	Diisobutyl succinate	925-06-4	EHS Support, (2023) – Appendix E.1

Material name	Typical volume	Maximum volume	Unit	Storage area	Chemical composition	CAS Number	Chemical risk assessment report
Diisobutyl adipate- plasticiser	179	537	L	Stimulation chemical storage area	Diisobutyl adipate	141-04-8	EHS Support, (2023) – Appendix E.1
Sodium thiosulphate- stabilising agent	4,763	14,289	L	Stimulation chemical storage area	Sodium thiosulphate	7772-98-7	EHS Support, (2023) – Appendix E.1
Sodium sulphate stabilising agent	913	2,739	L	Stimulation chemical storage area	Sodium sulphate	7757-82-6	AECOM, 2024 – Appendix E EHS Support, (2023) – Appendix E.1
Sodium sulphite stabilising agent	794	2,382	L	Stimulation chemical storage area	Sodium sulphite	7757-83-7	AECOM, 2024 – Appendix E EHS Support, (2023) – Appendix E.1
Ethylene glycol- crosslinker	5,112	15,336	L	Stimulation chemical storage area	Ethylene glycol	107-21-1	AECOM, 2024 – Appendix E EHS Support, (2023) – Appendix E.1
Choline chloride- clay stabiliser	10,301	30,903	L	Stimulation chemical storage area	Choline chloride	67-48-1	AECOM, 2024 – Appendix E EHS Support, (2023) – Appendix E.1
Glutaraldehyde- biocide	14,930	44,790	L	Stimulation chemical storage area	Glutaraldehyde	111-30-8	AECOM, 2024 – Appendix E EHS Support, (2023) – Appendix E.1
Ammonium sulphate- breaker	4,479	13,491	L	Stimulation chemical storage area	Ammonium sulphate	7783-20-2	AECOM, 2024 – Appendix E EHS Support, (2023) – Appendix E.1
Polyacrylamide- friction reducer	4,479	13,491	L	Stimulation chemical storage area	Polyacrylamide	25085-02-3	AECOM, 2024 – Appendix E EHS Support, (2023) – Appendix E.1
Sodium polyacrylate- gelling agent	746	2,238	L	Stimulation chemical storage area	Sodium polyacrylate	9003-04-7	AECOM, 2024 – Appendix E EHS Support, (2023) – Appendix E.1

Material name	Typical volume	Maximum volume	Unit	Storage area	Chemical composition	CAS Number	Chemical risk assessment report
Sodium bisulfite- stabiliser	149	447	L	Stimulation chemical storage area	Sodium bisulfite	7631-90-5	AECOM, 2024 – Appendix E EHS Support, (2023) – Appendix E.1
Alkyl alcohol- surfactant	149	447	L	Stimulation chemical storage area	Alkyl alcohol	56-81-5	EHS Support, (2023) – Appendix E.1
2-Propenoic acid, homopolymer, ammonium salt- biocide	149	447	L	Stimulation chemical storage area	2-Propenoic acid, homopolymer, ammonium salt	9003-03-6	AECOM, 2024 – Appendix E EHS Support, (2023) – Appendix E.1
Potassium persulfate-braker	149	447	L	Stimulation chemical storage area	Potassium persulfate	7727-21-1	AECOM, 2024 – Appendix E EHS Support, (2023) – Appendix E.1
2-Ethoxy-naphthalene-surfactant	149	447	L	Stimulation chemical storage area	2-Ethoxy-naphthalene	93-18-5	EHS Support, (2023) – Appendix E.1
Sodium gluconate- stabiliser	8,576	25,728	L	Stimulation chemical storage area	Sodium gluconate	527-07-1	EHS Support, (2023) – Appendix E.1
Boric acid- crosslinker	4,288	12,864	L	Stimulation chemical storage area	Boric acid	10043-35-3	EHS Support, (2023) – Appendix E.1
Potassium hydroxide- pH control	10,745	32,235	L	Stimulation chemical storage area	Potassium hydroxide	1310-58-3	AECOM, 2024 – Appendix E EHS Support, (2023) – Appendix E.1
Mannanase- crosslinker	2	6	L	Stimulation chemical storage area	Mannanase	37288-54-3	EHS Support, (2023) – Appendix E.1
Ammonium persulphate-breaker	7,451	22,353	L	Stimulation chemical storage area	Ammonium persulphate	7727-54-0	AECOM, 2024 – Appendix E EHS Support, (2023) – Appendix E.1
Talc- buffer	384	1,152	L	Stimulation chemical storage area	Talc	14807-96-6	AECOM, 2024 – Appendix E EHS Support, (2023) – Appendix E.1

Material name	Typical volume	Maximum volume	Unit	Storage area	Chemical composition	CAS Number	Chemical risk assessment report
Sodium bromate- breaker	50,441	151,323	L	Stimulation chemical storage area	Sodium bromate	7789-38-0	AECOM, 2024 – Appendix E EHS Support, (2023) – Appendix E.1
Hepta sodium phosphonate- Emulsifier	3,176	9,528	L	Stimulation chemical storage area	Hepta sodium phosphonate	22042-96-2	AECOM, 2024 – Appendix E EHS Support, (2023) – Appendix E.1
Distillates, hydrotreated light- friction reducer	54,231	162,693	L	Stimulation chemical storage area	Distillates, hydrotreated light	64742-47-8	AECOM, 2024 – Appendix E EHS Support, (2023) – Appendix E.1
Guar gum- viscosity regulator	15,141	45,423	L	Stimulation chemical storage area	Guar gum	9000-30-0	AECOM, 2024 – Appendix E EHS Support, (2023) – Appendix E.1
Poly-oxyethylene nonylphenol ether- surfactant	4,466	13,398	L	Stimulation chemical storage area	Poly-oxyethylene nonylphenol ether	9016-45-9	EHS Support, (2023) – Appendix E.1
Quaternary ammonium compounds, bis(hydrogenated tallow alkyl)dimethyl, salts with bentonite- biocide	4,466	13,398	L	Stimulation chemical storage area	Quaternary ammonium compounds, bis(hydrogenated tallow alkyl)dimethyl, salts with bentonite	68953-58-2	AECOM, 2024 – Appendix E EHS Support, (2023) – Appendix E.1
1,6-Hexanediol- cross linker	447	1,341	L	Stimulation chemical storage area	1,6-Hexanediol	629-11-8	EHS Support, (2023) – Appendix E.1
Hydrochloric acid- pH control	44,715	134,145	L	Stimulation chemical storage area	Hydrochloric acid	7647-01-0	AECOM, 2024 – Appendix E EHS Support, (2023) – Appendix E.1
N-Benzyl-alkylpyridinium chloride- pH control	28	84	L	Stimulation chemical storage area	N-Benzyl-alkylpyridinium chloride	68909-18-2	EHS Support, (2023) – Appendix E.1

Material name	Typical volume	Maximum volume	Unit	Storage area	Chemical composition	CAS Number	Chemical risk assessment report
Formic acid- corrosion inhibitor	38	114	L	Stimulation chemical storage area	Formic acid	64-18-6	EHS Support, (2023) – Appendix E.1
Sodium erythorbate- scaler prohibitor	334	1,002	L	Stimulation chemical storage area	Sodium erythorbate	6381-77-7	AECOM, 2024 – Appendix E EHS Support, (2023) – Appendix E.1
Citric acid- pH control	15,878	47,634	L	Stimulation chemical storage area	Citric acid	77-92-9	AECOM, 2024 – Appendix E EHS Support, (2023) – Appendix E.1
Acetic acid- pH control	15,878	47,634	L	Stimulation chemical storage area	Acetic acid	64-19-7	AECOM, 2024 – Appendix E EHS Support, (2023) – Appendix E.1
Isopropanol- clay management	83	249	L	Stimulation chemical storage area	Isopropanol	67-63-0	AECOM, 2024 – Appendix E EHS Support, (2023) – Appendix E.1
Ethoxylated C12-C16 alcohol - surfactant	57	171	L	Stimulation chemical storage area	Ethoxylated C12-C16 alcohol	68551-12-2	AECOM, 2024 – Appendix E EHS Support, (2023) – Appendix E.1
Ethoxylated decanol - surfactant	19	57	L	Stimulation chemical storage area	Ethoxylated decanol	26183-52-8	AECOM, 2024 – Appendix E EHS Support, (2023) – Appendix E.1
Cinnamaldehyde- biocide	57	171	L	Stimulation chemical storage area	Cinnamaldehyde	104-55-2	AECOM, 2024 – Appendix E EHS Support, (2023) – Appendix E.1
Ethoxylated tallow alkyl amine - surfactant	9	27	L	Stimulation chemical storage area	Ethoxylated tallow alkyl amine	61791-26-2	EHS Support, (2023) – Appendix E.1
Methanol- corrosion inhibitor	2	6	L	Stimulation chemical storage area	Methanol	67-56-1	AECOM, 2024 – Appendix E EHS Support, (2023) – Appendix E.1

Material name	Typical volume	Maximum volume	Unit	Storage area	Chemical composition	CAS Number	Chemical risk assessment report
Polyacrylamide - friction reducer	49,093	147,279	L	Stimulation chemical storage area	Polyacrylamide	9003-05-08	AECOM, 2024 – Appendix E EHS Support, (2023) – Appendix E.1
Polyethylene glycol trimethylnonyl ether - clay manager	87	261	L	Stimulation chemical storage area	Polyethylene glycol trimethylnonyl ether	127087-87-0	EHS Support, (2023) – Appendix E.1
Water in additive- stabiliser	66,804	200,412	L	Stimulation chemical storage area	Water in additive	7732-18-5	EHS Support, (2023) – Appendix E.1
Potassium sorbate food grade- corrosion inhibitor	14	42	L	Stimulation chemical storage area	Potassium sorbate	24634-61-5	EHS Support, (2023) – Appendix E.1
Mannanase (Mannan endo-1,4-beta-mannosidase)-cross linker	2	6	L	Stimulation chemical storage area	Mannanase (Mannan endo-1,4-beta-mannosidase)	37288-54-3	EHS Support, (2023) – Appendix E.1
Nonoxynol-9- surfactant	9	27	L	Stimulation chemical storage area	Nonoxynol-9	26571-11-9	EHS Support, (2023) – Appendix E.1
2-Ethylhexanol PO/EO polymer- stabiliser	9	27	L	Stimulation chemical storage area	2-Ethylhexanol PO/EO polymer	64366-70-7	EHS Support, (2023) – Appendix E.1
Corn oil- friction reducer	662	1,986	L	Stimulation chemical storage area	Corn oil	8001-30-7	EHS Support, (2023) – Appendix E.1
Sodium chloride- weighting agent	15,000	45,000	kg	Completion chemical storage area	Sodium chloride	7647-14-5	AECOM, 2024 – Appendix E
ALDACIDE G biocide	500	1,500	L	Completion chemical storage area	Glutaraldehyde Methanol	111-30-8 67-56-1	AECOM, 2024 – Appendix E
OXYGON Oxygen scavenger	100	300	kg	Completion chemical storage area	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	Proprietary	AECOM, 2024 – Appendix E

Material name	Typical volume	Maximum volume	Unit	Storage area	Chemical composition	CAS Number	Chemical risk assessment report
BARACOR 100 corrosion inhibitor	2,000	6,000	L	Completion chemical storage area	Ethanol, 2,2'-oxybis-, reaction products with ammonia, morpholine derivatives residues Methanol Nitrilotriacetic acid, trisodium salt monohydrate	68909-77-3 67-56-1 5064-31-3	AECOM, 2024 – Appendix E
Sodium Hypochlorite 10 – 30% cleaner	10,000	30,000	L	Completion chemical storage area	Sodium hypchlorite Sodium Hydroxide Water	7681-52-9 1310-73-2 7732-18-5	AECOM, 2024 – Appendix E
CON-DET wetting agent	50	150	kg	Drilling chemical storage area	Amides, coco, N,N-bis (hydroxyethyl) Benzenesulfonic acid, dimethyl-, sodium salt Isopropanol Potassium pyrophosphate Potassium hydroxide	68603-42-9 1300-72-7 67-63-0 7320-34-5 1310-58-3	AECOM, 2024 – Appendix E
SAPP- sodium acid phosphate cement treatment	50	150	kg	Drilling chemical storage area	DISODIUM PYROPHOSPHATE	7758-16-9	AECOM, 2024 – Appendix E
Bentonite- lubricant	3,000	9,000	kg	Drilling chemical storage area	Crystalline silica, quartz Crystalline silica, cristobalite Crystalline silica, tridymite	14808-60-7 14464-46-1 15468-32-3	AECOM, 2024 – Appendix E
Caustic Soda-pH control	1,400	4,200	kg	Drilling chemical storage area	SODIUM HYDROXIDE	1310-73-2	AECOM, 2024 – Appendix E

Material name	Typical volume	Maximum volume	Unit	Storage area	Chemical composition	CAS Number	Chemical risk assessment report
EZ MUD DP or EZ MUD Liquid- drilling mud	2000	6,000	kg	Drilling chemical storage area	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	Proprietary	AECOM, 2024 – Appendix E
ALDACIDE G biocide	336	1,008	kg	Drilling chemical storage area	Glutaraldehyde Methanol	111-30-8 67-56-1	AECOM, 2024 – Appendix E
STOPPIT loss of circulation material	1,000	3,000	kg	Drilling chemical storage area	Crystalline silica, quartz	14808-60-7	AECOM, 2024 – Appendix E
Soda Ash- drill mud conditioner	350	1,050	kg	Drilling chemical storage area	SODIUM CARBONATE	497-19-8	AECOM, 2024 – Appendix E
BARACOR 100 corrosion inhibitor	250	750	kg	Drilling chemical storage area	Ethanol, 2,2'-oxybis-, reaction products with ammonia, morpholine derivatives residues Methanol Nitrilotriacetic acid, trisodium salt monohydrate	68909-77-3 67-56-1 5064-31-3	AECOM, 2024 – Appendix E
Sodium chloride (flossy salt)- weighting agent and formation inhibitor	96,000	288,000	kg	Drilling chemical storage area	Sodium chloride	7647-14-5	AECOM, 2024 – Appendix E
Barite- weighting agent	500	1,500	kg	Drilling chemical storage area	Crystalline silica	14808-60-7	AECOM, 2024 – Appendix E
BARACARB loss of circulation material	500	1,500	kg	Drilling chemical storage area	Crystalline silica, quartz	14808-60-7	AECOM, 2024 – Appendix E
Citric acid- pH control	500	1,500	kg	Drilling chemical storage area	Citric acid	5949-29-1	AECOM, 2024 – Appendix E

Material name	Typical volume	Maximum volume	Unit	Storage area	Chemical composition	CAS Number	Chemical risk assessment report
BARADEFOAM HP drilling fluid/foam	500	1,500	kg	Drilling chemical storage area	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	Proprietary	AECOM, 2024 – Appendix E
Sodium bicarbonate- pH buffer	500	1,500	kg	Drilling chemical storage area	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	Proprietary	AECOM, 2024 – Appendix E
PERFORMATROL- polymer fluid system	500	1,500	kg	Drilling chemical storage area	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	Proprietary	AECOM, 2024 – Appendix E
SOURSCAV- mud additive treat H2S contamination	500	1,500	kg	Drilling chemical storage area	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	Proprietary	AECOM, 2024 – Appendix E
DRIL-N-SLIDE- casing lubricant	500	1,500	kg	Drilling chemical storage area	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	Proprietary	AECOM, 2024 – Appendix E

Material name	Typical volume	Maximum volume	Unit	Storage area	Chemical composition	CAS Number	Chemical risk assessment report
STEELSEAL- corrosion inhibitor	500	1,500	kg	Drilling chemical storage area	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	Proprietary	AECOM, 2024 – Appendix E
BARAZAN D or BARAZAN D PLUS- viscosity increaser	4,150	12,450	kg	Drilling chemical storage area	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	Proprietary	AECOM, 2024 – Appendix E
PAC L loss of circulation material	2,300	6,900	kg	Drilling chemical storage area	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	Proprietary	AECOM, 2024 – Appendix E
Potassium chloride- weighting agent and formation inhibitor	22,500	67,500	kg	Drilling chemical storage area	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	Proprietary	AECOM, 2024 – Appendix E
QUIK-FREE – drilling additive	500	1,500	kg	Drilling chemical storage area	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	Proprietary	AECOM, 2024 – Appendix E

Material name	Typical volume	Maximum volume	Unit	Storage area	Chemical composition	CAS Number	Chemical risk assessment report
BAROFIBRE, BAROFIBRE super fine and BAROFIBRE coarse loss of circulation material	500	1,500	kg	Drilling chemical storage area	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	Proprietary	AECOM, 2024 – Appendix E
BaraBlend-657 Loss of circulation material	500	1,500	kg	Drilling chemical storage area	Crystalline silica, quartz	14808-60-7	AECOM, 2024 – Appendix E
N-DRIL HT PLUS filtration control additive	500	1,500	kg	Drilling chemical storage area	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	Proprietary	AECOM, 2024 – Appendix E
DEXTRID LTE filtration control additive	4,600	13,800	kg	Drilling chemical storage area	Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	AECOM, 2024 – Appendix E
BARABUF pH buffer	500	1,500	kg	Drilling chemical storage area	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	Proprietary	AECOM, 2024 – Appendix E
BDF 933 or BaraLube W-933 drilling lubricant	864	2,592	kg	Drilling chemical storage area	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	Proprietary	AECOM, 2024 – Appendix E

Material name	Typical volume	Maximum volume	Unit	Storage area	Chemical composition	CAS Number	Chemical risk assessment report
BAROLIFT sweeping agent	500	1,500	kg	Drilling chemical storage area	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	Proprietary	AECOM, 2024 – Appendix E
OXYGON oxygen scavenger	500	1,500	kg	Drilling chemical storage area	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	Proprietary	AECOM, 2024 – Appendix E
ENVIRO-THIN filtration control additive	500	1,500	kg	Drilling chemical storage area	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	Proprietary	AECOM, 2024 – Appendix E
Lime pH buffer	500	1,500	kg	Drilling chemical storage area	Calcium hydroxide	1305-62-0	AECOM, 2024 – Appendix E
Calcium chloride	37,000	111,000	kg	Drilling chemical storage area	Calcium chloride	10043-52-4	AECOM, 2024 – Appendix E
Sodium bromide	8,160	24,480	kg	Drilling chemical storage area	Sodium bromide	7647-15-6	AECOM, 2024 – Appendix E
Evolube TR	14,500	43,500	L	Drilling chemical storage area	Triethylene glycol, monobutyl ether 2-Butoxyethanol Diethanolamine	143-22-6 111-76-2 111-42-2	AECOM, 2024 – Appendix E
Radiagreen EME	4,800	14,400	L	Drilling chemical storage area	Fatty esters Specialities	Proprietary	AECOM, 2024 – Appendix E
Radiagreen EBL	4,800	14,400	L	Drilling chemical storage area	Fatty esters	Proprietary	AECOM, 2024 – Appendix E

Material name	Typical volume	Maximum volume	Unit	Storage area	Chemical composition	CAS Number	Chemical risk assessment report
					Specialities		
Polydrill	7,500	22,500	kg	Drilling chemical storage area	SULPHONATED ORGANIC POLYMER	Proprietary	AECOM, 2024 – Appendix E
Alpine spotting beads	1,000	3,000	kg	Drilling chemical storage area	Styrene	100-42-5	AECOM, 2024 – Appendix E
Diesel	250	750	KL	Diesel storage tanks – CAS numbers and storage and as per safety data sheet			
Hydraulic oil	1,000	3,000	L	Workshop – CAS numbers and storage as per safety data sheet			
Engine oil	1,000	3,000	L	Workshop – CAS numbers and storage and as per safety data sheet			
Degreasers	100	300	L	Workshop – CAS numbers and storage and as per safety data sheet			
Waste drilling fluids	2,500	7,500	m^3	Drilling mud sump – as per Code			
Completion fluids	1.4	4.2	ML	Drilling mud sump/on-site tank – as per Code			
Condensate	10	10	KL	Self-bunded waste oil pods – as per Code			
Flowback	~10.8 ML per well		ML	Flowback tanks. Assessed by AECOM, 2024 – Appendix E			
Proppants*							
100 mesh sand- proppant	91,000	273,000	kg	Stimulation chemical storage area	Sand	14808-60-7	AECOM, 2024 – Appendix E EHS Support, (2023) – Appendix E.1
Quartz or organophilic phyllosilicate- proppant	1,084	3,252	L	Stimulation chemical storage area	Quartz or organophilic phyllosilicate	14808-60-7	AECOM, 2024 – Appendix E EHS Support, (2023) – Appendix E.1
40/70 sand- proppant	1,650,000	4,950,000	kg	Stimulation chemical storage area	Sand	14808-60-7	AECOM, 2024 – Appendix E EHS Support, (2023) – Appendix E.1
30/50 sand- proppant	610,000	1,830,000	kg	Stimulation chemical storage area	Sand	14808-60-7	AECOM, 2024 – Appendix E EHS Support, (2023) – Appendix E.1 as 20/40

Material name	Typical volume	Maximum volume	Unit	Storage area	Chemical composition	CAS Number	Chemical risk assessment report
* Proppants are sand which is inert. They do not require special chemical bunding but are co-located in the stimulation chemical storage area, within the well pad bund. Residual proppant from a stimulation campaign is often used to assist with chemical spills on the well pad, where contaminated spill material is removed.							

3.11.2 Chemical risk assessment

Chemical risk assessments were completed to evaluate the potential human health and environmental effects of all compounds to be used during drilling and stimulation (AECOM 2023; EHS Support 2023). The chemical risk assessments are provided in Appendix E and Appendix E.1.

The assessment methodology is based upon the following guidance documents:

- Northern Territory DEPWS – Draft Guideline for the Preparation of an EMP under the NT Petroleum (Environment) Regulations, 2016.
- Department of the Environment and Energy, Exposure Draft – Chemical Risk Assessment Guidance Manual: for chemicals associated with coal seam gas extraction, 2017, which includes the approach outlined in the National Chemical Risk Assessment Guidance Manuals published by the National Environmental Protection Council.
- enHealth "Environmental Health Risk Assessment, Guidelines for Assessing Human Health Risks from Environmental Hazards", 2012.
- National Environment Protection (Assessment of Site Contamination) Measure 1999 (ASC NEPM); Schedule B4, Site-specific health risk assessment methodology, 2013.

The chemical risk assessment comprised the following tasks:

- Hazard assessment: An evaluation of the environmental and human health hazards of the chemical additives in the hydraulic fracturing fluid, based on their environmental persistence, bioaccumulation and aquatic toxicity properties.
- Exposure assessment: The exposure assessment comprises an evaluation of surface and sub-surface exposure pathways and reviews the effectiveness of the proposed controls in preventing a complete pathway.
- Screening and validation processes via Tier 1 and Tier 2 assessments to determine chemicals known to be of low concern and identify chemicals for further risk assessment:
- Tier 1: Using published information about each chemical proposed to be used in the hydraulic fracturing activity.
- Tier 2: A quantitative evaluation of the risks using toxicity values and quantitative estimates of chemical intake to provide an estimate of potential human health and environmental risk associated with the hydraulic fracturing activities, based on the identification of complete exposure pathways and hazard identification.

3.11.2.1 Results of risk assessment

The results of the chemical hazard and exposure analyses are provided in Appendix E and Appendix E.1.

A Tier 1 assessment was undertaken on all chemicals (246) with a total of 125 chemicals undergoing a Tier 2 assessment. Certain chemicals (e.g. stimulation fluids (25), hybrid (30) and high velocity friction reducers (36)) require standard flowback water and wastewater disposal controls to ensure the risk of management is low (Appendix E and Appendix E.1). These controls are consistent with the requirements outlined in the Code and summarised in section 6 of this EMP. It must be noted that none of these chemicals were identified to be persistent and bioaccumulative and toxic.

An assessment of the potential valid environmental and human health exposure pathways is summarised in Table 20. The exposure pathways assessment considered the:

- Properties of the chemicals.
- Site setting and physical separation distances between receptors (environmental and human) and the activity as outlined in section 3.3.

- Listed threated species and high conservation value areas in the vicinity of the activity as outlined in section 4.2.
- Description of the activity and summary of controls as provided in section 3 and section 6.

The exposure pathway assessment identified only one partially complete exposure pathway; the on-site release of particulates and vapour during chemical mixing and flowback evaporation. The limited number of valid pathways is consistent with the size and duration of the proposed activities.

AECOM (2023) undertook a Tier 2 assessment on 124 chemicals to evaluate the toxicity of the individual chemicals and characterise the cumulative risks of the total fluid mixtures to workers (see Appendix E). EHS Support (2023) undertook a Tier 2 assessment on 1 chemical – glutaraldehyde (CAS number 111-30-8), which was identified in the Tier 1 assessment as having a potential avian wildlife exposure (see Appendix E.1). As per NICNAS 2017 and DOE 2017 guidance, the Margin of Exposure (MOE) approach was used to assess the health risk to workers. For each occupational activity scenario (i.e. transport and storage, mixing/blending of hydraulic fracturing chemicals, evaporation of flowback and cleaning and maintenance), an MOE was derived by comparing the point of departure (e.g. No Observed Adverse Effects Level) for long-term health effects from the critical toxicological study to the estimated total human internal dose from all routes of exposure.

Based on the calculated MOEs, the chemicals were of low concern for workers (refer to individual toxicity profiles in Appendix E and Appendix E.1 for further detail).

Table 20: Stimulation chemical exposure pathways

Pathway	Receptors	Controls	Regulatory controls/guidelines	Effectiveness of controls	Scientific certainty	Pathway assessment
Release or spill off the well site into the surrounding environment – water	Indigenous communities Pastoralist homestead Neighbouring groundwater bores Areas of cultural significance Sensitive / significant vegetation (as defined in the Land Clearing Guidelines) Listed threatened species and live-stock Workers Native fauna and livestock	As per the Spill Management Plan (Appendix F) 1. All chemical storage and handling areas to have appropriate secondary containment. 2.Well pads are bunded to contain any major spill of flowback chemicals (capacity of 110% of tank capacity) 3. Offset distances from environmental and community receptors (pastoral bores, homesteads, culturally sensitive areas and communities). 4. Routine inspections (daily inspections during the wet season and weekly during the dry season) are completed to ensure any leaks or spills from chemical and waste storage are prevented or promptly identified. 5. Gathering lines hydrotested prior to operation. 6. Flow meters used to detect leaks 7. Adequate buffers exist between known cultural heritage sites, sensitive / significant vegetation communities / riparian areas. For example, the buffer between Shenandoah N A and the Stream Order 1, creek is approximately 450 m. 8. There are no permanent water bodies within the vicinity of the well pads. 9. The risk of environmental harm would be negligible in the wet season flooding due to the high average rainfall and dilution and dispersion of the released produced water. 8. Spills are cleaned up immediately.	Code Part A – Surface Activities A.3.1 Site selection and planning A.3.2 Well pad site selection requirements 3.8 Containment of Contaminants C.7.2 Spill Management Plan American Petroleum Institute Standards API Recommended Practice (RP) 100-2 Managing Environmental Aspects Associated with Exploration and Production Operations Including Hydraulic Fracturing Section 13.2: Storage and Management of Fluids and Materials for Hydraulic Fracturing AS/NZS 4452: The storage and handling of toxic substances AS1940: The storage and handling of flammable and combustible liquids AS 3780:2008: The storage and handling of corrosive substances AS/NZS 3833:1998: The storage and handling of mixed classes of dangerous goods Code of Practice Upstream Polyethylene Gathering Networks – CSG Industry Version 5.0 (APGA 2019)	High – The use of secondary containment, bunding and gathering systems controls reduces the probability of an off-site release via a spill down to 'remote'.	High – The certainty around the use of secondary containment and bunding to prevent spills is well recognised within international spill containment standards and legislation. Gathering lines are commonly used globally, with the controls mature. Any release or produced water that reaches the environment is likely to cause localised impact to terrestrial ecosystems. The salinity of the produced water poses the highest risk to terrestrial ecosystems. In addition to salinity, radionuclides may inhibit plant growth. Boron and petroleum hydrocarbons may impact fauna drinking ponded produced water. A single release of wastewater is unlikely to cause significant accumulation of metals in soil based on the contaminant load in each event and dilution and dispersion from precipitation.	Multiple controls in place unlikely to result in contaminant releases from the well site.
On site (confined within the well site) release via spill – water	Workers Fauna	1. All chemical storage and handling areas to have appropriate secondary containment. 2. Routine inspections (daily during drilling weekly post drilling) are completed to ensure any leaks or spills are prevented, promptly identified and rectified. 3. Spill kits and clean up equipment available on-site. 4. site fenced to prevent access	Code Part A – Surface Activities 3.8 Containment of Contaminants C.7.2 Spill Management Plan American Petroleum Institute Standards API RP 100-2 Managing Environmental Aspects Associated with Exploration and production Operations Including Hydraulic Fracturing Section 13.2: Storage and Management of Fluids and Materials for Hydraulic Fracturing AS/NZS 4452: The storage and handling of toxic substances AS1940: The storage and handling of flammable and combustible liquids AS 3780:2008: The storage and handling of corrosive substances AS/NZS 3833:1998: The storage and handling of mixed classes of dangerous goods	High – The use of secondary containment and bunding reduces the probability of releases.	High – The certainty around the use of secondary containment and bunding to prevent spills is well recognised within international spill containment standards and legislation.	Multiple controls in place with high effectiveness, minimise the likelihood of contaminant exposure.

Pathway	Receptors	Controls	Regulatory controls/guidelines	Effectiveness of controls	Scientific certainty	Pathway assessment
Release of particulates during mixing and flowback evaporation to the environment outside the well site – air	Workers Neighbouring groundwater bores Indigenous communities Pastoralist homestead Areas of cultural significance Sensitive / significant vegetation (as defined in the Land Clearing Guidelines) Listed threatened species and live-stock	1. All chemical mixing on-site to comply with the Workplace Health and Safety guidelines for handling of chemicals. 2. Chemical transfer and mixing procedures deployed to avoid the generation of dust. 3. Chemical mixing location away from well site boundary, with a separation distance of 50 m and within a portable containment bund. 4. Wind speed and direction sensors deployed with automatic cut-offs to prevent off-site drift from evaporation units. 5. Adequate buffers exist between known cultural heritage sites, sensitive / significant vegetation communities / riparian areas. For example, the buffer between Shenandoah N A and the Stream Order 1, creek is approximately 450 m. 6. There are no permanent water bodies within the vicinity of the well pads. 7. Significant offset distances from environmental and community receptors.	Code Part A – Surface Activities Containment of Contaminants American Petroleum Institute Standards API RP 100-2 Managing Environmental Aspects Associated with Exploration and production Operations Including Hydraulic Fracturing Section 13.2: Storage and Management of Fluids and Materials for Hydraulic Fracturing Managing risks of hazardous chemicals in the workplace Code of Practices 2013 Section 4— Controlling risk AS/NZS 4452: The storage and handling of toxic substances AS1940: The storage and handling of flammable and combustible liquids AS 3780:2008: The storage and handling of corrosive substances AS/NZS 3833:1998: The storage and handling of mixed classes of dangerous goods	High – Legislation controlling the handling of chemicals is mature and standardised across Australia to limit exposure to employees and surrounding receptors.	High – The certainty around the handling of chemicals is mature and standardised across Australia to limit exposure to employees and surrounding receptors.	The deployment of standard chemical handling procedures to minimise particulate contaminates, combined with the separation distance from the well site boundary, is likely to limit off-site releases and impacts to receptors.
On-site (well site) release via particulate or direct exposure to substance – air and water	Workers Indigenous communities Pastoralist homestead Neighbouring groundwater bores Areas of cultural significance Sensitive / significant vegetation (as defined in the Land Clearing Guidelines) Fauna and live-stock	1 All chemicals approved for use under the NICNAS (or equivalent) chemical reporting scheme and chemical risk assessment completed. 2. All chemical mixing on-site to comply with the National Occupational Health and Safety Commission guidelines for handling of chemicals. 3. All chemicals in designated areas with daily/ weekly inspections. 4. Chemical transfer and mixing procedures deployed to avoid the generation of dust. 5. Chemical mixing location away from well site boundary, with a separation distance of at least 50 m and within a portable containment bund. 6. Experienced staff with HSE professionals deployed to assist to identify risks 7. Fauna monitoring completed	Code Part A – Surface Activities Containment of Contaminants American Petroleum Institute Standards API RP 100-2 Managing Environmental Aspects Associated with Exploration and production Operations Including Hydraulic Fracturing Section 13.2: Storage and Management of fluids and Materials for Hydraulic Fracturing Managing risks of hazardous chemicals in the workplace Code of Practices 2013 Section 4 – Controlling risk AS/NZS 4452: The storage and handling of toxic substances AS1940: The storage and handling of flammable and combustible liquids AS 3780:2008: The storage and handling of corrosive substances AS/NZS 3833:1998: The storage and handling of mixed classes of dangerous goods	High – Legislation controlling the handling of chemicals is mature and standardised across Australia to limit exposure to employees and surrounding receptors.	High – The certainty around the handling of chemicals is mature and standardised across Australia to limit exposure to employees and surrounding receptors.	On-site release of particulate contaminants during handling is possible through potential human error but limited due to the control effectiveness. Particulate releases are likely to be restricted to the near vicinity of the activities.

Pathway	Receptors	Controls	Regulatory controls/guidelines	Effectiveness of controls	Scientific certainty	Pathway assessment
Release via transport accident that is outside of the well site into the surrounding access track or road environment	General public and communities Areas of cultural significance Neighbouring groundwater bores Sensitive / significant vegetation (as defined in the Land Clearing Guidelines)Listed threatened species and live-stock	1. All chemicals and waste products to be transported by licenced contractors in accordance with the NT Dangerous Goods (Roads and Rail) Regulations and *NT Waste Management and Pollution Control Act 1998*. 2. Legislation, regulations and national standards set out the requirements for the safe transport of chemicals, including for packaging, driver training, safety equipment and vehicle standards. These measures reduce the risk of a spill occurring, or of not being detected and cleaned up if it does occur.	Code Part A – Surface Activities 3.8 Containment of Contaminants C.7.2 Spill Management Plan Transport of Dangerous Goods by Road and rail (National Uniform Legislation) Regulations 2011 Code of Practice Upstream Polyethylene Gathering Networks – CSG Industry Version 5.0 (APGA, 2019)	High – Legislation controlling the transportation of chemicals and wastes is mature and standardised across Australia. Gathering lines commonly used around Australia and globally.	High – The certainty around the transportation of chemicals and wastes is mature and well understood across Australia. Third party chemical transport companies undertake 1,000s of chemical transport activities without major incident. Gathering lines commonly used around Australia and globally with very few instances of failure. Any release or produced water that reaches the environment is likely to cause localised impact to terrestrial ecosystems. The salinity of the produced water poses the highest risk to terrestrial ecosystems. In addition to salinity, radionuclides may inhibit plant growth. Boron and petroleum hydrocarbons may impact fauna drinking ponded produced water. A single release of wastewater water is unlikely to cause significant accumulation of metals in soil based on the contaminant load in each event and dilution and dispersion from precipitation.	The probability of exposure via a transport accident or gathering lines is limited via the mature standards and legislative framework in place.
Subsurface release of chemicals to aquifer	Neighbouring groundwater bores Areas of cultural significance Sensitive / significant vegetation (as defined in the Land Clearing Guidelines) Groundwater GDEs	1.Code requiring multiple strings of casing and cement designed to protect aquifer. 2.Integrity validation of casing and cement barriers prior to completing stimulation. 3. Pressure monitoring during stimulation of both the formation and the B well anulus. 4. Physical separation distance of 1,400 m between aquifer and the target formation prevents any migration of stimulation fluid to aquifer units. 5. >1 km separation distance between exploration well and closest pastoralist extraction bores. 6. Adequate buffers exist between known CH sites and sensitive / significant vegetation communities – i.e. > 450 m. For example, the location of the Shenandoah N A site is greater than the 50 m buffer, being 450 m from the Stream Order 1, creek. 7. There are no permanent water bodies within the vicinity of the well pads. 8. Groundwater monitoring to detect aquifer contamination.	Code Part B – Well Operations B.4.2 Aquifer protection B.4.3 Well design and well barriers B.4.6 Casing and tubing B.4.10 Drilling fluids B.4.13 Hydraulic stimulation and flowback operations B.4.7 Primary cementing B.4.17 Groundwater monitoring B.5 BTEX Limit	High – The legislation and guidance notes relating to aquifer protection and well integrity is mature, with extensive industry experience.	High – High certainty around the effectiveness of controls around the protection of aquifers using industry standard practice.	The probability of contamination of an aquifer from release of stimulation fluid during stimulation is remote due to the control effectiveness.

Pathway	Receptors	Controls	Regulatory controls/guidelines	Effectiveness of controls	Scientific certainty	Pathway assessment
Surface release of chemicals to aquifer	Neighbouring groundwater bores Areas of cultural significance Sensitive / significant vegetation (as defined in the Land Clearing Guidelines) Groundwater GDEs	1. Secondary containment to be used to manage all chemicals and wastes handled on-site. 2. Code requires double-lined tanks with in-built leak detection. 3. Spill Management Plan (Appendix F) and Wastewater Management Plan (Appendix G) to be implemented. 4. Routine inspections to identify leaks (daily during drilling weekly post drilling). 5. 70 m vertical separation between surface and underlying aquifer. 6. Closest groundwater extraction bore is >1 km away. 7. Adequate buffers exist between known CH sites and sensitive / significant vegetation communities – i.e. > 450 m. For example, the location of the Shenandoah N A site is greater than the 50 m buffer, being 450 m from the Stream Order 1, creek. 8. There are no permanent water bodies within the vicinity of the well pads.	Code Part A – Surface Activities 3.8 Containment of Contaminants C.7.2 Spill Management Plan American Petroleum Institute Standards API RP 100-2 Managing Environmental Aspects Associated with Exploration and production Operations Including Hydraulic Fracturing Section 13.2: Storage and Management of Fluids and Materials for Hydraulic Fracturing	High – The controls managing the storage of chemicals and wastes are mature with secondary containment measures limiting potential pathways to receptors.	High – The certainty around the effectiveness of secondary containment in preventing groundwater contamination is mature.	The probability of contamination of an aquifer from release of stimulation fluid is remote due to multiple controls and their effectiveness .

3.12 Water supply and use

Water sourced for the EMP activities will be extracted from new and existing Gum Ridge Formation bores at each of the proposed sites. It is estimated that up to 375 ML/year of water will be extracted from the Gum Ridge Formation across the Shenandoah South to support the proposed E&A activities (Table 21). A water balance for the activities is provided in Figure 32, noting that all estimates are subject to operational changes. The groundwater take for the proposed exploration activities consists of the following breakdown per activity:

- 2.5 ML per E&A well for drilling and completions
- 72.0 ML per well for stimulation
- 5.0 ML for camp activities per site
- 20.0 ML civil construction, groundwater bore drilling, dust suppression and general activities per site
- 0.5 ML seismic –for dust suppression and shot installation

Any new bores constructed to support exploration activities will be registered and added to the WEL.

The extraction of water for all activities associated with stimulation will be covered under a Water Extraction Licence (WEL). Tamboran's current WEL GRF10285 permits the take of 175 ML/year from the Gum Ridge Formation. The WEL will be increased to cover the future proposed exploration activities. This application is covered under the Water Act and is separate to this EMP. The current WEL statement of reason is available from DEPWS Water Resources website at http://www.ntlis.nt.gov.au/walaps-portal/report/current/gwel.

Importantly, the allocated available groundwater take from the Gum Ridge Formation for the industry is 8,000 ML/yr for the Georgina Basin water management zone (NTG, 2024a). Tamboran's proposed licence application of 450 ML/yr represents 5.6% of the allocation (NTG, 2024a).

Tamboran's application is currently under assessment by the Department of Water Resources and is out for public comment until 16 April 2024. The conclusion of the analytical modelling and assessment of potential impacts to Aboriginal land, neighbouring entitlements and GDEs (NTG, 2024a) is as follows:

- **Aboriginal lands: "***The extraction scenario simulated is not expected to provide any significant impact to groundwater resources underneath the Aboriginal land parcels identified. Drawdown impact for nearby stock and domestic users show drawdown of less than 0.1 m, given the relative distance of Aboriginal lands, there would be negligible impact.*"
- **Neighbouring entitlements:** "*Potential impacts from the proposed pumping regime on existing groundwater extraction licenced bores have been simulated and presented. Simulated drawdown impacts on nearby identified licenced bores is minimal (<0.1 m) … Potential impacts from the proposed pumping regime on nearby stock and domestic bores have been simulated and presented. Simulated drawdown impacts on nearby identified stock and domestic bores is minimal (<0.1 m) …*"
- **GDEs:** "*Comments supplied in the Groundwater Impact Assessment by RDM Hydro (2023) are sufficient to address identification and potential impacts to Groundwater Dependent Ecosystems (GDE's) from proposed pumping activities.*"

  As demonstrated in the RDM Hydro (2023) assessment and the NTG's assessment, the depth to the regional water table in the vicinity of the planned groundwater bores indicates it is unlikely the aquifer is supporting any terrestrial or aquatic GDEs. These assumptions are also supported by the SREBA (2022).

To reduce groundwater take and minimise the storage and disposal of wastewater, flowback may be reused in the stimulation make up fluid where technically feasible (i.e. due to fluid compatibility). Where flowback is used for make-up fluid, flowback will be managed in accordance with section 3.13.2.5. This will potentially reduce raw water take by approximately 10-30 ML per site where re-use is proposed.

All groundwater take will be metered with continuous flow meters and reported to DEPWS as per the WEL conditions. Water take records will be kept and updated weekly during operations, to ensure the water take volumes are not exceeded.

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.

Modelling completed to support the revision of GRF 10285 confirms that the proposed increased take will not cause any material reductions in water levels. Peak drawdown is conservatively predicted to be less than 1 m at 1 km form the bore (Figure 30). Pump test and ongoing groundwater level monitoring results collected from monitoring bores within the Anthony Lagoon and Gum Ridge confirm that water levels will rapidly return to pre-pump levels. There are therefore no short or long-term impacts to pastoral bores and GDEs expected. Noting that the NTG (2024) assessment of impacts to neighbouring entitlements and GDEs is negligible.

Table 21: Predicted water take

Site	Predicted water use per year (estimated ML)					
	2023	2024	2025	2026	2027	2028
Kyalla 117 N2	12.5	80.4	1.5	-	188.9	-
Shenandoah S2	-	75.2	212.0	6.1	-	-
Shenandoah S B	-	146.5	8.2	127.0	-	-
Shenandoah S C	-	-	150.1	162.3	0.7	-
Shenandoah N A	-	-	2.9	-	-	-
Seismic	-	0.5	-	-	-	-
Total	**12.5**	**302.6**	**374.7**	**295.4**	**189.6**	**-**

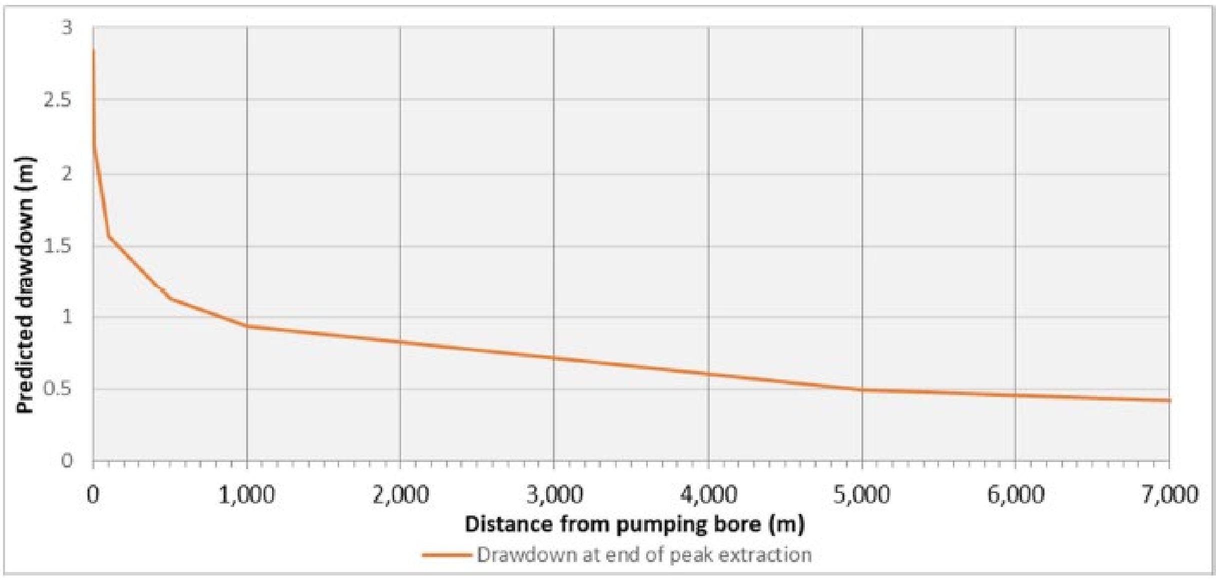


Figure 30: Conservative modelled peak drawdown associated with predicted future E&A water extraction take

The source water and volume for all well operations (drilling, workover and hydraulic fracture stimulation)will be recorded in the daily drilling report (DDR) and well completion report (WCR). The source of water and volume used for construction water, camp water and dust suppression will be tracked in the contractors monthly HSE data.

3.13 Wastewater management

A project-wide Wastewater Management Plan (WWMP) has been developed to manage wastewater generated under this EMP. The WWMP has been developed in accordance with the Code and covers the following wastewater streams:

- drilling fluids, water-based drilling muds and drilling cuttings
- stimulation fluids
- completion and kill fluids
- produced fluids.

The WWMP covers the following information on the management of wastewater during Tamboran's exploration activities:

- storage, handling and disposal requirements for wastewater, including the requirement for flowback tanks and gathering lines to transfer water between sites
- spill management and response requirements
- prohibited reinjection or surface disposal of wastewater.

The following section provides an overview of the wastewater management strategy, with further information provided in the WWMP (Appendix G).

3.13.1 Site water balance

A water balance has been prepared summarising the estimated volumes of water to be used and volumes of wastewater that is expected to be generated, stored and disposed of off-site. This balance includes existing wastewater generated from the existing E&A wells and all proposed activities associated with the drilling, stimulation and well testing of under this EMP. Observed average monthly rainfall and evaporation rates for the region are used to calculate the rainfall inputs and evaporation outputs from open tanks.

The water balance includes the make-up water and wastewater generated from the main processes of drilling, stimulation, well testing, dust suppression and camp activity.

An overview of on-site water management is provided in Figure 31 and Figure 32.

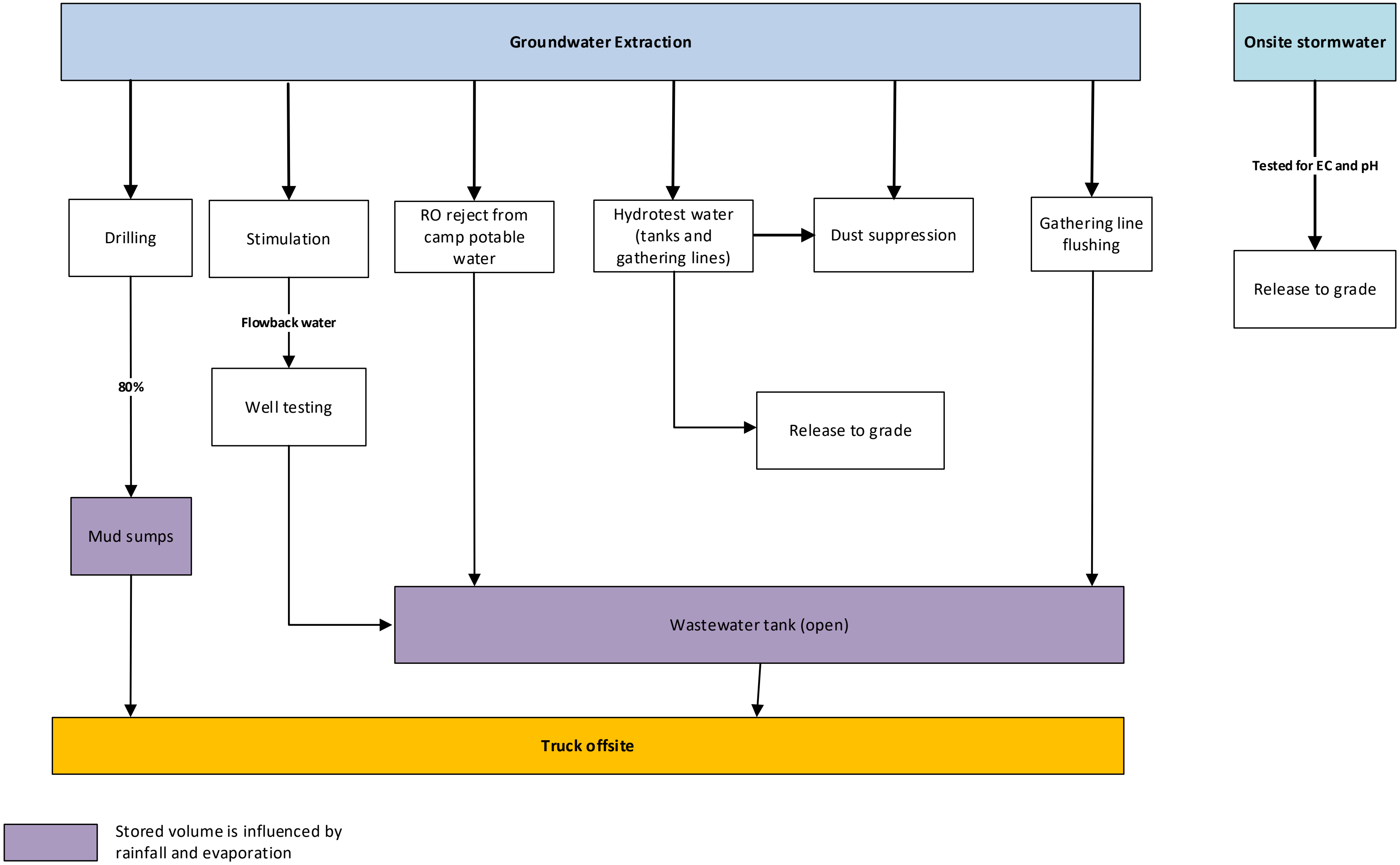


Figure 31: Site water management schematic

Summary: Shenandoah North A		2023		2024												2025											
	Month	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Water usage																											
Drilling	ML																					2.58					
Camp	ML																					0.31					
Dust suppression	ML																					0.00					
Total	ML																				0.00	2.89	0.00				
Wastewater generated																											
Drilling	ML																					1.55					
Camps	ML																					0.31					
Total	ML																				0.00	1.86	0.00				
Wastewater storage onsite																											
Mud sumps (free only)	ML																					1.32					
Wastewater tanks	ML																										
Total onsite wastewater	ML																					1.32					
Wastewater trucked to Kyalla 117 N2	ML																					1.32					

Summary: Shenandoah North A	2026												2027												2028					
Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Water usage																														
Drilling																														
Camp																														
Dust suppression																														
Total																														
Wastewater generated																														
Drilling																														
Camps																														
Total																														
Wastewater storage onsite																														
Mud sumps (free only)																														
Wastewater tanks																														
Total onsite wastewater																														
Wastewater trucked to Kyalla 117 N2																														

Summary: Kyalla 117 N2		2023		2024												2025											
	Month	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Water usage																											
Drilling	ML								2.50	2.58																	
Stimulation	ML	12.00								72.00																	
Camp	ML	0.09	0.09	0.09					0.60	1.24	0.09	0.09	0.09	0.09	0.09	0.09	0.08										
Dust suppression	ML	0.16	0.16	0.16							0.16	0.15	0.16	0.16	0.16	0.16	0.14	0.16			0.15	0.16	0.16	0.15	0.16	0.16	
Total	ML	12.25	0.25	0.25	0.00	0.00	0.00	0.00	3.10	75.82	0.25	0.24	0.25	0.25	0.25	0.25	0.22	0.16	0.00	0.00	0.15	0.16	0.16	0.15	0.16	0.16	0.00
Wastewater generated																											
Drilling	ML	0.00	0.00						1.25	1.29	0.00																
Well testing	ML	0.90	0.54	0.18							5.40	3.24	1.08	1.08	1.08	0.76											
Completion		0.00	0.00							0.05																	
Camps	ML	0.09	0.09	0.09					0.60	1.24	0.09	0.09	0.09	0.09	0.09	0.09	0.08										
Total	ML	0.99	0.63	0.27	0.00	0.00	0.00	0.00	1.85	2.58	5.49	3.33	1.17	1.17	1.17	0.85	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Wastewater storage onsite																											
Mud sumps (free only)	ML	0.72	0.54	0.48	0.49	0.43	0.17		0.99	2.12	1.45	0.70	0.42	0.16								0.74	0.51	0.23			
Wastewater tanks	ML											3.69	4.77	5.85	2.53	3.29	3.29	3.29	3.29	3.29	3.29	3.60	3.60	3.60	3.60	3.60	3.60
Max onsite wastewater	ML	0.72	0.54	0.48	0.49	0.43	0.17	0.00	0.99	2.12	1.45	4.39	5.19	6.01	2.53	3.29	0.00	3.29	3.29	3.29	3.29	4.35	4.11	3.83	3.60	3.60	3.60
Wastewater transfer to Shenandoah South 2	ML										9.80				4.40												

Summary: Kyalla 117 N2	2026												2027												2028					
Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Water usage																														
Drilling													2.58																	
Stimulation																183.92														
Camp													0.62			0.60	0.62	0.60												
Dust suppression																														
Total	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.20	0.00	0.00	184.52	0.62	0.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Wastewater generated																														
Drilling													1.29																	
Well testing																														
Completion																														
Camps													0.62			0.60	0.62	0.60												
Total	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.91	0.00	0.00	0.60	0.62	0.60	0.00	0.00	0.00	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Wastewater storage onsite																														
Mud sumps (free only)		0.01											1.23	1.34	1.14	0.56	0.31	0.05								0.01				
Wastewater tanks	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.83	4.17	18.77	21.18	19.88	13.21	11.21	9.00	6.72	5.54	4.16	3.34	3.11	2.09			
Max onsite wastewater	3.60	3.61	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	4.83	5.17	5.31	19.34	21.49	19.93	13.21	11.21	9.00	6.72	5.54	4.16	3.34	3.12	2.09	0.00	0.00	0.00
Wastewater transfer to Shenandoah South 2																	5.50	3.00	5.00			0.00								

Summary: Shenandoah South 2		2023		2024												2025											
	Month	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Raw water usage																											
Drilling	ML						2.50	2.50													2.50	2.58					
Stimulation	ML										62.20																200.80
Camp	ML									0.62	1.24	0.60	0.62	0.62	0.62	0.62	0.56								0.62	0.62	0.62
Dust suppression	ML									0.62	0.62	0.60	0.62	0.62	0.62	0.62	0.56								0.62	0.62	0.62
Total	ML						2.50	2.50	0.00	1.24	64.06	1.20	1.24	1.24	1.24	1.24	1.12	0.00	0.00	0.00	2.50	2.58	0.00	0.00	1.24	1.24	202.04
Wastewater generated																											
Drilling	ML						0.03	0.01		1.50	1.50	0.05	0.03	0.08	0.19	0.26	0.30	0.17	0.03	0.01		1.50	1.55				
Well testing	ML										5.40	3.24	1.08	0.76	0.11	0.11	0.11										16.20
Completion	ML																										
Camps	ML																										
Total	ML						0.03	0.01	0.00	1.50	6.90	3.29	1.11	0.84	0.30	0.37	0.40	0.17	0.03	0.01	0.00	1.50	1.55	0.00	0.00	0.00	16.20
Recycled wastewater																											
Total volume of recycled flowback wastewater	ML																									15.20	
Wastewater storage onsite																											
Mud sumps (free only)	ML									1.28	2.54	2.31	2.03	1.77	1.60	1.53	1.54	1.48	1.26	1.00	0.74	2.02	3.33	3.05	2.77	2.51	2.33
Wastewater tanks	ML										5.40	3.24	1.08	0.76	4.51	0.11	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		16.20
Max onsite wastewater	ML						0.00	0.00	0.00	1.28	7.94	5.55	3.11	2.53	6.10	1.64	1.65	1.48	1.26	1.00	0.74	2.02	3.33	3.05	2.77	2.51	18.53
Wastewater transfer to Kyalla 117 N2	ML																										

Summary: Shenandoah South 2	2026												2027												2028					
Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Raw water usage																														
Drilling																														
Stimulation																														
Camp	0.62	0.58	0.62	0.60	0.62																									
Dust suppression	0.62	0.58	0.62	0.60	0.62																									
Total	1.24	1.16	1.24	1.20	1.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Wastewater generated																														
Drilling																														
Well testing	9.72	3.24	2.27	0.32	0.32																									
Completion																														
Camps																														
Total	9.72	3.24	2.27	0.32	0.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Recycled wastewater																														
Total volume of recycled flowback wastewater																32.08														
Wastewater storage onsite																														
Mud sumps (free only)	2.32		2.26	2.04	1.78	1.52	1.30	1.06	0.78	0.50	0.24	0.07																		
Wastewater tanks	25.92	29.16	31.43	31.75	32.08	32.08	32.08	32.08	32.08	32.08	32.08	32.08	32.08	32.08	32.08		4.06	5.83	9.49	7.86	6.07	4.34	2.88	2.48	2.80	3.75	3.57	2.28	0.84	0.00
Max onsite wastewater	28.24	29.16	33.69	33.79	33.85	33.60	33.38	33.14	32.86	32.58	32.32	32.14	32.08	32.08	32.08	0.00	4.06	5.83	9.49	7.86	6.07	4.34	2.88	2.48	2.80	3.75	3.57	2.28	0.84	0.00
Wastewater transfer to Kyalla 117 N2																32.08														

Summary: Shenandoah South B		2023		2024												2025											
	Month	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Water usage																											
Drilling	ML																										2.58
Stimulation	ML													144.00													
Camp	ML											0.60	0.62	0.62	0.62	0.62	0.56					0.62	0.62	0.60	0.62	0.62	0.62
Dust suppression	ML																			0.16	0.15	0.16	0.16	0.15			
Total	ML									0.00	0.00	0.60	0.62	144.62	0.62	0.62	0.56	0.00	0.00	0.16	0.15	0.78	0.78	0.75	0.62	0.62	3.20
Wastewater generated																											
Drilling and completion fluid	ML											1.50	0.55	0.05													
Well testing	ML													10.80	6.48	2.16	1.51										
Completion	ML													0.05													
Camps	ML											0.60	0.62	0.62	0.62	0.62	0.56					0.62	0.62	0.60	0.62	0.62	0.62
Total	ML									0.00	0.00	2.10	1.17	11.52	7.10	2.78	2.07	0.00	0.00	0.00	0.00	0.62	0.62	0.60	0.62	0.62	0.62
Recycled wastewater																											
Total volume of recycled flowback wastewater	ML									0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	20.95	0.00	0.00	0.00	0.00
Wastewater storage onsite																											
Mud sumps (free only)	ML											0.71															
Drilling wastewater tank												0.71															
Flowback wastewater tanks	ML													10.80	17.28	19.44	20.95	20.95	20.95	20.95	20.95	20.95					
Max onsite wastewater	ML									0.00	0.00	1.43	0.00	10.80	17.28	19.44	20.95	20.95	20.95	20.95	20.95	20.95	0.00	0.00	0.00	0.00	0.00
Wastewater transfers																											
Wastewater transfer to Shenandoah South C	ML																										

Summary: Shenandoah South B	2026												2027												2028					
Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Water usage																														
Drilling	0.92																													
Stimulation								122.40																						
Camp						0.62	0.62	0.62	0.62	0.56	0.62																			
Dust suppression																														
Total	0.92	0.00	0.00	0.00	0.00	0.62	0.62	123.02	0.62	0.56	0.62	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Wastewater generated																														
Drilling and completion fluid						1.55	0.55		0.05																					
Well testing								10.80	6.48	2.16	1.51																			
Completion								0.00	0.05	0.00	0.00																			
Camps						0.62	0.62	0.62	0.62	0.56	0.62																			
Total	0.00	0.00	0.00	0.00	0.00	2.17	1.17	11.42	7.20	2.72	2.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Recycled wastewater																														
Total volume of recycled flowback wastewater	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Wastewater storage onsite																														
Mud sumps (free only)						1.00																								
Drilling wastewater tank						1.00																								
Flowback wastewater tanks								8.36	12.17	11.84	14.89	14.83	16.06	18.33	18.55	16.71	14.58	12.74	13.74	11.30	8.62	6.13	4.17	4.11	5.34	7.61	7.83	5.99	3.86	0.00
Max onsite wastewater	0.00	0.00	0.00	0.00	0.00	2.00	0.00	8.36	12.17	11.84	14.89	14.83	16.06	18.33	18.55	16.71	14.58	12.74	13.74	11.30	8.62	6.13	4.17	4.11	5.34	7.61	7.83	5.99	3.86	0.00
Wastewater transfers																														
Wastewater transfer to Shenandoah South C											3.50																			

Figure 32: Typical process water balance for each site

3.13.2 Drilling fluids, muds, cuttings and cement returns

The following section provides an overview of the management summary associated with waste drilling fluids, muds, cuttings and cement returns.

3.13.2.1 Sump design

Drilling fluids that will be recovered after use and reused, all drilling fluids, including cuttings, muds and cement returns, will be directed to the drilling sump on each site. The drilling sump is designed to accommodate the drilling of multiple wells. Waste drilling fluids may also be transferred and stored on-site in wastewater tanks or to sumps/ tanks on other approved sites to ensure sufficient capacity is always in place to accommodate the freeboard requirements.

An overview of the drilling sump design is provided in Appendix D. Each sump surface will be rolled and compacted, with a Coletanche liner (or equivalent). Coletanche is a composite liner consisting of five different layers:

- A highly resistant anti-root film able to withstand puncturing by vegetation or rough substrates.
- Glass fleece which ensures dimensional stability.
- A non-woven geotextile reinforced structure which is highly resistant to tearing and puncturing.
- An elastomeric bitumen binder ensures that the geotextile is waterproof and resistant to ageing.
- A coating of sand ensures that workers can move on the surface in all weather conditions to carry out maintenance work. It also provides a rough surface which allows coverage of the membrane by soil.

The Coletanche liner product data sheet is provided in Appendix D, which demonstrates it complies with the Code requirements C.4.1.2. Coletanche is anticipated to be used based upon the following:

- easily installed and shaped to fit sump geometry
- high resistance to tearing/puncturing and to hydrostatic pressures
- low water permeability, with a 4 x10^{-14} m/s permeability
- can withstand high temperature fluctuations.

In some circumstances, a conventional HDPE liner may be used. Where a HDPE (or alterative) liner is used, the liner specification shall meet or exceed the Code requirements (cl C.4.1.2).

3.13.2.2 Volume and quality

Approximately 3,000 m^3 (750 m^3 per E&A well) of waste drilling solids (cuttings, muds (water based) and cement returns) and approximately 4.5 ML (1.5 ML of wastewater per E&A well) of drilling and completion fluids will be generated at each of the Shenandoah South sites and Kyalla 117 N2 site. This estimate is based on engineering calculations and observed drilling waste volumes recorded during the existing wells at the sites. Drilling fluids and muds are saline, with sodium and potassium-based salts used as a weighting agent and formation inhibitor. Other compounds, such as barite (barium sulfate) and polymer-based compounds are also utilised during drilling process.

Drill cuttings waste will largely reflect the quality of the rock overburden and target shale formations. Drilling fluids and solids (cuttings, muds and cements returns) may be removed periodically from the sump between wells, or as required to maintain the safe operating level of the sump. Drilling fluids and solids may be transferred to lined tank/ pit (in accordance with section C.4.1.2 of the Code), disposed of in accordance with section 3.13 of this EMP.

3.13.2.3 Drilling muds, cuttings and cement returns disposal

Drilling material may either be disposed of during operations (i.e. between the drilling each E&A well to accommodate storage volume requirements) or upon completion of drilling/well testing operations (with the potential for on-site storage of material in in accordance with section C.4.1.2 of the Code).

Prior to the disposal of drilling waste material, a suitably qualified third-party will test the dried material and determine whether the material is suitable to be disposed of on the well pad (or within the approved disturbance area) using a 'mix, bury and cover' approach (as per C.4.1.2 of the Code). 'Mix, bury and cover' involves the mixing of dried drilling waste material with the soil located within the drilling sump batters to reduce the concentration of any potential contaminants to an acceptable level. The material is then track-rolled and approximately 300mm of clean material placed over the top. An additional 150 mm of topsoil is added to the sump upon remediation of the entire well site. DEPWS will be consulted if on-site disposal is proposed, with a regulation 22 approval submitted to authorise the activity.

If the material is unsuitable for on-site disposal (such as the moisture content is too high or the material is incompatible with surrounding soils or the analysis of the material indicates it is inappropriate for on-site disposal (as per C.4.1.2 of the Code), the material may be left in-situ across the wet season to allow for the material to dry during the subsequent dry season or be transported off-site. If on-site disposal is not feasible, all solid material) will be transported off-site to an alternative suitable exploration location or a licenced facility. Off-site disposal will be undertaken in accordance with the *NT Waste Management and Pollution Control Act 1998*.

All fluids collected in the drilling sumps (including rainwater) will either be evaporated in the sump or transferred to wastewater tanks for storage and evaporation. The use of evaporation is the main mechanism used to reduce the volume down to as low as possible. The residual concentrated liquid waste stream will be disposed of off-site at a licenced facility in accordance with the NT *Waste Management and Pollution Control Act 1998.*

The sumps will be operated with sufficient freeboard available to accommodate the total rainfall anticipated based on a 1:1,000-year ARI for the duration the sump is in operation. As per the calculations within the WWMP (Appendix G), this equates to a 1.3 m wet season freeboard and a 0.3 m of dry season freeboard.

3.13.2.4 Monitoring

Wastewater volumes within the mud sumps will be monitored daily during operations. Once drilling has finished, sump levels will be monitored weekly during the dry season and daily during the wet season. Monitoring may be undertaken via physical inspection, remote cameras or sensor. The wastewater balance and storage curves will be updated weekly to ensure sufficient freeboard in compliance with the Code.

Drilling mud and cuttings will be sampled prior to disposal and characterised in accordance with requirements set out in section 3.13.2.2.

3.13.2.5 Drilling waste composting/soil conditioner trial

To investigate the potential future re-use of drilling cuttings and solid waste material, a small trial to create a suitable compost/ soil conditioner for use in rehabilitation may be undertaken on a well pad.

This objectives of the trial will be designed to:

- Confirm whether the material can be successfully composted/ blended into a suitable compost/ soil conditioner to support future rehabilitation (such as gravel pit void backfilling).
- Develop the required procedures and know-how for future larger scale disposals.
- Build capacity with local traditional owners to take over the activity in the future.
- Obtain the required information to support future approvals.

Material generated under this approval will be either sent to a licenced landfill or additional approvals sought for onsite disposal as per cl C.4.1.2 of the Code.

The trial will involve the following steps:

- The trial will only be undertaken during the dry season (May to September), with any storage beyond this point to require lining and covers to prevent leachate formation and run off.
- A dedicated trial area will be located on either the formed well pad/ laydown yard and will be demarcated and signed. The size of the trial area will typically be no greater than 50 m x 50 m, at either Kyalla 117 N2 or Shenandoah S2.
- The trial area will be a compacted clay liner or geomembrane type liner meeting the requirements of clause B.4.16.2(h) and C.4.1.2 (b) of the code.
- The trial area will be bunded (using available material onsite) and graded to prevent both run-on and run-off of stormwater.
- Approximately 1 – 200 m^3 of dried drilling waste (moisture content <20%) will be transferred to the trial area and stored in stockpiles. In the unlikely event free liquids are encountered, they will be cleaned up immediately and recorded as per the spill management plan.
- Organic manure will be trucked in and stored on the trial pad in small stockpiles (~500 m^3). If manure is used, this will be sourced from local cattle stations in the region to reduce the risk of introducing weeds.
- Waste material will be blended with manure using a front end loader/ tractor/bob cat onsite at several different ratios (such as 1 part waste: 1 part manure etc.).
- The material will be stockpiled in windows/ static piles to allow aerobic composting for ~60 – 90 days.
- The material will be turned/worked monthly.
- The material will be tested in accordance with the suite in Table 9 of the Code.
- A selection of material (~1 m^3) will be used in large pots/ bags to assess the re-establishment of vegetation, with a seed mix and additional nutrients (specifically nitrogen) added where required. This will be left open over the wet season, with observation taken.
- Upon completion of the trial, the material will be either a) returned to the sump b) stockpiled on a liner with a cover or c) trucked offsite to a licenced landfill.
- The trial area will have all potential contaminated material removed, with validation testing confirming concentrations of contaminants of concern (notably EC, chlorides, barium and strontium) are consistent with background soil levels.

A simple report will be generated at the end of the trial summarising the trial results.

3.13.3 Flowback

The anticipated flowback will be composed of formation reservoir hydrocarbons only, with an absence of movable indigenous water from the reservoir. The absence of water is due to a combination of the extremely low reservoir permeabilities and clay adsorption effects.

3.13.3.1 Volume

Tamboran anticipates that a potential load fluid recovery of 15% of injected stimulation fluid over the testing duration based upon previous Amungee NW-1H results. Tamboran estimates a flowback wastewater production volume of approximately 10.8 ML per E&A well (assumes 72 ML used for stimulation and a 15% recovery rate). The majority (80% of encountered volume of flowback) is expected to be generated in the first 60 days of the well test.

The predicted maximum volume of flowback stored at each of the sites during a specific period is approximately 34 ML. This figure includes flowback from 2 wells at each site and includes treatment via enhanced evaporation.

An overview of the site wastewater balance is provided in section 3.13.1.

3.13.3.2 Quality

The quality of flowback at the 4 sites is expected to be like that encountered during the Amungee NW-1H well test (Table 22).

Geogenic chemicals require careful management, with salt the main contaminate of concern (predominantly sodium chloride). The flowback is likely to be elevated in some metals (primarily barium) and hydrocarbons. BTEX, phenolic compounds and polycyclic aromatic hydrocarbons (PAHs) are either not predicted, or likely to be present at low concentrations.

Additional information on flowback quality of the Amungee NW-1H well and other petroleum wells in the Beetaloo are available here: https://depws.nt.gov.au/onshore-gas/onshore-gas-in-the-northern-territory/industry-compliance-and-reporting/flowback-fluid-monitoring-results.

Table 22: Indicative flowback quality based on Amungee NW-1H flowback results

Parameter	Flowback levels
BTEX compounds	Total BTEX levels are anticipated to be low. Total BTEX in the Amungee NW-1 in flowback ranged between 2 and 15 µg/L
Total nitrogen (as N)	Maximum value of 62.1 mg/l observed within flowback
Salinity (TDS)	Saline with total dissolved solids level exceeding 49,000 mg/L
pH	Slightly acidic with a median value of 6.74
Major ions	Flowback predominantly Na and Cl dominated
Dissolved metals	All detected dissolved metal concentrations within the flowback were low, except for barium 54.5 mg/L) and boron (80.1 mg/L)
Polycyclic Aromatic Hydrocarbons	All values in the flowback below laboratory limit of reporting
Petroleum hydrocarbons	All fractions of TPH are anticipated to be elevated
Phenolic compounds	Low level of phenolic compounds detected in flowback
Radionuclides	Maximum Gross Alpha Activity and Gross Beta Activity of 12.4 Bq/L and 18.3 Bq/L encountered in the flowback, the anticipated source is likely to be radium-226

3.13.3.3 Flowback storage

On-site wastewater management will be an adaptive process, with enclosed tank and treatment capacity adjusted (added or removed) to meet operational requirements (including meeting mandatory Code requirements).The total volume of storage will be determined (typically) by the volume of water required for the stimulation. These tanks are then repurposed into flowback storages.

Depending on the tank design, some may be periodically converted to enclosed tanks (have lids installed) and vice versa, as flowback volume increase/decrease. This ensures maximum evaporation potential, whilst ensuring sufficient enclosed tank storage is available at any point in time.

Tank setup varies depending on season, with the operational strategy summarised in section 3.13.3.4. Total maximum available open and enclosed wet season flowback storage on each site (excluding freeboard) is predicted to be 66.9 ML, approximately double the predicted flowback generated per site (Table 22). It is anticipated that a reduced volume of tanks will be required as fluid transfers will be undertaken and some tank capacity may be removed (i.e. tank capacity may be installed at 66.9ML to supply raw water for the stimulation, but is reduced to <35 ML during flowback based on estimated return volumes).

During the dry season, flowback will be treated in open treatment tanks to reduce the wastewater volume as much as possible. Enclosed tanks will be on-site with enough capacity to store the 1:1,000 ARI dry season freeboard for all open flowback wastewater tanks operating on-site (effectively doubling onsite freeboard). The total available dry season open, and enclosed wastewater tank storage volume per site (accounting for freeboard) is 73.2 ML, double the anticipated 34 ML of flowback anticipated to be generated per site Table 23).

To manage both freshwater and flowback volume across the basin, longer term (1 – 5 years) there will be transfers between sites to enable the use of existing storage infrastructure. This will reduce the impact associated with additional land clearing required to construct more tanks at each site. Apart from Shenandoah N A which will not be stimulated, flowback and other wastewater will be transferred between a wastewater gathering network (refer section 3.6.6). Periodic trucking to off-site approved disposal locations and to other approved exploration sites within the Basin may also be undertaken to manage fluid levels (such as between the sites listed in this EMP, and Velkerri 76 S2, and Amungee NW).

Examples of enclosed wastewater tanks is provided previously as Figure 25.

Additional information regarding wastewater management during the wet season and dry season, is provided in the following section.

Table 23: Anticipated maximum wet season and dry season wastewater tank set-up, operating capacity and freeboard levels

Tank type	Tank dimensions (m^2)	Tank maximum operating capacity (ML)	Tank wet season freeboard volume (ML)	Total storage availability (ML) (minus freeboard)
Wet season				
5 x 13Ml C ring enclosed tanks (bladders)	3,629	13	2.8	56
2x 5.3 ML enclosed tanks (contingent tank type used for additional ad hoc storage)	3,058	5.3	1	7.6
3 x 5.3 ML open treatment tanks	3,058	1.3	4.0	3.9
Total tank storage capacity (minus freeboard)				**66.9**
Dry season				
5 x 13Ml C ring enclosed tanks (bladders)	3,629	13	2.8	56
2x 5.3 ML enclosed tanks (contingent tank type used for additional ad hoc storage)	3,058	5.3	1	4.3
3x 5.3 ML open treatment tanks	3,058	4.3	1.0	12.9
Total tank storage capacity (minus freeboard)				**73.2**

3.13.3.4 Wastewater operating strategy

The operating plan for the working evaporation tanks is provided in the WWMP (Appendix G). The wastewater treatment tanks will be operated in accordance with the following philosophy:

- During the dry season, all flowback wastewater will be treated in open tanks to maximise. Sufficient enclosed flowback wastewater storage will be available to manage the sum of all open tank freeboard volume on-site.
- Flowback will be recycled within stimulation make-up water where possible to reduce stored volumes.
- During the wet season, enough covered flowback wastewater storage capacity will be always on-site to manage all stored flowback wastewater volumes.
- Open tanks will be periodically converted to enclosed tanks as the volume of flowback water on-site increases (i.e. prior to commencement of wet season).
- Flowback wastewater levels and the interstitial space between each of the tank liners are monitored continuously with electric probes to prevent overtopping and leaks.
- Where sufficient enclosed tank capacity is unavailable, the well will be shut in to ensure compliance with the Code wastewater management guidelines and prevent overtopping of the tanks. Wastewater levels must be reduced to below the enclosed tank capacity before recommencing operations.
- Mechanical enhanced evaporators will be used within/on the evaporation tanks to maximise evaporation rates.
- All flowback wastewater stored within open working evaporation tanks will be transferred to enclosed storage at least 8 hours before the onset of a significant rainfall event (defined as a 300 mm rainfall event predicted over four days as per the WWMP):
- All open tanks will be operated with enough freeboard to manage the entire rainfall from of an entire 1:1,000 ARI wet or dry season (i.e. the entire seasons rainfall and not just one single event), as specified in the WWMP, this equates to a minimum 1.3 m of freeboard for the wet season and 300 mm for the dry season.
- Wastewater may be transferred for storage between approved sites within the Sub- basin, which includes wastewater taken to/from the Shenandoah South, Shenandoah North, Kyalla 117 N2, Amungee NW and Velkerri sites.

Mechanical enhanced evaporators may be used in/on each wastewater treatment tank to enhance natural evaporation. Up to three to five evaporator units may be deployed in/on each tank, with a combined water treatment rate of up to 1,000 L/minute. Based upon the results from the existing Kyalla 117 N2-1 well and Amungee NW, evaporation rates above 100 barrels (16,000 L) per day have been observed, which aligns with the estimated evaporation rates used in the wastewater balance (Figure 32). A picture of the wastewater evaporators in operation at Amungee and an insert of what the evaporators look like is provided in Figure 33.

The evaporator units have an estimated diesel consumption of 21 L/hour will be required while the units are in operation. To ensure no drift of wastewater occurs outside of the wastewater tank, the following will be implemented:

- The unit will be located in the predominantly upwind direction on/in the tank. They will be able to be moved around seasonally, based on the predominant wind directions. Predominant 3 p.m. wind direction for the sites is SE/NE- with evaporators to be located on the SE corner/ side of the tanks.

- the units will have an automated wind speed and direction cut-off mechanism to prevent wastewater drift outside the wastewater tank. The wind speed distance and direction is to be calibrated constantly onsite based on the location of the equipment in/on the tank and observed levels of drift.
- The automatic wind speed/ direction cut off is to be based on an onsite meteorological station associated with the unit. The meteorological unit will be located on the site to ensure it reflects on the ground conditions.
- Evaporators will be manually initiated and have daily inspections completed to identify drift. Where drift is identified outside of the wastewater tank, this shall be recorded as an incident as per section 8.6

This proposed approach was used successfully during the flowback operations at the Amungee NW and Kyalla 117 N2 site.

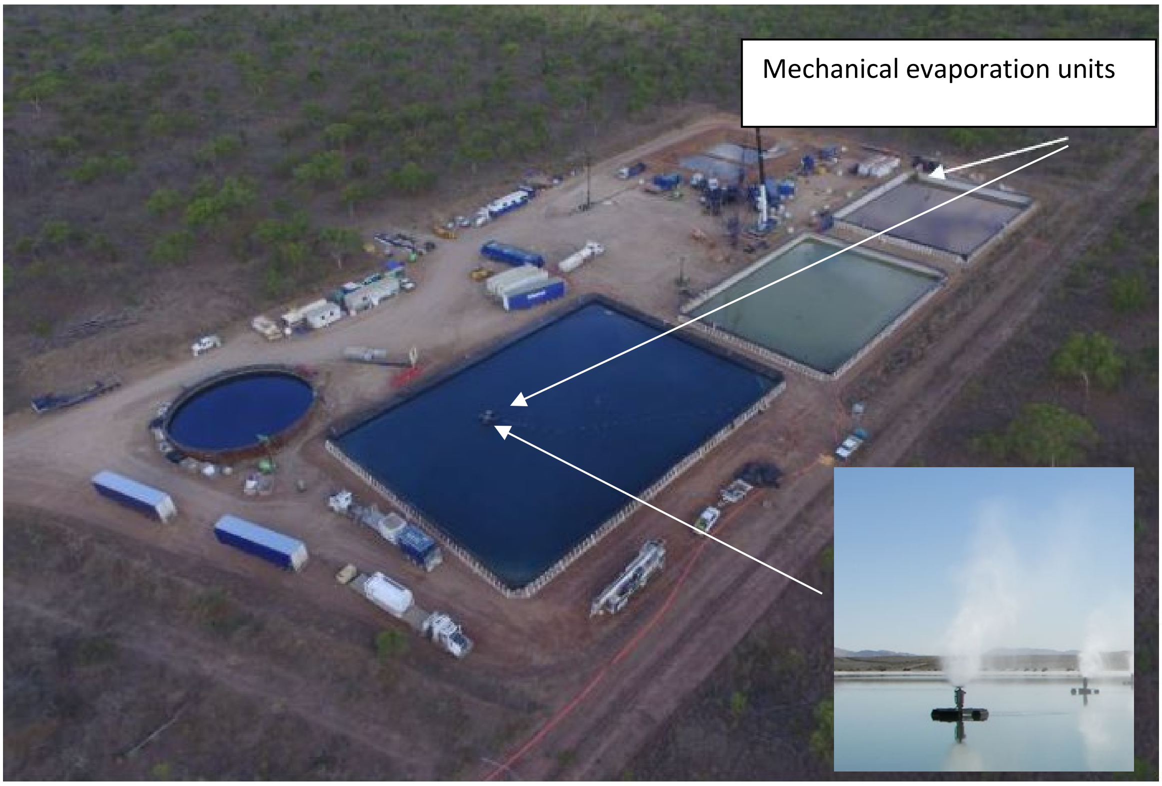


Figure 33: Example of mechanical evaporators used at the Amungee NW site in 2016

Where a significant rainfall event is predicted, the total volume of flowback stored on-site will be transferred to the covered storage tanks 8 hours prior to the onset of the event. The Bureau of Meteorology (BOM) 4-day total rain forecast (http://www.bom.gov.au/jsp/watl/rainfall/pme.jsp) will be reviewed daily to identify periods of significant rainfall. This forecast provides an 8-day look ahead, which will be able to identify periods of significant rainfall several days before its onset.

Tamboran will have up to 6 x 6-inch transfer pumps on-site, capable of transferring up to 23 ML/day each. The on-site pumping capacity is significantly more than the total worst-case volume of wastewater that will be stored on-site. Commencement time to begin transferring the flowback fluid will be selected to ensure that it is completed at least eight 8-hours prior to the predicted commencement of the significant rainfall event.

In the event of a catastrophic failure of a tank, all wastewater will be contained within the bunded site. For example, the earthen bund around the Amungee NW site has the capacity to manage approximately 6 ML of wastewater or sufficient to accommodate 110% of the volume of the largest tank on-site if the tank were to fail. Where a tank fails, water will be pumped from the bund into the available waste storage tanks on-site. In such a case, the exploration well would be shut in and the regulator notified as per the Spill Management Plan (SMP). A site assessment and rehabilitation strategy would be developed in alignment with Schedule A of the NEPM.

3.13.3.5 Wastewater monitoring

The following wastewater monitoring strategies will be implemented during extended production testing and wastewater storage:

- Each wastewater tank will be equipped with level sensors to monitor the fluid volumes in real time.
- Alarms are set below the freeboard level (referred to as the maximum operating water level) to trigger a management response if exceeded.
- Weekly tracking and storage forecasting will be undertaken to ensure freeboard requirements are not exceeded.
- Weekly wastewater tank integrity inspections to identify any tank structural defects (subject to site access due to weather, bushfire or other factors outside the operator’s control).
- Wastewater liner integrity monitored through continuous leak detection sensors within the liner interstitial space.
- Monitoring of flowback quality will be undertaken in accordance with section 3.13.3.2.

3.13.3.6 Flowback disposal

Flowback is to be disposed of via 2 main methods:

- Evaporation followed by offsite disposal (default disposal method).
- Recycling: where flowback is used as stimulation make-up water.

Enhanced evaporation and offsite disposal

Enhanced evaporation using mechanical evaporators is the primary wastewater treatment option anticipated to be deployed. Enhanced evaporation will reduce the residual flowback volumes at each site from a peak of approximately 9.5 ML to approximately 0.5 ML within 12 months of well testing commencement. At this point, approximately 20 B-Triples will transport the residual flow back to an approved disposal location. Associated residual solids, brines, sludges and liners will be sent interstate to the Hydrerra Tennant Creek wastewater handling facility or Westrex waste facility in Jackson, Queensland. Options for alternative authorised facilities are under review and if they become available during the disposal of flowback materials they may be used. All interstate transfers of controlled wastes will require an interstate/territory consignment authority to authorise the movement of waste between administrative boundaries.

Recycling

Flowback will be preferentially used as stimulation make-up water. Flowback is likely to be saline and will require mixing with raw groundwater to reduce the EC of the fluid prior to use. For example, the median EC for the Amungee NW 2H well was 40,260 µs/cm (Tamboran, 2023). Flowback, raw groundwater and stimulation chemicals will be mixed in the onsite mixers, prior to being injected downhole. This is anticipated to make up approximately 30% of the stimulation fluid volume, which could significantly reduce flowback storage and disposal requirements.

Returned flowback will then be further evaporated and then disposed of offsite at a licenced wastewater disposal facility.

Flowback and wastewater to/from Shenandoah S B and S C will be transferred via gathering lines to a central management facility at Shenandoah S B. Flowback and wastewater to/from Kyalla 117 N2 and Shenandoah S2, will be transferred via gathering lines to a central management facility at Shenandoah S2.

3.13.3.7 Gathering Line operation

Gathering lines will be used to transfer fluids between sites. Most (~80%) of the fluid transfers will occur in the first 30 days of a well test. Depending on the amount of water observed, flowback may be sent continuously from the separator or in batches stored on onsite tanks once enough volume has been collected.

Flow meters will be installed at each end of the gathering network to monitor flow volumes, with changes in flow rates used to identify potential leaks.

Gathering lines will be manually initiated by onsite operators, with telemetry to enable remote shut-off of gathering pipelines in the event of a leak alarm.

Mass balance of fluid transferred to and from sites will be retained as per the Code. Operation of the gathering lines to ensure compliance with MAOP and will be in accordance with Section 4.6.3 of the PEGN Code, which outlines the design factors necessary to ensure the network is fit for purpose. Should a leak alarm be triggered, the pipeline will be shut in and inspected immediately.

Raw water supplied via gathering lines that have contained wastewater will not be used when drilling through aquifers, including the Cambrian Limestone Aquifer (CLA) (Gum Ridge and Anthony Lagoon Formation) and Bukalara Sandstone (if present).

When water/wastewater is being transferred between two points, only the valves will be operated to direct the flow between those points and isolate the balance of the gathering line network. When wastewater is not being transferred, the gathering system will be isolated.

When a gathering line section has been transferring wastewater is no longer required to support operational activities it shall be suspended. Suspension will occur within 6 months of the cessation of wastewater transfer and involve the flushing of the gathering line with 125% of its volume with fresh water to purge it of wastewater or until the water quality returns to the consistency of the groundwater used for purging (defined as 110% of the source water utilised). Purging the line when not in use will reduce wastewater sitting in pipework when not in use for extended periods. Purge water will be directed to onsite wastewater tanks with records of volumes and destination retained.

Operations of gathering lines will not be undertaken where there is imminent threat of bushfire (bushfire expected to impact an area within 12 hours based on information sourced from the Bushfire NT and the Northern Australia Fire information portal) or 8 hours from a significant weather event (such as a cyclone) which may damage gathering lines/ equipment (such as from erosion or fire damage to infrastructure) .

The right of way is to be inspected as soon as practicable after a bushfire or major weather event, with transfers only re-initiated once inspections have been complete.

Gathering line right of ways will be inspected at least monthly during wastewater transfers, with weekly inspections where above ground piping is utilised. Right of way inspections will be undertaken to identify the following features:

- Subsidence and erosion along the gathering line
- Leaks from vents, drain and valve pits
- Unusual wet patches, salt scalding or stressed/dead vegetation along the pipeline

All spills/leaks will be reported and investigated in accordance with section 12 of the SMP (Appendix F) and NT statutes.

3.13.3.8 Leak detection and isolation

The gathering line network will be fitted with manifolds and valves at approximately 1km intervals to isolate it into sections. These valves will be always locked unless attended by authorised personnel to prevent unintentional operation.

Magnetic flow meters (or equivalent) are anticipated to be used on the inlet and outlet of the gathering lines. The meters have an accuracy of ±0.2% to ±0.5% instrument span for each instrument during typical transfer operations. Pressure transmitters would also be utilised at the inlet and outlet with an accuracy of ±0.2% of instrument span. All meters shall be maintained in accordance with the manufacturer specifications to ensure accuracy.

A leak detection system (ATMOS Pipe or equivalent system) will be utilised to detect rupture and leaks of the gathering line. This monitoring is based on volumetric balance measurement for leak detection during transfer operations and uses pressure monitoring for leak detection when the gathering line is shut in.

The system response time for a gathering line (~ 4km long) would be 10 minutes, based on a 1% leak.

The theoretical leak rate based on a response within 10 minutes is 1% x flowrate x 10min. Assuming a peak flowrate during initial flowback operations of 1.6ML/day, the minimum detection would be 110 litres.

A mass balance of flowback transfers over a 24 hour period will also be set up to detect sustained minor leaks.

The leak detection system will have alarms and automatic shut off protocols. Sites will have telemetry on selected valves to enable remote shut-off of gathering pipelines in the event of a leak alarm.

If there is a suspected leak detected, the system will alarm, and transfer operations stopped until the imbalance in flow is investigated and rectified. If the imbalance is the result of a spill from the gathering line network, the system will not be restarted until the leak is repaired and an investigation is carried out as to how the leak occurred and how it will be prevented from re-occurring.

The reporting of any "wastewater gathering line leak" events from the gathering line network will be recorded and reported in line with the SMP (Appendix F).

A volume of 74,182 litres is the theoretical worst-case scenario if a gathering line leak happens, being the entire volume of a section of gathering line (4.2km gathering line x 6 inch pipe). However, this scenario is implausible given the following:

- The whole gathering line network would not generally drain to a single point in the system.
- The leak detection system would detect the leak before the whole system drains.
- The automated valve shut in would be enacted to prevent the line from draining.
- Larger leaks will only happen when the system is operating and under pressure.

3.13.3.9 Wastewater tank decommissioning

Each wastewater tank will be decommissioned when no longer required to support current or future wastewater storage requirements. Decommissioning typically takes approximately 4-6 days and involves a 6t telehandler, Spreader bar, Vac tank, prime mover and multiple 30m skips. The process for decommissioning can be typically summarised as:

1. Tanks will be decommissioned when there is low forecasted chance of rainfall during the duration of the decommissioning activity.
2. The tank is first drained to another wastewater tank/ truck to a level that is as low as possible
3. For enclosed tanks, the lids are rolled up and removed- these will be stored on a bund/sealed skip awaiting disposal
4. Fluid transfer equipment is utilised to remove the residual fluids with ongoing fluid removal during deconstruction
5. A temporary bund (earthen or equivalent material)is constructed within the tank to prevent fluid from entering the cleaned section. The bund is sized to allow a section of the liner to be rolled up, cut and safely handled
6. Solids are removed from the section (as much as practicable).
7. The tank liners (primary and secondary) are detached from the tank wall in a section of the tank and several panels are removed to allow equipment and people access to the liner.
8. The primary liner is removed. The secondary liner is left in situ if possible (noting it may become damaged with equipment use).
9. The folded primary liner is cut off before the internal bund and transferred via telehandler to be stored within a bund to contain any potential residual fluids
10. The next area has any residual fluid removed and a new bund is constructed within the tank in preparation for the next section of liner to be removed.
11. Steps 6-9 are repeated until all liner is removed.
12. Once the primary liner is removed, the secondary liner and underlying geofab is removed to a skips (sealed if contains wet material)
13. The tanks panels are all deconstructed and removed from site/ stockpiled for re-use
14. All waste liners are removed to a licenced wastewater facility in a sealed skip (where wet and likely to spill) by a licences waste provider
15. Tank decommissioning will typically occur during the night, with a bund in place to prevent any overflow from rainfall during the evenings
16. Any spilled material/ contamination will be cleaned up immediately, with the spill management processes outlined in section7.3 of the EMP followed. If a long term suspected leak is identified, this shall be investigated with the affected material removed, stored in a bunded area/ sealed skip and trucked offsite to a licensed waste facility.
17. Any spills/ leaks will be reported as per section 8.6.

3.13.4 Fauna and bird access

Previous operations at the Amungee NW and Kyalla 117 N2 site have not identified any significant interaction of fauna with open wastewater storages. This is supported by company compliance and reporting, which can be found on the DEPWS website at: https://depws.nt.gov.au/onshore-gas/onshore-gas-in-the-northern-territory/industry-compliance-and-reporting. This is also supported by various pieces of literature which highlight the role of the salinity in deterring birds and fauna from consuming/interacting with wastewater (Bartholomew and Cade 1963; Ohmart and Smith, 1970; ANZECC, 1992; Griffiths et al, 2009).

For example, the Amungee NW-1H flowback wastewater is hypersaline, with total dissolved solids (TDS) >50,000 mg/L, and is indicative of the flowback water under this EMP. It is well documented that birds, insects and mammals are unable to drink hypersaline water >46,000 mg/L TDS (Bartholomew and Cade 1963; Ohmart and Smith, 1970; ANZECC, 1992; Griffiths et al, 2009). The TDS of the wastewater is likely to reduce the palatability of the wastewater, thus reducing the potential exposure of fauna, including birds to wastewater. This has been documented within the gold industry, where studies have identified links between the hyper salinity of wastewater to reduced bird mortality associated with cyanide ecotoxicity (Adams *et al.* 2013, Adams *et al.* 2008, Griffiths *et al.* 2009a and Griffiths *et al.* 2009b*).*

Monitoring of flowback storages and surrounding areas for fauna mortality will be implemented as per Table 33.

3.13.5 Stormwater

Each site will be operated in a manner that minimises the contamination of stormwater and overland flow. Stormwater is typically characterised by low electrical conductivity (<50 µs/cm), with a pH of approximately 5.2 (based on field measurements of rainwater collected at Daly Waters in March 2024).Stormwater will contain elevated levels of sediment sourced from the cleared well pad surface. These will be allowed to settle out as much as possible prior to release, noting the operating strategy will be to keep the sediment basins as low as possible to maintain the ability to intercept contaminants of concern in the event of a wastewater spill and prevent site bund failure/ overtopping. The following describes how stormwater is managed on the site:

- The well pad has been designed to divert stormwater r around the well pad to prevent contamination.
- The flowback wastewater storage areas will be bunded from the rest of the well site and designed to divert stormwater to prevent contamination during wastewater storage.
- A stormwater retention basin within the flowback wastewater storage areas will allow collected stormwater to be tested prior to release/re-use/ disposal in accordance with Table 23.
- Clean stormwater that meets the quality outlined in Table 23, will be discharged off-site in controlled manner or re-used for dust suppression.
- Where the water is visibly turbid, a sediment sock will be used to remove sediment from the release.
- All stormwater above the specified limit will be treated as wastewater and managed accordance with section 3.13.3.4.
- Once all work on the site has ceased and all contaminant sources have been removed from the well pad, the site will be left in a stable, non-polluting state with appropriate erosion and sediment controls in place.
- ESCP implemented (Appendix H).

Table 24: Stormwater off-site release and re-use (dust suppression) limits

Monitoring parameter	Release limit
Electrical conductivity	1,300 µs/cm
pH	5.2 – 9
Visible hydrocarbons, sheens, foaming or discolouration.	No visible oil, grease or other hydrocarbons No visible foams caused by surfactants and detergents No visible abnormal discoloration

3.13.5.1 Stormwater release limit justification

The main purpose of monitoring stormwater quality is to identify if stormwater runoff quality has been impacted by either wastewater or chemicals stored/ managed onsite.

Each site storing flowback wastewater is bunded to prevent the release of highly saline wastewater in case of a catastrophic failure. Flowback and drilling wastewater has an elevated electrical conductivity (EC) of ~32,000us/cm and spills/leaks will result in stormwater being elevated. The conductivity is approximately 1,000 times higher than rainwater, which was tested at 33us/cm at Daly Water on the March 20, 2024.The difference in EC between rainwater, stormwater and other water used on site (such as the Gum Ridge formation) makes it the most suitable indicator. EC is also a suitable indicator for a range of chemicals stored onsite, including sodium chloride, potassium chloride and calcium chloride. Salt is by far the largest chemical used by volume, further increasing the relevance of EC as an indicator of contamination.

EC measurements can be easily collected using standard equipment, is reliable and reproducible. Should the EC of stormwater be exceeded, this will be recorded as an incident, fluid transferred to wastewater tanks, an investigation onto the source of the contamination initiated (such as inspection of wastewater tanks and chemical storages) and additional laboratory testing will be undertaken to determine the source of the elevated level. The stormwater will be tested in accordance with the suite identified in C.8 of the Code. Laboratory testing is not considered an appropriate method of confirming contamination given the long sample analysis times and the inability to hold stormwater for extended periods without impacting the integrity of the site.

The proposed limit of 1,300 µs/cm was chosen as this aligned with the EC of the Gum Ridge formation (the main source of water used on proposed sites) and the ANZECC short term irrigation guideline value for moderately sensitive crops (Table 9.2.5 of the ANZEC Guidelines (2000) Volume 3, Chapter 9, Primary industries). The Gum Ridge water is used in construction water, dust suppression and is discharged to the sediment basin as a part of tank hydrotesting where the water cannot be re-used. Thus, placing a separate limit on the sediment basin for stormwater and hydrotest water would be extremely difficult.

Irrigation salinity values were considered relevant due to the absence of adjacent watercourses, with the protection of soils the most relevant environmental Value (EV). The ANZECC method (and associated references) is the only method available in Australia to evaluate the potential risk of application of water to land. The methods evaluate the impact of water to receptors such as terrestrial ecosystems, crops, and stock. The method is used across Australia for this kind of evaluation.

To assess the potential impact of a stormwater release at the specific limit, modelling was completed to assess the changing soil salinities and the potential for impact on the receiving vegetation types. The model used the maximum observed Gum Ridge Salinity of 1,600 µs/cm (1,046 mg/L Total Dissolved Solids) released over a 5 year period. This included estimates of stormwater collected and discharged from the site over the period, as well as the periodic release of hydrotest water. This modelling is extremely conservative as it a) assumed all water ran off from the site and b) that all water was of a quality consistent with the Gum Ridge. In theory, the amount of water released form site is likely to be significantly lower and of quality consistent with rainwater.

To understand the sensitive of the receiving vegetation to salinity, a literature review was completed. the receiving environment is characterised by Native grasses (including spinifex and tussock), with trees commonly found in the project area are moderately to highly tolerant to salinity. Eucalyptus species are known for their salt tolerance and can withstand salinity levels up to 8,000 µs/cm and greater. For example, *Eucalyptus camaldulensis* is present in the area (Table 19 of the Land Condition Report) is tolerant to salinity up to 8,000 µs/cm [28]. Several of the eucalyptus species in the area including *Eucalyptus microtheca* and *Eucalyptus camaldulensis* are specifically noted in the Salinity Management Handbook (Queensland

[28] https://www.agric.wa.gov.au/soil-salinity/salinity-tolerance-plants-agriculture-and-revegetation-western-australia

Government) as suitable for saline discharge sites[29]. Acacian and Melaleuca species found in the area can tolerate at least 2,000 µs/cm and greater than 16,000 µs/cm. *Corymbia* (Bloodwood) generally exhibit moderate to low salinity tolerance compared to eucalypts- but still greater than 2,000 µs/cm and up to 4,000 µs/cm.

Modelling of 3 scenarios in accordance with ANZECC defined methodology was undertaken using meteorological data, indicative well site and indicative data on receiving soils. The scenarios included:

1. During wet season operations (December to April inclusive). Water is only associated with rainfall.
2. Hydrotest during wet season operations (December to April inclusive). Conservatively assumes hydrotest is undertaken during wettest month.
3. 3. Hydrotesting during the dry season. Negligible rain

The results of the modelling indicates the maximum root zone salinity will be in the order of 1.6 dS/m (for a sandy loam) to 1.7 dS/m (for a clay). This is below the likely vegetation root zone salinity of the vegetation type in the area as previous discussed.

Elevated levels of Na^+ in irrigation water can lead to sodicity problems in the soil profile under irrigation. An estimation of sodicity levels in irrigation water can be predicted using the sodium adsorption ratio (SAR). This is calculated using the following equation, where ionic concentrations are in mmolec/L:

$$SAR = \frac{Na^+}{\sqrt{\frac{Ca^{2+} + Mg^{2+}}{2}}} \tag{4.2}$$

The inputs are results are shown in Table 25. The SAR calculated from the analytical results for sodium, magnesium, and calcium is consistent with that reported by the laboratory (2.24).

Table 25: Calculation of sodium adsorption ratio (SAR) based on observed Gum Ridge

Parameter	Average Value	Maximum Value	Comment
Sodium (Na)	87 mg/L	107 mg/L	
Calcium (Ca)	72 mg/L	109 mg/L	
Magnesium (Mg)	33 mg/L	49 mg/L	
Sodium	3.8 meq/L	4.6 meq/L	Conversion – divide by 23
Calcium	3.6 meq/L	5.4 meq/L	Conversion – divide by 20
Magnesium	2.7 meq/L	4.0 meq/L	Conversion – divide by 12.2
SAR	= Na[] / sqrt((Ca[] + Mg[])/2) = 2.1	= Na[] / sqrt((Ca[] + Mg[])/2) = 2.1	Inputs in meq/L

SAR for the Gum Ridge Formation was calculated at 2, which when combined with the EC values, falls to the right of the dashed line of the figure provided in the ANZECC guideline below (Figure 34). This result indicates that the release is unlikely to cause soil structural problems.

[29] Table 43 Salinity Management Handbook, Queensland

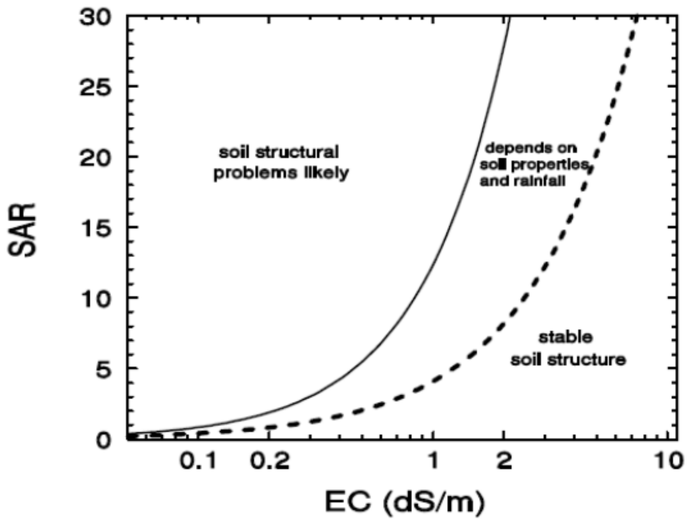


Figure 34: Relationship between SAR and EC of irrigation water for prediction of soil structural stability (from DNR 1997a, adapted from DNR 1997b; note that 1 dS/m = 1,000 µS/cm)

The proposed pH limit is a suitable indicator for a range of chemicals used in the process, including acids (hydrochloric acid, hypochlorite, acetic acid etc.) and bases (sodium hydroxide). The proposed minimum pH is reflective of observed regional rainfall pH levels, with pH levels of 5.24 observed at Daly Waters on March 20, 2024.Tamboran has observed pH levels on its enclosed tank lids and sediment basins around the pH of 5 level. Given the large volume of rainwater that falls on a site in a very short period, the pH in the sediment basin is anticipated to be low, before increasing as they interact with the receiving soils. This has been observed in sediment basins onsite, with pH increasing from 5.2 to 6.5 over several hours after a rainfall event due to the low buffer capacity of rainwater. Given the existing pH of rainwater is approximately 5.2, we believe this to be an appropriate release limit for storm water.

The proposed visible limits are designed to identify visual evidence of contamination, primarily associated with onsite storages of fuels, oils, and chemicals (such as polymers, surfactants, glycols, hydrocarbons etc.). This combined with the pH and EC limit, ensure the majority of chemicals are likely to be detected as well as all wastewater streams.

When assessing whether the release limit could result in wastewater being released from the site, the following should be considered.

- The salinity difference between wastewater and stormwater is significant and will result in rapid increases in salinity should contamination occur.
- The code requires mandatory inspection of tanks and secondary containment during the wet season- leaks and spills will be detected daily.
- Wastewater is not authorised to be released to waters- it is prohibited under the Water Act and Code.
- any large spill would be detected, limiting the potential impact of an event.
- Any small leak impacting site stormwater quality is anticipated to be small and temporary. The leak would be detected promptly through other inspection and wastewater tracking mechanism.
- The modelled salinity at the limit for 5 years does not result in a changed soil salinities beyond the sensitivity of the receiving vegetation.
- The presence of other metals or metalloids would be diluted by either the size of the spill and/or the volume of stormwater runoff. Given the short nature of the release and likely dilution, these are not anticipated to represent any material risk of harm.

3.14 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 well pad, camp pad and access tracks
- Firebreak maintenance
- Access track resurfacing and maintenance
- Well site, including camp pad resurfacing
- Water extraction bore maintenance
- Erosion and sediment control maintenance and repair
- Weed management

3.15 Ongoing monitoring and well integrity management

The ongoing monitoring and well integrity management of the proposed E&A wells is illustrated in Figure 35. Tamboran'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 to ensure the integrity of a well throughout its life.

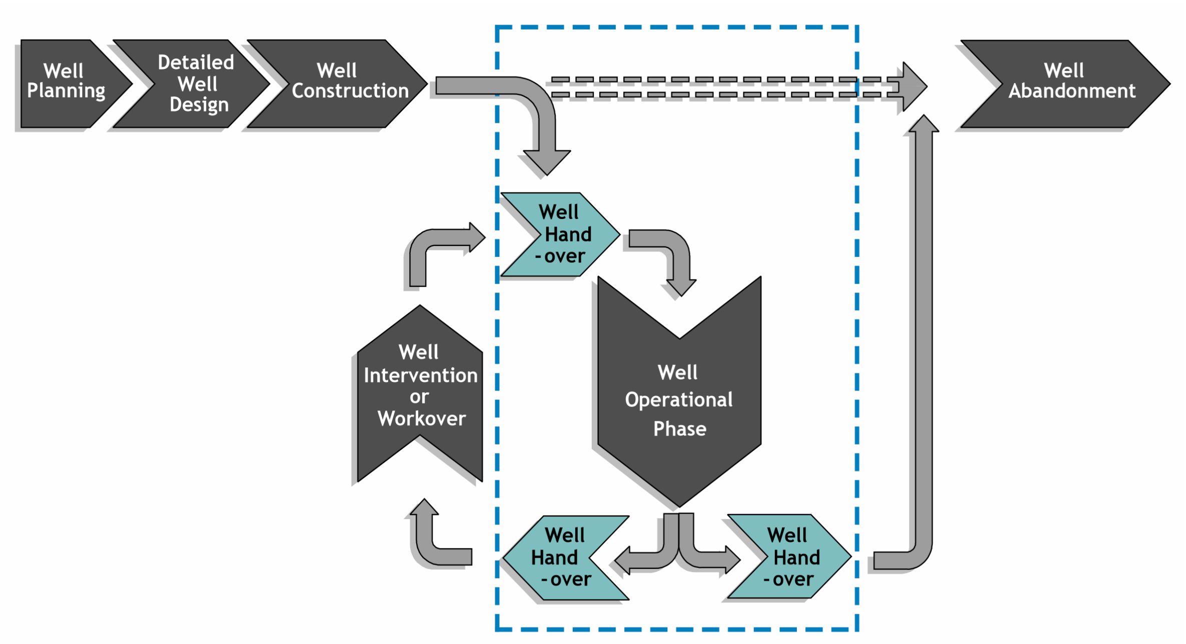


Figure 35: Well lifecycle with operational phase highlighted where well integrity monitoring is a key activity

Information from all Tamboran 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 well and outlines the well integrity status for each well.

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 – truck and 4WD with about 3 people to do 1-2 days of work on pressure testing, and maintaining the wellhead.
- Completion rig – a small rig with 6-7 trucks to pull tubing and potential recompleted the well if required.
- Wireline/slickline – 1 truck to either set a plug downhole or run additional logs.

3.16 Well build up testing, suspension and decommissioning

Once all drilling, stimulation and testing has been completed, each E&A well will either be put on build up test, suspended or plugged and decommissioned. The fundamental difference between the three options is as follows:

- **Build up test:** each well or a subset of wells may be shut in at the surface with pressure monitoring undertaken. This may be undertaken for a period of 12 months (or longer) and is used to understand the performance of the reservoir.
- **Well suspension:** the well is suspended with (at a minimum) cemented casing and a wellhead so that it can be re-entered later for further down-hole activities. While the well is suspended, pressures on the well will be continuously monitored as per Tamboran's WIMS to confirm well integrity is intact.
- **Well abandonment:** where a well is to be decommissioned, cement plugs will be installed as permanent barriers to flow prior to cutting off the wellhead. The cement plugs will be set and tested as per Section B.4.15.2 of the Code. In some circumstances, such as a loss of the bottom hole assembly or hole stability issues, the entire well or a specific section of a well may need to be plugged and abandoned with a new well drilled or the well side-tracked around the affected area. Such an activity is undertaken to ensure the operational integrity of the well.

3.17 Geohazards and seismicity

Major faults are avoided as they can represent hazards to both drilling and stimulation operations. Risks associated with geohazards are assessed and managed via the following steps:

- **Locating E&A wells:** Tamboran has over 9,500 km of 2D data available which is used to screen for large scale, regional faults or structures prior to the finalisation of any exploration well location. The data for Tamboran's broader Beetaloo exploration area indicates there are very few major faults present and that the strata within the Basin (i.e. away from the steep flanks) are relatively gently dipping.
- **Geohazard assessment post drilling:** Prior to completing stimulation, geological data is analysed to determine the presence of minor and major faults which may pose a hazard to stimulation activities. Where faulting is encountered during the drilling of the horizontal section of the well, a risk assessment is undertaken to determine whether stimulation activities can occur safely. In some instances, location of stimulation stages along the wellbore may need to be moved/removed, to isolate the feature encountered (such as encountered during the original Amungee NW-1H well where a casing deformation occurred).

- **Real-time monitoring of pressure during stimulation:** Pressure data provides a tool to prevent fault activation and fluid/pressure communication out of the target interval. If anomalous pressure behaviour is observed, stimulation operations can be ceased immediately. This prevents any substantial volume of fluid or proppant from being pumped into an open geological structure.

Preliminary drilling results from the existing E&A wells has confirmed the absence of major structural features or faults. For example, a casing deformation event within the Amungee NW-1H horizontal (i.e. within the Velkerri shale) was recorded during stimulation, however this was not considered a major hazard. This event resulted in poor production outcome (i.e. the production casing within the horizontal well installed within the Velkerri shale became damaged) and not an environment risk (i.e. no risk of interconnectivity with surface aquifers). The risk of induced seismicity is consistent with the current assessment level of low.

Monitoring of seismic events will be undertaken using the Geoscience Australia's Beetaloo seismic array and purpose installed seismic monitoring arrays located adjacent to selected well pads within the Shenandoah South area (Figure 36). It is likely that any material seismic events will be detected via these arrays if they occur.

An additional traffic light system is currently being developed by the NT in response to the NT Inquiry recommendation. This system is likely to be in place, prior to any full-scale development occurring.

A well plan summary is provided to DITT outlining any known geohazards, structural features or faults prior to stimulation.

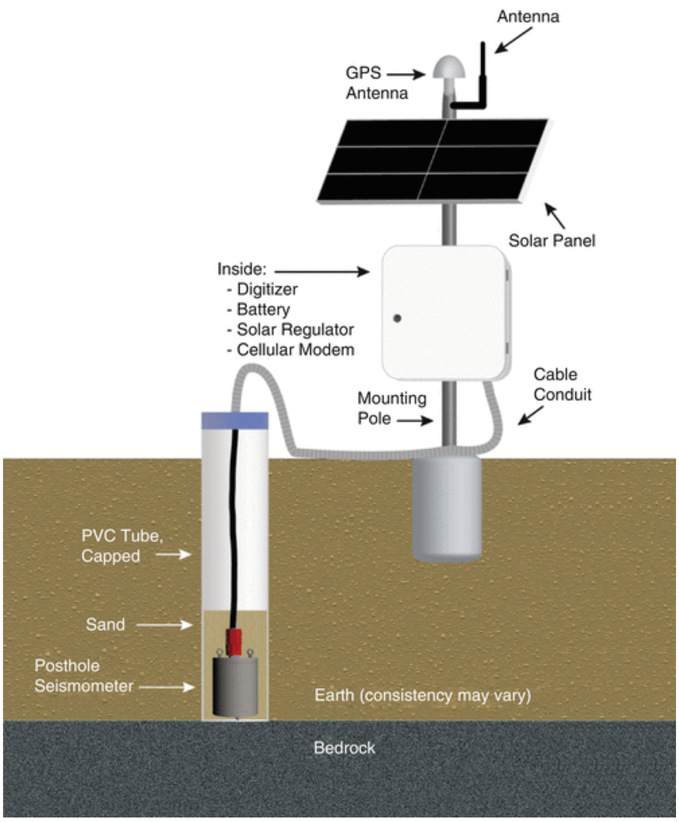


Figure 36: Seismic monitoring array to be set-up adjacent to selected exploration sites to monitor seismic activity

3.18 Greenhouse gas emissions

The anticipated well test emissions associated with the proposed activities will cover the emissions from construction, drilling, stimulation and well testing of multiple E&A wells over a 4-year period. Emission estimates are conservatively high, assuming that each well is successful (flows hydrocarbons), observed rates are of commercial quantities and activity on each well is completed. The peak activity emissions are estimated to peak at 190,838 tCO_2^{-e} in the FY 2025. A breakdown of the emission estimates is provided in Table 26 and Table 27.

Based on the predicted success case emission rates, the NT Large Emitter Policy and National Greenhouse and Energy Reporting Scheme (NGERS) Safeguard Mechanisms 100 $KtCO_2^{-e}$trigger is anticipated to be exceeded in FY 2025. In accordance with the updated NGERS safeguard mechanism requirements released in 2023, an activity becomes a “facility” once the emission threshold has been triggered. The safeguard mechanism requires a facility to have all scope 1 (direct) emissions offset in the year triggered, using Australian Carbon Credit Units granted under the Commonwealth Carbon Credits (Carbon Farming Initiative) Act 2011.

Approximately 90% of the emissions are associated with flaring. Flaring of produced hydrocarbons is required under exploration tenure to evaluate the commercial viability of a resource.

Well testing of up to 300 days will be required in FY 24 and FY 25 to obtain long term appraisal data to underpin future financial decisions regarding the sale of appraisal gas (appraisal gas is not included in the scope of this EMP). Flaring completed in FY 26 and 27 is anticipated to be restricted to the initial well clean up and stabilisation period, notionally 30 days (subject to the length of time a well takes to reach stabilised production post clean up). Should FY2025 well testing activities be delayed, some well testing activities may be carried over into subsequent FY26

Greenhouse gas emissions generation will be mitigated through the adoption of the Code and implementation of a MEMP (Appendix I). These include:

- Restrictions on venting (D.5.9).
- Use of a Reduced Emissions Completion (D.5.9).
- Six monthly routine leak detection and repair program on surface infrastructure (Gathering and wells) to detect, repair and report leaks to be implemented (D.5.2).
- Pressure and gas testing all in service equipment to ensure any leaks are identified and fixed prior to commissioning (D.5.2).
- Flanges, valves and fittings are all American Petroleum Institute (API) compliant and gas tight
- Equipment is appropriately sized and regularly maintained to minimise diesel wastage. (D.5.1).

RECs involve the capture and combustion of hydrocarbons in a flare; a standard practice that has been utilised by Tamboran for all exploration activities. The combustion of gases produced will reduce the emissions generated by flaring by 94% when compared to venting.

In addition to monitoring emissions from drilling, stimulation and well testing activities, baseline assessments have been completed by Commonwealth Scientific and Industrial Research Organisation (CSIRO) in the vicinity of the well pad as per the Code.

Table 26: Predicted greenhouse gas emissions breakdown per financial year, including offset requirements

Estimated emission financial year	FY24 tCO_2-e	Potential emission offset requirements (tCO_2)	Total residual emissions tCO_2 (Total emissions minus offsets)
FY 2024	24,662	1,825	22,837
FY 2025	190,838	190,838*	0*
FY 2026	98,115	14,423	83,692
FY 2027	86,395	15,897	70,498
Total	**400,010**	**222,983**	**177,028***

*Assumes the NGERS safeguard 100 $ktCO_2$ trigger has been reached and offset requirements triggered.

Table 27: Greenhouse gas calculation for the proposed activities

Activity	Estimated volume	Estimated tCO_2-e)	Estimate methodology and assumptions
Diesel combustion- civil construction and water bore activities	450 KL	1,219.5	Diesel estimates multiplied by NGERS emission factor from NGER Determination: Division 2.4.2 Method 1 emissions of carbon dioxide, methane and nitrous oxide from liquid fuels other than petroleum-based oils or greases, section 2.41 Method 1—emissions of carbon dioxide, methane and nitrous oxide and Part 3—Fuel combustion—liquid fuels and certain petroleum-based products for stationary energy purposes item 40: • Energy Content Factor (GJ/kg) 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
Diesel combustion –seismic program	25 KL	68	Diesel estimates multiplied by NGERS emission factor from NGER Determination: Division 2.4.2 Method 1 emissions of carbon dioxide, methane and nitrous oxide from liquid fuels other than petroleum-based oils or greases, section 2.41 Method 1—emissions of carbon dioxide, methane and nitrous oxide and Part 3—Fuel combustion—liquid fuels and certain petroleum-based products for stationary energy purposes item 40: • Energy Content Factor (GJ/kg) 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
Diesel combustion – transport to cover drilling/stimulation mobilisation and transport activities (including chemical, wastewater and ancillary transport support activities)	1,354 KL	3,679	Diesel estimates multiplied by NGERS emission factor from NGER Determination: Division 2.4.2 Method 1 emissions of carbon dioxide, methane and nitrous oxide from liquid fuels other than petroleum-based oils or greases, section 2.41 Method 1—emissions of carbon dioxide, methane and nitrous oxide and Part 3—Fuel combustion—liquid fuels and certain petroleum-based products for stationary energy purposes item 40: • Energy Content Factor (GJ/kill) 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

Activity	Estimated volume	Estimated tCO_2-e)	Estimate methodology and assumptions
Diesel combustion - drilling	3,416 KL	9,256	Diesel estimates multiplied by NGERS emission factor from NGER Determination: Division 2.4.2 Method 1 emissions of carbon dioxide, methane and nitrous oxide from liquid fuels other than petroleum-based oils or greases, section 2.41 Method 1—emissions of carbon dioxide, methane and nitrous oxide and Part 3—Fuel combustion—liquid fuels and certain petroleum-based products for stationary energy purposes item 40: • Energy Content Factor (GJ/kill) 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
Fugitive methane emissions – drill cuttings	19.1 tCH_4	536	Estimate by engineer based on gas saturation and core volume multiplied by NGERS Global Warming Potential (GWP) of 28 tCO_2e/tCH_4.
Well stimulation, completion and workovers – stationary sources (diesel combustion)	1,625 KL	4,403	Diesel consumption estimated from historical data and multiplied by NGERS emission factor from NGER Determination: Division 2.4.2 Method 1 emissions of carbon dioxide, methane and nitrous oxide from liquid fuels other than petroleum-based oils or greases, section 2.41 Method 1—emissions of carbon dioxide, methane and nitrous oxide and Part 3—Fuel combustion—liquid fuels and certain petroleum-based products for stationary energy purposes item 40: • Energy Content Factor (GJ/kg) 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
Well testing- stationary sources (diesel combustion)	610 KL	1,653	Diesel consumption estimated from historical data and multiplied by NGERS emission factor from NGER Determination: Division 2.4.2 Method 1 emissions of carbon dioxide, methane and nitrous oxide from liquid fuels other than petroleum-based oils or greases, section 2.41 Method 1—emissions of carbon dioxide, methane and nitrous oxide and Part 3—Fuel combustion—liquid fuels and certain petroleum-based products for stationary energy purposes item 40: • Energy Content Factor (GJ/kill) 38.6 • CO_2 Factor 69.9 $kgCO_2$-e/ GJ of diesel • CH_4 Factor 0.1 kgO_2-e/ GJ of diesel

Activity	Estimated volume	Estimated tCO_2-e)	Estimate methodology and assumptions
			• N_2O Factor 0.2 $kgCO_2$-e/ GJ of diesel
Fugitive emissions – completion (venting)	829 t methane	23,206	2 completion days anticipated per well. Table 5-23 Compendium of Greenhouse Gas Emissions Methodologies for the Oil and Gas Industry; API, 2009 NGERS completion factor of 25.9 tonnes of methane per day multiple by NGERS GWP of 28 tCO_2-e/tCH_4.
Well testing- flared natural gas emissions Total TJ flared	4,050TJ	345,165	Flared estimate using forecasted P50 success case of 9.0 TJ/day per well. Estimated production rates multiplied by NGER Determination: Subdivision 3.3.2.2—Oil or gas exploration and development (emissions that are flared) section 3.44 Method 1—oil or gas exploration and development item 1: • CO_2 Factor 2.8 tCO_2-e/ t unprocessed gas • CH_4 Factor 0.933 tCO_2-e/ t unprocessed gas • N_2O Factor 0.026 tCO_2-e/ t unprocessed gas • Note, no condensate is expected to be generated or flared.
Fugitive emission- wastewater storage and transfer (including gathering)[30]	60 t methane	1,675	10.8 ML/ well wastewater (assumes 72 ML stim volume per well with a recovery of 15%). Emissions multiplied by Table 5-10 produced saltwater tank methane flashing emission factors - Compendium of Greenhouse Gas Emissions Methodologies for the Oil and Gas Industry; API, 2009 emission factor of 0.11 tCH_4/ML (assuming 2% salinity, 250 psi separator pressure) multiplied by NGERS GWP of 28 tCO_2-e/tCH_4.
Diesel combustion- Camp	832.5 KL	2,256	Diesel consumption estimates multiplied by NGERS emission factor from NGER Determination: Division 2.4.2 Method 1 emissions of carbon dioxide, methane and nitrous oxide from liquid fuels other than petroleum-based oils or greases, section 2.41 Method 1—emissions of carbon dioxide, methane and nitrous oxide and Part 3—Fuel combustion—liquid fuels and certain petroleum-based products for stationary energy purposes item 40: • Energy Content Factor (GJ/kill) 38.6 • CO_2 Factor 69.9 $kgCO_2$-e/ GJ of diesel • CH_4 Factor 0.1 kgO_2-e/ GJ of diesel

[30] Gas gathering lines are not anticipated to be used for the 24/25/26 campaign and have not been included in the emission estimates. Should they be utilised, the emissions would be ~37 tCO_2 per site (based on 4.3 km of gathering used at one site and an emission factor of 0.02854 tCO_2e-/ km based on NGERS Determination 3.76 Method 1- natural gas transmission).

Activity	Estimated volume	Estimated tCO_2-e)	Estimate methodology and assumptions
			• N_2O Factor 0.2 $kgCO_2$-e/ GJ of diesel
Land clearing for site preparation and seismic surveys	119 ha land clearing (77 tCO_2e/ ha)	6,737	Transport Authorities Greenhouse Group 2013 Appendix I vegetation clearing methodology, Table 6, assumed maximum potential biomass class = 1.
Camp- wastewater methane emissions	30 people per day annualised average	156	Section 4.3 Estimating emissions from wastewater treatment: NATIONAL GREENHOUSE ACCOUNTS FACTORS Australian National Greenhouse Accounts August 2022 Unmanaged aerobic treatment • 0.12 tCO_2 per person per year
Total over 4 years (tCO_2-e)		400,010	

^ Based on GWP of 28 tCO_2-e/tCH_4 (Clean Energy Regulator 2020)

* https://www.api.org/~/media/files/ehs/climate-change/2009_ghg_=11201compendium.ashx

3.18.1 GHG cumulative emissions

The maximum annual emissions for Tamboran's current predicted activities are 190,976tCO_2-^{e}, peaking in FY 2025 (Table 28).

The potential (residual- not offset) emissions of Tamboran's activities represent 1.35% [31] of the total NT GHG emissions for 2021 or 0.04% of Australia's total emission to March 2022 [32]. it is appropriate to compare Tamboran's mission to the Territory level as Greenhouse Gas emissions are a jurisdictional issue and not confined by local or regional boundaries.

Table 28: Cumulative 2023-2027 financial year worst case greenhouse gas emission assessment by period for approved, proposed and potential future exploration activities

Activity	FY 24	FY 25	FY26	FY27	Comments
Existing approved EMPs					
Amungee NW-1 EMP	46	46	46	46	No material emissions anticipated
Beetaloo W-1 EMP	46	46	46	46	No material emissions anticipated
Velkerri 76 S2 water bores	0	0	0	0	No material emissions anticipated
Velkerri 76 S2 civil construction	46	46	46	46	No material emissions anticipated
Velkerri 76 S2-1H drilling, stimulation and well testing [33]	0	0	0		No material emissions anticipated
Amungee multi-well (Amungee NW NW-3H; Velkerri 76 S2-2H and S2-3H)	21,100	0	0		Drilling, stimulation and 90 day well test of one well on Amungee NW (Amungee NW 3H)
Amungee delineation EMP	0	0	0	0	The activities on the Amungee Delineation are dependent on the results of Amungee NW 3H and Shenandoah Sth. No material emissions are assumed, noting any activity completed under this EMP will be offset activity not completed under the Shenandoah South Pilot EMP
This EMP					
Shenandoah South E&A Program EMP	24,162	190,554	98,115	86,395	Activities include all those required to construct, drill, stimulate and well test the E&A wells over the FY 2024-2027 period
Total annual emissions (tCO_2e)	**45,901**	**190,976**	**98,253**	**86,533**	

3.18.2 Residual emissions offsets

Table 29 provides a summary of cumulative predicted greenhouse gas emissions breakdown per financial year, along with the estimated offset requirements and total residual emissions.

[31] https://www.greenhouseaccounts.climatechange.gov.au/

[32] Quarterly Update of Australia's National Greenhouse Gas Inventory: March 2022 (dcceew.gov.au)

[33] Based on the drilling of a horizontal and 90 day well test @4.5 TJ/day.

In accordance with the updated NGERS safeguard mechanism requirements released in 2023, an activity becomes a “facility” once the emission threshold has been triggered. The safeguard mechanism requires a facility to have all scope 1 emissions offset in the year triggered, using Australian Carbon Credit Units (ACCUs) granted under the Commonwealth *Carbon Credits (Carbon Farming Initiative) Act 2011*.

Tamboran also proposes to offset a percentage of residual greenhouse gas emissions where they are generated below the safeguard trigger level to meet the NT net zero by 2050 target. Tamboran will offset any residual emissions as per the following:

- That residual emissions be offset using carbon credit units approved by the Commonwealth Clean Energy Regulator or the Commonwealth's Climate Active Carbon Neutral Standard.
- Minimum offset levels shall increase year-on-year by 3.7% (based on a baseline financial year of 2023) to result in a linear decrease in residual emission levels to net zero by 2050 as per the following schedule:
- Financial year 2024 7.4% of total emissions offset
- Financial year 2025: 11.1% of total emission offset
- Financial year 2026 14.7% of total emissions offset
- Financial year 2027 18.4% of total emissions offset
- Actual emission levels produced during a financial year must be estimated in accordance with the NGERS reporting methodology.
- Offsets volumes shall be calculated retrospectively, by multiplying the actual emission volumes generated during a financial year with the corresponding financial year offset % requirement level.
- Offsets shall be secured and retired within 6 months of the end of a financial year.Noting any emission offset under the NGERS Safeguard mechanism will satisfy any obligation under the NT Large emitters policy and vice versa. This will avoid double counting.
- An appropriately qualified independent person with extensive carbon accounting experience shall verify the actual emission levels generated, the procurement and retirement of the required offset volumes for emission generated in the specified financial year.
- A report from the appropriately qualified independent person shall be provided to DEPWS by October 31 each year verifying the actual emission levels estimated and confirming the required offset for the previous financial year have been acquired and retired.
- That the Greenhouse Gas Abatement Program is updated annually based on actual emissions from the preceding year to ensure currency.

Table 29: Estimated cumualtive greenhosue gas emissions, offsets and residual emission levels

Emission period	Cumulative tCO_2-e	Potential emission offset requirements (tCO_2)	Total cumulative residual emissions tCO_2 (Total emissions minus offsets)
FY 2024	45,400	3,397	42,040
FY 2025	190,692	190,976*	0*
FY 2026	98,253	14,541	83,711
FY 2027	86,533	15,922	70,611
Total	**421,663**	**224,836***	**196,826***
*Assumes the NGERS safeguard 100 $ktCO_2$ trigger has been reached and offset requirements triggered.			

3.19 Naturally occurring radioactive material

A detailed assessment of Naturally Occurring Radioactive Material (NORM) was undertaken during the Amungee NW-1H well drilling and testing in 2016. The assessment collected data on the drill cuttings, gas and flowback water, with the results considered applicable to the drilling on the sites proposed under this EMP. The Shenandoah S-1H well is currently on test and additional data is anticipated to be collected in late March 2024.Results are expected to be similar to Amungee NW 1H given the shale is the same being targeted as the proposed wells and the resource is laterally continuous.

The observed radionuclide level within flowback and gas samples observed from Amungee NW-1H are at the lower end of those observed in the United States of America (USA) shale developments (Kibble *et al.* 2013).

The analysis concluded the following:

- **Drill cuttings:** X-Ray Fluorescence (XRF) data was collected at regular intervals (average 5 m), providing an estimate of up to 48 elements (including uranium, thorium and potassium) present in the formations being drilled. This data was analysed by a third-party contractor. Analysis determined that the uranium and thorium (primary sources for mineral contained Naturally Occurring Radioactive Materials, (NORMs) content of the geological formations drilled was well within the ranges of normal geological rocks. In addition, a study commissioned by Origin Energy in 2016 with the company ‘Radiation Professionals’ analysed drill cuttings samples from four (4) wells drilled by Origin (Kalala S-1, Amungee NW-1, Amungee NW-1H, Beetaloo W-1). Results concluded that none of the samples provided exceeded limits provided in the ‘Radiation Protection Regulations, 2012 (NT) Regulations 7’ or the ‘National Directory for Radiation Protection, Part B, section 3.2’. Given the distribution of the wells across the tenure and the geological continuality of the Roper Group formations, the risk of NORMs is considered low. The assessment of NORMs potential will be able to be accurately assessed and screened using a combination of well site wireline natural gamma and post drilling XRF analysis on cuttings samples to detected analogous samples with high radioactive producing elements such as uranium and thorium. If levels approaching the Radiation Protection Regulations are detected, a more thorough evaluation will be conducted. Furthermore, NORMs assessments of drilling muds are required under the Code and will be completed as per section 3.13.2.
- **Flowback:** NORMs samples of flowback were collected weekly during the well testing of Amungee NW-1H. An assessment of the results indicated that for the flowback to breach the regulatory limit of 1 mSv/year, a person would have to consume greater than 80 L of flowback fluid. Given fluid is strictly managed in accordance with the Code and corresponding WWMP, this scenario is considered highly unlikely.
- **Gas:** Results for the raw gas analysis from Amungee NW 1H indicated that at the observed radon level of 225 Bq/m^3. An exposure above 1 mSv/m^3 from raw natural gas is considered remote, as a person would need to be continuously exposed to raw gas on a long-term basis (years). This exposure scenario is not deemed a credible pathway, as there are stringent requirements in the Code, which prohibit unnecessary venting and require operators to conduct ongoing leak detection and repair program. Furthermore, the observed levels of radon are:
- Well below the maximum radon level limit for natural gas of 600 Bq/m^3. These limits are imposed by the Australian Energy Market Operation and outlined in the Australian Standard AS4564 Specification for general purpose natural gas (AEMO 2017) to protect the safety of the end domestic user of gas.
- Consistent with the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) recommendation that radon levels should not exceed 200 Bq/m^3 in households and 1000 Bq/m^3 in workplaces (ARPANSA 2019). The exposure of a pastoralist to unventilated gas is considered remote, based on the separation distance between the well and the inherent controls that limit

venting. The potential exposure to workers is also considered a low risk, based upon the radon levels being within the ARPANSA workplace guidelines and Code controls.

Risk controls have been implemented to manage the risk of exposure to personnel, including eliminating raw gas exposure and preventing access to drilling material and wastewater. The risk of exposure from NORMs generated during shale exploration activities is considered low. Testing of the drilling cuttings, gas and flowback water will be undertaken during this campaign, as described in Section 3.13.2.3.

Further information on the NORMs level encountered was provided to the Inquiry as part of Origin Energy's submission (https://frackinginquiry.nt.gov.au/?a=424843).

3.20 Wet season operations

Drilling, stimulation, well testing and wastewater storage and treatment operations are to occur over the wet season (defined by the Code of Practice as 1 October to 30 April inclusive). The 30-year average annual rainfall of the region is between 600 m – 1,000 m (BOM, 2024)(Figure 37). Wet season operations are undertaken with the following risk controls implemented:

- All chemicals, fuels, equipment, tanks and materials required for ongoing operations will be stored on-site prior to the onset of the wet season.
- All equipment required to respond to emergency situations will be on-site; this will be dictated by a pre-wet season risk assessment (based on the nature of activities underway) and include earth moving equipment, vacuum trucks, wireline rigs, cementing equipment etc. and equipment and material to deal with well control issues, spills and other emergency events.
- All chemicals storage areas will be bunded, with covers used (where safe and appropriate) to prevent rain ingress and bund overflows.
- Enclosed tanks will be used as the primary measure to store flowback wastewater with enough enclosed tank capacity to store all wastewater on-site.
- Enclosed wastewater storage volume will be sufficient to manage all flowback wastewater stored on-site.
- Open working evaporation tanks and mud sumps will have enough freeboard to manage an entire 1:1,000 ARI wet season event (not just one rainfall event but an entire season's rainfall total).
- Helicopters will be used to transport people and supplies into and out of the site when access is restricted.
- To reduce the risk of transportation of wastewater and chemicals during the wet season to ALARP, transportation will be undertaken in accordance with the following:
  - Risk assessment completed for all wet season transportation of chemicals and wastes prior to the commencement of the transport activity.
  - Transportation will not occur on tracks where the surface is not safe to allow transportation vehicles to drive upon.
  - Wastewater and chemical transportation will not be undertaken through flooded waterways.
  - The transportation of wastewater/ chemicals during rainfall events will be avoided.
  - Driving on unsealed roads and access tracks will be avoided 24 hours following a >20 mm rainfall event.
  - After a >20 mm rainfall event, or when the integrity of any unsealed road may be compromised due to prolonged rainfall, each unsealed access track proposed to be used for wastewater/ chemical transportation will be inspected to ensure the integrity of the road is sufficient to allow safe passage of the proposed transport vehicle.

- Chemicals will not be unloaded during rainfall events.
- Well pad is bunded, which will prevent all off-site release of chemicals and stormwater.
- All stormwater will be retained on-site via the sediment retention pond and tested prior to release.
- Overland flow will be diverted around well pads.
- Where wastewater is stored on-site, each site will either be manned or have remote monitoring within regional manning to respond to any emergencies.

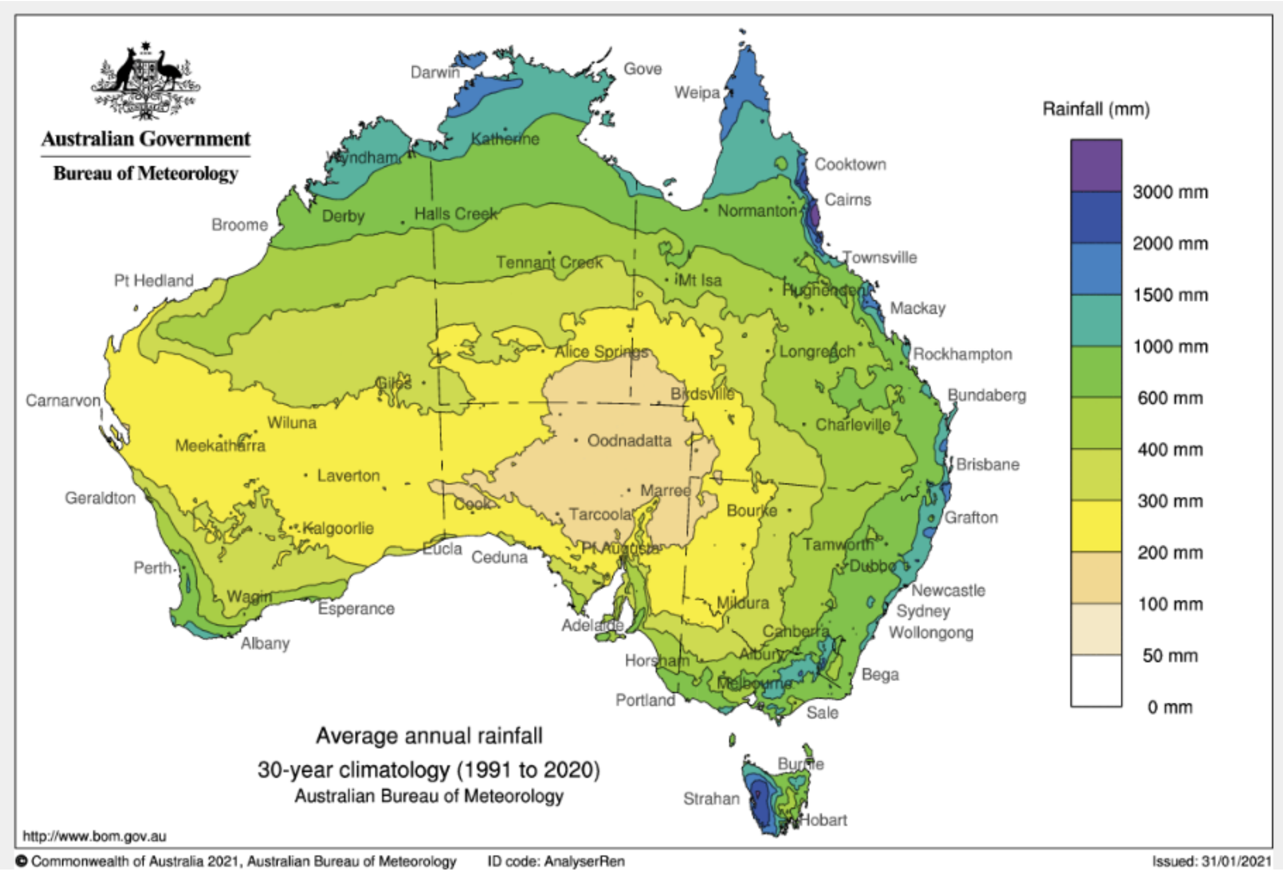


Figure 37: Rainfall averages for Daly Waters (source BOM, 2024)

3.21 Helicopter operations

If access to the site is prevented during operations, helicopters will be utilised to move people and supplies into and out of the site. Helicopter activities are an existing, approved activity at the sites. Helicopter activities ensures the site can be manned 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.

3.22 Waste management

Waste management methods for the proposed exploration program are summarised in Table 30. 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:

- **Avoid:** eliminate the generation of wastes through design modification
- **Reduce**: reduce unnecessary resource use or substitute a less resource intensive product or service
- **Re-use**: reuse a waste without further processing
- **Recycle**: recover resources from a waste
- **Treatment**: treat the waste to reduce the hazard of the waste prior to disposal
- **Disposal**: dispose of waste if there is no viable alternative
- Waste transfer certificates will be retained and provided to DEPWS upon completion of the project.
- Drilling, stimulation and well testing wastewater is managed in accordance with section 3.13.

Table 30: Waste and disposal methods

Activity	Disposal method
Sewage, grey and stormwater	**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 as per section 3.13.5 and either released off-site or re-used for dust suppression.
Food waste, paper and plastic	**Disposal:** Collected in dedicated waste bins for back-loading to an approved landfill.
Glass and cans	**Recycled:** Collected in separate waste bins for recycling at an off-site facility.
Chemical bags and cardboard packaging materials	**Recycled:** Compacted and collected at rig site for transport to a licenced recycling centre.
Scrap metals	**Recycled:** Collected in designated skip for recycling at an approved location.
Used chemical and fuel drums	**Recycled:** Collected in designated skip for recycling at an approved location.
Chemical wastes/ left over chemicals	**Re-use/disposal:** Re-used between programs where possible. Waste products to be collected in approved containers for disposal at approved landfill or returned to supplier or recycled.
Timber pallets (skids)	**Recycled:** Recycled at an approved facility
Vehicle tyres	**Disposal:** Disposed of at an approved landfill
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.

Activity	Disposal method
Condensate waste	**Recycled/disposal:** Condensate oil incidentally encountered during drilling/ flowback will be collected in self-bunded storage pods/tanks for disposal at approved landfill or recycled at an approved recycling facility.
Flowback	**Recycled, treatment and disposal:** Highly saline wastewater collected in a series of open and closed tanks. Where possible, flowback will be used as stimulation make up fluid to reduce raw water requirements. Where flowback cannot be recycled, it will be evaporated on-site using mechanical evaporators and then disposed of off-site at a licenced facility interstate. Flowback wastewater includes returned sand and shales during well clean up.
Exploration well drill cuttings, muds and fluids	**Treatment and disposal:** Saline fluids and solids stored within a lined sump. Fluids segregated from muds and cuttings. Solids dried out, with liquids evaporated. Solids tested and disposed of on-site or off-site depending on hazard. Fluids transported off-site to a licenced facility interstate.
Groundwater extraction bore drilling cutting and muds (cuttings mixed with drilling fluids)	**Disposal:** Freshwater cuttings and drilling muds with low hazard. Disposed of on-site in accordance with the *Minimum Construction Requirements for Waters Bores in Australia* for water bore drilling practices.
Ro Reject	**Disposal:** Captured in **bunded** poly tanks and periodically transferred to a wastewater tank.
Low point drain water	**Disposal:** Tested for compliance and either released to the ground within the right of way or captured and stored as wastewater in an enclosed tank
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. Stormwater will be tested and either released off-site or recovered and either recycled within the drilling process or disposed of at a licenced wastewater treatment facility in accordance with the *NT Waste Management and Pollution Control Act 1998*.

3.23 Camps

Camps at each site will be used for E&A activities. A main camp will be located regionally (at Kyalla 117 N2), with contingent provisions for the main camp to be located adjacent to each site if required, on-site will be designed to typically house 75 people. 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).

A drilling mini-camp will also be set-up on each of the exploration well pads during activities. The mini-camp will house up to eight people and will support the 24-hour drilling activities.

Each camp has its own sewage treatment plant and wastewater treatment plant. A notification of installation of wastewater management system outside a building control area will be submitted to the Department of Health after the installation of each system with a capacity above 2,000 L/day. Treated water is dispersed via drainage away from the camp to the designated irrigation area. The designated irrigation areas are located adjacent to the camp pad and exploration well pad. These areas are approximately 50 m x 50 m and are within the broader well site fence, which will exclude livestock access.

The existing camp infrastructure is temporary and portable and powered by diesel generators. The potable water supply for the camps may either be sourced from third party providers and stored onsite, or can be sourced from groundwater bores established for drilling activities and treated to the appropriate drinking water standards (2011 National Health and Medical Research Council Australian Drinking Water Guidelines). Should onsite supply of potable water be utilised, a temporary reverse osmosis (RO) water treatment plant will be used. The plant will produce approximately 10 KL of potable water per day. Approximately 2,000 L of RO reject is likely to be produced per day, which will have a total dissolved salt level of approximately 3,000mg/L. This water will be captured in a bunded poly tank and periodically transferred to a wastewater tank. The volume and destination of the water transferred will be tracked and the water managed in accordance with section 3.13. Once mixed, the RO reject will be considered drilling/ flowback wastewater dependent on the storage point.

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.

There is potential for pest species to be attracted to increased site activities causing an increased abundance in the landscape. Pest controls that shall be implemented include:

- Camp wastes to be storage to be animal proof.
- All food scraps to be removed from site and disposed of at a licenced facility.
- Food scraps to be frozen and stored within freezer during wet season.
- Targeted rodent control around the camp areas
- Water sources are reduced around camps through centralised mess halls.

All feral animal observations will be Tracked in the incident management system. Where ongoing feral animal presence is detected at Tamboran site, additional controls will be investigated in consultation with the pastoralist (such as fencing, removal of water sources etc.). However, experience from existing activities has not detected increased feral animal prevalence, with only 1 feral dog and cat identified in 6 months of camp operations.

For an estimate and breakdown of workforce numbers across activities refer section 3.1.1.

3.24 Noise

In alignment with Table 3.4 of the NT Noise Management Framework Guideline, a minimum night-time, adverse weather project intrusiveness noise level of 35 LAEQ, 15min dB[A] at a sensitive feature has been adopted.A 35 dB[A] sound level is considered quiet, to very quiet as outlined in Table 31.

Based upon field noise monitoring verification completed for various exploration activities undertaken in Queensland, impacts to environmental or community receptors are not expected to occur within the following buffers (assuming worst case night-time and adverse weather conditions)[34]:

- Construction activities 1.2 km
- Seismic operations (vibroseis) 0.75 km
- Drilling- 1.75 km
- Cementing- 2.6 km
- Stimulation- 3.5 km

Given there are no environmental or community receptors within 10 km of the site (refer section 3.3.3), noise impacts from Tamboran's exploration activities are not anticipated.

Table 31: Subjective evaluation of noise summary table (source SKM 2015 Monitoring of Rig Noise Levels Atlas 1)

Sound Pressure Level (dBA)	Typical Source	Subjective Evaluation
130	Threshold of pain	Intolerable
120	Heavy rock concert	Extremely noisy
110	Grinding on steel	
100	Loud car horn at 3 m	Very noisy
90	Construction site with pneumatic hammering	
80	Kerbside of busy street	Loud
70	Loud radio or television	
60	Department store	Moderate to quiet
50	General Office	
40	Inside private office	Quiet to very quiet
30	Inside bedroom	
20	Recording studio	Almost silent

3.25 Traffic

The periods of highest traffic generated from exploration and appraisal activities will generally occur over a short duration and are associated with the mobilisation and demobilisation of equipment. The peak maximum traffic flow increase associated with the activity is conservatively (high) estimated at approximately 44 vehicles per day during the demobilisation of drilling equipment from site.

To assess the potential impact on pastoralist and tourism amenity and experience, a Traffic Impact Assessment (TIA) is discussed below. This assessment includes heavy equipment mobilisation to and from site and is a suitable conservative scenario to assess the potential associated traffic impacts.

The TIA involved the following steps:

[34] Based on noise verification monitoring of the Atlas 1 rig, Ensign 964 rig, Ensign 966 rig, Nitschke Rig 1, Gel HFS completed on Ramyard 30H, Condor frack spread, Schlumberger cementing rig, Envirovibe Minibuggy, and gathering noise construction assessment.

- Identification of project traffic movements including approach and departure direction
- Existing traffic levels and road Level of Service
- Assessment of total traffic levels and potential impacts
- Determine required impact-mitigating treatments.
- The results of the TIA are discussed below.

3.25.1 Identification of project traffic movements

Access to the sites is via the Stuart Highway, approximately 23 km south of the town of Dunmarra. The Stuart Highway is a 130 km/hour posted speed limit in the vicinity of the project. The Stuart Highway will also be upgraded and sealed to DIPL specifications. A road corridor permit, and traffic controls will mitigate the risk to road users. Tamboran is currently in discussions with DIPL regarding the nature and timing of the upgrades to the existing access track turn-in.

The peak maximum traffic flow increase associated with the activity will be approximately 44 vehicles per day, during rig and heavy equipment mobilisation and demobilisation from site. Given the sites are near each other, most rig movements between wells are likely to be internal moves, which reduces offsite traffic movements along major roads.

Peak movements during drilling and stimulation are likely to be restricted to a two-week period during mobilisation and a two-week period during the final demobilisation. Average daily traffic additions during the operational phase (drilling, stimulation and well testing) of the period are likely to be 10 – 15 movements per day for the first three-six months, reducing to three-four movements for the remainder of the period. Daily transport volumes have largely been reduced using on-site/regional camps, with busses used to facilitate crew change overs.

3.25.2 Existing traffic levels, road capacity and level of service

Existing traffic figures were obtained from the DIPL Annual Traffic Report 2022 (DIPL 2022), showing Average Annual Daily Traffic (AADT) figures for the Stuart Highway 20 km north of Elliott. This location is approximately 60 km south of the turn-in to the Kyalla 117 access track, and it can be assumed that the traffic figures at the site will be similar.

The total daily traffic flows on the Stuart Highway from the 2022 annual survey data are estimated as 565. The total traffic flows are split relatively evenly between north and south bound traffic (Figure 38). Traffic rates during the dry season are likely to be substantially higher than the average figures, with peak dry season traffic observed to be up to 50% higher than the average volumes (GHD 2013). Therefore, a revised figure of 822 vehicles per day on the Stuart Highway is considered a representative worst-case traffic volume.

AUSTROADS guidelines (Austroads 2020) were used to determine the typical capacity that would be expected by traffic on the Stuart Highway to maintain a free-flow Level of Service (LOS). The capacity of roads is based on the maximum rate at which persons or vehicles can reasonably be expected to traverse a point or uniform section of lane or roadway during a given timeframe. The Level of Service relates to the operating conditions encountered by traffic as defined in the AUSTROADS guidelines (Austroads 2020). This data was then used to determine the capacity of the Stuart Highway to maintain a Category A (free flowing) LOS for the site. A conservative 700 – 1,000 vehicle/hr/lane figure was used to determine the vehicle movement capacity.

In an urban situation it can be assumed that the peak hour volumes will be about 10% of the daily traffic volumes. However, the remoteness of this site means that a peak hour is not realistic and has not been considered. Due to the low volumes that are likely to be spread over the duration of the day, this is considered appropriate.

Rural Coverage Count Stations | Year: 2022
Table: 4.1 AADT For Coverage Stations - 10 Year Period | Region: Tennant Creek

Road Name / Location	ADT Station	Direction	Units	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Carpentaria Highway	RTVDC033	Inbound	Veh		51		42		46		41		50
5km East of Tablelands Highway		Outbound	Veh		46		42		47		37		48
		Both	Veh		97		84		93		78		98
Nathan River Road	RTVDC034	Inbound	Veh		9		4		6		11		14
2km North of Ryans Bend Road		Outbound	Veh		7		5		6		9		18
		Both	Veh		16		9		12		20		32
Newcastle Waters Road	RTVDC037	Inbound	Veh	41		40		39		29		52	
2km West of Stuart Highway		Outbound	Veh	50		50		51		33		45	
		Both	Veh	91		90		90		62		97	
Old Bing Bong Road	RTVDC035	Inbound	Veh		73		59		67		38		75
5km North of Borroloola		Outbound	Veh		75		49		68		39		74
		Both	Veh		148		108		135		77		149
Ranken Road	RTVDC028	Inbound	Veh	1		1		2		3		1	
5km East of Brunette Downs		Outbound	Veh	2		2		3		1		1	
		Both	Veh	3		3		5		4		2	
Stuart Highway	RTVDC020	Inbound	Veh	225	222	229	223	280	262	233	174	284	292
20km North of Elliott		Outbound	Veh	205	213	213	222	271	247	227	167	263	273
		Both	Veh	430	435	442	445	551	509	460	341	547	565
Stuart Highway	RTVDC021	Inbound	Veh	197	206	183	198	185	225	235	152	151	216
15km South of Wauchope		Outbound	Veh	175	192	170	186	161	213	195	154	143	273
		Both	Veh	372	398	353	384	346	438	430	306	294	489
Stuart Highway	RTVDC022	Inbound	Veh	166	189	163	208	197	197	189	129	206	202
30km North of Barrow Creek		Outbound	Veh	165	188	142	191	171	184	150	133	211	175
		Both	Veh	331	377	305	399	368	381	339	262	417	377

Figure 38: Traffic flows on the Stuart Highway approximately 60 km south of the site access turn-in (DIPL, 2022)

3.25.3 Assessment of total traffic levels and reduction to road capacity and level of service

The total peak traffic volume for the project has been determined at 866 vehicles per day for the Stuart Highway. This consists of an additional peak project vehicle movement level of 44 vehicles per day in addition to the existing peak dry season traffic volumes of 822 vehicles per day.

The total volume of traffic is considerably lower than the capacity of the Stuart Highway, with any reduction in LOS from the volume of project traffic considered extremely unlikely.

Traffic LOS may also be impacted through changes in traffic compositions, with the volume of trucks affecting the road capacity greater than light vehicles. To assess the changes in traffic composition, vehicle category data obtained from the DIPL Annual Traffic Report 2022, were assessed against expected total project traffic figures. These figures were increased by 50% to represent peak dry season traffic volumes. The assessment is provided in Table 32.

Table 32: Traffic impact summary for the Stuart Highway – existing versus proposed additional (adapted from DIPL, 2022)

Vehicle category	Existing vehicles per day (vpd) and % (approx.)	Proposed additional vehicles per day (vpd)	Total vehicles per day (vpd) during activity and % (approx.)
Short (light vehicles)	404 vpd (49%)	12 vpd	416 vpd (48%)
Medium (heavy vehicles or short towing)	257 vpd (31%)	0 vpd	257 vpd (30%)
Long (heavy vehicles)	67 vpd (8%)	5 vpd	72 vpd (8%)
Medium combination (heavy vehicles)	23 vpd (3%)	0 vpd	23 vpd (3%)
Large combination (heavy vehicles)	71 vpd (9%)	27 vpd	98 vpd (11%)

The results above demonstrate that there are small changes in traffic composition associated with the project, with an additional 2% of large combination vehicles (the vehicle class considered the highest potential risk to local road users) when compared to the total volume composition. This percentage is unlikely to significantly impact upon the road's capacity and LOS.

3.25.4 Traffic risk management strategies

The management of risks of injury to staff, contractors and the community is a key focus of every Tamboran activity. To reduce the risks associated transport, all vehicle movements undertaken as a part of Tamboran activities must comply with the National Land Transport Directive. Mandatory controls include:

- Avoiding vehicle movements where possible (such as the use of buses and aircraft)
- Requirement for all vehicles to be fitted with an in-vehicle monitoring systems to monitor speed limits, seat belt usage, harsh breaking and acceleration, and fatigue
- Driving at night to be avoided
- Defensive driver training for all employees and contractors performing work
- Zero alcohol and drug policy – with all staff breath tested when on-site and random drug tests completed.
- Fatigue management policy – with mandatory breaks required for every 2 hours and maximum 10 hours in a single 24-hour period working hours (unless the driver of a fatigue regulated heavy vehicle, where the driver must then comply with the applicable law for fatigue management where the vehicle is operated).
- Chain of responsibility training for all logistics/supply chain roles to ensure they understand their obligations to ensure the safety of their transport activities under the Heavy Vehicle National Law
- Journey management plan requirements for all remote journeys, with all journeys lodged with the Tamboran Health Safety and Environment (HSE) team.
- Requirements to comply with the National Transport Code Load Restraint Guide.
- Contractor and employee driver performance tracking and reporting, with all breaches investigated, formally documented and disciplinary actions taken.

In addition to the above requirements, Tamboran has also implemented the following additional controls:

- Current use of the access track Stuart Highway intersection was previously approved by DIPL with traffic management in place where required. Ongoing engagement with DIPL is underway covering all future exploration activities and intersection upgrades. Tamboran also commits to obtaining approval under the Planning Scheme 2020, which is separate to the approval required under the Petroleum (Environment) Regulation 2016.
- Large loads to have their own journey management plan outlining proposed controls, including fatigue management, route selection, load constraint, speed restrictions, pilot requirements etc.
- Communication with pastoralists when heavy/multiple transports are likely to occur.
- Peak transport period to be restricted to the demobilisation of the rig, with most mobilisations occurring via internal access tracks.
- The use of camps reduces vehicle movements between the site and local communities.
- Other potential risks and controls associated with traffic are discussed further in section 6.

3.26 Cumulative impact summary

This section provides a summary of the cumulative impacts associated with the proposed activity in accordance with Section 3b of the Regulations. 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 33.

Table 33: Summary of cumulative impacts addressed within the EMP

Aspect	Summary	EMP section
Water	Groundwater extraction cumulative impacts assessed under the WEL GRF 10285. This includes water use for Tamboran's future exploration program, adjacent petroleum operators and surrounding users. No material impacts on surrounding users expected.	Section 3.12
Flora and fauna (land clearing	Estimated clearing associated with this EMP, including existing disturbance is ~145.26.ha. Impacts associated with the introduction of weeds are managed through the weed management plan. All other petroleum operators and pastoralists are required to have a weed management plan.	Section 3.3.2.1
Greenhouse gases	Cumulative emissions from all of Tamboran's FY 2024-2027 activities have been provided. Emission levels are mainly attributed to flaring.	Section 3.18.1
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 approximately 44 movements per day during demobilisation.	Section 3.25.3
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.	Appendix M

3.27 Monitoring

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

- monitor and detect changes in environmental values associated with Tamboran's activities
- characterise waste streams to understand the nature of the waste and determine the disposal requirements
- characterise the quality of the produced hydrocarbons

- report on rehabilitation progress.

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

3.27.1 Groundwater monitoring

Baseline monitoring data will be collected from the control monitoring bores in accordance with condition B.4.17.2(b) of the Code. Baseline groundwater monitoring results will be collected from each new control bore as soon as drilled and quarterly until the commencement of drilling. Groundwater monitoring of impact bores will commence upon drilling of the bore (prior to stimulation).During stimulation, level loggers will be installed in the bores at least 1 month before and after. Upon Completion of stimulation, monitoring of the control and impact bores will continue for a period of 3 years.

For the 2024 drilling program, baseline has been achieved for the proposed Shenandoah S-2H well proposed for the Kyalla 117 N2 site. For the proposed Shenandoah S2-1H and 2H wells, delays outside of Tamboran's control have impacted approval timing by approximately 6 months, primarily associated with technical availability of field scouts and consultants in preparation of the required approvals. Additional time was also allowed to accommodate ongoing stakeholder engagement to ensure stakeholders had sufficient time to understand the content of the EMP prior to submission. Subject to the timing of the proposed drilling of Shenandoah S2-1H and 2H wells, these delays may result in Tamboran not being able to achieve the 6 months of baseline groundwater monitoring prior to drilling. Given the circumstances were outside of Tamboran's control, Tamboran has complied with Section B.4.17.2 of the code and will ensure monitoring bores are constructed prior to drilling and 6 Months of baseline data will be obtained prior to stimulation.

A summary of the groundwater monitoring program is included in Table 33.

Monitoring data 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 34: Monitoring program summary

Monitoring program	Purpose	Monitoring points	Parameters	Frequency	Investigation thresholds	Reference document
Flowback monitoring	Characterise flowback quality Field chemistry	Post separator before entering flowback tank	Field Chemistry: pH, Dissolved Oxygen, temperature and electrical conductivity Analytical suite: C.8 of the Code of Practice.	Field Chemistry: /continuous (at least one sample every 24 hours). Analytical Suite: Weekly until the EC level stabilises (<10% change over 2 weeks) and then monthly until practical completion of flowback activities.	N/A	Code C.5.4
	Characterise stimulation fluid – laboratory analysis	Exploration well pre-injection	Field Chemistry: pH, Dissolved Oxygen, temperature and electrical conductivity Analytical suite: Appendix J including NORMS	Each fluid system used during injection (one of each in total)	N/A	Code C.5.4 and C.5.3
	Flowback storage characterisation	Each wastewater tank	C.8 of the Code of Practice.	6 monthly	N/A	Code C.5.4 (C)
	Source water characterisation	Source water utilised for fracture stimulation	C.8 of the Code of Practice.	Prior to stimulation	N/A	B.4.13.2(c)
Drill cuttings, fluid and muds characterisation	Characterise the quality of drill cuttings, fluids and muds to	Drilling sump – as determined by a suitably qualified third-party	Table 9 of the Code (NORMs), Particle size distribution, bulk density	Prior to disposal	N/A	Code C.5.2

Monitoring program	Purpose	Monitoring points	Parameters	Frequency	Investigation thresholds	Reference document
	determine disposal options	Drilling sump/liner	Visual	Daily during wet season Weekly at other times		
Hydrotesting	Monitor	Release point of fluid proposed to be released from test-includes gathering lines and wastewater tanks	Electrical conductivity and pH	Each activity	EC- 1600 µs/cm pH 6.5-9.0	N/A
Gas composition and isotopes	Characterise produced gas	Post-separator	Gas composition (nitrogen, oxygen, carbon dioxide, C1-C10+, H_2S) Isotopes (C^{13} (CO_2 and CH_4) and H^2 (CH_4, C_2H_6 +). Radon and radioactivity.	Monthly – internal characterisation program	N/A	N/A
Soil monitoring	Monitor impact to surrounding soils	Well pad	Visual inspection: ● chemical storage ● flowback / wastewater storage	Weekly	N/A	N/A
Wastewater tank liner integrity	Identify potential leaks in wastewater tank liners	Wastewater tank interstitial space	Leak detection alarm initiation	Ad hoc	Upon alarm	Code A .3.8

Monitoring program	Purpose	Monitoring points	Parameters	Frequency	Investigation thresholds	Reference document
Groundwater monitoring	Detect changes in groundwater resulting from drilling and stimulation activities	Newly constructed impact and monitoring bores at Shenandoah S2, Shenandoah S B and Shenandoah SC. Groundwater monitoring bores at Kyalla 117 N2: • RN040896 Anthony Lagoon Bed CMB. • RN041132 Gum Ridge Formation CMB. • RN041136 Gum Ridge Formation IMB. • RN041137 Anthony Lagoon Beds IMB. • Any proposed bores to be constructed to support the	Level and EC	Quarterly measurements with real-time (continuous) level and electrical conductivity logging before, during and 1 month after stimulation	+/-1 m water level change observed at the impact monitoring bore EC >200 µs/cm change or within 1 standard deviation of arithmetic mean[35]	Code B.4.17
			Temperature, electrical conductivity, pH	Quarterly commencing 6 months prior (baseline) and three-monthly after stimulation and then annually for 3 years	EC >200 µs/cm change pH >1 unit change or Within 1 standard deviation of arithmetic mean[35]	

[35] 1 Standard deviation from the arithmetic mean applies where greater than 2 years of data has been collected from a site specific bore. Before this point, it is likely that natural variability will reduce the effectiveness of the standard deviation until an appropriate sample size can be collected.

Monitoring program	Purpose	Monitoring points	Parameters	Frequency	Investigation thresholds	Reference document
		additional A&E wells.	Water monitoring suites (Appendix J)	Quarterly commencing 6 months prior (baseline) and three-monthly after stimulation	BTEX and Dissolved Methane - outside of the baseline, control bore and 1 standard deviation[36]	
	Pastoralist bore monitoring	Pastoralist bores within 10 km of an exploration well	Level	Baseline collected 3 months prior to stimulation and 12 months after stimulation	1 m sustained water level decline against baseline	N/A
			Temperature, electrical conductivity, pH	Baseline collected 3 months prior to stimulation and 12 months after stimulation	+/- 20% compared to pre-stimulation reading	N/A
			Water monitoring suites (Appendix J)	Baseline collected 3 months prior to stimulation and 12 months after stimulation	BTEX and dissolved methane – outside of baseline interquartile range	N/A

[36] 1 Standard deviation from the arithmetic mean applies where greater than 2 years of data has been collected from a site specific bore. Before this point, it is likely that natural variability will reduce the effectiveness of the standard deviation until an appropriate sample size can be collected.

Monitoring program	Purpose	Monitoring points	Parameters	Frequency	Investigation thresholds	Reference document
Groundwater take	Groundwater volume	Each groundwater extraction bore	Litres	Continuous flow meter	250ML/year [37]	NT Water Act
Gathering line inspections	Detect water leaks from gathering lines	Each gathering line section	Visual observations for: 1. *Subsidence and erosion along the gathering line* 2. *Leaks from vents, drain and valve pits* 3. *Unusual wet patches, salt scalding or stressed/dead vegetation along the pipeline*	Monthly for buried gathering lines (when in operation); weekly for above ground lines (when in operation)	Visual evidence that suggests a leak may be present.	Code Cl D.5.2.2(a)
Low point drain	Confirm water is suitable for release	Each Low point drain on the gas gathering line where water condensation has accumulated	Field EC, pH and volume	Prior to each release	• pH 5.2-9 • EC 1300 µs/cm	N/A
Stormwater	Manage stormwater collected during activities	Sediment basin release point	Field EC and pH	Prior to release and at least every 12 hours during continuous discharges	Off-site release and dust suppression limits: • pH 6-9 • EC 1300 µs/cm	N/A

[37] This volume is set at 250 ML/site assuming Tamboran's groundwater extraction permit be amended to increase groundwater take per annum to 450ML.

Monitoring program	Purpose	Monitoring points	Parameters	Frequency	Investigation thresholds	Reference document
Erosion and sediment control	To detect the presence of erosion and sedimentation from infrastructure	Inspection of all disturbed areas, including well 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	Erosion and Sediment Control Plan (ESCP)
Fauna - routine inspections	Collect data on fauna interactions with wastewater	Wastewater tanks and sump inspections	Inspection records	Weekly checks of all open tanks area immediately surrounding well pad for fauna deaths.	>4 per month or >1 threatened fauna species	Field Guide to NT Fauna
Weeds	Identify weeds potentially introduced or spread by Tamboran's activities	Inspection of all disturbed areas, including well pads, access tracks, gravel pits, laydown yards, camp pads, seismic lines etc.	Visual inspection	Visual inspections post-wet season	Positive confirmation of the detection of a weed of national significance species within Tamboran's disturbance footprint An increase in existing weed density and spatial extent	Weed Management Plan (WMP)

Monitoring program	Purpose	Monitoring points	Parameters	Frequency	Investigation thresholds	Reference document
Methane emission monitoring program	To identify and remediate gas leaks	Each exploration well and gathering line (including vents, valves and drains)	Methane (PPM)	6 monthly	>500 PPM	Methane Emission Management Plan (MEMP)
	To monitor combustion efficiency	Flare	Gas volume	Daily	N/A	
Seismicity monitoring	To identify induced seismic events caused by hydraulic fracturing	Seismometers installed adjacent to selected well sites	Ground motion	2 months before and 2 months after	Seismic event	Section 3.17
Rehabilitation of seismic lines	Monitor disturbed seismic lines	Inspect disturbed seismic lines	Visual inspection of: • Revegetation	Daily during seismic activity and reinstatement	Visual evidence of revegetation	Rehabilitation Management Plan (RMP) (Appendix O)
Post rehabilitation	Monitor ongoing rehabilitation success	Inspection of all rehabilitated areas, including well pads, seismic lines, access tracks, gravel pits and camp pads	Visual inspections of: • Canopy cover % • Ground cover % • Species diversity • Erosion	Annually	Decline in rehabilitation criteria value compared to previous year results	Section 7.7 and Rehabilitation Management Plan (RMP) (Appendix O)

3.27.2 Water sampling methodology

Water samples will be collected in accordance with Table 35. All samples will be collected by appropriately qualified personnel, with all meters calibrated in accordance with the manufacturer's instructions before use. Samples will be collected in laboratory-supplied sampling containers and placed in chilled eskies and transported under chain of custody 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 is cross-referenced to the monitoring location and time of sampling. 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 35: 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 monitoring	• 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
Groundwater monitoring	• AS/NZ5667.11: 1998. Water Quality Sampling Part 11: Guidance on Sampling of Groundwaters • 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 • Tamboran groundwater purging and sampling procedure • Geoscience Australia 2009: Groundwater Sampling and Analysis

3.27.3 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 39.

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 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 8.6.

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.

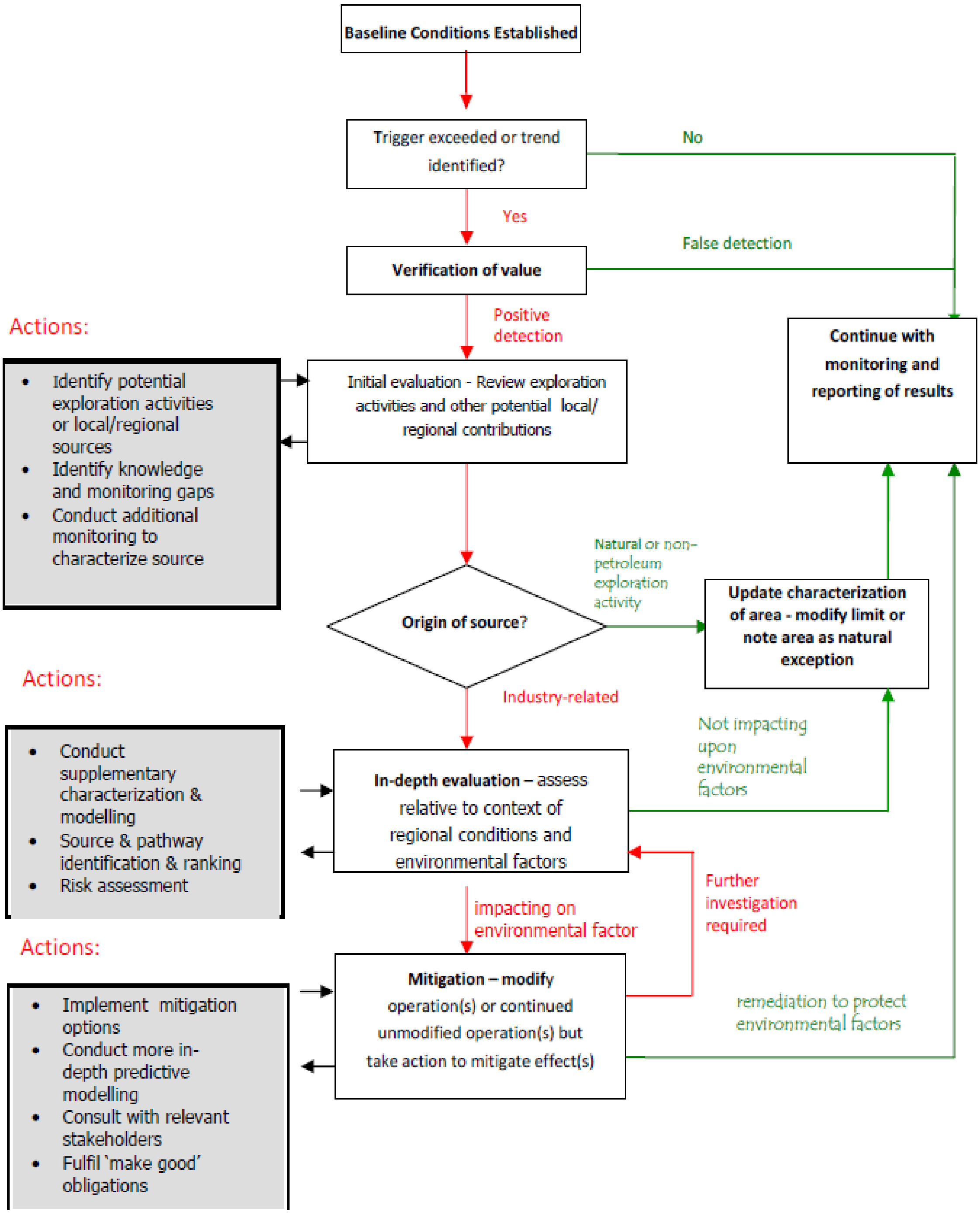


Figure 39: Investigation and response process

4 Description of the existing environment

The full description of the biological environment of the Shenandoah South E&A program is provided in the land condition report completed by AECOM (2023) in Appendix K. Broader information on the existing environment, including the seismic program, are provided in the following sections with an overview of the Shenandoah South E&A program survey sites shown in Figure 40.

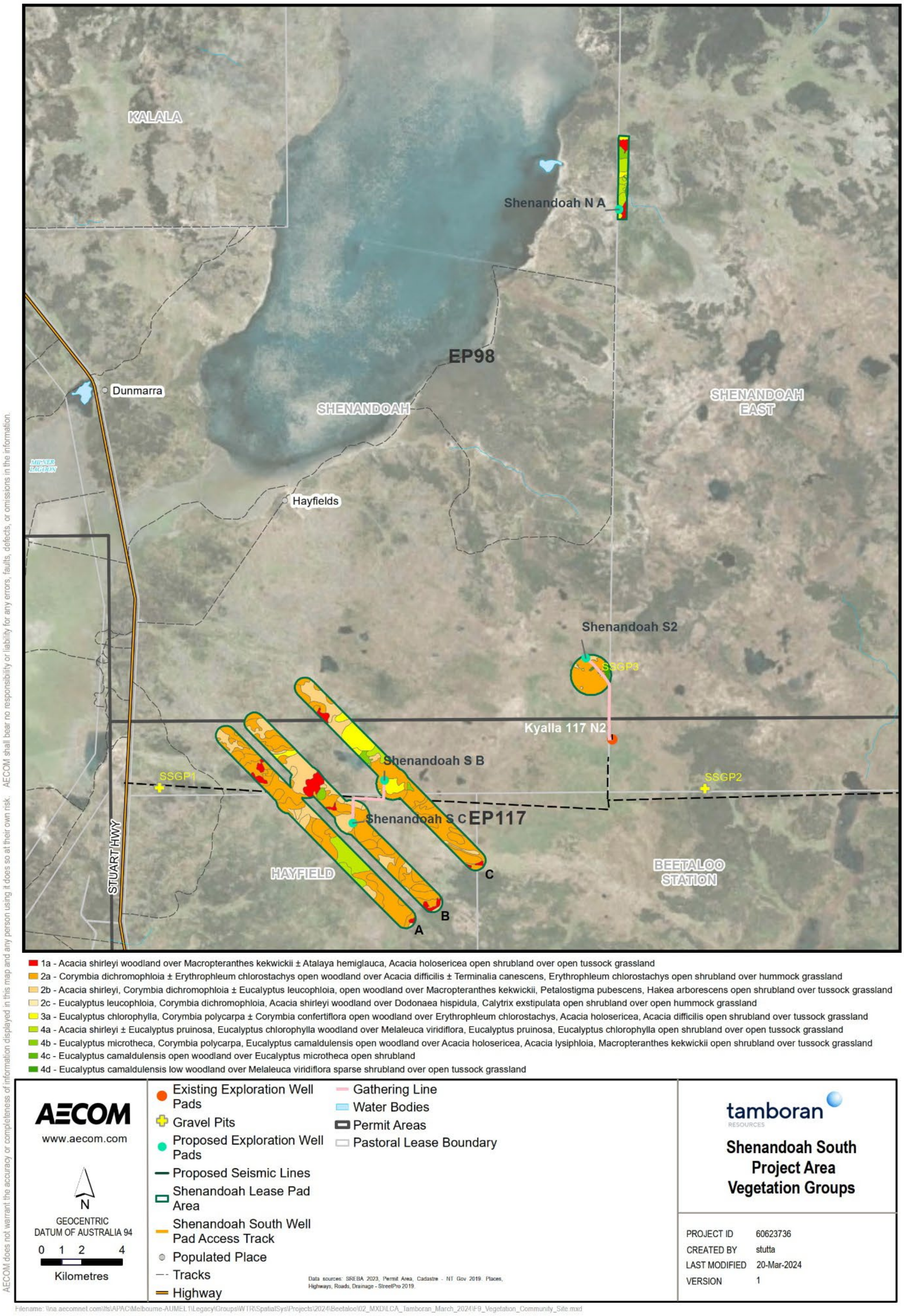


Figure 40: Shenandoah South survey sites

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 April, and a dry winter season between May and September, with September and April being transitional months with occasional rainfall.

Mean annual rainfall in the north of the Beetaloo exploration area is recorded at 678 mm at Daly Waters (SREBA, 2022). The southern portion of the permit areas records an average annual rainfall of 536 mm at Newcastle Waters and 602 mm at Elliott. Approximately 90% of the rainfall occurs during the wet season from November to April but primarily in December to March (SREBA, 2022).

The area is characterised by an average net precipitation deficit of -2,150 mm per year based on evaporation and rainfall data for Daly Water and Elliott (BOM, 2017a; Fulton and Knapton, 2015).

4.1.2 1:1,000 wet season annual re-occurrence interval calculations

Monthly rainfall totals were analysed from the Scientific Information for Land Owners data 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) 3 months 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 1,000 year, 3-month duration wet season (Figure 41) and 3-month dry season (Figure 42). This method is consistent with the Australian Rainfall & Runoff methodologies. The median 1 in 1,000-year 3-month wet season is 1,289 mm and 3-month dry season is 300 mm. These figures do not include any evaporation and are therefore considered extremely conservative.

Based on the assessment, a 1,300 mm wet season and 300 mm dry season freeboard will be applied to all open sumps and tanks.

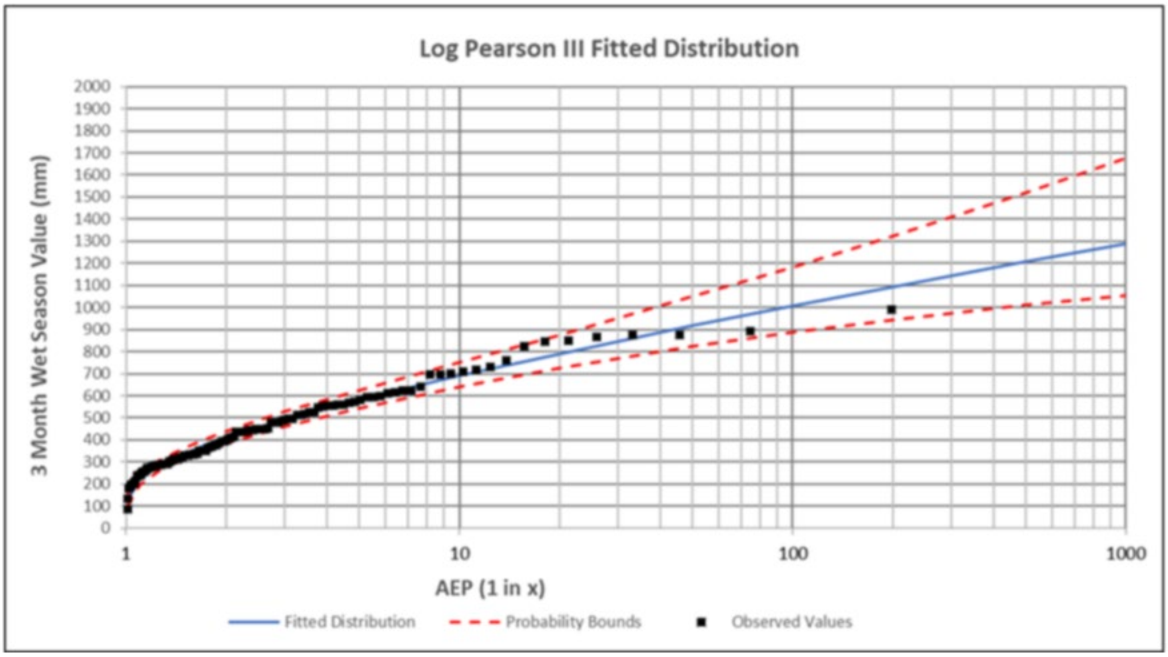


Figure 41: Log Pearson determination of 1:1000 wet season ARI

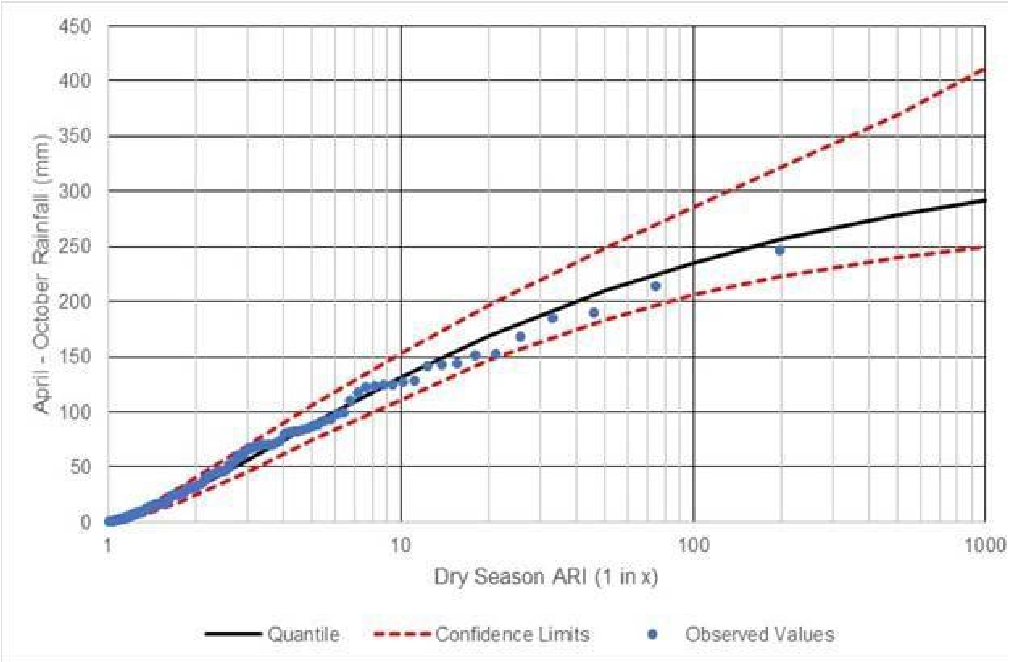


Figure 42: Log Pearson determination of 1:1000 dry season ARI

4.1.3 Geology

The geology of the Beetaloo Sub-basin continues to undergo stratigraphic refinement and characterisation, as new data sets become available. This section largely draws on the Technical Appendix for the Geological and Bioregional Assessment Program; a collaborative study between the CSIRO, Geoscience Australia, BOM and the Department of the Environment and Energy, reported in Orr *et al.,* (2020).

The Beetaloo Sub-basin comprises a thick sequence of mudstone and sandstone formations (Roper Group) that were deposited during the Mesopreterozoic era,[38] approximately 1,500 – 1,300 million years ago (Ma) (Orr *et al.*, 2020). The highly prospective source shales of the Kyalla and middle Velkerri formations, lie within the Roper Group, which is estimated to reach more than 5,000 m in thickness in the centre of the Sub-basin and estimated to be thinner outside the formally defined Beetaloo Sub-basin (Orr *et al.,* 2020).

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 CLA, a significant water supply aquifer (Orr *et al.,* 2020).

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. The shale and sandstone layers of the Beetaloo Sub-basin - specifically the Kyalla Formation and Velkerri Formation — hosts the gas plays that are the target for petroleum exploration activities in the area (SREBA, 2022).

The proposed wells will be completed in the Velkerri formation. Organic richness within the Velkerri formation is generally confined to three to four main shale intervals, the A, A-B, B and C shales. The proposed E&A wells will likely be located in the Velkerri B Shale (as per the Amungee NW-1H well), although other shales (A, A-B or C) may be targeted in the future.

The Velkerri Formation Amungee Member is overlain with thick series of low permeability units (mudstone, siltstones, tight sandstone and Volcanic units) which include the Velkerri Formation Wyworrie Member, Kyalla Formation, Shenandoah-East Formation, and Antrim Plateau Volcanics (Fulton & Knapton, 2015). These formations provide thick and multilayered effective geological barriers, with the Gum Ridge

[38] A geologic era that occurred from 1,600 to 1,000 million years ago. Known as the first era of Earth's geologic history.

Formation separated from the target formations by >1500 m. The effectiveness of geological barriers to fracture height growth will be assessed prior to stimulation with geomechanical data from core analysis, wireline log data and modelling.

4.1.4 Soils

The Sturt 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; SREBA, 2022).

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, through to cracking clays in the south-east (AECOM, 2023; Appendix K).

The lateritic plains, located with the permit area, are classed as very strongly leached soils of the Tertiary land surface. The three main soil types located within the permit area (AECOM, 2023; Appendix K), 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 36 and Table 37 present the erosion risk rating based on average monthly rainfall for Daly Waters and Newcastle Waters, using the rating system provided in the International Erosion Control Association (2008) Table 4.4.2. Erosion mitigations, include the installation of a stormwater basin on all well pads during construction activities; and limited clearing or major civil construction activities (Section 3.6) planned to occur during periods of high rainfall (e.g. December – March). Based on the implementation of these mitigations, which predominantly coincide with dry season activities, the overall risk of erosion is considered very low.

Table 36: 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 37: 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)												

4.1.5 Seismicity

Large earthquakes are relatively rare in Australia with an earthquake exceeding magnitude 7 on the Richter scale occurring somewhere in Australia every 100 years (SRC 2017).

The distribution of earthquakes between 1901 – 2011, of ≥ 3 magnitude largely occur north-west, south-west and south-east (in the Simpson Desert) of Alice Springs; and predominantly in, or to the west of Tennant Creek (McCue 2013). On 22 January 1988, several earthquakes with a magnitude of 6.2-6.4 occurred in a 12-hour period in Tennant Creek, resulting in thousands of aftershocks. By 2013, while the rate of aftershocks has decreased, it had not returned to its pre-1987 level (McCue 2013).

As shown in Figure 43, the earthquakes are comparably rare in the Beetaloo and in the vicinity of the regulated activities, aside from those areas around Tennant Creek and west of Alice Springs. In the Beetaloo, there have been no earthquakes over magnitude 3 measured since records began. The area is not prone to seismic activity and there is no evidence of recent earthquake activity as most faults and the major subsurface structure are confined to Cambrian or older strata.

The issue of induced seismicity from HFS activities has gained increasing exposure due to some high magnitude events in Oklahoma. However, the United States Geological Survey has stated very clearly that HFS is not causing most of the induced earthquakes and has pointed out that wastewater disposal via reinjection is the primary cause of recent earthquakes in the Central USA (USGS 2017b). Davies *et al.* (2013) illustrates that induced seismicity directly attributed to HFS operations is of such low occurrence that the documented cases are statistical anomalies rather than commonly occurring phenomena.

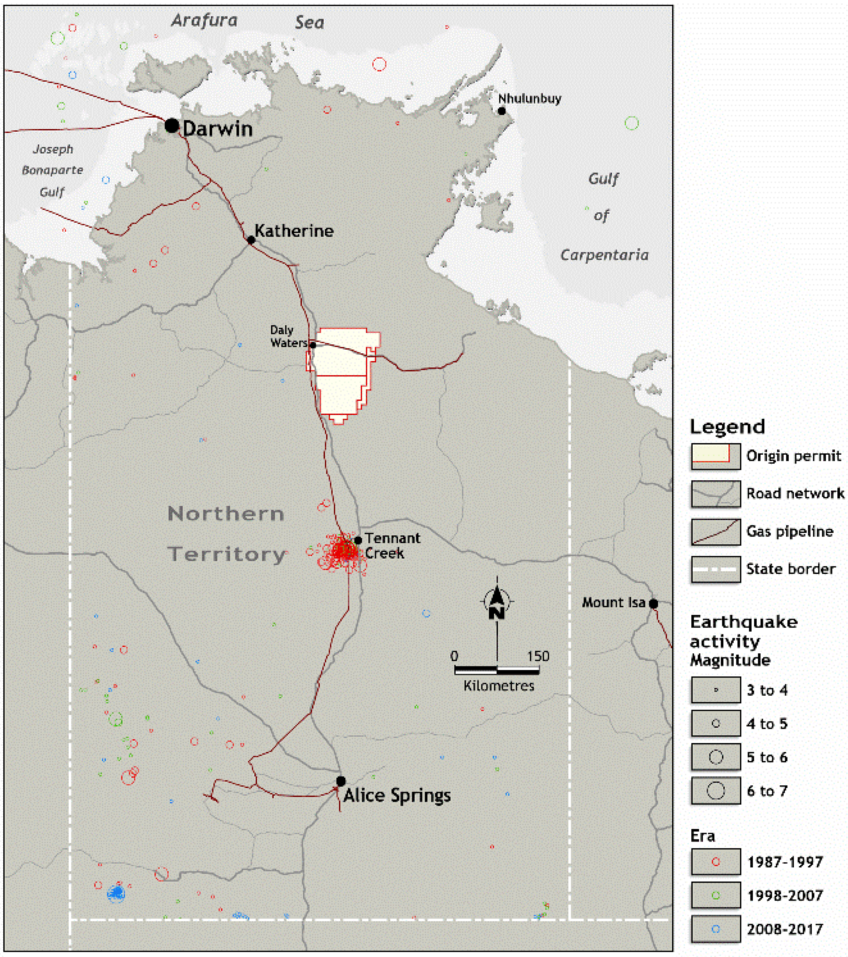


Figure 43: Earthquakes greater than magnitude 3 from 1987 to 2017 across the NT showing an absence of seismic activity in the Beetaloo area (adapted from McCue, 2013)

4.1.6 Hydrology

The Shenandoah South sites fall within the Georgina Basin Water Management Area (DEPWS, 2022). The Georgina Basin Water Management Area covers the southern half of EP 98 (south of the Carpentaria Highway), the majority of EP 76 and a large portion of EP 117; it is internally drained by Newcastle Creek and several small ephemeral creeks (Figure 44). Newcastle Creek ultimately flows into Lake Woods, which is located south of the Newcastle Waters Station. Lake Woods covers an area of inundation of approximately 50,000 ha (500 km^2) in normal rainfall years, extending to 80,000 ha (800 km^2) 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). Some semi-permanent and many ephemeral waterholes are located across the permit area (HLA, 2006b).

There are no creeks intersecting proposed sites within the Shenandoah South E&A Program. However, there are some occurrences of palustrine (non-riverine or non-channel systems) and floodplain systems, with shallow depressions, to the north of the Shenandoah S B well pad (Figure 45) and a stream order 1, intermittent stream, that is located over 450 m east of the Shenandoah N A site (Figure 46).

These surface water systems will require management actions that aim to avoid activity in a waterway as to not materially change the shape of the water way, the volume, speed or direction or a cause change to the bed or bank stability. Where avoidance is not achievable Tamboran will seek a permit to Interfere with a Waterway under the NT Water Act 1992.

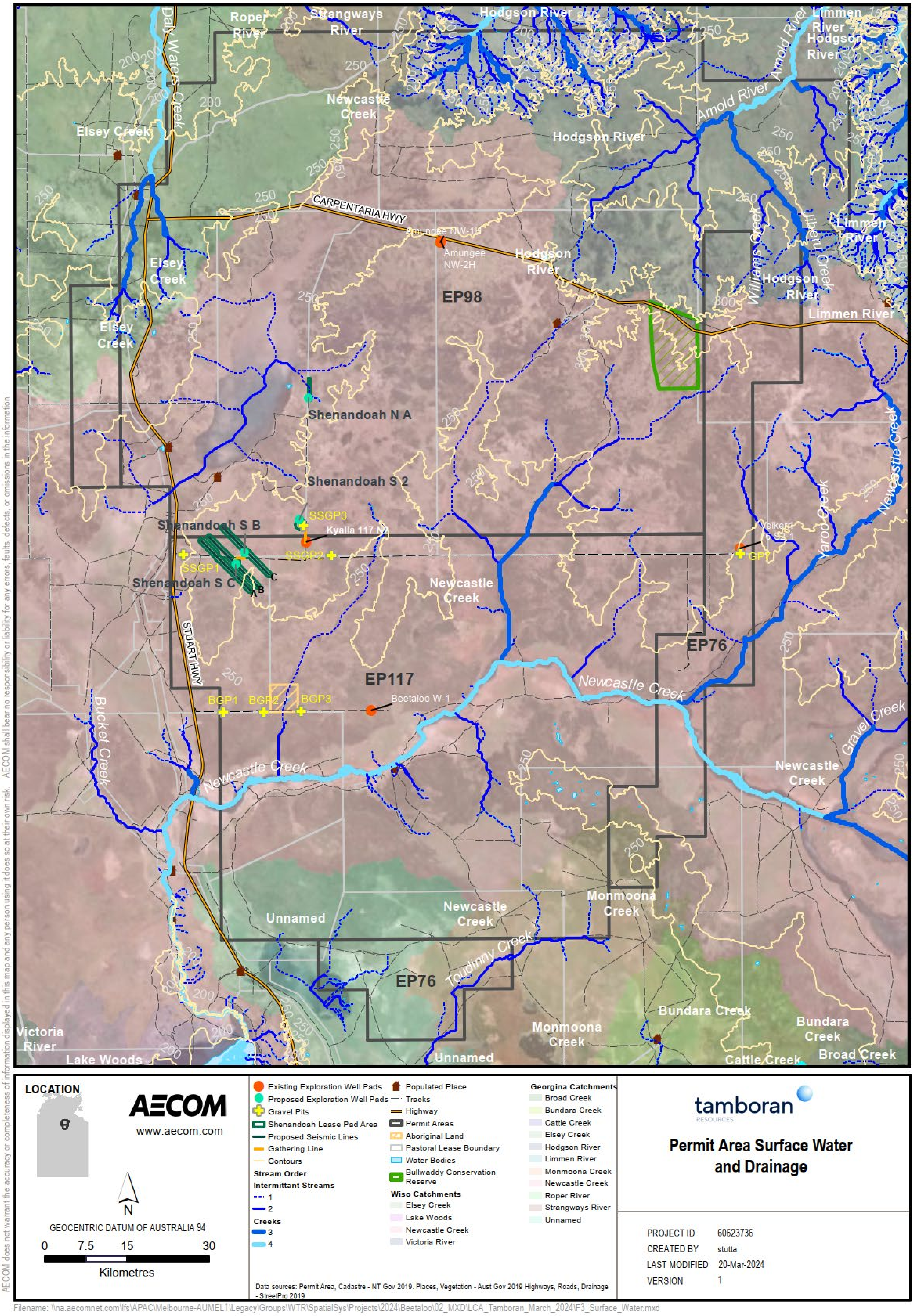


Figure 44: Surface water and drainage of the Shenandoah South E&A program

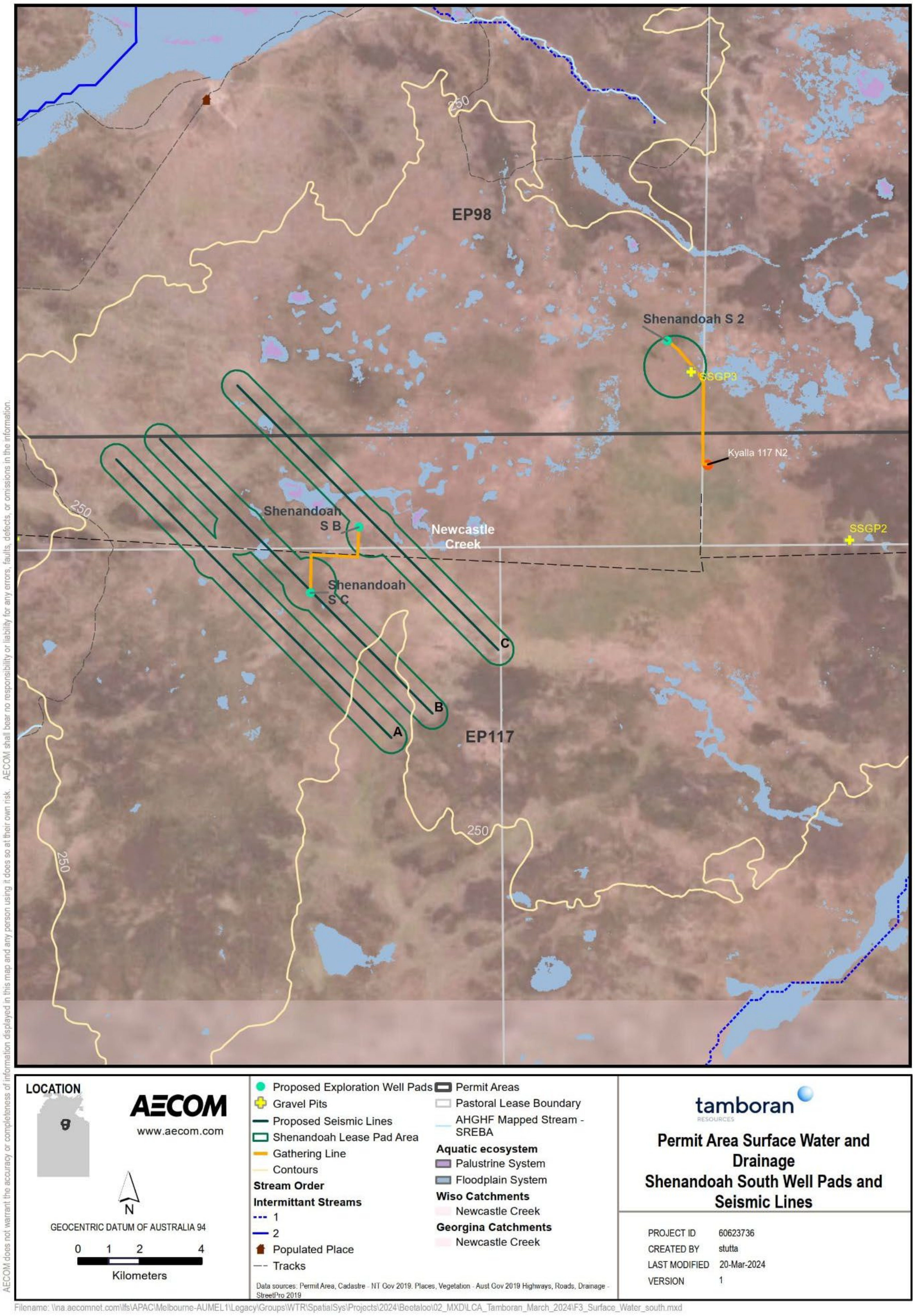


Figure 45: Surface water and drainage catchment of Shenandoah South well pads and seismic lines

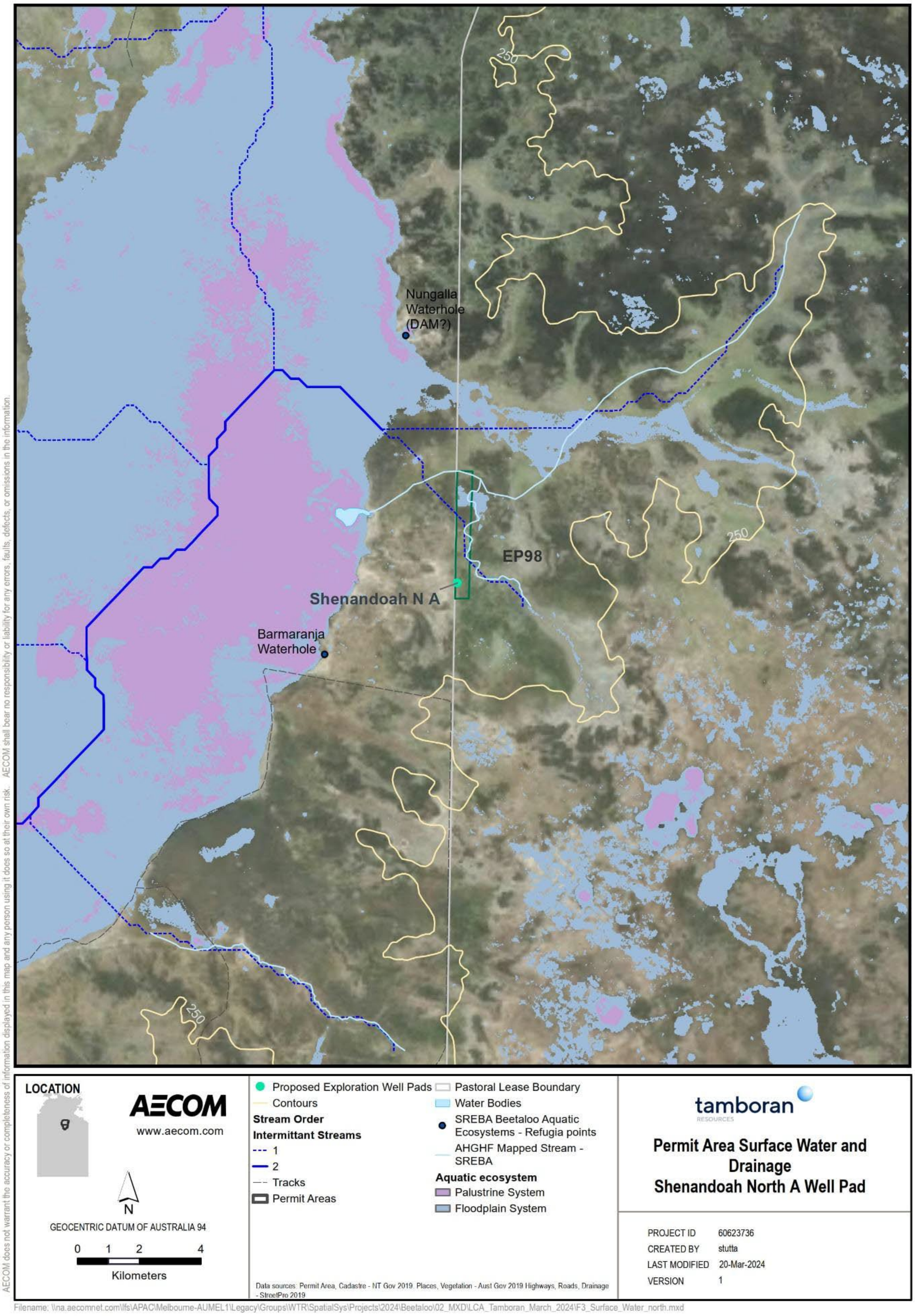


Figure 46: Surface water and drainage of the Shenandoah N A well pad

During the wet season, it is likely the broader region could experience widespread periodic surface flooding, to a depth of 300 mm, which has previously been identified by debris being collected along the pastoral fence lines (HLA, 2005; AECOM, 2021). The flood risk assessment presented in Section 4.1.7 identifies the risk from flooding at the well pads in the local catchment is low with maximum water depths ranging from 0 to 200 mm. All sites will be elevated above ground level, fully bunded with flood diversion works undertaken to prevent inundation.

4.1.7 Flood risk assessment

The extent of inundation within the permit area depends on the severity of the wet season and can range from remaining completely dry to widespread flooding during the wet season. As a part of the Land Condition Assessment (Appendix K), AECOM assessed the 1% Annual Exceedance Probability (AEP) flood depths and levels to determine the risk of flood inundation during the 100-year flood event from a local or regional flooding for each of the Shenandoah South exploration well sites (Table 38).

Table 38: 1% AEP Results for each new well pad

Well pad	SRTM ground elevation (m AHD)[1]	Maximum water depth (m)	Flood level at nearest channel (m AHD)
Shenandoah S2	267.5	-	267.3
Shenandoah S B	258.8	-	254.6
Shenandoah S C	263.4	-	262.4
Shenandoah N A	240.5	-	238.0
Kyalla 117 N2 (previously assessed)	272.3	-	272.5
[1] AHD – Australian Height Datum			

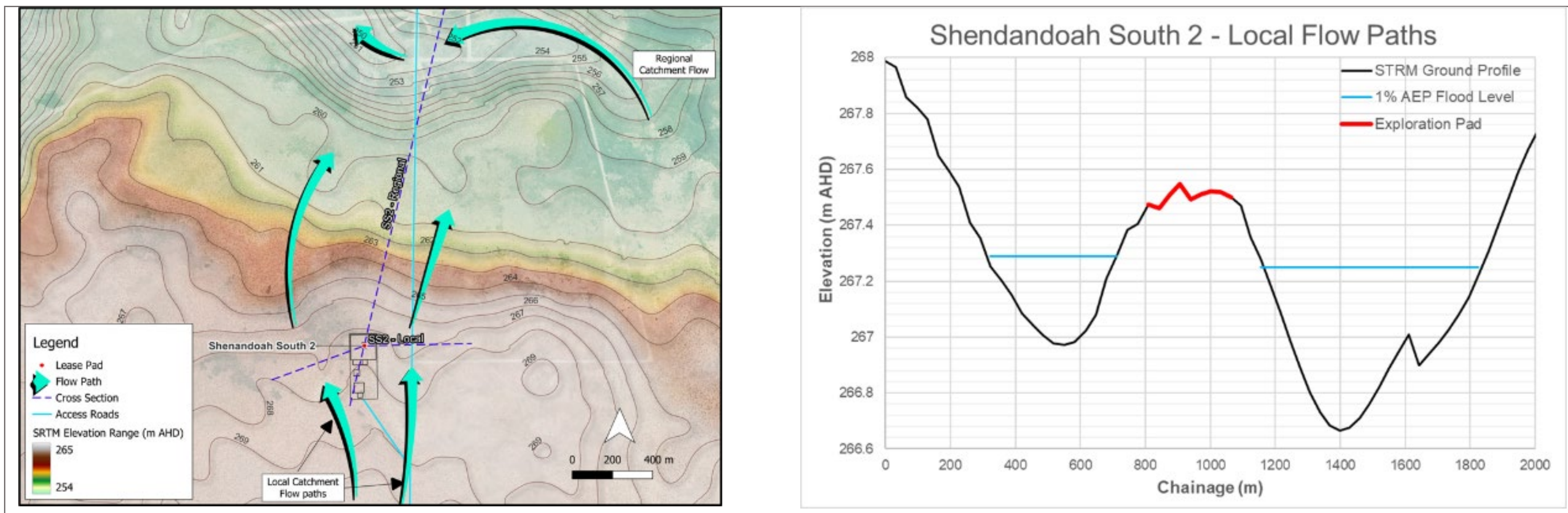
The greatest risk of flooding to the new exploration well sites is from local catchment sheet-flow (rainfall immediately over the area draining to the site). The site bund is typically ~0.5 m in height, meaning all sites should be protected from widespread inundation. The local catchment runoff from major storm events will be the considering factor for the establishment of well pad finish levels and the well pad designs will take this into consideration for the final placement in the landscape. It should be noted that given the lack of topography within the Sturt Plateau, that high velocity flood waters outside regional and local flow paths are considered unlikely. Anecdotal evidence confirms that flooding is generally slow moving standing water which represents a lower risk of impacting site stability or the integrity of infrastructure.

The hydraulic assessment of the well pads indicates the following:

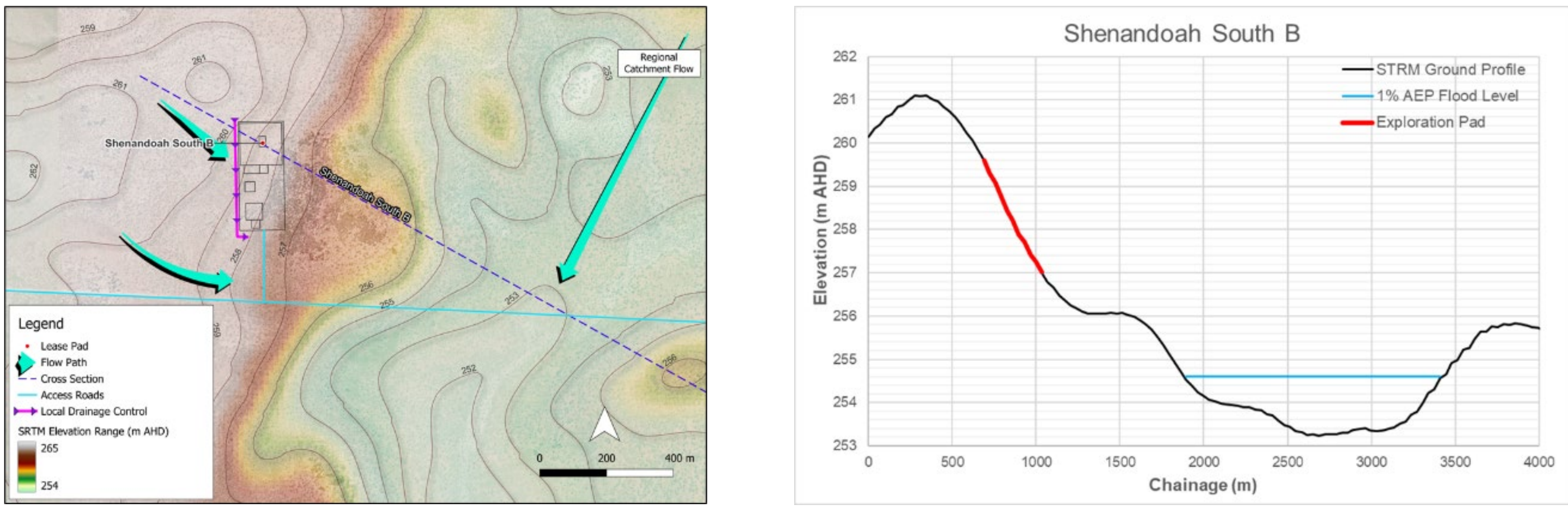
- Shenandoah S2 (Figure 47a): The risk from inundation in the 1% AEP from a regional and local catchment flood event is low. The position of the well pad on a ridge between two local flow paths reduces the risk of inundation from regional catchment flows.
- Shenandoah S B (Figure 47b): The risk from inundation in the 1% AEP from a regional catchment flood event is low. The low flood risk from regional flooding is associated with the position of the pad on the side of a flat hill above the nearest watercourse channel. The position of the well pad on the side of a hill means that diversion drains along the western perimeter of the site is required to direct local catchment flows around the site. The local catchment flooding is anticipated to be from low velocity sheet flows from runoff.
- Shenandoah S C (Figure 47c): The well pad is currently positioned on a ridge and demonstrates a low risk of inundation in the 1% AEP flood event from local and regional catchment flooding. The position of the well pad also means that diversion drainage works around the perimeter of the well

pad are not required. Potential access via the ridgeline will minimise drainage works along the access track.

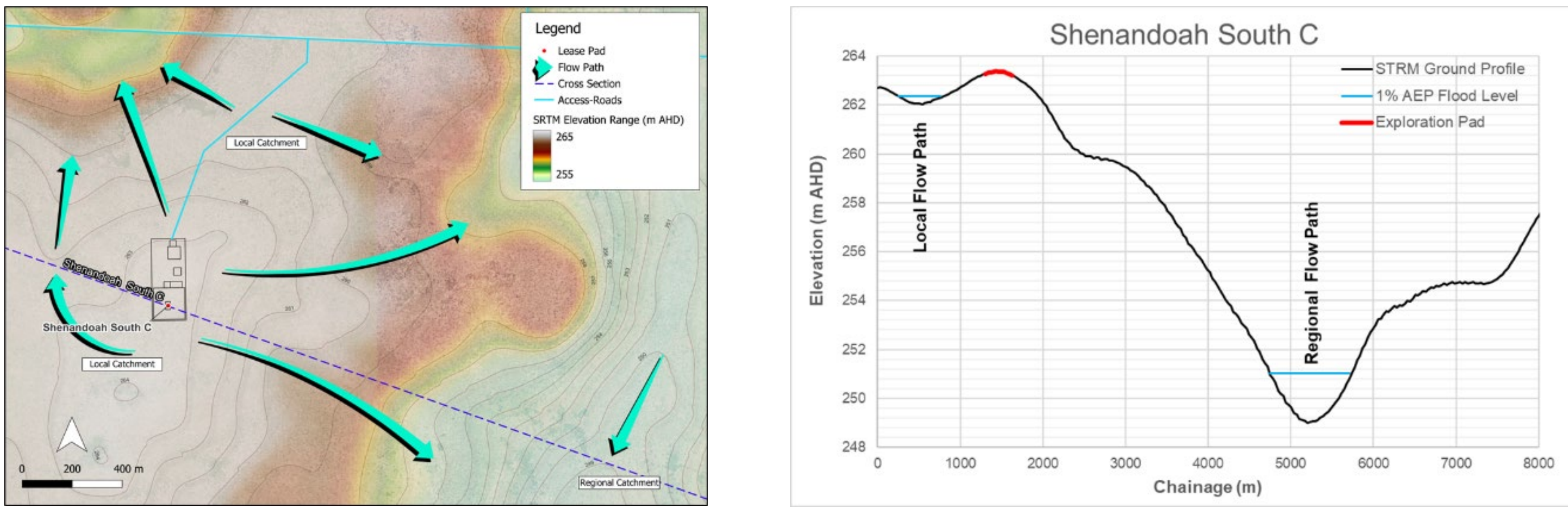
- Shenandoah N A (Figure 47d): The elevated position of the well pad relative to the nearest watercourse means that there is a low risk of inundation from a regional catchment 1% AEP flood event. However, the well pad is subject to potential inundation from local catchment runoff driven by the smaller catchment to the site. This can be managed through well pad level to be at least 200 mm above natural ground levels and erosion and sediment control measures to manage flows around the site and capture any sediment before it enters nearby drainage channels.



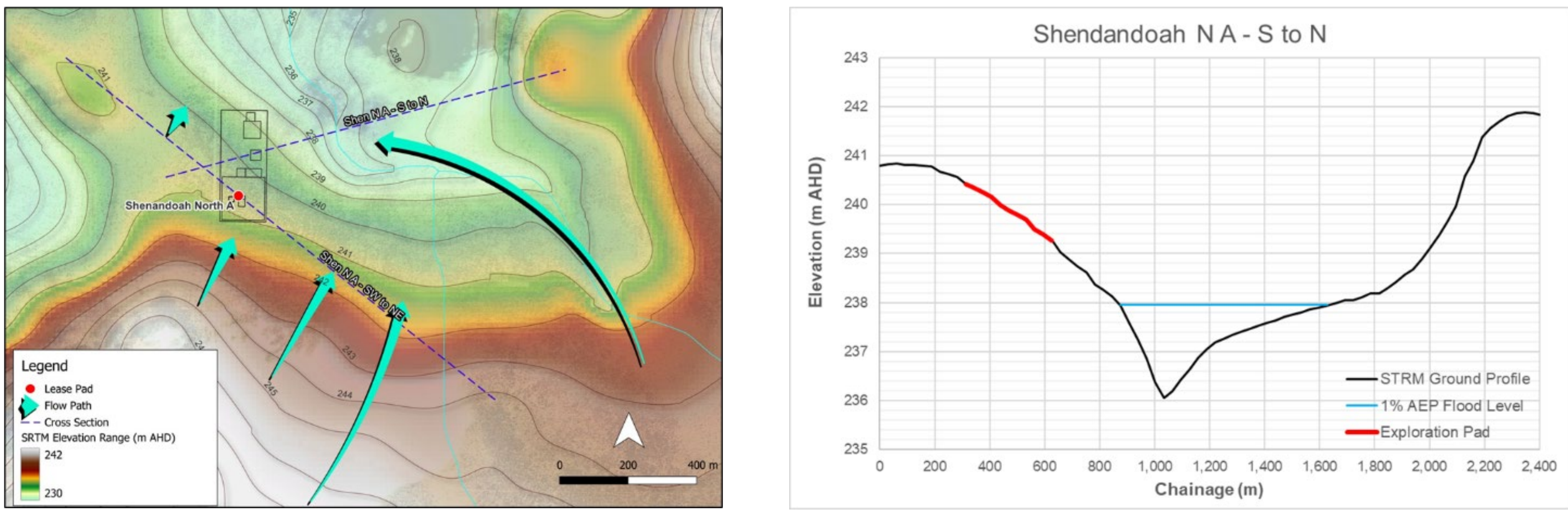
a) Shenandoah S2



b) Shenandoah S B



c) Shenandoah S C



d) Shenandoah N A

Figure 47: Hydraulic assessment for new well pads – a) Shenandoah S2; b) Shenandoah S B; c) Shenandoah S C; and d) Shenandoah N A

4.1.8 Hydrogeology

Within the Beetaloo exploration area, groundwater use is primarily from the CLA with minor, localised use from formations where shallower groundwater is intersected, where the CLA is too deep, or where the CLA is absent from erosion. This includes:

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

Table 39 summarises the stratigraphy based on previous drilling at the Kyalla 117 N2. Descriptions of the stratigraphic units have been revised to align with the generalised hydrostratigraphy presented in SREBA (2022).

Table 39: Summary hydrostratigraphy based on encountered depths at Kyalla 117 N2 (adapted from SREBA, 2022)

<table>
<tr><th>Province</th><th>Period / age</th><th colspan="2">Formation</th><th>Aquifer status</th><th>Encountered Depths[1] (approx. top and bottom) (m)</th><th>Regional yield (L/s)</th><th>Avg regional EC (µs/cm)</th></tr>
<tr><td>CARPENTARIA BASIN</td><td>CRETACEOUS
145 – 66 Ms</td><td colspan="2">Undifferentiated</td><td>Local-scale aquifer</td><td>0 – 70.0</td><td>0.3 – 4.0</td><td>1,800</td></tr>
<tr><td rowspan="4">GEORGINA BASIN</td><td rowspan="4">CAMBRIAN
497 – 630 Ma</td><td rowspan="2">Cambrian Limestone Aquifer (CLA)</td><td>Anthony Lagoon Formation</td><td>Regional aquifer</td><td>70.0 – 191.4</td><td>1.0 – 10.0</td><td>1,600</td></tr>
<tr><td>Gum Ridge Formation</td><td>Regional aquifer</td><td>191.4 – 399.5</td><td>>20.0</td><td>1,400</td></tr>
<tr><td colspan="2">Antrim Plateau Volcanics</td><td>Regional aquitard</td><td>399.5 – 499.0</td><td><2.0</td><td>900</td></tr>
<tr><td colspan="2">Bukalara Sandstone</td><td>Local aquifer (not regionally connected)</td><td>499.0 – 506.7</td><td>0.3 – 5.0</td><td>1,000</td></tr>
<tr><td rowspan="6">BEETALOO SUB-BASIN
(ROPER GROUP)</td><td rowspan="2">UNKNOWN</td><td colspan="2">Hayfield formation</td><td>Regional aquifer</td><td>506.7 – 899.33</td><td>ID</td><td>32,000</td></tr>
<tr><td colspan="2">Jamison Sandstone</td><td>Local aquifer (not regionally connected)</td><td>891.33 – 988.97</td><td>ID</td><td>138,000</td></tr>
<tr><td rowspan="4">MESO
PROTEROZOIC
1,430-1,500 Ma</td><td colspan="2">Kyalla Formation</td><td>Regional aquitard</td><td>988.97 – 1,851.75</td><td>ID</td><td>ID</td></tr>
<tr><td colspan="2">Moroak Sandstone</td><td>Local aquifer (not regionally connected)</td><td>1,851.75 – not determined</td><td>0.5 – 5.0</td><td>131,000</td></tr>
<tr><td colspan="2">Velkerri Formation</td><td>Regional aquitard</td><td>700 – 900</td><td>–</td><td>–</td></tr>
<tr><td colspan="2">Bessie Creek Sandstone</td><td>Local aquifer (not regionally connected)</td><td>450</td><td>0.5 – 5.0</td><td>–</td></tr>
</table>

The CLA, comprising the Gum Ridge Formation and the Anthony Lagoon Beds, is an extensive, multi-layered regional aquifer system covering at least 200,000 km^2 that forms the principal water resource in the Beetaloo Sub-basin, (SREBA, 2022).

The CLA is a highly productive aquifer that has high regional connectivity due to the development of significant fracture and karstic secondary porosity (SREBA, 2022). 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 at least 10 L/s (SREBA, 2023). Shallow, perched groundwater has also been recorded in the laterised zone within the permit area with groundwater levels recorded between 1 and 6 mBGL. These systems are dynamic with periodic saturation resulting from recharge during the wet season with no documented groundwater use.

Near the Kyalla 117 N2 site, for example, both aquifer units have a standing water level of approximately 114 m below top of casing. The limestone in the CLA is commonly fractured and cavernous; in the Katherine region, bore yields of up to 100 L/s have been recorded from this aquifer (SREBA, 2023). Such high yielding sections were encountered when drilling the Kyalla 117 N2-1 E&A well through the Anthony Lagoon and Gum Ridge Formation, with total losses of drilling fluid circulation at specific intervals.

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 Elliott, 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 210,000 ML per year (NTG, 2023). Fulton and Knapton (2015) estimated groundwater use in the Beetaloo Sub-basin to be at 6,000 ML/year, and primarily used for agricultural production. Recent estimated current water usage (licenced and unlicenced) is approximately 11,230 ML and 3,800 ML for the Georgina Basin and Wiso Basin, respectively (NTG, 2023).As previously demonstrated in section 3.12, future groundwater extraction has been assessed by the NTG, demonstrating negligible impact to groundwater allocations for Aboriginal land, neighbouring entitlements and GDEs (refer section 3.12 and section 4.5.2.4).

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 (Fulton and Knapton, 2015). There is no reported use within the 3 petroleum EPs held by Tamboran.

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 (Fulton and Knapton, 2015). 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 – 126,000 ML/yr and provides an estimate of the magnitude groundwater discharge from the CLA. Large decadal changes in the discharge to the Roper River suggest that most recharge input occurs close to the discharge zone (i.e. beyond the Beetaloo Sub-basin region). Groundwater recharge mechanisms to the CLA are poorly characterised but are likely to be dominated by infiltration through sinkholes and preferential recharge through soil cavities (AECOM, 2023; Appendix K).

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 and very high salinity. Groundwater in the Roper Group and undefined Neoproterozoic group is highly saline (>100,000 mg/L chlorides) and contrasts with the shallower, utilised aquifers of the Georgina Basin sediments in which groundwater is generally of drinking water quality (AECOM, 2023; Appendix K).

4.1.8.1 Groundwater monitoring results

Groundwater monitoring data has been collected from groundwater bores located at the Kyalla 117 N2 site since March 2019 until present (Figure 48). A summary of the baseline monitoring data is provided in Table 40.

Over the course of the groundwater monitoring program, the analytical results from the Kyalla 117 N2 Gum Ridge impact monitoring bore (RN041136) and Anthony Lagoon impact monitoring bore (RN041137) have recorded several results outside of the interquartile range. However, the 75th percentile exceedances observed from both impact monitoring bores are not considered to be outside of potential natural variability based on the hydrogeological conceptualisation of the limestone aquifer and the low absolute concentrations where exceedances occur.

All exceedances are believed to be the result of natural variability within the aquifer. As shown in, water quality collected from the impact bores generally shows close correlation with the water chemistry from the control monitoring bores. Key shale indicators, such as EC, boron, barium, strontium and sodium are within the expected range with no upward trend.

Data collected during Tamboran'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.

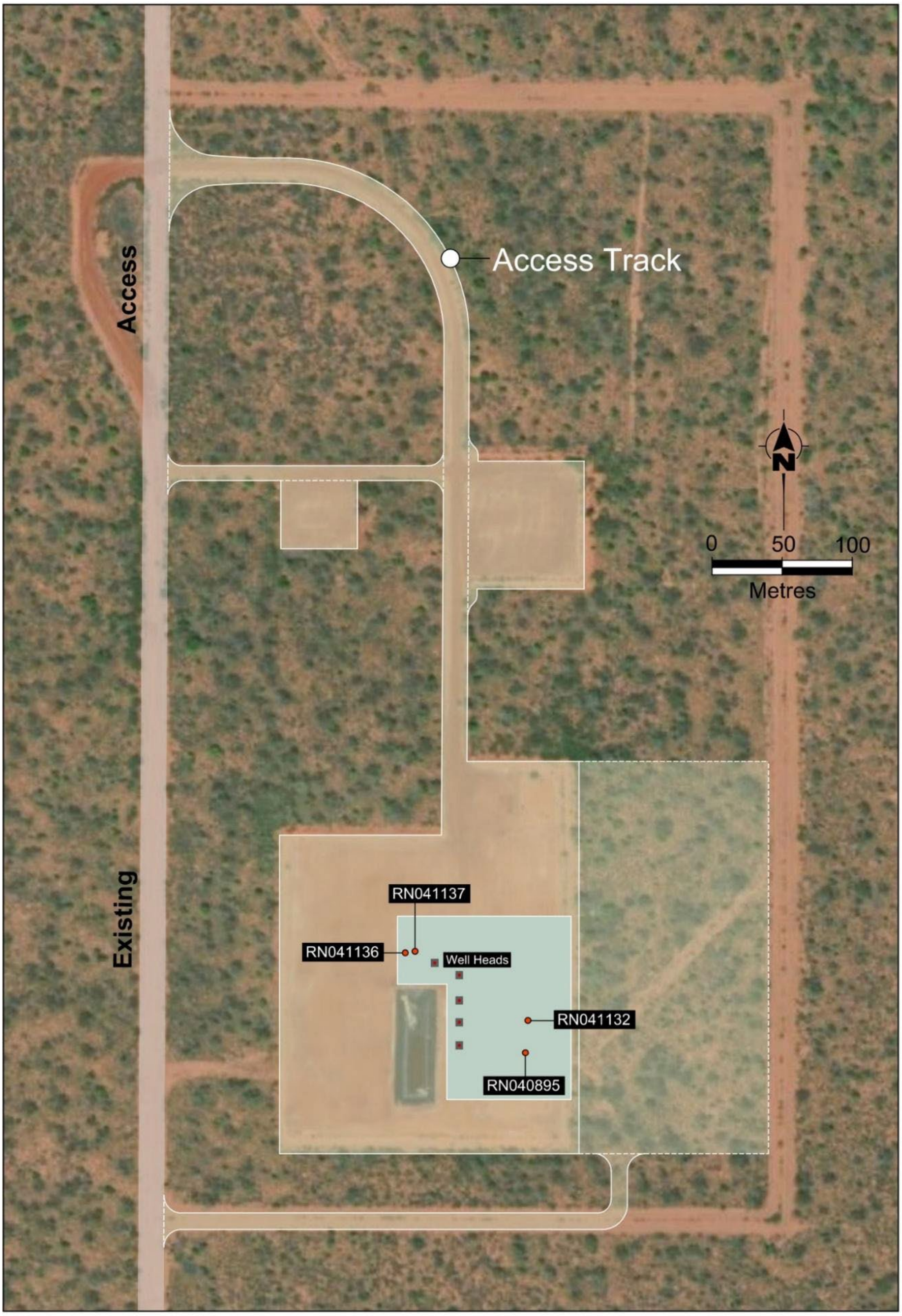


Figure 48: Location of existing control monitoring bores (RN040895 ALB and RN 041132 GRF) and impact monitoring bores (RN041137 ALB and RN 041136 GRF) on Kyalla 117 N2, in relation to existing and conceptual wellhead locations

Table 40: Summary of groundwater monitoring results collected at the Kyalla 117 N2 site, within the Anthony Lagoon Beds (ALB) and GRF

			RN040895 ALB – CMB			RN041137 ALB – IMB			RN041132 GRF – CMB			RN041136 GRF – IMB		
Analyte	**Unit**	**Reporting limit**	**# of Results**	**Max. Conc.**	**Ave. Conc.**	**# of Results**	**Max Conc.**	**Aver Conc.**	**# of Results**	**Max Conc.**	**Ave Conc.**	**# of Results**	**Max Conc.**	**Ave. Conc.**
Alkalinity (Bicarbonate as $CaCO_3$)	mg/L	1	28	318	275	10	384	310	21	393	309	19	372	264
Alkalinity (total) as $CaCO_3$	mg/L	1	28	318	275	10	384	310	21	393	309	19	372	264
Anions Total	meq/L	0.01	28	14.1	13	10	13.3	12	21	14.6	13	19	19.1	12.3
Calcium (filtered)	mg/L	1	28	92	80	10	96	83	21	109	89	19	147	72
Cations Total	meq/L	0.01	28	13.6	12	10	12.4	12	21	14	12	19	17.5	11.8
Chloride	mg/L	1	28	192	170	10	165	144	21	180	163	19	198	153
Electrical Conductivity (Lab)	µS/cm	1	28	1,380	1,206	10	1,350	1,153	21	1,380	1,219	19	1,690	1,160
Fluoride	mg/L	0.1	28	1.2	1.1	10	1.2	1.1	21	1.6	1.4	19	1.5	1.2
Methane	mg/L	0.01	28	0.072	0.02	10	0.021	0.015	21	0.039	0.017	19	0.058	<0.01
pH (Lab)	-	0.01	28	7.89	7.6	10	7.79	7.6	21	7.82	7.6	19	7.78	7.42
Potassium (filtered)	mg/L	1	28	16	14	10	16	15	21	17	15	19	25	14
Sodium (filtered)	mg/L	1	28	119	107	10	100	90	21	107	98	19	107	92
Sulfate as SO_4 - (filtered)	mg/L	1	1	118		1	106		1	116		1	117	117
Sulfate (filtered)	mg/L	1	28	167	130	10	122	104	21	183	129	19	295	109
Total Dissolved Solids (Lab)	mg/L	10	28	787	699	10	696	656	21	808	705	19	1,020	628
Barium	mg/L	0.001	27	0.127	0.069	9	0.092	0.081	20	0.077	0.063	19	0.08	0.049
Barium (filtered)	mg/L	0.001	28	0.105	0.064	10	0.09	0.079	21	0.064	0.059	19	0.072	0.046
Strontium	mg/L	0.001	27	0.736	0.67	9	0.712	0.65	20	0.924	0.8	19	0.91	0.715
Strontium (filtered)	mg/L	0.001	28	0.718	0.63	10	0.735	0.64	21	0.806	0.75	19	0.858	0.718

4.2 Biological environment

4.2.1 Bioregions

The Shenandoah South E&A program 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 is eucalypt woodland, which include 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

Surveys of the vegetation communities of the proposed activity locations within the Shenandoah South E&A program were completed in March-April 2023 by AECOM. Data has also been used from previous baseline assessments completed in 2004, 2006 (HLA, 2006; 2006c), 2010, 2014, 2016 ,2018 and 2021 (AECOM, 2011; 2014; 2016; 2018; and 2021).

The proposed activity locations (e.g. well sites, seismic lines and associated infrastructure detailed in section 3) of the Shenandoah South E&A program have been evaluated through detailed habitat assessments. Assessments 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 SREBA (2022), Terrestrial Ecosystems Baseline Report identified 51 vegetation communities and 21 broad vegetation groups comprising the final vegetation classification for the study area (Young *et al*, 2022). Within the Shenandoah South E&A program, 21 vegetation communities are noted (Figure 49).

Significant vegetation communities identified by the SREBA Baseline Report were also identified in the Shenandoah E&A Program. These include wetland, floodplains/drainage depressions and run-on areas. The planned well pads are shown to be outside these areas (Figure 50), with only minor interaction associated with the seismic lines on floodplains, drainage depressions and run-on areas.

Based on the SREBA definition of significant vegetation (DEWPS 2022), it is considered that the floodplains and drainage depressions within the Shenandoah South E&A Program area are not classified as high value wetlands, however they do have important ecological values for the local flora and fauna. The floodplains, drainage depressions and run-on areas are generally not considered sensitive to impacts from adjacent land use due to the relatively large spatial extent (DEPWS 2022). Seismic exploration activities can be conducted to minimise the extent and duration of any disturbances on the significant vegetation communities. This can be achieved by minimising clearing impacts to the greatest extent practicable on the key habitat features that contribute to their importance in the region (i.e. large habitat trees with hollows).

In accordance with the NT *Water Act* 1992 to interfere with a waterway, it is considered that the seismic program would either not cause a material change or alteration to the waterway or occur generally in a lower tier stream order (i.e. Stream Order 1). Permits to interfere with a waterway can be obtained through DEPWS Water Resources Branch.

A summary of the land condition assessment (LCA) for the Shenandoah South E&A program is provided in Table 41 to Table 44. The main vegetation communities that will be disturbed at the new sites within the Shenandoah South E&A program are summarised in Table 45 based on area and percentage cover, and discussed further in section 4.2.2.1. Community 2a, which is the most widespread vegetation community within the Shenandoah E&A Program will result in <3% of that vegetation being disturbed in the immediate area (worst case)

.

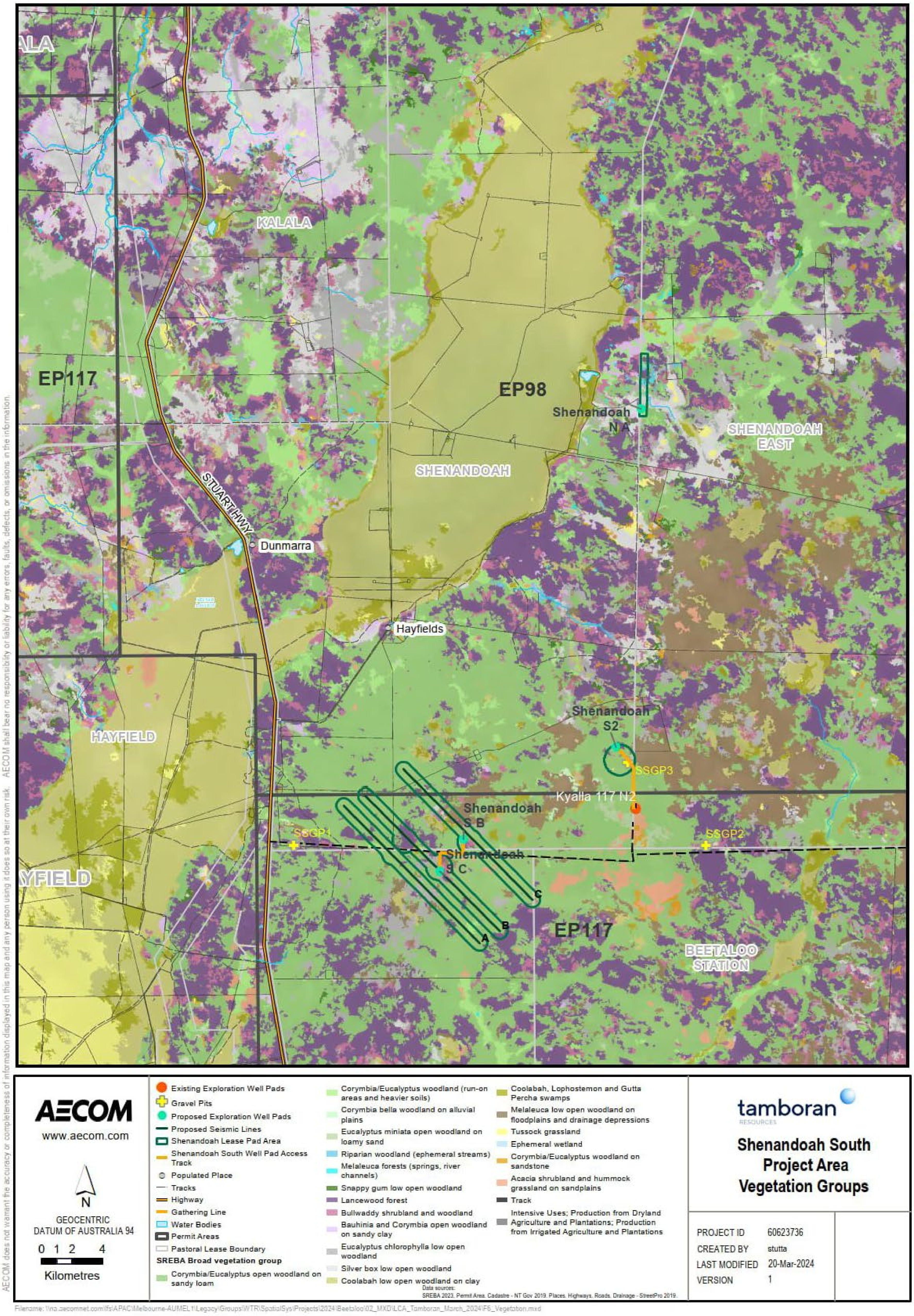


Figure 49: Shenandoah South E&A program SREBA vegetation community boundaries.

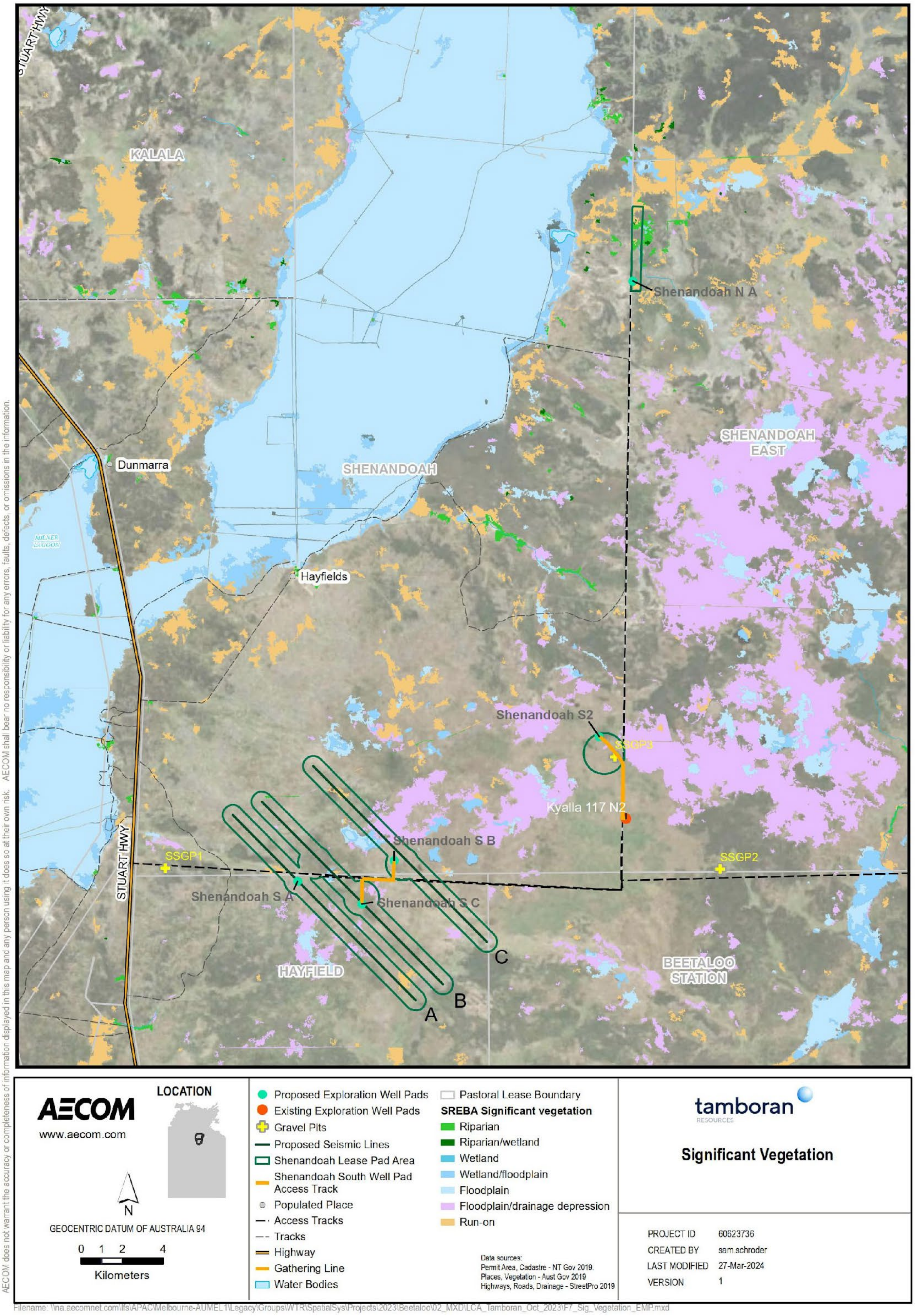


Figure 50: Shenandoah E&A program area significant vegetation communities.

Table 41: Summary of existing environment and surrounds – Shendandoah S2

Shenandoah S2		
Location	GDA94, Zone 53, 355291E, 8140676N	**Survey photos of the vegetation/habitat of the surrounding environment**
Landform and soil	5YR 3/4 dark reddish brown (upper) to 5YR 3/3 dark reddish brown clay loam, sandy. Well drained on flat surface, no slope (0%).	 
Vegetation community	**2a:** *Corymbia dichromophloia* ± *Erythrophleum chlorostachys* open woodland over *Acacia difficilis* ± *Terminalia canescens, Erythrophleum chlorostachys* open shrubland over hummock grassland	
Vegetation description	*Corymbia dichromophloia* ± *Erythrophleum chlorostachys* mid high open woodland, over *Acacia difficilis* ± *Terminalia canescens, Erythrophleum chlorostachys* mid high open shrubland, over *Triodia bitextura*, *Aristida hygrometrica*, *Chrysopogon fallax* mid high hummock grassland	
Dominant flora species	*Corymbia dichromophloia*, *Erythrophleum chlorostachys* *Erythrophleum chlorostachys*, *Acacia difficilis*, *Terminalia canescens* *Triodia bitextura*	 
Habitat condition	Moderate - Common tree hollows and falling logs. Mistletoe and flowering plants absent. Shallow leaf litter. Termite mounds: Nil. Fire damage > 2 years ago. No erosion. Minor cattle impacts. Ground cover: 55% vegetation, 2% leaf litter, 43% bare.	
Weeds	No Weeds of National Significance present.	
Potential listed threatened species (SREBA 2023)	Northern Shrike-tit (*Falcunculus frontatus whitei*), Gouldian Finch (*Erythrura gouldiae*), Plains Death Adder (*Acanthophis hawkei*), Yellow Spotted Monitor (*Varanus panoptes*), Grey Falcon (*Falco hypoleucos*), Common Brushtail Possum (*Trichosurus vulpecula arnhemensis*), Mertens' Water Monitor (*Varanus mertensi*)	

Shenandoah S2	
Hydrogeology	Groundwater resources and use is primarily from the Cambrian Limestone Aquifers (the Anthony Lagoon Formation and Gum Ridge Formation) with the shallower undifferentiated Cretaceous or perched alluvium systems being unsaturated.

Table 42: Summary of existing environment and surrounds – Shendandoah S B

Shenandoah S B			
Location	GDA94, Zone 53, 345579E, 8135469N	**Survey photos of the vegetation/habitat of the surrounding environment**	
Landform and soil	Dark grey; clay loam sandy in upper 0.5 m. Light medium clay to 0.7 m. No surface gravels. Well drained, potential for standing water following rainfall on slope <1%.		
Vegetation community	**3a:** *Corymbia polycarpa, Eucalyptus chlorophylla, Acacia shirleyi* mid-high open woodland.		
Vegetation description	*Corymbia polycarpa, Eucalyptus chlorophylla, Acacia shirleyi* mid high open woodland over *Acacia difficilis, Acacia gonoclada, Macropteranthes kekwickii* mid high open shrubland over *Aristida contorta, Aristida hygrometrica* mid high open tussock grassland.		
Dominant flora species	*Corymbia polycarpa, Eucalyptus chlorophylla, Acacia shirleyi* *Acacia difficilis, Acacia gonoclada, Macropteranthes kekwickii* *Aristida contorta*, *Aristida hygrometrica*		
Habitat condition	Moderate -Scattered tree hollows, fallen logs and flowering plants common. Mistletoe and leaf litter absent. Fire damage low > 2 years ago. No erosion. Minor cattle impacts. Termite mounds sparse. Ground cover: 15% vegetation, 10% litter, 25% bare soil, 50% gravel.		
Weeds	No Weeds of National Significance present.		

Shenandoah S B	
Potential listed threatened species (SREBA 2023)	Northern Shrike-tit (*Falcunculus frontatus whitei*), Gouldian Finch (*Erythrura gouldiae*), Plains Death Adder (*Acanthophis hawkei*), Yellow Spotted Monitor (*Varanus panoptes*), Grey Falcon (*Falco hypoleucos*), Common Brushtail Possum (*Trichosurus vulpecula arnhemensis*), Mertens' Water Monitor (*Varanus mertensi*)
Hydrogeology	Groundwater resources and use is primarily from the Cambrian Limestone Aquifers (the Anthony Lagoon Formation and Gum Ridge Formation) with the shallower undifferentiated Cretaceous or perched alluvium systems being unsaturated.

Table 43: Summary of existing environment and surrounds – Shendandoah S C

Shenandoah S C		
Location	GDA94, Zone 53, 343472E, 8133331N	**Survey photos of the vegetation/habitat of the surrounding environment**
Landform and soil	Dark reddish brown silty clay loam in upper 0.3 m. Progressing to Clay. No surface gravels. Well drained on a simple slope <1%.	 
Vegetation community	**2b:** *Acacia shirleyi, Corymbia dichromophloia ± Eucalyptus leucophloia, C. polycarpa* mid-high open woodland	
Vegetation description	*Acacia shirleyi, Ventilago viminalis* mid high open woodland over *Macropteranthes kekwickii, Terminalia volucris, Eucalyptus chlorophylla* mid high open shrubland over *Sorghum intrans, Eulalia aurea, Chrysopogon fallax* mid high tussock grassland.	
Dominant flora species	*Acacia shirleyi*, *Ventilago viminalis* *Macropteranthes kekwickii*, *Terminalia volucris*, *Eucalyptus chlorophylla* *Sorghum intrans*, *Eulalia aurea*, *Chrysopogon fallax*	 
Habitat condition	Moderate - Tree hollows, Mistletoe and leaf litter absent. Fallen logs and flowering plants common. Fire damage moderate > 2 years ago. No erosion. Minor cattle impacts. Termite mounds spares. Ground cover: 40% vegetation, 25% litter, 25% bare soil, 10% gravel.	

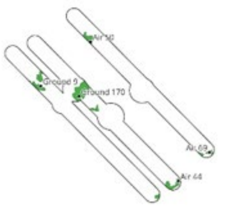
Shenandoah S C	
Weeds	No Weeds of National Significance present.
Potential listed threatened species (SREBA 2023)	Northern Shrike-tit (*Falcunculus frontatus whitei*), Gouldian Finch (*Erythrura gouldiae*), Plains Death Adder (*Acanthophis hawkei*), Yellow Spotted Monitor (*Varanus panoptes*), Grey Falcon (*Falco hypoleucos*), Common Brushtail Possum (*Trichosurus vulpecula arnhemensis*), Mertens' Water Monitor (*Varanus mertensi*)
Hydrogeology	Groundwater resources and use is primarily from the Cambrian Limestone Aquifers (the Anthony Lagoon Formation and Gum Ridge Formation) with the shallower undifferentiated Cretaceous or perched alluvium systems being unsaturated.

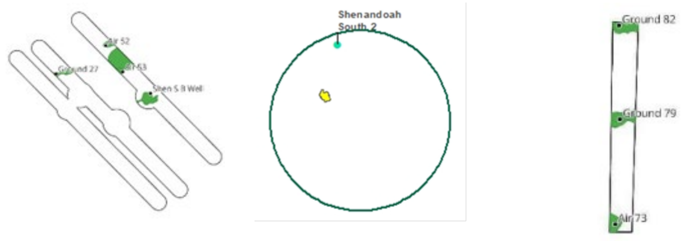
Table 44: Summary of existing environment and surrounds – Shendandoah N A

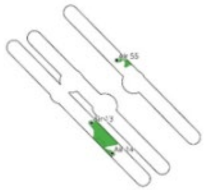
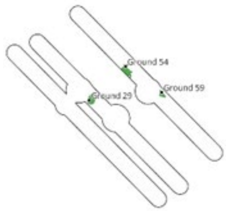
<table>
<tr><th colspan="4">Shenandoah N A</th></tr>
<tr><td>Location</td><td>GDA94, Zone 53, 356697E, 8163759N</td><td colspan="2">Survey photos of the vegetation/habitat of the surrounding environment</td></tr>
<tr><td>Landform and soil</td><td>5YR 4/1. dark grey sandy loam in upper 0.4 m. No surface gravels. Well drained, on a simple slope <1%.</td><td rowspan="3">
</td><td rowspan="3">
</td></tr>
<tr><td>Vegetation community</td><td>1a: Acacia shirleyi mid high woodland</td></tr>
<tr><td>Vegetation description</td><td>Acacia shirleyi mid high woodland over Macropteranthes kekwickii, Atalaya hemiglauca, Acacia holosericea mid high open shrubland over Fimbristylis sp., Brachyachne convergens, Aristida contorta mid high open tussock grassland.</td></tr>
<tr><td>Dominant flora species</td><td>Acacia shirleyi
Macropteranthes kekwickii, Atalaya hemiglauca, Acacia holosericea
Fimbristylis sp., Brachyachne convergens, Aristida contorta</td><td rowspan="2">
</td><td rowspan="2">
</td></tr>
<tr><td>Habitat condition</td><td>Moderate - tree hollows, Mistletoe and leaf litter absent, fallen logs and flowering plants common. Fire damage moderate >2years ago. No erosion. Moderate cattle impacts. Termite mounds sparse. Ground cover: 70%</td></tr>
</table>

Shenandoah N A			
	vegetation, 5% litter, 10% bare soil, 15% gravel.		
Weeds	No Weeds of National Significance present.		
Potential listed threatened species (SREBA 2023)	Northern Shrike-tit (*Falcunculus frontatus whitei*), Gouldian Finch (*Erythrura gouldiae*), Plains Death Adder (*Acanthophis hawkei*), Yellow Spotted Monitor (*Varanus panoptes*), Grey Falcon (*Falco hypoleucos*), Common Brushtail Possum (*Trichosurus vulpecula arnhemensis*), Mertens' Water Monitor (*Varanus mertensi*)		
Hydrogeology	Groundwater resources and use is primarily from the Cambrian Limestone Aquifers (the Anthony Lagoon Formation and Gum Ridge Formation) with the shallower undifferentiated Cretaceous or perched alluvium systems being unsaturated.		

Table 45: Area and percentage of vegetation community within the Shenandoah South E&A Program – Shenandoah S2, S B, S C and N A (adapted from Appendix K)

Vegetation community		Area (ha)	% of vegetation community within Shenandoah South E&A program
Lateritic plains and rises with sandy loam kandosol soils			
 	Community 1a: *Acacia shirleyi* woodland over *Macropteranthes kekwickii*, *Terminalia volucris* ± *Acacia difficilis* shrubland, over open tussock grassland	199	6.02

Vegetation community		**Area (ha)**	**% of vegetation community within Shenandoah South E&A program**
	Community 2a: *Corymbia dichromophloia* ± Erythrophleum *chlorostachys* open woodland, over *Acacia difficilis* ± *Terminalia canescens*, *Erythrophleum chlorostachys* open shrubland, over hummock grassland	1,895	57.19
	Community 2b: *Acacia shirleyi*, *Corymbia dichromophloia* ± *Eucalyptus leucophloia*, *Corymbia polycarpa* open woodland, over *Macropteranthes kekwickii*, *Petalostigma pubescens*, *Hakea arborescens* open shrubland, over tussock grassland	697	21.04
	Community 3a: *Corymbia polycarpa*, *Eucalyptus chlorophylla*, *Acacia shirleyi* open woodland, over *Acacia difficilis*, *Macropteranthes kekwickii*, *Erythrophleum chlorostachys* open shrubland, over open tussock grassland	360	5.79

Vegetation community		Area (ha)	% of vegetation community within Shenandoah South E&A program
Drainage floors and relic drainages with clay and alluvial soils			
 	Community 4a: *Acacia shirleyi* ± *Eucalyptus pruinosa*, *Eucalyptus chlorophylla* woodland, over *Melaleuca viridiflora*, *Eucalyptus pruinosa*, *Eucalyptus chlorophylla* open shrubland, over open tussock grassland	126	3.82
 	Community 4b: *Corymbia polycarpa*, *Eucalyptus microtheca* low open woodland, over *Melaleuca nervosa*, *Hakea arborescens*, *Melaleuca viridiflora* open shrubland, over tussock grassland	76	2.30

Vegetation community		Area (ha)	% of vegetation community within Shenandoah South E&A program
Riparian creek lines with sandy and alluvial soils			
 	Community 4d: *Eucalyptus camaldulensis* low woodland over *Melaleuca viridiflora* sparse shrubland over open tussock grassland	32	0.98
Note: Approximately 47% of vegetation communities identified during the survey do not occur on the proposed sites, which is equal to ~2914 ha of a total area of ~6228 ha.			

Potential risks and impacts to the environment have been identified based on environmental conditions observed during the field survey. The overall disturbance footprint for the Shenandoah South E&A program (including the existing Kyalla 117 N2) is ~139.41 ha. However with the development of mitigation measures to minimise impacts to the environment (e.g. avoidance of large trees and, environmental and community receptors; use of existing pastoral access tracks), Tamboran could reduce disturbance, especially during seismic acquisition.

During the LCA the infrastructure sites, including proposed seismic lines were assessed to be in generally good condition with no evidence of weeds, and minor evidence of erosion and disturbance from cattle.

The 7 vegetation communities identified from 66 vegetation sites recorded within the Shenandoah South E&A program (adapted from Appendix K) are shown in Figure 51 and summarised in Table 46 to Table 52. These data provide an overview of the vegetation communities associated with the proposed exploration well sites and 2D seismic lines.

The vegetation communities are considered regionally extensive and not subjected to extensive clearing. Further detail regarding the individual sites assessed within the Shenandoah South E&A program is provide in the LCA, Appendix K.

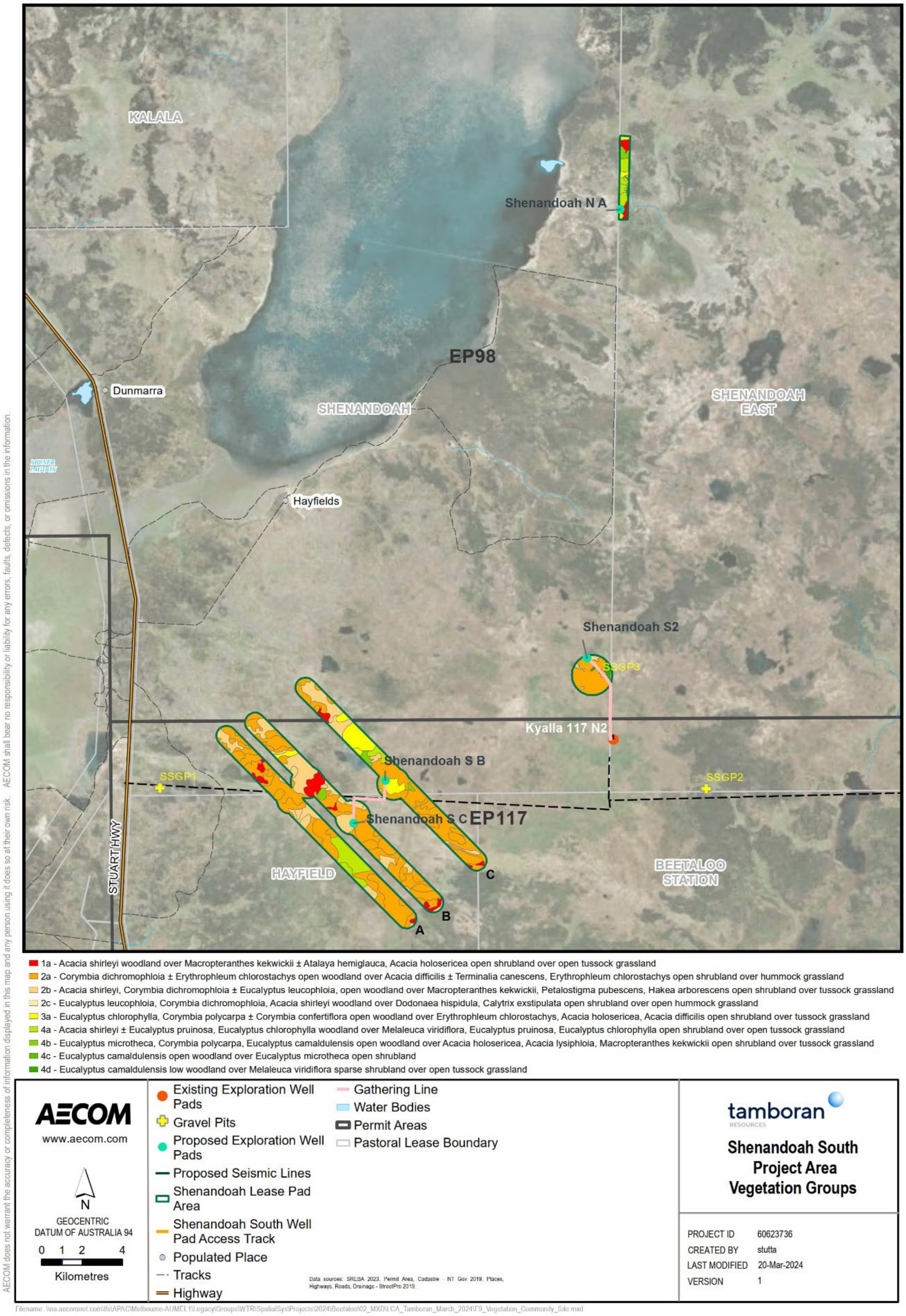
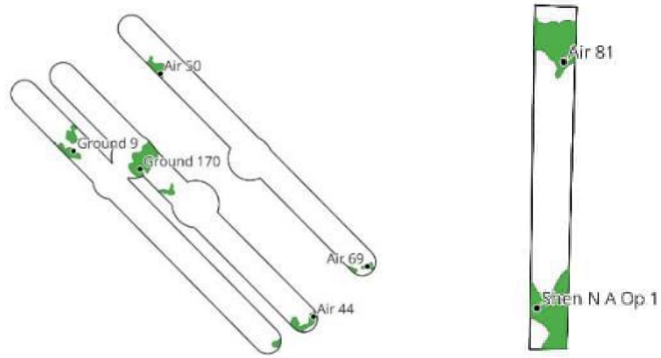


Figure 51: Vegetation communities and scouting locations within the proposed exploration sites within the Shenandoah South site.

Table 46: Community 1a

Community 1a - *Acacia shirleyi* mid high woodland over *Macropteranthes kekwickii, Terminalia volucris* ± *Acacia difficilis* mid high shrubland, over *Panicum trichoides*, *Panicum mindanaense*, *Bulbostylis barbata* mid high open tussock grassland
Upper 1: Mid high woodland dominated by *Acacia shirleyi*
Mid 1: Mid high shrubland dominated by *Macropteranthes kekwickii, Terminalia volucris ± Acacia difficilis* mid
Ground 1: Mid high open tussock grassland dominated by *Panicum trichoides, Panicum mindanaense, Bulbostylis barbata*



No. of sites: (6) Ground 9, Ground 170, Air 44, Air 50, Air 69; Shenandoah N A & Air 81
Other common species
Upper stratum (U1): -
Mid stratum (M1): -
Ground stratum (G1): Shenandoah South sites: *Bidens bipinnata, Waltheria indica, Hibiscus sturtii var. campylochlamys*; Shenandoah North sites: -
Landform: Lateritic Plains and Rises -associated with deeply weathered profiles (laterite) including sand sheets and other depositional products, sandy and earth soils
Soil: Brown sandy loam kandosol soils.

Table 47: Community 2a

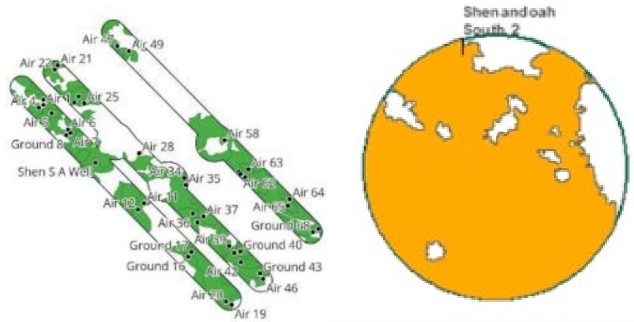
Community 2a - *Corymbia dichromophloia* ± *Erythrophleum chlorostachys* mid high open woodland, over *Acacia difficilis* ± *Terminalia canescens*, *Erythrophleum chlorostachys* mid high open shrubland, over *Triodia bitextura*, *Aristida hygrometrica*, *Chrysopogon fallax* mid high hummock grassland	
Upper 1: Mid high open woodland dominated by *Corymbia dichromophloia ± Erythrophleum chlorostachys*	
Mid 1: Mid high open shrubland dominated by *Acacia difficilis ± Terminalia canescens, Erythrophleum*	
Ground 1: Mid high hummock grassland dominated by *Triodia bitextura*, *Aristida hygrometrica*, *Chrysopogon fallax*	
	
No. of sites: (43) Shen S A, Ground 8, Ground 16, Ground 17, ground 24, Ground 40, Ground 41, Ground 43, Ground 60, Ground 61, Ground 66, Ground 68, Air 1, Air 2, Air 4, Air 5, Air 6, Air 7, Air 11, Air 12, Air 19, Air 20, Air 21, Air 22, Air 23, Air 25, Air 28, Air 34, Air 35, Air 36, Air 37, Air 38, Air 39, Air 42, Air 46, Air 47, Air 49, Air 58, Air 62, Air 63, Air 64, Air 65, Shen S 2	
Other common species	
Upper stratum (U1): *Acacia shirleyi, Eucalyptus chlorophylla*	
Mid stratum (M1): *Grevillea parallela, Dodonaea hispidula, Ehretia saligna, Acacia drepanocarpa subsp. latifolia, Acacia thomsonii, Acacia gonoclada, Brachychiton diversifolius, Brachychiton paradoxus, Grewia savannicola, Macropteranthes kekwickii, Persoonia falcata, Petalostigma pubescens, Wrightia saligna*	
Ground stratum (G1): *Aristida inaequiglumis, Setaria surgens, Corchorus sidoides, Eriachne ciliata, Mnesithea formosa*	
Landform: Lateritic Plains and Rises -associated with deeply weathered profiles (laterite) including sand sheets and other depositional products, sandy and earth soils	
Soil: Brown sandy loam kandosol soils.	

Table 48: Community 2b

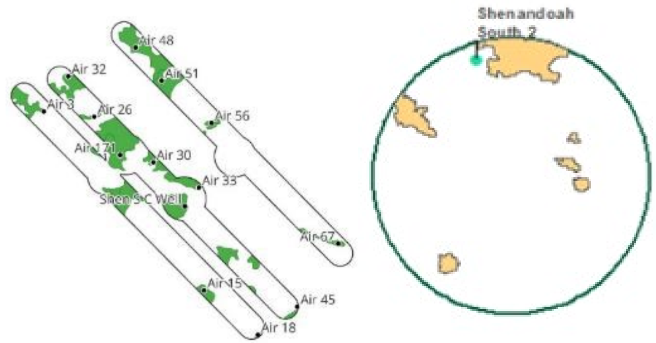
Community 2b - *Acacia shirleyi, Corymbia dichromophloia* ± *Eucalyptus leucophloia, Corymbia polycarpa* mid high open woodland, over *Macropteranthes kekwickii, Petalostigma pubescens, Hakea arborescens* mid high open shrubland, over *Chrysopogon fallax, Mnesithea formosa, Eriachne ciliata* mid high tussock grassland
Upper 1: Mid high open woodland dominated by *Acacia shirleyi, Corymbia dichromophloia* ± *Eucalyptus leucophloia, Corymbia polycarpa*
Mid 1: Mid high open shrubland dominated by *Macropteranthes kekwickii, Petalostigma pubescens, Hakea arborescens*
Ground 1: Mid high tussock grassland dominated by *Chrysopogon fallax, Mnesithea formosa, Eriachne ciliata*
 
No. of sites: (14) Shen S C Well, Air 3, Air 15, Air 18, Air 26, Air 30, Air 32, Air 33, Air 45, Air 48, Air 51, Air 56, Air 67, Air 171 (incorporated veg description from Shenandoah North)
Other common species
Upper stratum (U1): *Ventilago viminalis*
Mid stratum (M1): *Calytrix exstipulata, Eucalyptus chlorophylla, Terminalia volucris*
Ground stratum (G1): *Sorghum intrans, Eulalia aurea*
Landform: Lateritic Plains and Rises -associated with deeply weathered profiles (laterite) including sand sheets and other depositional products, sandy and earth soils
Soil: Brown sandy loam kandosol soils.

Table 49: Community 3a

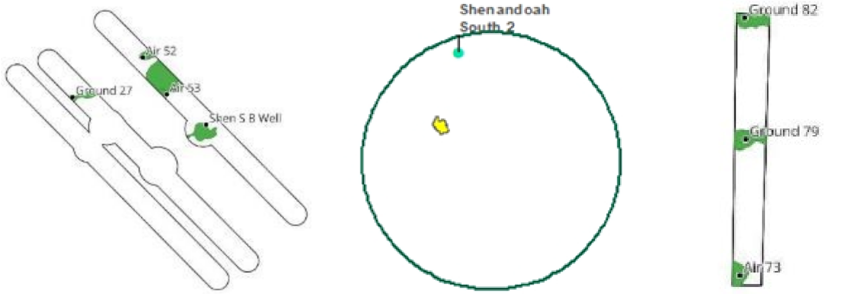
Community 3a - *Corymbia polycarpa*, *Eucalyptus chlorophylla*, *Acacia shirleyi* mid high open woodland, over *Acacia difficilis, Macropteranthes kekwickii, Erythrophleum chlorostachys* mid high open shrubland, over *Aristida* sp1, *Aristida* sp3 mid high open tussock grassland
Upper 1: Mid high open woodland dominated by *Corymbia polycarpa, Eucalyptus chlorophylla, Acacia shirleyi*
Mid 1: Mid high open shrubland dominated by *Acacia difficilis, Macropteranthes kekwickii, Erythrophleum chlorostachys*
Ground 1: Mid high open tussock grassland dominated by *Aristida hygrometrica, Aristida contorta*
 
No. of sites: (8) Shen S B Well, Shen S2, Ground 27, Air 52, Air 53; Shenandoah N A: Ground 79, Ground 82, Air 73
Other common species
Upper stratum (U1): *Erythrophleum chlorostachys, Acacia shirleyi* (Shenandoah North sites)
Mid stratum (M1): *Atalaya hemiglauca*
Ground stratum (G1): *Pterocaulon serrulatum, Grewia savannicola*
Landform: Lateritic Plains and Rises -associated with deeply weathered profiles (laterite) including sand sheets and other depositional products, sandy and earth soils
Soil: Brown sandy loam kandosol soils.

Table 50: Community 4a

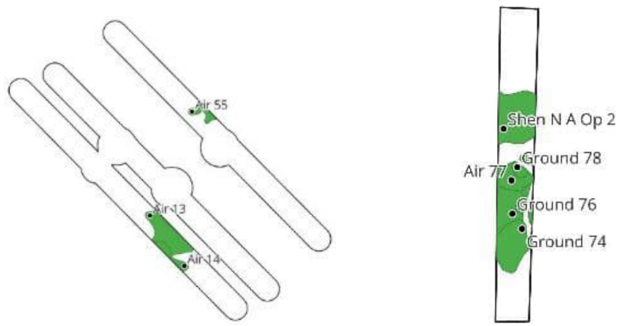
Community 4a - *Acacia shirleyi* ± *Eucalyptus pruinosa, Eucalyptus chlorophylla* mid high woodland, over *Melaleuca viridiflora, Eucalyptus pruinosa, Eucalyptus chlorophylla* mid high open shrubland, over *Eriachne armitii, Eragrostis cumingii, Aristida contorta* mid high open tussock grassland
Upper 1: Mid high woodland dominated by *Acacia shirleyi* ± *Eucalyptus pruinosa, Eucalyptus chlorophylla*
Mid 1: Mid high open shrubland dominated by *Melaleuca viridiflora, Eucalyptus pruinosa, Eucalyptus chlorophylla*
Ground 1: Mid high open tussock grassland dominated by *Eriachne armitii, Eragrostis cumingii, Aristida contorta*
 
No. of sites: (7) Air 13, Air 14, Air 55; Shenandoah N A: Ground 74, Ground 76, Ground 78, S Air 77
Other common species
Upper stratum (U1): -
Mid stratum (M1): *Acacia difficilis, Carissa lanceolata, Macropteranthes kekwickii, Corymbia grandifolia*
Ground stratum (G1): -
Landform: Drainage floors and relic drainages associated with clay and alluvial soils
Soil: Brown clay soils

Table 51: Community 4b

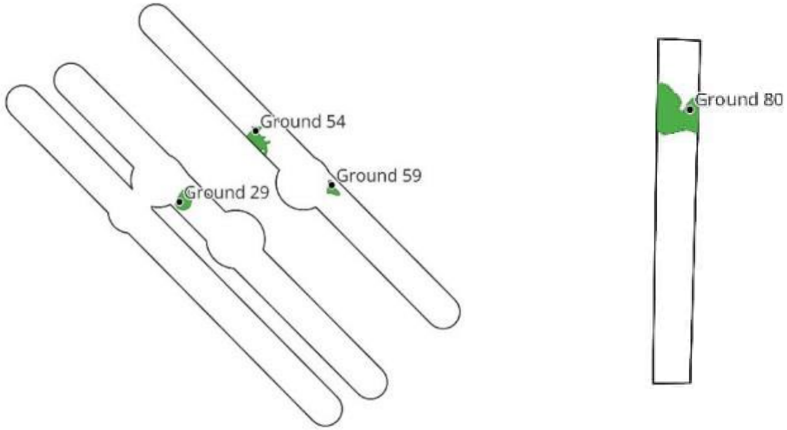
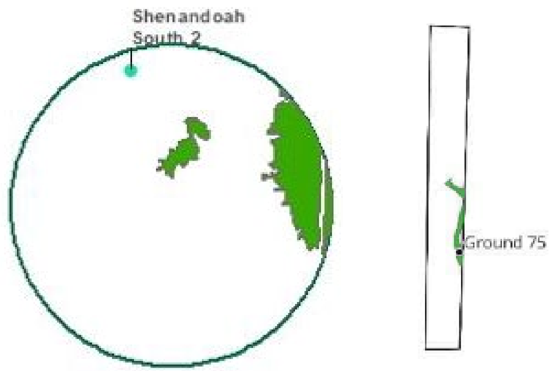
<table>
<tr><th colspan="2">Community 4b - Corymbia polycarpa, Eucalyptus microtheca low open woodland, over Melaleuca nervosa, Hakea arborescens, Melaleuca viridiflora mid high open shrubland, over Aristida contorta, Waltheria indica, Eriachne armitii mid high tussock grassland</th></tr>
<tr><td colspan="2">Upper 1: Low open woodland dominated by Corymbia polycarpa, Eucalyptus microtheca</td></tr>
<tr><td colspan="2">Mid 1: Mid high open shrubland dominated by Melaleuca nervosa, Hakea arborescens, Melaleuca viridiflora</td></tr>
<tr><td colspan="2">Ground 1: Mid high tussock grassland dominated by Aristida contorta, Waltheria indica, Eriachne armitii</td></tr>
<tr><td></td><td>
</td></tr>
<tr><td colspan="2">No. of sites: (4) Ground 29, Ground 54, Ground 59; Shenandoah N A Ground 80</td></tr>
<tr><td colspan="2">Other common species</td></tr>
<tr><td colspan="2">Upper stratum (U1): -</td></tr>
<tr><td colspan="2">Mid stratum (M1): Acacia difficilis, Acacia holosericea, Macropteranthes kekwickii</td></tr>
<tr><td colspan="2">Ground stratum (G1): Aristida hygrometrica, Eulalia aurea, Setaria surgens</td></tr>
<tr><td colspan="2">Landform: Drainage floors and relic drainages associated with clay and alluvial soils</td></tr>
<tr><td colspan="2">Soil: Brown clay soils</td></tr>
</table>

Table 52: Community 4d

Community 4d - *Eucalyptus camaldulensis* low woodland over *Melaleuca viridiflora* mid high sparse shrubland over *Dactyloctenium radulans, Eragrostis cumingii* mid high open tussock grassland	
Upper 1: Low woodland dominated by *Eucalyptus camaldulensis*	
Mid 1: Mid high sparse shrubland dominated by *Melaleuca viridiflora*	
Ground 1: Mid high open tussock grassland dominated by *Dactyloctenium radulans*, *Eragrostis cumingii*	
	
No. of sites: (2) Shenandoah S 2; Shenandoah N A Ground 75	
Other common species	
Upper stratum (U1): -	
Mid stratum (M1): -	
Ground stratum (G1): -	
Landform: Riparian creek lines with sandy and alluvial soils	
Soil: Brown sandy clay soils.	

4.2.2.1 Flora

A search of the DCCEEW Protected Matters database of nationally significant fauna (PMST) and the NT Government flora atlas database was undertaken for the exploration area, with a 10 km buffer applied. No threatened vegetation communities are listed as likely to occur within the Shenandoah South E&A program, which is supported by the SREBA (2022) surveys that indicate no threatened plant species were known to occur, or considered likely to occur within the Beetaloo Sub-basin. [39]

Overall, the SREBA (2022) surveys contributed 15,419 new plant records within the SREBA study area. A total of 1,818 plant species have been recorded within the Beetaloo exploration area (SREBA 2022). The SREBA (2022) survey indicates that disturbance was prevalent across all broad vegetation groups, despite efforts to select "best on offer" vegetation sites. Primary contributors to disturbance include fire, cattle, pigs and weeds.

The field survey undertaken during April 2023 recorded 1,372 individual flora species. The survey focused on recording dominant species to describe vegetation communities rather than undertake a comprehensive floristic assessment. No threatened flora were identified during the LCA.

4.2.2.2 Habitat fragmentation

As outlined in SREBA (2022) *"…vegetation communities and habitats may vary in their sensitivity to degradation, fragmentation and loss as a result of onshore gas and other development."*

Impacts identified in SREBA (2022), include land clearing, inappropriate fire regimes, weed incursion and grazing by introduced herbivores, which can lead to long term loss of species abundance and richness. The cumulative impacts of clearing from a regional perspective have been discussed in section 3.3.2.1. Currently onshore gas develop represents ~3% of all clearing in the Barkly/Gulf Region (2003 – 2023).[40]

Nevertheless, Tamboran is committed to minimising its impact and reducing the potential for habitat fragmentation. Key mitigations include:

- Use of centralised sites
- Construction of multi well pads
- Use of existing pastoral access tracks
- Completion of rehabilitation of seismic lines within 2 – 6 weeks post seismic acquisition
- Ongoing and active fire management
- Ongoing active weed management.

4.2.2.3 Weeds

Baseline weed surveys completed during the land condition assessments, and annual surveys within the Tamboran EPs have recorded a low number and density of weed species, indicating that the overall land condition is generally good. Three declared weed species, *Calotropis procera* (Rubber bush), *Parkinsonia aculeata* (Parkinsonia) and *Mesosphaerum suaveolens* (Hyptis), have been recorded during previous Kyalla baseline surveys.

No weeds were detected within the Shenandoah South E&A program during the December 2022 and March – April 2023 field surveys. The areas traversed during field surveys are displayed in Figure 52.

---

[39] Noting that *Carex fascicularis* a densely-tufted perennial sedge (Vulnerable; TPWC Act) and *Spermacoce reticulata* an annual herb (restricted range species) were both recorded on the Hayfield Station (SREBA 2022) approximately 30 – 34 km south-west of the proposed regulated activities. *Carex fascicularis* was recorded near a flowing creek (HAY18); *Spermacoce reticulata* was recorded in a Lancewood low open forest (HAY01).

[40] Refer Footnote 24.

High-risk weeds have been determined through consideration of the following criteria:

- Weed species that has been confirmed in the area within the relevant Regional Weed Strategies and Plans (NTG 2024b), or through field surveys
- Weed species listed in a statutory plan that are near Tamboran tenure
- Weed species that are at risk of introduction using machinery sourced from other regions in the NT or from other states

There are four classes of weeds under the NT *Weed Management Act 2001*, which was amended in May 2022. The classes are described as:

a. *it is necessary to eradicate the plant*

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

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

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

Based on the available data for the weeds likely to occur within the Shenandoah South E&A Program area, there is no Class D status.

Table 53 provides a list of weed species that are known to occur or likely to occur Shenandoah South E&A program based on a desktop review of the following sources:

- Mapping data provided by the Weed Management Branch, DEPWS.
- Guidelines for the Management of the Weeds of Beetaloo 2018 (DLRM & CDU, 2018).
- DCCEEW Environment Protection and Biodiversity Conservation Act 1999 Commonwealth (EPBC Act) Protected Matters Report database.
- Current and previous data collected by AECOM and Tamboran's weed contractor in the permit area.

Table 53: NT listed weeds known or likely to occur within the Shenandoah South E&A program sites

Scientific Name	Common Name	Category of priority	Status*
Alternanthera pungens	Khaki Weed	4	Class B and C
Andropogon gayanus	Gamba Grass	1	Class A and C, Weed of National Significance (WoNS)
Azadirachta indica	Neem	2	Class B and C
Calotropis procera	Rubber Bush	1	Class B and C (south of 16°30' S latitude)
Cenchrus ciliaris	Buffel Grass	3	Not declared in NT
Cenchrus echinatus	Mossman River Grass	3	Class B and C
Datura ferox	Fierce Thornapple	3	Class A and C
Mesosphaerum suaveolens	Hyptis	4	Class B and C
Jatropha gossypiifolia	Bellyache Bush	1	Class A/B and C, WoNS
Parkinsonia aculeata	Parkinsonia	2	Class B and C, WoNS
Sida acuta	Spinyhead Sida	4	Class B and C

Scientific Name	Common Name	Category of priority	Status*
Sida cordifolia	Flannel Weed	4	Class B and C
Sida rhombifolia	Paddy's Lucerne	4	Class B and C
Tamarix aphylla	Athel Pine	2	Class A/B and C, WoNS
Themeda quadrivalvis	Grader Grass	5	Class B and C, WoNS
Tribulus terrestris	Caltrop	4	Class B and C
Vachellia nilotica	Prickly Acacia	1	Class A and C, WoNS
* All Class A and B weeds are also Class C weeds.			

During the biannual monitoring weed surveys undertaken in May 2022, which focused on the edge of tracks, disturbance areas and along the Stuart and Carpentaria Highway, the following weeds were recorded:

- Hyptis (Mesosphaerum suaveolens)
- Sida (Sida acuta)
- Annual Mission grass (Cenchrus pedicellatus) - Environmental weed of concern

The class B weed Hyptis was observed along the Carpentaria Highway and along fence line tracks. Sida was observed predominantly in areas heavily disturbed by cattle, such as where drinking troughs were located. This emphasises the importance of the weed hygiene declaration, which is in force for all vehicles and equipment entering Tamboran's sites.

Additional information on the full list of weeds and control measures implemented across Tamboran's EPs is provided in the WMP (Appendix C) and LCA (Appendix K).

Weeds will continue to be managed in accordance with the WMP (Appendix C) and the Code.

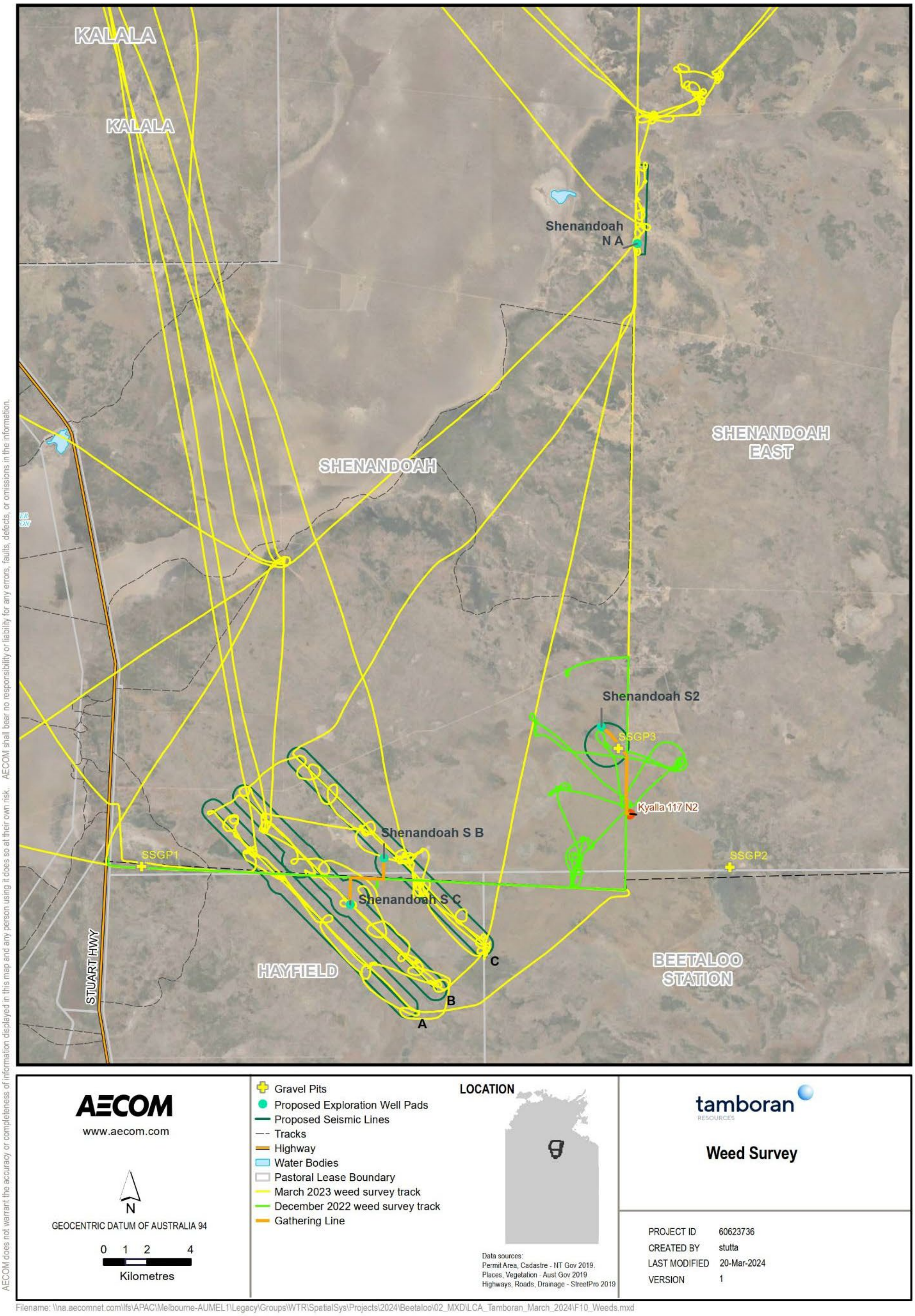


Figure 52: March 2023 weed survey track

4.2.3 Air quality

4.2.3.1 GHG survey

The GHG baseline study completed as part of the SREBA, undertook 3 mobile survey campaigns across more than 14,000 km between October 2021 and June 2022 (Ong, *et al.,* 2022). The aim of the study was to establish GHG across the Beetaloo Sub-basin study area and establish reference sites and a program for ongoing monitoring.

Importantly the study assessed wet and dry season fluctuations in methane concentrations, which varied from between 1.863 and 1.868 ppm (dry season) and 1.845 ppm (wet season) (Ong, *et al.,* 2022). The seasonal increase in methane concentrations in the dry is predominantly attributed to Top End fire regimes, discussed below. Overall, the results of the SREBA GHG baseline study were found to be comparative to the findings of the initial CSIRO Gas Industry Social and Environmental Research Alliance (GISERA) study completed in 2018/19, and seasonal national reference trends across Australia (Ong, *et al.,* 2022).

The two main sources of elevated methane concentrations detected during this study that are relevant to the location of the Shenandoah South E&A project, were cattle 51,650 t/year and fire 5,360 t/year (Ong, *et al.,* 2022). Estimates of methane emissions from the regulated activity total approximately 910 t over 4 years, or less than 230 t/year (see section 3.18, Table 26).

Tamboran has a sound understanding of the fire regime prevalent within the region of its assets. During the dry season, Tamboran is in constant communication with pastoralists and conducts continuous reviews of the North Australia Fire Information (NAFI) website to ensure ongoing protection of life and assets.

4.2.3.2 Baseline air quality assessment program

5 ambient air locations were set up across the Beetaloo basin as a part of the SREBA to collect Particulate matter, Nitrogen Oxides (NO_X), Sulphur Dioxide (SO_2), Volatile Organic Compounds (VOC's) and meteorological conditions.This includes stations as Elliott, Daly Waters and the Bullwaddy Conservation area. A copy of the report is provided here: Territory Stories - Environmental Health Interim Baseline Report: Air Quality Strategic Regional Environmental and Baseline Assessment for the Beetaloo Sub-basin

Monitoring confirmed the undeveloped nature of the Beetaloo Basin, with low levels of all gases sampled below the relevant National Environmental Protection Measures. A summary of the maximum results against the relevant NEPM standard is provide below in Table 54. Maximum particulate matter readings were recorded above the NEPM guidelines, which is consistent with air quality in the NT which is affected by episodic fire events (Figure 53).

The results confirm Tamboran's exploration activities are unlikely to cause any levels to go above the NEPM guidelines.

Table 54: Summary of gaseous pollutants collected during the SREBA baseline survey across the basin.

Pollutant	NEPM Standard (ug/m3)	Maximum observed concentration (ug/m3)	Location
NOx	31	3.4	Elliott
SO2	57	2	Daly Waters
Formaldehyde	54	0.9	Daly Waters
Benzene	10	0.03	Mataranka, Daly Waters
Toluene	411	0.21	Manbulloo
Xylenes	947	0.04	Manbulloo

Table 5.2 Particulate concentrations for monitoring period

Parameter	Averaging period	Limit ($\mu g/m^3$)	Mataranka	Manbulloo	Bullwaddy	Elliott	Daly Waters
PM_{10}	Annual average[1]	**25**	39	56	14	8.3	8.7
	24-hour maximum	**50**	156	199	31	23	27
$PM_{2.5}$	Annual average[1]	**8**	-	54	13	7.6	8.2
	24-hour maximum	**25**	-	195	30	21	27

Notes:

1) Annual average has been calculated for data measured to date, and should be considered indicative only until

Figure 53: Summary of particulate matter monitoring results from the SREBA Beetaloo air quality baseline assessment

4.2.4 Fire regime

Fire is a natural occurrence in most Australian ecosystems and plays an important role in their ecology. Fire management practices by the Pastoralists, generally exclude fire from the Mitchell grasslands (dominated by *Astrebla spp.)* to maintain forage throughout the dry season (HLA, 2005). Mitchell grasslands are located west of the Shenandoah South E&A program in the floodplain area. Fires are more frequent in the Sturt Plateau in the eucalypt/corymbia and acacia woodlands where Shenandoah South E&A program is located.

Historically most high intensity fires within EP 98 and 117 occur during the dry season (HLA, 2005). Wet season fires have occurred within the EPs; however these fires are likely to be patchy and of lower intensity, depending on the state of curing of the fuel load. Land condition assessments of the Shenandoah South E&A program indicate low intensity fire events >2 years ago at Shenandoah S2 and S B, and moderate intensity fire >2 years ago at Shenandoah S C. Fire frequency was highest in areas of woodland and less frequent in areas of dense Lancewood and Bullwaddy shrubland (AECOM, 2022). Figure 53 shows the fire frequency within the exploration areas over the past 10 years (2011 to 2021). Fire has occurred generally 4 to 8 times at each area within the last 10 years.

Site BMPs have been developed to manage bushfire risks associated with the proposed regulated activities within the Shenandoah South E&A program (Appendix B). These plans provide the hazard reduction strategies, resources and response to bushfire emergencies.

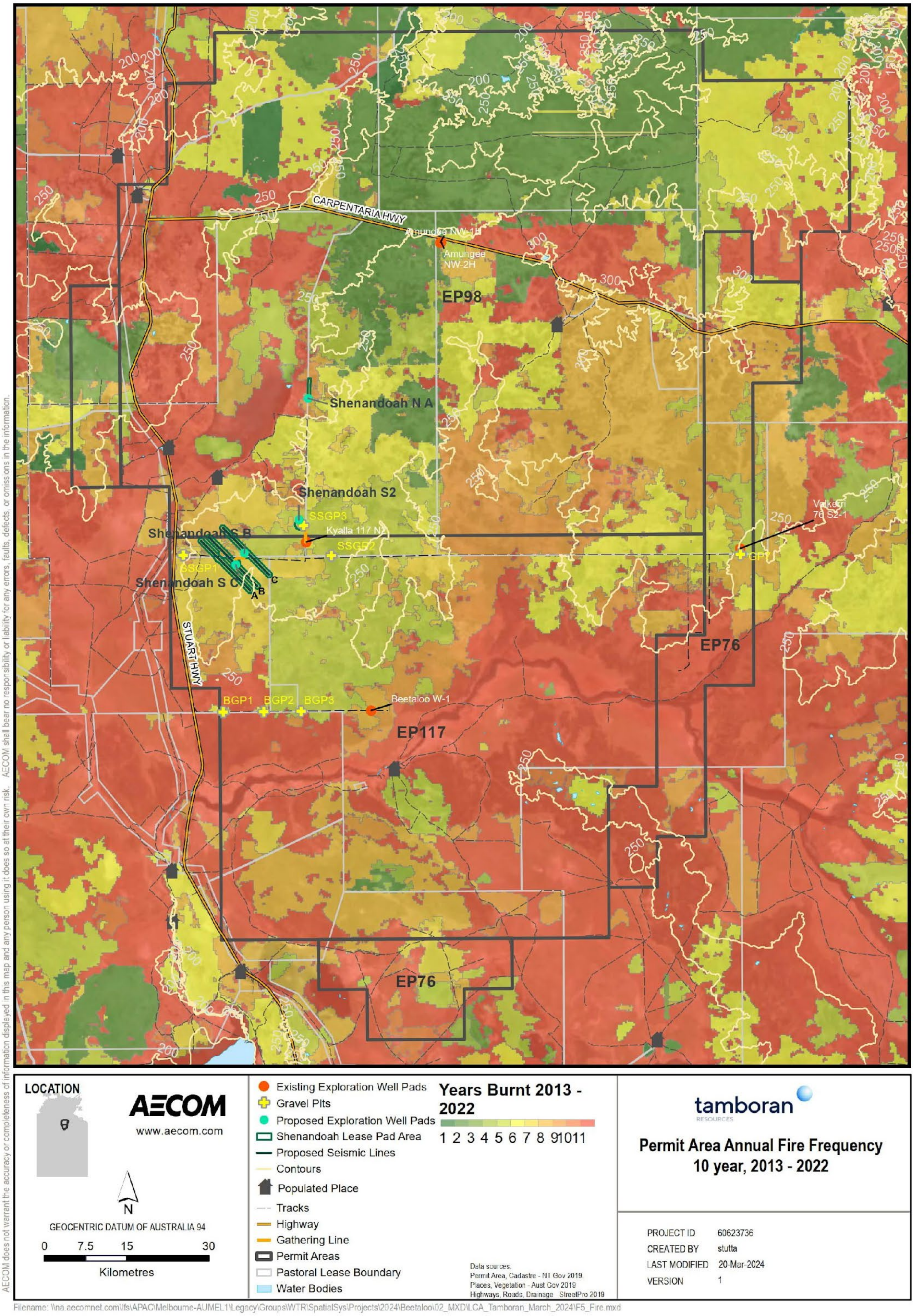


Figure 54: Fire frequency map

4.2.5 Fauna

A review of the SREBA (2022) reveals that a total of 354 vertebrate species were recorded from all surveys and incidental observations during the SREBA and GBA studies in the Beetaloo Sub-basin, indicating relatively high total vertebrate species richness but no species endemism within the SREBA study area. Species consisted of 202 bird, 99 reptiles, 39 mammals and 14 amphibians.

The Shenandoah South E&A program primarily comprises open woodland consisting of mixed Eucalyptus/ Corymbia species with a mixed tussock grass understorey. Often, scattered stands of Bullwaddy/ Lancewood communities occur across the proposed sites and individuals of both species are dispersed throughout. In the wider landscape, including proposed access tracks and seismic lines, additional vegetation types include those associated with drainage lines, grasslands/floodplains and Acacia sp. shrublands.

Eucalyptus/Corymbia sp. woodland provides habitat for a range of species. The proposed disturbance areas had high native grass cover and included 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. 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 Northern Shrike-tit (*Falcunculus frontatus whitei*) are rare and known to utilise this habitat (Ward, 2008). Many of the sites have a high density of hollow-bearing trees that provide important habitat for many fauna species. Avoiding clearing large hollow-bearing trees will reduce the impact to native wildlife within the EPs.

The Lancewood/Bullwaddy vegetation community provides shady habitat for fauna within a hot arid landscape, including species as the Spectacled Hare-Wallaby (*Lagorchestes conspicillatus leichardtii*) and the Northern Nailtail Wallaby (*Onychogalea unguifera*) (PWCNT, 2005).

No fauna sightings to enable identification were recorded within the Shenandoah South E&A program during the April 2023 field survey.

4.2.5.1 Threatened fauna

A search of the DCCEEW Protected Matters database of nationally significant fauna (PMST) and records from the NT Government Fauna Atlas database (NR Maps) was undertaken at 10 km and 50 km of the proposed well sites and access tracks. The search results indicate the potential presence of 18 fauna species listed as threatened under the EPBC Act and/or the Territory Parks and Wildlife Conservation Act (TPWC Act). These included ten birds, five mammals, two reptiles and one shark.

The likelihood of occurrence assessment 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 project area. As some areas in the proposed well pad area have not been subject to intensive survey and some species are very cryptic, a conservative approach has been taken to assess species presence. A full description of each species, their distribution and habitat associations are provided in Table 52.

No habitat that can be classified as critical for the survival of threatened fauna was identified within the Shenandoah South E&A area. However, some species may occur and are known to occur in the wider landscape. Threatened species that potentially occur include:

- Gouldian Finch *Erythrura gouldiae* (Endangered EPBC Act, Vulnerable TPWC Act)
- Grey Falcon Falco hypoleucos (Vulnerable EPBC Act and TPWC Act)
- Northern Shrike-tit Falcunculus whitei (Vulnerable EPBC Act)
- Painted Honeyeater Grantiella picta (Vulnerable EPBC Act and TPWC Act)
- Pale Field-rat Rattus tunneyi (Vulnerable TPWC Act)

- Common Brushtail Possum (northern) Trichosurus vulpecula arnhemensis (Vulnerable EPBC Act)
- Plains Death Adder Acanthopsis hawkei (Vulnerable EPBC ACT and TPWC Act)
- Northern Blue-tongue Skink Tiliqua scincoides intermedia (Critically Endangered EPBC Act)
- Yellow-spotted Monitor Varanus panoptes (Vulnerable TPWC Act).

As records of species may be limited in remote areas the precautionary principle has been applied during the assessment. There are some species that have been assessed as possibly occurring even though their primary habitat is not found within the proposed sites or access tracks. These include species that are associated with ephemeral wetlands, low lying areas that may be seasonally inundated and creeks. During the wet and early dry season these areas may sustain threatened species such as wetland birds (including migratory species).

Gouldian Finch

Research has shown that critical components of suitable habitat for the Gouldian Finch include suitable nesting trees during the breeding season (particularly *Eucalyptus tintinnans*, *E. brevifolia* or *E. leucophloia*), a water source and a diverse range of favoured annual and perennial grasses (Dostine & Franklin, 2002).

No nesting habitat was recorded during the surveys, and it is unlikely this species breeds in close vicinity to the exploration well sites within the Shenandoah South E&A Program. During the wet season, Gouldian Finches move from breeding habitat on hillsides with suitable trees down to lower lying areas where they forage on perennial grasses such as *Triodia* sp., *Alloteropsis semialata*, and *Chrysopogon fallax* (Palmer et al. 2012). Some of the perennial grasses were recorded during recent surveys so potential foraging habitat is present; however, there are limited records in the vicinity.

The proposed exploration well pad areas, seismic lines, gravel pits and vegetation sites were surveyed for Gouldian Finch, congruent with the Northern Shrike-tit surveys. Call playback was not undertaken for Gouldian Finch. Primary nesting trees such as *Eucalyptus brevifolia*, *Eucalyptus leucophloia* and *Eucalyptus tintinnans* were not observed in the area. Corymbia and Eucalyptus trees that are potentially suitable for nesting and perennial grasses suitable for feeding were observed at several sites. Habitat in the Shenandoah South E&A Program area is moderately suitable for Gouldian Finch, but critical habitat was absent. No Gouldian Finch were observed during the bird surveys (Figure 55).

The SREBA species distribution model for Gouldian Finch indicates a low probability of the species occurring throughout most of the project area, as displayed below inset (Young *et al*, 2022).

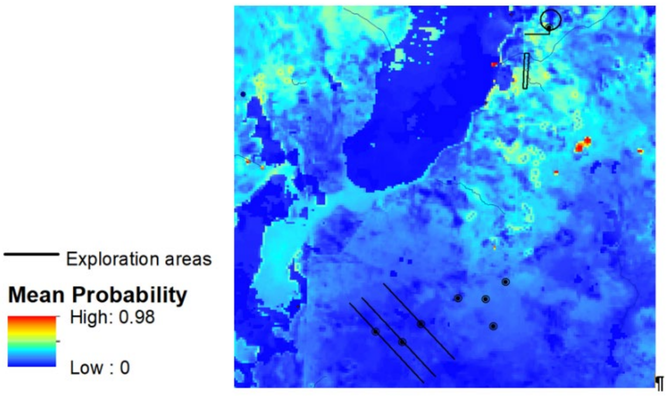


Figure 55: Mean probability of presence of Gouldian Finch within the exploration areas (Young *et al.*, 2022)

Grey Falcon

The Grey Falcon (*Falco hypoleucos*) is a widespread species listed as Vulnerable in the NT and considered possibly present in the study area. The species occurs in low densities throughout arid and semi-arid areas of Australia (DEPWS, 2021a). The species is known to nest on repeater towers in the region, including one site located approximately 100 km south-west of the Shenandoah South E&A program area where the species bred in 2014 (Jonny Schoenjahn, personal communication, 2022).

The species is also known to nest in the tallest trees along watercourses, such as Red River Gums (Eucalyptus camaldulensis) (TSSC, 2020). Grey Falcon may forage within the Shenandoah South E&A Program but is unlikely to be impacted by project activities because it is unlikely suitable nesting trees would be cleared.

One repeater tower located within the Tamboran's EPs next to the Carpentaria Highway was surveyed for Grey Falcon. The species was not detected.

While the risks to Gouldian Finch are low, impacts can be reduced by avoiding impacts to large hollow bearing trees with a trunk diameter greater than 25 cm at 1.3 m above the ground (NT Land Clearing Guideline).

Northern Shrike-tit

The Northern Shrike-tit lives in dry Eucalypt forests and woodlands where it feeds on insects from the canopy and under bark. It has been recorded in wet Melaleuca open woodlands and woodlands dominated by Nutwood (*Terminalia arostrata*) and Bloodwoods with flaky bark and ironwood (Ward, 2008). In the NT, nesting has been recorded from September through to January and nests are built in terminal branches at the top of trees (Ward *et al*., 2009). The stronghold of this species is north of the Shenandoah E&A area, with NR Maps showing only four records south of -16.25° latitude. Targeted surveys by the NT Government in the Beetaloo Basin failed to detect the species south of -16.0° latitude despite significant survey effort (>30 call playback surveys) (Young et al., 2022).

Although it is possible the Northern Shrike-tit may be present in the area, it is unlikely to represent an important area for this species. During the May 2022 and April 2023 field survey call-playback was undertaken for Northern Shrike-tit. Call-playback was undertaken for approximately 5 minutes at all the proposed exploration well pad areas. Following 5 minutes of call playback the area was surveyed for approximately 10 minutes with binoculars. The search area was within 50 m of where call playback was undertaken, covering an approximate 0.8 ha search area. No Northern Shrike-tits have been observed during these surveys. The targeted call-playback surveys failed to detect the bird at the exploration well pads or the vegetation assessment sites.

Painted Honeyeater

The Painted Honeyeater (*Grantiella picta*) has been known to occur in region, however, given it does not breed in the NT it would only be present intermittently for foraging. Suitable habitat for the species potentially occurs within the Shenandoah South E&A program area. The area proposed for clearance is relatively small compared to available suitable habitat within the region.

Pale Field-rat

The Pale Field-rat occurs in a wide range of habitats, including tall grasslands and woodlands (Cole & Woinarski, 2002). There are no recent records of the species within the region; however, this may reflect a lack of survey effort. Suitable habitat for the species occurs within the Shenandoah South E&A program. The proposed area of impact is relatively small compared to available suitable habitat within the region.

Common Brushtail Possum

Recent surveys have detected Common Brushtail Possum (Trichosurus vulpecula arnhemensis) on Kalala Station (NTG Flora & Fauna, personal communication, 2022). Suitable woodland habitat is contiguous through the landscape; therefore the species potentially occurs within the Shenandoah South E&A Program. Given the large amount of suitable habitat within the region comparative to the project footprint the risk to regional populations of the species is small.

Plains Death Adder

Suitable habitat for the Plains Death Adder consists of flat, treeless, cracking-soil riverine floodplains (Cogger, 2000). A population of the species occur in the Barkly Tableland from the Northern Territory to central-western Queensland. In the Beetaloo Basin Records of the species occur close to Lake Woods, Lake Sylvester and Lake Tarrabool. The species may occur within the project area, particularly following heavy wet season rainfall.

Northern Blue-tongue Skink

The Northern Blue-tongue Skink occurs in a wide variety of vegetation communities, eucalypt woodland and savanna, sparse and dense shrubland, and spinifex and tussock grassland. Areas of dense vegetation that provide cool and moist conditions within hot, dry, and flammable landscapes are critical habitat for the survival of the species, as such habitat provides the Northern Blue-tongue Skink with food, water and protection from environmental exposure and predation. Examples of such habitat includes rainforest and vine thicket, riparian forests, well-vegetated creeks and drainage lines, well-vegetated swamps and springs, and dense thickets within floodplains, grasslands, shrublands, savannas and woodlands (DCCEEW, 2023).

Several recent (2020-2022) records of the species occur within 100 km, and suitable habitat occurs within the project area. The Northern Blue-tongue Skink was recently listed as Critically Endangered under the EPBC Act in December 2023, therefore the species has not been assessed under the SREBA assessments.

Yellow-spotted Monitor

The Yellow-spotted Monitor (*Varanus panoptes*) occurs across northern Australia where it occupies a variety of habitats, including grasslands and woodlands (Ward et al., 2012). Most records of this species are from the Top End, though it has been recorded in the Barkly Tablelands. The species likely occurs close to wetlands and riparian habitats within the permit areas; however, such habitat won't be impacted by proposed activities.

The SREBA Terrestrial Ecosystem Report developed a species distribution for Yellow-spotted Monitor that indicated low-high probability for the species throughout the north of the project area, while the probability is low in most parts of the south of the project area, as displayed in Figure 56 (Young et al, 2022).

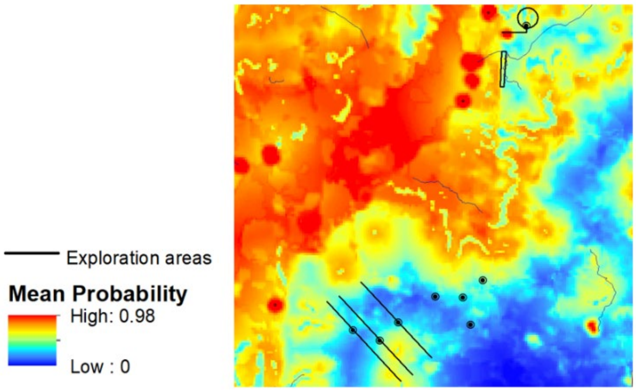


Figure 56: Mean probability of presence of Yellow-spotted Monitor within the exploration areas (Young *et al.*, 2022)

As records of species may be limited in remote areas the precautionary principle has been applied. There are some species that have been assessed as possibly occurring even though their primary habitat is not found within the proposed sites or access tracks. These include species that are associated with ephemeral wetlands, low lying areas that may be seasonally inundated and creeks. During the wet and early dry season these areas may sustain threatened species such as wetland birds (including migratory species).

Table 55: Commonwealth EPBC Act and Territory TPWC Act listed threatened species and likelihood occurrence assessment within the new sites

Species	Listed status		Distribution	Habitat	Likelihood
	Commonwealth (Cth)[1]	NT[2]			
Birds					
Curlew Sandpiper *Calidris ferruginea*	Marine Migratory	VU	In the NT this species occurs around Darwin, north to Melville Island and Cobourg Peninsula, and east and south-east to Gove. It has been recorded inland from Victoria River Downs and around Alice Springs (Higgins & Davies, 1996).	Coastal habitats, inland it has been found around lakes, dams and ephemeral/permanent waterholes.	Unlikely No suitable habitat within project area
Red Goshawk *Erythrotriorchis radiatus*	VU	VU	Found across most of Northern Australia, in the NT most records are from the Top End but there are records from central Australia (Pizzey & Knight, 2012).	Red Goshawks occupy a range of habitats, often at ecotones, including coastal and sub-coastal tall open forest, tropical savannahs crossed by wooded or forested watercourses. In the NT, it inhabits tall open forest/woodland as well as tall riparian woodland (Aumann & Baker-Gabb, 1991).	Unlikely No records and no suitable breeding habitat within the project area
Gouldian Finch *Erythrura gouldiae*	EN	VU	Formerly widespread across northern Australia. In the NT they are found in the Top End south past Daly Waters (Palmer *et al.*, 2012).	Gouldian Finches occupy different habitat types in the breeding and non-breeding season. Breeding habitat consists of hillsides with suitable nesting trees. Outside of the breeding season they are found in lowland drainages to feed on suitable perennial grasses (Dostine & Franklin, 2002).	Possible The closest record occurs 75 km east of the project area. Suitable foraging habitat is present
Grey Falcon *Falco hypoleucos*	VU	VU	This species has a widespread distribution and records occur throughout the NT. However, most records are from arid and semi-arid regions (Pizzey & Knight, 2012).	Grey Falcon is typically found on inland drainage systems in lightly treed lowland plains, pastoral lands, timbered watercourses and, occasionally, the driest deserts (DEPWS, 2021a).	Possible The species may forage within the project area but is unlikely to breed

Species	Listed status		Distribution	Habitat	Likelihood
	Commonwealth (Cth)[1]	NT [2]			
Northern Shrike-tit *Falcunculus frontatus whitei*	VU	NT D	This species has been recorded from widely scattered localities from near Timber Creek to the east Gulf Country, north to Kakadu National Park and in north-eastern Arnhem Land (DEPWS, 2021b).	Occupies wet and semi-arid melaleuca and eucalypt open woodlands. May be associated with bloodwoods with flaky bark and ironwood (Ward, 2008).	Possible No records in the vicinity of the project area. Sub-optimal habitat is present. Call-playback surveys failed to detect the species
Painted Honeyeater *Grantiella picta*	VU	VU	This species is migratory based on seasonal variation in occurrence. They breed on the inland slopes of the Great Dividing Range. After the breeding season they sometimes occur in the north-eastern NT, south of the Roper River (Garnett & Baker, 2021).	Painted Honeyeater inhabits woodlands dominated by Acacia and/or Eucalyptus species and open forests but prefers habitats with abundant mature trees that host mistletoes. The species specialises on the fruit of mistletoes although it may also forage on nectar and insects (Garnett *et al.*, 2011).	Possible No recent records occur close to the project area; however suitable habitat is present
Night Parrot *Pezoporus occidentalis*	EN	EN	Night Parrot was once widespread across arid and semi-arid regions. Recent confirmed records of the species come from widely separated locations in western Queensland and Western Australia (DEPWS, 2021c).	This species occupies spinifex grasslands in stony or sandy areas, in ephemeral herblands, samphire and chenopod shrublands on floodplains (DEPWS, 2021c).	Unlikely Suitable habitat does not occur within the project area. No recent records occur within the area
Princess Parrot, Alexandra's Parrot *Polytelis alexandrae*	VU	VU	This species irregularly occurs across the arid zone from near Oodnadatta in South Australia, west to near Coolgardie and the east Murchison River in Western Australia, and north to near the Fitzroy River in Western Australia and to Howell Ponds in the Northern Territory (Higgins 1999; Baxter & Henderson 2000).	Princess Parrot is usually recorded from shrubland in swales between sand dunes, with occupied sites typically having a variety of shrubs (including *Grevillea*, *Hakea*, *Cassia* and *Eremophila* species) among scattered emergent trees, with a ground-cover of spinifex *Triodia* species. The species occurs less often in woodland. The princess parrot forages on the ground and in	Unlikely No recent records occur close to the project area. Suitable habitat limited.

Species	Listed status		Distribution	Habitat	Likelihood
	Commonwealth (Cth)[1]	NT [2]			
				flowering shrubs and trees (Higgins 1999; Pavey et al. 2014)	
Australian Painted Snipe *Rostratula australis*	CE	VU	Records of the species occur across the NT. More recent records come from McMinns Lagoon near Darwin, Yellow Waters in Kakadu, the Sturt Plateau, the Barkly and the Tanami (DEPWS, 2021c).	Australian Painted Snipe prefers a habitat of recently flooded temporary vegetated wetlands during the non-breeding period and brackish temporary freshwater wetlands with minimum vegetation during breeding periods. Birds usually forage in thick, low vegetated areas during the day (Curtis *et al*, 2012).	Unlikely Suitable habitat does not occur within the project area.
Masked Owl (northern) *Tyto novaehollandiae kimberli*	VU	VU	The subspecies occurs in northern Australia, although its distribution is not well known. In the NT, occurs from Cobourg south to Katherine and the VRD and east to the McArthur River (DoE, 2014).	This species inhabits tall open eucalypt forest in the NT, especially those associated with *Eucalyptus miniata* and *E. tetrodonta (*Woinarski, 2007*)*. Also found in riparian and monsoonal forest and rainforest (DoE, 2014).	Unlikely No recent records occur close to the project area and suitable habitat is not present.
Mammals					
Northern Quoll *Dasyurus hallucatus*	CE	EN	The species once occurred throughout most of Northern Australia although it is has declined across much of its range (Woinarski & Hill, 2012). In the NT it is found in the Top End as far southeast as Borroloola	Northern Quolls do not have highly specific habitat requirements although the most suitable appear to be rocky habitats. They occur in a variety of habitats across their range, including open forest and woodland. Daytime den sites provide important shelter. Shelter sites include rocky outcrops, tree hollows, hollow logs, termite mounds, goanna burrows and human dwellings (Woinarski & Hill, 2012).	Unlikely No recent records, occur in the vicinity of the project area and habitat is sub-optimal
Ghost Bat *Macroderma gigas*	VU	NT D	The species' range in northern Australia is from relatively arid conditions in the Pilbara region of Western Australia to humid	The distribution of Ghost Bats is influenced by the availability of suitable caves and mines for	Unlikely Suitable habitat does not occur within the project area.

Species	Listed status		Distribution	Habitat	Likelihood
	Commonwealth (Cth)[1]	NT [2]			
			rainforests of northern Queensland. A large colony occurs in a series of gold mine workings at Pine Creek, NT. This species has also been recorded throughout the mainland Top End north of approximately 17° latitude (DEPWS, 2021d).	roost sites. The species often roosts in a deep crack or cave during the day (DEPWS, 2021d).	
Greater Bilby *Macrotis lagotis*	VU	VU	This species occurs in south-western Queensland and in arid north-western Australia (Western Australia and Northern Territory). This species was previously widespread in arid and semi-arid Australia (Pavey, 2006). The most northern records are from Newcastle Waters and Wave Hill (Southgate & Paltridge, 1998).	In the NT, this species is found on sandy soils dominated by spinifex. Also hummock grassland associated with low lying drainage systems and alluvial areas (Pavey, 2006). Recent surveys in the Beetaloo region have recorded Greater Bilby in Eucalyptus and Corymbia woodlands mixed tussock and hummock grasses in sandy/loam soils (Davis *et al*., 2021).	Unlikely No recent records, occur in the vicinity of the project area and suitable habitat is not present.
Bare-rumped Sheath-Tailed Bat *Saccolaimus saccolaimus nudicluniatus*	CE	DD	Wide distribution from India through south-eastern Asia to the Solomon Islands, including north-eastern Queensland and the NT. Records of the species in the NT are sparsely scattered across the Top End (DEPWS, 2021e).	Previous specimens have been collected from Open *Pandanus* woodland fringing the sedgelands of the South Alligator River in Kakadu National Park, and from eucalypt woodlands and forests from coastal and adjacent inland areas (DEPWS, 2021e).	Unlikely No recent records, occur in the vicinity of the project area and habitat is not suitable.
Common Brushtail Possum *Trichosurus vulpecula arnhemensis*	VU	NTD	The Common Brushtail Possum (northern subspecies) occurs discontinuously from the Gulf of Carpentaria hinterland near Borroloola, NT westward to the Kimberley, WA (TSSC, 2020b).	The species occurs mainly in tall eucalypt open forests with large hollow-bearing trees, particularly where the understorey includes some shrubs that bear fleshy fruits (TSSC, 2020b).	Possible Recent records of the species occur at nearby Kalala Station and suitable habitat occurs within the project area.

Species	Listed status		Distribution	Habitat	Likelihood
	Commonwealth (Cth)[1]	NT [2]			
Pale Field-rat *Rattus tunneyi*	-	VU	Pale Field-rat inhabits higher rainfall areas of northern and eastern Australia, including the Top End of the NT (Menkhorst & Knight, 2011).	This species favours dense vegetation found along rivers where it occupies burrows in loose colonies (Cole & Woinarski, 2002). Pale Field-rat occurs within a variety of habitats including woodlands if a dense understorey of grasses is present (Menkhorst & Knight, 2011).	Possible One record from 1999 occurs approximately 55 km from the project area. Suitable habitat occurs within the project area.
Reptiles					
Plains Death Adder *Scanthophis hawkei*	VU	VU	Fragmented populations of the plains death adder are known to occur in the Mitchell Grass Downs of western Queensland, the Barkly Tableland on the NT / Queensland border and east of Darwin in the NT. In the NT this species is found in the floodplains of the Adelaide, Mary and Alligator Rivers and the Barkly Tablelands (Ward & Phillips, 2012).	Suitable habitat for the plains death adder consists of flat, treeless, cracking-soil riverine floodplains (Cogger, 2000).	Possible Moderately suitable habitat occurs within the project area. A record from 2019 occurs within 60 km of the project area.
Gulf Snapping Turtle *Elseya lavarackorum*	-	EN	Gulf Snapping Turtle is restricted to rivers draining into the Gulf of Carpentaria, including the Calvert and Nicholson River systems (DEPWS, 2021f)	The species occurs in deep pools in the upper catchments of permanently flowing spring-fed river systems, particularly in areas with intact riparian vegetation (DEPWS, 2021f).	Unlikely No rivers or large permanent water bodies occur within the project area
Northern Blue-tongue Skink *Tiliqua scincoides intermedia*	CE	-	The northern blue-tongue skink occurs across northern Australia from Eighty Mile Beach in Western Australia (WA), across the southern Kimberley and Top End of the Northern Territory (NT), to approximately the Gregory Downs / Cloncurry area in western Queensland (DCCEEW, 2023a).	The northern blue-tongue skink occurs in a wide variety of ecosystems, including riparian forest, vine scrub, monsoon rainforest, pandanus-lined gorges, melaleuca forest, eucalypt woodland and savanna, sparse and dense shrubland, and spinifex and tussock grassland.	Possible Recent records occur nearby and suitable habitat occurs within the project area.

Species	Listed status		Distribution	Habitat	Likelihood
	Commonwealth (Cth)[1]	NT [2]			
				GPS tracking has shown that northern blue-tongue skinks move widely across savanna landscapes in the wet-season, but they spend most (~ 95 %) of their time in small, fragmented patches of relatively dense vegetation that provide cool, shaded, and damp conditions (DCCEEW, 2023a).	
Mertens' Water Monitor *Varanus mertensi*	EN	VU	Mertens' Water Monitor has a broad distribution that encompasses coastal and inland waters across the far north of Australia. In the NT, the species has been recorded across most of the Top End and the Gulf region (DEPWS, 2021k).	Mertens' Water Monitor is highly aquatic and rarely ventures more than 5-10 m from the edge of water. The species has been recorded in the following habitat: Perennial and semi-permanent pools, including springs, seeps, swamps, creeks and gorges, The margins of permanent streams, rivers and lakes, Floodplain billabongs, lagoons, swamps and soaks, Perennial waterholes in woodlands, Man-made irrigation channels and the margins of dams (DCCEEW, 2023b).	Possible Sparse records at similar latitudes occur across the NT, and suitable habitat is sparsely distributed across the project area.
Mitchell's Water Monitor *Varanus mitchelli*	-	VU	Michell's water monitor occurs across the wet-dry tropics of northern Australia from the far west Kimberley of WA across the Top End of the NT to far northwest of Queensland (DCCEEW, 2023c)	Mitchell's water monitor inhabits freshwater and saline wetlands that range from seasonal gorges in upper catchments to large rivers and coastal floodplains. It is recorded from rivers, creeks, gorges, springs, lagoons, swamps, mangroves, and foreshores (DCCEEW, 2023c).	Unlikely No recent records occur at similar latitudes and the project area appears to be south of the species current distribution.
Yellow-spotted Monitor *Varanus panoptes*	-	VU	Occurs across a broad geographic range across northern Australia. In the NT most records are from the Top End but occurs as far south as Renner Springs (Ward *et al*., 2012).	Occupies a variety of habitats including coastal beaches, floodplains, grasslands and woodlands (Ward *et al*., 2012).	Possible 2017 records occur approximately 20 km from the project area and suitable habitat is present.

Species	Listed status		Distribution	Habitat	Likelihood
	Commonwealth (Cth)[1]	NT [2]			
Shark					
Freshwater Sawfish *Pristis pristis*	VU	VU	Freshwater Sawfish may potentially occur in all large rivers of northern Australia from the Fitzroy River, Western Australia, to the western side of Cape York Peninsula, Queensland. It is mainly confined to the main channels of large rivers (Allen 2000, pers. comm.).	This species in northern Australia appears to be confined to freshwater drainages and the upper reaches of estuaries, occasionally being found as far as 400 km from the sea (Thorburn et al. 2007; Whitty et al. 2008).	Unlikely No rivers or large permanent water bodies occur within the project area.

[1] Cth Status: EN, Endangered; VU, Vulnerable as listed under the *EPBC Act*

[2] NT Status: EN, Endangered; VU, Vulnerable; NTD, Near Threatened; DD, Data Deficient as listed under the *TPWC Act.*

4.2.5.2 Marine and Listed Species

The EPBC Act Protected Matters database indicated the potential presence of 20 migratory and marine listed species within the Shenandoah South sites (Table 56). Of these species, three are considered likely to occur, nine possibly occur and eight are unlikely to occur within the Shenandoah South sites. Several migratory wetland bird would possibly occur within the area in ephemeral wetlands that would fill up following wet season rainfall. The Shenandoah South sites does not contain critical habitat for any migratory or marine listed species.

Table 56: Migratory listed species potentially occurring within the new sites

Scientific name	Common name	EPBC Act	Likelihood of occurrence
Actitis hypoleucos	Common Sandpiper	Migratory, Marine	Possible
Anseranas semipalmata	Magpie Goose	Marine	Possible
Apus pacificus	Fork-tailed Swift	Migratory, Marine	Likely
Bubulcus ibis (Ardea ibis)	Cattle Egret	Marine	Likely
Calidris acuminata	Sharp-tailed Sandpiper	Migratory, Marine	Possible
Calidris ferruginea	Curlew Sandpiper	Migratory, Marine	Possible
Calidris melanotos	Pectoral Sandpiper	Migratory, Marine	Possible
Cecropis daurica	Red-rumped Swallow	Migratory, Marine	Unlikely
Charadrius veredus	Oriental Plover	Migratory, Marine	Possible
Chalcites osculans (Chrysococcyx osculans)	Black-eared Cuckoo	Marine	Possible
Cuculus optatus	Oriental Cuckoo	Migratory	Possible
Glareola maldivarum	Oriental Pratincole	Migratory, Marine	Possible
Haliaeetus leucogaster	White-bellied Sea-eagle	Marine	Unlikely
Hirundo rustica	Barn Swallow	Migratory, Marine	Unlikely
Merops ornatus	Rainbow Bee-eater	Marine	Likely
Motacilla cinerea	Grey Wagtail	Migratory, Marine	Unlikely
Motacilla flava	Yellow Wagtail	Migratory, Marine	Unlikely
Pristis pristis	Freshwater Sawfish	Migratory	Unlikely
Rostratula australis (Rostratula benghalensis)	Australian Painted Snipe	Migratory, Marine	Unlikely

4.2.5.3 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*), and domestic cattle (*Bos Taurus*).

During December 2022 and April 2023 field survey evidence of current cattle grazing or grazing within the last 1 to 2 years was recorded at most assessed sites.

The cane toad is known to be present in the project area and the Commonwealth DCCEEW recognises this species as a 'key threatening process' related to their impacts on biodiversity through predation, competition, land degradation and poisoning. In the NT, the cane toad has been implicated in the decline of several species including many reptiles such as the Plains Death Adder (*Acanthophis hawkei*), King Brown Snake (*Pseudechis australis*) and *Varanus* spp. (Smith & Phillips, 2006).

Pest predators such as cats likely occur within the project area, though their abundance is difficult to assess due to their cryptic nature. Introduced predators such as cats can impact many vertebrates (Dickman, 1996 & 2009). One of the primary concerns of introduced predators are the impacts on reptiles and ground-dwelling birds. Feral cats are also believed to be one of the factors that have led to the decline of the threatened ground-dwelling Partridge Pigeon (Woinarski *et al.* 2007).

4.2.5.4 Groundwater dependent ecosystems

A search of the National Groundwater Dependent Ecosystems (GDE) was conducted in September 2023 (BOM, 2017b), indicating 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.

Until recently, all known and moderate potential GDE locations occurred at distances >20 km from the vicinity of the proposed regulated activities. The impact on these units from Tamboran's total water extraction across the Beetaloo exploration area was assessed during the granting of WEL GRF 10285.

Stygofauna comprise aquatic taxa occurring in groundwater aquifers and subterranean water bodies. Stygofauna inhabit the interstitial spaces of the cavities of alluvial, sedimentary and karstic aquifers. Data is available that can provide an indication of the likelihood of stygofauna presence, with Hose, *et al* (2015) outlining the following factors affecting the distribution of stygofauna:

- **Formation type:** Stygofauna are predominantly found in aquifers with large (mm or greater) pore spaces, which a more common for alluvial, karstic and some fractured rock aquifers.
- **Depth below ground level:** The abundance and diversity of stygofauna typically decreases with depth below ground, with fauna are rarely found more than 100 m below ground level (Hose, *et al* 2015).
- **Proximity of exchange and recharge:** Stygofauna are more abundant in areas of surface water-groundwater exchange, compared to deeper areas or those further along the groundwater flow path remote from areas of exchange or recharge

A characterisation of the stygofauna and microbiological assemblages of the Beetaloo Sub-basin was conducted as part of the Gas Industry Social and Environment Research Alliance (GISERA) (Rees *et al.,* 2020). The study collected data from 3 locations north of Elliott within the vicinity of the Shenandoah South E&A program. The study found two stygofauna specimens (*Parisia unguis* and *Bathynellaceae Bresvisomabathynella* sp.) and stygofauna eDNA from the Carpentaria Highway Roadside Bore (RN00592) located over 50 km north of the Shenandoah South E&A program area, while there were no reported findings of stygofauna in the Hayfield Homestead bore and the Sturt Plains Homestead bore. However, the study did identify eDNA which may indicate stygofauna presence. The results are consistent with Hose *et al*

(2015), which indicates stygofauna are likely to be present at lower abundance at the observed groundwater depth within the Shenandoah South sites (~106 m below ground level).

These results are supported by the extensive field surveys of aquatic groundwater fauna undertaken in October 2021 and May 2022, as part of the SREBA aquatic ecosystem studies (Humphreys *et al.*, 2022). A total of 66 groundwater bores were sampled, with the sites selected to obtain spatial coverage across the study area and to stratify sampling by the hydrogeological formations present (Humphreys *et al.*, 2022). Results of the surveys returned a total of 280 stygofauna specimens across 28 taxa, with the highest diversity of stygofauna detected in the Tindall limestone aquifer (Humphreys *et al.*, 2022), which lies approximately 100 km northwest of the Shanandoah South E&A Program and Kyalla 117 N2 site.

The results of the aquatic ecosystem studies (Humphreys *et al.*, 2022) further indicate that total taxa richness across 8 taxa groups occur in riverine sites in northern-draining catchments; specifically 8 of the top 10 sites occur in the Roper catchment, with the maximum number of species (80) recorded within a seasonally flowing channel of the Little Roper River, which is over 200 km NW of the proposed regulated activities.

Based on the outcomes of the studies above, the depth of the groundwater, likely low abundance of stygofauna and limited extraction draw down observed at the Kyalla extraction bores, concludes that impacts to stygofauna from extraction are considered highly unlikely. Any impacts are likely to be extremely localised, in the vicinity of metres.

This is supported by the NTG (2024) assessment Tamboran's WEL application, which is currently available for public comment. As stated in NTG (2024): *"The depth to the regional water table in the CLA aquifer ranges from 80 to 120 mbgl in the vicinities of the planned exploration sites, which indicates it is unlikely the aquifer is supporting any terrestrial or aquatic … GDEs. These groundwater depths are consistent with the findings of the … SREBA … Groundwater is considered unlikely to support terrestrial GDEs at water table depths exceeding 20 mbgl. The SREBA … identifies small, disparate areas of low to moderate confidence seasonal GDEs across the region, however these are likely to be associated with shallow, perched systems."*

Changes in groundwater quality may also result in impacts to stygofauna. Impacts to aquifers are mitigated through the following controls:

- Well design and construction to isolate aquifers.
- Use of low toxicity drilling fluid systems.
- Groundwater monitoring bores will be located on each site which will be used to detect changes in groundwater quality, with monitoring around existing wells not identifying any material changes in water quality likely to impact stygofauna.

Based upon the above information, the presence of significant assemblages of stygofauna in the area is considered limited and impacts considered unlikely.

4.3 Environmental and cultural sensitivities

4.3.1 Native Title

Three native title determinations have been finalised across the Shenandoah South E&A program with the most relevant being NTD21/2010 and NTD26/2010 (Table 57).

Table 57: Native title and IULA agreements current for the permit areas

Type	Site	Name	Summary
Native Title	Shenandoah South E&A program	NTD21/2010 Shenandoah Pastoral Lease	Native title exists in parts of the determination area and is held by the Kinbininggu and Bamarrngganja groups

Type	Site	Name	Summary
		NTD26/2010 Hayfield pastoral lease	Native title exists in parts of the determination area and is held by the Kinbininggu, Warranangku and Marlinja groups
		NTD27/2010 Beetaloo pastoral lease	Native title exists in parts of the determination area and is held by the Karranjinji, Bamarrnganja, Warranangku, Pinda (OT Downs) and Liga/Muwartpi groups

The Native Title Petroleum Exploration Agreement between Tamboran 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 site rehabilitation.

4.3.2 Archaeology assessment

Archaeological assessments were completed by AECOM in April 2023 for the proposed sites within the Shenandoah South E&A program. The assessment involved a desktop review of existing heritage data from the Australian Heritage Database, the NT Heritage Branch and the AAPA, previous archaeological survey reports prepared for the local area, as well as consultation with traditional owners of the study area and field inspection. The survey was designed around the archaeological predictive model that was initially established in 2007 and has been continually refined over the last 17 years through on ground (pedestrian) and aerial surveys (Appendix L).

The field surveys were conducted by an AECOM archaeologist and traditional custodians to identify sensitive landforms that may have cultural significance. The archaeological surveys involved aerial surveys of the proposed seismic lines and E&A sites, and vehicle and pedestrian surveys of all sites within the Shenandoah South E&A program apart from Shenandoah SA seismic line. On ground surveys / inspections on Shenandoah SA seismic line was unable to be completed because the area could not be accessed safely by helicopter due to dense vegetation cover. Based on the predictive model, the only sensitive feature identified along the proposed Shenandoah SA seismic line was Lancewood-Bullwaddy Woodland stands bordering seasonal water plains; however these were not identified as a "high priority" areas during the surveys by the archaeologist and traditional owners. Implementation of the unexpected find protocol procedure gives added protection, should a heritage find be identified during any land clearing / disturbance activities. Cultural managers are also proposed to be utilised for all line access and disturbance.

During the on ground surveys / inspections, 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. The archaeological assessment is provided in Appendix L.

The inspection results indicated that apart from the high priority areas identified along the Shenandoah S C and Shenandoah S B seismic lines, no other sensitive areas of high priority were identified. No artefacts or sensitive landforms of cultural significance within the activity areas for the Shenandoah South E&A program were identified. A large, medium density artefact scatter (TAM_23_AS_01) lies approximately 500 m to the south-east of the proposed Shenandoah N A well pad (Figure 57). The site of the artefact scatter is located within and around an identified sensitive landform zone, adjacent to a linear, seasonal water source and will be avoided (see Appendix L).

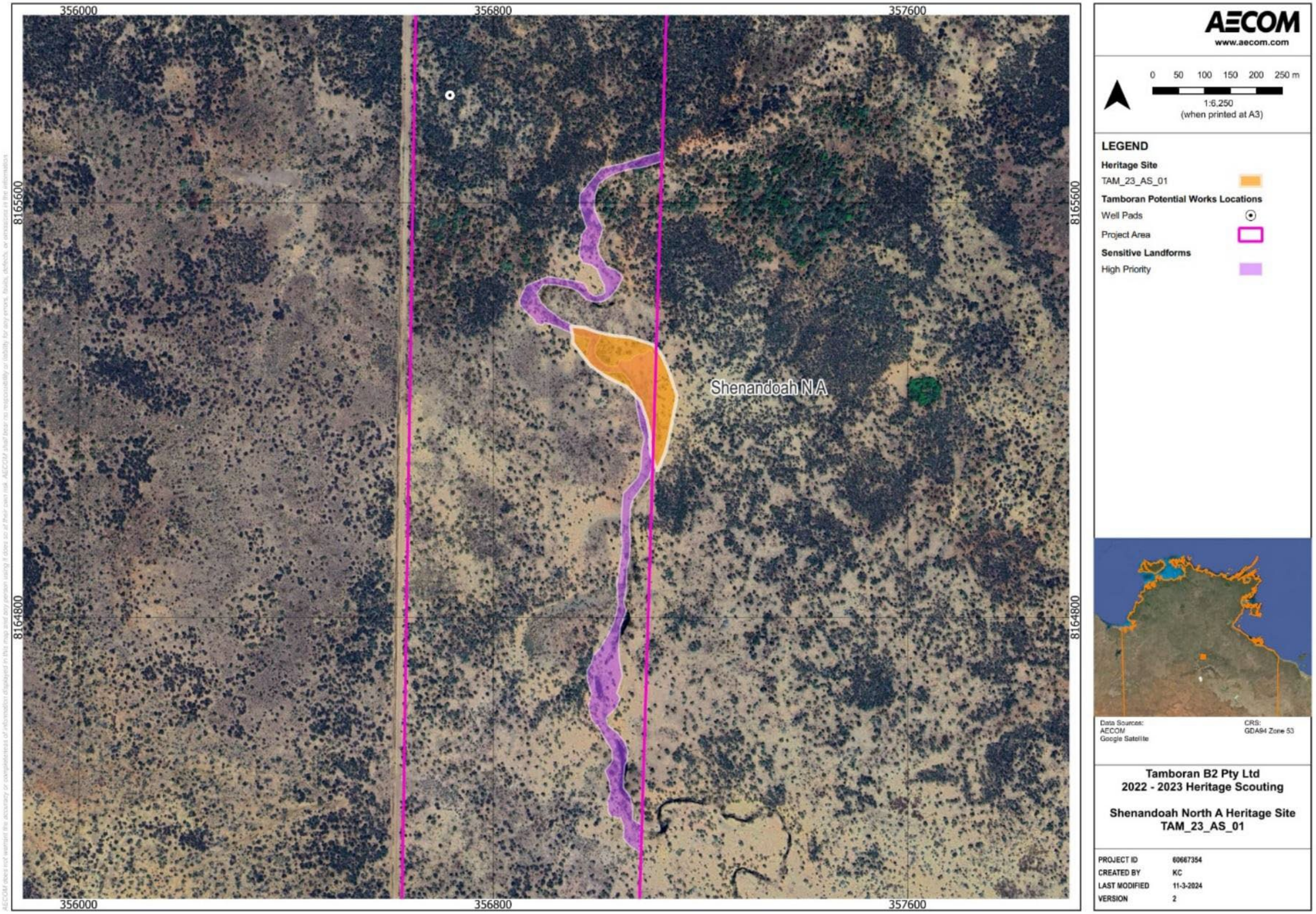


Figure 57: Location of artefact scatter TAM_23_AS_01 approximately 500 m to the south-east of the proposed Shenandoah N A site

An unexpected finds procedure has been developed to respond to any potential additional artifact or sacred site finds during Tamboran's activities, which is appended to the archaeological assessment (Appendix L).

4.3.3 Areas of cultural significance

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. The proposed activities at the Shenandoah S2, B, C, Shenandoah N A and Kyalla 117 N2 sites, including 2D seismic will occur within the subject land area which has been approved by the native title holders and the NLC and is currently under assessment by AAPA. Existing activities at Kyalla 117 N2 were approved under AAPA certificates: C2019/014, C2019/039 and C2023/049. One RWA is identified within the vicinity of the Shenandoah N A site (RWA3), which occurs west of, and parallel to a portion of the north-south pastoral access track leading to the site. No other RWAs were recorded within the Shenandoah South sites or the Kyalla 117 N2 site.

4.3.4 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.

4.3.5 Heritage assessment

A search of the Australia Heritage Database identified that no statutory listed heritage places were present within the proposed Shenandoah South E&A program.

Frew Ponds, a reserve paying tribute to the building and joining of the Overland Telegraph Line is located approximately 20 km west south-west of the proposed Shenandoah South E&A program and approximately 16 km south of the access track turn-in from the Stuart Highway.

No heritage places or artefacts are registered within the proposed impact areas.

4.3.6 Protected or conservation areas

There are no conservation reserves, national parks, world heritage places, Commonwealth land, heritage places or critical habitat areas listed under the EPBC Act located within or adjacent to the proposed sites.

The Bullwaddy Conservation Reserve lies 70 km – 87 km to the north-east of the Kyalla 117 N2 site and Shenandoah South E&A program. The EPBC Act Listed Lake Woods is located approximately 90 km – 100 km south of the Shenandoah South E&A Program sites and is listed on the National directory of important Wetlands.

The risks to this receptor through aquifer contamination, spills, sediment release, habitat destruction have been addressed in the risk assessment presented in Appendix M. The main mitigation measures/ factors include:

- As the proposed site are 100 km (direct) from Lake Woods, contamination is not likely to reach the area at any undiluted impactable state.
- Surface water flow is to the south into a tributary of Newcastle Creek which flows into Lake Woods via Newcastle Waters. Any spill would need to exceed the capacity of the site bund and travel over approximately 100 km to reach Lake Woods. A surface water spill cannot impact the Bullwaddy Conservation Area as it lies north-east of the existing Kyalla 117 site and proposed Shenandoah South sites and is not in the overland flow path from any of the proposed sites.
- Groundwater depth throughout the Bullwaddy Conservation Reserve is approximately 70 m of depth with vegetation not being able to access groundwater at this depth. The flow path (north-west) is not in alignment with the conservation area, meaning a valid contamination pathway does not exist.

4.4 Social environment

4.4.1 Social context

The proposed EMP activities will occur within the Roper Gulf regional Council area, which covers 201,000 km^2. The approximate population is estimated for the Roper Guld region of 5,592 people (Roper Gulf Council Regional Plan 2022-23).

The closest neighbouring regional towns and communities identified as being within proximity to these regulated activities include:

- Dunmarra (~30 km)
- Elliott (~80 km)
- Daly Waters (~70 km)
- Newcastle Waters (~60 km)

There is one small area of Aboriginal freehold land known as Jingaloo on EP 117, which is located approximately 80 km from the proposed Shenandoah South sites.

4.4.2 Pastoral activity

The proposed 2D seismic and Shenandoah S2, S B and S C well pads are located on the Hayfield / Shenandoah East Stations. The existing Kyalla 117 N2 well pad is located on the Shenandoah East Station. Within the Tamboran's Beetaloo exploration permit area there are nine pastoral properties (Table 55). All the land within the permit area is leasehold land.

Table 58: Pastoral properties in the permit area

Pastoral property	Permit areas			Contacts
	EP 76	EP 98	EP 117	
Amungee Mungee	✓	✓	✓	N/A
Hayfield / Shenandoah		✓	✓	Val Dyer [redacted]

Pastoral property	Permit areas			Contacts
	EP 76	EP 98	EP 117	
				Phone: [redacted]
Kalala		✓	✓	N/A
Tanumbirini	✓	✓		
Beetaloo [41]	✓		✓	Jane and Scott Armstrong [redacted]
Ucharonidge	✓		✓	N/A
Tandyidgee	✓	✓		
Nutwood Downs		✓		
Newcastle Waters			✓	

4.4.3 Other land uses in the area

A range of other land uses exist in the permit 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 Elliott 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 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 EP 117 and crosses the boundary of one part of EP 98. It also runs parallel with the Carpentaria Highway to the Gulf of Carpentaria, through EP 98 and EP 76.
- 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 EP 98 to the west.
- Conservation areas – including the Bullwaddy Conservation Reserve, which lies within EP 98, and Lake Woods and the Junction Stock Reserve outside EP 117, approximately 100 km south.
- Heritage – There are 7 heritage sites within the exploration permit 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.

The proposed activities covers under this plan have bene specifically designed to avoid impacts to these receptors.

5 Stakeholder engagement

5.1 Purpose and objectives

Tamboran's stakeholder engagement is focused on building respectful relationships with key stakeholders and developing a positive reputation founded on Tamboran's core values. Tamboran'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 Tamboran's full attention. Tamboran 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 Tamboran undertakes stakeholder engagement above and beyond the requirements outlined in the Regulations.

Stakeholder engagement records for the new activities are provided in Appendix N (the Stakeholder Engagement Logs Part A and Part B); Appendix N.1.1 (pastoral) and Appendix N.1.2 (NLC). Historic stakeholder engagement records for approved regulated activities incorporated into this EMP, relating to Kyalla 117 N2 are provided in Appendix N.1.3.

5.2 Identification of stakeholders

The Regulations define 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) *an agent or representative of a person or body mentioned in paragraph (a).* [42]

Tamboran's directly affected stakeholders have been, and will continue to be, consulted in a respectful, open and consistent manner. This has been the case since 2014, when Origin assumed operatorship of EP 98, EP 117 and EP 76 and again in November 2022 when Tamboran assumed operatorship of EPs 98, 117 and 76.

For this EMP, Tamboran identifies its stakeholders, in compliance with the regulations as:

- **Host traditional owners** recognised as the native title holders and/or claimants and their representative, the NLC, as described in Exploration Agreements between the parties for EP 98, EP 117 and EP 76; and
- **Host pastoralists** recognised as the landholders of the nine pastoral stations (Table 58). For the drilling and hydraulic fracturing activities at Kyalla 117 N2, Shenandoah S2, SB, SC and the 2D seismic acquisition described in this EMP, the owners of the pastoral leases for Amungee Mungee Station and Shenandoah-East Station are recognised as the pastoralist stakeholders directly impacted.

Stakeholder and community engagement for the proposed work program has been held with host pastoralists and traditional owners directly affected by the proposed activities. Activities performed on EPs will be conducted in a manner consistent with the Code, which Tamboran considers an appropriate regulatory instrument for ensuring Tamboran's activities are in line with community expectations and legislative requirements.

[42] Refer section 7(3) of the Regulations.

Tamboran also recognises and engages, where appropriate with other interested parties that are not classified as directly affected under the Regulations. These include government agencies, land councils, local and regional suppliers, non-government organisations, councils and peak industry bodies.

5.3 Pastoralist stakeholder engagement

Tamboran has engaged with the pastoral stakeholders identified previously (Table 58) on an ongoing basis, including engagement with the leaseholders and/or representatives of the Hayfield / Shenandoah East Station, regarding the full range of exploration activities outlined in this EMP. Key engagement efforts Tamboran has undertaken include:

- Ongoing regular engagement with pastoralist about Tamboran's general activities.
- Providing the landholder with copies of a stakeholder engagement pack covering exploration activities and providing opportunity for the landholder to comment

The Stakeholder Engagement Logs Part A and Part B (Appendix N) summarise Tamboran's engagement with the leaseholders of Hayfield / Shenandoah East Station as a relevant stakeholder and provide information in accordance with section 7(2)(a) of the Regulations.

Appendix N.1.1 provides the detailed records of communication between Tamboran and the pastoralist regarding the proposed activities.

5.4 Host traditional owner(s) engagement

Tamboran has undertaken detailed engagement with the host traditional owners through the NLC to facilitate an ongoing relationship between Tamboran and their host traditional owners. Engagement efforts undertaken by Tamboran include:

- Execution of Exploration Agreement(s) between Tamboran and native title holders for all EPs. This includes a range of additional reporting and environmental protection measures, in addition to the minimum stator requirements outlined in the NT Petroleum (Environment) regulations .
- Provision of annual work program updates and sacred site clearances providing detailed information on the proposed regulated activities, including description, location, impacts, risks and controls.
- Execution of Sacred Site clearance and avoidance surveys on the specific areas of land. A formal NLC Sacred Site Avoidance and Anthropological Report is generated by the NLC and submitted to the AAPA to assist with the issuing of an Authority Certificate in compliance with the NT's Aboriginal Sacred Sites Act.
- In person consultation between Tamboran, host traditional owners and their statutory representative body, the NLC regarding Tamboran's proposed exploration activities as a part of annual work program update meetings
- On country meetings held with NLC and traditional owners to discuss proposed activities, schedule and address any questions. The on-country meetings conclude the engagement and consultation necessary with traditional owners prior to commencement of each years' activities.
- Ongoing consultation regarding Tamboran 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.
- Regular site visits to walk through activities underway (such as drilling and stimulation) and answer any questions regarding E&A activities underway.

The traditional owner stakeholder engagement is summarised in Appendix N, Part A & B. Detailed records of communication between Tamboran and the host traditional owners (via NLC), regarding the proposed activities is provided in Appendix N.1.3.

The NLC is the contact point for all native title holders:

Northern Land Council
[redacted]

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 ensure petroleum activities can sustainably co-exist.
- 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.

A summary of the potential consequences of the activity on stakeholders' activities and mitigation controls is provided in Table 59.

Table 59: Potential consequences of Tamboran's activities on stakeholders' activities and control measures which are outlined in the SEPs

Pastoralist activity	Potential consequence to activities	Mitigations
Pastoralists		
Pastoral time	• Impact to pastoralist time as they are required to engage with Tamboran as a part of the planning and approval for the proposed activity.	• Tamboran undertakes engagement in good faith, with information provided in a variety of formats to reduce time pressures as far as reasonably practicable.
Pastoralist site access	• Exploration vehicles along access track may interact with pastoralist activities- mustering and pastoralist vehicles. • Restricted access to exploration well and fenced area during the length of proposed activities. • Restricted access during seismic surveys.	• Pastoralist engaged throughout exploration activity planning to incorporate pastoralist feedback into activity to reduce impacts. • Camps with workers bussed to site (where possible) to minimise vehicle movements. • Hazardous areas to be fenced and signed to communicate potential safety hazards. • Compensation to be paid for loss of available grazing land and disturbance.
Pastoral activities- grazing and mustering	• Minor elevated levels of noise in the immediate vicinity of the well pad during exploration activities (limited noise at all other times). • Potential elevated noise and vibration within vicinity of seismic shoot (typically within 2-500m of activity).	• Pastoralist engaged throughout exploration activity planning to minimise impact on cattle and pastoral activities. • Compensation to be paid for loss of available grazing land and disturbance. • Full fencing of well pad to restrict cattle.

Pastoralist activity	Potential consequence to activities	Mitigations
	• Disturbance of cattle in the immediate vicinity of the activity when works are undertaken. • Dust impacts on immediate adjacent vegetation has the potential to temporarily reduce yield, similar to existing pastoral tracks. • Reduction in pastoral productivity through poor rehabilitation. • Potential introduction or spread of weeds. • Helicopter movements in vicinity of pastoral activities may disturb cattle/ mustering operations. • Potential impacts on cattle and pastoral business where gates are left open.	• Speed limits restricted to 60 km/hr. • Dust control utilised to reduce dust emissions. • Site to be rehabilitated back to pre-existing state, with security bond in place if company fails to rehabilitate. • 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 to notified and engaged prior to commencing helicopter movements to mitigate interference. • Induction with all exploration contractors and staff in relation to pastoral operations. This induction to be developed with input from pastoralist. • Use of grids, gate signage, inductions and regular gate monitoring and reporting to pastoralist to minimise occurrence of gates being left open. • On-going liaising with pastoralist throughout on ground operations.
Pastoral activities- ongoing productivity of area post rehabilitation	• Reduction in productivity due to erosion and sediment releases. • Reduction in productivity due to wastewater, 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.

Pastoralist activity	Potential consequence to activities	Mitigations
Pastoral access to groundwater	• No anticipated impacts as proposed groundwater take is to be covered under a WEL.	• All groundwater take to be authorised under a WEL. • Water extraction from pastoralist bores not proposed, unless specifically approved by pastoralist through an agreement.
Pastoral access to surface water	• No anticipated impacts as no surface water take, interference or wastewater discharges proposed.	• No surface water proposed to be taken. •
Pastoralist's amenity	• Minor elevated levels of noise in the immediate vicinity of the well pad during activities consistent with the 2016 drilling campaign. • During seismic charge detonation, noise is infrequent and typically a dull thud. • Visual presence of infrastructure within pastoralist lease. • Potential visible hue form flare and night-time at distance.	• Site to be located away from main pastoralist entry points and homestead. • Noise and vibration from seismic surveys is typically a dull thud not felt outside of 200 m or heard outside of 2 km. • Site selection to avoid placing flares and exploration activities on regional high points.
Native Title Holder		
Native Title Holder Time	• Impact to Native title holder time as they are required to engage with Tamboran as a part of the planning and approval for the proposed activity.	• Exploration agreements are in place outlining how engagement with Native Title holders is to occur. • Royalties paid in accordance with Exploration agreements. • Tamboran works closely with the NLC to provide information in a manner to reduce time pressures as far as reasonably practicable. • For scouting and/or activities requiring cultural managers, compensation for time is provided
Native Title holder site access	• Restricted access to exploration well and fenced area during the length of proposed activities. • Restricted access during seismic surveys.	• Native Title Holders are provided updates on proposed activities annually via the NLC. • Royalties paid in accordance with Exploration agreements. • Operational staff are in direct contact with Native Title holders who may request access to any site. Tamboran will facilitate each access request. • Cultural managers used for scouting to identify and avoid culturally significant areas- including areas regularly used for hunting, gathering or for cultural purposes

Pastoralist activity	Potential consequence to activities	Mitigations
		• Camps with workers bussed to site (where possible) to minimise vehicle movements. • Hazardous areas to be fenced and signed to communicate potential safety hazards.
Native Title holder – amenity and enjoyment	• Minor elevated levels of noise in the immediate vicinity of the well pad during exploration activities (limited noise at all other times). • Potential elevated noise and vibration within vicinity of seismic shoot (typically within 2-500m of activity). • Disturbance of wildlife in the immediate vicinity of the activity when works are undertaken. • Dust impacts on immediate adjacent vegetation has the potential to temporarily reduce yield, similar to existing pastoral tracks. • Reduction in productivity through poor rehabilitation. • Potential introduction or spread of weeds. • Helicopter movements in vicinity of activities may disturb wildlife/ access/ hunting	• Exploration agreements are in place outlining how engagement with Native Title holders is to occur. • Royalties paid in accordance with Exploration agreements. • Speed limits restricted to 60 km/hr. • Dust control utilised to reduce dust emissions. • Site to be rehabilitated back to pre-existing state, with security bond in place if company fails to rehabilitate. • 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. • Annual work program meetings and reports provided to native title holder outlining the proposed activities and locations. • Induction with all exploration contractors and staff in relation to native title holders and sacred sites. This induction to be developed with input from pastoralist. • Operational staff are in direct contact with Native Title holders who may request access to any site. Tamboran will facilitate each access request.
Pastoral activities- ongoing productivity of area post rehabilitation	• Reduction in productivity of country due to erosion and sediment releases. • Impact to country from wastewater, chemical/fuel spills. • Impact to country from 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

Pastoralist activity	Potential consequence to activities	Mitigations
		• 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.
Access to groundwater	• No anticipated impacts as proposed groundwater take is to be covered under a WEL.	• All groundwater take to be authorised under a WEL. • No long term groundwater reductions anticipated.
Native Title holder access to surface water	• No anticipated impacts as no surface water take, interference or wastewater discharges proposed.	• No surface water proposed to be taken.
Native title holder sacred sites/ protected features	• access and/or damage to sacred sites	• No access to sacred sites proposed • All activities to occur in areas cleared by native Title holders of Sacred Sites • AAPA certificates granted covering proposed activities

5.6 Northern Territory business engagement

Broader engagement has occurred with local and regional business within the local communities of Daly Waters, Elliott, Katherine and the broader Northern Territory region.

Northern Territory businesses have been engaged on the scope of Tamboran's activities through information sessions and tender opportunities covering a range of material supply and support services, such as:

- people transport and logistics
- accommodation and food
- provision of temporary camps and camp services
- civil construction work
- freight and transport
- water bore drilling
- water carting and waste management
- site maintenance and inspections
- weed management and control
- equipment and materials storage
- oil country tubular goods
- environmental and civil consulting
- surveying and geotechnical assessments

- general provisions of goods and services (such as personal protective equipment and hire cars).

5.7 Ongoing stakeholder and community engagement

Tamboran is committed to continuing to engage with stakeholders regarding the exploration activities under EP 98, EP 117 and EP 76, and any associated environmental outcomes prior to, during and after performance of exploration activities.

Tamboran 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).

Tamboran 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 within the immediate timeframe. With the engagement frequency agreed to with the pastoralist.
  - Quarterly engagement with future host pastoralists for which activity is proposed within the next year.
  - Annual consultation with all pastoralists, including surrounding pastoralists with no immediate proposed activities.
- Native title holders of the area in which the activity is occurring:
  - Ad hoc updates for the NLC when required, informing them of progress of exploration activities underway.
  - Quarterly project status updates to the NLC 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 Reg 7 of the Regulations will continue.

6 Environmental risk assessment

6.1 Tamboran's risk management approach

Tamboran uses 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

- Tamboran 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 Code or legislation).

Tamboran's risk assessment process is undertaken in accordance with section 5.4.3 of International Organisation for Standardisation (ISO) 31000. Assessment of risk is completed using Tamboran's risk matrix (Figure 58) 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.

Tamboran risk management processes requires regular assessment of all risks once controls are applied, the effectiveness of controls (Table 60) and the likelihood and consequence of a risk event.[43] A residual risk is either accepted in accordance with strict delegations of authority or the activity does not proceed.

Tamboran also includes site specific controls for each identified risk, which further demonstrates how it achieves a residual risk that meets its ALARP and acceptable criteria. When applying the existing controls during the risk analysis (as per ISO 31000), there is very often little material change to most risk profiles identified in the risk register (Appendix M). This is a function of the comprehensive nature of the Code, which was designed to mandate a high level of environmental performance and minimise environmental risk.

Table 60: Risk assessment ratings

Rating	Explanation
Effective	• All controls are well designed and address the cause/s of the risk. • All controls operate to the required level. • Ongoing monitoring required.
Can be improved	• Majority of controls are well designed and address the cause/s of the risk. • Majority of controls operate to the required level. • Certain controls can be improved. • Ongoing monitoring required.
Must 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. • All the controls require improvement.

[43] Includes applying existing controls, such as compliance with regulatory requirements which are mandatory (e.g. the Code, Regulations Schedule 1, etc),

tamboran RESOURCES

RISK MATRIX

CONSEQUENCES	IMPACT ON TAMBORAN			EXTERNAL RESPONSE		LIKELIHOOD					
	PEOPLE	ENVIRONMENT, HERITAGE & COMMUNITY	FINANCIAL ($A)	STAKEHOLDER	LAWS, REGULATION AND CIVIL ACTIONS	1 REMOTE <1% chance of occurring within the next year. 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	Multiple fatalities >4 or life-threatening illness or total permanent disability to a large, exposed group (≥10 people).	Extensive, permanent damage to the environment, including species, habitats, ecosystems or area/s of cultural significance. Long- term social unrest and outrage within community.	>$100m	Multiple stakeholder groups taking coordinated action, as reflected in media channels with significant reach and influence (e.g. blockade/boycott negatively impacts substantial aspects of operations and are 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 Leadership time. Loss of licence to operate.	HIGH	HIGH	VERY HIGH	VERY HIGH	VERY HIGH	VERY HIGH
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 the environment, including species, habitats, ecosystems or area/s of cultural significance. Prolonged community outrage.	>$25-100m	Multiple stakeholder groups mobilising and encouraging others to act, as reflected in media channels with significant reach and influence with substantial negative influence (e.g. 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.	MEDIUM	MEDIUM	HIGH	VERY HIGH	VERY HIGH	VERY HIGH
4 MAJOR	Injury or illness to one or more persons, resulting in permanent partial disability.	Long-term, reversible damage to the environment, including species, habitats, ecosystems or area/s of cultural significance. High levels of tension within the community.	>$10-25m	More than one stakeholder group's opinion or view influencing other stakeholders, reported through media channels with some reach and influence (e.g. government comments in national media or in Parliament).	Criminal charges against any employee (not described above) Major litigation – exposure to damages / fines / costs.	MEDIUM	MEDIUM	MEDIUM	HIGH	VERY HIGH	VERY HIGH
3 SERIOUS*	Injury or illness that requires treatment as an in-patient in a hospital OR immediate treatment for a serious injury OR medical treatment within 48 hours of exposure to a substance.	Serious, medium –term, reversible impacts to the environment, including species, habitats, ecosystems or area/s of cultural significance. Moderate levels of community tension.	>$1-10m	More than one group offering an opinion or view, reported through media channels with reach and influence (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 and exposure to damages / fines / costs.	LOW	MEDIUM	MEDIUM	MEDIUM	HIGH	HIGH
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 the environment, including species, habitat, ecosystems or area of cultural significance. Isolated examples of community tension.	>$250k-$1m	A single stakeholder group drawing attention to an incident, issue or approach, conveyed though media channels with potential reach and influence (e.g. 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).	LOW	LOW	MEDIUM	MEDIUM	MEDIUM	MEDIUM
1 MINOR	Injury or illness requiring first aid to 1 or more persons, or a no treatment case.	Limited environmental or cultural heritage impact- readily dealt with and contained on site. Individual community member voicing concern.	<$100k	A person or organisation signalling interest in an incident or event using channels with limited reach or influence (e.g. letter of complaint).	Minor non-compliance with external mandatory obligations or breach of contractual or other legal obligations.	LOW	LOW	LOW	MEDIUM	MEDIUM	MEDIUM

Revision 2
11/08/2023

Figure 58: Tamboran's risk matrix

6.2 ALARP

The 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 Code and associated regulatory changes provides a high level of inherent protection to ensure activities are undertaken in a safe and consistent manner.

Tamboran 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, Tamboran considers ALARP to be achieved where the following criteria have been met:

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

6.3 Risk acceptability

Tamboran uses a series of criteria (Table 61) to determine the acceptability of a risk once all controls are identified / implemented. Each risk event and final risk rating outlined in Appendix M is assessed against these criteria to determine whether Tamboran believes it is acceptable.

Table 61: Risk acceptability criteria

#	Criteria	Tamboran's acceptance threshold
1	Risk level after treatments / controls are applied	Consistent with Tamboran'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. **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 2. Consistent with regional strategies and conservation/threat abatement plans

#	Criteria	Tamboran's acceptance threshold
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	ESD Principles	Risk is consistent with the principles of ESD as defined in section2.1. This also includes weighting to consider the social and economic benefits of the project.

6.4 Assessment of scientific uncertainty

The Regulations require 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 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.

As per the EMP Guidelines, scientific certainty is qualitatively assessed using a generic means of ranking the data available in accordance with Table 62. Considerations of uncertainty have been included in the risk assessment discussed in section 6.5.

Table 62: Scoring system and ranking for scientific uncertainty (adapted from EFSA, 2009)

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

Score	Description
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 using the Tamboran risk assessment framework described in section 6.1. The 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-references 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:

- Activities covering 16 future E&A wells (15 new horizontals and 1 vertical wells) and 2 existing E&A wells Kyalla 117 N2-1H and Shenandoah S- 1H) for the 2023 - 2028 period, as per the current approved tenure work plan.
- 2D seismic acquisition.
- Existing land users (predominately pastoralists).

There were no residual risks above a 'Medium' risk ranking, with 26 risk scenarios. Within these risk scenarios, the assessment considered 87 risk sources which may potentially result in a risk occurring. Of the 99 risk sources, 12 were ranked as 'Moderate' with the remaining ranked as 'Low'. The medium residual risks sources identified through the risk assessment include:

a. Loss in long-term soil productivity and viability due to soil erosion from cleared areas (existing access tracks, well pads, camp pads and 2D seismic) – risk ID 28
b. Impact to listed threatened habitats and listed threatened flora and fauna, including non-listed fauna and livestock through surface activities – risk ID 45, risk ID 46, risk ID 53, risk ID 54 and risk ID 55
c. Disturbance of a sacred site or culturally sensitive area and decline in environmental value of area used for cultural purposes through the accidental ignition of fire by site activities – risk ID 59 and risk ID 64
d. Reduction in agriculture productivity through the introduction and spread of weeds in the area or accidental ignition from surface activities – risk ID 73 and risk ID 76
e. Increased nuisance from dust emissions associated with the activities – risk ID 88 and risk ID 89

The assessment demonstrates that the risks associated with drilling and stimulation-related activities, often referred to as "high consequence, low likelihood" risks, such as contamination of potable groundwater from onshore gas activities, have been assessed to a "low" risk rating, and demonstrate ALARP and acceptable through multiple well integrity safeguards, including isolation barriers to protect against contamination of groundwater aquifers.

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, including the offsetting of residual GHG emissions.
- The protection and enhancement of community and cultural values, places and amenity.

At completion of E&A activities, the sites will be returned to a safe, stable and non-polluting form consistent with pre-disturbed conditions.

The 'Medium' risks identified were consistent with standard construction or pastoralist activities carried out across the NT, being the potential spread of weeds, erosion and sediment control, and ignition of bushfires from the proposed activities. The reduced risk profile associated with stimulation activities (such as potential spills and groundwater contamination) is reflective of the stringent regulatory requirements in the Code.

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 shale exploration activities demonstrated in the Inquiry Final Report and through the various reports published by the US EPA (such as USEPA 2016- U.S. EPA. Hydraulic Fracturing for Oil and Gas: Impacts from the Hydraulic Fracturing Water Cycle on Drinking Water Resources in the United States (Final Report)).

A count of the post-treatment environmental risks associated with this EMP is provided in Table 63. A copy of the risk assessment is provided in Appendix M.

Table 63: Count of environmental risks for the drilling, stimulation and seismic program

	Environmental risk rating with applied controls			
	Low	**Medium**	**High**	**Very high**
Total 90	87	12	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 M. Table 64 to Table 70 provide the environmental outcomes, performance standards and measurement criteria, based on the NT EPA's environmental factors and objectives, to demonstrate whether controls have been effective during the activity and that the stated environmental outcomes have been achieved.

6.6.1 Land

Table 64: Environmental outcomes, performance standards and measurement criteria – landforms and terrestrial environmental quality

Environmental performance measures – landforms and terrestrial environmental quality				
Environmental outcome	**Environmental performance standards**		**Measurement criteria**	**Records**
Ecological function of soils and landforms at the well pad and surrounding area consistent with current (non-petroleum) land use following the activities under this EMP	L-1	No reportable spills or leaks of flowback, wastewater and chemicals from Tamboran's exploration activities- including gathering.	• No reportable wastewater or chemical spills from the activity • Evidence of all spills being cleaned up as soon as possible • Open tank/sump level measurement confirm no overtopping events • Tank level measurements recorded on all tanks and confirm no loss of wastewater from any tank. • All leak detection alarms responded to within 24 hours (or as soon as possible subject to access) and all liner repairs completed as soon as possible • Sediment basin releases tested prior to release and comply with specified EC and pH limits • Monthly gathering line inspections completed	Weekly site inspection for wastewater tank integrity completed. Records of wastewater tank/ sump level and volume measurements retained Records of daily wastewater tank secondary containment leak monitoring retained, including leak alarms and leak alarm responses Records of liner and gathering line maintenance and repairs retained. Daily records of chemical storage secondary containment inspections retained during the wet season and weekly during the dry season. Incident records retained with spill location, volumes and clean-up information, including leak locations Monthly gathering line inspection record All incidents logged in incident management system
	L-2	No reportable incidents involving erosion or sediment release beyond the site boundary	• Civil contractor reports demonstrate erosion and sediment controls implemented • Daily civil construction reports show visual inspection of civil construction activities completed after 20mm rainfall event.	Civil construction daily reports Civil maintenance records of ESCP retained 6 monthly erosion and sediment control inspections

Environmental performance measures – landforms and terrestrial environmental quality				
Environmental outcome	**Environmental performance standards**		**Measurement criteria**	**Records**
			• 6 monthly erosion and sediment control inspection of disturbed areas completed identifying defects requiring immediate repair, repair prior to wet season or defects that should be monitored • Maintenance results confirm all defects flagged as requiring immediate rectification, including reportable incidents, are rectified as soon as possible. • Evidence of maintenance completed on demonstrating pre-wet season maintenance on erosion and sediment controls completed	
	L-3	Stormwater released within the EMP limits	Monitoring results of stormwater releases demonstrates releases were within the EMP limits	Stormwater release spreadsheet
	L-4	Low point drain releases are within the EMP limits	Monitoring results of stormwater releases demonstrates releases were within the EMP limits	Low point drain release spreadsheet
	L-5	No drift of evaporators that results in visible evidence of wastewater droplets beyond the wastewater tank	Daily inspections completed during wastewater evaporation confirming no drift outside of the wastewater tank	Daily operator logs Incident management system records
	L-6	Disturbed exploration infrastructure no longer required are rehabilitated back to the pre-existing state	• Rehabilitation of unused infrastructure to occur within 6 months of activity completion	Annual rehabilitation monitoring report

Environmental performance measures – landforms and terrestrial environmental quality				
Environmental outcome	**Environmental performance standards**		**Measurement criteria**	**Records**
			• Annual rehabilitation monitoring completed, with recommended maintenance completed within 3 months (contingent on weather and access) • Final RMP success criteria achieved at project completion	
	L-7	Disturbed seismic lines are reinstated promptly and rehabilitation implemented to return ecological function back to the pre-existing state	• Seismic reinstatement commences within 4 weeks upon completion of seismic data acquisition. • Annual rehabilitation monitoring completed, with recommended maintenance completed within 3 months (contingent on weather and access) • Final RMP success criteria achieved at project completion	Daily seismic activity reports. Annual rehabilitation monitoring report
Risk sources	• Soil compaction from access tracks, leases, camp pads, helipads, 2D seismic lines etc.(Risk ID 27) • Soil erosion from cleared areas (access tracks, well pad, and camp pads and seismic lines) (Risk ID 28) • Soil erosion and instability from 2D seismic charge detonation (Risk ID 29) • Spills/leaks from the on-site storing and handling of fuels (condensate, hydrocarbons, drilling additives, stimulation additives, drilling fluids, flowback fluid, solid wastes, storage and transportation of wastes) (Risk ID 30) • Drill sump and flowback tank overtopping (Risk ID 31) • Chemical and waste transportation accident (Risk ID 33) • On-site disposal of drill muds and cuttings (Risk ID 34) • Failure of a flowback tank (Risk ID 36) • Wastewater evaporation mist transported off-site during wastewater treatment (Risk ID 37) • Greywater and sewerage disposal (camps) (Risk ID 39) • Failure or leak from wastewater gathering network (Risk ID 39)			

Table 65: Environmental outcomes, performance standards and measurement criteria –terrestrial ecosystems

Environmental performance measures – terrestrial ecosystems				
Environmental outcome	**Environmental performance standards**		**Measurement criteria**	**Records**
Tamboran's activities do not adversely impact surrounding vegetation, significant vegetation communities and listed threatened flora and fauna, with sites rehabilitated back to the current (non-petroleum) land use following the activities under this EMP	EC-1	No releases of wastewater (drilling fluid and flowback) or chemicals off the well site or from gathering lines into the surrounding vegetation.	• No offsite wastewater or chemical spills from the activity • Weekly inspections during wastewater storage confirm the bund is in good working order • Open tank/sump level measurement confirm no overtopping events • Tank level measurements recorded on all tanks and confirm no loss of wastewater from any tank. • All leak detection alarms responded to within 24 hours (subject to access) and all liner repairs completed as soon as possible • Sediment basin releases tested prior to release and comply with specified EC and pH limits	Weekly site inspection for wastewater tank integrity completed Records of wastewater tank/ sump level and volume measurements retained Records of daily leak monitoring of secondary containment of wastewater retained, including leak alarms and leak alarm responses Incident records retained with leak/spill location, volumes and clean up information Sediment basin release spreadsheet
	EC-2	No significant (<4 individual deaths per month) impacts to fauna due to wastewater storages	Weekly checks of enclosed tanks and area immediately surrounding well pad for fauna deaths confirm <4 individual fauna deaths per month caused by flowback water storage.	Weekly site inspection completed during wastewater storage. Fauna interaction log retained.
	EC-3	No listed threatened fauna deaths caused by flowback storage.	Weekly checks of enclosed tanks and area immediately surrounding well pad for fauna deaths confirm no listed fauna deaths caused by flowback water storage.	Weekly site inspection completed during wastewater storage. Fauna interaction log retained.
	EC-4	No uncontrolled bushfires caused by Tamboran's exploration activities (including civil construction, seismic and E&A activities).	Zero reported incidents of bushfire caused by Tamboran's activities.	Fire incident data to be retained

Environmental performance measures – terrestrial ecosystems				
Environmental outcome	**Environmental performance standards**		**Measurement criteria**	**Records**
	EC-5	No WONS (Class A and C) introduced to any Tamboran activity area that are attributed to exploration activities	• Weed monitoring completed pre and post wet season on all disturbed areas • Weed monitoring does not identify any newly introduced Class A and Class C WONS • Weed control applied to all declared weeds	Weed monitoring records and annual report retained
	EC-6	Year-on-year decline in the size and density of all weed infestations introduced because of Tamboran's activities.	Annual report demonstrates weed infestation size and density of weed outbreaks introduced by Tamboran's activities are reducing each year.	Annual weed monitoring and management report.
	EC-7	Disturbed seismic lines are reinstated promptly and rehabilitation back to the pre-existing state	• Seismic reinstatement commences within 4 weeks upon completion of seismic data acquisition. • Annual rehabilitation monitoring completed, with recommended maintenance completed within 3 months (contingent on weather and access) • Final RMP success criteria achieved at project completion	Daily seismic activity reports. Annual rehabilitation monitoring report
	EC-8	Disturbed exploration infrastructure no longer required are rehabilitated back to pre-existing state	• Rehabilitation of unused infrastructure to occur within 6 months of activity completion • Annual rehabilitation monitoring completed, with recommended maintenance completed within 3 months (contingent on weather and access)	Annual rehabilitation monitoring report

Environmental performance measures – terrestrial ecosystems				
Environmental outcome	**Environmental performance standards**		**Measurement criteria**	**Records**
			• Final RMP success criteria achieved at project completion	
	EC-9	No unauthorised clearing	Total clearing levels are lower than the authorised clearing levels stated in the EMP No clearing outside of approved areas defined in the EMP	Survey and spatial data collected confirms disturbance levels are within approved limits and areas
	EC-10	Wetlands and riparian vegetation protected from clearing	No clearing of riparian vegetation or wetlands recorded	Global Positioning system survey data for disturbed areas retained
	EC-11	Impacts to large trees (>25cm trunk @ 1.3m) minimised during clearing	All large trees proposed to be cleared are recorded, with justification as to why clearing could not be avoided retained	Large tree clearing log to be retained including trees that were avoided.
	EC-12	No disturbance to grey Falcon nesting sites	Cultural managers engaged to identify Grey Falcon nesting sites, with any nests documented No clearing within 300m of suspected Grey Falcon nesting site	Records of pre-clearance surveys retained documenting evidence of flacon nesting sites
Risk sources	• Land clearing impacts listed threatened species and/or their habitat(Risk ID 40) • Activity (vehicle and machinery) noise and lighting on well pads and access tracks (Risk ID 41) • Structural failure and overtopping of flowback storage tanks and drilling sump (Risk ID 42) • Failure or leak from wastewater gathering network (Risk ID 43) • Introduction and spread of weeds in the area (Risk ID 45) • Accidental ignition of fire from exploration activities (drilling, stimulation, flaring and general access (Risk ID 46) • Poor rehabilitation of the site reduces regional habitat and promotes weed invasions (Risk ID 47) • Trapping and drowning of fauna in storage tanks and sumps (Risk ID 48) • Contaminants in water and soil pass through the food chain and bioaccumulate in fauna causing detrimental impacts to local species and communities (Risk ID 49) • Vehicle collisions with fauna – fauna mortality results in a localised decline in species abundance (Risk ID 50)			

Environmental performance measures – terrestrial ecosystems			
Environmental outcome	**Environmental performance standards**	**Measurement criteria**	**Records**
	• Encouragement of feral animals and other pest species increases leading to competition with native species. This includes the introduction of cane toads (Risk ID 51) • Activity (vehicle, machinery and seismic activity) noise and vibration during 2D seismic acquisition (Risk ID 52) • Introduction and spread of weeds during 2D seismic (Risk ID 53) • Accidental ignition of fire during 2D seismic acquisition and general access (Risk ID 54) • Poor rehabilitation of the 2D seismic lines reduces regional habitat and promotes weed invasions (Risk ID 56) • Vehicle and machinery collisions with fauna during 2D seismic activities – fauna mortality results in a localised impact to listed threatened species (Risk ID 57) • Cumulative impacts on terrestrial ecology (Risk ID 96)		

6.6.2 Water

Table 66: Environmental outcomes, performance standards and measurement criteria – hydrological processes

Environmental performance measure – hydrological processes				
Environmental outcome	**Environmental performance standards**		**Measurement criteria**	**Records**
The environmental values of the underlying groundwater resources are maintained with no adverse impacts to users of the resource resulting from Tamboran's exploration activities.	GW-1	All aquifers isolated through cement and casing.	Isolation of Aquifers, including the Gum Ridge Formation and Anthony Lagoons Formation are confirmed through cement bond logs and casing pressure tests.	Well completion report and/or Well barrier verification report
	GW-2	No reportable spills or leaks of flowback, wastewater and chemicals from Tamboran's exploration activities- including gathering lines	• No reportable wastewater or chemical spills from the activity • Spill register confirms spills being tracked and cleaned up as soon as possible • Open tank/sump level measurements confirm no overtopping events • Tank level measurements recorded on all tanks confirms no loss of wastewater from any tank. • All leak detection alarms responded to within 24 hours (subject to access) and all liner repairs completed as soon as possible • Sediment basin releases tested prior to release and comply with specified EC and pH limits • Monthly gathering line inspections completed	Weekly site inspection completed during wastewater storage. Records of wastewater tank/ sump level and volume measurements retained Records of daily wastewater tank secondary containment leak monitoring retained, including leak alarms and leak alarm responses Records of liner and gathering line maintenance and repairs retained. Daily records of chemical storage secondary containment inspections retained during the wet season and weekly during the dry season. Incident records retained with spill location, volumes and clean-up information, including leak locations Monthly gathering line inspection record All incidents logged in incident management system

Environmental performance measure – hydrological processes				
Environmental outcome	**Environmental performance standards**		**Measurement criteria**	**Records**
	GW-3	No seismic events over Ml 3.5 attributable to Tamboran's activities.	No seismic events over Ml 3.5 recorded in vicinity of a hydraulic fracture operation measured at the Warramunga seismic monitoring station or adjacent site seismometer during period that hydraulic fracture stimulations have occurred.	Monitoring results available at https://earthquakes.ga.gov.au/.
	GW-4	No reduction in the quality of underlying groundwater resulting in a change to the environmental values of the resource attributable to Tamboran's activities.	Groundwater monitoring undertaken as per the Code of Practice Analysis against location specific values, control and baseline data demonstrates no material decline in groundwater quality attributable to Petroleum activities against environmental values (Livestock and drinking water use)	Quarterly groundwater monitoring results retained.
	GW-5	No reduction in groundwater level observed in the impact monitoring bore that results in >1 m decline in groundwater water level.	Quarterly groundwater monitoring data collected and analysed against baseline data confirms no material (>1 m) decline in groundwater level. Total groundwater extraction volume below the approved water extraction licence take	Quarterly groundwater monitoring results retained. Groundwater take records retained
Risk sources	• Sub-surface loss of drilling fluids during drilling (Risk ID 1) • Sub-surface cross flow of formation through inappropriate well barrier design and construction (Risk ID 2) • Sub-surface crossflow through fracture growth into aquifer from stimulation activities allowing the migration of fluid and gas (Risk ID 3) • Stimulation activity induces seismic activity that enables cross formational flow between shallow aquifers (Risk ID 4) • Sub-surface migration of fluid and gasses via fractures intersecting with offset wells (including the adjacent horizontal wells) or intersecting an existing geohazard (Risk ID 5) • Crossflow/well integrity caused by the deviation of an E&A well into the adjacent well during drilling (Risk ID 6) • Leakage of either flowback, produced water, or hydrocarbons (liquid and gaseous) from suspended or abandoned wells (Risk ID 7)			

Environmental performance measure – hydrological processes			
Environmental outcome	**Environmental performance standards**	**Measurement criteria**	**Records**
	• Surface spills/contamination from the storage and disposal of drilling fluids, additives, muds and cuttings on-site (Risk ID 8) • Surface spills from the storage, handling and transportation of produced hydrocarbons (condensate) (Risk ID 9) • Surface spills from storage, handling and transportation of flowback water (Risk ID 10) • Surface spills from the storage, handling and transportation of chemicals, fuels and wastes (Risk ID 11) • Surface spills from the overtopping of drilling sumps and flowback tanks (including during wet season) (Risk ID 12) • Surface spills from the failure of flowback storage tank (Risk ID 13) • Over extraction of groundwater for exploration activities (Risk ID 14) • Cumulative impact from regional groundwater take exceeds the natural recharge rate of the Basin (Risk ID 95)		
Instrument calibration	Groundwater volume: N/A approved DEPWS meter used with no calibration required.		

Table 67: Environmental outcomes, performance standards and measurement criteria – Inland water environmental quality and aquatic ecosystems

Environmental performance measure – Inland water environmental quality and aquatic ecosystems				
Environmental outcome	**Environmental performance standards**		**Measurement criteria**	**Records**
Maintain the quality of surface water and aquatic ecosystems and prevent any adverse impacts from Tamboran's exploration activities.	SW-1	Stormwater released within the EMP limits with no evidence of contamination (including wastewater, hydrocarbons, chemicals and wastes).	Monitoring results of stormwater releases demonstrates releases were within the EMP limits	Stormwater release spreadsheet
	SW-2	No seismic events over Ml 3.5 attributable to Tamboran's activities.	No seismic events over Ml 3.5 recorded in vicinity of a hydraulic fracture operation measured at the Warramunga seismic monitoring station or adjacent seismometer during period that hydraulic fracture stimulations have occurred resulting in surface subsidence and impacting surface hydrology.	Monitoring results available at https://earthquakes.ga.gov.au/.
	SW-3	No releases of wastewater (drilling fluid and flowback) or chemicals off the well site or from gathering lines into surrounding drainage depressions or watercourses	• No offsite wastewater or chemical spills from the activity • Weekly inspections during wastewater storage confirm the bund is in good working order • Open tank/sump level measurement confirm no overtopping events • Tank level measurements recorded on all tanks and confirm no loss of wastewater from any tank. • All leak detection alarms responded to within 24 hours (subject to access) and all liner repairs completed as soon as possible	Weekly site inspection for wastewater tank integrity completed during flowback wastewater storage Records of wastewater tank/ sump level and volume measurements retained Records of daily leak monitoring of secondary containment of wastewater tanks retained, including leak alarms and leak alarm responses

Environmental performance measure – Inland water environmental quality and aquatic ecosystems				
Environmental outcome	**Environmental performance standards**		**Measurement criteria**	**Records**
	SW-4	No reportable incidents involving erosion or sediment release beyond the site boundary into drainage depression or watercourse (extent of disturbance footprint of a site)	• Civil contractor reports demonstrate erosion and sediment controls implemented • Daily civil construction reports show visual inspection of civil construction activities completed after 20mm rainfall event. • 6 monthly erosion and sediment control inspection of disturbed areas completed identifying defects requiring immediate repair, repair prior to wet season or defects that should be monitored • Maintenance results confirm all defects flagged as requiring immediate rectification, including reportable incidents, are rectified as soon as possible. • Evidence of maintenance completed on demonstrating pre-wet season maintenance on erosion and sediment controls completed	Civil construction daily reports 6 monthly erosion and sediment control inspections Civil maintenance records of ESCP retained

Environmental performance measure – Inland water environmental quality and aquatic ecosystems			
Environmental outcome	**Environmental performance standards**	**Measurement criteria**	**Records**
Risk sources	• Failure of flowback storage tank (Risk ID 15) • Overtopping of drilling sumps and flowback tanks (including wet season operations) (Risk ID 16) • Transportation accident releasing chemical or wastewater (drilling fluid and flowback) (Risk ID 17) • Storage and handling of drilling and stimulation chemicals and hydrocarbons (Risk ID 18) • Release of stormwater from activities to surface water (Risk ID 19) • Runoff from sewage treatment irrigation areas (Risk ID 20) • Failure or leak from wastewater gathering network (Risk ID 21) • Infrastructure located on regional flow path resulting in changes to surface water flow (Risk ID 22) • Changes to terrestrial ground surface levels associated with seismic activity (Risk ID 26) • Cumulative impacts on surface water quality (Risk ID 98)		
Instrument calibration	Management of storm water: 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 1413 µs/cm (or similar) standard.		

6.6.3 Air

Table 68: Environmental outcomes, performance standards and measurement criteria – air quality and atmospheric processes

Environmental performance measures – air quality and atmospheric processes				
Environmental outcome	**Environmental performance standards**		**Measurement criteria**	**Records**
No reduction on local air quality and minimisation of greenhouse gas emission generated from Tamboran's exploration activities.	AQ-1	All produced hydrocarbons to be sent to the flare where technically possible (e.g. when pressure is sufficient for the separator to function).	Daily reports confirm all technically recovered hydrocarbons sent to the flare is metered and recorded. Periods of venting documented	Gas flow volumes and separator operation recorded in daily log
	AQ-2	All greenhouse gases reporting in accordance with NGERS requirements.	All emissions related data (fuel use, flaring volumes, venting volumes, wastewater volumes etc.) reported in accordance with NGERS requirements	Emission related data (fuel use, flare volumes, wastewater volumes etc.) retained.
	AQ-3	All offsets retired in accordance with GGAP	All offsets to be secured and retired in accordance with GGAP. All emission data to be audited and reported to DEPWS annually	Audit report on emissions report confirms retirement of required ACCU's
	AQ-4	All leaks detected and repaired in accordance with Code.	6-monthly leak detection program completed on surface equipment (wells, surface facilities and gathering lines) . Maintenance records indicate all minor leaks rectified as per Code within 30 days. Maintenance records indicate all significant leak is repaired as per the Code within 72-hours.	Leak detection records retained. Leaks repairs recorded.
	AQ-5	Flare efficiency achieve 98% combustion efficiency	Flare efficiency calculated in compliance with US EPA 40 CFR § 60.18 exceeds 98%	Engineering calculation included within annual emission audit report on emissions report confirms

Environmental performance measures – air quality and atmospheric processes			
Environmental outcome	**Environmental performance standards**	**Measurement criteria**	**Records**
Risk sources	• Emissions from the combustion of diesel (Risk ID 84) • Air emissions from gas and condensate flaring (Risk ID 85) • Air emissions from chemical releases during drilling and stimulation activities (Risk ID 86) • 2D seismic emissions from the combustion of diesel, detonation of charges and dust from clearing (Risk ID 87) • Dust and particulate emissions from civil activities, drilling operations, well testing and 2D seismic (88) • Bushfire from accidental ignition by site activities (civil works, seismic, drilling, flaring, grinding) or personnel (Risk ID 89) • Combustion of diesel for exploration activities, including civil construction, 2D seismic and E&A activities (Risk ID 90) • Avoidable GHG generation through flaring of gas and condensate during well testing (Risk ID 91) • Uncontrolled release of gas encountered during drilling, stimulation, barrier failure, operator error or vehicle collision under a multi-well scenario (Risk ID 92) • Uncontrolled release of gas from well due to sabotage (Risk ID 93) • Leak of gas from wells (Risk ID 94) • Cumulative impacts on greenhouse gas emissions (Risk ID 99)		
Instrument calibration	Identification and remediation of gas leaks: Gas detector calibrated monthly with a 10 ppm (or similar) methane calibration gas.		

6.6.4 People

Table 69: Environmental outcomes, performance standards and measurement criteria – community and economy, and human health

Environmental performance measures – community and economy, and human health				
Environmental outcome	**Environmental performance standards**		**Measurement criteria**	**Records**
No adverse impacts to the community resulting from Tamboran's exploration activities.	CO-1	All community complaints made directly to Tamboran of nuisance investigated and resolved.	All community complaints received directly by Tamboran responded to within 24 hours with actions to remedy nuisance implemented as soon as possible (depending on the nature of the complaint).	Records of community complaints and actions completed.
	CO-2	>60% of addressable spend[46] to be from NT businesses.	Project expenditure data confirms the NT business spend on the Beetaloo exploration	Data on NT business spend retained.

Environmental performance measures – community and economy, and human health				
Environmental outcome	**Environmental performance standards**		**Measurement criteria**	**Records**
			project exceeds >60% of addressable spend [44] of the project.	
	CO-3	All vehicle accidents investigated and reported in accordance with NT Police, Fire and Emergency Services requirements.	Zero incidents requiring an external emergency response.	Records retained in the incident register.
Risk sources	• Industrialisation of landscape (Risk ID 67) • Increased traffic (Risk ID 68) • Light emissions impact on community receptor (such as pastoralist) (Risk ID 69) • Influx of workers to region (Risk ID 70) • Noise emissions from activities (Risk ID 71) • Noise emissions from activities (Risk ID 72) • Introduction and spread of weeds in the area (Risk ID 73) • Over extraction of groundwater (Risk ID 74) • Impact to surface hydrology reduces water capture (Risk ID 75) • Bushfire from accidental ignition by site activities (civil works, seismic, drilling, flaring grinding) or personnel (Risk ID 76) • Poor rehabilitation of exploration infrastructure (Risk ID 77) • Increased risk of vehicle accident (Risk ID 82) • Exploration activities compete with agricultural industry for resources (Risk ID 83) • Cumulative impacts on amenity (Risk ID 97)			

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

Table 70: 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 because of Tamboran's exploration activities.	CH-1	No non-compliances with Native Title Holder Exploration Agreements and AAPA certificate conditions.	No non-compliances with AAPA certificate conditions including unauthorised work within RWA. No breaches of native title holders' exploration agreements.	Incidents retained where unauthorised activities are identified.
Protection of culture and heritage through ongoing engagement and consultation	CH -2	Native title holders are actively engaged on Tamboran's work program, including understanding of Tamboran's current and future exploration activities.	Annual work program update report completed and submitted On country meetings completed providing status of work program and future activities- including ongoing presentation of story boards and other activity information. Engagement and presence of local cultural managers during new land disturbance activities. Indigenous business involved in at least 2 environmental monitoring program, such as weed monitoring, groundwater monitoring, leak detection and site stability monitoring.	Records of annual work program update report retained. Records of on country meetings retained. Records of native title holders attending disturbance activities. Records of environmental programs completed by indigenous contractors retained.
Risk sources	• Sites disturbed directly by exploration activities (Risk ID 58) • Accidental ignition by site activities (civil works, drilling, grinding) or site personnel (Risk ID 59) • Flowback tank structural failure (Risk ID 60) • Personnel unauthorised access to sacred site (Risk ID 62) • Sites disturbed directly by 2D seismic activities (Risk ID 63) • Accidental ignition during 2D seismic activities (Risk ID 64) • Personnel unauthorised access to scared site during 2D seismic (Risk ID 66) • Cumulative impact on amenity (Risk ID 97)			

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.

7.1 Bushfire management plan

A Bushfire Management Plan (BMP) has been developed for each site and the seismic program (Appendix B). The BMP outlines the controls to prevent, detect and respond to fires associated with Tamboran's activities. Controls implemented include:

- Implementation and maintenance of firebreaks.
- Monitoring during periods of high fire danger.
- Flaring controls, including separation distances and cessation of flaring during total fire bans.
- Fire response and reporting.

7.2 Weed management plan

Exploration activities are undertaken in accordance with Tamboran's Beetaloo Weed Management Plan (Appendix C). 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 is 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.

7.3 Spill management plan

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

A SMP has been developed covering Tamboran's proposed exploration activities. This SMP is provided in Appendix F.

An example of bunding used for drilling and stimulation activities is provided in Figure 59.

Figure 59: Examples of spill mats used to contain potential wastewater transfer spills

7.4 Wastewater management plan

A WWMP has been developed to satisfy the requirements of the Code. The WWMP describes how Tamboran will store wastewater to minimise risks to the environment. A copy of the WWMP is provided in Appendix G.

7.5 Erosion and sediment control plan

An ESCP has been developed to outline how the Kyalla 117 N2 and Shenandoah South sites will be operated to minimise the risk of erosion and sediment releases to the surrounding environment. The ESCP is provided in Appendix H.

7.6 Methane emissions management plan

A MEMP is required to be developed to demonstrate how methane emissions will be managed (Appendix I). The MEMP describes how Tamboran:

- 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

7.7 Rehabilitation management plan

Once a determination has been made to decommission an asset, a site-specific rehabilitation strategy will be developed for each disturbed area, based on the criteria and methodology outlined in the RMP (Appendix O). A specific strategy for each area is required to ensure the operational history of the site is considered during rehabilitation planning (such as spills etc.). As per the Code, rehabilitation will commence within 12 months of determining an asset is no longer required. Where it relates to seismic survey rehabilitation, progressive rehabilitation will commence after seismic has been acquired on each line to reduce exposed soils and minimise runoff in first flush events. This is expected to commence within two to six weeks of seismic line acquisition, and before the onset of the wet season.

Each petroleum well will be plugged and decommissioned in accordance with the Code. All tanks, surface infrastructure and wastes will be removed from site and disposed of in accordance with the *Waste Management and Pollution Control Act 1998*.

All remaining assets will be rehabilitated in accordance with the requirements of the Code. All disturbance shall be returned to the pre-existing condition in accordance with Clause A.3.9(d) of the Code 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
- Where required, spreading seed of suitable local native species which have been determined through analogue sites representative of the surrounding vegetation communities
- Source native seed supply and rehabilitation services from indigenous suppliers (where available).
- Monitoring of rehabilitation success will be completed annually to assess the rehabilitation status of a site and determine where additional remedial works are required.

7.8 Well operations management plan

A well operations management plan (WOMP) must be developed and submitted to the Minister for Industry and Trade for approval prior to the commencement of activities. The WOMP is a separate approval from the EMP and provides an operational description of how Tamboran plans to operate, suspend and decommission the proposed wells in a manner that ensures all risk to the environment are reduced to ALARP and acceptable.

8 Implementation strategy

8.1 Environment, health and safety management system

Tamboran's activities are governed by a Health, Safety and Environment (HSSE) policy (Figure 60). Tamboran will implement a Health, Safety and Environment Management System (HSEMS), which ensures we conduct our business in line with all the elements of this policy, including but not limited to:

- Risk management and compliance
- Training and competency
- Contractor management
- Safety management and emergency response.

tamboran RESOURCES

Health, Safety, Security and Environment (HSSE) Policy

Tamboran Resources Limited (Tamboran) is committed to a high standard of health, safety, security and environmental performance for our employees, contractors, service providers, visitors, and affected communities involved in, or impacted by, our operations and work activities. We believe every incident and injury is avoidable and unacceptable. Our objective is to design, build and operate our assets with sustained integrity and efficiency, through successful realisation of occupational and process safety, and environmental impact reduction elements. Tamboran strives to develop resources in an environmentally responsible manner and shall conduct all activities and operations in a manner consistent with the principles of Ecologically Sustainable Development.

HSSE performance delivery is integral to our long-term sustainability. Everyone who works for and with Tamboran - employee, contractor, partner, supplier or visitor (Workforce) - has responsibility for adhering to this Policy.

Our shared duty is to assure the health, security and safety of people, the integrity and safe operation of our assets, and the protection of the environment. We accomplish this by setting clear expectations including target setting, training of our Workforce, and empowering our Workforce to stop work whenever they believe there is a danger to people, the environment, or the safe operation of our assets.

We strive for zero harm to our Workforce. We commit to reducing to as low as reasonably practicable all risks in our operations having potential to adversely affect people or the environment in which we operate, and to apply best available techniques in managing our environmental impact.

To meet these commitments Tamboran will:

- Create, implement, and maintain an HSSE Management System.
- Ensure continuous improvement of the HSSE Management System through the auditing process, learning from incidents and consultation with our employees.
- Seek every reasonable means and required resources to provide a safe work environment for all workers.
- Use practices and procedures that meet or exceed relevant health and safety statutory and regulatory requirements as well as recognized industry standards.
- Encourage the active participation and support of its employees in promoting and implementing an effective safety program.
- Commit management and supervisory personnel to have a direct responsibility for ensuring that these objectives are met.
- Create a culture of work where it is understood that no task is too important that time cannot be taken to ensure the task is performed safely.
- Require all contractors and service providers to have and manage their health and safety with standards and practices in-line with this Policy.

Activities shall be planned and implemented in a sustainable way to ensure impacts to the environment are either avoided or minimised to an acceptable level by:

- Complying with applicable environmental legislation, industry standards, and its own policies;
- Making environmental considerations an integral part of our planning process;
- Seeking and implementing reasonable means to minimise water, fuel usage, and disturbance to soil, flora, and fauna;
- Promptly providing relevant information to all stakeholders affected by our operations and to be responsive and sensitive to legitimate stakeholder concerns;
- Identifying and mitigating the adverse impacts of our operations on the environment in keeping with good environmental and business practices;
- Responding to environmental emergencies in a prompt and efficient manner; and
- Ensuring that our Workforce are fully informed of their responsibilities to comply with Tamboran's environmental management plans to protect the environment while performing their duties.

The Audit and Risk Management Committee is responsible for reviewing and ensuring compliance to Tamboran HSSE Policy.

Tamboran's senior leadership are accountable for ensuring this HSSE Policy is reviewed at least every two years and implemented accordingly.

Policy authorised by

Chief Executive Officer	Chairman
Date: 1 April 2021	Date: 1 April 2021

Figure 60: Tamboran's Health, Safety, Security and Environment (HSSE) Policy

8.2 Roles and responsibilities

Overall roles and responsibilities for the implementation of the regulated activities described in this EMP are outlined in Table 71. There are two primary streams of responsibility which sit under the Chief Operating Officer and the Executive Vice President, Strategy and Sustainability.

Table 71: Roles and responsibilities

Role		Responsibility
Stream 1	Chief Operating Officer	Tamboran employee responsible for the overall program.
Stream 1	VP Drilling and Completions	Tamboran employee responsible for operations and execution.
Stream 1	Drilling Engineering Technical Advisor Drilling Engineering Lead Drilling Ops Superintendent Senior Geotechnical and Technical Advisor	Tamboran personnel responsible for well drilling, hydraulic fracture stimulation and well testing activities. These roles broadly cover a range of responsibilities, including: • Ensuring the activities are designed and implemented in accordance with the NT legislation and the Code, as well as complying with the requirements detailed in the WOMP and this EMP. • Execution of the drilling of the wells in accordance with the WOMP and drilling program, this EMP while taking rig calls from the onsite company representatives, and HSE representative.
Stream 1	Completions Manager and Senior Technical Advisor	Ensures all areas of drilling, completion and well testing are carried out in accordance with the WOMP, this EMP and work instruction(s). All well drilling, hydraulic fracture stimulation and well testing contractors report to this position.
Stream 1	Manager Field Operations Senior HSE Manager Operating Company Representative Field HSE Advisor(s) Contract Administrator	Tamboran employees/consultants responsible executing operations in accordance with the WOMP, this EMP, Tamboran's HSEMS, contractual agreements and the exploration quality controls. These roles are ultimately responsible for ensuring all other parties are working within the HSE guidelines and provide guidance and advice to site personnel on: • Day-to-day management of the environment and implementation of this EMP, including reporting, monitoring compliance of operations of all regulated and associated activities. • Planning and implementation of Tamboran monitoring requirements including weeds, groundwater, soil and erosion, bushfire and emergency response
Stream 1	Specialist contractors	Contractors engaged by Tamboran to deliver on elements of the exploration program (drilling, completions, civil construction and camp operation). They are responsible for compliance with this EMP at all times during execution of their work.
Stream 2	Vice President- Environment and Approvals	Tamboran employee responsible for managing regulatory approvals and program changes and reporting, and supporting operations (including HSE). Also responsible for notifying the responsible Minister(s) and the owner/occupier of the land on which the activity is to be carried out; and for communications with the regulator and key stakeholders.
Stream 2	Cultural managers	NLC representatives to provide cultural clearances during clearing and grubbing activities to ensure activities are conducted to avoid areas of cultural significance.

8.3 Contractor management

Most of the work executed under this EMP is done via contractors with oversight from a Tamboran Representative. Assessing the level of capability and competency of the contractors is a major focus of the execution strategy.

The interfaces between Tamboran and contractors HSEMS are formalised and documented within the HSE bridging document. This is an operational document which is used on site to identify the systems / processes that take precedence during the execution of a work scope. Figure 61 provides an overview of the EMP implementation process.

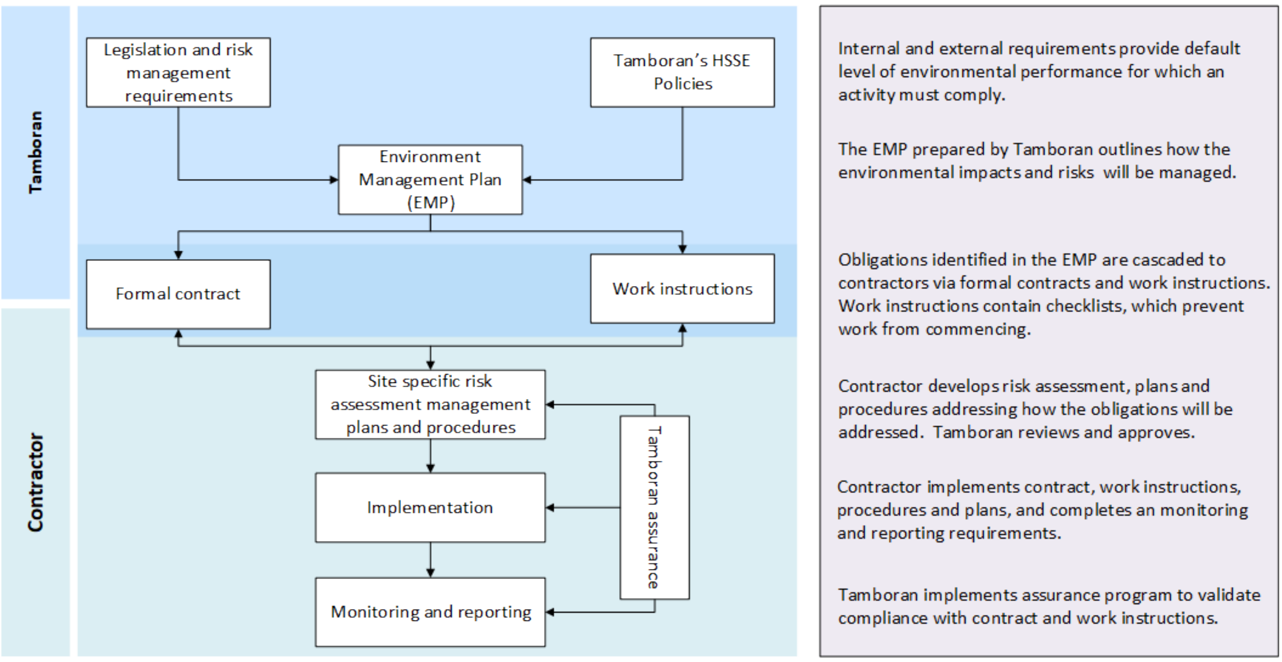


Figure 61: EMP implementation overview flowchart

8.4 Environmental commitment summary

The program environmental commitments outlined in Appendix P are sourced from the risk assessment (Appendix M) and environmental outcomes, performance standards and measurement criteria tables (Table 64 -Table 70). The implementation and compliance against these risk controls will be assessed as part of the annual environmental report (refer in section 8.10).

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/HSE advisor will undertake site inspections and direct such action as may be considered necessary to protect, minimise or rectify any environmental concerns.

8.5 Work instructions

An instrument referred to as a 'work instruction' is the mechanism used to cascade the relevant environmental commitments to Tamboran personnel and contractors. It outlines the minimum compliance requirements that must be implemented and includes:

- Key compliance and system documents.
- A list of compliance commitments with responsible parties allocated.

- A list of inspections, procedures and other tools required to implement the content of the EMP.
- Monitoring and reporting requirements.

8.6 Incident reporting and investigation

All personnel working on site (including visitors) are required to report incidents and near-misses that have the potential to, or do, affect the environment.

All environmental incidents and near misses are managed as per Tamboran's Incident Management Procedure and tracked through an online incident reporting system. Incidents are investigated with the level of investigation and methodology (5 whys, ICAM etc) dependent on actual and potential consequence.

Personnel are also encouraged to submit hazard / observation cards to maintain a level of awareness of environmental risk and to ensure a cycle of continual improvement.

8.7 Reportable environmental incident reporting

The 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. This also includes any potential or actual damage to a sacred site. Environmental offences and penalties that meet this criteria are defined in s. 117AAB of the Petroleum Act.

Tamboran will assess incidents as they occur 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.

The Regulations 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.

Tamboran 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).

8.7.1 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), Tamboran 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

Tamboran shall make all notification under the WMPCA via the NT EPA Pollution Hotline 1800 064 567 and Petroleum Operations via the DEPWS email: onshoregas.depws@nt.gov.au.

8.7.2 Gas leak reporting

Each gas leak shall be classified, repaired and reported in accordance with Table 72.

Table 72: Leak classification and remediation summary

Classification	Threshold	Notification	Comments
Minor Leak	>500 ppm measured at the surface of the component	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	>5,000 ppm (or 10%of the Lower Explosive Limit) when measured at the surface or A Liquid Petroleum (condensate/oil) loss of containment that exceeds 200 L or The leak is too large or not safe to measure. Or A leak due to an unplanned release from a gathering system -subsurface pipeline that, at ground level; gives a sustained reading greater than 500 ppm (by volume) for a 15 second duration.	In the case of an emergency, DITT 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: • if the leak cannot be repaired immediately; and • if the leak is likely to affect any of the landowner'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. If finalising the remediation is delayed more than 7 business days from the identification of the leak an update must be	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
		submitted on that day. The final close out report shall be provided when all work is completed. Where environmental impacts have occurred Tamboran will notify DEPWS Petroleum Operations immediately: Onshoregas.depws@nt.gov.au.	

8.8 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 instruction will be undertaken by Tamboran during the execution of the activity. System deficiencies/non-compliances arising from activities will have corrective actions agreed and assigned to the relevant personnel and may be the subject of a formal non-conformance. These non-conformances or corrective actions shall be logged, and remedial actions identified and implemented. The status of corrective actions will be tracked through to closure and reported in the annual environmental report.

Audits assessing the implementation of the EMP commitments will be completed for each activity (Table 73).

The results will be included in the annual environmental report.

Table 73: EMP audit schedule

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

8.9 Emergency response plan

An Emergency Response Plan (ERP) has been developed and supports all Tamboran's activities within the Beetaloo Sub-basin (Appendix Q). The ERP provides the framework for managing emergencies (i.e. spills, bushfires, medical emergencies) to minimise the impacts to personnel health and safety, and the environment.

8.10 Reporting

Internal and government reporting on performance standards will be carried out by the Tamboran authorised representative, and distributed to Tamboran management and the DEPWS, in accordance with Section 35 of the Regulations. 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 74).

Table 74: EMP reporting schedule

Frequency	Report detail	Recipient
Prior to the commencement of construction and drilling	A commencement of construction or drilling activity notification.	a) Minister for Environment (via DEPWS) b) Occupier of the land in which the activity is carried out

Frequency	Report detail	Recipient
		c) 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 environment performance 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 • Results of related research or of an ongoing monitoring program. • The relevant records outlined with section 8.11.	Tamboran management DEPWS
Report about flowback fluid and produced water	A report regarding flowback and produced water is required within 6 months of the flowback commencing, in accordance with Regulation 37A and 37B of the Regulations. Reporting must include full human health risk assessment relating to any chemical found in the flowback fluid and produced water (Reg 37A(2A) and Reg 37B(2A)).	Minister for Environment (via DEPWS)
Geospatial information	As per A.3.5 of the Code, geospatial information must be provided to the Minister. Geospatial data of all areas cleared and rehabilitated will be provided annually as a part of the Annual Environmental Performance Report.	Minister for Environment (via DEPWS)

8.11 Record keeping

The following records will be retained within Tamboran's document management system for a period of five years:

- Records linked to measurement criteria, commitments and statutory reporting requirements.
- Hydrotest/ leak testing reports on all wastewater tanks and gathering lines
- 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 Regulations, 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.

8.12 Management of change

A management of change process will be implemented to ensure any changes to the regulated activities described in this EMP are assessed and communicated to ensure no new or unintended environmental 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 where there is no new regulated activity, risk (including risk level) or impact is introduced. Where a new regulated activity, risk (including risk level) or impact is introduced, then a Revision of the EMP is required under the Regulations.

Examples of changes in the location of the regulated activity that may need to be considered in the future, include, a well pad, gathering lines, access, track, seismic line, gravel pit, laydowns etc. For changes in location of the regulated activities listed in this EMP, the following processes will be completed:

- Stakeholder engagement.
- A land condition assessment for the new location, including ecological and heritage scouting.
- An AAPA certificate granted covering the new location.
- The relevant management plans outlined in Section 7 of this EMP will be updated as required.
- A Regulation 22 will be submitted to DEPWS to modify the EMP, where the change to the location of the regulated activity does not introduce a new or increased environmental risk or impact not provided for in the EMP.
- A Regulation 17 will be submitted to DEPWS to revise the EMP where the change to the location of the regulated activity has the potential to introduce a new or increased environmental risk or impact not provided for in the EMP.

For proposed changes in chemicals used in the regulated activity, the chemical risk assessment will be updated and submitted to DEPWS under Regulation 22 (where no new or increased environmental risk or impact is introduced) or a Regulation 17 (where there is a potential for new or increased environmental risk or impact).

8.13 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.

9 References

Adams, MD, Donato, DB, Schulz, RS, Smith, GB, Gibbons, T, Davies, S and Hillier D. 2013. *Hypersaline-Induced Reduction in Cyanide Ecotoxicity at Gold Operations, thereby Obviating Detoxification Plants*. Conference Paper, World Gold Conference, Australia, Brisbane.

Adams, MD, Donato, DB, Schulz, RS and Smith, GB. 2008. *Influences of hypersaline tailings on wildlife cyanide toxicosis: MERIWA project M398 (Phase II) cyanide ecotoxicity at hypersaline gold operations*. *Final Report Volume 2—Definitive Investigation*. Minerals and Energy Research Institute of Western Australia, Perth.

AECOM. 2011. A*rchaeological Assessment – Drill Sites and Access Roads*, unpublished for Falcon Oil and Gas Australia.

AECOM. 2012b. *Interim Report Archaeological Surveys 2011*, unpublished report for Hess Australia (Beetaloo) Pty Limited.

AECOM. 2013. *Environmental Closeout Survey, Sweetpea Seismic Survey 2006*, Prepared by AECOM for submission to DME, Darwin, NT.

AECOM. 2021. *Land Condition Assessment for Exploration Lease Pads 2021) Velkerri 76 N1, Amungee NW and Beetaloo W*, Prepared by AECOM for Origin Energy.

AECOM. 2023. *Beetaloo Exploration and Appraisal Program - Hydraulic Fracturing Chemical Risk Assessment,* dated 15 June 2023.

AECOM. 2023. *Cultural Heritage Assessment – Shenandoah and Amungee Heritage Scouting,* dated 23 June 2023.

AECOM. 2023. *Land Condition Assessment Shenandoah South E&A Program,* dated 22 October 2023.

AECOM. 2024. *Beetaloo Exploration and Appraisal Program - Hydraulic Fracturing Chemical Risk Assessment*, dated 20 March 2024

Aldrick JM and Wilson PL. 1990. *Land systems of the Southern Gulf Region, Northern Territory*, *Technical Report No. 42*, Conservation Commission of the Northern Territory, Palmerston, NT.

Aumann, T and Baker-Gabb, D. 1991. RAOU Report 75. *A Management Plan for the Red Goshawk*. RAOU. Royal Australasian Ornithologists Union, Melbourne.

Australian Natural Resources Atlas (ANRA), 2008. *Rangelands 2008 Taking the Pulse- Stuart Plateau Bioregion*.

Australian Pipelines and Gas Association 2019. *APGA Code of Practice for Upstream Polyethylene Gathering Networks in the Coal Seam Gas Industry*, Version 5.0, August 2019, https://www.apga.org.au/sites/default/files/uploaded-content/field_f_content_file/cop_for_upstream_pe_gathering_lines_in_the_csg_industry_050919.pdf.

Australian Radiation Protection and Nuclear Safety Agency, 2019. Radon exposure and health, website access 06/09/2019, https://www.arpansa.gov.au/understanding-radiation/radiation-sources/more-radiation-sources/radon.

Australian Petroleum Production and Exploration Association Limited, 2008. *Code of Environmental Practice*, Canberra, ACT.

AustRoads. 2019. *Guide To Traffic Management Part 12: Traffic Impacts of Developments.*

AustRoads. 2020. *Guide to Traffic Management Part 3: Traffic Studies and Analysis Methods.* https://austroads.com.au/publications/traffic-management/agtm03. Viewed online 10 March 2024.

Barrett, G, Silcocks, A, Barry, S, Cunningham, R and Poulter, R. 2003. *The New Atlas of Australian Birds*. Royal Australasian Ornithologists Union, Melbourne.

Barkly Regional Council, 2018. *The Region*, website accessed 18 September 2018, https://www.barkly.nt.gov.au/region/demographics.

Bubb, A, 2004. *'Pastoral industry survey 2004. Tennant Creek'*. Northern Territory Government: Darwin.

BOM, 2017a. Bureau of Meteorology Submission #475. Hydraulic Fracturing Inquiry – NT Bureau of Meteorology input. https://frackinginquiry.nt.gov.au/__data/assets/pdf_file/0003/452118/Bureau-of-Meteorology-Submission-475_Redacted.pdf. Accessed 12 March 2024.

BOM, 2017b.Groundwater Dependent Ecosystems Atlas. Commonwealth of Australia. www.bom.gov.au/water/groundwater/gde accessed October 2023.

BOM, 2024. *Average annual rainfall. 30-year climatology (1991 – 2020).* Average annual, seasonal and monthly rainfall maps.http://www.bom.gov.au/climate/maps/averages/rainfall/?period=an&region=aus, accessed 22 March 2024.

Commonwealth of Australia. 2001. *Australian Native Vegetation Assessment 2001*, Land and Water Australia, Canberra.

Christian CS, Noakes LC, Perry RA, Slatyer RO, Stewart GA and Traves DM. 1951. *Survey of the Barkly Region, Northern Territory and Queensland, 1947-48*, Land Research Series No. 3, CSIRO, Melbourne, SA.

Churchill, S. 2008. *Australian Bats*. Second edition. Jacana Books, Crow's Nest.

Cogger, HG. 2000. *Reptiles and Amphibians of Australia - 6th edition*. Sydney, NSW: Reed New Holland.

Cole, J and Woinarski, J. 2002. *Field Guide to the Rodents and Dasyurids of the Northern Territory*. Surrey Beatty and Sons, Chipping Norton, NSW.

Cooney, SJN. 2009. *Ecological associations of the hooded parrot (Psephotus dissimilis)*. Ph.D. Thesis, Australian National University.

Curtis, Lee K, Dennis, AJ, McDonald, K R, Kyne, PM, and Debus SJS, (eds.) 2012. *Queensland's Threatened Animals*. CSIRO Publishing, Collingswood.

CSIRO. 2024. *Bushfire Best Practice Guide.* https://research.csiro.au/bushfire/bushfire-basics/how-bushfires-behave/vegetation/, accessed 18 March 2024.

Davies, R, Foulger, G, Bindley, A and Styles, P. 2013. Induced seismicity and Hydraulic Fracturing for the recovery of hydrocarbons. Marine and petroleum geology, V45. P 171-1785.

Debus, S. 2012. *Birds of prey of Australia*, *2nd edition*. CSIRO Publishing, Collingwood.

Department of the Environment. 2014. *Tyto novaehollandiae kimberli in Species Profile and Threats* Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat. Accessed Wed, 10 Sep 2014.

Department of the Environment. 2014. *Dasyurus hallucatus in Species Profile and Threats Database*, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat. Accessed Wed, 10 Sep 2014.

Department of Environment and Energy. 2018. *State and Territory Greenhouse Gas Inventories 2016*, published February 2018.

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

Department of Environment and Natural Resource. 2018. *Daly Roper Beetaloo Water Control District*, Northern Territory Government, Darwin, NT.

DEPWS. 2018a. *Listing of "Threatened Animals", "Plants" and "Weeds"*, accessed August and September 2018. https://nt.gov.au/environment/animals/threatened-animals.

DEPWS. 2018b. *Northern Territory Stream Order, Strahler stream orders over the Northern Territory, topographic scale data 250k*, Spatial Data and Mapping Branch, Water Resources Division, Northern Territory Government, Darwin, NT.

DEPWS. 2021. *Land Clearing Guidelines. Northern Territory Planning Scheme*. Version 1.3 dated 24 September 2021. https://nt.gov.au/__data/assets/pdf_file/0007/236815/land-clearing-guidelines.pdf.

DEPWS. 2022. *Regional Report: Strategic Regional Environmental and Baseline Assessment for the Beetaloo Sub-basin*. DEPWS Technical Report 41/2022. Department of Environment, Parks and Water Security, Northern Territory Government. Berrimah, Northern Territory.

DEPWS. 2022. *SREBA Strategic Regional Environmental and Baseline Assessment* and *Data Catalogue*. https://srebadata.nt.gov.au/domain/NTG, accessed May 2022.

DEPWS. 2023 *Regional weeds strategies and plans*. https://depws.nt.gov.au/rangelands/guidelines-and-management-plans/weed-management-strategies-and-plans, accessed 30 June 2023.

Department of Environment, Science and Innovation (DESI). 2016. *Streamlined model conditions for petroleum activities—ESR/2016/1989,* version 2.02, effective 05 May 2016. Queensland Government. Available at: https://environment.des.qld.gov.au/policies?a=272936:policy_registry/rs-gl-streamlined-model-conditions-petroleum.pdf. Viewed online 5 March 2024.

DITT. 2016. *Partheneum found in the NT*. https://dpir.nt.gov.au/news/2016/december/parthenium-found-in-the-nt, accessed 14 September 2018.

DIPL. 2022. *Annual Traffic Report 2022*, Version 1, dated May 2022. https://dipl.nt.gov.au/__data/assets/pdf_file/0006/1251654/annual-traffic-report-2022.pdf, accessed 15 March 2024.

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

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

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

Dickman CR. 2009. House cats as predators in the Australian environment: impacts and management. Human-Wildlife Conflicts 3:41-48.

Dickman, CR. 1996. Impact of exotic generalist predators on the native fauna of Australia. Wildlife Biology 2(3):185-195.

Dostine, PL and Franklin, DC. 2002. A comparison of the diet of three finch species in the Yinberrie Hills area, Northern Territory. Emu 102:159-164.

EHS Support. 2023. *Hydraulic Stimulation Chemical Risk Assessment Tamboran Resources Northern Territory Tenements*, dated 12 January 2023.

Environment Australia. 1998. *Best Practice Environmental Management in Mining - Dust Control*, Canberra, ACT.

Environment Protection Agency. 1995. *Best Practice Environmental Management in Mining - Environmental Impact Assessment*, Canberra, ACT.

Environment Australia. 1997. *Best Practice Environmental Management in Mining - Hazardous Materials Management, Storage and Disposal*, Canberra, ACT.

Environment Australia. 1998. *Best Practice Environmental Management in Mining - Landform Design for Rehabilitation*, Canberra, ACT.

Environment Australia. 1998. *Best Practice Environmental Management in Mining - Noise, Vibration and Airblast Control*, Canberra, ACT.

Environment Protection Agency. 1996. *Best Practice Environmental Management in Mining - Onshore Minerals and Petroleum Exploration*, Canberra, ACT.

European Food Safety Authority (EFSA), 2009. *Scientific Opinion of the Panel on Animal Health and Welfare on a request from the European Commission on welfare aspect of the main systems of stunning and killing of farmed eel* (*Anguilla anguilla*). The European Food Safety Authority (EFSA) Journal, 1014: 1-42.

Faulks, JJ. 2001. *Roper River Catchment - An Assessment of the Physical and Ecological Condition of the Roper River and its Major Tributaries, Technical Report No. 36/2001*. Natural Resources Division, Department of Lands, Planning and Environment, Katherine, NT.

Fisher, A and Woinarski, J. 1994. Golden Bandicoot. Australian Natural History *26*, 20-21.

Fisher, A. 2001. *Biogeography and Conservation of Mitchell Grasslands in Northern Australia, PhD Thesis*, Faculty of Science, Information Technology and Education, Northern Territory University, Darwin, NT.

Fisher, A, Baker, B, Woinarski, J. 2002 *Biodiversity Audit – Bioregional Summaries*, Compilation of individual summaries for the National Land and Water Audit, Parks and Wildlife Service, NT.

Fitzsimons, P, Bond, M and Webber, S. 2010. *Creating a participatory adaptive capacity index for climate change adaptation - Report of engagement process in the South-West of Victoria*. Department of Primary Industries Victoria (in press).

Fleming MR, Johnson KA, Latz PK and McKean JR. 1983. *A Biological Survey of Junction Stock Reserve and Newcastle Waters Pastoral Lease on The Barkly Tablelands*, Wildlife Research Section, Conservation Commission of the NT.

Fulton, S and Knapton, A. 2015. *Beetaloo Basin Hydrogeological Assessment*. Prepared by CloudGMS.

Garnett, S and Baker, GB. 2021. *The Action Plan for Australian Birds 2020*. CSIRO Publishing.

Garnett, S, Szabo, J and Dutson, G. 2011. *The Action Plan for Australian Birds 2010*. CSIRO Publishing.

GHD. 2013. *Vista Gold Australia Pty Ltd Mt Todd Gold Project Traffic and Transport Impact Assessment June*, available at https://ntepa.nt.gov.au/__data/assets/pdf_file/0005/289625/appendixV_traffic_transport.pdf

Gibbons, RD, Bhaumik, DK and Aryal S. 2009. *Statistical Methods for Groundwater Monitoring*, Second Edition, Wiley 374pp.

Gillespie, G R, Brennan, K, Gentles, T, Hill, B, Low Choy, J, Mahney, T, Stevens, A and Stokeld, D. 2015. *A guide for the use of remote cameras for wildlife survey in northern Australia*. Darwin: Charles Darwin University

Griffiths SR, Smith GB, Donato DB, Gillespie, CG. 2009a. Factors influencing the risk of wildlife cyanide poisoning on a tailing storage facility in the Eastern Goldfields of Western Australia. Ecotoxicology and Environmental Safety 72 (2009) 1579-1586.

Griffiths SR, Smith GB, Donato DB, Lumsden LF, Coulson G. 2009b. Hypersalinity reduces the risk of cyanide toxicosis to insectivorous bats interacting with wastewater impoundments at gold mines. Ecotoxicology and Environmental Safety 99 (2014) 28-34.

Groves RH and Williams OB. 1981. *Natural grasslands*. In Groves RH, (ed.) Australian Vegetation, pp. 293-316. Cambridge University Press, Melbourne.

Heinz, S, Baynes, T, Haque, N, Barrett, D and Geschke, A. 2019. *Whole of Life Greenhouse Gas Emissions Assessment of a Coal Seam Gas to Liquefied Natural Gas Project in the Surat Basin, Queensland, Australia*. Final Report for GISERA Project G2. https://gisera.csiro.au/wp-content/uploads/2019/07/GISERA_G2_Final_Report-whole-of-life-GHG-assessment.pdf.

Heritage Surveys. 1999. *Additional archaeological assessments, Daly Waters to McArthur River Gas Pipeline, Northern Territory*, unpublished report to Northern Territory Power and Water Authority.

Hermes, M. 1986. *Amadeus Basin to Darwin Natural Gas Pipeline – Spread 2: Internal report on archaeological findings*, unpublished report to Museums and Art Galleries of the Northern Territory.

Higgins, PJ and Davies, SJJF. (eds.) 1996. *Handbook of Australian, New Zealand and Antarctic Birds. Volume Three - Snipe to Pigeons*. Melbourne, Victoria: Oxford University Press.

Hirano, T., M. Kiyota, et al. 1995. "Physical effects of dust on leaf physiology of cucumber and kidney bean plants." Environmental Pollution. vol. 89, no. 3, pp. 255-261.

HLA-Envirosciences Pty Ltd (HLA). 2005. E*nvironmental Management Plan: Onshore Petroleum Exploration Beetaloo Basin, NT*. Report prepared for Sweetpea Petroleum Pty Ltd.

HLA. 2006a. *An Analysis of Available Water Quality Data and Gap Analysis for Beetaloo Basin, Northern Territory.* Report prepared for Sweetpea Petroleum Pty Ltd.

HLA. 2006b. *Surface Water Quality Investigation, Beetaloo Basin, Northern Territory.* Report prepared for Sweetpea Petroleum Pty Ltd.

HLA. 2006c. *Sweetpea Petroleum Environmental Program 2006: Baseline Vegetation Assessment.* Report prepared for Sweetpea Petroleum Pty Ltd.

HLA. 2006d. *Archaeological Assessment 2006 for the Sweetpea Petroleum Seismic Program, Beetaloo Basin, NT, 2006*. Report prepared for Sweetpea Petroleum Pty Ltd.

HLA. 2006e. *Beetaloo Basin: Cooee Hill and 80 Metre Tower Archaeological Assessment*. Report prepared for Sweetpea Petroleum Pty Ltd.

HLA. 2006f. *Beetaloo Basin: Yaroo, South Martyr's Tree and Dunmarra Archaeological Assessment*, unpublished report for Sweetpea Petroleum.

HLA. 2007a. *Supplementary Environmental Management Plan, Drilling Program 2007, Beetaloo Basin, NT.* Report prepared for Sweetpea Petroleum Pty Ltd.

HLA. 2007b. 2007 *Environmental Works Progress Report 1 (March to May 2007)*. Letter to Sweetpea Petroleum dated 28 May 2007.

HLA. 2007c. *Groundwater Monitoring Program, Sweetpea Petroleum Exploration Program, Beetaloo Basin, NT*. Report prepared for Sweetpea Petroleum Pty Ltd.

HLA. 2007d. *Archaeological Assessment Newcastle Waters Proposed Drilling Site for the Sweetpea Petroleum Seismic Program, Beetaloo Basin, NT, 2006*. Report prepared for Sweetpea Petroleum Pty Ltd.

Hose, GC, Sreekanth, J, Barron, O and Pollino, C. 2015. *Stygofauna in Australian Groundwater Systems: Extent of knowledge*. CSIRO, Australia.

Humphreys, G. Hamilton, Z., Finston, T. and Hitchen, Y. 2022. *Beetaloo Sub-basin Stygofauna Baseline Assessment*. Prepared for the Northern Territory Department of Environment, Parks and Water Security by Biota Environmental Sciences and Helix Molecular Solutions.

Land and Water Australia, 2004. *Australian Water Resources Assessment*. In: National Land and Water Resource Audit, 2004. Canberra, ACT.

De León, LF and Castillo, A. 2015. *Rhinella Marina* (Cane Toad). Salinity Tolerance. *Herpetological Review* 46(2):237-238.

Kerle, JA, Foulkes, JN, Kimber, RG and Papenfus, D. 1992. The decline of the brushtail possum, *Trichosurus vulpecula* (Kerr 1798), in arid Australia. Rangelands Journal 14, 107-127.

Land and Water Australia, 2004. *Australian Water Resources Assessment*. In: National Land and Water Resource Audit, 2004. Canberra, ACT.

Lloyd, P, Sanders, M, Reis, T and Abbott, A. 2013. Targeted trapping surveys shed new light on the distribution and habitat characteristics of the *Carpentarian pseudantechinus (Pseudantechinus mimulus)*, a threatened *dasyurid* marsupial. Australian Mammalogy 35:220-223.

Mayes, P J. 2006. *The ecology and behaviour of Varanus mertensi (Reptilia: Varanidae)*. PhD Thesis. Edith Cowan University. Retrieved from *http://ro.ecu.edu.au/theses/42*.

McCue, K. 2013 Historical earthquakes in the northern Territory, Australian Earthquake Engineering Society, Historical earthquakes in the Northern Territory (aees.org.au). Accessed 21 January 2019.

Menkhorst, P and Knight F. 2011. *A Field Guide to the Mammals of Australia*. Oxford University Press, Sydney.

Morcombe, M. 2000. *Field guide to Australian birds*. Steve Parish Publishing.

National Uniform Drillers Licensing Committee. 2020. *Minimum Construction Requirements for Water Bores in Australia,* Fourth Edition 2020.https://adia.com.au/wp-content/uploads/2020/09/Minimum-Construction-Requirements-Edition-4.pdf.

Noakes LC and Traves DM. 1951. *Outline of the Geology of the Barkly Region*. In: Survey of the Barkly Region, Northern Territory and Queensland, 1947-48. CSIRO Land Research Series No. 3.

North Australia Fire Information (NAFI), 2018. *Fire Maps*. http://www.firenorth.org.au Accessed 16 September 2018.

NTG. 2015. *NT Weed Management Handbook*.

NTG. 2017. *Northern Territory Weed ID Deck*.

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

Northern Territory Government. 2005. *Integrated Natural Resource Management Plan for the Northern Territory*, Northern Territory Government.

NTG. 2023. *Georgina Wiso Background Report 2023-2031*. Report 13/2023.Department of Environment, Parks and Water Security: Northern Territory, Australia. Accessed online 19 March 2024.

NTG. 2024a. Memorandum: GWEL ASSESSMENT – GRF10285 – TAMBORAN B2 PTY, dated 10 January 2024. In: NTG, 2024. *Notice of intention to make a water extraction licence decision (Pursuant to section 71B of the Water Act 1992)*. N.D. Accessed online 19 March 2024.

NTG. 2024b. Weed management plans and regional strategies. https://nt.gov.au/environment/weeds/how-to-comply-with-the-law/weed-management-plans-regional-strategy accessed 12 March 2024.

Ong, C, Heath, c, Down, D, Maney, B, Mainson, M, Frery, E, Caccetta, M, Markov, J and D Wilson (2022). *Methane and Greenhouse Gas Studies for the Beetaloo Sub-basin Strategic Regional Environmental and Baseline Assessment*. DEPWS Technical Report 39/2022. CSIRO, Australia.

Orr, DM and Holmes, WE. 1984 *'Mitchell Grasslands.'* In G.N. Harrington, A.D. Wilson and M.D. Young (eds) Management of Australia's Rangelands, Australia, CSIRO: 241-254.

Orr ML, Bernardel G, Owens R, Hall LS, Skeers N, Reese B and Woods M (2020). *Geology of the Beetaloo GBA region*. Technical appendix for the Geological and Bioregional Assessment: Stage 2. Department of the Environment and Energy, Bureau of Meteorology, CSIRO and Geoscience Australia, Australia.

Palmer, C, Woinarski, J and Ward S. 2012. *Threatened Species of the Northern Territory: Gouldian Finch Erythrura gouldiae*. Department of Land Resource Management, Northern Territory Government.

Parks and Wildlife Commission of the NT. 2005. *Bullwaddy Conservation Reserve Plan of Management*, Parks and Wildlife Commission of the NT, Darwin.

Pavey, C. 2006. *National Recovery Plan for the Greater Bilby Macrotis lagotis*. Northern Territory Department of Natural Resources, Environment and the Arts.

Pizzey, G, Knight, F and Pizzey, S. 2012. *The Field Guide to Australian Birds*. HarperCollins Publishers, Sydney.

Primary Health Network, Northern Territory. 2020. *Barkly Region Data Report*. Australian Government, https://www.ntphn.org.au/wp-content/uploads/2021/06/Barkly-Regional-Data-Profile_FINAL.pdf.

Quaternary Archaeological Surveys. 1998. *Archaeological survey of the Stuart Highway to Mataranka Homestead Optic Fibre Cable Corridor, Northern Territory*, unpublished report for Telstra.

Randal MA. 1967. *Groundwater in the Barkly Tableland, NT*, Bulletin 91, Bureau of Mineral Resources, Geology and Geophysics, Canberra, ACT.

RDM Hydro. 2023. *Tamboran Resources Ltd Water Extraction Licence Application – Gum Ridge Formation Groundwater Impact Assessment*,27 October 2023. In: NTG, 2024. *Notice of intention to make a water extraction licence decision (Pursuant to section 71B of the Water Act 1992)*. N.D. Accessed online 19 March 2024.

Rees GN, Oberprieler S, Nielsen D, Watson G, Shackleton M, Davis JA (2020) *Characterisation of the stygofauna and microbial assemblages of the Beetaloo Sub-basin, Northern Territory*. CSIRO, Australia.

Ryder Scott Company (Ryder Scott), 2010. *Evaluation of the Unconventional Oil Resource Potential Pertaining to Certain Acreage Interests in the Beetaloo Basin, Northern Territory, Australia*. Report prepared for Falcon Oil and Gas Australia Pty Ltd.

Schandl, Baynes, HT, Haque, N, Barrett, D and Geschke, A. 2019. *Final Report for Final Report for GISERA Project G2 - Whole of Life Greenhouse Gas Emissions Assessment of a Coal Seam Gas to Liquefied Natural Gas Project in the Surat Basin, Queensland, Australia*. CSIRO, Australia.

Seismology Research Centre. 2017. *Earthquakes in Australia*, https://www.src.com.au/earthquakes/seismology-101/earthquakes-in-australia/ Accessed January 21, 2019.

Southgate, RI and Paltridge, R. 1998. *Recovery of the Greater Bilby Macrotis lagotis*. Final Report for Project Number 185, Nature Australia, Biodiversity Group, Endangered Species Program and Feral Pests Program.

Smith, JG and Phillips, BL. 2006. Toxic tucker: the potential impact of cane toads on Australian reptiles. Pacific Conservation Biology 12:40-49.

Smith, MA. 1986. An investigation of possible Pleistocene occupation at Lake Woods, Northern Territory, Australian Archaeology, 22:60-72.

Tamboran, 2023. *Amungee NW 2H Flowback Report EP 98*, Rev 1, dated 15 September 2023.

Tennant Creek Regional Economic Development Committee, 2014, *Tennant Creek and Barkly Region Strategic & Action Plan 2014-2016*, endorsed 28 October 2014, Northern Territory Government, https://nt.gov.au/__data/assets/pdf_file/0007/198340/tennant-creek-and-barkly-region-strategic-and-action-plan.pdf

Tickell, SJ. 2003. *Water Resource Mapping Barkly Tablelands*, Unpublished draft report prepared by the Department of Infrastructure Planning and Environment, Darwin, NT.

Trainor, CR. 2005. Distribution and Natural History of the Cryptic Dragon *Chelosonia Brunnea*: A Review of Records. Northern Territory Naturalist 18:24-44.

United States Geological Survey (USGS) 2017. *Induced Earthquakes, myths and misconceptions,* https://earthquake.usgs.gov/research/induced/myths.php Accessed January 21 2019.

US EPA. 2016. *Hydraulic Fracturing for Oil and Gas: Impacts from the Hydraulic Fracturing Water Cycle on Drinking Water Resources in the United States (Final Report)*. U.S. Environment Protection Agency, Washington, DC, EPA/600/R-16/236F, 2016.

Ward, SJ. 2008. *Habitat-use, foraging and breeding ecology of the northern shrike-tit Falcunculus frontatus whitei.* Report to NHT (Department of Natural Resources, Environment, the Arts and Sport, Darwin).

Ward, SJ, Berghout, M and Baker, B. 2009. Notes on the form and habitat of nests of the northern shrike-tit. Northern Territory Naturalist 21:54-60.

Wilson, S and Swan, G. 2010. *A Complete Guide to the Reptiles of Australia. 2010.* New Holland, Sydney.

Woinarski, J.C.Z. 2004a. *National Multi-species Recovery Plan for the Partridge Pigeon Geophaps smithii smithii, Crested Shrike-tit, Falcunculus frontatus whitei, Masked Owl Tyto novaehollandiae kimberli and Masked Owl Tiwi Islands Tyto novaehollandiae melvillensis 2004-2009*. Northern Territory Department of Infrastructure Planning and Environment. Available http://www.environment.gov.au/biodiversity/threatened/publications/recovery/smithii-whitei-kimberli-melvillensis/index.html.

Woinarski, JCZ. 2004b. *National Multi-species Recovery Plan for the Carpentarian Antechinus Pseudantechinus mimulus, Butler's Dunnart Sminthopsis butleri and Northern Hopping-mouse Notomys aquilo, 2004 - 2009*. Northern Territory Department of Infrastructure Planning and Environment.

Woinarski, JCZ and Fisher, A. 1995. Wildlife of lancewood (*Acacia shirleyi*) thickets and woodlands in northern Australia. 1. Variation in vertebrate species composition across the environmental range occupied by lancewood vegetation in the Northern Territory. Wildlife Research 22: 379-411.

Woinarski JCZ, Pavey C, Kerrigan R, Cowie I and Ward S. 2007. *Lost from our Landscape: Threatened Species of the Northern Territory*. Palmerston: Department of Natural Resources, Environment and the Arts.

Woinarski, JCZ and Tidemann, SC. 1991. The bird fauna of a deciduous woodland in the wet-dry tropics of northern Australia. Wildlife Research 18: 479-500.

Woinarski, JCZ and Ward, S. 2012. *Threatened Species of the Northern Territory: Crested Shrike-tit Falcunculus (frontatus) whitei*. Department of Land Resource Management, Northern Territory Government.

10 Acronyms and Abbreviations

Acronym	Meaning
4WD	Four wheel drive
°C	degrees Celsius
%	percentage
AADT	Average Annual Daily Traffic
AAPA	Aboriginal Areas Protection Authority
AEP	Annual Exceedance Probability
AHD	Australian Height Datum
ALARP	as low as reasonably practicable
ANZECC Guidelines	Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2000
API	American Petroleum Institute
ARI	annual re-occurrence Interval
AS	Australian Standard
BMP	Bushfire Management Plan
BOM	Bureau of Meteorology
BOP	blow-out preventer
BOWD	Basis of Well Design
BTEX	Benzene, Toluene, Ethylbenzene and Xylene
CAS	Chemical Abstracts Services
CFR	Code of Federal Regulations
CFT	chemical frac tracers
CLA	Cambrian Limestone Aquifer
Code	Code of Practice: Onshore Petroleum Activities in the Northern Territory
CSG	Coal Seam Gas
CSIRO	Commonwealth Scientific and Industrial Research Organisation
Cth	Commonwealth
DCCEEW	Department of Climate Change, Energy, the Environment and Water
DD	Data Deficient
DEPWS	Department of Environment, Parks and Water Security
DFIT	Diagnostic Fracture Injection Test
DIPL	Department of Infrastructure, Planning and Logistics
DITT	Department of Industry, Trade and Tourism
DOC	depth of cover

Acronym	Meaning
E&A	Exploration & Appraisal
EC	electrical conductivity
EMP	Environment Management Plan
EN	Endangered
EP	exploration permit (e.g. EP 76, EP 98 and EP 117)
EPA	Environment Protection Authority (NT)
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* Commonwealth
ERP	Emergency Response Plan
ESC	erosion and sediment controls
ESCP	Erosion and Sediment Control Plan
ESD	Ecological Sustainable Development
FIT	Formation Integrity Test
GDE	Groundwater Dependent Ecosystems
GFT	gas frac tracers
GHG	Greenhouse gas
GISERA	Gas Industry Social and Environmental Research Alliance
GJ	Gigajoule
GPS	Global Positioning System
GWP	Global Warming Potential
ha	hectare
HDPE	High-Density Polyethylene
HFS	Hydraulic fracture stimulation
HPVs	high point vent
HSE	Health, Safety and Environment
HSEMS	Health, Safety and Environment Management System
ID	Identification number
ISO	International Organisation for Standardisation
KCl	Potassium chloride
KL	kilolitre
km	kilometre
km^2	square kilometres
km/hr	kilometres per hour
LCM	loss of circulation material

Acronym	Meaning
LOS	Level of Service
LOT	Leak-Off Test
m	metre
Ma	millions of years ago
MAOP	Maximum Allowable Operating Pressure
MAPP	Maximum Allowable Pumping Pressure
MEM	Mechanical Earth Model
MEMP	Methane Emission Management Plan
ML	megalitre
Ml	Local magnitude
mm	millimetre
MEMP	Methane Emissions Management Plan
MNES	Matters of National Environmental Significance
MOE	Margin of Exposure
NaCl	Sodium chloride
NAFI	Northern Australian Fire Information
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
NT	Northern Territory
NTD	Near Threatened
NTPFES	Northern Territory Police, Fire & Emergency Services
NTG	Northern Territory Government
NUDLC	National Uniform Drillers Licensing Committee
NW	North West
NZS	New Zealand Standards
ORI1-1	Beetaloo Basin Kyalla, civil construction EP 117 N2 EMP
ORI3-2	Beetaloo Basin Kyalla drilling hydraulic fracture stimulation and well testing program EP 117 N2 EMP
ORI6-3	Beetaloo Sub-basin Kyalla 117 N2 multi-well drilling, hydraulic fracturing and well testing program EMP

Acronym	Meaning
ppm	parts per million
PEGN Code	APGA Code of Practice for Upstream Polyethylene Gathering Networks
QLD	Queensland
RMP	Rehabilitation Management Plan
RO	reverse osmosis
ROW	rights-of-way
RP	Recommended Practice
RWA	Restricted Work Area
SAR	sodium adsorption ratio
SE	South East
Shenandoah South S2 Shenandoah South S B Shenandoah South S C Shenandoah South N A	Denotes an abbreviation for the location of the well pads and infrastructure – south and north: Shenandoah South 2 Shenandoah South B Shenandoah South C Shenandoah North A
SMP	Spill Management Plan
SREBA	Strategic Regional Environmental and Baseline Assessment
tCO_2e	tonnes of carbon dioxide equivalent
Tamboran	Tamboran B2
TDS	Total Dissolved Solids
TIA	Traffic Impact Assessment
TJ/day	Terajoules per day
TMP	Traffic Management Plan
TO	Traditional owner
TVDSS	True Vertical Depth from Surface Sea level
TPH	Total Petroleum Hydrocarbons
TPWC Act	Territory Parks and Wildlife Conservation Act
USA	United States of America
US EPA	United States Environmental Protection Agency
VU	Vulnerable
WAC	Well Acceptance Criteria
WEL	Water Extraction Licence
WIMP	Well Integrity Management Plan

Acronym	Meaning
WIMS	Well Integrity Management System
WMP	Weed Management Plan
WMPCA	Waste Management and Pollution Control Act 1998
WOMP	Well Operations Management Plan
WoNS	Weed of National Significance
WWMP	Wastewater Management Plan
XRF	X-Ray Fluorescence