Statement of Reasons

ORIGIN ENERGY B2 PTY LTD – ENVIRONMENT MANAGEMENT PLAN (EMP) FOR THE BEETALOO SUB-BASIN VELKERRI DRILLING, HYDRAULIC FRACTURING AND WELL TESTING EXPLORATION PERMIT (EP) 76

PROPOSAL

The Environment Management Plan (EMP) for the Beetaloo Sub-basin Velkerri drilling, hydraulic fracturing and well testing exploration permit (EP) 76 (the Proposal)[1] was referred by Origin Energy B2 Pty Ltd (the Proponent)[2] to the Northern Territory Environment Protection Authority (NT EPA) on 1 October 2019 for consideration under the *Environmental Assessment Act 1982* (EA Act).

The Proponent proposes to undertake a program of drilling, hydraulic fracturing[3] and well testing of the Velkerri Formation at exploration petroleum well location S2 on the Velkerri EP76 lease pad/site, followed by extended production test (EPT) on the well that will run between 90 and 365 days. On completion of EPT, the well will either be suspended for future re-entry, suspended on build-up, or permanently decommissioned by 2024. At the completion of operations all surface infrastructure will be removed (excluding the well head). The Proposal occurs at one well site location on Velkerri EP76, which lies approximately 280 km west of Gulf of Carpentaria in the Beetaloo Sub-basin and includes:

- drilling of the Velkerri 76 S2-1 exploration well:
  - drilling of a vertical well section to 2,000 – 3,000 m below ground level
  - drilling of a horizontal well section up to 3,000 m in length
- hydraulic fracturing of a horizontal exploration well, with up to 20 stages completed
- exploration well completion and testing including:
  - completion of up to 12 months of well testing
  - storage and treatment of up to 12 ML of wastewater flowback onsite
- exploration well suspension and decommissioning of an exploration well
- construction and operation of a temporary camp
- helicopter operations
- asset maintenance and monitoring activities
- site decommissioning and rehabilitation
- all activities ancillary to the above.

1 'Proposal' has the same meaning as 'Regulated Activity' under the *Petroleum Act 1984*.
2 'Proponent' has the same meaning as 'Interest Holder' under the *Petroleum Act 1984*.
3 Hydraulic fracturing means the underground gas and oil extraction process that involves the injection of fluids at a high pressure into a geological formation to induce fractures that conduct hydrocarbons for extraction.

The Proposal does not include other petroleum exploration activities on EP76 for land clearing, water bore construction or civil construction, which were previously approved in the following related EMPs:

- Beetaloo Sub-basin Velkerri civil construction EP76 S2 (approved 26/09/2019) [4]
- Beetaloo Sub-basin groundwater monitoring bore installation program, Velkerri EP76 (approved 19/07/2019).[4]

The key components of the Proposal are summarised in Table 1.

Table 1: Key components of the Proposal

Component	Description
AAPA certificate	C2019/039
Groundwater extraction licence	GRF 10285
Total area of exploration lease (EP161)	1,880 km^2
Total area of disturbance	Nil – well site is already established
Number of exploration wells	1: Velkerri EP76 S2-1
Timing of works	2019 – 2024 (includes the drilling and well testing 2019 – 2020)
Duration of hydraulic fracturing operations	~1 month
Duration of well testing (appraisal) operations	3 months – 12 months
Operational workforce	~50 during drilling and hydraulic fracturing (2 – 6 persons during well testing)
Camp capacity	60+ persons
Peak traffic movements for all Velkerri activities (per day)	~44
Average traffic movements per day for first 3 months	~10 – 15
Average traffic movements per day for the remaining 9 month period	~3 – 4
Truck load-out: Wastewater transport	Up to 100 truck movements
Estimated groundwater usage	~15 – 38 ML (based on a maximum 20 stages)
Water storage tank capacity (both make-up and flowback water)	Up to 30 ML
Bunded tank pad containment capacity	~21 ML
Flowback/wastewater volume – initial predicted	~7.5 ML
Flowback/wastewater volume– final predicted for treatment and off-site disposal	<1.0 ML
Volume of drilling mud and cuttings generated	~750 m^3

[4] Approved EMPs are available at: https://denr.nt.gov.au/environment-information/onshore-gas-in-the-northern-territory/environment-management-plan/approved-emps.

Component	Description
Proppant usage (total)	3,600 t (for maximum 20 stages, or 180 t per stage)
tCO_2-e emissions	~18,815 t – ~65,894 t (3 – 12 months testing)
Rehabilitation	7.4 ha

CONSULTATION

The EMP has been reviewed as a notification under the EA Act in consultation with Northern Territory Government advisory bodies (see Attachment A) and the responsible Minister, in accordance with clause 8(1) of the Environmental Assessment Administrative Procedures 1984.

The Proposal includes the drilling, hydraulic fracturing and well testing of one petroleum exploration well, and in accordance with the Petroleum (Environment) Regulations 2016, the EMP was made available for public comment for a period of 28 days from 5 October to 1 November 2019.

A brief overview of the key topics raised during the pubic consultation is provided under Public Consultation**.** The NT EPA has reviewed the public submissions as part of its decision-making and providing advice to the Minister.

JUSTIFICATION

The NT EPA assessed the potentially significant environmental impacts and risks associated with the Proposal in line with the NT EPA's environmental factors and objectives, and in accordance with the requirements under the EA Act. The NT EPA identified six environmental factors that could be significantly impacted by the Proposal (

Table **2**).

The NT EPA considered the importance of other environmental factors specific to the Proposal during the course of its assessment. However, those factors were not identified as potentially significantly impacted or have been previously assessed in the Origin Velkerri EP76 civil construction EMP EP76.[4]

Table 2: Key environmental factors considered for this assessment

Theme	Environmental factor	Objective
Water	Inland water environmental quality	Maintain the quality of groundwater and surface water so that environmental values including ecological health, land uses, and the welfare and amenity of people are protected.
	Hydrological processes	Maintain the hydrological regimes of groundwater and surface water so that environmental values are protected.
Land	Terrestrial environmental quality	Maintain the quality of land and soils so that environmental values are protected.

Theme	Environmental factor	Objective
People and Communities	Human health	Ensure that the risks to human health are identified, understood and adequately avoided and/or mitigated.
	Social, economic and cultural surroundings	Protect the rich social, economic, cultural and heritage values of the Northern Territory.
Air	Air quality and greenhouse gas emissions	Maintain air quality and minimise emissions and their impact so that environmental values are protected.

1. Inland water environmental quality

Objective: Maintain the quality of groundwater and surface water so that environmental values including ecological health, land uses, and the welfare and amenity of people are protected.

The well site is located on the Amungee Mungee pastoral station within the Wiso River Basin catchment where second and third-order ephemeral tributaries may flow for a short period during the wet season. During heavy wet seasons, large areas of the internal drainage system of the catchment may be flooded. The closest major creek system to the Proposal is Newcastle Creek (Stream Order 4) approximately 13 km south-east, which ultimately flows into Lake Woods, located approximately 125 km away. The EMP identifies Newcastle Creek and a number of small ephemeral creeks (Stream Order 1 and 2) that intersect the existing access track to the Velkerri EP76 S2 site. The streams are overland flow paths that only flow for a short period during the wet season. The Proposal infrastructure is not located within the major flow pathway of Newcastle Creek and ephemeral creeks.

The well site is located within the central, eastern region of the Cambrian Limestone Aquifer (CLA), where the Gum Ridge aquifer and Anthony Lagoon aquifer are in the saturated zone. The Bukulara aquifer is not expected to be present at this location. The CLA forms the major water resource for the Beetaloo Sub-basin, providing groundwater supply for the communities of Elliott, Daly Waters, Larrimah, Newcastle Waters and the pastoral industry that comprises 90% of land use in the Beetaloo Sub-basin. At the Velkerri site, the water table is approximately 50 m below ground level.

Potential impacts to inland water environmental quality from the Proposal include:

- unintended release or overflow from wastewater storage tanks during flooding events
- spills associated with chemicals, wastewater, fuel storage, handling and transport
- well integrity failure during hydraulic fracturing operation
- groundwater contamination from the target zone via hydraulic fracture vertical height growth or via existing natural faults during the hydraulic fracturing operation
- upward migration of hydraulic fracturing fluid and brine through bedrock over the long-term

Surface overflow, flow paths and spills

As assessed in the EMP, a preliminary flood assessment indicated the proposed site may be inundated by 700 mm during a 1% Annual Exceedance Probability (AEP) flood event.[5] Although the drainage lines are overland flow pathways, they only flow for a short period during the wet season.

[5] A flood event that has a 1 in 100 chance of occurring, or being exceeded, in any given year.

The well site is situated on higher ground than the surrounding area and measures have been taken to avoid surface water flow and spill impacts to the catchment downstream of the activity. These measures include:

- site selection informed by a multi-criteria assessment process to avoid surface water flow pathways, drainage lines and water courses
- the design of the flowback fluid and wastewater tank pads to divert any overland flow around the pad area
- pad construction with an approximate 0.2 degree gradient, which terminates into a purpose-built basin to manage rainfall runoff on the lease pad
    - lease pad bunding designed to prevent water ingress during such events with a containment capacity of approximately 21 ML
    - minimal cut and fill required during construction to stabilise the site
    - lease pad compaction to a predicted permeability less than 1×10^{-7} m/s
    - use of spill mats / spill trays under all drilling and hydraulic fracturing equipment to reduce spills / infiltration
- tanks with capacity to manage all of the flowback fluid and wastewater from the well with a 1,300 mm freeboard to manage a 0.1% AEP (wet season containment)
    - freeboard will be managed during dry season (May to September inclusive) operations when evaporation vastly exceeds cumulative potential rainfall
- real-time, continuous leak detection system integrated on the tank pad, reducing reaction time to potential impacts from leaks
- installation of real-time, continuous level sensors to prevent tank overtopping
- tank design to withstand cyclonic winds
- a spill management plan in compliance with the Code of Practice: Onshore Petroleum Activities in the Northern Territory[6] (the Code) to deal with spills at site in a prompt and effective manner.

Open tanks on the tank pad will be used to reduce the volume of wastewater by evaporation. In compliance with the Code, open tanks must be operated with a sufficient freeboard to not overflow with an annual exceedance probability (AEP)[7] for a total 90-day rainfall event.[8] The AEP represents a rainfall event that might be expected to occur once in a thousand years for the period that treatment infrastructure contains wastewater. This is a statistically derived probability from rainfall records and in the Beetaloo Sub-basin region. Based on analysis discussed in the Wastewater Management Plan, a 3-month wet season containment period minimum freeboard requirement is 1,300 mm and 3-month dry season containment period minimum freeboard requirement is 300 mm. These figures do not include any evaporation and are conservative. The wet season freeboard requirement is more than twice the average total annual rainfall (684 mm) for the Beetaloo and almost equal to the highest 12-month rainfall total reported in the 130-year rainfall record used in the analysis for the region.

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6 The Code provides minimum standards that the onshore petroleum industry in the NT must adhere to and is available at: https://denr.nt.gov.au/__data/assets/pdf_file/0011/705890/code-of-practice-onshore-petroleum-activity-nt.pdf

7 The probability that a given rainfall total accumulated over a given duration will be exceeded in any one year.

8 The shorthand for this is 0.1% 90-day AEP.

Wastewater can be transferred from the evaporation tanks to enclosed tanks and vice versa within 8 hours, meeting the requirement of the Code, whereby flowback water held in an open tank for evaporation must be transferred to an enclosed storage tank at least 8 hours in advance of a predicted significant rainfall event. A significant rainfall event is defined as 0.1% 4-day AEP, which is equal to approximately 300 mm in the Beetaloo area.

The EMP commits to a range of mitigation measures to reduce the potential risks and impacts to inland water quality from spills and chemicals and wastewater storage, transport and management at the well site. These are included in the Spill Management Plan, Wastewater Management Plan and Emergency Response Plan, which have been developed in accordance with the Code. Key measures committed to in these plans that have not already been discussed above include:

- manned sites during operations and routine inspections of chemical storage, hoses and treating lines to identify and isolate any potential leakage; spill kits will be available
- all hydraulic fracturing chemicals, hazardous chemicals and fuel will be stored using secondary containment barriers and contained within designated chemical storage areas
- separation distance from sensitive cultural receptors is greater than 5 km, with homesteads, communities, conservation areas, and major water courses located greater than 10 km from the Proposal
- automated hydraulic fracture stimulation pumping unit and high-pressure shut-off controls
- automated cut-off sensors on wastewater tanks to ensure levels do not exceed the 0.1% AEP
- hydraulic fracturing fluids and proppant (sand) are mixed in blending units via hoppers within an enclosed system, without risk of overspills
- the blender and pumping units are computer automated; both systems are equipped with alarms and shut-offs, which detect over and under pressure events
- use of separators to segregate hydrocarbons and flowback water; flowback is stored and managed in tanks as previously described
- gas is sent to a flare stack where it is flared on location and any separated liquid hydrocarbon (condensate) is stored in onsite enclosed storage tanks
- the flare flume (pit) will be designed to overflow directly into the mud sump to ensure it has sufficient freeboard to manage a 0.1% AEP wet or dry season event, without reducing the freeboard of the mud sump
- all volumes of condensate must be recorded before off-site transport occurs
- the bunded tank pad area has sufficient storage capacity (21 ML) to accommodate the simultaneous (catastrophic) failure of up to 3 tanks

The Department of Environment and Natural Resources (DENR) reports on laboratory analysis of a suite of more than 60 analytes tested in flowback fluid from two previously hydraulically fractured petroleum exploration wells in the Beetaloo Sub-basin are available at the DENR Onshore Petroleum

webpage[9]. Contaminants of potential concern in the flowback fluid[10], due to their persistence and higher toxicity in the environment, including heavy metals (such as arsenic, cadmium, chromium and mercury), polyaromatic hydrocarbons (such as benzo-a-pyrene) were all below limits of reporting. The results are similar to those reported in major studies of flowback from shale plays in North America (Hayes, 2009; Gandhi *et. al*, 2018).[11] The NT EPA will provide separate advice to the Minister that the Proponent be required to demonstrate 'no change' to existing groundwater quality at the Velkerri well site.

The Proponent will be required to monitor and report on the risk assessment of flowback fluid (including the presence of naturally occurring radioactive material - NORM) in accordance with the Code, within 60 days after commencement of flowback for publishing on the DENR onshore petroleum webpage.

NORM commonly precipitates in the flowback tank and accompany non-NORM solids that have been produced with the flowback. For normal exposure situations, it is usually unnecessary to regulate materials with radionuclides of natural origin with activity concentrations below 1,000 Bq/kg (ARPANSA, 2008).[12] Exceedence of this threshold is considered unlikely, based on reports on flowback fluid from two previously hydraulically fractured petroleum exploration wells in the Beetaloo Sub-basin at the nearby Amungee–NW and Shenandoah petroleum exploration wells targeting the Velkerri shale. The reports are available at the DENR Onshore Petroleum webpage.[9]

The Code defines the wet season as the months October to April inclusive. The EMP includes an emergency response plan that commits to not transporting chemicals and wastewater during the wet season unless a risk assessment is undertaken that demonstrates the risk is ALARP and acceptable (as per the Code). It is estimated that residual flowback wastewater for transport to a licensed waste facility, following volume reduction by evaporation, will be approximately 3 ML from the well site. This is estimated to require approximately 100 truck load-outs for the well site. The flowback wastewater is considered a listed waste and therefore must be managed under listed waste provisions of the *Waste Management and Pollution Control Act 1998*.

The EMP provides a risk assessment of the transport of chemicals and wastewater that shows the risk of spills is as low as reasonably practicable and acceptable, and commits to:

- risk assessing road conditions for any wet season heavy vehicle transport prior to mobilisation in accordance with the Code
    - if the conditions are assessed to be unsuitable for heavy vehicle transport, there is adequate chemical and waste storage capacity available on site
- only transporting flowback wastewater off-site in double-lined enclosed tanks
- maximum speed limits on unsealed roads of 60 km/hr with the actual speed limit most likely being restricted by road conditions and therefore lower than 60 km/hr
- use of licensed waste transporters to transport listed waste including flowback wastewater

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9 https://denr.nt.gov.au/onshore-gas/onshore-gas-in-the-northern-territory/industry-compliance-and-reporting/groundwater-monitoring-results

10 Flowback fluid means fluid that is a mixture of hydraulic fracturing fluid and formation fluid that is allowed to flow from the well following hydraulic fracturing. Once this flowback fluid comes to surface it is stored and managed as wastewater under the Wastewater Management Plan.

11 Hayes, T. 2009. *Sampling and Analysis of Water Streams Associated with the Development of Marcellus Shale Gas*, Final Report, 31 December 2009.
Gandhi, H, Sadiq, R, Hu, G, and Hewage, K. 2018. Ecological Risk Assessment of Accidental Release of Flowback Water: A Conceptual Framework. *Human & Ecological Risk Assessment* 24(2): 398-426.

12 ARPANSA 2008. Safety Guide for the Management of Naturally Occurring Radioactive Material (NORM), Radiation Protection Series No. 15. Commonwealth of Australia.

- the proposed activity has a Land Access and Compensation Agreement in place with the landholder which includes “make good” provisions in the event of damage to roads and other infrastructure on the property as a result of the activity.

As discussed previously, the well site has been constructed to mitigate potential impacts from overland flow and run-off. During the wet season, flowback from the well and EPT may be undertaken. This will only require a small crew stationed at the well site. If anomalous wet season conditions or other emergency circumstances are experienced, the petroleum wells can be immediately shut-in and safely secured; and flow back and EPT halted for as long as required.

The NT EPA will provide separate advice to the Minister that the Proponent be required to provide fortnightly weather forecasts to DENR, for the duration of the activity during the wet season.

Well integrity failure during hydraulic fracture stimulation

Well integrity failure during the hydraulic fracturing pumping operations could potentially enable contaminants from the hydraulic fracturing sub-surface operations to be released into the aquifer. If well construction is not done properly any potential contamination of the aquifer is via the well bore annulus (the area between the un-cemented casing and the well bore rock wall). In compliance with the Code, a petroleum well must be constructed, maintained and decommissioned so there are at least two verified well barriers between a deep, saline bearing formation and potable aquifers and the surface. Aquifers must be isolated behind cemented concentric casing strings. The NT EPA will provide advice to the Minister that the Proponent be required to provide a cementing report within seven (7) day of cementing completion for the surface casing (13 3/8”).

The construction of petroleum wells to ensure aquifers are isolated from the surface, multiple aquifers and from deeper hydrocarbon bearing zones was assessed and conditioned under the previously approved Kyalla EP117 HF EMP.[13] There are no material changes to the construction methods proposed for the Velkerri EP76 S2 well site compared to those approved at the Kyalla EP117 well site. The Well Operations Management Plan (WOMP) sets out the key information required to ensure safe operation and well integrity is maintained throughout the well life-cycle including: well design considerations for all phases of the well life-cycle, casing and cementing design, risk management, control measures, measurement criteria, and other relevant information. Key environmental control measures for well design and management for hydraulic fracturing operations contained in the WOMP are outlined in the EMP. Measures include:

- Any new geohazards (e.g. small faults) identified in the target Velkerri formation during drilling operations must be identified and managed via depth correction while drilling and hydraulic fracture stimulation stage spacing; logging while drilling will enable detection of faults and other potential loss zones.
- The reservoir engineering parameters and results of hydraulic fracture modelling that informs the final design of each hydraulic fracturing stage treatment must be provided to Department of Primary Industry and Resources (DPIR) prior to undertaking the hydraulic fracturing activity.
- In compliance with the Code, conducting cement bond logging and the upload on the DPIR website of a Well Barrier Integrity Validation (WBIV) report certified by an independent and reputable validator in accordance with Clause 302a of the Schedule of Onshore Petroleum Exploration and Production Requirements (2019). The WBIV must comply with the DPIR Well Barrier Integrity Validation Reporting guideline and be approved prior to conducting a DFIT.
- In compliance with the Code, the mechanical integrity of the well must be assessed and certified by the Proponent to reconfirm well integrity prior to hydraulic fracturing

[13] https://ntepa.nt.gov.au/environmental-assessments/projects-not-requiring-assessment.

operations. The results of these tests will be provided to DPIR in compliance with the Code.

- All flowlines, valves and equipment used in a production test must have a rated working pressure in excess of all anticipated pressures and must be tested and operated in accordance with relevant standards at “rig-up” and prior to conducting the hydraulic fracturing operation. Pressure monitoring capability will be available at the wellhead.
- If an issue with the primary barrier did occur during hydraulic fracturing operations, operations would cease and it would be repaired to meet the design requirements before proceeding.
- Intermediate and surface casing strings will provide additional integrity should an issue with the primary barrier occur. These strings will be monitored during fracturing treatments to provide verification of their integrity.
- Well barriers are comprised of a 4 string well design and provide a minimum two well barriers between the hydrocarbon bearing zone, aquifer and surface.
- A pressure relief valve (PRV) will be installed on the surface treating line to instantaneously reduce pressures if the pressure exceeds the maximum allowable pumping pressure (MAPP).

Contamination of groundwater from vertical hydraulic fracture growth and natural geohazards

The proposal has the potential to impact groundwater quality from contamination pathways such as vertical hydraulic fractures and geohazards. This was investigated during the Hydraulic Fracturing Inquiry (HFI), which found seismic surveys demonstrate that most of the Beetaloo Sub-basin contains relatively little internal faulting. HFI investigations into the potential migration of hydraulic fracturing fluids due to fracture outgrowth out of the production zone to be extremely low. HFI investigations into potential migration of contaminated material via hydraulic fractures intersecting the geological features, such as permeable faults or pre-existing natural features, was found to be extremely low.

The rate of well integrity failures that have the potential to cause environmental contamination of this nature has been independently reviewed by the CSIRO and found to be in the order of 0.01%. To reduce the risk of hydraulic fractures reaching the base of existing aquifers to an acceptable level, the Code adopts an internationally accepted minimum offset distance between the target hydrocarbon formation and the base of the nearest aquifer of 600 m. This internationally accepted minimum offset, or protection distance, is based on extensive published research on how high hydraulic fractures can plausibly extend in shale formations.[14]

The target zones for hydraulic fracturing consist of clay rich, organically lean layers which act as impermeable aquitards to fluid migration, as illustrated by the organic-enriched layers still containing gas hundreds of millions of years after it was generated. They also provide effective barriers to vertical fracture growth during hydraulic fracture operations.

The stratigraphic formations intersected by the petroleum well have been adequately described; informed by more than 9,500 km of 2D seismic data used to screen for large scale, regional faults or structures prior to the finalisation of any exploration well location. Current data of the 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.

[14] Fisher, K, and N Warpinksi. (2012), ‘Hydraulic-Fracture-Height Growth: Real Data.’ SPE Production & Operations 27(1): 8-19.

Given the lack of major faults and structures across the deeper areas of the Beetaloo Sub-basin[15] there is a low geohazard risk associated with through-going faults,[16] therefore a very low likelihood of contamination to shallow aquifers occurring via this mechanism. A similar conclusion was reached by the US EPA which found that fault reactivation due to hydraulic fracturing would likely occur on small distances of a few metres.[17]

The location of faults is taken into consideration during the design and construction of each well and actively avoided because their occurrence can seriously compromise the effectiveness of the hydraulic fracturing operation, as well as being a potential environmental risk. Wireline logging is proposed for the lower (deeper) formations that lie within the production hole section of the well, to provide continuous measurement of the formation properties and identify any potential geohazards such as faults, which could be a potential groundwater contamination pathway.

Geohazards encountered during drilling of the petroleum well are risk assessed in the WOMP to ensure hydraulic fracturing activities can occur safely. Hydraulic fracturing activities will not occur until the integrity of a well has been confirmed. Real-time, continuous monitoring of the pumping pressure is conducted during hydraulic fracturing operations to ensure the Maximum Allowable Operating Pressure (MAOP) of 10,000 psi is not exceeded. In addition anomalous pressure behaviour in the well annulus at surface is also monitored in real-time. A traffic light system will be implemented in accordance with the HFI recommendations to monitor anomalous seismicity (tremors) during the hydraulic fracturing operations at the well site. The risk of induced earth tremors as a result of hydraulic fracturing that can be felt at surface is considered very low.

Upward migration of hydraulic fracturing fluid and brine

Potential environmental impacts from upward migration of hydraulic fracture fluid and brine from the target reservoir was assessed in the EMP as a 'low' risk. The proposed design of the hydraulic fracture affects a very limited portion of the entire thickness of the overlying bedrock and therefore, is unable to produce direct hydraulic communication between the target zones and shallow aquifers via induced fractures. The overlying Hayfield Mudstone and Kyalla formation are notable thick regional aquitards.[18]

The Moroak Sandstone which will be intersected by the Velkerri well is considered to be a saline aquifer for the purposes of the petroleum well design in the Well Operations Management Plan (WOMP). The Moroak Sandstone has been tested on opposite sides of the basin in which Origin is exploring, at the Amungee NW-1, Elliott-1 and Ronald-1 well bores. Inflow testing at Amungee NW-1, Elliott-1 and Ronald-1 well bores indicated no pressure in the reservoir (i.e. no hydraulic head).

As a result, upward migration of hydraulic fracturing fluid and brine is controlled by pre-existing hydraulic gradients and bedrock permeability. Recent international studies show that in cases where

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15 Scrimgeour I. (2016) *Summary of current knowledge of petroleum geology, shale gas resources and exploration in the Beetaloo Sub-basin*. Information Provided by the Northern Territory Geological Survey to the Scientific Inquiry into Hydraulic Fracturing in the Northern Territory.

16 Through-going fault is a strike-slip fault that in sedimentary basin geology is considered a fault that is continuous from basement bedrock to surficial aquifers (i.e. several km throw) and is readily observed in seismic profiling as a major fault.

17 US EPA. 2012. Study of the potential impacts of hydraulic fracturing on drinking water resources: Progress report, Report, United States Environmental Protection Agency, Washington, D. C. Available at: http://www2.epa.gov/sites/production/files/documents/hfprogress-report-exec summary20121214.pdf

18 Permeability is the ability of a rock to transmit fluids. Aquitards are low permeability rock formations. The grain-size distribution is the dominant control on permeability; however, other factors are also important at depth, including effective stress, partial saturation, and cementation, often reducing permeability by orders of magnitude. Overall, the preponderance of fine-grained rocks (i.e., shale, siltstone, and mudstone) and the layered structure of sedimentary basins will constrain the vertical permeability of bedrock above black shales toward the low end of measured values. Low permeability layers at depth in sedimentary basins are common, due to the effects of effective stress, cementation, and partial saturation.

there is an upward gradient, permeability is low, upward flow rates are low, and mean travel times are long (often greater than 1 million years).[19] The studies concluded that unrealistically high estimates of upward flow are the result of invalid assumptions about hydraulic fracturing and the hydrogeology of sedimentary basins and the mechanism does not appear to be physically plausible. This is supported by the Proponent's assessment indicating that overlying sequences have a higher fracturing pressure than the target formation, reducing the risk of fracturing migration out of the target shale. Also, a physical separation distance of approximately 1,400 m between the Gum Ridge Aquifer and the Velkerri Formation (target) prevents any migration of stimulation fluid to aquifer units. This separation distance is more than twice the internationally accepted minimum vertical separation distance of 600 m required by the Code.

NT EPA assessment

The Proponent is currently drilling four groundwater monitoring bores at the well site (2 control and two impact monitoring bores) in accordance with the Code and approved EMP NT-2050-15-MP-0017. The Proponent is required to submit 6 months of groundwater quality laboratory reports together with continuous water level logging information for the control monitoring bore prior to hydraulic fracturing. Water quality monitoring data will be submitted on a quarterly basis for three years to DENR and published on the DENR webpage.[9] These data will provide important scientific information regarding spatial and temporal trends in 40 key water quality analytes, including metals, hydrocarbons and naturally occurring radionuclide materials (NORM) in the CLA system at Velkerri, for this well site location. Impact monitoring bores situated 20 m down-gradient (downstream) of the petroleum well will enable rapid detection of any anomalous water quality trends above future background values at the well site. Any anomalous drawdown in water levels will also be detected.

Provided that the mitigation and management measures outlined in the EMP, including the groundwater monitoring program, wastewater and spill management plans are implemented, the NT EPA considers that the Proposal is unlikely to have a significant impact on surface water and groundwater quality, and the NT EPA's objective for inland water environmental quality is likely to be met.

2. Hydrological processes

Objective: Maintain the hydrological regimes of groundwater and surface water so that environmental values are protected.

The nearest pastoralist groundwater bore and homestead are 11.4 km and 50 km from the Proposal respectively. At Velkerri, groundwater will be extracted from the Gum Ridge aquifer. Once the groundwater monitoring bores are installed, they will be included in the groundwater extraction licence GRF10285, which takes into account the cumulative impacts of groundwater extraction for all of the Proponent's activities in EP76. The EMP includes provision for a further two bores as contingency, in case of low yields or bore failure. At this stage, it is unlikely additional bores will be constructed. All bores must be included in the groundwater extraction licence GRF10285 and the maximum extraction volume must not exceed current approval – i.e. 175 ML per year.

Hydrological processes include the occurrence, distribution, connectivity, movement and quantity of water. The main potential impacts to these processes include:

- over extraction of groundwater leading to drawdown and impacting groundwater users
- groundwater drawdown leading to changes in levels and flows that may impact on groundwater dependent ecosystems

[19] Flewelling, S, and Sharma, M. 2014. *Constraints on upward migration of hydraulic fracturing fluid and brine*. Groundwater: 52(4):492-4.

Groundwater drawdown – impacts to users

There is limited demand for groundwater for domestic use in the region. Approximately 300 ML of water per year is estimated for domestic water use including 100 ML for 26 homesteads and 200 ML from the Gum Ridge aquifer for the township of Elliott. Due to the remote location and pastoral land use in the area, future domestic demand is unlikely to change significantly. The nearest sensitive receptor to the well site is a pastoralist bore situated more than 11.4 km from the proposed activity.

The Proposal has potential to impact on groundwater drawdown associated with groundwater extraction. The total estimated groundwater volume required for the Proposal is 38 ML. Based on previous transmissivity analysis, the total water extraction requirement is well within sustainable recharge levels. The estimated total cumulative volume of groundwater to be extracted during the exploration activities, predominantly occurring during 2019-20 is shown in Table 3.

Table 3: Cumulative water use for the exploration program across EP117 (Kyalla) and EP76 (Velkerri)

Source of water use	Megalitres (ML)
EMP: Kyalla EP117 civil construction (approved)	20.0
EMP: Kyalla EP117 drilling, hydraulic fracturing and well testing (approved)	38.0
EMP: Velkerri civil construction (approved)	20.0
EMP: Velkerri water bore construction (approved)	15.5
EMP: Velkerri Drilling, hydraulic fracturing and well testing	38.0
Cumulative water use	**131.5**

A groundwater extraction licence has been granted to the Interest Holder for 175 ML per year for 3 years from May 2019 to December 2023 (GRF10285). The total cumulative volume of groundwater to be extracted for the approved activities and including this EMP for drilling and hydraulic fracturing is within this volume. Groundwater extraction is informed by the NT Water Allocation Planning Framework, which indicates the volume of groundwater held in storage in the Gum Ridge aquifer is estimated to range from 1,766,000 GL to 3,532,000 GL. Cumulative groundwater extraction from the Gum Ridge Aquifer from May 2019 to December 2023 is approximately 1,492.5 ML, significantly less than the estimated water available for extraction under the Framework and within the Extraction Licence. The Proponent's licence allocation is less than 0.01% of the estimated sustainable yield of the Gum Ridge aquifer. When deciding to grant a groundwater licence, specific factors are taken into account including the availability of water in the area, existing and likely future demand for water and any adverse effects likely to be created as a result of activities on other entitled users. Groundwater extraction volumes will be recorded and submitted to the DENR Water Resources Division, in accordance with the requirements of the groundwater extraction licence.

Standing water level of the Gum Ridge aquifer will be continuously measured using a logger at the well site. The results will be reported quarterly and published on the DENR webpage.

Groundwater drawdown – impacts to groundwater dependent ecosystems

Groundwater drawdown has potential to impact on groundwater dependent ecosystems (GDE) that may be associated with the CLA. At Velkerri the water table is predicted to be approximately 50 m below ground level. It is unlikely aquatic ecosystems will be impacted by the purposed activities, given that no sensitive vegetation will be disturbed and there is a lack of permanent surface waters and aquatic GDEs in the Proposal area. The groundwater level monitoring undertaken at the well site, will inform drawdown rates of groundwater sources.

NT EPA assessment

The NT EPA considers that the potential impacts and risks to hydrological processes can be mitigated through implementation of the management measures presented in the EMP, including compliance with the groundwater extraction licence, and that its objective for hydrological processes is likely to be met.

3. Terrestrial environmental quality

Objective: Maintain the quality of land and soils so that environmental values are protected.

The disturbance footprint for the proposal is small (7.5 ha), with the lease pad area accounting for approximately 75% of the clearing (5.5 ha). Impacts from land clearing were previously assessed in the Origin Velkerri EP76 civil construction EMP EP76.[20] Potential localised contamination of land and soils due to inappropriate storage of drilling mud and chemicals and spill or overflow of drilling mud was assessed previously for the Kyalla EP117 HF EMP. The mitigations for this Proposal remain the same as those previously described in the Kyalla EP117 HF EMP, including:

- the proposed lease pad area has been constructed using a mixture of silt, clay and gravel resulting in reduced infiltration and leaching compared to non-compacted soil; the predicted permeability of the area is less than 1×10^{-7} m/s
- implementation of a Spill Management Plan, Emergency Response Plan and Wastewater Management Plan, describing effective response management strategies and mitigation measures to be implemented to manage the transport, handling, storage, bunding and clean-up of hazardous substances and materials
- the transfer of liquids from cuttings and residue drilling muds from the sump to the double-lined wastewater storage tanks upon completion of the activity; wastewater storage tanks are also fitted with leak detection
- exploration lease pad and camp pad will be surrounded by an approximate 1.0 m bund to contain and prevent overland flow of contaminants in the event of a major spill.

NT EPA Assessment

The NT EPA considers that the potential impacts and risks to the terrestrial environmental quality can be mitigated through the management measures presented in the EMP, and that its objective for terrestrial environmental quality is likely to be met.

4. Human Health

Objective: Ensure that the risks to human health are identified, understood and adequately avoided and/or mitigated.

Implementation of the Proposal could have implications for the health of members of the public from chemicals and naturally occurring radionuclide material (NORM) impacting the groundwater sources.

Chemicals

Potential impacts to human health were identified from hydraulic fracturing chemicals entering aquifers that are known groundwater sources for community and/or livestock. As discussed under **2 Hydrological processes**, there is currently limited demand for groundwater for domestic water in the vicinity of the Proposal from the Gum Ridge Aquifer.

[20] DENR *supra* Note 4.

The assessment of potential impacts to human health is supported by a full chemical risk assessment for all drilling and hydraulic fracturing chemicals, which identified that the majority of the chemicals were not persistent and bioaccumulative and in very low concentrations with inorganic chemicals being quickly neutralised and organic chemicals quickly denaturing under high temperature and pressure.

Mitigation measures associated with well construction and integrity to minimise potential impacts to human health, including development of the WOMP were addressed under section **1 Inland water environmental quality.**

Naturally Occurring Radioactive Material (NORM)

NORM and associated decay products are dissolved in very low concentrations during normal reactions between water and rock or soil. Routine assessment for presence of NORM is conducted by measuring gross alpha and gross beta concentrations measured in becquerels (Bq)/L and compared to a range of standards such as drinking water guidelines; 1 Bq is equivalent to one nuclear disintegration per second. Groundwater monitoring of the Gum Ridge Aquifer to date by the Proponent shows that lead-210 levels were generally less than 0.01 µg/L, well below the National Health and Medical Resource Council (NHMRC) health guideline value.

In relation to hazardous materials or contamination, the Proponent concluded that there are limited complete exposure pathways and therefore a negligible risk to human health.

NT EPA Assessment

The NT EPA considers that the potential impacts and risks to human health can be mitigated through implementation of the management measures presented in the EMP, and that its objective for human health is likely to be met.

5. Social, economic and cultural surroundings

Objective: Protect the rich social, economic, cultural and heritage values of the Northern Territory.

Implementation of the Proposal could have implications for the public due to increased traffic on public roads, or through changes in social, economic and cultural surroundings.

Social considerations

The Proponent has undertaken stakeholder engagement with NT Government agencies, landholders and land managers, traditional owners, the Northern Land Council (NLC) and the Aboriginal Areas Protection Authority (AAPA). The EMP cites several current agreements and operating consents associated with the Proposal. Concerns were raised in some public submissions regarding perceived lack of stakeholder engagement.

The Proponent has engaged with the road authority to determine traffic management requirements for the Stuart Highway. A traffic impact assessment has been prepared and provided to the road authority. The Proponent has assessed the impacts of traffic from their activity on the existing traffic levels/flows. Additional peak project vehicle movement is 44 vehicles/day in addition to the existing peak dry season traffic volumes of 827 vehicles/day. The results demonstrate that there are minimal changes in traffic composition associated with the Proposal, with an additional 1.2% of large combination vehicles when compared to the total volume composition. This percentage is unlikely to significantly impact upon the road's capacity and level of service.

The estimated operational trucking requirements during the hydraulic fracturing operations are shown in Table 1. The Proponent has a Traffic Management Plan for the activity approved by the Department of Infrastructure, Planning and Logistics (DIPL).

Potential amenity impacts from the Proposal include nuisance dust and noise impacting sensitive receptors. The nearest homestead and community are located approximately 50 km and 100 km away from the Proposal, respectively. There will be a camp at the well site capable of accommodating approximately 60 people to support the full operation. Noise is not considered a significant issue due to the implementation of control measures and distance to sensitive receptors. Dust will be managed through the use of water carts and vehicle speed restrictions such as 60 km per hour on gravel roads. Further, the Proponent has committed to ongoing stakeholder engagement with all affected pastoral property owners to ensure nuisance factors do not impact pastoral activities.

The proposed development has a Land Access and Compensation Agreement with the landholder(s). Through this agreement and the Bushfire Management Plan presented in the EMP, the Proponent will also ensure that the Proposal does not affect the landholder's fire management obligations and strategies.

Cultural heritage

AAPA has confirmed the relevant AAPA Authority Certificate is in place (C2019/039). The EMP commits to management strategies for the protection of Aboriginal and cultural heritage, including cultural heritage site inductions and an 'unexpected heritage (artefact) finds' stop work procedure.

NT EPA assessment

The NT EPA considers that the potential impacts and risks to social, economic and cultural surroundings can be mitigated through implementation of the management measures presented in the EMP and that its objective social, economic and cultural surroundings is likely to be meet.

6. Air quality and greenhouse gases

Objective: Maintain air quality and minimise emissions and their impact so that environmental values are protected.

Ambient air quality within the vicinity of the Proposal is good, except during bushfires and dust from exposed soils in windy conditions during the dry season. Bushfires are the largest contributor to air quality pollutants in the Northern Territory.

Implementation of the Proposal would result in the generation of dust and combustion products predominantly from vehicle and equipment movements, and during drilling, as per previous EMP assessments. Dust impacts generated from activities such as vehicle movements and wind at the well site will be suppressed through the use of water trucks; 60 km/hr speed limits on gravel roads; and the fitting of pollution control devices to equipment.

Greenhouse gases

The Proposal has potential to increase greenhouse gas (GHG) emissions generated from direct and fugitive emission sources. Flaring also poses a potential bushfire risk.

Base on a maximum 12 month testing scenario, the Proposal will generate an estimated 66,000 tCO_2-e (tonnes of carbon dioxide equivalent) of GHG emissions.[21] This comprises approximately 62,300 tCO_2-e from flaring of condensate and natural gas (including allowance for flare tip inefficiency),[22] 1,400 tCO_2-e from fugitive (direct) emissions of methane during drilling and

[21] Based on the National Greenhouse and Energy Reporting (Measurement) Determination 2008 (Section 3.44) Emissions factor of CO_2-e/tonnes flared.

[22] Flare tip efficiency assumptions were calculated using published NGER 2017-18 guideline values, (Section 3.44 and 3.52), for natural gas and condensate emissions, respectively.

stimulation (including wastewater storage) and 2,300 tCO_2-e from combustion of diesel in transport and onsite machinery.

Standard GHG mitigation measures outlined in the Code such as combustion flaring will be implemented. Compared to venting, combustion flaring is expected to reduce the emissions; this is attributed to flare tip combustion efficiency of over 96%. Other mitigation measures include:

- measurement of the amount of gas and condensate disposed to flare using flow meters compliant with the National Greenhouse Energy Reporting Scheme (NGERS)
- six monthly leak detection on the well head (Christmas tree)
- ongoing emissions reporting compliant with NGERS
- compliance with the methane emissions monitoring program, provided as Appendix P to the EMP

The NT EPA will provide separate advice to the Minister that the Proponent be required to provide an analysis of offsite disposal and beneficial use options (other than flaring) for liquid hydrocarbons.

In addition to the mandatory leak detection and reporting (LDAR) required under the Code (section D.5.2), the NT EPA will provide separate advice to the Minister that the Proponent be required to undertake leak detection of equipment that is in hydrocarbon service and under pressure within seven days of well commissioning.

The Proponent has estimated cumulative GHG emissions from its exploration activities on Kyalla EP117 and Velkerri EP76. Total cumulative GHG emissions for the combined exploration activities on EP117 and EP76 are estimated to be 148,300 tCO_2-e (Table 4), assuming a worst case extended production test (EPT) period of 12 months at the Kyalla and Velkerri well sites. The total estimated GHG emissions for the Origin exploration program will likely result in an overall increase in NT GHG emissions[23] of 0.9%, noting that this is largely incurred as a result of the EPT and only required in the exploration phase. Under these circumstances of preliminary exploration activity, the NT EPA considers that cumulative emissions are not significant when considered in context of 2017 NT and Australian emissions, which were approximately 16.5 million tonnes and 535 million tonnes respectively.[24]

The NT EPA notes that the EPT which involves measuring hydrocarbon flow from the well over an extended period is the major component (93%) of total cumulative emissions for the approved exploration activities. An EPT is only required to be conducted during the exploration phase of petroleum operations to characterise the reservoir. Fugitive emissions of methane from drilling, hydraulic fracturing, well testing and wastewater storage (excluding flare tip inefficiency) is approximately 2% of the total estimated GHG emissions for the Proposal.

[23] NT and Australian GHG emissions in 2017 were approximately 16.5 million tonnes and 535 million tonnes, respectively, as reported in the DOEE (2019) *State and Territory Greenhouse Gas Inventories 2017,* http://www.environment.gov.au/system/files/resources/917a98ab-85cd-45e4-ae7a-bcd1b914cfb2/files/state-territory-inventories-2017.pdf

[24] Department of the Environment and Energy (2019) *State and Territory Greenhouse Gas Inventories 2017*. https://www.environment.gov.au/system/files/resources/917a98ab-85cd-45e4-ae7a-bcd1b914cfb2/files/state-territory-inventories-2017.pdf

Table 4: Estimated cumulative greenhouse gas emissions for the exploration program in EP76 and EP117

Source of GHG emissions	tCO_2-e
EMP: Kyalla EP117 civil construction (approved)	717
EMP: Kyalla EP117 drilling, hydraulic fracturing and well testing (approved)	77,471*
EMP: Kyalla EP117 groundwater monitoring (approved)	2,183
EMP: Velkerri civil construction (approved)	626
EMP: Velkerri water bore construction (approved)	1,406
EMP: Velkerri Drilling, hydraulic fracturing and well testing	66,894*
Cumulative GHG emissions (EP117 and EP76)	**148,297**

* Total emissions at both wells are based on a 12 month ETP. Under a 3 month EPT, cumulative emissions are significantly less.

Bushfires originating from the proposed activities have the potential to impact on air quality. The proposed activities will be located on existing cleared infrastructure. A Bushfire Management Plan has been developed. Firebreaks will be implemented around the lease with minimum setbacks to infrastructure based on flaring design. Fire control zones will be cleared of vegetation and maintained to limit the risk of fire spread during project activities. A flare separation distance (buffer) of 45 m from vegetation will be applied to ensure safe operations during fire danger periods and designed, prepared and operated in accordance with relevant standards and fire suppression equipment will be available. During the horizontal flaring of condensate a water curtain will be used to dampen the flare flame and reduce heat radiation. During declared fire ban periods, flaring would not be permitted to occur.

NT EPA assessment

The NT EPA considers that the potential impacts and risks on air quality and emissions can be mitigated through implementation of the management measures presented in the EMP including the Methane Emissions Management Plan, Bushfire Management Plan and flare stack designs, and that its objective for air quality and greenhouse gasses is likely to be met.

Public consultation

The Proposal includes the drilling, hydraulic fracturing (HF) and well testing of one petroleum exploration well. In accordance with the Petroleum (Environment) Regulations 2016, the EMP was made available for public comment for a period of 28 days from 5 October to 1 November 2019. DENR received 29 submissions: 23 from community members, 5 from non-government organisations and 1 from a business. Sixteen submissions were received from within the Northern Territory.

Comments raised in the public submissions (in order of frequency) related mainly to waste management (23), climate change/greenhouse gas emissions (22), water/contamination of groundwater (21), regulation and compliance (14), and social licence to operate (13). The NT EPA has reviewed the public submissions as part of its decision-making under the EA Act. Where appropriate these issues have been discussed in the relevant environmental factors. The NT EPA considers many of the public concerns raised about the protection of environmental values, have been adequately addressed by the Proponent in the EMP and the mitigation and management measures provided in the supporting sub-plans.

The public submissions are discussed in further detail in the NT EPA's advice to the Minister for Environment and Natural Resources.

CONCLUSION

The EMP has assessed cumulative impacts as they apply to the proposed activities and the broader exploration activities that have been previously approved on EP117 and EP76, including for GHG emissions and groundwater extraction. The NT EPA considers that such impacts are not significant, and manageable within the commitments of the EMP, compliance with the Code and the constraints of the groundwater extraction licence. This EMP deals with exploration activities of short duration and limited scope involving hydraulic fracturing and EPT of one exploration well and provides a detailed schedule of Proposal activities.

The NT EPA considers that the potential environmental impacts and risks associated with this Proposal are not significant and that the Proposal does not require assessment under the EA Act. The Proponent has prepared the EMP in accordance with the Petroleum (Environment) Regulations 2016 and to demonstrate how it will also meet compliance with the Code.

Comments from NTG advisory bodies and public submissions have been provided to the Proponent for consideration and amendment; these are evaluated during the EMP assessment process.

The Minister for Environment and Natural Resources has asked the NT EPA to provide advice under the Petroleum (Environment) Regulations 2016, as to whether the EMP meets certain requirements of the Regulations, specifically:

- whether the EMP is appropriate for the nature and scale of the regulated activity to which the plan relates; and
- whether the EMP demonstrates that the activity will be carried out in a manner by which the environmental impacts and environmental risks of the activity will be reduced to a level that is as low as reasonably practicable and acceptable; and
- the principles of ecologically sustainable development

As part of the assessment to provide that advice, the NT EPA proposes to make recommendations to the Minister for Environment on conditions to improve environmental outcomes. The NT EPA's decision not to assess the EMP under the EA Act is not reliant on the Minister accepting the NT EPA advice.

DECISION

The proposed action by Origin Energy B2 Pty Ltd has been examined by the NT EPA and investigations and inquiries conducted.

The NT EPA has decided that the potential environmental impacts and risks of the Proposal are not so significant as to warrant environmental impact assessment by the NT EPA under provisions of the EA Act at the level of a Public Environmental Report or Environmental Impact Statement. The Proposal will require approval under the Petroleum (Environment) Regulations 2016. Groundwater extraction will be subject to the conditions of the groundwater licence under the *Water Act 1992*. The Proponent must have a permit to burn (or flare) during fire danger periods under the *Bushfires Management Act 2016* and adhere to declared fire ban periods over the life of the Proposal. Environmental management of the potential environmental impacts is the responsibility of the Proponent through implementation of procedures and management plans specified in the EMP and any conditions imposed by the Minister for Environment under the Petroleum (Environment) Regulations 2016.

This decision is made in accordance with clause 8(2) of Environmental Assessment Administrative Procedures 1984, and subject to clause 14A the administrative procedures under the *Environmental Assessment Act 1982* are at an end with respect to the proposed action.

DR PAUL VOGEL AM MAICD

CHAIRPERSON

NORTHERN TERRITORY ENVIRONMENT PROTECTION AUTHORITY

18 DECEMBER 2019

Attachment A: Northern Territory Government Advisory bodies consulted on the Notice of Intent

Department	Division
Department of Environment and Natural Resources	Flora and Fauna Water Resources Weeds Environment Bushfires NT Onshore Gas Reform
Department of Infrastructure, Planning and Logistics	Planning Transport and Civil Services and Infrastructure
Department of Primary Industry and Resources	Mining Compliance Petroleum Primary Industry
Department of Tourism, Sport and Culture	Parks, Wildlife and Heritage Tourism NT
NT Police, Fire and Emergency Services	Business Improvement and Planning
Department of Health	Environmental Health Medical Entomology
Department of Trade, Business and Innovation	Economics and Policy Strategic Policy and Research
Department of Local Government, Housing and Community Development	Office of the Chief Executive
Power and Water Corporation	
Aboriginal Areas Protection Authority	Technical
Department of the Attorney-General and Justice	Commercial Division NT Worksafe
Department of the Chief Minister	Economic and Environmental Policy Social Policy Co-ordination