ntepa Northern Territory Environment Protection Authority

Statement of Reasons

SANTOS QNT PTY LTD – ENVIRONMENT MANAGEMENT PLAN (EMP) FOR THE MCARTHUR BASIN 2019-20 HYDRAULIC FRACTURING PROGRAM EP 161

PROPOSAL

The Environment Management Plan (EMP) for the McArthur Basin 2019-20 Hydraulic Fracturing Program Exploration Permit (EP) 161 (the Proposal)[1] was referred by Santos QNT Pty Ltd (the Proponent)[2] to the Northern Territory Environment Protection Authority (NT EPA) on 27 August 2019 for consideration under the *Environmental Assessment Act 1982* (EA Act).

The Proponent proposes to undertake a program of hydraulic fracturing[3] of the Velkerri Formation in the Tanumbirini 1, Tanumbirini 2H and Inacumba 1H exploration petroleum wells followed by extended production tests (EPT) on each of the wells that will run between 90 and 365 days. On completion of EPT, the wells will either be suspended for future re-entry, suspended on build-up, or decommissioned with permanent cement plugs. At the completion of operations all surface infrastructure will be removed (excluding the well head). The Proposal occurs at two well site locations, Tanumbirini and Inacumba on EP 161, and includes:

- mobilisation of rig and hydraulic fracture materials to each well site
- hydraulic fracture preparation activities including well integrity assessment
- cased hole Diagnostic Fracture Injection Testing (DFIT)[4]
- installation of passive seismic monitoring surface array at Tanumbirini and Inacumba
- vertical seismic profile (VSP) at Tanumbirini
- microseismic monitoring at Tanumbirini
- hydraulic fracture of each exploration well
- completion and flowback from each exploration well
- storage and evaporation of flowback wastewater in tanks at each well site
- EPT including flaring of each exploration well
- routine maintenance and monitoring activities
- transport of wastewater from each well site to an authorised disposal facility

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.
4 A well integrity assessment and DFIT has been completed for Tanumburini-1 under previously approved McArthur Basin Drilling Program EP161 EMP

- removal of tanks and other equipment and material from each well site
- minor ancillary works associated with the above activities
- well suspension or decommissioning of each exploration well
- progressive stabilisation and rehabilitation of land disturbance areas.

The Proposal does not include other petroleum exploration activities on EP 161 for seismic survey, land clearing, water bore construction, civil construction and drilling of petroleum wells which were previously approved in the following related EMPs:

- McArthur Basin 2D Seismic Exploration Survey - 2013
- Tanumbirini 1 Exploration Well Drilling EP161 – 2014
- Tanumbirini North Water Bore Monitoring Program EP161 – November 2018
- Water Bore Monitoring Program EP161 – December 2018
- McArthur Basin Civil and Seismic Program EP161 – June 2019
- McArthur Basin 2019 Drilling Program EP161 – July 2019.

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

Table 1: Key components of the Proposal

Component	**Size/capacity/detail**
Total area of exploration lease (EP161)	13,350 km^2
Total area of disturbance	Nil – well sites already established
Number of exploration wells at each well site	2 at Tanumbirini and 1 at Inacumba
Timing of works	October 2019 – November 2020
Duration of hydraulic fracturing operations	~1 month
Duration of well testing (appraisal) operations	90 ~ 360 days
Operational workforce	120 person during hydraulic fracture
Camp	120 person during hydraulic fracture
Operational workforce	12 during well testing
Truck movements per well site operational – per week	4
Truck movements per well site – initial mobilisation equipment	~50
Truck movements per well site – HF materials mobilisation equipment	~< 80
Truck loadout - Waste water transport per well site	~75
Groundwater usage per well site	40 +/- 5 ML
Flowback/wastewater volume – initial predicted	~< 10.5 ML /well
Bunded tank pad containment capacity	15.3 ML
Flowback/wastewater volume– final predicted for disposal	~< 3.5 ML /well
Proppant per well site	<4,200 tonnes at Inacumba < 5,000 tonnes at Tanumbirini
tCO_2-e emissions	~ 130,000 tonnes
Rehabilitation	59.6 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 hydraulic fracturing of three petroleum exploration wells, and in accordance with the Petroleum (Environment) Regulations 2016, the EMP was made available for public comment for a period of 28 days from 30 August to 27 September 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 during the course of its assessment, however those factors were not identified as potentially significantly impacted or have been previously assessed in the Santos Civil and Seismic EMP or the Santos Drilling Program 2019 EMP[5].

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.
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 quality	Air quality and greenhouse gases	Maintain air quality and minimise emissions and their impact so that environmental values are protected.

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

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 two well sites, Tanumbirini and Inacumba, are located on Tanumbirini pastoral station at the top of the Limmen Bight River 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 generally flat landscape also has a range of wetlands associated with springs, sinkholes and minor depressions. There are no waterholes or permanent water features that are near (<10 km) the well sites based on aerial imagery and field survey. The closest recognised creek to the Tanumbirini well site is Tanumbirini Creek which is approximately 2.5 km to the east of the well site. The closest recognised creek to the Inacumba well site is October Creek which is approximately 12 km to the east of the well site. The EMP identifies a number of small ephemeral drainage lines (Stream Order 1 and 2) located along existing access tracks and nearer each well site. The drainage lines are overland flow paths that only flow for a short period during the wet season. In significant rainfall events, these drain into larger rivers and eventually into the Gulf of Carpentaria.

The two well sites are located at the boundary of the north eastern extent of the Cambrian Limestone Aquifer (CLA) where only the Gum Ridge aquifer (and not the shallower Anthony Lagoon aquifer) is in the saturated zone. Water supply and monitoring bores have also accessed the stratigraphically deeper Bukulara Sandstone aquifer at the Inacumba well site for water supply. The CLA forms the major water resource for the Beetaloo Basin, providing groundwater supply for the communities of Elliot, Daly Waters, Larrimah, Newcastle Waters and the pastoral industry that comprises 90% of land use in the Beetaloo Basin. At Tanumbirini the water table is approximately 57.9 m below ground level and at Inacumba it is approximately 73.5 m below ground level (BGL).

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
- camp sewage.

Surface overflow and spills

As assessed in the Santos Drilling Program 2019 EMP[6], a preliminary flood assessment for the well sites indicated that the critical infrastructure (wastewater tanks pads) at the Tanumbirini 1/2H and Inacumba 1/1H locations are unaffected by a 1% AEP flood event.

The two well sites are situated on higher ground than the surrounding areas and measures have been taken to avoid surface water flow impacts to the catchment downstream of the activity. These measures include the design of the flowback wastewater tank pads to divert any overland flow around the pad areas; wastewater tank bunding capable of holding the "carrying capacity[7]" of

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

[7] "Carrying capacity" of tank pad is equivalent to volume of all enclosed tanks including 50 cm freeboard. This is also equal to maximum carrying capacity of open tanks with mandatory minimum 1.5m operational freeboard for 0.1% 90-day AEP

wastewater on the tank pad; leak detection system integrated on the tank pad; enclosed tanks with capacity to manage all of the flowback wastewater from each well with 50cm freeboard; all tanks are 2 m high, made of steel and are double lined; and a spill management plan (SMP) in compliance with the Code of Practice: Onshore Petroleum Activities in the Northern Territory (the Code) to deal with spills at site in a prompt and effective manner.

Additional uncovered tanks on the tank pad will be used to reduce the volume of wastewater by evaporation. In compliance with the Code these open tanks must be operated with a sufficient freeboard to not overflow with an annual exceedance probability (AEP)[8] for a total 90-day rainfall event[9] that might be expected to occur once in a thousand years. This is a statistically derived probability from rainfall records in the Beetaloo sub-basin region and is equal to 1,448 mm of rain. This 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. The minimum operational freeboard for the evaporation tanks is set at 1.5 m. 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 wastewater 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. The EMP defines a significant rainfall event as a rainfall forecast published by the Bureau of Meteorology which is greater than 300mm of total rainfall over a 4-day period (0.1% AEP).

The SMP (Appendix H, EMP) describes spill modelling using a worst-case scenario analysis at site to predict the extent of a site spill volume of 15.3 ML which exceeds the maximum carrying capacity of the wastewater tank arrangement (10.8 ML). The modelling indicated such a release would be contained within the bunded tank pad which has a capacity of 15.3 ML. Moreover, the modelling, using real infiltration data from natural (non-compacted) soil cores taken from each of the well sites, predicted it would take 130 days (with a constant 3 m head) to move through the first metre of the well site soil horizon and approximately 22 years to reach the water table. The NT EPA will provide separate advice to the Minister on reporting and clean-up requirements in the event of accidental release (spill or leak) of flowback wastewater.

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 on each well site. These are included in the Wastewater Management Plan (WWMP) and SMP, which have been developed in accordance with the Code. Key measures committed to in these plans that have not already been discussed above include:

- sites will be manned during operations with 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
- other than the 2 m^3 tank used to mix fluid and proppant, all other mixing of fracturing fluids will occur in enclosed systems, without risk of overspills
- the downhole blender unit is computer automated and equipped with alarms
- use of separators to segregate hydrocarbons and flowback water; flowback wastewater is stored and managed in tanks as previously described

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

[9] The shorthand for this is 0.1% 90-day AEP.

- 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.

- all volumes of condensate must be recorded before off-site transport occurs

- the bunded tank pad area at each well site will accommodate the largest potential stored flowback wastewater tank volume at each well site in the event of a tank failure.

The Department of Environment and Natural Resources (DENR) reports on laboratory analysis of a suite of more than 60 analytes tested in flowback wastewater from two previously hydraulically fractured petroleum exploration wells in the Beetaloo sub-basin are available at the DENR Onshore Petroleum webpage[10]. In terms of approximate composition, the flowback comprised of approximately 93% sodium chloride, 5.3% calcium carbonate, 0.8% magnesium chloride, 0.25% barium sulfate, 0.2% potassium chloride and 0.12% boron, which accounts for 99.67% of the flowback constituents measured. Contaminants of potential concern in the flowback wastewater, 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 Proponent must monitor and report on the risk assessment of flowback wastewater (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. As a further precautionary step the NT EPA will provide separate advice to the Minister that the Proponent be required to store flowback wastewater in enclosed tanks during the wet season until otherwise advised by DENR.

NORM commonly precipitates in the flowback tank and accompany non-NORM solids that may be 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]. Based on reports in flowback wastewater from two previously hydraulically fractured petroleum exploration wells in the Beetaloo sub-basin, exceedance of this threshold is considered unlikely but warrants further investigation.

The Code defines the wet season as the months October to April inclusive and requires the transport of chemicals and wastewater on unsealed roads to not be undertaken during the wet season unless a risk assessment on spills has been conducted under these conditions. It is estimated that residual flowback wastewater, following volume reduction by evaporation for transport to a licensed waste facility, will be less than 3.6 ML at each well site. This is estimated to require approximately 75 B-double truck load outs for each 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 includes an emergency contingency plan and commits to not transporting chemicals and wastewater in the event of rainfall events leading to unstable road conditions on unsealed roads. The mobilisation of the hydraulic fracturing rig and heavy vehicle support logistics will occur outside the period of rain events that would impede heavy vehicle access. The EMP provides a wet season

---

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

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.

risk assessment of 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 heavy vehicle transport prior to mobilisation on unsealed roads and using detailed weather forecasting
- if the conditions are assessed to be unsuitable for heavy vehicle transport, there will be no transport of chemicals or wastewater.
- only transporting flowback wastewater off-site in double lined enclosed tanks
- use of licensed waste transporters to transport listed waste including flowback wastewater
- 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 sites have been constructed to mitigate potential impacts from overland flow and run-off. During the wet season, flowback from wells 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. In addition the Rapid Response Site Demobilisation and Stabilisation Plan previously approved in the McArthur Basin 2019 Drilling Program EP161 will be activated.

The NT EPA will provide separate advice to the Minister that the Proponent provides regular 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. These concerns have been raised in public submissions. 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 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 Santos Drilling Program 2019 EMP. 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 and include:

- Any new geohazards (e.g. small faults) identified in the target Velkerri formation during drilling operations must be identified and considered in the hydraulic fracturing (HF) perforating design.

- The reservoir engineering parameters and results of hydraulic fracture modelling that informs the final design of each HF stage treatment must be provided to Department of Primary Industry and Resources (DPIR) prior to undertaking the HF 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 re-confirm well integrity prior to hydraulic fracturing operations. The well must be pressure tested at a level that exceeds the maximum anticipated pressures in the hydraulic fracturing design to demonstrate mechanical integrity and define a maximum allowable operating pressure (MAOP). 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.

- A pressure relief valve (PRV) will be installed on the well annulus to release any overpressure observed.

Contamination of groundwater from vertical hydraulic fracture growth and natural geohazards

Concerns regarding potential contamination of groundwater from vertical hydraulic fracture growth and natural geohazards were raised in public submissions. 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[13].

The Bukulara Sandstone, which is stratigraphically deeper than the CLA, is recognised as an aquifer on a regional basis. At the Inacumba well site, the base of the Bukulara Sandstone is approximately 1,850 m from the target Velkerri shale and at the Tanumbirini well site, the Bukulara Sandstone is approximately 2,800 m from the target. Therefore, at both well sites the base of the Bukulara Sandstone and top of the target Velkerri shale interval have a minimum offset distance that exceeds the minimum 600 m offset required under the Code.

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.

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

The McArthur Basin 2D Seismic Exploration Survey – 2013 provides the basis for the Proponent's subsurface geohazards assessment. An additional seismic control line has also been surveyed at Tanumbirini well site in accordance with the approved McArthur Basin Civil and Seismic Program EP161 – June 2019. Wells are located away from known geohazards identified through seismic surveys, offset wells and other geological information.

Two-dimensional (2D) seismic profiles can detect faults with a throw of about 30 m or more. The 'resolution' - the finest detail that can be seen - is at least 30 m in length[14]. However, small inactive faults (average 6 m of throw with a maximum ~15 m of throw) with limited vertical extent will occur, and these are unlikely to show up on seismic surveys. These faults are typically located during drilling. The spacing and intervals selected for the hydraulic fracturing stages are based on modelled reservoir properties and the locations of interpreted small faults with a suitable standoff (~20m) from the identified faults. 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 meters[17].

A vertical seismic profile (VSP) will be conducted at Tanumbirini by placing geophones in the Tanumburini-1 vertical well at different depths while providing a seismic source (vibroseis truck) along existing seismic lines that intersect the well site. This enables reservoir engineers to calibrate the subsurface velocity distribution through the stratigraphic formations including the Velkerri shale. This improves the accuracy of downhole microseismic event location in the Velkerri shale more than 2 km below the surface during HF operations. Because there will not be an available offset well at the Inacumba well site for deployment of downhole geophones, a VSP and microseismic monitoring will not be conducted when hydraulic fracturing of the Inacumba 1-H well is undertaken. However, tiltmeters and passive seismic monitoring ("traffic light" risk management) will be conducted at Inacumba

During HF operations of Tanumburini 2H, surface and acoustic receivers located downhole in the nearby Tanumburini-1 well will be deployed. These acoustic receivers will be connected to the microseismic office using a radio array. Events greater than a certain magnitude (determined from baseline data) will be sent to the microseismic office. Based on the layout of the acoustic receivers, the x, y, z location of microseismic events can be determined in real-time, allowing the propagation of fractures in the Velkerri shale to be mapped. Fracture geometry evaluation monitored with tiltmeters at surface will be conducted at both well sites.

The overall objective of the seismic program in this procedure is to monitor the degree of horizontal fracture propagation as well as vertical fracture orientation in the target reservoir (Velkerri shale) during the hydraulic fracturing operations and to enable mapping of fracturing extent (height, length, and orientation) and estimation of resultant stimulated rock volume (SRV) or fracture network for each hydraulic fracture stage. A Diagnostic Fracture Injection Test (DFIT) will be conducted to

[14] Rutqvist R, Rinaldi A, Cappa F, Moridis G (2013). Modelling of Fault Reactivation and Induced Seismicity During Hydraulic Fracturing of Shale-Gas Reservoir. Journal of Petroleum and Science Engineering. Accessed at: http://www2.epa.gov/sites/production/files/2013-12/documents/faultreactivation.pdf

[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

validate and update the proposed hydraulic fracture design prior to HF. A DFIT has been completed at Tanumbirini 1 during August – October 2019.

Geohazards encountered during drilling of the petroleum wells are risk assessed in the WOMP to ensure hydraulic fracturing activities can occur safely. As discussed above, hydraulic fracturing activities will not occur until the integrity of a well has been confirmed. Real-time monitoring of the pumping pressure is conducted during hydraulic fracturing operations to ensure MAOP 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 Code to monitor anomalous seismicity (tremors) during the hydraulic fracturing operations at both well sites. The risk of induced earth tremors as a result of hydraulic fracturing that can be felt at surface is considered very low.

Water soluble chemical tracers will be included to help allocate flowback returns to the specific treatment stage, with gas tracers confirming the zonal contribution of gas from each stage interval.

Upward migration of hydraulic fracturing fluid and brine

Concerns regarding potential environmental impacts associated with predictions of upward migration of hydraulic fracture fluid and brine from the target reservoir were raised in public submissions. This was considered in the EMP. 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 create direct hydraulic communication between the target zones and shallow aquifers via induced fractures. The overlying Hayfield Mudstone and Kyalla formation are notable thick aquitards[18] in this region. 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 there is an upward gradient, permeability is low, upward flow rates are low, and mean travel times are long (often > 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.

Camp Sewage

All camps will have their own sewage treatment plant. Treated water will be dispersed via drainage away from the camp to a designated irrigation area in accordance with the Code of Practice for Small Onsite Sewage and Sullage Treatment Systems and the Disposal or Reuse of Sewage Effluent, issued by the NT Department of Health. Designated irrigation areas will be fenced adjacent to the camp. These areas will not require clearing and will be fenced to exclude livestock access. All camps will be managed in compliance with the NT Environmental Health Fact Sheet No 700, Requirements for mining and construction projects and "Health requirements for mining and construction camps"[20]

[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.

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

[20] https://nt.gov.au/property/building-and-development/health-andsafety/health-requirements-mining-construction-projects

NT EPA assessment

The Proponent has complied with the precautionary baseline groundwater monitoring requirements specified in the Code at both well sites since December 2018. The Proponent submits groundwater quality laboratory reports together with continuous water level logging information for both well sites on a quarterly basis to DENR and published on the DENR Onshore Petroleum webpage. The information provides important scientific information regarding spatial and temporal trends in forty (40) key water quality analytes, including metals, hydrocarbons and naturally occurring radionuclide materials (NORM) in the CLA system, and also the Bukalara Sandstone at Inacumba, for these wellsite locations. Impact monitoring bores situated 20 m downgradient (downstream) of the petroleum wells will enable rapid detection of any anomalous water quality trends above established background values at the well sites. The stratigraphy of groundwater monitoring bores drilled at both well sites indicates the top of the Bukalara is in direct contact with the base of the Gum Ridge aquifer at these locations.

The NT EPA will provide separate advice to the Minister that requires the Proponent demonstrate there is no change in existing baseline groundwater quality (i.e. no change in the natural range of values) as a result of the regulated activity at both well sites.

Provided that the mitigation and management measures outlined in the EMP, 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 groundwater user is the Tanumbirini Homestead situated 22 km from the Inacumba well location and 8.5 km from the Tanumbirini well location. Station bores are more than 2 km from each well site and bores in the Proponents groundwater extraction licence GRF10280. At Inacumba groundwater will be extracted from the deeper Bukalara Sandstone due to the low production of the Gum Ridge aquifer at this location which appears to be at the north-eastern boundary extent of saturation in the CLA. At Tanumbirini, groundwater will be extracted from existing bores in the Cambrian Limestone Aquifer (CLA) Gum Ridge aquifer. These bores are included in the groundwater extraction licence GRF10280, which takes into account the cumulative impacts of groundwater extraction for all of the Proponent's activities, in EP 161.

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
- surface water flow paths
- cross flow between aquifers resulting in flow of low quality groundwater into an aquifer that contains high quality groundwater

These potential environmental impacts were also raised in public submissions.

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 both well sites is a pastoralist bore; both bores are situated more than 1km from the proposed activity in accordance with the Code.

The Proposal has potential to impact on groundwater drawdown associated with groundwater extraction. The total estimated groundwater volume required for the proposed activities is 85.2 ML. Tanumbirini 2H and Inacumba 1H wells each require 32 ML while Tanumbirini 1 requires 7 ML for the hydraulic fracturing operation. Based on transmissivity analysis, the total water extraction requirement is well within sustainable recharge levels.

The estimated total cumulative volume of groundwater to be extracted in the 2019-20 exploration program is shown in Table 3.

Table 3: Cumulative water use for the 2019-20 exploration program in EP 161

Source of water use	Megalitres (ML)
EMP: McArthur Basin 2019 Civils and Seismic Program	45.5
EMP: McArthur Basin 2019 Drilling Program	12.0
EMP: McArthur Basin 2019-20 Hydraulic Fracturing Program	85.2
Cumulative water use	142.7

An extraction licence has been granted to the Proponent for 193.5 ML per year for 3 years from May 2019 to December 2023 (GRF10280). The total cumulative volume of groundwater to be extracted for the approved activities and including this EMP for 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. The Framework states the total extraction over the period of at least 100 years should not exceed the estimated sustainable yield (ESY) range of 1,412,800 – 2,825,600 GL. Cumulative groundwater extraction from the Gum Ridge aquifer over the period May 2019 to December 2023 is approximately 1,500 ML, significantly less than the estimated water available for extraction under the framework. The Proponent's licence allocation is less than 0.01% of the ESY 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, any water allocation plan applying to 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 is continuously measured using a logger at both Tanumbirini and Inacumba well sites. At Inacumba, the Bukulara Sandstone water level is also continuously measured. The results are reported quarterly and published on the DENR webpage. Water level at both well sites has remained static since monitoring commenced in December 2018. During this time, the civil construction works for both well sites have largely been completed and this represents over 30% of the cumulative estimated water requirements for the 2019 program. This

suggests water drawdown from the total cumulative impact provided in the licence is likely to be negligible at both well sites.

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 Tanumbirini the water table is approximately 57.9 m below ground level and at Inacumba it is approximately 73.5 m below ground level (BGL). 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 both well sites, discussed above, suggests negligible drawdown of groundwater will occur at the well sites.

Surface water flow paths

The two well sites are situated on higher ground than the surrounding areas and at the top of the Limmen Bight catchment. Potential flooding during high rainfall events is predicted to be contained to drainage flowlines and adjoining embankments. The drainage lines are overland flow paths that only flow for a short period during the wet season. In significant rainfall events, these drain into larger rivers and eventually into the Gulf of Carpentaria. Measures have been taken to avoid surface water flow impacts to the catchment downstream of the activity. These measures include the design of the flowback wastewater tank pads to divert any overland flow around the pad areas. Stabilisation of the well sites has been undertaken using competent base material brought into the sites, laser levelling and compaction and installation of rock chute drainage to manage storm water run-off from the well sites and ensure natural surface water flow paths are maintained.

Cross flow between aquifers

The potential for leakage in aquifers (failure to isolate) as a result of the intersection by the petroleum wells has been considered in the previously approved McArthur Basin 2019 Drilling Program EP161. The design criteria for the surface casing (9 5/8") of each of the petroleum wells includes the base of the surface casing (casing shoe) extending well below the deepest aquifer (Bukulara Sandstone) into the Hayfield Mudstone aquitard; a requirement for cement to be brought to surface in the surface casing well annulus to ensure complete isolation of aquifers from deeper formations; testing of the cement bond using pressure testing; and conducting a cement bond log to document the evaluation of the integrity of the cement in the surface casing annulus. The Proponent must supply this information to DPIR in a Well Barrier Integrity Validation (WBIV) report for assessment and approval and prior to hydraulic fracturing occurring.

NT EPA assessment

The NT EPA considers that the potential impacts and risks on 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 area in which the well sites are situated on at Tanumbirini pastoral station have intact soils within ephemeral creeks. Natural drainage lines maintain the stability of water course and reduce sedimentation when rainfall events that induce sheet flow occur. The EMP describes the three main soils types within the vicinity of the activity as highly leached soils of the Tertiary land surface: Tertiary Lateritic Red Earths, Tertiary Lateritic Red Sands and Tertiary Lateritic Podzolic Soils. Potential impacts to soils from the Proposal include erosion of exposed soils from the cleared well pad and

potential soil contamination as a result of spills and leaks associated with storage, handling and transport of chemicals and wastewater.

The exploration lease pad and wastewater tank pad will be compacted for load bearing capacity and to minimise impacts of infiltration from spills. Impacts from spills or releases at site including flowback wastewater have been addressed previously under section 1 **Inland water environmental quality**.

The recovered wastewater produced following hydraulic fracturing activities, will be stored in flowback tanks on a purpose built tank pad, which will be double lined and located in a bunded containment area. A total of 15.3 ML can be contained within the bunded tank pad area which exceeds the maximum covered storage capacity of 10.5 ML Leak detection monitoring between the primary and secondary liner is proposed to further manage the risk of wastewater seepage to soils in the vicinity of the tank pad. The NT EPA will provide separate advice to the Minister that in the event of any spill or leak, the Proponent provide a written report detailing corrective actions including volume and depth of impacted soil removed for appropriate disposal.

A rehabilitation plan is essential to minimise the risk of subsequent erosion and return the disturbed land to an environment similar to the original conditions. The majority of site-specific rehabilitation objectives and activities were assessed in the Santos Civils and Seismic EMP[21]. The Rehabilitation Plan was developed in compliance with the Code requirements. All stages of the regulated activity, including progressive rehabilitation of all disturbed areas to an acceptable standard, would be at the cost of the Proponent. The Proponent will be required to provide an adequate environmental rehabilitation security to ensure rehabilitation objectives are met. The NT EPA will provide separate advice to the Minister for the Proponent to undertake progressive rehabilitation for this activity and more generally for the previously approved activities in the 2019-2020 exploration program.

NT EPA assessment

The NT EPA considers that the potential impacts and risks to terrestrial environmental quality can be mitigated through implementation of the mitigation measures presented in the EMP. These include appropriate site selection and the implementation of management strategies consistent with the International Erosion Control Association Best Practice Erosion and Sediment Control standard and the Code.

Based on these mitigation measures, the NT EPA considers 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

Potential impacts to human health were identified from hydraulic fracturing chemicals entering aquifers or exposure to workers through inhalation. Similar concerns were raised in public submissions. The potential for hydraulic fracturing chemicals to contaminate aquifers that are known groundwater sources for community and livestock was discussed under the Inland water environmental quality objective.

A chemical risk assessment was completed for all chemical additives proposed to be used during the hydraulic fracturing program (Appendix A, EMP). A tier-based assessment was conducted on two hydraulic fracturing fluid systems using a screening of the potential human health and ecological hazards that should be considered for potential exposure to chemical additives during transportation, hydraulic fracturing activities (including storage), and subsequent treatment and disposal of flowback wastewater.

[21] https://denr.nt.gov.au/onshore-gas/environment-management-plan/approved-emps

Of the chemicals evaluated for the two hydraulic fracturing system formulations, the only additive that was carried through to a Tier 2 assessment for human health was hydro-treated light petroleum distillate (CAS number 64742-47-8) based on the potential for inhalation exposures to workers during hydraulic fracturing activities. The assessment found the chemical is considered of low health concern for workers given the very low concentration in the fluid system. Based on the outcomes of this assessment, no further management controls are considered necessary, apart from those measures of personal protection listed in the relevant Safety Data Sheets.

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**. Procedures for handling chemicals at surface during preparation of the hydraulic fracturing fluid, which only occurs prior to pumping each HF stage and is completed within 2 hours, are provided in the Spill Management Plan (Appendix H, EMP). The plan commits to a range of measures, including:

- the mixing of hydraulic fracturing fluids in enclosed systems (0ther than the 2 m^3 tank used to mix fluid and proppant)
- continuous supervision of mixing operations by a dedicated operator
- continuous monitoring of tank levels
- routine inspections of all hoses and treating lines to identify and isolate any potential leakage
- flushing of all hoses and lines with freshwater prior to breaking lines at the completion of operations, with portable spill trays used when breaking connections
- all bleed off lines are directed into flowback tanks.

Management of NORM and other constituents in flowback wastewater were addressed previously under the Inland water environmental quality objective.

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 of ensuring that the risks to human health are identified, understood and adequately avoided and/or mitigated 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.

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, and AAPA has confirmed the relevant AAPA Authority Certificate is in place. Concerns were raised in some public submissions regarding perceived lack of stakeholder engagement. These have been further addressed in the revised EMP by the Proponent.

Access to the well sites is via the Stuart Highway. The Highway has a 130 km/h posted speed limit in the vicinity of the project and is a two-way road with a sealed width of 7 m and unsealed or grassed

shoulders of varying width. Mobilisation of the hydraulic fracturing "spread" (the term used to describe the various trucks and equipment needed) and associated services will require approximately 35 – 50 loads/trailers mobilised to the nominated wellsite. There will also be 40 – 80 loads to each wellsite required to transport materials like proppant to the location. Demobilisation will involve moving all equipment out from location via the proposed access routes. There will be a daily commute by 4WD to mobilise and demobilise crews from the camp to the hydraulic fracturing spread.

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 is located approximately 8.5 km southwest of Tanumbirini 1/2H location and the nearest community is approximately 100 km away. There will be a camp at each of the two well site locations and each camp can hold up to 120 people. Noise is not considered a significant issue due to the implementation of control measures and distance to sensitive receptors. Dust will be managed through use of water carts and vehicle speed restrictions. 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 Fire 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

An Aboriginal and Historic Cultural Heritage Assessment was completed and provided in the EMP and the proposal is covered by AAPA Certificate 2019/043.

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 on social, economic and cultural surroundings can be mitigated through implementation of the management measures presented in the EMP and that its objective for 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.

The Proposal has potential to increase greenhouse gas (GHG) emissions generated from direct and fugitive emission sources. Flaring also poses a potential bushfire risk. The Proposal will generate an estimated 130,000 tCO_2-e (tonnes of carbon dioxide equivalent) of GHG emissions[22]. This comprises

[22] Based on the National Greenhouse and Energy Reporting (Measurement) Determination 2008 (Section 3.44) Emissions factor of CO2-e/tonnes flared

128,500 tCO_2-e from flaring of methane (including allowance for flare tip inefficiency[23]), 650 tCO_2-e from fugitive (direct) emissions of methane during well completion, and 600 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 Combustion flaring is expected to reduce the emissions by approximately 85% compared to venting. 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 L to the EMP.

The NT EPA will provide separate advice to the Minister regarding a requirement for the Proponent to undertake leak detection and reporting (LDAR) at well sites.

Total cumulative GHG emissions for the approved activities in Santos 2019-20 exploration program on EP 161 are estimated to be 144,000 tCO_2-e (Table 4), assuming a worst case EPT period of 12 months. The total estimated GHG emissions for the Santos 2019 exploration program will likely result in an overall increase in NT GHG emission 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]. Therefore the NT EPA considers that GHG offsets are not required for the proposed activity.

The NT EPA notes that the EPT which involves measuring hydrocarbon flow from the well over an extended period is the major component (89%) of total cumulative emissions for the approved activities in the Santos 2019-20 exploration program. An EPT is only required to be conducted during the exploration phase of petroleum operations to characterise the reservoir. Fugitive emissions of methane from well completion in the activity (excluding flare tip inefficiency) is estimated to be 0.5% of total estimated GHG emissions in the activity.

Table 4: Estimated cumulative greenhouse gas emissions for the 2019-20 exploration program in EP 161

Source of GHG emissions	**tCO_2-e**
EMP: McArthur Basin 2019 Civils and Seismic Program	11,700
EMP: McArthur Basin 2019-20 Drilling Program	2,800
EMP: McArthur Basin 2019-20 Hydraulic Fracturing Program	130,000
Cumulative GHG emissions	144,500

[23] Flare tip efficiency assumption has been calculated using published CO2 emissions factor for methane flaring tCO2-e is 2.8 (35,700t x 2.8) = 99,960 + CH4 emissions factor tCO2-e is 0.8 (35,700t x 0.8) = 28,560

[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

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 Fire 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. Flares will be located more than 30 m from vegetation 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 fire ban periods, flaring is not 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, Fire Management Plan and flare stack design, that its objective for air quality and greenhouse gasses is likely to be met.

Public consultation

The Proposal includes the hydraulic fracturing (HF) of three petroleum exploration wells, and in accordance with the Petroleum (Environment) Regulations 2016, the EMP was made available for public comment for a period of 28 days from 30 August to 27 September 2019. Ten submissions were received by DENR, five from community members and five from non-government organisations. The majority of submissions were from within the Northern Territory.

Frequent comments raised in the public submissions related to well integrity, greenhouse gas emissions, human health, groundwater extraction, wastewater, chemicals and contamination of ground water. The NT EPA has reviewed the public submissions as part of its decision-making under the EA Act. Where appropriate these issues have been noted and 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 WWMP and SMP.

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 2019-2020 exploration program that has been previously approved, 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, 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 three exploration wells.

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 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

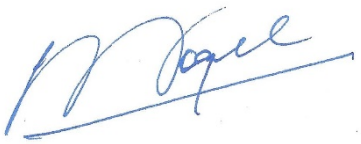
As part of the assessment to provide that advice, the NT EPA proposes to make recommendations to the Minister for Environment on conditions to improve environmental outcomes. The NT EPA's decision not to assess the EMP under the EA Act is not reliant on the Minister accepting the NT EPA advice.

DECISION

The proposed action by Santos QNT 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.* 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

CHAIRMAN

NORTHERN TERRITORY ENVIRONMENT PROTECTION AUTHORITY

15 OCTOBER 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 Infrastructure
Department of Primary Industry and Resources	Mining Compliance Petroleum Primary Industry Fisheries
Department of Tourism, Sport and Culture	Parks and Wildlife Heritage Tourism NT Arts and Museums
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	Maintenance Planning Housing supply
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