EMP IMP3-4 Imperial O&G 2021 Carpentaria 1 Program Appendices

Table of Contents

Appendix 01- Description of the existing environment for the Project Area

1 - Description of the existing environment for the Project Area

Contents

List of Tables

List of Figures

1.1 Climate

The Project area experiences a tropical savannah climate within the humid zone with a distinct Wet and Dry season which can experience an average rainfall between 600 – 800mm per year over the summer wet. The seasonal contrast between the Wet and the Dry has significant implications for water resources. The summer monsoon season brings rain and cyclones, and during this period the project area experiences significant rainfall events. These rainfall events can cause flooding, which is determined by the volume, duration and spatial distribution of the rainfall. It is these flooding events that provide the recharge to the aquifers. In contrast, the Dry season between April and December experiences little rain which results in many of the rivers ceasing to flow.

The mean daily minimum temperatures at the Daly Waters mine range from 11.3 to 23.4°C and a maximum mean daily temperature range from 28.9 – 37.6 °C. Average annual evaporation is approximately 2,418mm for the region which, even in the wettest of years, exceeds the annual rainfall.

Table 1 (BoM.a, 2020) displays the mean monthly rainfall and temperature data for the Daly Waters region with the data drawn from this weather station.

Table 1: Daly Waters long term averages

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
Mean Max (°C)	35.7	34.7	34.3	33.6	31.5	29.0	28.9	32.0	34.5	36.9	37.5	37.6	33.8
Mean Min (°C)	23.4	23.0	21.8	19.0	15.3	12.1	11.3	13.4	16.3	20.3	22.9	23.5	18.4
Mean Rain (mm)	162.4	161.6	112.8	23.1	4.9	4.4	1.2	1.7	4.5	22.5	61.0	110.7	655.4
Media Rain (mm)	150.3	135.6	74.9	6.9	0.0	0.0	0.0	0.0	0.0	10.4	51.2	92.7	615.9
Mean Rain Days	12.0	11.8	8.2	2.4	0.6	0.5	0.2	0.2	0.7	2.8	6.0	9.7	48.8

The mean daily minimum temperatures at the McArthur River mine range from 12.1 to 25.1°C and a maximum mean daily temperature range from 29.9 – 38.6 °C. Average annual evaporation is approximately 2,400mm for the region which, even in the wettest of years, exceeds the annual rainfall (BoM b., 2020).

Table 2 displays the mean monthly rainfall and temperature data for the McArthur River region with the data drawn from its weather station.

Table 2: McArthur River Mine long term averages

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
Mean Max (°C)	35.9	35.2	35.0	34.7	32.4	29.8	29.9	32.1	35.3	37.8	38.6	37.8	*34.5*
Mean Min (°C)	24.9	24.7	23.4	20.5	16.7	12.7	12.1	13.4	17.2	21.0	24.1	25.1	*19.6*
Mean Rain (mm)	210.3	184.4	153.8	33.5	7.7	1.7	2.4	0.3	5.1	20.3	62.2	129.9	*819.2*
Media Rain (mm)	170.0	162.1	109.2	14.4	0.4	0.0	0.0	0.0	0.0	1.6	37.2	88.6	*669.5*
Mean Rain Days	13.6	13.3	10.8	3.5	1.2	0.5	0.4	0.3	0.7	2.0	5.7	9.7	*59.2*

1.2 Rainfall & Evaporation

The project area lies between Daly Waters and McArthur River Mine, being 196km from Daly Waters and 110km from McArthur River Mine. Imperial has utilised Bureau of Meteorology (BOM) data from weather station 14618 (Daly Waters) and 14704 (McArthur River Mine Airport) in its analysis of rainfall patterns and intensity. Daly Waters BOM station has 147 years of daily rainfall data (1873 to current), and McArthur River Mine Airport BOM station has 52 years of data (1968 to present). Imperial has evaluated average daily rainfall, historically Significant Rainfall Events (SREs), and 1 in 1000-year events when assessing the risks of rainfall for this EMP.

1.2.1 Average Daily Rainfall

The average daily rainfall records for Daly Waters and McArthur River Mine Airport both show that the amount of rainfall expected, and the uncertainty range is highest in December through March, inclusive. The average rainfall and uncertainty range for both locations in April through November is relatively low, with averages below 2mm per day. In October and November, the rainfall is not only low, but is falling on dry ground, so little runoff is expected.

The daily recorded rainfall for Daly Waters and McArthur River Mine Airport showing the Minimum, lower quartile, median, upper quartile, Maximum and Outliers (1.5 times the Maximum) are shown in Figure 1 and Figure 2 respectively.

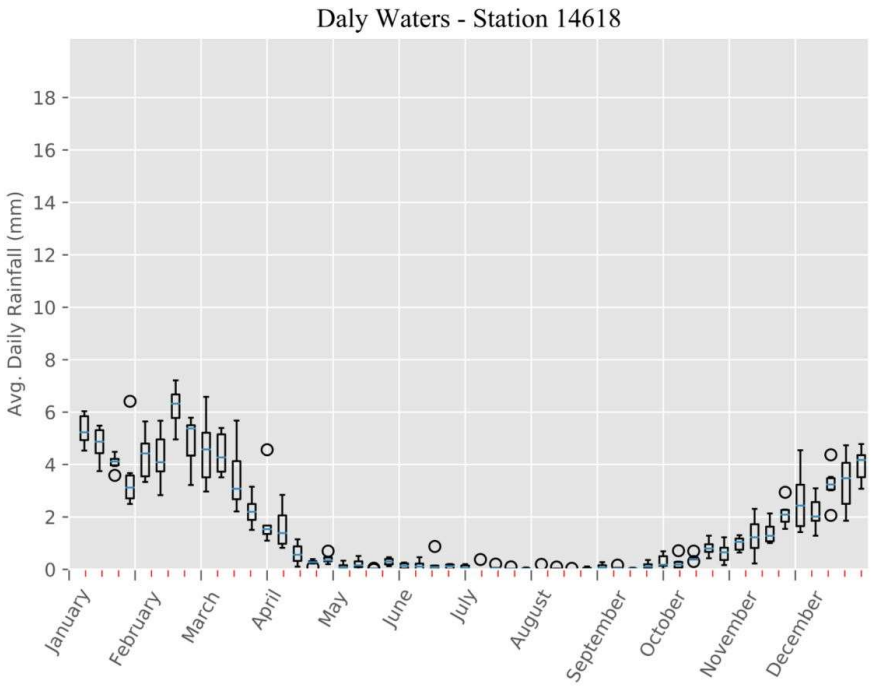

Figure 1: Daly Waters Avg. Daily Rainfall by Month

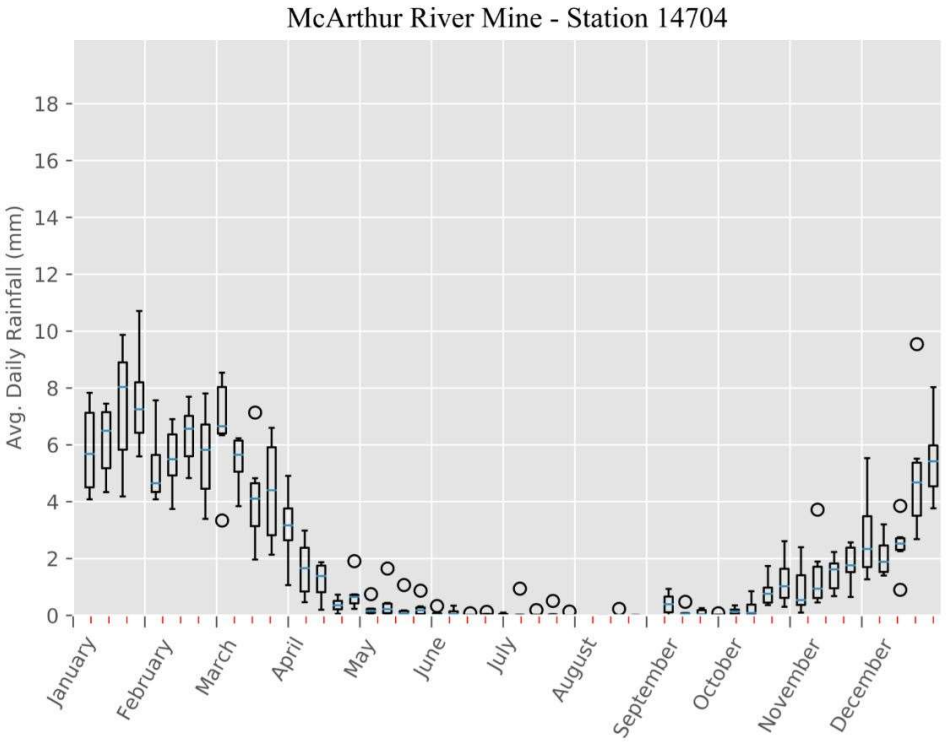

Figure 2: McArthur River Mine Avg. Daily Rainfall by month

1.2.2 Significant Rainfall Events

Imperial has defined a Significant Rainfall Event (SRE) in this EMP as an event where greater than 300mm of total rainfall occurs over four days. This type of rain is consistent with rainfall from monsoonal troughs, tropical lows or cyclones. The three historical SREs for McArthur River Mine Airport are shown in Figure 3, along with Darwin Airport for comparison, Daly Waters is not shown in this figure as there are no recorded SREs.

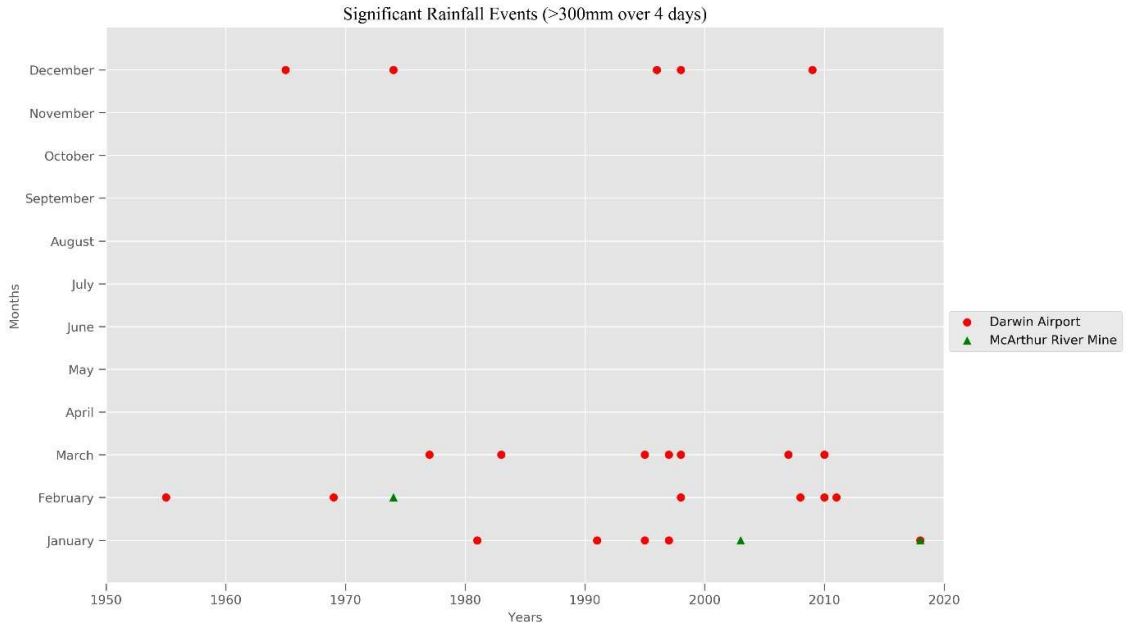

Figure 3: SREs for Darwin Airport and McArthur River Mine

1.2.3 Evaporation

Imperial has utilised SILO Data Drill lake evaporation data for the calculation of evaporation in the project area. Monthly evaporation depth totals have been listed in Table 3 for the 10th, 50th and 90th percentiles (labelled as P10, P50 and P90). Percentiles are based on 130 years of SILO Data Drill lake evaporation data.

Table 3: Monthly evaporation depths (mm) – SILO lake evaporation

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
P10	178	147	158	148	125	106	116	146	172	202	203	189	1890
P50	197	170	180	158	132	112	123	152	180	213	213	212	2043
P90	219	192	200	169	140	118	129	156	187	223	223	227	2183

Given that the highest rainfall months for the Project area are December, January and February, Imperial has used the sum of the P10 lake evaporation for December, January and February being 514mm based on the same 130 years of SILO Data. As such Imperial will use a 90-day evaporation of 500mm when calculating freeboard requirements to cater for 1 in 1000-year rainfall events.

1.2.4 1 in 1000-year events – Wet Season

Consistent with industry-accepted methodology associated with practices such as dam risk assessments (which calculate the wet season based on your geographical location) a 3 month period was determined applicable.

The highest three-month rainfall periods for both Daly Waters and McArthur River Mine Airport were utilised and a Log Pearson III distribution was fitted to the data. This analysis allowed us to extrapolate the 1,000-year, three-month duration wet season.

The median highest predicted 1 in 1000-year total rainfall in a three-month period, within the wet season, for Daly Waters and McArthur River Mine Airport is 1030mm and 1450mm, respectively. However, confidence bounds show that it could be up to 1130mm for Daly Waters, and 1600mm for McArthur River Mine airport. These calculations do not allow for any evaporation.

Based on the most conservative of these values; being McArthur River Mine Airport at 1600mm, and with a P10 evaporation of 500mm factored into the extreme rain event duration of 90 days, a freeboard of 1100mm will be applied to all open pits and unattended open-top tanks to minimise the risk of overtopping. Figure 4 shows the Log Pearson III distribution plots for Daly Waters and McArthur River Mine Airport, with 10% uncertainty bounds.

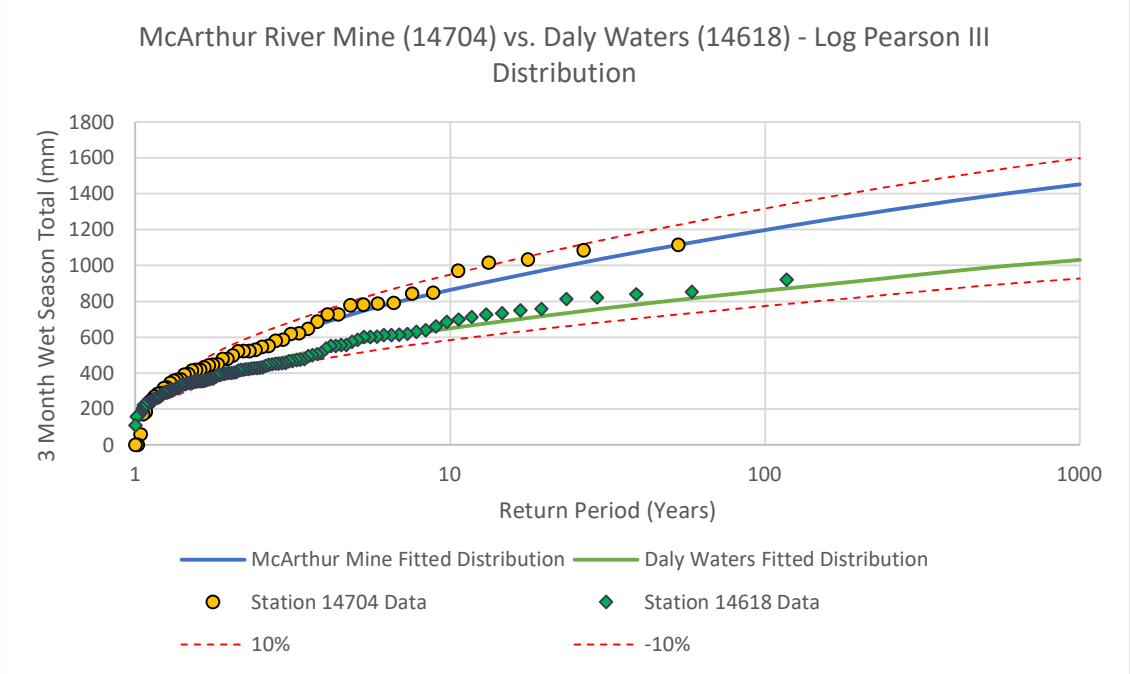

Figure 4: 1:1000-year events for Daly Waters and McArthur River Mine Airport.

A similar approach was used to predict the magnitude of 1 in 1000 year rainfall events over seven-day periods. Figure 5 and Figure 6 below show the Log Pearson III distributions for Daly Waters and McArthur River Mine respectively:

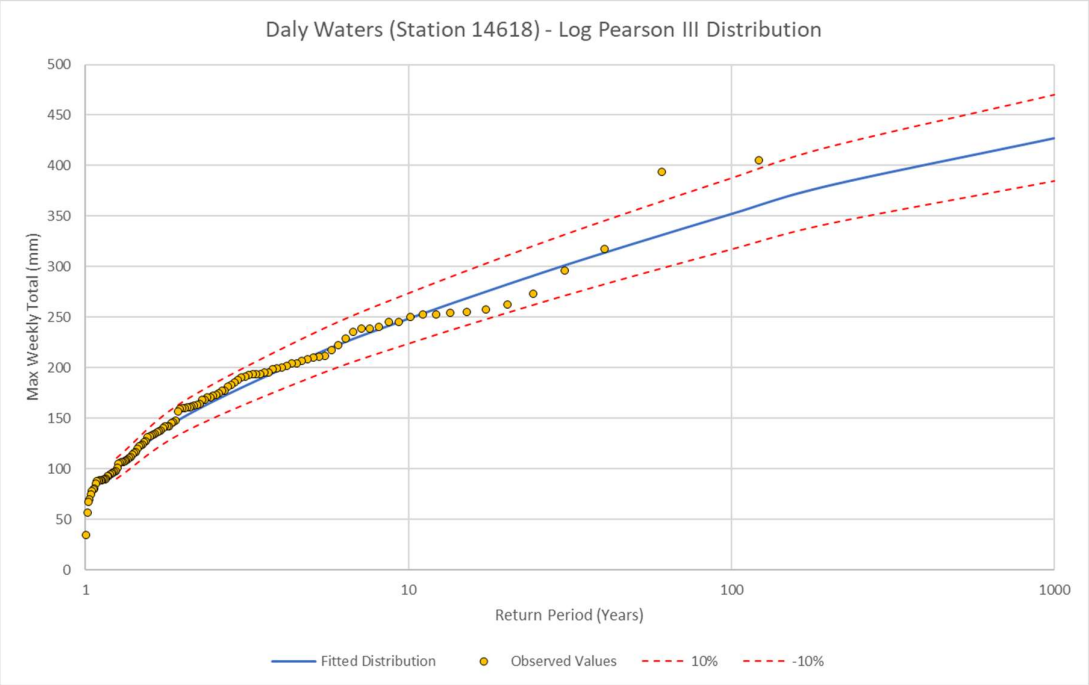

Figure 5: Seven day 1:1000-year event for Daly Waters (wet season)

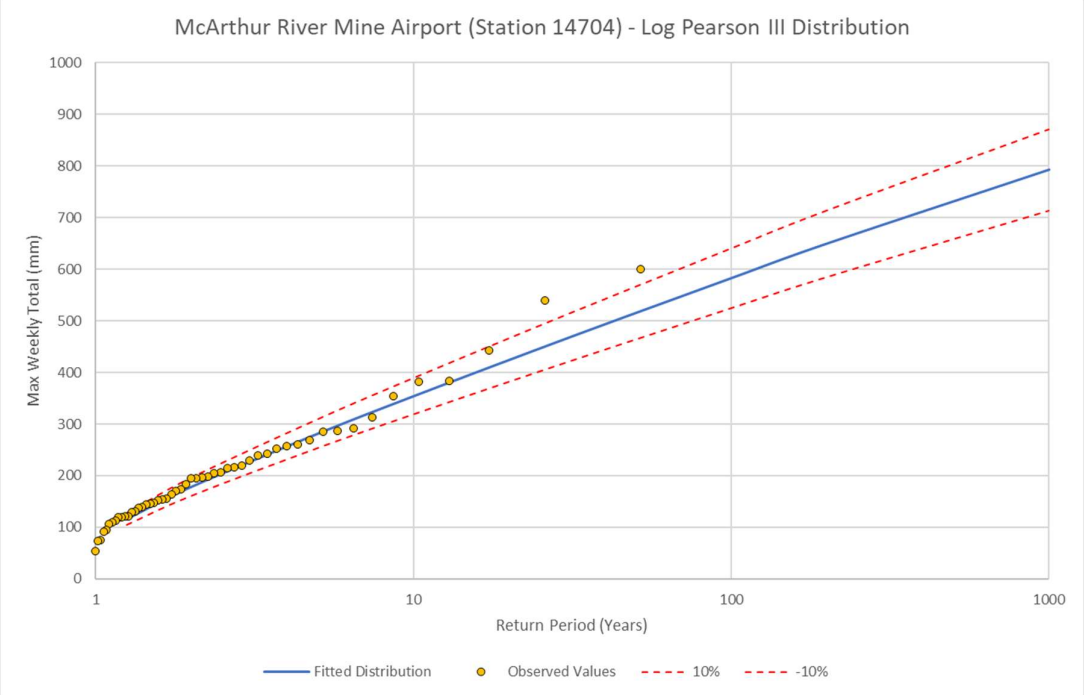

Figure 6: Seven day 1:1000-year event for McArthur River Mine (wet season)

Imperial has calculated a seven-day 1 in 1,000-year rainfall event of 470mm for Daly Waters, and 871mm for McArthur River Mine.

Should a 1 in 1000-year rainfall event occur (i.e., 871mm of rainfall in 7 days) while freeboard was a minimum level of 1.1m, then the remaining freeboard would be 0.23m. Therefore, Imperial can meet ALARP allowances of freeboard requirements of the code with a 1.1m freeboard design without overtopping.

1.2.5 1 in 1000-year events – Dry Season

During the dry season, Imperial will use 0.5m of freeboard due to the lack of historically large rain events as seen in Figure 3 above. Imperial has calculated a rolling three-month 1 in 1,000-year rainfall event for EP187 during the dry season (both Daly Waters and McArthur River Mine).

The highest three-month 1 in 1000-year total during the dry season is for the May-July period, at 304mm for McArthur River Mine and 175mm for Daly Waters. Which is approximately 60% of the 0.5m freeboard that Imperial is implementing.

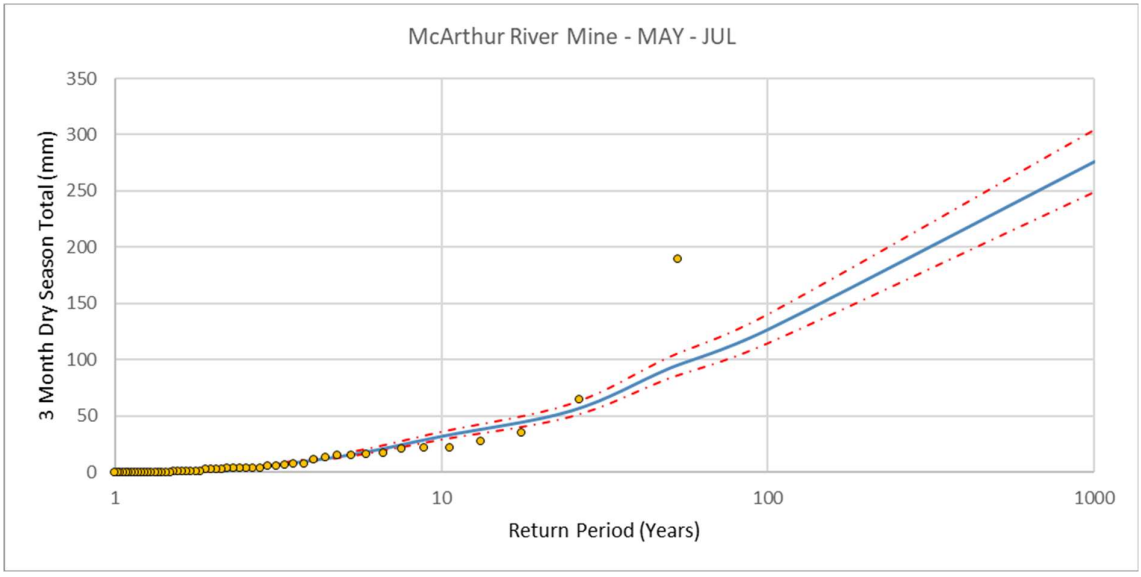

Figure 7: 1:1000-year event for May to July (inclusive) for McArthur River Mine Airport.

Due to limitations with the Log Pearson III Distribution method, it is not feasible to accurately predict 1 in 1000 rainfall events over a seven-day period during the dry season. Since collection of rainfall data in Daly Waters began in the 1880s, almost one quarter of all dry seasons have had no recorded rainfall, which skews the remaining data.

Therefore, another method is required to estimate dry season 1 in 1000 year events for 1 week intervals. The maximum 1 week rainfall total for each year during the dry season was collected for both Daly Waters and McArthur River mine. These points were then plotted against a logarithmic probability scale from 0 to 100%, with a line of best fit passing through the data. This is illustrated for Daly Waters and McArthur River Mine in the following figures:

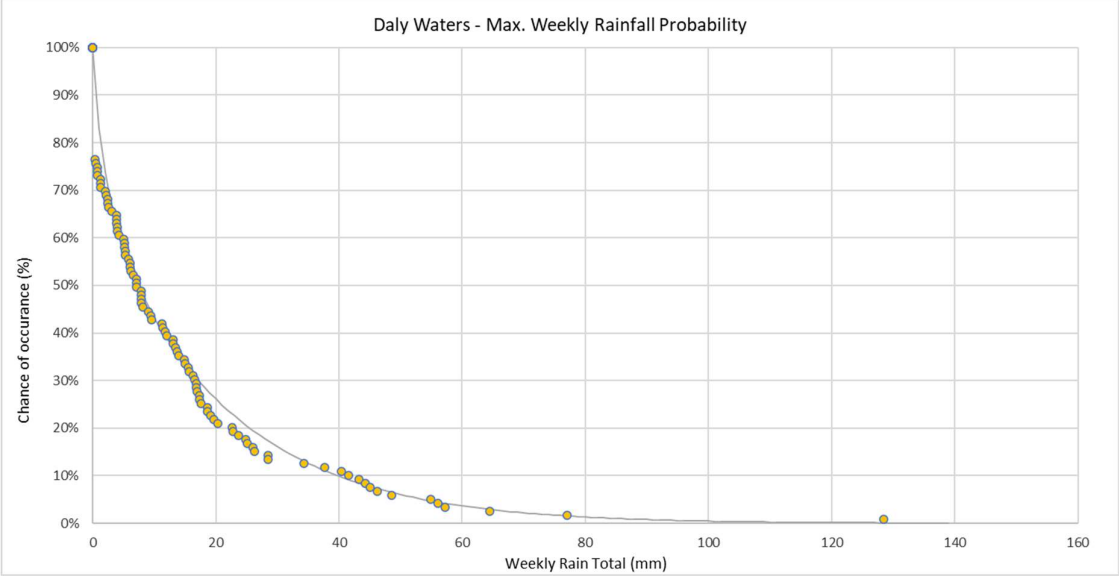

Figure 8: Daly Waters - total weekly rainfall probability estimate

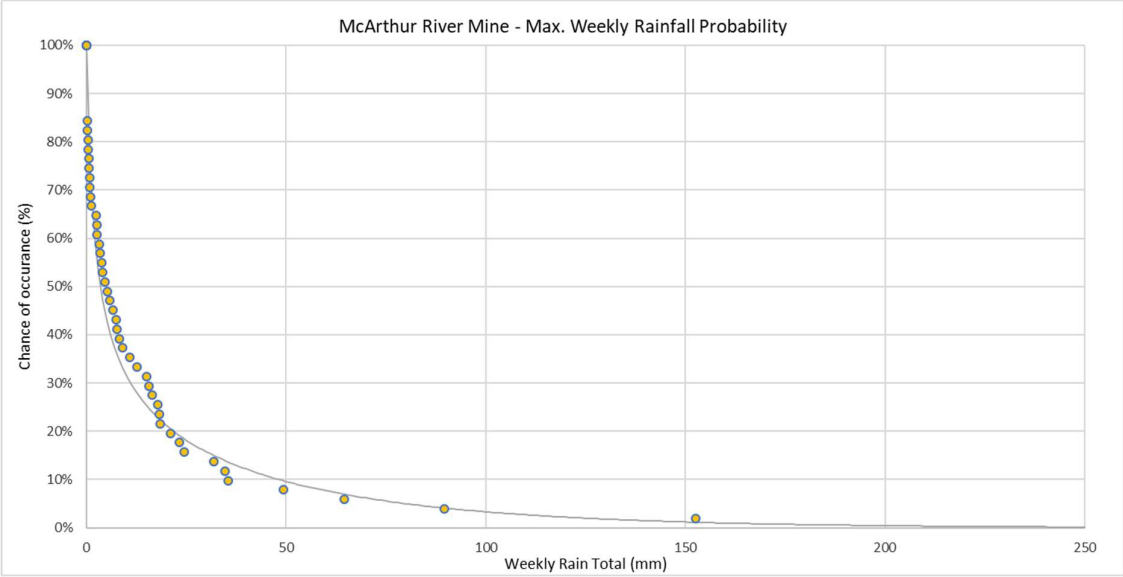

Figure 9: McArthur River Mine - total weekly rainfall probability estimate

Using the trendlines, it is possible to estimate the maximum weekly rain total associated with a probability of 0.1% (1 in 1000); for Daly Waters this indicates a value of 130mm, and for McArthur River Mine this value is 273mm.

To be conservative, Imperial will use the McArthur River Mine value. Should a 1 in 1000-year dry season rainfall event occur (i.e., 273mm of rainfall) the remaining freeboard (assuming that existing fluid levels before the rainfall event were at the 0.5m freeboard level) would be 0.23m, which would be sufficient remaining freeboard to avoid overtopping.

1.3 Geology

Organically rich source rocks with the potential to generate and host both oil and gas, are present in several intervals within thick Meso and Palaeo-Proterozoic age formations of the McArthur Basin such as the Velkerri and Barney Creek Formations.

The Velkerri Formation and the Barney Creek Formation are the major organic-rich source rocks and the primary unconventional targets for hydrocarbon generation. These formations have been proven to be gas-bearing in exploration wells drilled during 2012 and 2013 by Armour Energy, Santos/Tamboran in 2014 in the Tanumbirini 1 well in EP161 which is immediately adjacent to Imperial's EP187 Tenement, and by Origin Energy in the Amungee NW-1 well within the Beetaloo Sub-Basin.

The Velkerri Formation is overlain by other formations of the Roper Group (Maiwok Sub-group), including the Moroak Sandstone, Kyalla Formation, Bukalorkmi Sandstone and Chambers River Formation. These comprise a thick sequence of fine-grained siltstones and mudstones interbedded with sandstones, which provide excellent isolation between the target zones in the underlying Velkerri Formation and the overlying aquifer. (Top Springs Formation). A chronostratigraphic column indicating the sequence of these formations is shown in Figure 10 (Ahmed et al., 2001).

Recognised conventional reservoirs are developed at various levels within carbonates of the McArthur Group. Shales potentially seal them in Barney Creek and Lynott Formations or by thick evaporites at the base of the Balbirini Dolomite.

The uppermost unit, the Roper Group varies between 1,500 and 4,000m in thickness. The Roper Group thickens to the north-west from EP187 as it develops across the Beetaloo Sub-Basin of the McArthur Basin. It consists of alternating quartz arenites, siltstones and shales. The Roper Group unconformably overlies the McArthur and the Nathan Groups. An illustrative section through the Beetaloo Sub-Basin is presented in Figure 11 (DPIR, 2018).

The sedimentary sequences within the Roper Group have significant lateral extent, with more uniform facies when compared to the underlying successions of the Nathan, McArthur and Tawallah Groups. The estimated age of the Roper Group is at least 1,430 Ma. An un-named sequence of sandstones and shales of probable Neo-Proterozoic age overlies the Roper Group. These formations have a maximum thickness of over 600 m. The Tawallah Group is the lowermost of the four major sequences present in the McArthur Basin and is up to 4,500 m thick and represents the economic or practical basement. However, it also contains shales with hydrocarbon generating potential in the Wollogorang and McDermott Formations.

The Bukalara Sandstone is unconformably overlain by the Cambrian age Top Springs Limestone (also known as the Gum Ridge Formation, and informally as the Cambrian Limestone Aquifer). This unit is recognised as a regional aquifer and is considered to be the deepest aquifer present at the Project area.

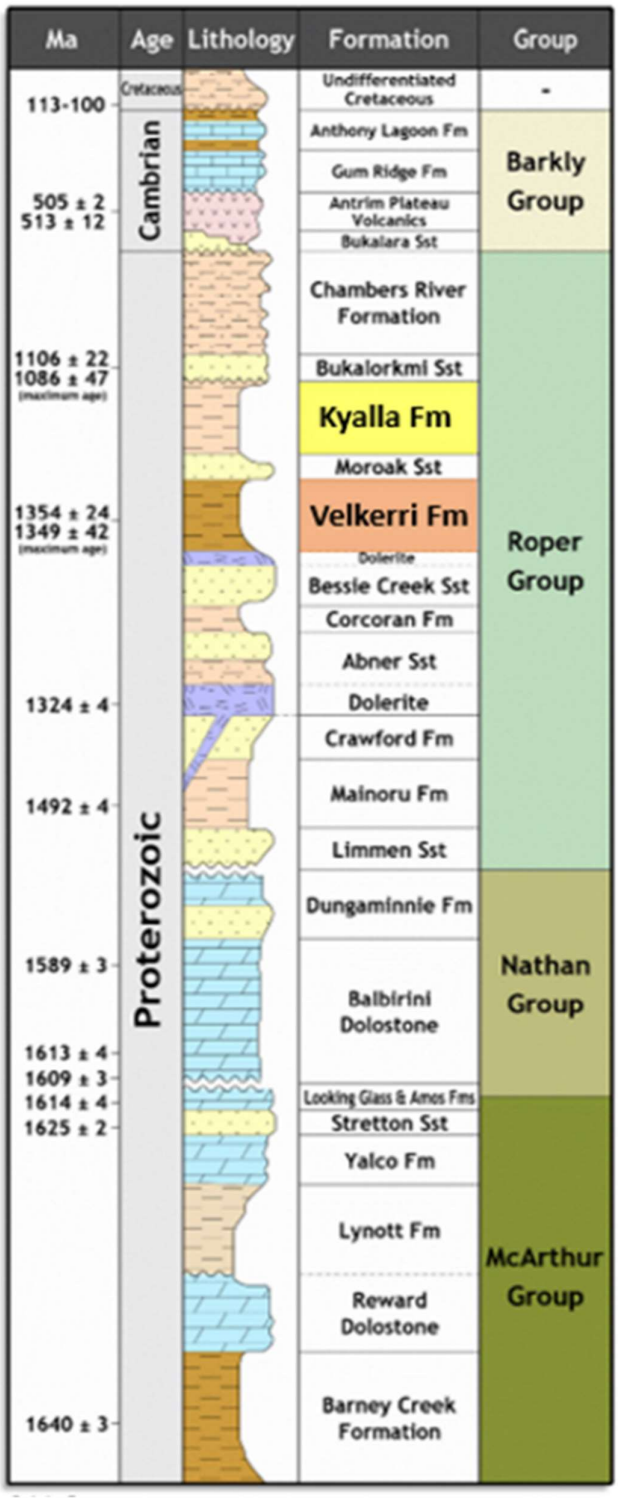

Figure 10: Chronostratigraphic framework of formations within the McArthur Basin

Based on Ahmed et al. (in prep). Ages from Lindsay (2001) and Ahmed et al. Oil & Gas potential from Powell et al. (1987) and Pegum (1979)

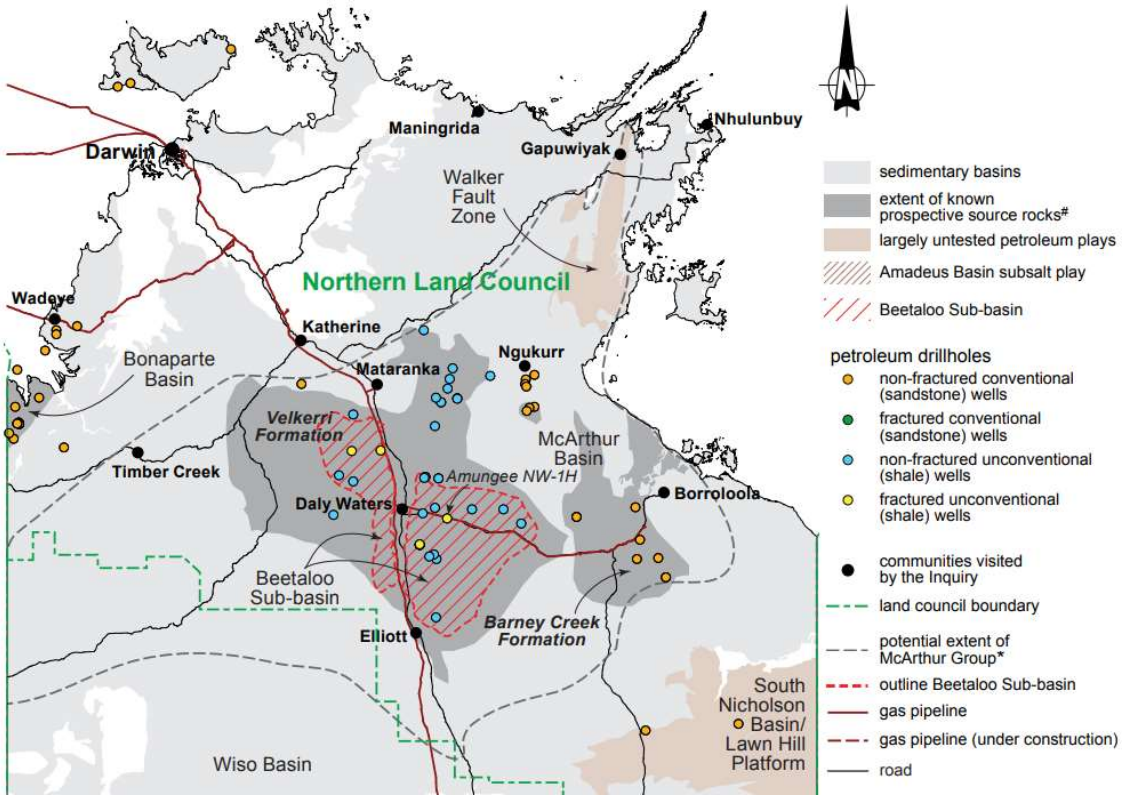

Figure 11: Geological Setting of the Beetaloo Sub-basin / McArthur Basin

1.4 Topography

The region comprises predominantly gently sloping terrain with scattered low hills and breakaways. The northern edge of the bioregion includes Proterozoic age quartz sandstones, shale and chert of the lower McArthur and Tawallah Group. (Figure 11)

Carpentaria 1 well is located on the Sturt Plateau, which is described as an ancient, uplifted erosion surface of some 250m elevation. It is a flat to gently undulating plain that is deeply weathered, covered by thick laterite and associated soils and supports predominantly savannah vegetation (Day et al., 1985).

The map of the topography of EP187 is presented in Figure 12.

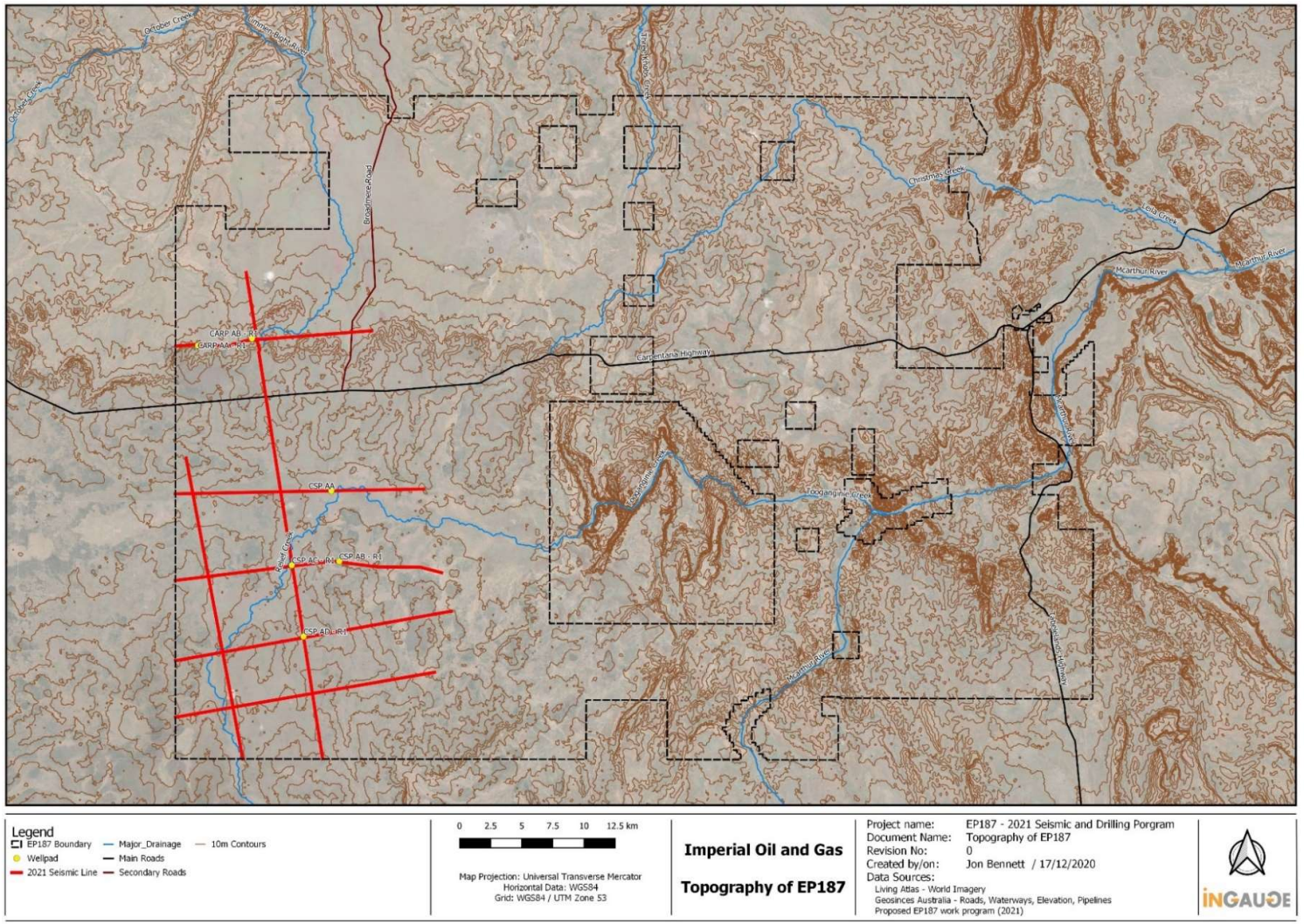

Figure 12: Topography of EP187

1.5 Soils

The proposed activities are located in an area generally described as plains and rises associated with deeply weathered profiles (laterite) including sand sheets and other depositional products; sandy and earth soils (NAFI, 2020). See Figure 13.

Kandosols and rudosols dominate the project area with no occurrence of acid sulphate soils. (Appendix 3). Kandosols are massive and gravelly soils (formed red, yellow and brown earths) that are widespread across the Sturt Plateau bioregion. Rudosols are very shallow soils or those with minimal soil development and include very sallow rocky and gravely across rugged terrain.

1.6 Land Systems

Land system is based on the ecosystem concept, in which several local land features sequences are repetitive are integrated, e.g. climate, geological material, landform, soil and native vegetation. Land system information for the project area is shown in Figure 14.

Table 4 presents the description of the land systems of the proposed area (Aldrick J. M et al., 1992).

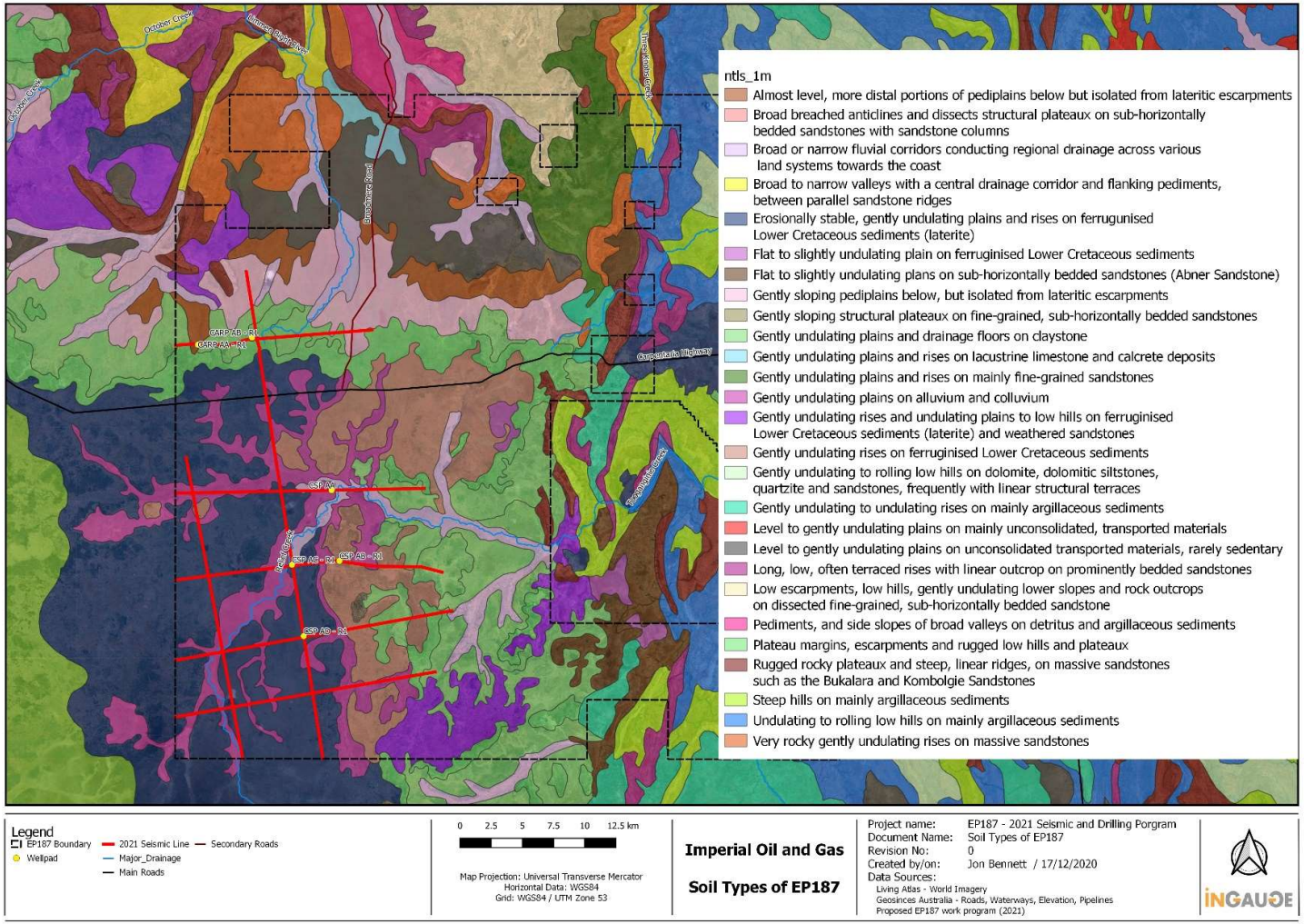

Figure 13: Soil Type

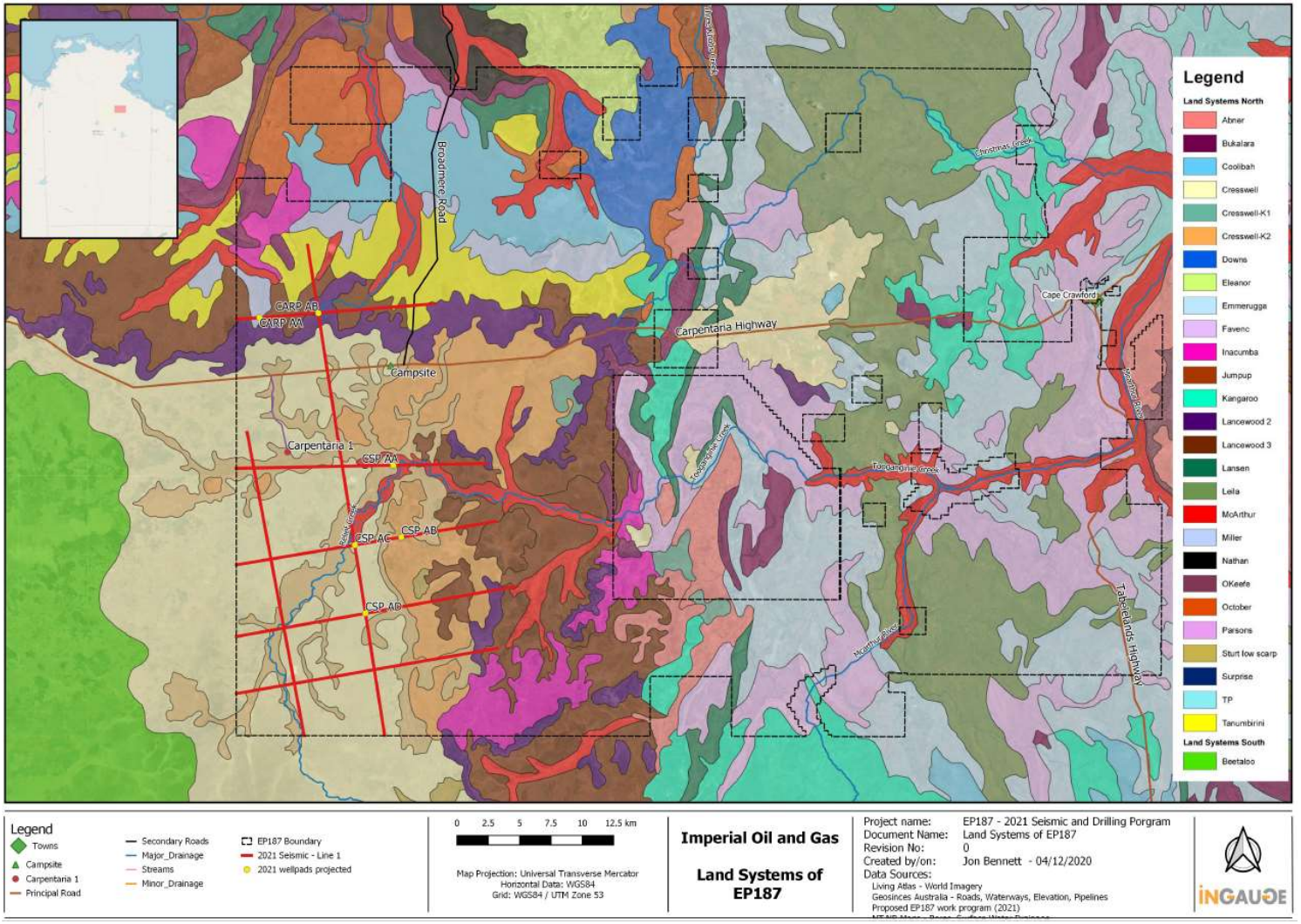

Figure 14: Land system map

Table 4: Description of Land Systems

Land System	Landscape class	Class Description	Landform	Soil description	Vegetation Description	% approx. of area
Cresswell	Lateritic plains and rises	Plains and rises associated with deeply weathered profiles (laterite) including sand sheets and other depositional products; sandy and earth soils	Erosionally stable, gently undulating plains and rises on ferrugunised Lower Cretaceous sediments (laterite)	Ferruginous lithosols, lateritic podsolics, red and yellow earths, earthy sands and brown clays	Mid-high open woodland of C. dichromophloia, C. bleeseri, E. tetrodonta, Erythrophleum chlorostachys with isolated stands of A. shirleyi on crests over Chrysopogon fallax, Plectrachne pungens, Sorghum plumosum	80
TP	Lateritic plains and rises	Plains and rises associated with deeply weathered profiles (laterite) including sand sheets and other depositional products; sandy and earth soils	Gently undulating plains on alluvium and colluvium	Shallow to moderately deep gravelly yellow earths	Woodland of E. tectifica over Chrysopogon fallax and Dicanthium fecundum and low open woodland of E. pruinose over Dicanthium fecundum and Sehima nervosa	15
Cresswell-K2	Lateritic plains and rises	Plains and rises associated with deeply weathered profiles (laterite) including sand sheets and other depositional products; sandy and earth soils	Gently undulating rises on ferruginised Lower Cretaceous sediments	Lithosols and shallow siliceous sands	Open forest of Acacia shirleyi and woodland of C. dichromophloia, E. luecophloia over Chrysopogon fallax, Plectrachne pungens	4
McArthur	Alluvial floodplains	Alluvial floodplains, swamps, drainage depressions and alluvial fans; sandy, silty and clay soils on Qaternary alluvium	Broad or narrow fluvial corridos conducting regional drainage across various land systems towards the coast	Aq Vertosols, Red and Yello Kandosols and Orthic Tenosols	Mid-high open woodland of C. terminalis, E. microtheca, Excoecaria parvifolia, Lysiphyllum cunninghami, C. papuana over Chrysopogon spp, Eulalia fulva, Iseilema vaginiflorum	1

1.7 Groundwater

The Table 5 below summarises the regional hydrostratigraphy of the Beetaloo Basin (Fulton S, & Knapton A., 2015).

Table 5: Summary of Beetaloo Basin Hydrostratigraphy

PROVINCE	PERIOD / AGE	FORMATION		AQUIFER STATUS	THICKNESS (m)	YIELD (l/s)	AVE. EC (µs/cm)
CARPENTARIA BASIN	CRETACEOUS 145 – 66 Ma	Undifferentiated		*Local Aquifer*	0 - 130	0.3 - 4	1800
GEORGINA BASIN	CAMBRIAN 497-630 Ma	Cambrian Limestone Aquifer (CLA)	Anthony Lagoon Beds	REGIONAL AQUIFER	0 – 200	1 - 10	1600
			Gum Ridge Formation	REGIONAL AQUIFER	0 – 300	0.3 - >20	1400
		Antrim Plateau Volcanics		REGIONAL AQUITARD *Local Aquifer*	0 – 440	0.3 - 5	900
		Bukalara Sandstone		*Local Aquifer*	0 – 75	0.3 - 5	1000
BEETALOO BASIN (ROPER GROUP)	NOT KNOWN	Hayfield Mudstone		REGIONAL AQUITARD *Local Aquifer*	0 – 450	-	32000
		Jamison Sandstone		*Local Aquifer*	0 – 150	-	138000
	MESO-PROTEROZOIC 1430-1500 Ma	Kyalla Formation		REGIONAL AQUITARD	0 – 800	-	-
		Moroak Sandstone		*Local Aquifer*	0 – 500	0.5 - 5	131000
		Velkerri Formation		REGIONAL AQUITARD	700 – 900	-	-
		Bessie Ck Sandstone		*Local Aquifer*	450	0.5 - 5	-

EP187 is not within a water allocation plan area. It lies immediately to the east of the Daly Roper Beetaloo Water Control District, straddling the northeast boundary of the Georgina Basin. It partially overlies the aquifer known as the Gum Ridge Formation, part of the extensive regional Cambrian Limestone Aquifer which includes the Tindall Limestone Aquifer to the north in the Daly Basin.

Any guidelines published by the Northern Territory Government relating to groundwater monitoring parameters, methodologies, frequencies, reporting and data submission for petroleum operations will be followed, including the Preliminary Guideline: Groundwater Monitoring Bores for Exploration Petroleum Wells in the Beetaloo Sub-basin and the requirements for a water extraction license.

1.7.1 Regional Groundwater within the Cambrian Limestone Aquifer (CLA)

The Beetaloo Basin straddles the basement divide that separates regional groundwater flow systems in the Georgina and Wiso Basins. Groundwater flow in the Georgina Basin emanates approximately 300km southeast of the Beetaloo Basin where a significant flow divide occurs in the CLA. Groundwater southeast of this divide flow toward discharge points in the Lawn Hill Creek and the Gregory River in Queensland. Groundwater north-west of the divide flows through the Beetaloo Basin and discharges in the Roper River region which supports aquatic, riparian and floodplain ecosystem function. Recharge to the CLA forms a local flow component where the aquifer outcrops along the flanks of the Ashburton Ranges. Nonetheless, groundwater recharge mechanisms to the CLA are poorly characterised but are likely to be dominated by infiltration through sinkholes and preferential recharge through soil cavities.

The regional flow direction within the Beetaloo Basin is to the north-west. Gradients in the CLA are flat-lying averaging around 10m per 100km (gradient of 0.0001) and flow rates are in the order of metres/year (Tickell, 2003). Along the northern edge of the basin, groundwater flow in the CLA is

channelled between outcropping Proterozoic rocks to the east and a zone of lower permeability Antrim Plateau Colcanis to the west. Groundwater flow emerges from the CLA in the Roper River 100km north-west of the Beetaloo Basin. It provides a significant flow component of spring discharge in the Roper River between Matarkanka and Elsey National Park. High sulphate concentrations in the Bukalara Sandstone aquifer immediately north of the Beetaloo Basin suggests there is a component of flow north into local Proterozoic aquifers.

Relatively minor groundwater extraction occurs in the McArthur River basin for small community supplies. A review of the available historical bore data has indicated the water drawn from bores for this region is from aquifers shallower than 100m deep.

An initial baseline assessment was conducted in 2019 (Refer to Appendix 01.1 for full detail of groundwater survey). Groundwater samples were collected from five (5) existing bores; HWY-1 (RN027848), 4B-1 (RN007696), 5B-1 (RN007699), HB-1 (RN039575), and, RCB-1 (RN027945) Bores were selected based on their location within the extent of the proposed exploration activities. Samples were analysed for a range of characterisation parameters relevant for exploration purposes.

Control and impact monitoring bores were drilled into the Gum Ridge aquifer on Carpentaria 1 during the 2020 drilling program, being RN04168 and RN041800 respectively.

Monitoring samples have been undertaken from the nearby water supply bores, (RN027848 and RN039574), and the Gum Ridge Monitoring bores, to demonstrate a baseline of water quality data for the area and to comply with recommendations from the Scientific Inquiry into Hydraulic Fracturing in the Northern Territory, March 2018 (NT Government, 2018).

The Stratigraphy in the project area, as confirmed in the 2020 drilling program is shown in the EMP.

Naturally occurring elevated heavy metal concentrations (zinc) above trigger levels were reported in House Bore (HB-1), No.5 Bore (5B-1), and No.4 Bore (4B-1). These concentrations are consistent with the natural ore bodies in the area and is expected. Total Petroleum Hydrocarbons (TPH), Total Recoverable Hydrocarbons (TRH) fractions of benzene, toluene, ethylbenzene and xylenes (BTEX) were less than the laboratory level of reporting (LoR) from all samples collected. Physical parameters (pH, conductivity and TDS), major cations and total hardness were consistent with historical results.

The project groundwater monitoring bores are shown in Figure 15.

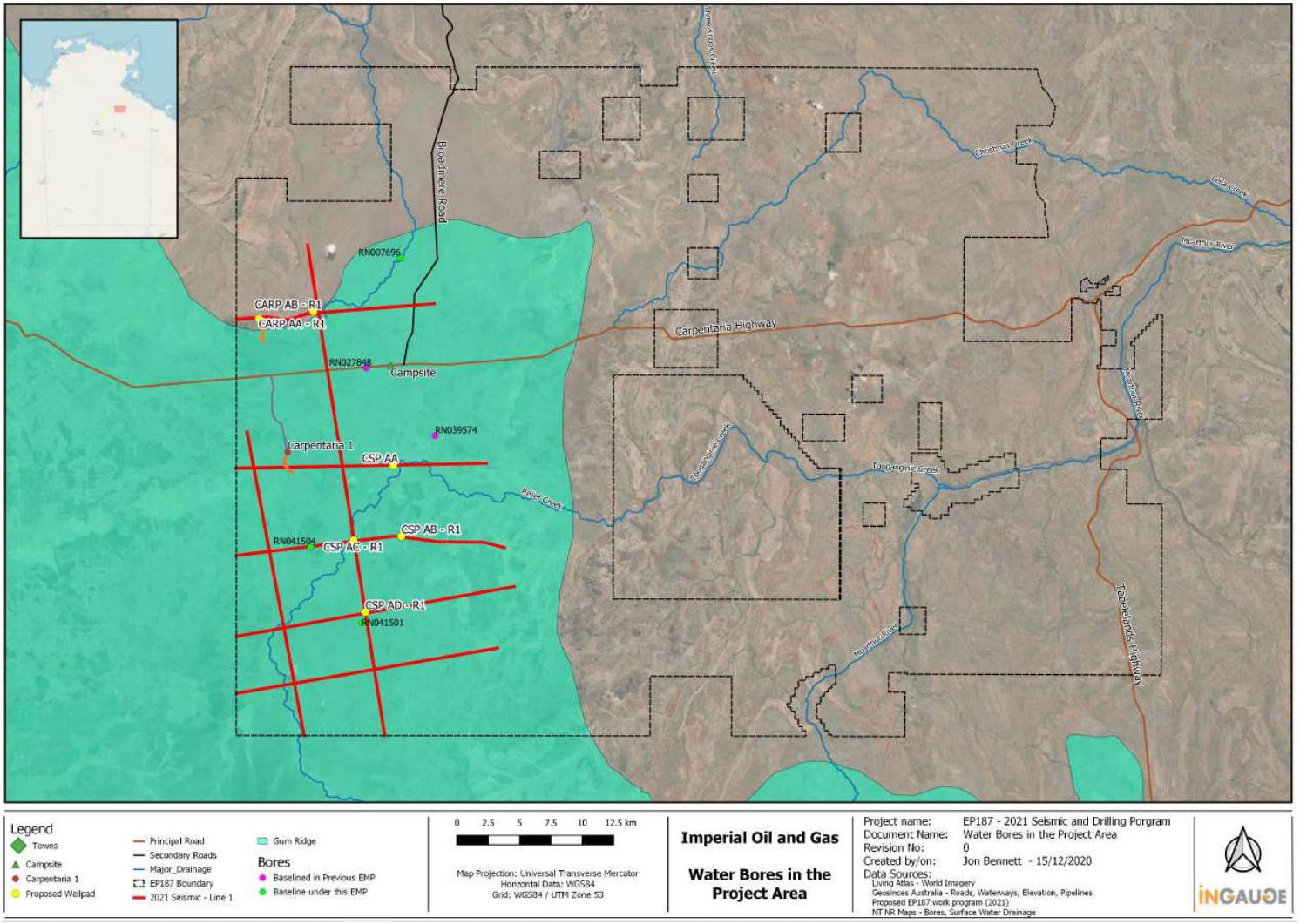

Figure 15: Location of proposed monitoring bores.

1.8 Surface Water

The Project area is part of the Gulf Fall and Uplands region and part of the catchment of the McArthur River and its tributaries. The McArthur River generally flows in a northerly direction from the upland of the Barkly Tableland to the Southern Gulf in the region of the Sir Edward Pellew Islands. The geology of this region does influence the drainage system and the extensive cap of the Bukalara Sandstone outcrop in the south of the area, provides an extensive network of ephemeral creeks and streams that follow significant faults and joints within the rock formation.

The McArthur River is the prominent surface water feature in the region. This watercourse drains the whole area into the Gulf of Carpentaria. The Glyde is the main tributary to the McArthur River and lies to the east of the Project area. The Glyde is not affected by any proposed exploration operations within EP187.

The EP187 tenement includes the floodplains associated with the Upper McArthur River catchment, the Leila Creek Catchment, Tooganginie Creek, Christmas Tree Creek and the upper reaches of the Balbirini Creek (Figure 16). Only limited freshwater flood plain habitat is associated with the Upper McArthur River. As reported in the Biodiversity Assessment - Gulf Coastal report (2009), no wetlands of significance occur in this bioregion.

Since there is little or no rain over the dry season, the waters which flow in permanent streams are in connection with the local water table. In some parts of the upper reaches of the McArthur River, Balbirini Creek and Toongannie Creek permanent surface water pools persist throughout the year as waterholes, springs and minor swamps. The other broad group of surface waters are ephemeral. This group is also made up of streams, waterholes, lagoons and swamps but they receive insufficient groundwater recharge to sustain them for the whole year. The region also includes minor floodplains associated with the upper reaches of the McArthur River.

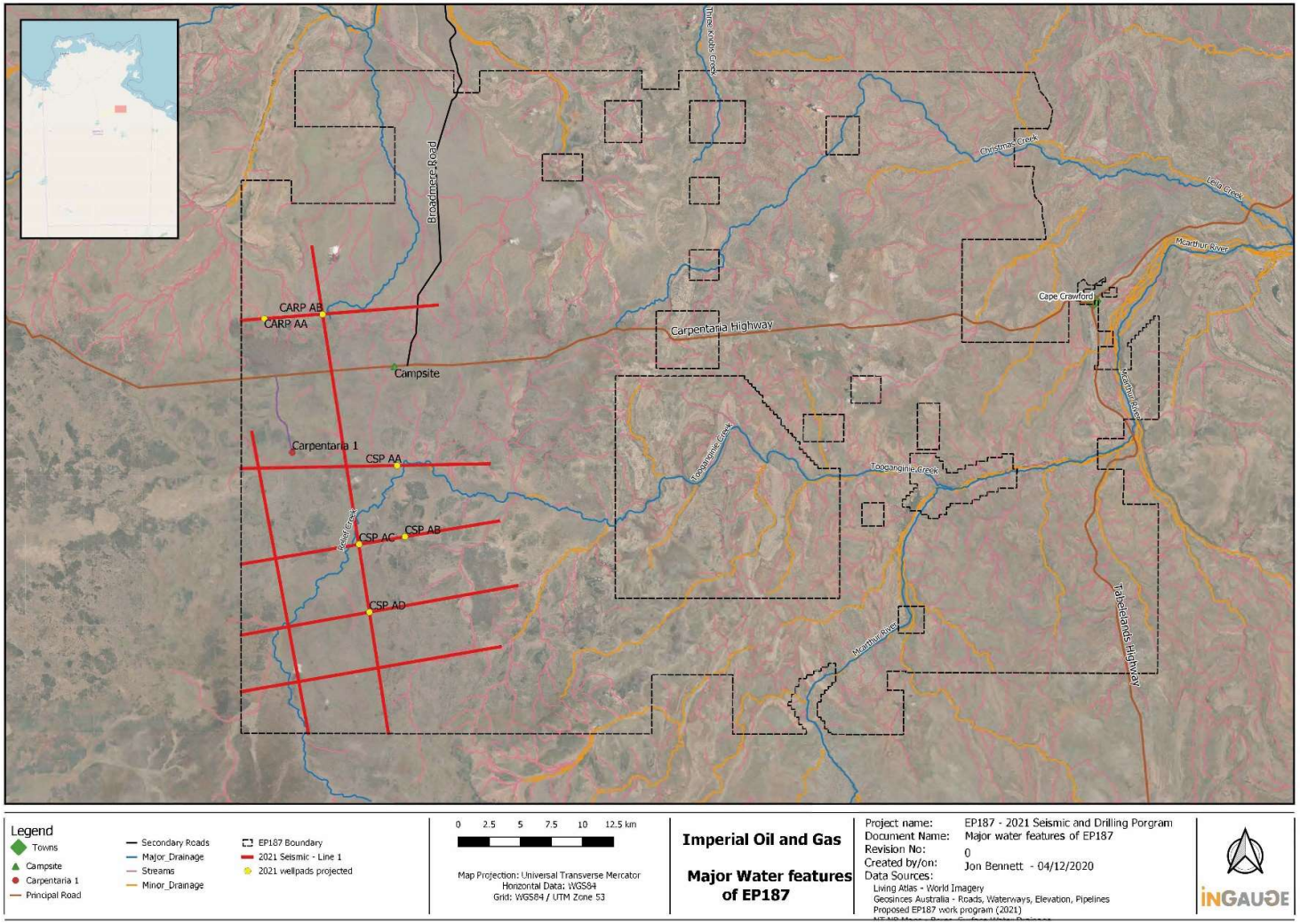

Figure 16. Major water features of EP187

1.9 Air Quality

Imperial has studied the available CSIRO report (Ong C., Myers M., Mainson M., Maney B., & day S. 2018) on baseline methane values across the Beetaloo Sub-basin in consideration of compliance with the requirements of the NT Scientific Inquiry into Hydraulic Fracturing (the " Inquiry'). Imperial consider The Beetaloo Basin methane baseline monitoring program conducted by the CSIRO in 2018 applicable across the operational area of EP187. Data collected of this monitoring are available online (CSIRO, 2019).

A Methane Emissions Monitoring Plan is available in Appendix 10. Imperial is committed to undertake a 6-monthly leak detection at the well pad as per Part D (5) of the Code.

1.10 Bioregions

Bioregions provide a consistent and robust framework for biodiversity assessment and planning. The classification is based on typical climate, geology, landform, native vegetation and species information. As shown in Figure 17, the project area is located over the Sturt Plateau bioregion.

The Sturt Plateau bioregion mostly comprises a gently undulating plain on lateritised Cretaceous sandstones. Soils are predominantly neutral sandy red and yellow earths. The most extensive vegetation is eucalypt woodland (dominated by variable – barked bloodwood Eucalyptus dichromophloia) with spinifex understory. Still, there are also large areas of lancewood (Acacia shirleyi) thickets, bullwaddy (Macropteranthes keckwickii) woodlands, Acacia shrublands on deep sands, and open eucalypt forest (dominated by a range of species including Darwin stringybark Eucalyptus tretodonta) over tussock grass understory. The Sturt Plateau bioregion includes the most extensive areas of the distinctive lancewood-bullwaddy vegetation associations, with associated fauna including spectacled hare-wallaby.

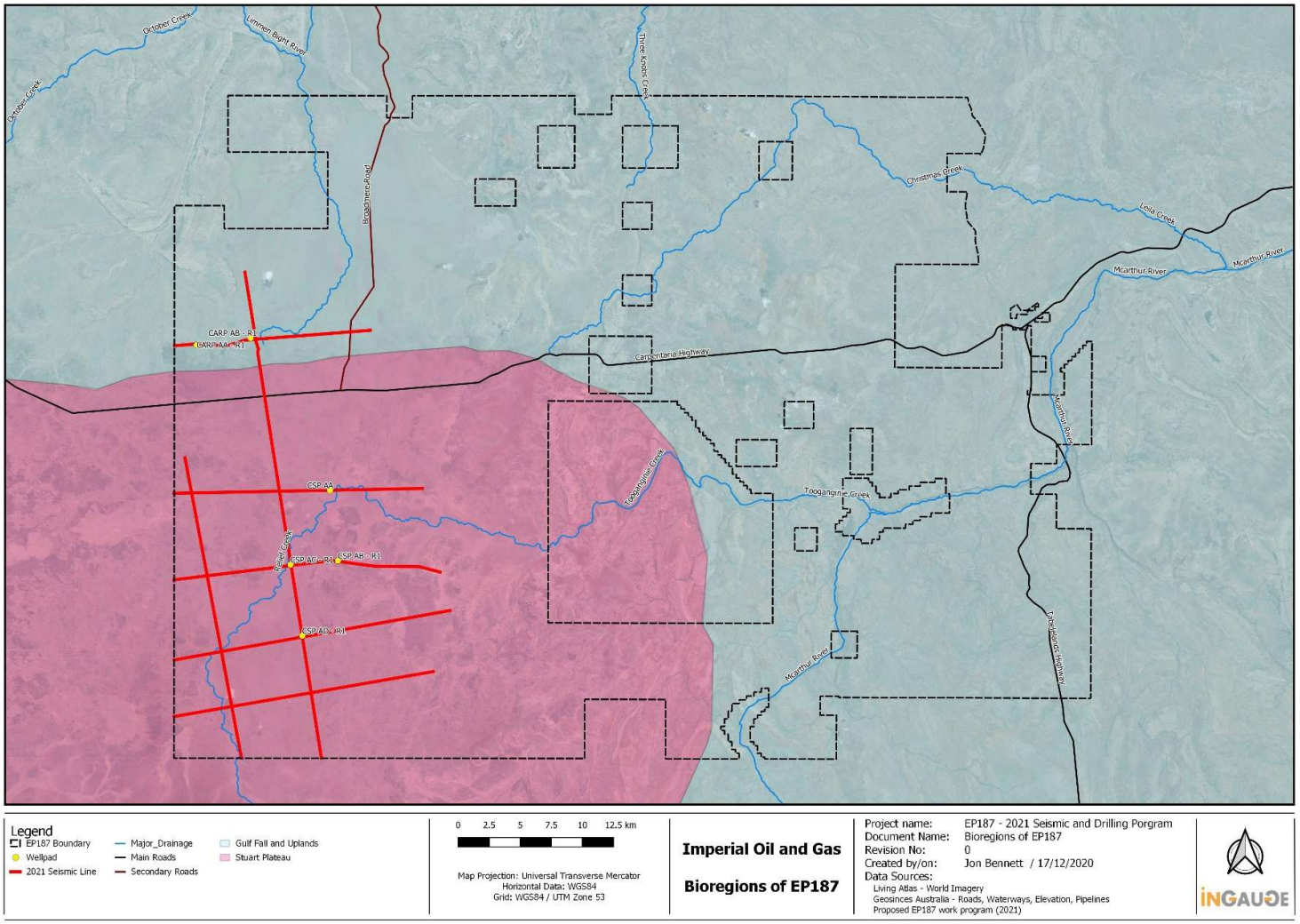

Figure 17: Bioregions of EP187

1.11 Vegetation

The National Vegetation Information System (NVIS) provides information on the extent and distribution of vegetation types in Australian landscapes. Figure 18 presents the vegetation communities over the project area. At a 20km radius of the proposed area, Eucalyptus low open woodland/Acacia mild sparse shrubland/Astrebla low tussock grassland dominates the area (approx. 50%), followed by Acacia low woodland/Erlachne low open tussock grassland (approx. 35%), Corymbia low woodland/Terminalla mid sparse shrubland/Chrysopongon low tussock grassland (approx. 10%) and Acacia mid open forest/Acacia tail open shrubland/Chrysopogon low open tussock grassland (approx. 5%).

The woodland communities vary according to topography. The most common community which occurs on the undulating plains is a Darwin Stringybark (E. tetrodonta) / Darwin woolly butt (E. miniata) open forest with a sparse to open shrub layer and a dense ground layer dominated by sorghum species. Other woodland species may include ironwood (Erythrophleum chlorostachys), cypress pine (Callitris intratropica), northern box (E. tectifica) and round-leaved bloodwood (Corymbia latifolia). Mid storey species include fan palm (Livistona humilis) and zamia palm (Cycas armstrongii).

On the rugged sandstone plateaus and rocky outcrops, there is low open woodland of variable-barked bloodwood (Corymbia dichromophloia) and Darwin woolly butt, with a variable mid-layer and ground layer dominated by curly spinifex (Plectrachne pungens). Stringybark and rusty bloodwood (Corymbia ferruginea) may also occur.

In the poorly drained soils and riverine areas communities of paperbark (Melaleuca viridiflora), screw palm (Pandanus spirilis) and river pandanus (Pandanus aquaticus) occur.

The majority of this region is covered by open forest and light density woodland dominated by Darwin Stringybark (E. tetrodonta). To the east in proximity to the Abner Range, there are also patches of monsoon forest scattered throughout the woodlands, mainly where there are permanent springs.

Significant vegetation on site is only associated with the riparian areas. See Figure 18 for a visual representation of the spread of significant vegetation types through the region. Riparian vegetation is primarily cantered around the Relief Creek and is the closest major watercourse to the project area.

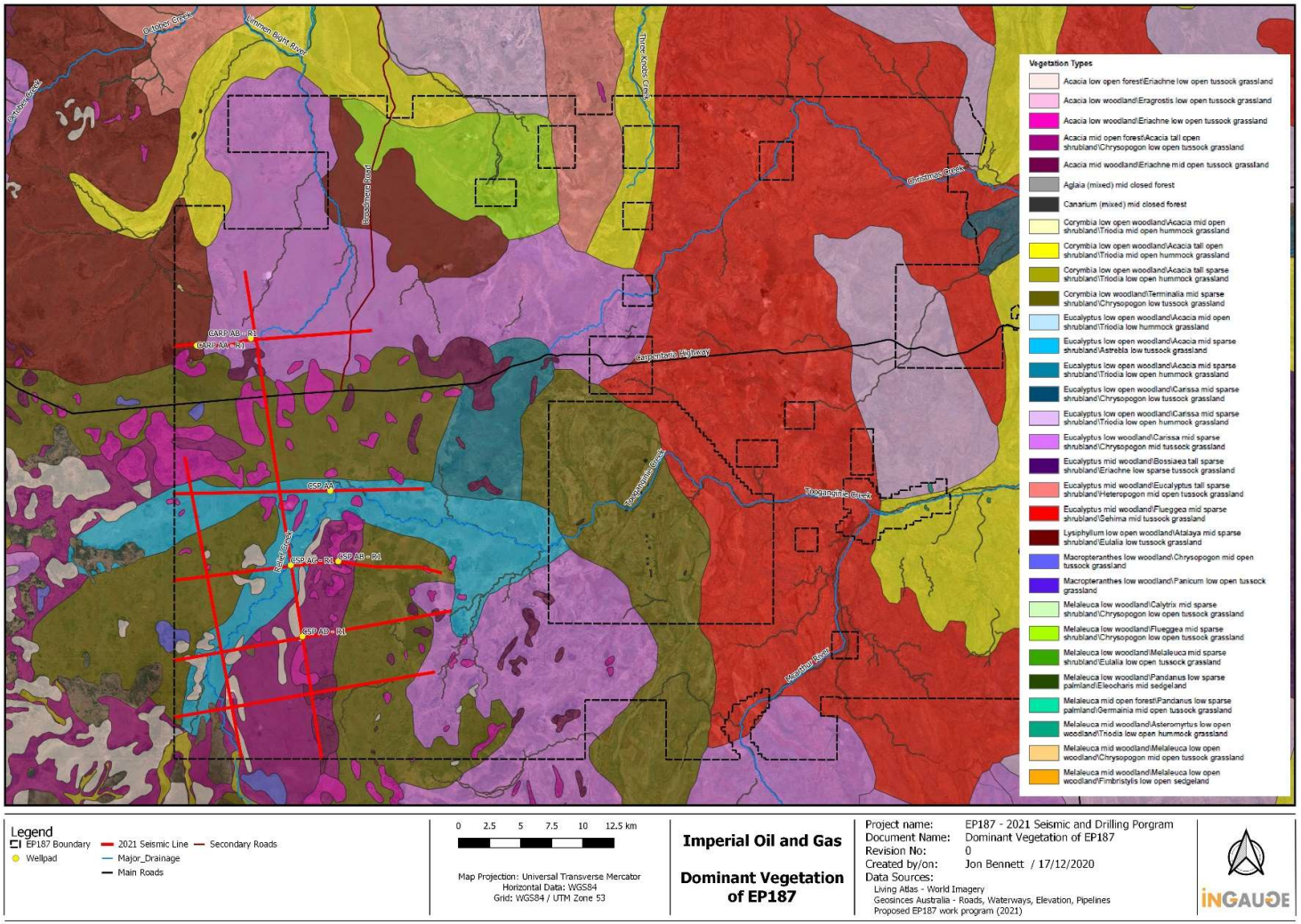

Figure 18: Dominant Vegetation types of EP187

1.12 Listed Threatened Species

A search of the NT Flora and Fauna Atlas (NR Maps, 2020) completed on 16 December 2020 recorded one threatened species (*Erythrura gouldiae* (Gouldian Finch)) within 20km radius from the project area. The Protected Matters Search Tool (PMST), on the other hand, identified eleven (11) threatened species that may occur within the area. One (1) classified as Critically Endangered, (*Calidris ferruginea* (Curlew Sandpiper)) that is not expected to occur within the area due to the absence of suitable habitat (e.g. Wetland). The second threatened fauna species (*Erythrura gouldiae* (Gouldian Finch)) was not identified through NT or Commonwealth database searches, but rather is included due to anecdotal evidence. Australian Painted Snipe which mainly occurs on freshwater swamps, claypans or inundate grassland.

Table 6: Threatened Fauna and Flora

Species Name	Common Name	EPBC Act Status	TPWC Act Status	Likelihood of occurrence	Records and Habitat
Birds					
Calidris ferruginea	Curlew Sandpiper	CE	V	Low	In the Northern Territory (NT), Curlew Sandpipers have been recorded from most coastal areas, and these are important non breeding and stop-over areas (NT Gov, 2020); therefore, it is unlikely to occur within the Project Area.
Erythrotriorchis radiatus	Red Goshawk	V	V	Low	No previous records and no suitable habitat
Erythrura gouldiae	Gouldian finch[1]	E	V	Medium	The species has been recorded in the region (desktop searches), and suitable habitat is present along Relief Creek (around 10km southeast of Carpentaria 1).
Falco hypoleucos	Grey Falcon	V	V	Low	The majority of the records are from the southern half of the NT, and typically on inland drainage systems. (Ward S. , 2012). This species may occasionally occur within the study area.
Falcunculus frontatus whitei	Crested Shrike-tit (northern)	V	-	Low	Species has not been recorded in the project area (no records from desktop searches).
Grantiella picta	Painted Honeyealer	V	V	Low	There are few records of this species in the NT, most coming from the Barkly Tablelands. There is no evidence of a breeding population in the Territory. The records are thought to be of irregular visitors from the southeast.
Rostratula australis	Australian Painted Snipe	E	V	Low	Occur in shallow, vegetated, freshwater swamps, claypans or inundate grassland (including temporary wetlands). Records from tropical northern Australia are mostly from Queensland. It is very unlikely to occur within the Project Area

Species Name	Common Name	EPBC Act Status	TPWC Act Status	Likelihood of occurrence	Records and Habitat
Tyto novaehollandiae kimberli	Masked Owl (northern)	V	V	Low	Species has not been recorded in the region (no records from desktop searches) and marginal potentially suitable habitat occurs. No large hollows are in the proposed area. Risk of impact is considered low.
Mammals					
Macroderma gigas	Ghost Bat	V	-	Low	Current known distribution does not encompass the Project area and no suitable habitat in the Project area.
Macrotis lagotis	Greater Bilby	V	V	Low	Current known distribution does not encompass the Project area.
Reptiles					
Elseya lavarackorum	Gulf Snapping Turtle	E	-	Low	The turtle is restricted to rivers. In the NT, this includes the Calvert to the Nicholson River System (NT Gov, 2020).

Table 6 above, lists the threatened fauna and flora species present within a 20km radius of the proposed activities. Appendix 01.03 includes an assessment on the level of impact/risk to threatened species.

EPBC Act (species listed under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act), Aust.): CE = Critically Endangered, E = Endangered, V = Vulnerable, M = Migratory, Ma = Marine. TPWC Act (species listed under the Territory Parks and Wildlife Conservation Act 2000 (TPWC Act), NT): CE = Critically Endangered, E = Endangered, V = Vulnerable, NT=Near Threatened, DD = Data Deficient. 1 – anecdotal.

1.13 Listed Migratory Species

Table 7 list the migratory fauna species that may occur within the project area (20km radius of the proposed project site).

Table 7: Migratory species likely to occur within the proposed area

Species Name	Common Name	EPBC Act Status	TPWC Act Status	Likelihood of occurrence	Records and Habitat
Migratory Marine Birds					
Apus pacificus	Fork-tailed swift	Ma, M	-	Medium	In Australia, they mostly occur over inland plains but sometimes above foothills or in coastal areas. They often occur over cliffs and beaches and also over islands and sometimes well out to sea. They also occur over settled areas, including towns, urban areas and cities. They mostly occur over dry or open habitats, including riparian woodland and tea-tree swamps, low scrub, heathland or saltmarsh (Atlas, 2020)
Migratory Terrestrial Species					
Cecropis daurica	Red-rumped swallow	Ma, M	-	Low	Predominately forages over wetlands and open well-watered grasslands (EPBC, 2015)
Cuculus optatus	Oriental cuckoo	Ma	-	Low	Monsoonal rainforest, vine thickets, wet sclerophyll forest or open Casuarina, Acacia or Eucalyptus woodlands. Frequently at edges or ecotones between habitat types. Riparian forest is favoured habitat in the Kimberley region. (EPBC, 2015)
Hirundo rustica	Barn swallow	M, Ma	-	Low	Occurs in the air above open vegetated areas including native and agricultural grasslands as well as over open water areas (EPBC, 2015)
Motacilla cinerea	Grey wagtail	M, Ma	-	Low	Has a strong association with water, particularly rocky substrates along water courses but also lakes and marshes. (EPBC, 2015)
Motacilla flava	Yellow wagtail	M, Ma	-	Low	Mostly well-watered open grasslands and the fringes of wetlands. Roosts in mangroves and other dense vegetation. (EPBC, 2015)
Migratory Wetlands Species					
Actitis hypoleucos	Common Sandpiper	Ma, M	-	Low	The species utilises a wide range of coastal wetlands and some inland wetlands, with varying levels of salinity, and is mostly found around muddy margins or rocky shores and rarely on mudflats. The Common Sandpiper avoids areas with congregations of more gregarious waders. (DAWE, 2020)
Calidris acuminata	Sharp-tailed Sandpiper	M	-	Low	In Australasia, the Sharp-tailed Sandpiper prefers muddy edges of shallow fresh or brackish wetlands, with inundated or emergent sedges, grass, saltmarsh or other

Species Name	Common Name	EPBC Act Status	TPWC Act Status	Likelihood of occurrence	Records and Habitat
					low vegetation. They also occur in saltworks and sewage farms. They use flooded paddocks, sedgelands and other ephemeral wetlands, but leave when they dry. (DAWE a., 2020)
Calidris ferruginea	Curlew Sandpiper	CE, M	V	Low	In the Northern Territory (NT), Curlew Sandpipers have been recorded from most coastal areas and these are important nonbreeding and stop-over areas. Chatto (2003) considered the Fog Bay and Chambers Bay areas and the Port McArthur area as the main areas for the species in the NT. (Ward S. a., 2012)
Calidris melanotos	Pectoral Sandpiper	M	-	Low	The species is usually found in coastal or near coastal habitat but occasionally found further inland. It prefers wetlands that have open fringing mudflats and low, emergent or fringing vegetation, such as grass or samphire. In the Northern Territory (NT), the Pectoral Sandpiper is found at Darwin and Alice Springs. (DAWE b., 2020)
Charadrius veredus	Oriental Plover, Oriental Dotterel	M, Ma	-	Medium	they usually inhabit flat, open, semi-arid or arid grasslands, where the grass is short and sparse, and interspersed with hard, bare ground, such as claypans, dry paddocks, playing fields, lawns and cattle camps, or open areas that have been recently burnt. At the onset of the Wet Season, some may move into lightly wooded grasslands. Some remain in estuarine and littoral environments, and a few are occasionally recorded around terrestrial wetlands or flooded paddocks. (DAWE c., 2020)
Glareola maldivarum	Oriental Pratincole	M	-	Low	In non-breeding grounds in Australia, the Oriental Pratincole usually inhabits open plains, floodplains or short grassland (including farmland or airstrips), often with extensive bare areas. They often occur near terrestrial wetlands, such as billabongs, lakes or creeks, and artificial wetlands such as reservoirs, saltworks and sewage farms, especially around the margins. (DAWE d., 2020)
Pandion haliaetus	Osprey	M	-	Very Low	They are mostly found in coastal areas but occasionally travel inland along major rivers, particularly in northern Australia. They require extensive areas of open fresh, brackish or saline water for foraging. They frequent a variety of wetland habitats including inshore waters, reefs, bays, coastal cliffs, beaches, estuaries, mangrove swamps, broad rivers, reservoirs and large lakes and waterholes. (DAWE e., 2020)

EPBC Act (species listed under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act), Aust.): M = Migratory, Ma = Marine.

TPWC Act (species listed under the Territory Parks and Wildlife Conservation Act 2019 (TPWC Act), NT): NT=Near Threatened

1.14 Pest Species and Weeds

The NT classification for declared weeds are grouped into the following classes:

- class A - eradicate
- class B - control
- class C - prevent entry.

All class A and class B weeds are also class C weeds.

The EPBC PMST Report (2020) identified eleven invasive species, including plants and animals, potentially occurring within 20km of the Project Area. The NT Natural Resource Map identified three (3) weed species and 1 introduced animal (*Equus caballus* (Horse)). Weed species identified are presented in Table 8.

Table 8: Pest Species within 20km radius of the Project area

Scientific Name	Common Name	NT Class (NT Gov, 2020)	WoNS (WoNS, 2020)	Plant Type
Cenchrus ciliaris	Buffelgrass, Black Buffelgrass	Not declared	No	Grass
Mesosphaerum suaveolens	Hyptis, Mint Weed	B	No	Herb
Parkinsonia aculeata	Parkinsonia, Jerusalem Thorn, Jelly Bean Tree, Horse Bean	B	Yes	Tree
Vachellia nilotica	Prickly Acacia, Blackthorn, Prickly Mimosa, Black Piquant, Babul	A	Yes	Tree

Identified pests to be present in the bioregion with a significant impact on the natural environment are as follows: cane toads, buffalos, domestic cattle, domestic dogs, horses, cats, feral pigs. Pigs and buffalos may be considered a resource by local Aboriginal people.

The Table 9 below provides the list of weeds observed in and around the Project area (Appendix 6) during the pre and post 2018/19 weed survey conducted in conjunction with a Senior Weeds Officer of the Department Environment Natural Resources (DENR). Further weed surveying will be conducted after 20/21 wet season and before clearing is undertaken. Findings will be included as an addendum to Appendix 09 (Weed Management Plan).

Table 9: Weeds recorded in the EP187 surveyed area

Common Name	Scientific Name	NT Class	WoNS	Plant Type
Hyptis	*Hyptis suaveolens*	B	-	Herb
Parkinsonia	*Parkinsonia aculeata*	B	Yes	Tree
Caltrop	*Tribulus sp.*	B		Herb

Further information around Imperials management of weeds can be found in the WMP under appendix 9.

1.15 Protected Areas

There are no Parks, World Heritage Properties, National Heritage Places, Wetlands of International Importance or conservation areas or Sites of Conservation significance within the Project Area (Figure 19 and Figure 20). The only area identified as a site of significance adjacent to the proposed project area is located in a different catchment which is The Limmen National Park, situated approximately 50km North-East of the project area. The National Park covers an area of approximately 12,300 square kilometres. The Limmen Bight Marine Park and the adjoining Federal Limmen Marine Park are located within the Gulf of Carpentaria and are adjacent to the Limmen National Park.

Imperial doesn't foresee any impact to the park neither to visitors that may be travelling through to and passing along the exploration permit. All traffic, transport and possible community and people impact will be managed following Appendix 03 (Environmental Risk Assessment).

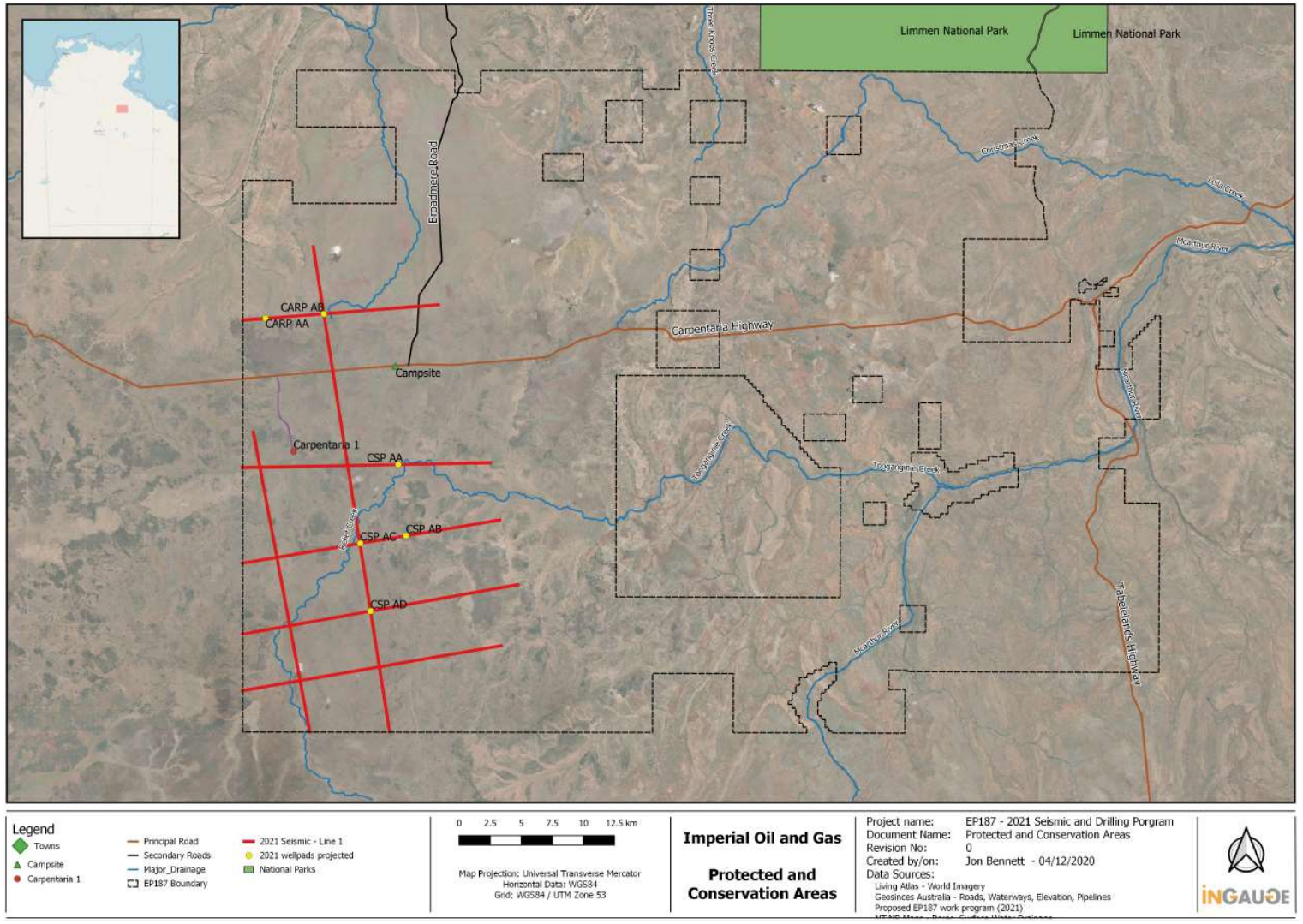

Figure 19: Protected and Conservation areas in relation to the proposed well location

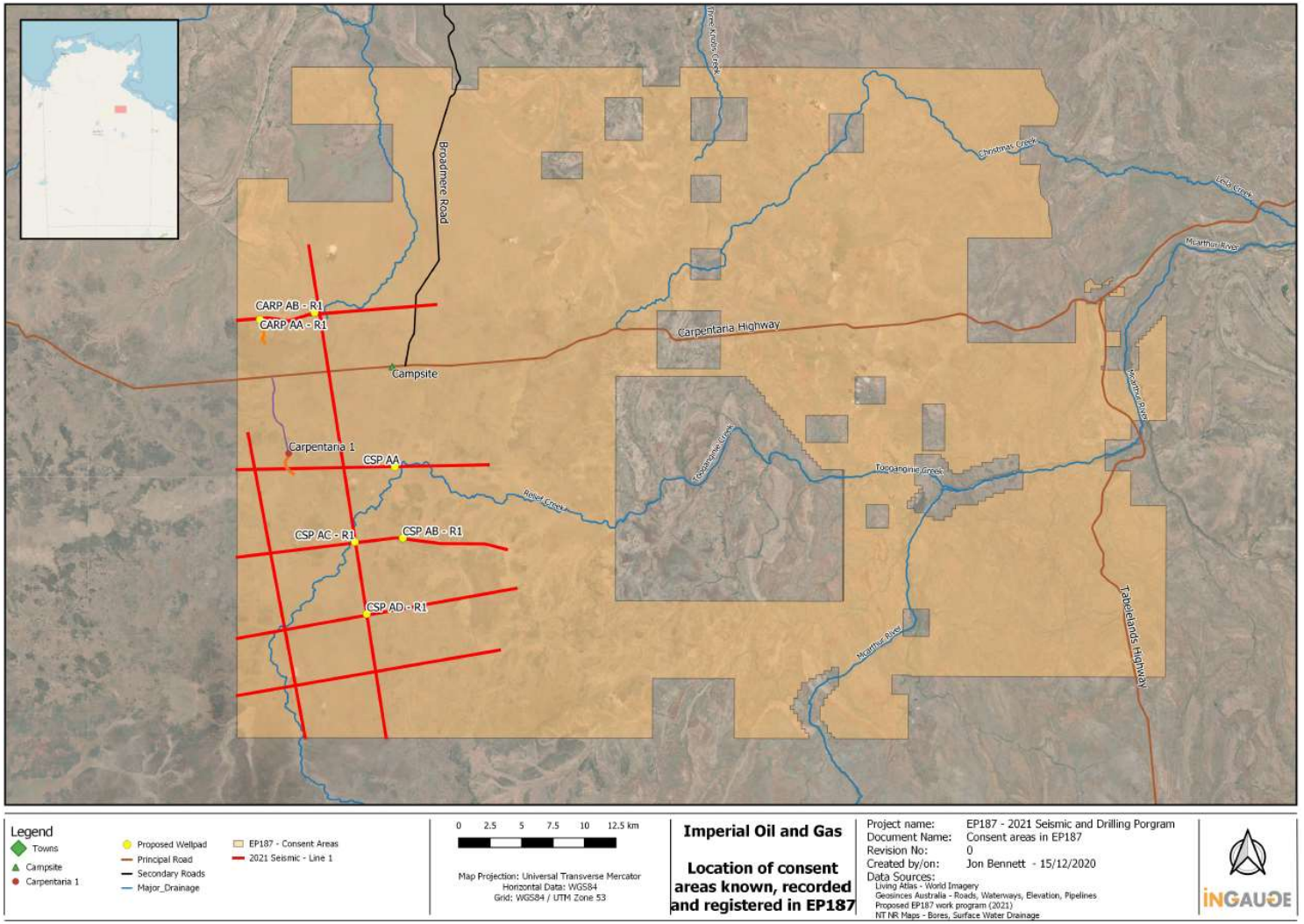

Figure 20: Known and recorded consent areas EP187

1.16 Groundwater Dependent Ecosystems (GDEs)

GDEs are complex dynamic natural ecosystems that require access to groundwater to meet all or some of their water requirements on a permanent or intermittent basis, to maintain their communities of plants and animals, ecosystem processes and ecosystem 'services' (Richardson et al., 2011). These diverse ecosystems are primarily driven by temporal groundwater flow variability contingent on climate, geology and land-use (Alfaro and Wallace, 1994, Bertrand et al., 2012, Kløve et al., 2014) (Elsevier, 2017).

A search of the National Groundwater Dependent Ecosystems (GDEs) Atlas (BoM, 2020) conducted in November 2020 did not identify any terrestrial or aquatic GDEs within the Project area. However, there is a moderate potential of terrestrial GDE occurring along the Relief Creek located at 9.5km southeast from site. The riparian vegetation communities present along the watercourse, particularly those dominated by Eucalyptus camaldulensis may rely on rainfall stored in alluvial sediments and therefore may be groundwater dependent; and a high potential of GDE occurring at 20km southwest from site related to Melaleuca citrolens, M. viridiflora low woodland ecosystem.

Other materials such as previous groundwater test conducted in the nearby water bores results did not identify terrestrial or aquatic GDEs within the Project area.

Imperial Oil & Gas believes that the likelihood of GDEs in the area is very low and is confident that the project activities are unlikely to have any impact on these communities.

1.17 Fire

The Project area within EP187 is generally an open grassland savannah lightly timbered. The area is regularly burnt using aerial firebombing and traditional owner cultural fire management practices.

More recently the area has been increasingly utilised for cattle grazing, and therefore many new fence lines and fire breaks have been constructed through the exploration area. As a part of grazing management practices towards the end of the dry season, the area is regularly burnt to reduce fuel load and to promote new pasture growth through the following wet season. The practice of regular burns reduces the risk of significant hot fires and allows for a cooler less intense burn; however, the risk of bush fires and wildfires remains in some areas.

Mapping obtained from the North Australia Fire Information website (NAFI, 2020) indicates that Project area was last burnt in 2017, covering an area of 785.10km2.

Imperials Bushfire Management Plan was developed as part of the Exploration Program and is provided in Appendix 08.

1.18 Historical and Natural Heritage

A search of the NT Heritage Register (DTC, 2020) for EP187 was conducted and no recorded NT heritage items or places to be present in the Project area. Also, a search of the EPBC PMST database (EPBC, 2020) showed no World Heritage Properties or National Heritage Places registered within 5 km of the Project area.

An anthropological survey was conducted in May 2015 by NLC across the tenement area to ensure no sites of significance would be impacted by the project. The anthropological survey report from this survey was submitted to the DITT and DEWPS as part of the Drilling EMP.

An archaeological survey was conducted in December 2020 by Ellengowan Enterprises, who is an approved NT archaeological consultant. The archeological report from this survey is attached to this EMP as appendix 01.01.

Traditional Owner Representatives will be present at all land clearing activities for the project. The disturbance footprint for these activities is not within the vicinity of any known Aboriginal cultural or heritage sites. Therefore, Imperial consider that the risk of contamination or damage to these sites is considered to be extremely low to negligible.

1.18.1 Northern Land Council

Imperial will acquire the necessary NLC approvals for this project.

1.18.2 AAPA

An application for an Authority Certificate for the planned activities and the work area will be submitted to the AAPA. The certificate will be forwarded to the relevant government departments when Imperial receives certificate approval.

The AAPA Authority Certificate aims to prevent damage to, and interference with sacred sites, by identifying and setting out the conditions for entering and working on the land. Proponents are required to obtain an AAPA certificate to ensure areas of significance for sacred sites are identified and protected from proposed activities.

1.19 Socioeconomic Environment

EP187 is on Aboriginal freehold land and held by the Mambaliya Rrumburriya Wuyaliya Aboriginal Land Trust. The deed of agreement for access to the land is held with the Northern Land Council.

Borroloola is the nearest township community to the Project area and is the main service centre for the McArthur River and Robinson River Southern gulf region.

The land within the tenement mainly supports Indigenous use with pastoral grazing rights awarded across the tenement area divided into several blocks to pastoralists under Section 19 agreements. Other than mining at McArthur River and pastoral activities, there are no significant industries within the region. There is some limited tourism at the site of Paradise Pools done by helicopter tours.

The McArthur River Mine is located approximately 100km east of EP187; nonetheless, the local area remains generally undeveloped in terms of infrastructure and roads. Major infrastructure within EP187 includes the Carpentaria Highway and the Daly Waters to McArthur River gas pipeline which runs approximately parallel with one another east-west through the middle of the tenement. Imperial Oil and Gas has a permit in place with the pipeline owner to construct the access tracks required for the project.

1.20 Petroleum Reserved Block

EP187 does not lie within a Reserved block, or contain any Proposed Reserved Block as identified in NT Governments "Petroleum Reserved Block Policy, July 2019" (Northern Territory Government, 2019)

1.21 Settlements

EP187 is sparsely populated with several S19 leaseholders having permanent camps scattered throughout; none are within a 10km radius of the Project area. The closest settlement is Heartbreak Hotel, which is 60km to the east of the Project area along the Carpentaria Highway.

The nearest Aboriginal community is the township of Borroloola and the associated outstations at Campbell Springs, Devil Springs and Cow Lagoon. Each of these residential locations lies approximately 100km to the northeast of EP187. The Aboriginal community of Minyerri (Hodgson Downs) lies approximately 180 km to the north-west of EP187.

Figure 21 shows the stations and communities in the vicinity of the EP187.

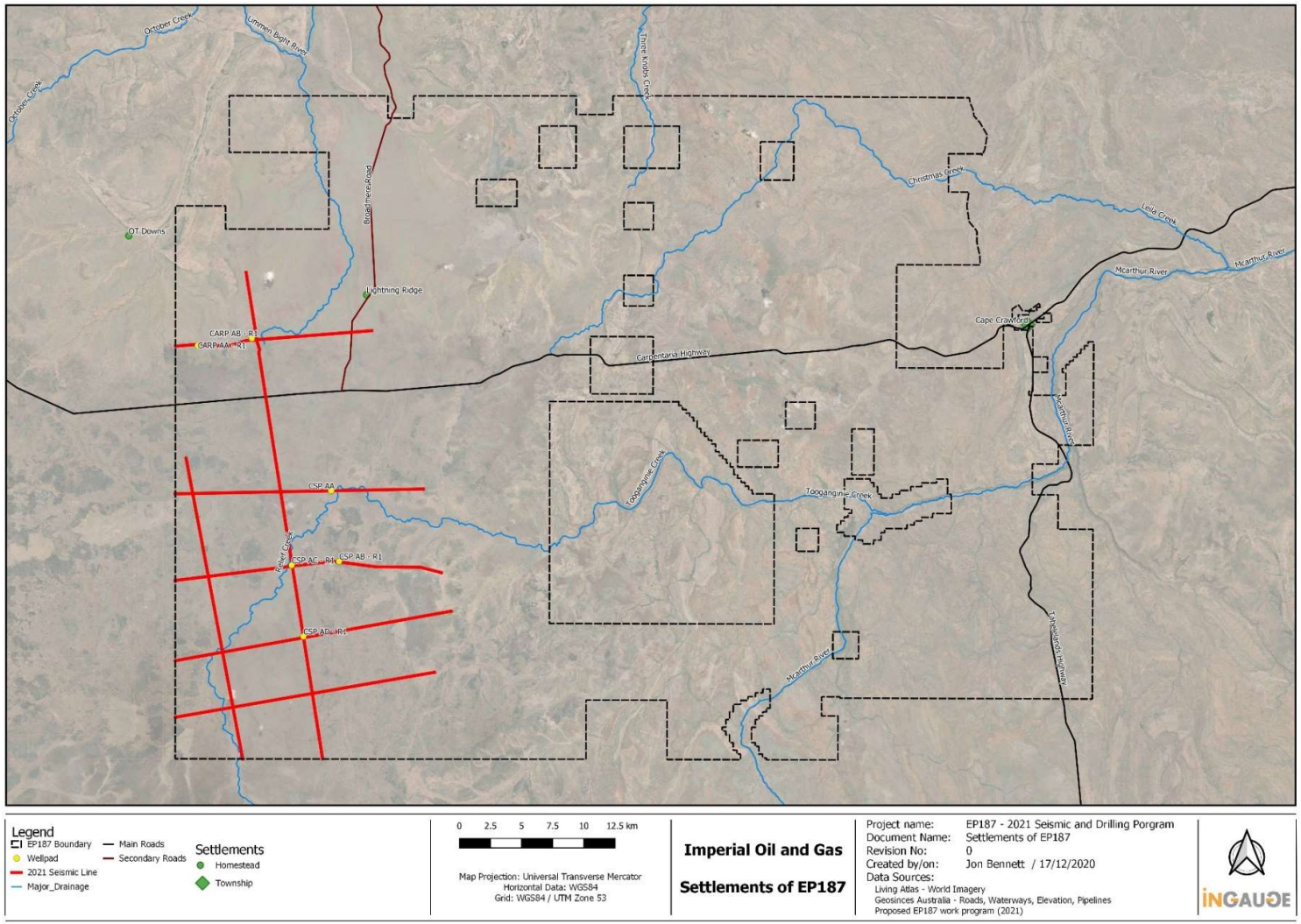

Figure 21: Stations and Communities in and around EP187

1.22 Environmental Values as defined under the Environmental Assessment Act

The Environment Protection Act 2019 and Environment Protection Regulations 2020 require that any operator conducting an activity that has a potential environmental impact to assess all the matters fully, and evaluates the effectiveness of the proposed safeguards to mitigate these impacts. It also recommends actions to ensure the development and operational phases of the project are managed in an environmentally sound manner.

A combination of desktop assessment and field surveys were conducted to describe the existing environmental values of the area. The assessment determines the likelihood of occurrence for threatened fauna and flora species identified. Appendix 01.03 in conjunction with

Table 10 shows the environmental values and likelihood of occurrence, potential effect on the environmental factors due to activities, as well as applicable codes of practice to ensure risk and/or impacts are reduced to ALARP.

Table 10: Environmental Values and/or Sensitivities that may be affected by the project

Area	Environmental Factors	Applicable Code of Practice	Environmental Values and Sensitivities	Summary	Potential significant effect on an environmental factor
Land	Terrestrial Flora and Fauna	Part A. Surface Activities A.3.1 Site Selection A.3.2 Well Pad site selection requirements A.3.5 Biodiversity protection A.3.6 Weed Management A.3.7 Fire Management A.3.9 Rehabilitation	Sensitive or significant vegetation	(Fox & Co, 2019) recorded riparian vegetation in the study area, present as predominantly sparse woodland.	Activity is unlikely to result in significant impacts on high valued vegetation communities or threatened flora and fauna or areas of essential habitat.
			Groundwater dependent ecosystems	There is low potential for terrestrial GDEs and aquatic GDEs in the Project Area (BoM, 2020)	
			Threatened fauna species and their habitat	The EPBC PMST identified 11 threatened species that have the potential to occur in the Project Area. Of these, the Gouldian Finch have a high potential to occur but a low risk to be impacted and Yellow-Spotted Monitor has a moderate likelihood of occurrence.	
			Listed migratory species	The EPBC listed 12 migratory species that were potentially occurring in the Project Area. They are all scored a low potential to occur.	
			Listed threatened flora species and ecological communities	There are no Threatened Ecological Communities (TECs) or threatened flora listed under the EPBC Act and/or TPWC Act known to occur within the 20km of the Project Area.	
	Terrestrial Environmental Quality	Part A. Surface Activities A.3.1 Site Selection A.3.2 Well Pad site selection requirements A.3.4 Erosion and sediment control and hydrology A.3.9 Rehabilitation	Soils	The Project Area lies within a region of soils that are considered to be in their second cycle of erosion which has produced infertile soils with a near-neutral reaction. These 'soils' are akin to alluvial soils in that they show no profile development.	Assessment indicates activity unlikely to result in significant impacts from increased erosion and sediment releases.

Area	Environmental Factors	Applicable Code of Practice	Environmental Values and Sensitivities	Summary	Potential significant effect on an environmental factor
		Part C – Well site water management C.4.2 Management of produced water and flowback fluid			
Water	Inland water environmental quality	Part A. Surface Activities A.3.1 Site Selection A.3.2 Well Pad site selection requirements A.3.8 Containment of contaminants Part B. Well Operations B.4.1 Well integrity management B.4.2 Aquifer protection B.4.3 Well design and barriers B.4.9 Well control B.4.10 Drilling fluids B.4.12 Hydraulic stimulation and flowback operations B.4.16 Site material and fluids management B.4.17 Groundwater monitoring B.5 BTEX Limits Part C. Well site water management C.4.2 Management of produced water and flowback fluid C.5 Monitoring mandatory requirements C.7 Mandatory requirements for management plants for wastewater and spills.	Surface water	The McArthur River is the primary water drain of the exploration area. This watercourse drains the whole area into the Gulf of Carpentaria. The Glyde is the main tributary to the McArthur River and lies to the east of the Project area.	Assessment indicates activity unlikely to result in significant impacts on surface water and groundwater.
			Groundwater	The Chambers River Formation and Cambrian Limestone are regional-scale aquifers that provide groundwater resources for pastoral enterprises, domestic bores at homesteads and town water supplies several communities across the region; and supports aquatic, riparian and floodplain ecosystems.	

Area	Environmental Factors	Applicable Code of Practice	Environmental Values and Sensitivities	Summary	Potential significant effect on an environmental factor
	Hydrological processes	Part A. Surface Activities A.3.1 Site Selection A.3.2 Well Pad site selection requirements A.3.4 Erosion and sediment control and hydrology A.3.8 Containment of contaminants Part B. Well Operations B.4.1 Well Integrity management B4.2 Aquifer protection B.4.3 Well design and barriers B.4.17 Groundwater monitoring Part C. Well site water management C.4.2 Management of produced water and flowback fluid C.5 Monitoring mandatory requirements C.7 Mandatory requirements for management plants for wastewater and spills.	Supply and quantity of water	The Project area is part of the Gulf Fall and Uplands region and part of the catchment of the McArthur River and its tributaries. The McArthur River and its major tributary the Glyde River drain a significant portion of the Barkly Tablelands and the low-lying country of the Southern McArthur Basin. The geology of this region does influence the drainage system and provides an extensive network of ephemeral creeks and streams.	Assessment indicates activity unlikely to result in significant impacts to groundwater and surface water.
Air	Air Quality and Greenhouse Gases	A.3.1 Site Selection Part D. Methane emissions monitoring, leak management, detection and reporting D.4 Regional methane monitoring D.5 Emissions detection and management D.5.9 Venting and flaring D.5.9.4 Other fugitive emissions D.6 Reporting	Air quality conducive to suitability for the life, health and wellbeing of humans and ecosystems	The Beetaloo Basin methane baseline monitoring program conducted by the CSIRO in 2018 is applicable across the operational area of EP187. No significant impact or risks anticipated	Assessment indicates activity unlikely to result in significant impacts to air quality of greenhouse gas generation.

Area	Environmental Factors	Applicable Code of Practice	Environmental Values and Sensitivities	Summary	Potential significant effect on an environmental factor
People and Communities	Social, economic and cultural surroundings	Part A – Surface Activities A.3.1 Site selection and planning A.3.2 Well pad site selection requirements A.3.3 Noise	Cultural heritage, sacred sites.	An application for an Authority Certificate will be submitted to the AAPA for the activities covered under this EMP and will be provided once approved. An extensive anthropological survey of the land area was also undertaken in May 2015 by the Anthropology Division of the Northern Land Council (NLC) in conjunction with the Traditional Owners of the land before grant of the tenement. The anthropological survey report from this survey was submitted to the DITT and DEWPS as part of the Drilling EMP.	Low-intensity activity not anticipated to have significant impacts to the local community or tourism
	Human Health	Part A. Surface Activities A.3.1 Site selection and planning A.3.3 Noise Part D. Methane emissions monitoring, leak management, detection and reporting. D.4 Regional methane monitoring D.5 Emissions detection and management D.6. Reporting.	People and communities	There are several pastoral properties with livestock and infrastructure in the vicinity of the tenement. The nearest property is OT Downs Homestead located approximately 20km North-West of the proposed area.	Low-intensity activity with limited receptors

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Appendix 01.01 - Archaeological Report

IMPERIAL ENERGY SEISMIC LINE AND DRILL PAD ARCHAEOLOGICAL SURVEY – FAVENC RANGE, NORTHERN TERRITORY

A report for Imperial Oil and Gas Pty Ltd (Imperial Energy)

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Principal
Ellengowan Enterprises – archaeological consultant
ABN: 47 208 214 348

August 2019

Cover photo: RTF(QZ) bifacially retouched point and VH-RQJ at LZ10.

EXECUTIVE SUMMARY

Imperial Oil and Gas (Imperial Energy) are proposing to construct six seismic lines totalling 231.8km on the eastern edge of the Favenc Range, halfway between Daly Waters and Borroloola in the Northern Territory. An aerial survey was the most efficient method to cover a large area in the short time available. Two drill pads and four alternative drive pad sites are also planned including access tracks to those sites. These works required an archaeological assessment to mitigate their impact on cultural material.

Four low-density background scatters and one significant archaeological site were found. All of the sites occur in the vicinity of Balbirini Creek, an important water way in the north of the survey area. The proposed works will have little to no impact on three of the sites. The high-density artefact scatter, Imperial Energy Archaeological Site 1 (IEAS01) will, however, is directly impacted. A Restricted Work Area (RWA) is suggested for the site. A site boundary polygon has been recorded. All works should avoid the site.

Summary of recommendations:

- **Mitigation schedule of sites:**

No.	Site ID	Site Type	Individual site type	GPS Grid Reference (Centroid) Datum: WGS 84, Zone: 53L		Description	Significance	Recommendation
			Artefacts (n.)	Easting	Northing			
1	IEBS01	Artefact scatter	2			Low density, 50m radius	Low	Option 1. Avoid. Site is 100m to the west of Line 3
2	IEBS02	Artefact scatter	4			Low density, 145m radius	Low	Option 1. Avoid. Option 2. Destroy
3	IEBS03	Artefact scatter	4			Low density, 30m radius	Low	Option 1. Avoid. Site is 30m to the east of Line 6
4	IEBS04	Artefact scatter	3			Low density, 6m radius	Low	Option 1. Avoid. Site is 10m to the east of Line 4. Wpt No. 801 moved 10m to the east
5	IEAS01	Artefact scatter	>5 per m^2			High density artefact scatter with a range of tool types	High	Option 1. Avoid. Line 6 runs through the site. Refer to RWA (Fig. 11 and Appendix 2)

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1.0 INTRODUCTION

1.1 Background and consultancy brief

Imperial Oil and Gas Ltd Pty (Imperial Energy) are proposing to build 231.80kms of seismic survey lines and two drill pads on the eastern edge of the Favenc Range, off the Carpentaria Highway, half way between Daly Waters and Borroloola in the Northern Territory (Figs 1 and 2). An archaeological survey was required to assess the impact of the proposed works, if any, on archaeological sites, or objects.

A four-day aerial survey was conducted from 5 to 8 August 2019 by archaeologists Douglas Hobbs, Silvano Jung and with Traditional Owner Peter Ellis from the Lightning Ridge outstation off Broadmere Road. Our pilot was Clinton Brisk, who flew a Robinson R44 (VH-RQJ). The consultancy brief was specifically to:

- Identify any prescribed archaeological objects or places as defined under the Northern Territory *Heritage Act (2012)*, and any archaeological sites located within the entire survey area.

- Assess the nature, distribution and significance of these objects or places and discuss possible constraints to the works posed by the presence of archaeological and historic sites and an indication of what sites are likely to be the most sensitive in this respect.

- Present a final report including a summary of survey results, determination of significance of sites and the likely impact of the proposed development, and recommendations regarding management strategies or mitigation procedures as appropriate under the Northern Territory *Heritage Act (2012)*.

The 231.8kms of survey lines are divided into six lines. The lines will be approximately 10m wide i.e., five metres either side of the survey centre line. Line One, which runs parallel to the Carpentaria Highway, from east to west, is 33.6km long. Line Two, which runs parallel and to the south of Line One, is 25.3kms long. Line Three runs perpendicular to the previous two lines, and is 50.4kms long. This line runs from the north of the highway on the Balbirini Creek and crosses the highway in a south by southeasterly direction. Lines Four, Five and Six run in a similar direction and are 33kms, 34.4kms and 55.1kms long respectively.

Two drill pads are also proposed, one (SL-4) on Line Four, with four alternative sites (SL-4 ALT 1 - 4). The other proposed drill site is on Line Two (SL-3) with no alternative sites. The drill pad sites are 120m^2. Two access tracks to these drill pads from the highway were also part of the survey. The track to SL-4 is 6.3kms long and the track to SL-3 is 5.5kms long.

Several previously recorded archaeological sites north of the highway were relocated, but these were well outside of the construction corridor for the seismic lines. The corridor is ten metres wide. Four background scatter sites and one archaeological site were found during the survey. All sites were characteristically stone artefact scatters. The following describes the methods and outcomes of the survey, together with recommendations for the proposed works.

1.2 Environmental description

The survey area north of the Carpentaria Highway is characterised by open woodland and savannah, with a major waterway to the north of the highway, Balbirini Creek. This section of the survey area is heavily dissected across the Favenc Range, levelling out across black soil plain. North of the highway, quartzite outcrops occur.

In the southern section of the survey area, it is virtually all floodplain with only one major waterway, Relief Creek, which was dry at the time of the survey. The only permanent water sources are Cockatoo (near the eastern end of line 1) and at Eleanor Pool Yard1, off Broadmere Road.

Some ten kilometres southeast of the survey area is Paradise Pool, not far from the McArthur River, which would have been a significant refugia for Aboriginal People. It's triple waterfalls fill a permanent pool with abundant resources.

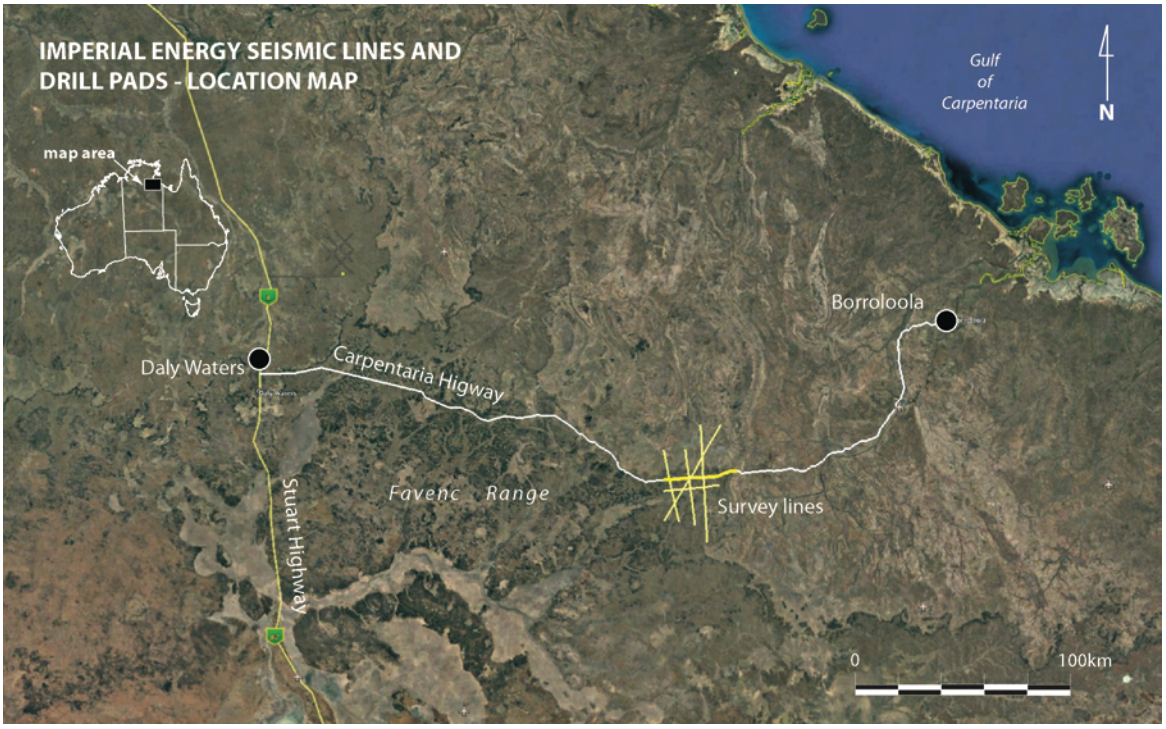

Figure 1. Location map of the study area, between Daly Waters and Borroloola on the Carpentaria Highway, on the eastern edge of the Favenc Range (After Google Earth).

The geology is recorded as predominately black soil plains north of the Carpentaria Highway and bounded at the northern end of the survey lines, associated with alluvial and lateritic deposits south of the highway. The following geological units occur in the survey area:

- KI Sandstone, lithic sandstone, clayey sandstone, conglomerate, sandy claystone and siltstone, commonly ferruginised and silicified; claystone may contain bivalve and brachiopod shell impressions and possible belemnite casts; sandstone commonly contains plant debris casts and leaf imprints.

- Czl – Pisolitic and mottled laterite: in situ and reworked remnants of standard laterite profiles (Fig. 2)

- Cz – Undifferentiated alluvial, colluvial and eluvial deposits: unconsolidated gravel, sand, silt, clay, ferruginous cemented detritus, minor calcrete, silcrete and ferricrete.

- Czb – Grey-black, earthy, clay-rich soil; black soil plain

- Pre – Ridge-forming: pseudo-karstically weathered, strongly jointed quartzarenite; feldspathic and ferruginous in places; predominantly planar cross-beds, ripple marks (Fig. 3).

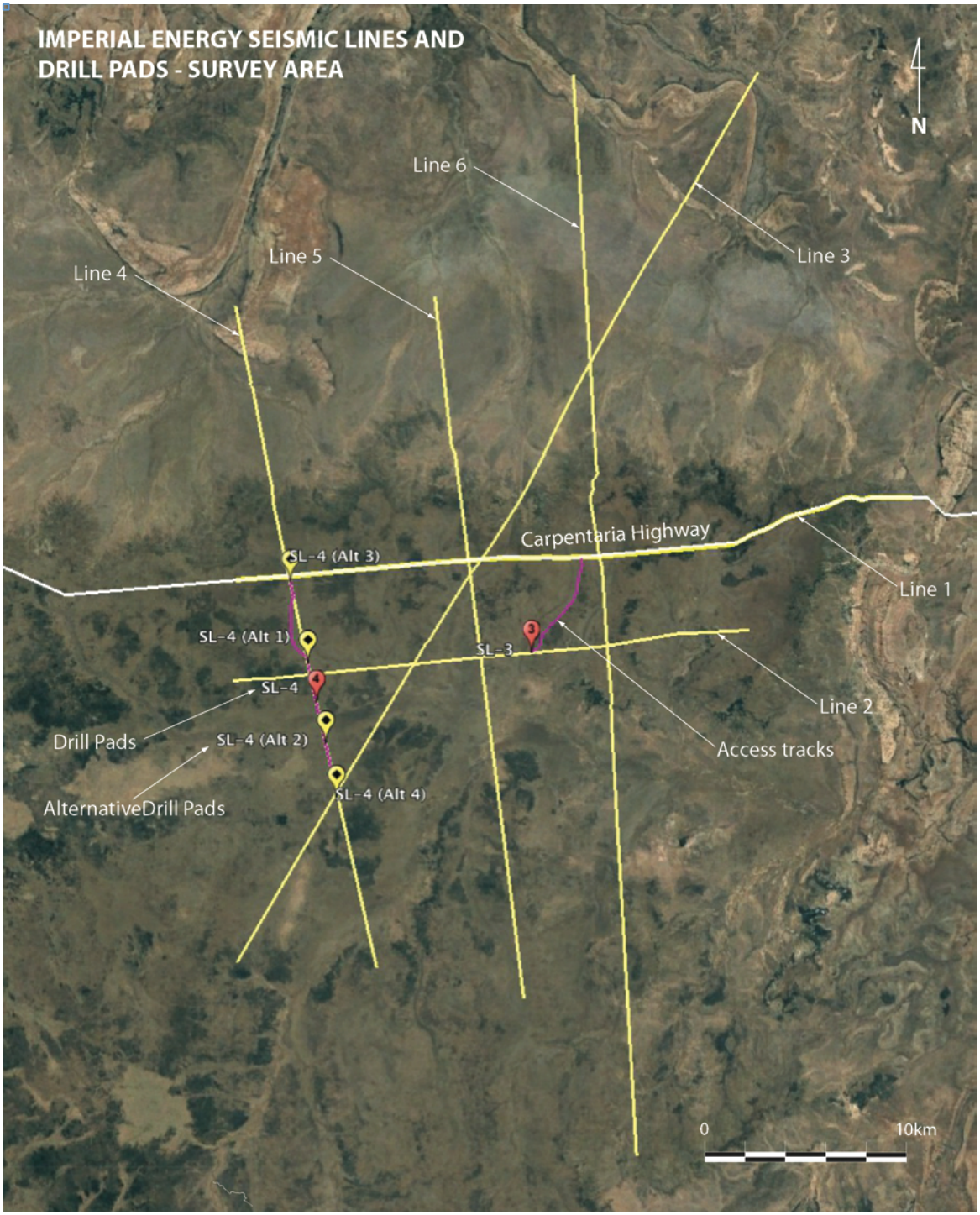

Figure 2. Location of the study area on the Carpentaria Highway, showing seismic lines, drill pads and access tracks (After Google Earth).

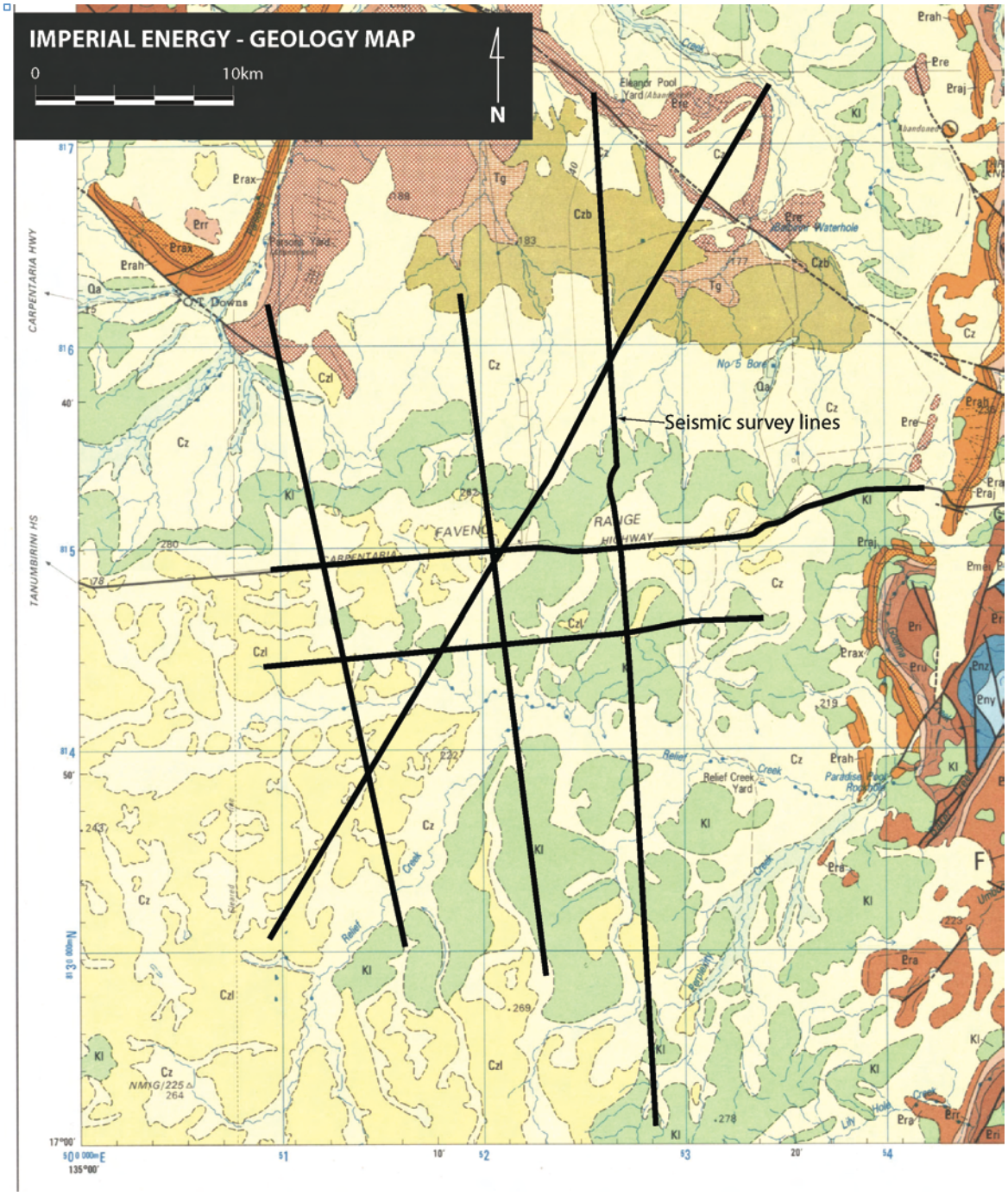

Figure 3. Geology map of the survey area with overlaid seismic survey lines (After BAUHINIA DOWNS se5303. Geoscience Australia. 1: 250 000 Geological Map, 1st edition 1991. http://scanned-maps.geoscience.gov.au/250dpi/se5303.jpg. Accessed 11 August 2019).

The vegetation communities are open woodland dry sclerophyll forests *of E. miniata* (Darwin Wooly Butt), *E. tetrodonta* (Stringybark) and *E. bleeseri* (Smooth-stemmed Bloodwood), extensively covered by an understorey of Mitchell and spinifex grasses. *E. pruinosa* (Silverleaf Box) occurs extensively in the survey area, south of the Carpentaria Highway on the Barkly Tablelands.

2.0 HERITAGE LEGISLATIVE FRAMEWORK

2.1. Northern Territory legislation

There are two kinds of heritage sites protected under the Northern Territory *Heritage Act* (2012), hereafter referred to as the Act, declared and prescribed places and objects. The Act places legal constraints on owners of private property, local government and the Crown:

- Places or objects listed on the Northern Territory Heritage Register are declared heritage places and objects that are protected under section 33 of the Act, and

- Prescribed archaeological places and objects, which may or may not be declared, are protected under sections 29 and 39 of the Act.

It is an offence under the Act to damage, destroy, alter or carry out work of any sort on declared or prescribed sites without the written consent of the Minister or Minister's delegate. If considered appropriate, the Heritage Branch may on occasion utilise the discretion available in the Act to give permission for small-scale disturbance (such as the relocation of isolated stone artefacts) without the need for a formal application. The discretion is allowed under s148 of the Act, which in effect says that a heritage officer (such as an archaeologist) may undertake actions (or authorize actions), not construed as an offence.

2.1.1 Declared heritage places and objects

Categories, which describe the status of each site on the Northern Territory Heritage Register database, are listed in Table 1.

Table 1. Site status on the Northern Territory Heritage Register database

Status	Description
D	Declared heritage place.
NR	Not recommended. HC* determined that the place did not meet heritage assessment criteria and did not hold sufficient value to warrant declaration under the *Act*.
RF	Refused by the Minister. HC* recommended for declaration and Minister refused to do so.
P	Proposed. HC* has determined that the place warrants declaration under the *Act* but has not yet made its recommendations to the minister.
RV	Revoked. Declaration as a heritage place pursuant to Section 26(1) of the *Act* is revoked.
N	Nominated. HC* has yet to complete its assessment of the heritage value of the place.

*Heritage Council

The Northern Territory Heritage Register contains places that possess special significance for the Northern Territory and have been recognized for a wide range of natural and cultural values. As a result it includes places that have been deemed significant because of their environmental and/or cultural characteristics. For the purposes of the current report, only places of historic or archaeological significance have been included. A search of the register indicates that the proposed Imperial Energy works will not impact on any sites listed in the Heritage Register.

2.1.2 Prescribed archaeological places and objects

Most archaeological places and objects are listed in the *Heritage Conservation Regulations* (1999) as prescribed places and objects. The Heritage Branch, Department of Tourism and Culture, formerly the Department Lands, Planning and Environment (DLPE), formerly the Department of Natural Resources Environment and the Arts (NRETAS) hold the Archaeological Sites Register. Included in this register are the protected prescribed sites that consist of all archaeological sites and objects pertaining to the past occupation by Aboriginal People. Any historic sites listed on this register do not indicate that these sites are protected or hold legal significance under the Northern Territory *Heritage Act* (2012).

2.2. Constraints

2.2.1 Ground Integrity (GI)

Assessing ground surface integrity provides an indicator of whether or not the landscape under study has been modified, and if so the degree of disturbance encountered. It then becomes possible to gauge the degree to which modification has influenced the environmental context within which artefacts and/or places of cultural and/or scientific interest are located. Ground surface integrity must also be assessed from the perspective of the current legislation.

The *Aboriginal Cultural Heritage Act 2003* (in Queensland, but equally applicable to the Northern Territory) provides a definition for GI that includes the removal of native vegetation as inferring the ground has been subjected to 'significant ground disturbance'. Under these criteria of modification, therefore, the *Act* assumes that archaeological integrity and significance is greatly reduced, is negligible, or even extinguished completely.

Contrary to this however, archaeologists are continually finding evidence that important cultural heritage material and/or places regularly survive not only land clearing activities but also invasive farming techniques such as ploughing.

Combined with this is the fact that, regardless of levels of GI, significant Aboriginal objects and/or significant Aboriginal areas can be defined on entirely cultural grounds, by Traditional Owners, not requiring any assessment of ground surface integrity.

Levels of GI are determined using a percentage range between 0-100% where 0% indicates all GI is gone, and 100% represents excellent preservation of the original context. Zero – 0%; Poor – 1-25%; Moderate- 26-50 %; Fair – 51-75 %; Good – 76-85%; Excellent 86-100%.

2.2.2 Ground Surface Visibility (GSV)

Assessments of ground surface visibility provide an indication of how much of the ground surface can actually be seen.

Ground surface visibility (GSV) is most commonly inhibited by vegetation but other inhibitors may include concrete, gravel and bitumen. Levels are determined using a percentage scale similar to that used for the calculation of Ground Integrity (GI), in that 0% represents zero visibility and 100% represents maximum visibility (bare ground). Zero – 0%; Poor – 1-25%; Moderate – 26-50 %; Fair – 51-75 %; Good – 76-85%; Excellent – 86-100%. The better the visibility, the more potential there is for locating cultural/archaeological material.

3.0 PREVIOUS RESEARCH

3.1 Literature review

The geologist Ernest Favenc mapped the Favenc Range in 1883 (Gibbney, 1972). The main concentrations of Aboriginal People that he saw were at Anthony Lagoon, Corella Lagoon and Brunette Creek, just to the south of the survey area and to the east of the former overland telegraph line (Sydney Mail, 1883). A map of expedition shows that he departed from Cresswell Creek in a north, northeasterly direction to Borroloola (National Archives of Australia. Series Number: A6128, Control Symbol: NTR119B and Series Number: A6128, Control Symbol: NTR119C).

The first archaeological survey conducted was in 1998 for the Nabre seismic line (Guse and Collis, 1998). The results of that survey discovered six archaeological sites, which occur in this year's survey area, most of which were stone artefact scatters (Table 2). Imperial Energy's proposed works, however, will directly impact none of those sites. The route of the 1998 survey is shown if Figure 4. The 1998 survey only covered one transect north of the Carpentaria Highway. No previous work has been conducted south of the highway.

Table 2. Previously recorded archaeological sites in the study area (Courtesy: Heritage Branch, NTG)

Site_Name	Easting	Northing	Zone	No#_Map _Sheet	Map_ Sheet	Site_Type	Contents	Comments
Balbirini Creek1					O.T. Downs	Stone artefact scatter	Artefact scatter	
Balbirini Creek2					O.T. Downs	Stone artefact scatter	Artefact scatter	
Eleanor Pool Yard1					O.T. Downs	stone artefact scatter, historic site, stone arrangement, grindstone portable	Artefact scatter, stone arrangement, faunal remains	Contact site, knapped glass
OT Downs1					O.T. Downs	Quarry	Quarry	
OT Down2					O.T. Downs	Stone artefact scatter	Artefact scatter	
OT Down3					O.T. Downs	Stone artefact scatter, grindstone portable	Artefact scatter	

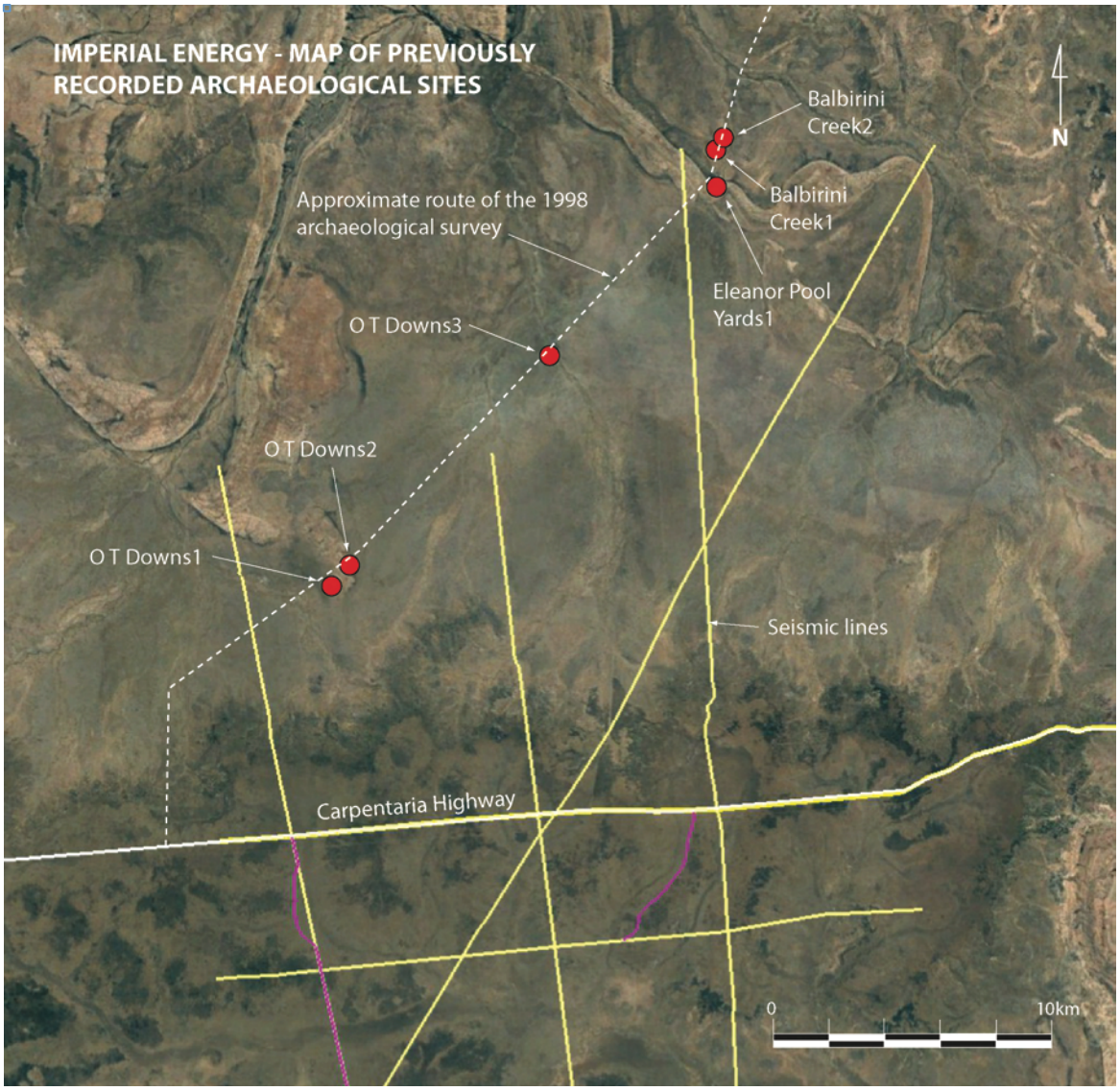

Figure 4. Map of previously recorded archaeological sites in the survey area (After Guse and Collis, 1998: between pages 5 and 6).

4.0 METHODS

4.1 Survey method

The survey method was to use a helicopter to assay likely habitation areas. Water is a key determinate as to where people were in the environment. Waterways were targeted in the aerial survey, as well as low stoney laterite ridges on the edges of swamps and drainage channels. Rock outcrops were also investigated, as well as rocky ridges for possible stone arrangements and or quarries. A pedestrian survey was conducted along each of the survey lines from the helicopter land zones (LZs). Artefacts were photographed and a GPS grid reference was recorded. Previously recorded sites were relocated to confirm their locations with current GPS accuracy, as the GPS coordinates for sites recorded in 1998 were still being dithered.

4.1.1 Identification of archaeological material

Stone artefacts, including tools and debitage, the by-product of manufacture, are identified on the following criteria after McCarthy (1976), Holdaway and Stern (2004):

- Bulb of percussion
- Erailure scar (on the ventral surface)
- Point of force application (PFA) and associated ring crack
- Termination types (e.g. feathered, stepped, hinged, plunge)
- Flake scars (dorsal scars and ridges)
- Cores (identified by the presence of negative flake scars)
- Hammer stones (identified by the presence of end-crushing on pebble stones)
- Retouch (reworking of flake margins)
- Raw material type
- Grinding stones (very smooth wear on upper surface)

List of artefact type abbreviations:

- Ad – Adze
- An – Anvil
- Bl – Blade
- Co – core
- Cf – Core fragment
- Ct – Core tool
- F – flake
- Fp – flake piece
- Gs – Grindstone/Grinding plate
- Hs – Hammer stone
- M – Manuport
- Mp – Multi platform core
- Rtf – retouched flake
- S – Scraper
- Sp – Single platform core
- Ts – Top stone
- X – Axe/wasted cobble
- Z – Other e.g., ceremonial

List of artefact raw material abbreviations:

- Ch – Chert
- G – Greywacke
- Hs – Hornsfel

- Im – Indurated mudstone
- J – Japser
- SS – Sandstone
- S – Silcrete
- Q – Quartz
- Qz – Quartzite
- V – Volcanic

4.1.2 Definition of archaeological sites

4.1.2.1 Historical Sites

Historical sites in north Australia are those that have physical evidence of European and non-European activities. These range from Macassan sites to military sites of WWII. These sites may overlap with Aboriginal heritage sites.

4.1.2.2 Aboriginal Heritage Sites

Aboriginal archaeological sites can be classified by six main types: 1) stone knapping sites, including quarries, 2) background scatters, including isoliths, 3) stone arrangements, such as mounds, walls, fish traps or stone motifs, 4) shell middens, 5) burials, 6) scarred trees and 7) rock art sites.

Burke and Smith (2004:63) define an archaeological site as ‘any place that contains the physical evidence of past human activity. Australia, however, has what has been referred to as a background scatter of stone artefacts, which refers to low-density artefact scatters that either represent singular knapping events (‘dinner-time’ camps or ‘hunting camps’), or larger sites that have been buried or disturbed. To differentiate this site type from larger sites that may contain thousands of artefacts, the term Archaeological Site (AS) is used to describe home-camps or quarries i.e., places where people have been returning to for millennia, as opposed to sites that have very low artefact densities that represent sporadic visits i.e., background scatters (BS).

5.0 RESULTS

5.1 Archaeology

Thirty-four landings were made along the six survey lines and at the drill pads (Table 3 and Fig. 5). GSV was generally 80 – 90% across the survey area. GI was assessed as 90%. Cattle and pig damage accounted for lowering GI. Four low-density background scatters and a high-density archaeological site were located, all in proximity to Balbirini Creek. The location data and find descriptions are presented in Table 4 and mapped in Figure 6. Artefact photographs are listed in Appendix 1.

All previously recorded sites were relocated with the exception of OT Downs2, whereby only a chert core was found. No grindstone was found at OT Downs3. The stone arrangement at Eleanor Pool Yards1 was not found and was most likely destroyed during the construction of water tanks on top of the ridge. The drill pads SL-3 and SL-4 (and it's four alternative sites) were inspected, but no archaeological material was found. Figure 7 shows the drill site for SL-4, with typical vegetation and terrain for the area.

The two access tracks leading to the drill pad sites were assayed from the air, but no suitable habitation areas were seen along their routes.

Table 3. Location of LZs and descriptions

Format: UTM M/D/Y H:M:S 9.50 hrs Datum[121]: WGS 84					
Name	**Description**	**Zone**	**Zone**	**Easting**	**Northing**
LZ01	OT Downs1				
LZ02	SL-4 (ALT3) drill pad, flat, open woodland				
LZ03	Line 1, eastern edge of range. Heavily dissected, narrow valley floors. Rocky ridges				
LZ04	Line 1, eastern edge of range. Heavily dissected, narrow valley floors. Rocky ridges				
LZ05	Line 1, eastern edge of range. Heavily dissected, narrow valley floors. Rocky ridges				
LZ06	Line 2, flat, open woodland with understory of Mitchell grass, laterised light brown soils				
LZ07	Line 2, ephemeral creek				
LZ08	SL-3 drill pad, flat, open woodland				
LZ09	Line 3, Balbirini Creek, northern bank. IEBS01				
LZ10	Line 3, Balbirini Creek, southern bank. IEBS02				
LZ11	Eleanor Pool Yard1				
LZ12	Balbirini Creek1				
LZ13	Line 3, small ephemeral creek, open woodland, flat				
LZ14	Line 3, Small creek line on edge of Broadmere Road				
LZ15	SL-4 (ALT4) drill pad, flat, open woodland				
LZ16	Line 4, Relief Creek, ephemeral, open				

	woodland, flat, bloodwoods, and stringy barks.				
LZ17	SL-4 (ALT2) drill pad, flat, open woodland				
LZ18	O T Down2				
LZ19	Line 4. On top of stoney ridge, quartzite outcrop. Adjacent to ephemeral creek, flat, yellow sandy, laterised soils – IEBS04				
LZ20	Line 4, ephemeral creek, flat, open woodland, underground of spinifex, stoney, laterised soils				
LZ21	Line 4, northern edge of Favenc Range, gentle slopping ridges from creek like to the base of the range				
LZ22	SL-4 (ALT-1), open woodland, flat, understory of Mitchell grass				
LZ23	SL-4 drill pad. Open woodland, flat, understory of Mitchell grass				
LZ24	Line 5, open woodland, flat, understory of Mitchell grass				
LZ25	Line 5, near Relief Creek, large creek with steep banks, adjacent to large black soil billabong (dry)				
LZ26	Line 5, gentle undulating rises, edge of Favenc Range				
LZ27	Line 5, rocky quartzite outcrop				
LZ28	OT Downs3				
LZ29	Line 6, Balbirini Creek				
LZ30	Line 6, Balbirini Creek IEBS03, IEAS01				
LZ31	Line 6, stoney quartzite outcrops				
LZ32	Line 6, edge of Favenc Range				
LZ33	Line 6, heavily dissected valleys, sandy floors with drainage lines				
LZ34	Line 6, flat open woodland, dry ephemeral creek bed, yellow soils				

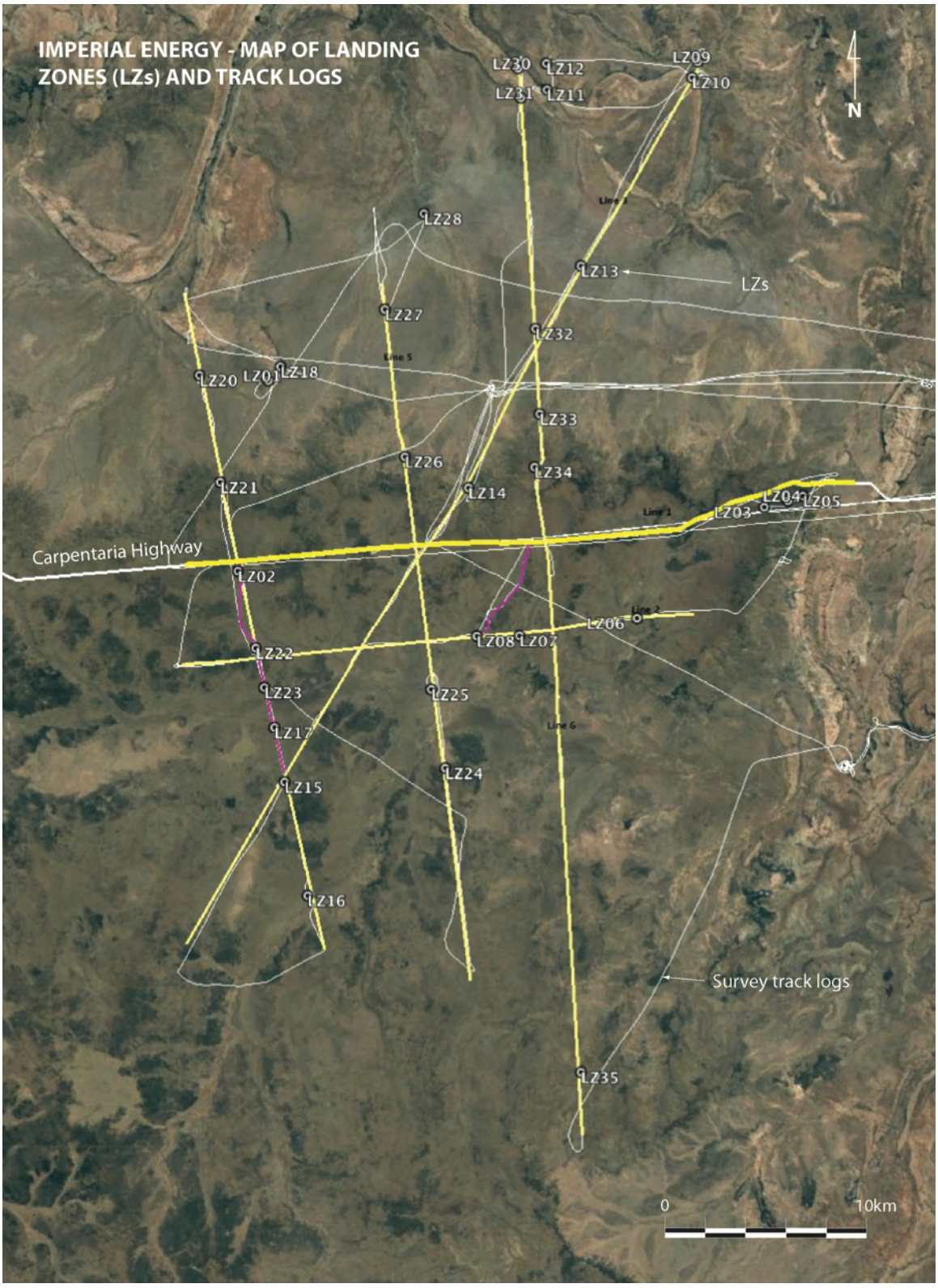

Figure 5. Map of Landing Zones (LZs) and survey track logs (After Google Earth).

Table 4. Background Scatters (BS) and Archaeological Sites (AS)

Format: UTM M/D/Y H:M:S 9.50 hrs Datum[121]: WGS 84						
WPT Name	**Comment**	**Zone**	**Zone**	**Easting**	**Northing**	**Photo No.**
IEBS01						
796	F(S)					DSCN9203 DSCN9204 Site photo
IEBS02						
797	F(QZ)X1. FP(QZ) X2					DSCN9208
798	F(QZ)					
BALBIRINI CREEK1						
799	BALBIRINI SITE 01					
BALBIRINI CREEK2						
800	C(C)					DSC_7354
IEBS03						
804	FP(QZ)					DSCN9236
805	F(QZ)					DSCN9237
806	FP(QZ)					DSCN9238
807	F(C)					DSCN9239 DSCN9240 Site photo
IEBS04						
801	RTF(QZ) BIFACIAL, BROKEN TIP					DSCN9218 Obverse DSCN9219 Reverse
801-R (Relocated)						
803-1	FP(S)					DSCN9232
803-2	FP(S)					DSCN9233
OT Downs3						
802	C(C)					DSCN9228
OT Downs 2						
						DSCN9213
IEAS01						
808	F(S) DISTAL					DSCN9241
809	FP(QZ)					DSCN9242
810	F(QZ)					DSCN9243
811	F(QZ)					DSCN9244
812	S(QZ)					DSCN9245

						DSCN9246 Site photo
813	S(QZ)					DSCN9247
814	S(QZ)					DSCN9248
815	S(C)					DSCN9249
824	C(S)					DSCN9250
Paradise Pool						
835	Permanent water source					
Cockatoo						
	Near by permanent water source adjacent to the highway, just north of Line 1					

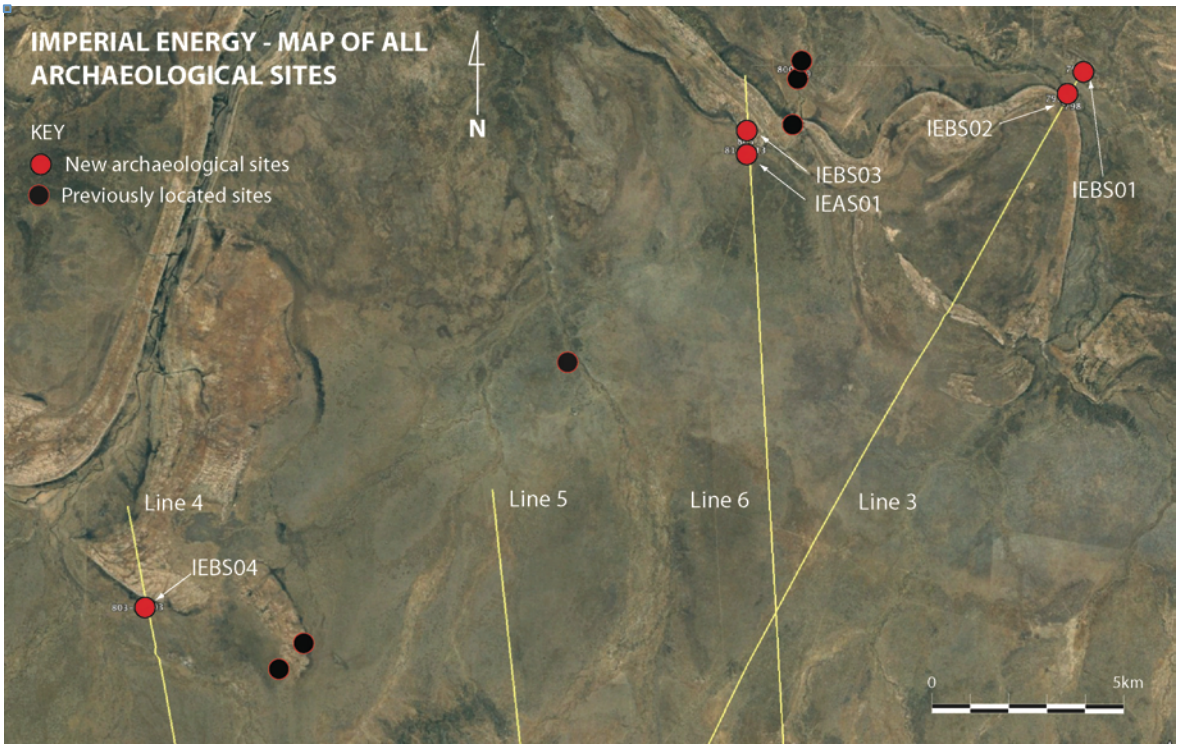

Figure 6. Map of all archaeological sites – red dots (After Google Earth).

Figure 7. Drill pad SL-4 environment with VH-RQJ virtually on the GPS mark.

5.2 Background scatters (BS) and archaeological sites (AS)

5.2.1 IEBS01

Low-density artefact scatter at the northern end of Line 3 at Balbirini Creek. On low laterite rise to the north of the creek. It is in an open woodland with Mitchell grass cover and is relatively flat (Fig. 8).

Figure 8. IEBS01 site photo.

5.2.2 IEBS02

Low-density artefact scatter on stoney rise at the northern end of Line 3. At base of stoney rise. Generally flat with low outcrops of silcrete and quartzite.

5.2.3 IEBS03

Low-density artefact scatter on top of stoney rise about 12m above ground flood plain. Outcrops of sandstone, quartzite and silcrete (Fig. 9). Site leads down to IEAS01.

Figure 9. IEBS03 site photo. Scale in 2m.

5.2.4 IEBS04

Low-density artefact scatter in reddish/brown laterite soils at the base of a quartzite and silcrete rise. Significantly, the only retouched point found in the survey was found here. It is bifacially retouched, which is rare. Retouched points are generally unifacially retouched in this region (Fig. 10). The point is virtually intact, except for the tip, which is broken.

Figure 10. Traditional Owner, Peter Ellis holding the bifacially retouched point at IEBS04.

5.2.5 IEAS01

Just south of IEBS03 at the base of a rocky ridge near Balbirini Creek, lies a high-density artefact scatter with a range of tool types including scrapers, flakes and flake pieces. The site is at the edge of a waterway that runs at the base of the ridge and lies exposed on yellow/brownish laterite soils. It was dry at the time of the survey. The site is close to Broadmere Road. A Restricted Work Area (RWA) polygon was established around the site. Line 6 goes through the site. Figure 11 maps the site and shows it's proximity to Broadmere Road and it's relation to IEBS03 on top of the nearby ridge. Figures 12 and 13 show ground and aerial perspectives of the site. The light brown, yellowish laterite soils provide a clear view of artefacts with increased GSV.

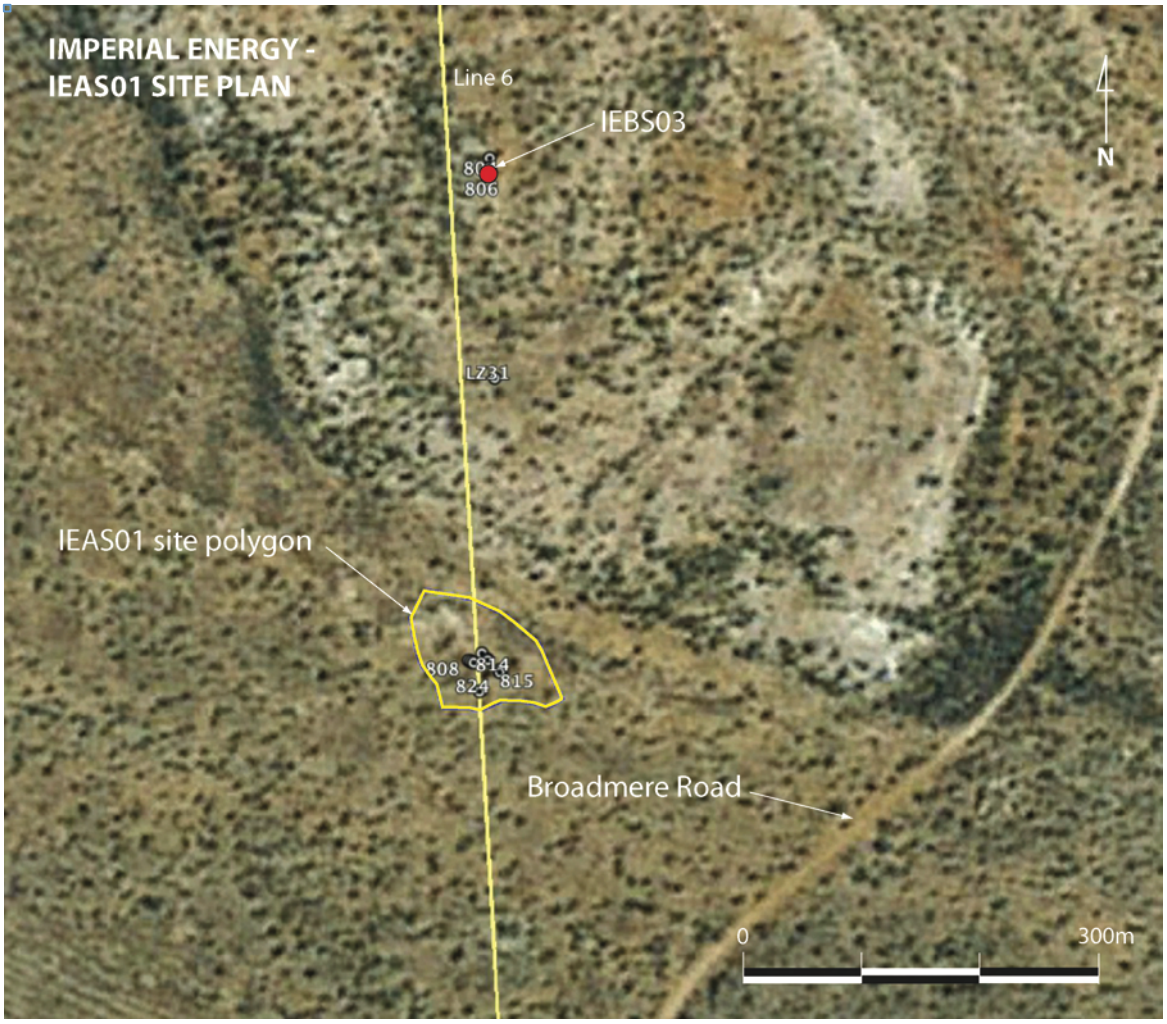

Figure 11. IEAS01 site plan (After Google Earth).

Figure 12. IEAS01 site photo. Scale in 2m.

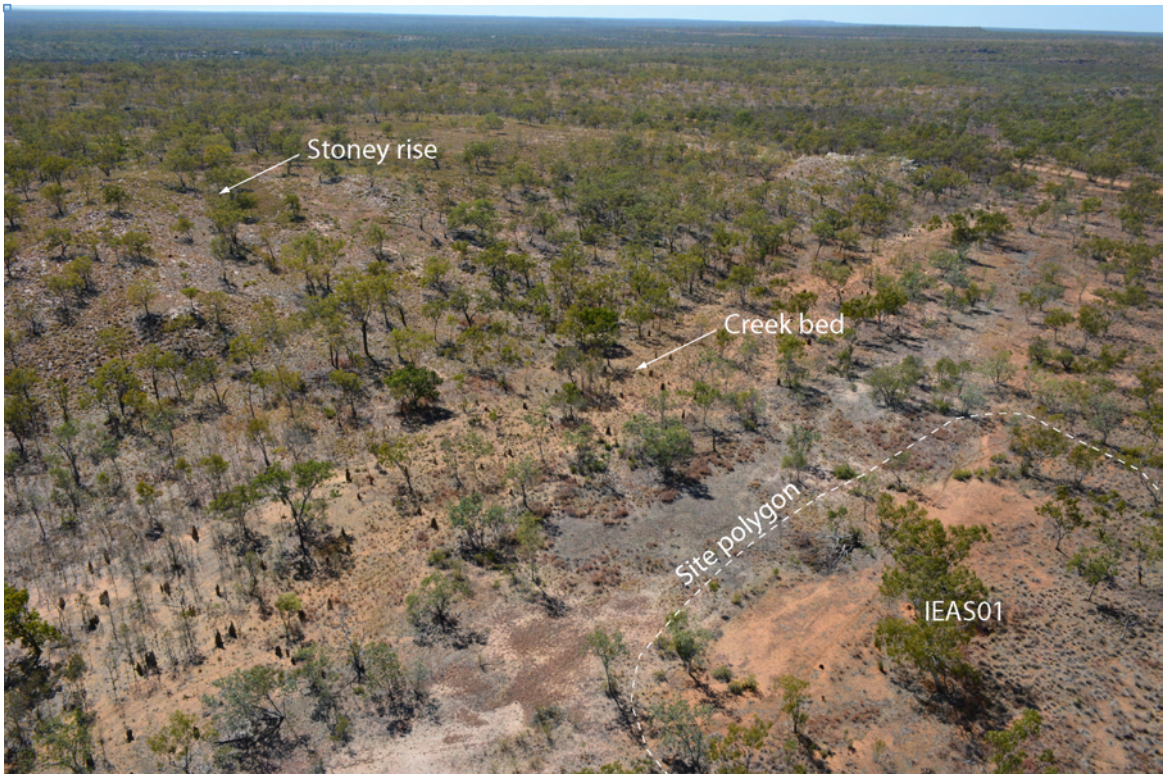

Figure 13. Aerial view of IEAS01 at the base of a stoney rise, adjacent to ephemeral creek.

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

The archaeological survey of Imperial Energy's proposed seismic line and drilling programme on the Favenc Range in the Northern Territory recorded five sites. Four of these were low-density artefact scatters, or Backgound Scatters and one is a high-density archaeological site near Broadmere Road. All of the finds occur in the northern section of the survey area in close proximity to Balbirini Creek.

No cultural material was found south of the Carpentaria Highway. There were no suitable rock outcrops found there and there is only one significant waterway, Relief Creek, which was dry at the time of the survey. No cultural material was found at the six proposed drill pad sites and access tracks.

The following recommendations arise from this report:

6.2 Recommendations

6.2.1 Recommendation 1: Site Avoidance

- The proposed works will have no impact on IEBS01 and IEBS03 (Line 3 and Line 6 respectively) as these sites were greater than ten metres from the centre line of the proposed seismic lines. No further action is required.
- IEBS04 is >10m to the east of Line 4. No further action is required.
- Line 6 will impact IEAS. A RWA has been established for the site and the site should be avoided. Appendix 2 lists the grid references for the RWA site polygon.

6.2.2 Recommendation 1: Site destruction

- IEBS02 covers a considerable area. It was impractical to move the finds. Site recommendations should be to avoid the last 1km northern section of Line 3 at Balbirini Creek. If not, the artefacts may be destroyed as they are of low archaeological significance.

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National Archives of Australia. Series Number: A6128, Control Symbol: NTR119B, Title: Track in Red shows the new road explored and opened up by W. R. Creswell, from Anthony's Lagoon to Borroloola April 1885. Base is sketch map showing explorations made by Ernest Favenc 1878 to 1883. National Archives of Australia, Canberra.

National Archives of Australia. Series Number: A6128, Control Symbol: NTR119C, Title: [shows track from Anthony's Lagoon to Borroloola]. Reduced 5/8 from E. Favenc's Exploration. National Archives of Australia, Canberra.

Newspapers:
Sydney Mail. 1883. 'Mr Ernest Favenc's expeditions in the Northern Territory'. Sydney Mail and New South Wales Advertiser (NSW: 1871 - 1912), Saturday 10 November 1883, page 905.

APPENDIX 1: Artefact photographs

Figure 14. Wpt No. 796 F(S). Scale in 1cm.

Figure 15. Wpt No. 797 FP(QZ) x 2, F(QZ). Scale in 1cm.

Figure 16. Wpt No. 801 RTF(QZ) Bifacially retouched point. Obverse. Scale in 1cm.

Figure 17. Wpt No. 801 RTF(QZ) Bifacially retouched point. Reverse. Scale in 1cm.

Figure 18. Wpt No. 804 FP(QZ). Scale in 1cm.

Figure 19. Wpt No. 805 F(QZ). Scale in 1cm.

Figure 20. Wpt No. 806 FP(QZ). Scale in 1 cm.

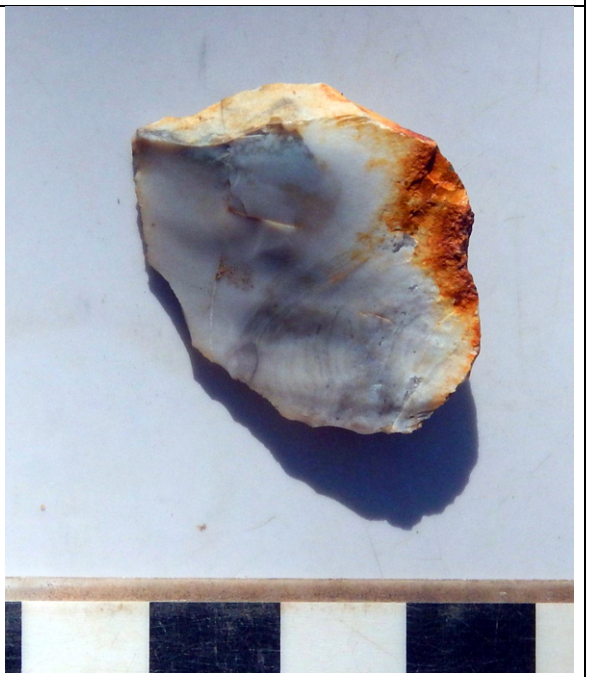

Figure 21. Wpt No. 807 F(C). Scale in 1 cm.

Figure 22. Wpt No. 808 F(S) distal. Scale in 1cm.

Figure 23. Wpt No 809 FP(QZ). Scale in 1cm.

Figure 24. Wpt No. 810 F(QZ). Scale in 1cm.

Figure 25. Wpt No. 811 F(QZ). Scale in 1cm.

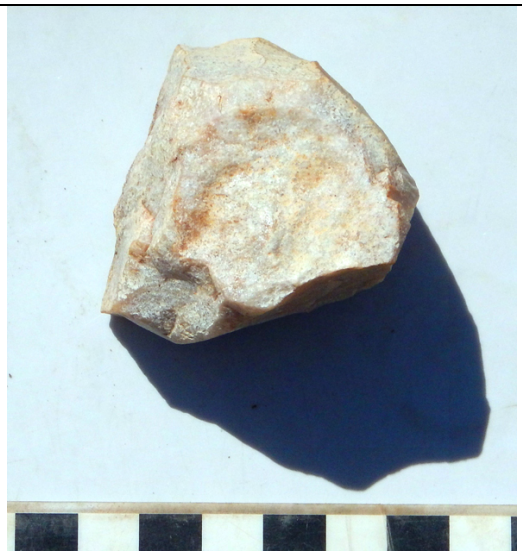

Figure 26. Wpt No. 812 C(QZ). Scale in 1cm.

Figure 27. Wpt No. 813 S(QZ). Scale in 1cm.

Figure 28. Wpt No. 814 S(QZ). Scale in 1cm.

Figure 29. Wpt No. 815 S(C). Scale in 1cm.

Figure 30. Wpt No. 824 C(S). Scale in 1cm.

Figure 31. Stone artefacts at OT Downs2. Scale in 1cm.

Figure 32. Silcrete core at OT Downs2. Scale in 1cm.

APPENDIX 2: IEAS01 Restricted Work Area (RWA) polygon coordinates

Format: UTM M/D/Y H:M:S 9.50 hrs Datum[121]: WGS 84				
ID	Zone	Zone	Easting	Northing
T	53	K		
T	53	K		
T	53	K		
T	53	K		
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