Environmental Management Plan

Carpentaria Pilot Project

Imperial Oil & Gas

EP 187

IMP 5-3

Document Control

Prepared for: **Imperial Oil & Gas Pty Ltd**

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Executive Summary

a. Location

The Regulated Activity and associated works (the Activity) covered by this EMP will occur within the area referred to as the Carpentaria Pilot Project (CPP) Area (**Figure. i**). The CPP Area is within the Barkly region of the Northern Territory. The Activity will be wholly contained within Exploration Permit (EP) 187, which is in the Beetaloo extended survey area (BESA) of the Beetaloo geological and bioregional assessment (GBA) program [DEPWS, 2023B].

The CPP Area is situated on the southwest flank of EP 187 in the Sturt Plateau and Gulf Fall and Uplands bioregions at the divide between the Limmen Bight River and the McArthur River catchments [DCCEEW, 2022]. The nearest dwelling is 1.3 km east of the CPP boundary on Carpentaria Highway, and approximately 7.5 km away from the proposed Carpentaria Gas Plant. The nearest community/town is Cape Crawford, 66 km east of the CPP Area. Borroloola is 150 km northeast, Daly Waters is 200 km northwest, and Darwin is 640 km northwest of the CPP Area.

b. Background

The Activity follows on from petroleum exploration and appraisal undertaken within the EP since 2019. Such work includes 388 km of 2D seismic acquisition, the drilling of four petroleum wells (two horizontal and two vertical), and the hydraulic fracturing (HF) of three of those wells. These wells provided encouraging extended gas flow test results. Initial flow rates over the first 30 days (IP30) of extended production tests for the two horizontal wells averaged 2.0 and 3.5 TJ/day per normalised 1,000 m of the lateral wellbore from the target shale formation, which is at a depth of approximately 1,600 m subsurface. The composition of gas in the CPP Area is provided in **Table. i**.

Imperial believes that the Activity satisfies the requirements of Section 57AAA to recover petroleum on an appraisal basis and is progressing with the requirement of Section 57AAA (5)(d) to obtain approval, consent, or agreement with the NLC and Traditional Owners for the sale or other beneficial use of petroleum recovered on an appraisal basis.

Table. i CPP Gas Composition

Gas Composition – Vol. %					
Component			**Carpentaria - 2H**		**Carpentaria - 3H**
			Phase 1 2022 Testing	**Phase 2 2023 Testing**	**Phase 2 2023**
C1	Methane	**Hydrocarbons**	83.17	82.80	83.58
C2	Ethane		11.95	12.40	11.54
C3	Propane		1.47	1.50	1.4
C4	Butane		0.30	0.30	0.27
C5+	Pentane and Higher		0.60	0.06	0.06
He	Helium	**Inerts**	0.16	0.12	0.15
CO_2	Carbon Dioxide		0.88	0.91	0.86
N_2	Nitrogen		2.01	1.91	2.13
Total Gas Composition			**100**	**100**	**100**

The Activity covered by this EMP represents the ongoing appraisal phase of the shale gas discovery, which was announced to the ASX in 2021 with the successful production test of the Carpentaria-1 petroleum well. Imperial is progressing with the requirement in Section 57AAA to obtain approval, consent or agreement with the NLC and Traditional Owners for the sale or other beneficial use of petroleum recovered on an appraisal basis.

Unconventional resource assessment, such as shale, requires testing over multiple years to optimise and characterise well performance. Unlike conventional gas fields, where reservoir permeability is sufficient to enable gas to flow freely to the surface, shale reservoirs require a more extensive appraisal phase.

The Activity has the following objectives:

- Evaluate gas production from appraisal wells for an extended period of years to help define well performance and decline rates and estimate the expected ultimate recovery (EUR) of resources.
- Assess the commerciality of the resource necessary for moving beyond the appraisal phase into full-field development.

- Further delineate the shale resource through the appraisal of up to nine new wells on up to four new pads in addition to the existing well pads in the CPP Area.
- Optimise operations, including HF flowback management and fluid reuse, to develop the resource most efficiently and effectively for all stakeholders.

A scenario of flaring produced gas would make up over 90% of the potential total annual greenhouse gas (GHG) emissions associated with the Activity. Imperial proposes to export the gas flow to customers via the McArthur River Gas Pipeline that crosses the CPP Area to eliminate these unnecessary GHG emissions. Compared to BAU, this would eliminate over 90% of Scope 1 GHG emissions associated with the Activity. This EMP does not cover the maintenance and operational activities of the McArthur River Gas Pipeline.

The *Greenhouse Gas Emissions Management for New and Expanding Large Emitters (*the Large Emitters Policy*)* identifies the NT Government's minimum requirements for managing greenhouse gas emissions from new or expanding industrial and land use development projects. It has been established in recognition of the Northern Territory's target of net zero greenhouse gas emissions by 2050. The policy came into effect on 1 September 2021. The *Large Emitters Policy* will be given effect through environmental authorisations granted under Northern Territory environmental legislation.

This policy establishes the NT Government's expectations for new large emitting projects, or significant emitting expansions of existing projects, to reduce and manage their emissions to enable development while contributing to the Northern Territory's emissions target.

Large greenhouse gas emitters under this policy include industrial projects (e.g., petroleum, mining, extractive, refining, or manufacturing projects) that meet the emissions threshold of estimated scope one emissions of 100,000 tCO_2-e in any financial year over the life cycle of a project, not counting emissions generated from land clearing directly associated with the Activity [NORTHERN TERRITORY GOVERNMENT, 2021].

To recover petroleum on an appraisal basis, Imperial is progressing with the requirement of Section 57AAA (5)(d) of the *Petroleum Act, 1984 (NT)* to obtain approval, consent, or agreement with the NLC and Traditional Owners for the sale or other beneficial use of petroleum recovered on an appraisal basis. If successful, this will enable Imperial to conduct production appraisal tests without significant flaring. If the application under Section 57AAA is unsuccessful and the Activity must proceed on a basis different to the one described, this EMP will be revised or modified under the *PER* to account for any new or increased environmental impacts or risks. This revision would include a greenhouse gas abatement plan if Imperial's estimated scope 1 emissions exceed 100,000 tCO_2-e in any financial year over the life cycle of the project. By exporting gas to the MRGP, the average annual GHG estimated emissions from the Activity are approximately 30,000 tCO_2-e over the period covered by the EMP. In no financial year covered by the EMP do the estimated emissions exceed the 'large greenhouse gas emitters' Industrial project annual threshold of 100,000 tCO_2-e [NT EPA, 2022A].

Gas recovery of ~25 TJ/day is expected during the appraisal phase. Flaring of ~25 TJ/day during the appraisal phase would result in ~475,000 tCO_2-e per year. Exporting this gas to the MRGP significantly reduces Scope 1 GHG emissions from the CPP Area.

c. Scope

The Activity (summarised in **Table. ii**, and described in **Section 3.1**) will include the following:

- Land clearing and earthworks.
- Drilling, hydraulic facture, completion, testing, maintenance, suspension, and abandonment of wells.
- Construction, operation, modification and maintenance of facilities, and gas and wastewater flowlines used to recover petroleum, treat water, and treat gas.
- Decommissioning and rehabilitation.

The Activity is planned to commence in 2024.

The well pads will each have an approximate disturbance area of 12 ha, including fire breaks. The well pad design incorporates stockpiling locations for vegetation and topsoil for subsequent site rehabilitation. The Activity is being conducted in an EP with existing clearing and infrastructure. The Activity will expand the land disturbance footprint by 226 ha (including 21 ha of contingency) from the existing 43.4 ha to approximately 269 ha within the 442,700 ha area of EP 187.

Multiple wells may be drilled off each well pad. The wells true vertical depth (TVD) to the target shale is approximately 1,600 m; the lateral length of the horizontal section can reach up to 5 km, although are typically 3 km.

The multi-well pad design significantly scales up the potential energy production intensity of each well pad if the appraisal phase is successful and:

- Maximises petroleum production so that the optimum value of the resource is returned to the Northern Territory [PETROLEUM ACT, 1984 (NT)].
- Minimises the disturbance footprint and resources required to undertake the Activity in accordance with ESD principles [ENVIRONMENT PROTECTION ACT, 2019 (NT)].

Imperial proposes to export and estimated 25 TJ/day of gas to the MRGP during the appraisal phase. The pipeline transects the CPP Area from east to west along the Carpentaria Highway.

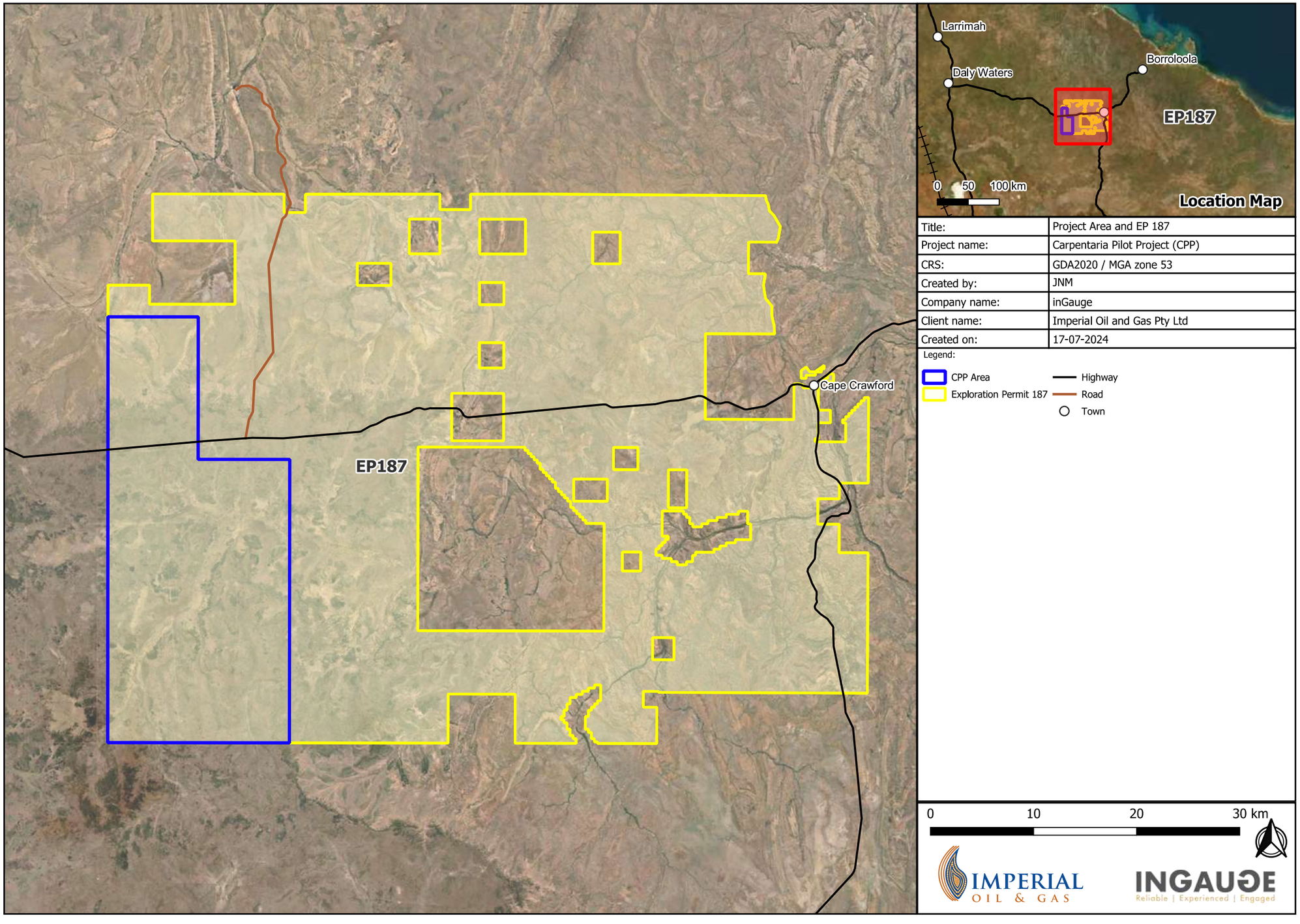

Figure. i EP 187 and CPP Area Location

Table. ii Summary of Activity

Component	**Quantity** (up to)	
AAPA Certificate	Authority Certificate application submitted and accepted on 7th September 2023	
Total Area of Exploration Permit (EP 187) (ha)	442,700	
Estimated Disturbance	**Existing** (ha)	**New** (ha) (includes contingency)
Estimated Max Disturbance	**43.4**	**226**
Well Pads	9.30	62.1
Access Tracks	24.0	24.2
Gravel Pits	2.5	57.6
Laydown Area	7.6	0.0
Water Bore Pads	-	1.1
Flowline	-	60.0
MRGP Connection	-	3.2
Campsite	-	1.2
Gas Plant	-	5.7
Communications Satellite dish	-	0.3
Water Handling Station	-	10.6
Petroleum & HF Stimulation		
Wells	Up to 9 new (including re-entry of one) and 3 existing wells	
Well Pads	Up to 4 new (plus use, and potential expansion, of 2 existing)	
Wells to be Hydraulically Fractured	Up to 9	
Proppant (sand) (tons)	Up to 14,000 tonnes per well	
Gravel Pits		
Quantity	Up to 9 (plus use, and potential expansion, of 3 existing gravel pits)	

Component		Quantity (up to)	
Predicted Extraction Volume (m^3)		100,000 m^3	
Groundwater			
Extraction Licence		Applied for (Anticipated that current extraction licence GRF10316 is amended)	
Extraction Licence Quantity (ML)		750 ML / year	
Estimated Number of Production Bores*		Up to 9 new (plus use of the 5 existing under GRF10316)	
Estimated Number of New Water Bore Pads		Up to 9	
Estimated Total Groundwater Usage (ML)		~950	
Estimated Control Monitoring Bores		~8*	
Estimated Impact Monitoring Bores		~8*	
Estimated Flowline Length (km)		~ 50 – 60**	
Waste & Wastewater			
Generation		**Storage & Handling**	
Estimated Volume of Drilling By-products (m^3)	1,500 m^3 / well	**Well pad Sump Capacity (Each)** (m^3)	4,500
HF Flowback Generated (ML)	~35 ML / well (Intended to be reused)	**Number of Above-ground Tanks**	**Water Handling Station:** Main configuration up to 110 ML in capacity. Indicatively planned to be one 55 ML and four smaller above-ground tanks. **Well pads and WHS:** Up to one contingency 13 ML tank per pad (theoretical max amount of 7 contingency tanks)
Flowback/Wastewater Final Predicated for Treatment and Offsite Disposal (%)	~5% / well	**Largest Potential Above-ground**	110

Component	Quantity (up to)	
	Tank Total Capacity (ML)	
Indicative Schedule		
Activity Duration	5 years (2024 – 2029) subject to extension	
Cumulative Duration of Hydraulic Fracturing (months)	~25	
Indicative Work Force / Personnel		
Personnel Estimate per Work Force (Persons)	Drilling: ~40 Hydraulic fracturing: ~40 Civil Construction: ~20 Gas Plant: ~6	
Quantity of Campsites	1 central camp site	
Indicative Traffic		
Estimated Peak Traffic Movement for the Activity (in a week)	~240 Light Vehicle ~74 Heavy Vehicle	
Average Movements for First 3 Months / week (first 3 months)	~186 Light Vehicle ~39 Heavy Vehicle	
Average Movements / week (remaining months)	~65 Light Vehicle ~29 Heavy Vehicle	
Estimated Greenhouse Gas Emissions		
Estimated Total (tCO_2-e)	~180,381	
Petroleum Production		
Gas Exportation	~25 TJ/day	

* Control and Impact monitoring bores will be installed as per *the Code* and the *Preliminary Guideline: Groundwater Monitoring Bores for Exploration Petroleum Wells in the Beetaloo Sub-Basin* [DENR, 2018]. This number is based on a fair assumption of aquifers present at four new well pad locations.

** Upper bound includes contingency flowlines.

d. Existing Environmental Features

The environmental features in the CPP Area are described in the *Terrestrial Ecosystems Baseline Report: Strategic Environmental and Baseline Assessment for the Beetaloo Sub-basin* (Beetaloo SREBA Report) [YOUNG L ET AL; DEPWS, 2023] and summarised in **Section 4** below. Imperial has commissioned desktop studies and field assessments to map the environmental and historical features of the CPP Area and the surrounding region. These assessments are presented in **Appendix 01** (Environmental Assessment Report) and **Appendix 02** (Archaeological Survey Report). The features of the existing environment are summarised in **Table. iii**.

Table. iii Summary of the Existing Environment

Theme	Environmental Feature	Description
Land	Bioregions	• Majority portion of CPP Area: Sturt Plateau • Minority portion of CPP Area: Gulf Fall and Uplands
	Land System	• Lateritic plains and rises • Bukalara land system
	Land Use	• Cattle grazing • Traditional Aboriginal land management practices
	Vegetation	Large perennial tussock grasses, broad-leaved and lilioid herbs in the inter tussock spaces, and sparse presence of woody plants.
Water	Surface Water	Several streams transect the CPP Area, with the largest being order three. The CPP Area is located on the divide between the Limmen Bight River and McArthur River catchments.
	Groundwater	The recognised aquifer system at the CPP Area is the Cambrian Limestone Aquifer (CLA). Imperial's estimated groundwater usage for the Activity is 950 ML. Imperial will apply for an increased water allocation in Groundwater Extraction Licence (GWEL) GRF10316 from 85 ML/a to 750 ML/a for the Activity. This is less than 10% of the Georgina Basin petroleum activity cap of 8 GL/a and approximately 0.4% of the Georgina Basin beneficial groundwater allocation of 186.154 GL/a [DEPWS, 2023B].

Theme	Environmental Feature	Description
		Reuse of HF flowback may reduce the Activity's overall potential annual groundwater extraction requirements by up to 40%.
Significant, Threatened, and Pest Species	Significant or Threatened Species	The Environmental Assessment (**Appendix 01**) identified two birds species listed under the *Environment Protection Biodiversity Conservation Act, 1999 (EPBC Act)* and/or *Territory Parks and Wildlife Conservation Act, 1976 (TPWC Act)* that are known to or are highly likely to occur in the CPP Area. Four species listed as migratory (*EPBC* only) are known or highly likely to occur. No Threatened Ecological Communities (TEC) were found to occur within the study area. An addendum to the Environmental Assessment, which considers subsequent EPBC status updates, also identified two EPBC listed reptile species, one of which has a high likelihood of occurrence in the study area.
	Pest Flora	Two Class A and six Class B weeds have been identified in either desktop or ground surveys in EP 187. None of these species occur within the disturbance area of the Activity and hence are outside of the management area.
People	Community and Economy	The CPP Area is located within the Mambaliya Rrumburriya Wuyaliya Aboriginal Land Trust (NT Portion 5706). There are no settlements within the CPP Area. The closest dwelling is West Balbirini, which is 1.3 km east of the CPP Area.
	Culture and Heritage	[redacted] No World Heritage Properties, National Heritage Places, Wetlands of International Importance, Great Barrier Reef Marine Park, or Commonwealth Marine Areas occur within the study area.
	Existing Infrastructure	The Carpentaria Highway and the McArthur River Gas Pipeline transect the CPP Area (east to west) and are generally aligned with each other and follow topographic high points in the local landscape at approximately 250 m AHD.

e. Environmental Impacts and Risks

Risks and impacts associated with the Activity have been identified via an Environmental Risk Assessment (ERA) using the S-P-R model (source, pathway, and receptor). The implementation of numerous environmental controls has enabled the reduction of residual risk to ALARP.

The ERA process combines the likelihood and consequence of an event occurring to give a relative indication of risk ranking associated with that event. The ERA identified sensitive environmental factors, and their initial and residual risk rankings. The EMP presents a detailed ERA.

The highest risk ranking of 5 relates to fugitive greenhouse gas emissions, and the flaring or venting of gas during appraisal phase, potentially contributing to anthropomorphic climate change. Good design and operation practices will significantly reduce the risk of fugitive emissions, and gas recovery on an appraisal basis would significantly reduce flaring and venting emissions (approval is currently being sought under Section 57AAA of the P*etroleum Act, 1984 (NT)*. With these controls this risk is reduced to a ranking of 3. If the application under Section 57AAA is unsuccessful and the Activity proceeds on a basis different to the one described, this EMP will be revised or modified under the *PER* to account for any new or increased environmental impacts or risks. This revision would include a greenhouse gas abatement plan if Imperial's estimated scope 1 emissions exceed 100,000 tCO_2-e in any financial year over the life cycle of the project.

The results of the ERA for environmental factors with an initial risk ranking of 4 and 5 are summarised in **Table. iv**. The risk assessment process and a comprehensive risk assessment table detailing the full range of environmental factors, potential impacts, mitigation measures and initial and residual risk rankings is provided in **Section 6**, **Table 6.2—3** Risk Assessment Table of this EMP.

f. Chemicals Risk Assessment

Due to hydraulic fracturing, a tiered chemical and human health risk assessment has been undertaken to identify chemicals of concern to both human health and the environment. Potential chemical exposure routes include transportation, storage, hydraulic fracturing, and the subsequent treatment and disposal of flowback fluids.

The tiered method employed is as follows:

- **Tier 1** – Identify chemicals of low human health and ecological concern that do not require additional chemical risk assessment in the tier assessment process.
- **Tier 2** – Identify chemicals that are not identified as a low human health and ecological concern and therefore require an additional risk assessment to characterise potential

risks. This risk assessment is conducted using a quantitative evaluation of the risks based on the potential complete exposure pathways and Tier 1 assessment.

Three hydraulic fracturing system formulations were assessed, with ten chemicals carried through to a Tier 2 assessment. These were as follows:

- Amine oxides, cocoalkyldimethyl
- Chlorous acid, sodium salt
- Crontonaldehyde
- Glutaraldehyde
- Tributyl tetradecyl phosphonium chloride
- Dicoco dimethyl quaternary ammonium chloride
- Octamethylcyclotetrasiloxane
- Decamethylcylopentasiloxane
- Dodecamethylcyclohexasiloxane
- Copper (II) sulfate

Based on an assessment including the persistent, bioaccumulative, and toxic (PBT) nature of the chemicals, a hazard quotient (HQ) of less than one was determined for all considered chemicals. On this basis, no further management controls are deemed necessary.

Imperial acknowledges chemical variations in stated hydraulic fracturing chemicals may require a modification or revision of the EMP.

Table. iv Summary Environmental Factors Risk Ranking Assessment

Environmental Factor	Source	Potential Impact	Initial Risk Ranking	Residual Risk Ranking
Atmospheric Processes	**Operation of Petroleum Wells**	Flaring or venting gas during appraisal phase contributes to anthropomorphic climate change	**5**	**3**
Terrestrial Environmental Quality	**Wastewater flowline**	Wastewater flowline leak impacting soil	**4**	**3**
Terrestrial Environmental Quality	**HF Flowback Water Storage**	HF flowback water loss of containment impacting soil	**4**	**3**
Culture and Heritage	**Infrastructure Site Selection**	Damage to cultural and heritage places and objects	**4**	**3**
Culture and Heritage	**Land Clearing**	Damage to cultural and heritage places and objects	**4**	**3**
Human Health	**Hydraulic Fracturing**	HF sand dust silicosis impacts	**4**	**3**
Inland Environmental Quality	**Wastewater flowline**	HF flowback water flowline leaks impacting inland surface water	**4**	**3**
Inland Water Environmental Quality	**HF Flowback Water Storage**	HF flowback water loss of containment impacting inland surface water	**4**	**3**

*Environmental factors with an initial risk ranking of 4 and 5.

g. Environmental Outcomes

This EMP has been developed to comply with the *Petroleum (Environment) Regulations, 2016 (NT)* and *the Code*. This includes using the Activity's Environmental Outcomes, Environmental Performance Standards (EPS), and SMART Measurement Criteria, to determine whether an environmental outcome or EPS has been met. **Table. v** provides a summary of Imperial's environmental outcomes; environmental performance standards and measurement criteria can be found in **Section 6.3**.

Table. v Summary of the Environmental Outcomes

Theme	Environmental Factor	Environmental Outcome
Land	Terrestrial Environmental Quality	No significant impact on threatened flora and fauna.
	Terrestrial Ecosystems	No significant long-term impact on soil stability, quality, or surface water.
Water	Inland Water Quality	No significant impact on groundwater quality or quantity.
Air	Air Quality	No unnecessary greenhouse gas emissions are generated from the Activity.
People	Community and Economy	No significant negative impact on community (inc. Human Health).
	Culture and Heritage	No significant impact on Indigenous and non-indigenous artefacts, sacred or heritage sites.

h. Stakeholder Engagement

EP 187, including the CPP Area, is situated on the land of the Mambaliya Rrumburriya Wuyaliya Aboriginal Land Trust within NT Portion 5706. An Exploration Deed between Imperial and the Northern Land Council (NLC) was executed on 5 February 2014 under the *Aboriginal Land Rights Act, 1976 (NT)* (ALRA), enabling petroleum exploration to proceed, subject to the deed conditions, including appraisal testing. The EP 187 NLC Exploration Deed describes the petroleum shale resource of interest and sets out the terms and conditions agreed upon by the NLC and Imperial.

The CPP Area encompasses several lease holdings (as referenced in Section 19 of ALRA), which are run as extensive cattle grazing agistments, allowing livestock access to grassland, watercourses, and riparian areas within respective S-19 agistment leasehold areas. The nearest sensitive receptor to the CPP Area is West Balbirini, 1.3 km east of the CPP Area.

On 14 September 2016, the NT Government announced a moratorium on hydraulic fracturing of onshore unconventional reservoirs. The moratorium was subsequently removed on 17 April 2018, and the *Code of Practice: Onshore Petroleum Activities in the Northern Territory, 2019 (NT)* (*the Code*) was released in 2019.

Since then, Imperial has conducted an active annual petroleum exploration program on EP 187 focused in the CPP Area, requiring annual stakeholder engagement meetings on-country, engagement of custodian representatives through the NLC as Cultural Monitors in a variety of field operations, and proactively focusing on building respectful relationships with stakeholders as the Activity has matured.

Imperial has taken a proactive approach to early and ongoing engagement with a diverse range of stakeholders and the broader community so that they are informed of Imperial's ongoing works, are consulted and involved to ensure their aspirations are considered.

Imperial seeks to establish and maintain enduring and mutually beneficial relationships with the communities it is a part of, ensuring that activities generate positive economic and social benefits for and in partnership with these communities.

A list of Stakeholder contact details can be found in **Table. vi** and a summary of the engagement conducted in **Table. vii**. The rationale behind the engagement and commitment to carry out future engagement is outlined in **Section 5** and a report and full communications log in **Appendix 10**.

Table. vi Stakeholder Contact Details

Stakeholder	Contact Details
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]

Table. vii Key Consultation Activity Summary

Consultation Methodology	Description	Engagement Reach	Ongoing Commitments
Targeted Group Presentations	20 August 2023 Meeting undertaken in Katherine attendance from some Traditional Owners and interested community relevant to EP 187 - Facilitated by NLC. Content included general overview of Activities with the exception of the requirement of Section 57AAA (5)(d) to obtain approval, consent, or agreement with the NLC and Traditional Owners for the sale or other beneficial use of petroleum recovered on an appraisal basis.	24 x Traditional Owners and community members in attendance.	Targeted group presentations will remain a core methodology to continue stakeholder engagement where stakeholders have requested, or Imperial believes it would be beneficial.
	21 August 2023 Meeting undertaken in Katherine attendance from some Traditional Owners and interested community relevant to EP 187 - Facilitated by NLC. Content included general overview of Activities with the exception of the requirement of Section 57AAA (5)(d) to obtain approval, consent, or agreement with the NLC and Traditional Owners for the sale or other beneficial use of petroleum recovered on an appraisal basis.	35 x Traditional Owners and community members in attendance.	
	22 August 2023 Meeting undertaken in Elliot with attendance from some Traditional Owners and interested community relevant to EP 187 - Facilitated by NLC. Content included general overview of Activities with the exception of the requirement of Section 57AAA (5)(d) to obtain approval, consent, or agreement with the NLC and Traditional Owners for the sale or other beneficial use of petroleum recovered on an appraisal basis.	10 x Traditional Owners and community members in attendance.	
	25 August 2023 Meeting undertaken in Borroloola with attendance from some Traditional Owners and interested community relevant to EP 187 - Facilitated by NLC. Content included general overview of Activities with the exception of the requirement of Section 57AAA (5)(d) to obtain approval, consent, or agreement with the NLC and Traditional Owners for the sale or other beneficial use of petroleum recovered on an appraisal basis.	21 x Traditional Owners and community members in attendance.	
	29 November 2023 Meeting undertaken with Daly Waters Progress Association (DWPA) members.	7 x Community Organisation members in attendance.	
Community Drop-in Sessions	21 November 2023 – Robinson River	13 x community members in attendance.	

Consultation Methodology	Description	Engagement Reach	Ongoing Commitments
	Community session; advertised on local notice boards and Mungoorbada Aboriginal Corporation Facebook page.		Community drop-in sessions are to be scheduled annually to continue to build on transparent sharing of Activity information and activity updates.
	30 November 2023 – Borroloola Community session; advertised on local notice boards across the township and on the MAWA Aboriginal Corporation's Facebook page.	20 x community members in attendance.	
	1 December 2023 – Daly Waters (Hiway Inn) Community session; advertised on local notice boards.	7 x community members in attendance.	
	2 December 2023 – Elliott Community session; advertised on local notice boards.	7 x community members in attendance.	
	8 December 2023 – Darwin Community session; advertised through NT News printed media and Mix 104.9 local radio station.	10 x community members in attendance.	
Online Consultation Portal and Contact Mechanism	22 November 2023 Online consultation portal launched and available to the public.	N/A	Online consultation portal to be updated with relevant information and CPP updates.
Fact Sheets and Email Briefings	From 21 November 2023 Direct email campaign to identified stakeholders and community members.	62 x stakeholders and community representatives were directly provided with information.	Revise relevant stakeholder matrix to continue to provide relevant CPP information and updates.
Field Visits	18-20 December 2022 Traditional owners and local aboriginal community members were invited to participate in field visits while Imperial was undertaking various activities, including: • Drilling Carpentaria-4V • Fracking Carpentaria-3H • Other civil operations to support project activities • Monitoring of existing infrastructure	25 x Traditional Owners and community members attended across 3 days of scheduled site visits.	Facilitation of site visits will remain an ongoing core methodology to continue providing opportunities for further stakeholder engagement for directly and indirectly affected stakeholders, when appropriate. Any requests from directly affected stakeholders to undertake field visits will be considered as a priority.
Regional Conferences and Business Network Events	13 September 2023 NT Resources Week Annual Conference. CEO presentation to provide attendees with an update on Imperial's activities and outlook for future proposed activities.	Unmeasured	Participation will remain ongoing to continue stakeholder engagement and consider other forums for participation.
	7-8 June 2023 - Alice Springs Regional Show	Unmeasured	

Consultation Methodology	Description	Engagement Reach	Ongoing Commitments
Regional Community Events and Shows Days	Provision of information on activities to date and CPP aspirations with Imperial representatives available to engage directly with community members to answer questions.		Participation will remain ongoing to continue stakeholder engagement and consider other community events relevant to stakeholder engagement.
	14 June 2023 - Tennant Creek Regional Show Provision of information on activities to date and CPP aspirations with Imperial representatives available to engage directly with community members to answer questions.	Unmeasured	
	21 June 2023 - Katherine Regional Show Provision of information on activities to date and CPP aspirations with Imperial representatives available to engage directly with community members to answer questions.	Unmeasured	
	27-29 June 2023 - Darwin Regional Show Provision of information on activities to date and CPP aspirations with Imperial representatives available to engage directly with community members to answer questions.	Unmeasured	
Local Business Supply Chain Briefings	6 December 2023 - Katherine Supply Chain Briefing facilitated by ICN NT.	17 x Local Business representatives in attendance	Participation will remain ongoing to continue stakeholder engagement
	8 December 2023 - Darwin Supply Chain Briefing facilitated by ICN NT.	97 x Local Business representatives in attendance	
Advertising and Media	22 November 2023 Printed NT News advertisement for general public awareness of Activity information and online consultation portal.	Unmeasured	Public advertising and media are to be considered where relevant to provide the general public with CPP information and updates.
	1 December 2023 Printed NT News advertisement for general public awareness of scheduled Darwin community drop-in session (8 December 2023).	Unmeasured	
	4-8 December Consistent radio advertisement slots to advertise for general public awareness of scheduled Darwin community drop-in session (8 December 2023).	Unmeasured	
One-on-one Meetings	Various one-on-one engagement meetings with stakeholders and community members were undertaken throughout 2023 as detailed in the Communications Log (**Appendix 10**, **Section 3**).	N/A	One-on-one meetings will remain a core methodology to continue stakeholder engagement where stakeholders have requested, or Imperial believes it would be beneficial.

Definitions

Terminology	Definition
Above-ground Tank	An above-ground tank used to contain produced water and flowback fluid as per C.4.2.2 of *the Code*.
Appraisal	Evaluation and can be undertaken through flaring or sales (BUA).
Appraisal Phase	A phase of the Activity that recovers petroleum on an appraisal basis as defined by Section 5 (12) *Petroleum Act, 1984 (NT)*.
Activity (may be referred to as "the Activity" in this EMP)	The Regulated Activity and associated works covered by this EMP include: • Land clearing to establish up to four new well pads out of five locations being considered, as well as the potential expansion of the existing well pads at Carpentaria 2/3 and 4. • Clearing for new access tracks and the expansion of existing landowner tracks. • Clearing for gas and water/wastewater flowlines and a connection to the McArthur River Gas Pipeline (MRGP). • Clearing for up to 9 new gravel pits plus the expansion of three existing gravel pits at Carpentaria 1, 2/3 and 4. • Clearing to establish a gas plant, water handling station, campsite, groundwater extraction and control monitoring bores, and a communications satellite dish. • Earthworks associated with excavating drilling sumps, turkey's nests, trenching for gas, and water flowline and MRGP connection. • Construction of new groundwater extraction bores, above-ground tanks, the Carpentaria Gas Plant (CGP) (including office warehouse, workshop), Water Handling Station (WHS)), gas and water/wastewater flowlines. • Drilling, hydraulic fracturing, completion, and workover of up to 9 new wells (including the re-entry of the existing well at Carpentaria 4), and the tie in and testing of up to 9 new wells plus the existing wells at Carpentaria 2/3 and 1 additional well from IMP4-3. • Operations and maintenance of up to 12 (up to 9 new and 3 existing) gas wells, new and existing well pads, laydown yard and helipad location at Carpentaria 1, groundwater extraction bores, above-ground tanks, the Carpentaria Gas Plant (CGP), Water Handling Station (WHS), gas and water/wastewater flowlines and camps (inc. irrigation of treated sewage effluent and grey water). • The storage and transportation of petroleum from up to 12 gas wells through flowlines and gas plant to the MRGP. • The storage, transfer, reuse, use, and disposal of wastewater or hazardous substances via flowline and heavy vehicle. • The recovery of petroleum on an appraisal basis. • Suspension or abandonment of the wells, and decommissioning of facilities.
Atmospheric Separator	An atmospheric separator, also referred to as a well completion vessel in *the Code*, is utilised before the pressurised separator will function.
Camp Wastewater	Treated sewage effluent and greywater from campsite/s and offices (e.g., laundry, showers, and sink wastes).
Completions Fluids	Fluid used to control a well during well completion.
CPP Area	Carpentaria Pilot Project Area – the location of the Activity within EP 187.
Decommissioning	The process by which a well is permanently sealed to prevent the flow of fluids into, out of, and along the wellbore at the end of its useful life. Also refers to a process of managing or removing facilities or infrastructure at end of use.
Drilling by-products	Residual drilling fluids, cuttings, and cement returns.
Drilling Fluids	The mixture of water and additives for drilling purposes (e.g., well control, lubricating the drill bit and removing cuttings).
Environmental Aspects	Planned and unplanned aspects of the Activity that have the potential to have an environmental impact.
Environmental Factors	Environmental factors are broad divisions of the environment that may be impacted by the Activity.
Environmental Impact	*Petroleum (Environmental) Regulations – Part 1 Regulation 3* *'Any adverse change, or potential adverse change, to the environment resulting wholly or partly from a regulated activity.'*
Environmental Risk	*Petroleum (Environmental) Regulations – Part 1 Regulation 3* *'The chance of something happening that will have an environmental impact, measured in terms of the environmental consequences and the likelihood of those consequences occurring.'*

Terminology	Definition
Extended Production Testing	Flow testing a well over a period to gather data.
Facility	New groundwater extraction bores, above-ground tanks, the Carpentaria Gas Plant (including office warehouse, workshop), Water Handling Station.
Flowback Fluid	Fluid that is a mixture of hydraulic fracturing fluid and formation fluid that is allowed to flow from the well following hydraulic fracturing.
Gravel Pit	Location of material for construction of infrastructure (e.g., gravel or clay).
Implementation Strategy	*Petroleum (Environmental) Regulations – Part 1 Regulation 3* *'The implementation strategy for a regulated activity that is included in the environmental management plan for the activity, as required by Schedule 1, Part 2 [of the PER]'.*
Indicative	Reflective of the plan but may be adjusted to suit site conditions or Activity requirements.
Infrastructure	Access tracks, well pads, wells, Carpentaria Gas Plant, Water Handling Station, groundwater bore pads, camp, gravel pits, flowlines, pipelines.
Infrastructure Movement Zone	Zones within EP 187 where the Activity infrastructure will be located. Initially, the potential locations of infrastructure are identified based on previous exploration data and experience in EP 187. Zones around the initial locations are then determined to allow for movement of the final location of infrastructure to avoid sensitive environmental and cultural receptors and their buffers, if any. The initial movement zones are then further constrained as more information about environmental and culturally sensitive receptors becomes available.
Interest Holder	Imperial Oil and Gas Pty Ltd (Imperial). May also be referred to as the Operator in this EMP.
MRGP Connection	The pipework interface point required to connect the Carpentaria Gas Plant (CGP) to the McArthur River Gas Pipeline (MRGP).
Open-topped Treatment Tank	An above-ground tank used to contain wastewater for treatment.
Operations	In relation to land in the CPP Area, means the conduct of the Activity on CPP Area land up until that land is not required for the ongoing conduct of the Activity or future regulated activities.
Pastoralist	Person or entity who leases or owns land for the purposes of carrying out livestock grazing activities.
Precautionary Principle	The precautionary principle is a mandate to address uncertainty and to ensure that potential, though not well-defined or understood, hazards are taken into account in decision making.
Produced Water	Naturally occurring water that is extracted from the geological formation following hydraulic fracturing.
CPP Footprint	The total land clearing area for infrastructure.
Recordable Incident	*Petroleum (Environmental) Regulations – Part 1 Regulation 3* *'recordable incident means an incident arising from a regulated activity:* (a) *that:* (i) *has resulted in an environmental impact or environmental risk not specified in the current plan for the activity; or* (ii) *has resulted in a contravention of an environmental* performance standard specified in the current plan for the activity; or (iii) *is inconsistent with an environmental outcome specified in the current plan for the activity; and* *(b) is not a reportable incident.'*
Regulated Activity	*Petroleum (Environmental) Regulations – Part 1 Regulation 5(1)* *'a regulated activity is an activity or a stage of an activity:* *(a) carried out, or proposed to be carried out, in connection with a technical works programme for a petroleum interest; and* *(b) that has, or will have, an environmental impact or environmental risk.'*
Reportable Incident	*Petroleum (Environmental) Regulations – Part 1 Regulation 3* *'means an incident, arising from a regulated activity, that has caused or has the potential to cause material environmental harm or significant environmental harm.'*
Significant Rainfall Event	Defined as an event where > 300 mm of rainfall occurs over four days.

Terminology	Definition
Suitably qualified person	As defined by the *Code*: A person who has professional qualifications, training or skills or experience relevant to the nominated subject matters or tasks and can give authoritative assessment, advice and analysis about performance relevant to the subject matters using relevant protocols, standards, methods or literature or conduct tasks in accordance with requirements.
Sump	Earthen excavation constructed to contain drilling by-products (drilling cuttings, fluids, cement returns). May also be called a storage pit.
the Code	*Code of Practice: Onshore Petroleum Activities in the Northern Territory 2019*
Traditional Owner	Has the meaning given in the *Aboriginal Land Rights Act 1976* (NT): *'traditional Aboriginal owners, in relation to land, means a local descent group of Aboriginals who:* (a) *have common spiritual affiliations to a site on the land, being affiliations that place the group under a primary spiritual responsibility for that site and for the land; and* *(b) are entitled by Aboriginal tradition to forage as of right over that land.'*
Wastewater	*Code of Practice: Onshore Petroleum Activities in the Northern Territory 2019 – Section C.2.1 and C.2.2* Water and wastewater to which Section C.2.1 of *the Code* applies being: *(a) water that has been used in or produced from petroleum wells, whether it is being re-used, recycled, treated, or disposed of, and includes flowback fluid, produced water, drilling fluids, completion fluids, well suspension fluids and non-aqueous drilling fluids;* *(b) "waste material" and material containing "contaminants" as defined in s 4 (1) of the Waste Management and Pollution Control Act 1998 (NT);* *(c) wastewater meeting the definition of "waste" under the Waste Management and Pollution Control Act 1998 (NT);* *(d) water that has been acquired or used in petroleum activities that is being disposed of, (for example, unused volumes of hydraulic fracture fluid or drilling fluid, raw water, or waters described in C.2.1 (a)); and* *(e) residual drilling waste, e.g., muds and cuttings (which may be more or less in a solid state) in addition to the fluids mentioned in (a) to (d) above;* *but not to the material set out in section C.2.2'.* Water and wastewater do not include fluids defined in Section C.2.2 being: *(a) recoverable hydrocarbons (e.g. oil, condensate and natural gas) produced from a well;* *(b) acquisition, storage and disposal of potable water;* *(c) stormwater which has not come into contact with petroleum products or wastes on site;* *(d) sewage; or* *(e) wastewater or waste that is generated from petroleum activities once it leaves the site of an approved petroleum activity.'*

Acronyms, Abbreviations & Units

Acronym / Abbreviation	Description
AADT	Annual Average Daily Traffic
AAPA	Aboriginal Areas Protection Authority
AEP	Annual Exceedance Probability
AHD	Australian Height Datum - equivalent to approximately "mean sea level"
AICS	Australian Inventory of Chemical Substances
ALARP	As low as reasonably practicable
ALRA	Aboriginal Land Rights (Northern Territory) Act 1976
APGA	Australian Pipelines and Gas Association
APPEA	Australian Petroleum Production and Exploration Association
ASX	Australian Stock Exchange
AWP	Annual Works Program
BAU	Business as Usual
BESA	Beetaloo extended survey area
BGL	Below Ground Level
BoM	Bureau of Meteorology
CBL	Cement Bond Log
CEC	Cation Exchange Capacity
CEO	Chief Executive Officer
CGP	Carpentaria Gas Plant
CLA	Cambrian Limestone Aquifer
CO_{2-e}	Carbon dioxide equivalent
CoPC	Constituents/Chemicals of Potential Concern
CPESC	Certified Professional in Erosion and Sediment Control
CPP	Carpentaria Pilot Project
CPPRP	Carpentaria Pilot Project Rehabilitation Plan
D&C	Drilling and Completions

Acronym / Abbreviation	Description
DAWE	Dept of Agriculture, Water and the Environment
DD	Data Deficient
DDR	Daily Drilling Report
DEPWS	Department of Environment, Parks and Water Security
DFIT	Diagnostic Fracture Injection Test
DIPL	Department of Infrastructure, Planning and Logistics
DITT	Department of Industry, Tourism and Trade
DoEE	Department of Environment and Energy
EC	Electrical Conductivity
EMP	Environmental Management Plan
EP	Exploration Permit
EP Act	Environment Protection Act 2019
EPA	Environment Protection Authority (NT)
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999
EPS	Environmental Performance Standards
ERA	Environmental Risk Assessment
ERN	Emergency Response Numbers
ERP	Emergency Response Plan
ESCP	Erosion Sediment Control Plan
ESD	Ecologically Sustainable Development
ESY	Estimated Sustainable Yield
EUR	Estimated Ultimate Recoverable
EVNT	Endangered, Vulnerable or Near Threatened
FTE	Full-time Equivalent
GBA	Geological and bioregional assessment
GDE	Groundwater Dependant Ecosystem
GHG	Greenhouse Gas

Acronym / Abbreviation	Description
GIS	Geographic Information System
GISERA	Gas Industry Social and Environmental Research Alliance
GL	Gigalitres (1,000,000,000 litres)
GL/a	Gigalitres per annum
GRF	Gum Ridge Formation
GW	Giga Watt
GWEL	Ground water extraction licence
GWWAP	Georgina Wiso Water Allocation Plan 2023-2031
ha	Hectares
HDD	Horizontal directional drilling
HF	Hydraulic Fracturing
HFI	Hydraulic Fracturing Inquiry
HHERA	Human Health & Environmental Risk Assessment
HSEMS	Health Safety Environment Management System
HV	Heavy Vehicle
IADC	International Association of Drilling Contractors
Imperial	Imperial Oil & Gas Pty Limited
IMS	Integrity Management System
kg	Kilograms
km	Kilometre
KOP	Kick-Off Point
L	Litres
LACA	Land Access and Compensation Agreement
LCG	Land Clearing Guidelines
LEL	Lower Explosive Limit
LoR	Level of Reporting
LWD	Logging While Drilling

Acronym / Abbreviation	Description
LV	Light Vehicle
m	Metres
m BGL	Metres Below Ground Level
MAASP	Maximum Allowable Annular Surface Pressure
MAOP	Maximum Allowable Operating Pressure
MD	Measured Depth
MEMP	Methane Emissions Management Plan
MESP	Maximum Expected Surface Pressure
ML	Megalitres (1,000,000 litres)
ML/a	Megalitres per annum
mm	Millimetres
MMCF	Million Cubic Feet
MNES	Matters of National Environment Significance
MoC	Management of Change
MPa	Megapascal
MRGP	McArthur River Gas Pipeline
MRM	McArthur River Mine
mRT	Metres Rotary Table, referenced to the rotary table height of the original drilling rig, all wellbore geometry is measured in mRT.
MVD	Motor Vehicles per Day
MW	Mega Watt
NAFI	North Australia Fire Information
NEPM	National Environment Protection Measure
NGERS	National Greenhouse Energy Reporting Scheme
NLC	Northern Land Council
NRM	Natural Resource Management
NT	Northern Territory
NT EPA	Northern Territory Environment Protection Authority

Acronym / Abbreviation	Description
NVIS	National Vegetation Information System
OEM	Original Equipment Manufacturer
P/E	Precipitation to Evaporation
Panel	Independent Scientific Panel
PBT	Persistent-Bio-accumulative-Toxic
PEGN	Polyethylene gathering network
PCBU	Person Conducting Business or Undertaking
PJ	Peta joule
PL	Petroleum Lease
PM	Project Manager
PM10	Particulate Matter < 10 micron (µm)
PM2.5	Particulate Matter < 2.5 micron (µm)
PMP	Probable Maximum Precipitation
PMST	Protected Matters Search Tool
ppb	Parts per Billion
PPE	Personal Protection Equipment
PPL	Petroleum Pipeline License
ppm	Parts per Million
psi	Pounds per Square Inch
ROW	Right of Way
SC	Site Coordinator
SCADA	Supervisory Control and Data Acquisition
SDS	Safety data sheets
SHRR	Significant Hazard Risk Register
SMP	Spill Management Plan
SQP	Suitably Qualified Person
SRE	Significant Rainfall Event

Acronym / Abbreviation	Description
SREBA	Strategic Regional Environmental Baseline Assessment
SRTM	Shuttle Radar Topography Mission
SRV	Stimulated Rock Volume
SSCC	Sacred Site Clearance Certificate
tCO_2-e	Tonnes of carbon dioxide equivalent
TD	Total Depth
TDS	Total dissolved solids
TEC	Threatened Ecological Communities
TEG	Tri-ethylene glycol
TIA	Traffic Impact Assessment
TJ	Tera Joule
TO	Traditional Owners
ToC	Top of Cement
TOC	Total Organic Content
TVD	True Vertical Depth
TVDSS	True Vertical Depth referenced to sea-level (Australian Height Datum)
UCL	Upper Control Limit
WAC	Well Acceptance Criteria
WBIV	Well Barrier Integrity Validation
WCBD	Well Control Bridging Document
WHS	Water Handling Station
WMP	Weed Management Plan
WOMP	Well Operations Management Plan
WoNS	Weed of National Significance
WWMP	Waste and Wastewater Management Plan

Conversion Values

Unit	Conversion Equivalence
1 TJ	= 0.001 PJ = 1,000 GJ
1 km^2	= 100 ha = 1,000,000 m^2
1 ppm	= 1 mg.l^{-1} = 1000 ppb = 0.0001%
1 MPa	= 145 psi
1 ML	= 1,000,000 L = 0.001 GL = 264,172 US gallons

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1 Introduction

1.1 Background and Motivation

The Activity covered by this EMP will occur within the area referred to as the Carpentaria Pilot Project (CPP) Area (shown in **Figure 1.4—2**) within EP 187. The CPP Area is within the Barkly region of the Northern Territory approximately 150 km southwest of Borroloola, in the Beetaloo extended survey area [DEPWS, 2023B].

The Activity proposed under this EMP follows on from petroleum exploration and appraisal within the EP since 2019, and includes:

- Land clearing and earthworks.
- Drilling, hydraulic facture, completion, testing, maintenance, suspension, and abandonment of wells.
- Construction, operation, modification of facilities, and gas and wastewater flowlines used to recover petroleum, treat water, and treat gas.
- Decommissioning and rehabilitation.

Work undertaken in the EP to date includes:

- 388 km of 2D seismic acquisition.
- The drilling of four petroleum exploration and appraisal wells (two horizontal and two vertical).
- The hydraulic fracturing (HF) and extended production testing of three of those wells.

The testing of the existing wells, although of a limited duration, has provided positive results that led to this pilot development.

The Activity proposed under this EMP represents the ongoing appraisal phase of the shale gas discovery that was announced to the ASX in 2021 with the successful production test at the Carpentaria-1 petroleum well. The gas produced by the Activity will be recovered on an appraisal basis rather than flared.

A scenario of flaring produced gas will make up over 90% of the potential total annual GHG emissions associated with the Activity. To eliminate these unnecessary GHG emissions, Imperial proposes to export the gas flow to customers via the McArthur River Gas Pipeline that crosses the CPP Area. This would eliminate over 90% of GHG emissions associated with the Activity. Note: The Activity proposed in this EMP does not pertain to the maintenance and operational activities of the McArthur River Gas Pipeline.

A key objective of the NTEPA's *Environmental Factors and Objectives* is the Environmental Factor for atmospheric processes, which is to minimise greenhouse gas emissions, contributing to the NT Government's goal of achieving net zero greenhouse gas emissions by 2050 [NT EPA, 2022B]. *Greenhouse Gas Emissions Management for New and Expanding Large Emitters* applies to all new projects and expanding existing projects likely to be large greenhouse gas emitters and is defined for an industrial project threshold as below.

> *Estimated scope 1 emissions of 100,000 tCO_2-e in any financial year over the life cycle of a project, not counting emissions generated from land clearing directly associated with the project [NORTHERN TERRITORY GOVERNMENT, 2021].*

Imperial believes that the Activity satisfies the requirements of Section 57AAA to recover petroleum on an appraisal basis and is progressing with the requirement of Section 57AAA (5)(d) to obtain approval, consent, or agreement with the NLC and Traditional Owners for the sale or other beneficial use of petroleum recovered on an appraisal basis. If successful, this will enable Imperial to conduct testing at each of the well pads without extended flaring. The Carpentaria Gas Plant (CGP) will be constructed to treat and compress gas for export to the existing McArthur River Gas as Pipeline. Exportation is forecast to commence in 2025 (**Figure 1.6—1**). If the application under Section 57AAA is unsuccessful and the Activity proceeds on a basis different to the one described, this EMP will be revised or modified under the *PER* to account for any new or increased environmental impact or risk. This revision would include a greenhouse gas abatement plan if Imperial's estimated scope 1 emissions exceed 100,000 tCO_2-e in any financial year over the life cycle of the project. The Activity is forecasted to export ~25 TJ/day from wells during the appraisal phase, primarily to characterise a longer-term well production decline curve over an extended period of three years or more. This appraisal gas production is equivalent to approximately 475,000 tonnes of GHG emissions/year if flared rather than exported.

Unconventional resources, such as shale, require testing from several wells over multiple years to statistically define type well performance and gas recovery distributions, both of which are key determinants for assessing commerciality. Unlike conventional gas fields, where naturally existing reservoir permeability is sufficient to enable gas to flow freely to the surface, shale reservoirs require a more cautious, extensive appraisal phase.

The Activity has the following objectives:

- Evaluate gas production from appraisal wells for an extended period of years to help define well performance and decline rates and estimate the expected ultimate recovery (EUR) of resources.
- Assess the commerciality of the resource necessary for moving beyond the pilot phase into full-field development.

- Further delineate the shale resource through the appraisal of up to nine new wells on up to four new pads, in addition to the existing well pads in the CPP Area.
- Optimise operations, including hydraulic fracture (HF) flowback management and fluid reuse, to most efficiently and effectively develop the resource for all stakeholders.

The Activity is located on the elevated divide between two catchments. The containment, appropriate treatment, and management of HF flow back fluid and produced water at a centralised water handling station (WHS) that is secure, purpose-built, and designed for treatment and re-use is proposed. It is essential to the overall sustainability of the Activity.

The well pad design, the proposed location of the WHS, and the use of buried high-density polyethylene (HDPE) flowlines, constructed in compliance with the *Australian Polyethylene Gathering Network Code (PEGN)* [APGA, 2019] to transfer high volumes of HF flowback fluid and wastewater between the well pads and WHS, provides a high level of confidence in containment and integrity in managing wastewater and HF flowback fluid transfer. The flowlines will also be used to transfer water to well pads for use as make-up water for HF operations. In periods when the flowlines are out of service for maintenance or other operational reasons, HF Flowback may be transported by truck to the WHS for off-site disposal or transferred to an above-ground tank at a well pad within the CPP Area.

If the Appraisal Phase is not deemed successful after the conduct of the Activity, the residual environmental impacts will not be significant. Careful attention in the well pad design and other disturbance areas to the discreet storage of vegetation and topsoil containing high cation exchange capacity (CEC) will enhance native savannah tussock grassland recovery in the rehabilitation of disturbed sites to baseline conditions. No PBT chemicals of human health concern are proposed for use in the Activity; and overall land clearing and groundwater extraction will be modest compared to other industrial activities. The decommissioning of facilities and of petroleum wells is regulated, and Imperial will decommission and rehabilitate the cleared land as per the regulations and Codes in place at the time as reflected in the Rehabilitation Management Plan – **Appendix 05** of the EMP.

1.2 Interest Holder/Operator Details

Imperial Oil & Gas Pty Limited (Imperial) is a wholly owned subsidiary of Empire Energy Group Limited and holds a 100% interest in Exploration Permit (EP) 187. **Table 1.2—1** provides details of Imperial and the nominated liaison person.

Imperial will notify and provide updated details to the Department of Industry, Tourism and Trade (DITT) and the Department of Environment, Parks and Water Security (DEPWS) if there is a change in the contact details for the Interest Holder/Operator or liaison person.

Table 1.2—1 Details of the Interest Holder/Operator and Nominated Liaison Person

Interest Holder/Operator Details	Liaison Contact Person
Interest Holder: Imperial Oil & Gas Pty Limited	**Name:** Alex Underwood
Operator: Imperial Oil & Gas Pty Limited	**Position:** Chief Executive Officer
Telephone: 02 9251 1846	**Company:** Imperial Oil & Gas Pty Limited
Address: Level 5, 6-10 O'Connell Street, Sydney, NSW, 2000	**Address:** Level 5, 6-10 O'Connell Street, Sydney, NSW, 2000
Telephone: 02 9251 1846	**Telephone:** 02 9251 1846
ABN: 92 002 699 578	**Email:** info@empiregp.net

1.3 Purpose

The purpose of this EMP is to:

- Describe how Imperial will conduct the proposed Activity under the EMP in a manner consistent with the principles of ecologically sustainable development such that impacts and risks are reduced to ALARP and acceptable.
- Provide a systematic description and quantitative assessment of the existing environmental factors, potential risk sources, and pathways.
- Provide environmental performance standards, controls, and statutory management plans to assist Imperial:
    - Undertake construction and operations across the CPP Area, which are environmentally focused on Isolation-Containment-Integrity and Monitoring.
    - Maintain a positive position in the local community during the construction, operation, maintenance, and decommissioning phases.
- Be a practical document with environmental management principles that are transparent and able to be implemented and effective.
- Demonstrate that Imperial is aligned with the principles of Ecological Sustainable Development.

1.3.1 Ecologically Sustainable Development

The word sustainability is derived from the Latin *sustinere* (*tenere*, to hold; *sus*, up). Since the 1980s, sustainability has been used more in the sense of human sustainability. Ecologically Sustainable Development (ESD) relies on implementing sustainable development practices and principles so that development meets the needs of present generations without compromising the ability of future generations to meet their needs. There is no universally accepted definition of ESD; however, the Commonwealth Government of Australia suggests the following:

> *'Using, conserving and enhancing the community's resources so that ecological processes, on which life depends, are maintained, and the total quality of life, now and in the future, can be increased' [Ecologically Sustainable Development Steering Committee, 1992].*

The aim of ESD for Imperial in this EMP is to:

- Document and promote environmental, social, and economic best practice for the Carpentaria Pilot Project and ensure that the principles of ecological sustainable development, community expectations, and the needs of other user groups are integrated into the management and operation of the Activity.
- Formalise Imperial's commitment to environmentally sustainable practices and a duty of care for the environment and heritage in which the CPP Activity is located.

All aspects of potential environmental and heritage impacts have been assessed, and appropriate preventative and mitigative measures have been implemented and will be monitored to ensure that all aspects of the Activity are managed and developed in accordance with the ESD concepts and this EMP.

Imperial recognises that the CPP Activity, while explorative in nature, provides significant opportunity for preferencing suitable contractors within the NT, and this is documented **in Section 5** – Stakeholder Engagement and detailed in **Appendix 10**.

Imperial also recognises the importance of providing local opportunities for on-the-job training, certification and employment locally during the Activity. Imperial will continue to engage and consult with Traditional Owners on identifying potential opportunities.

1.4 Location and Layout of the Activity

The CPP Area is in the southwest of EP 187. EP 187 is comprised of 52 total and partial graticular blocks, or approximately 298,400 ha, on the eastern boundary of the Sturt Plateau bioregion (Figure 1.4—2). The nearest house is 1.3 km east of the CPP Area boundary on Carpentaria Highway and 7.5 km away from the main project activities (Figure 1.4—2). The nearest

community/town of Cape Crawford is 66 km east. Borroloola is 150 km northeast; Birdum is 190 km northwest; and Darwin is 640 km northwest.

In this tropical savannah country, elevation is a key consideration in site selection. Within the CPP Area, ground elevations vary from approximately 220 m to 270 m AHD, and key sites preferentially avoid predicted 1/100-year inundation levels.

The CPP Area lies wholly within NT Portion 5706, which is an Indigenous estate for the Mambaliya Rrumburriya Wuyaliya Aboriginal Land Trust as landowners. In 2013, Imperial applied for the grant of a petroleum exploration permit. Pursuant to Section 41 of the *Aboriginal Land Rights Act, 1986 (NT),* Imperial applied to the Northern Land Council (NLC) for consent to the NTG grant of petroleum Exploration Permit (EP) 187.

The CPP Area also overlies several agistment S-19 Lease holdings, which are run as extensive cattle grazing leaseholds, allowing livestock access to savannah, watercourses, and riparian areas.

An NLC Exploration Deed was executed with Imperial on 5 February 2014. The EP 187 NLC Exploration Deed describes the petroleum shale resource of interest. It sets out the terms and conditions agreed upon by the NLC and Imperial, under Part IV of the *Aboriginal Land Rights Act, 1986 (NT)*, including appraisal testing.

Imperial believes that the Activity satisfies the requirements of Section 57AAA to recover petroleum on an appraisal basis and is progressing with the requirement of Section 57AAA (5)(d) to obtain approval, consent, or agreement with the NLC and Traditional Owners for the sale or other beneficial use of petroleum recovered on an appraisal basis.

On 14 September 2016, the Northern Territory Government announced a moratorium on hydraulic fracturing of onshore unconventional reservoirs. The moratorium was removed on 17 April 2018 with the promulgation of *the Code of Practice: Onshore Petroleum Activities in the Northern Territory 2019 (NT)* (*the Code*). Since then, Imperial has conducted an active annual exploration program on EP 187 focused in the CPP Area, requiring annual stakeholder engagement meetings on-Country, and proactively focusing on building respectful relationships with stakeholders as the EP 187 shale exploration and appraisal has matured.

The layout of the Activity within the CPP Area is shown in Figure 1.4—2. Imperial intends to produce natural gas at approximately 25 TJ/day from up to six well pads. The produced gas will be exported via the McArthur River Gas Pipeline that crosses the CPP Area. The potential Production License area within EP 187, which may follow a successful appraisal phrase, comprises eight graticular blocks, six of which are partial, as shown in **Figure 1.4—1**.

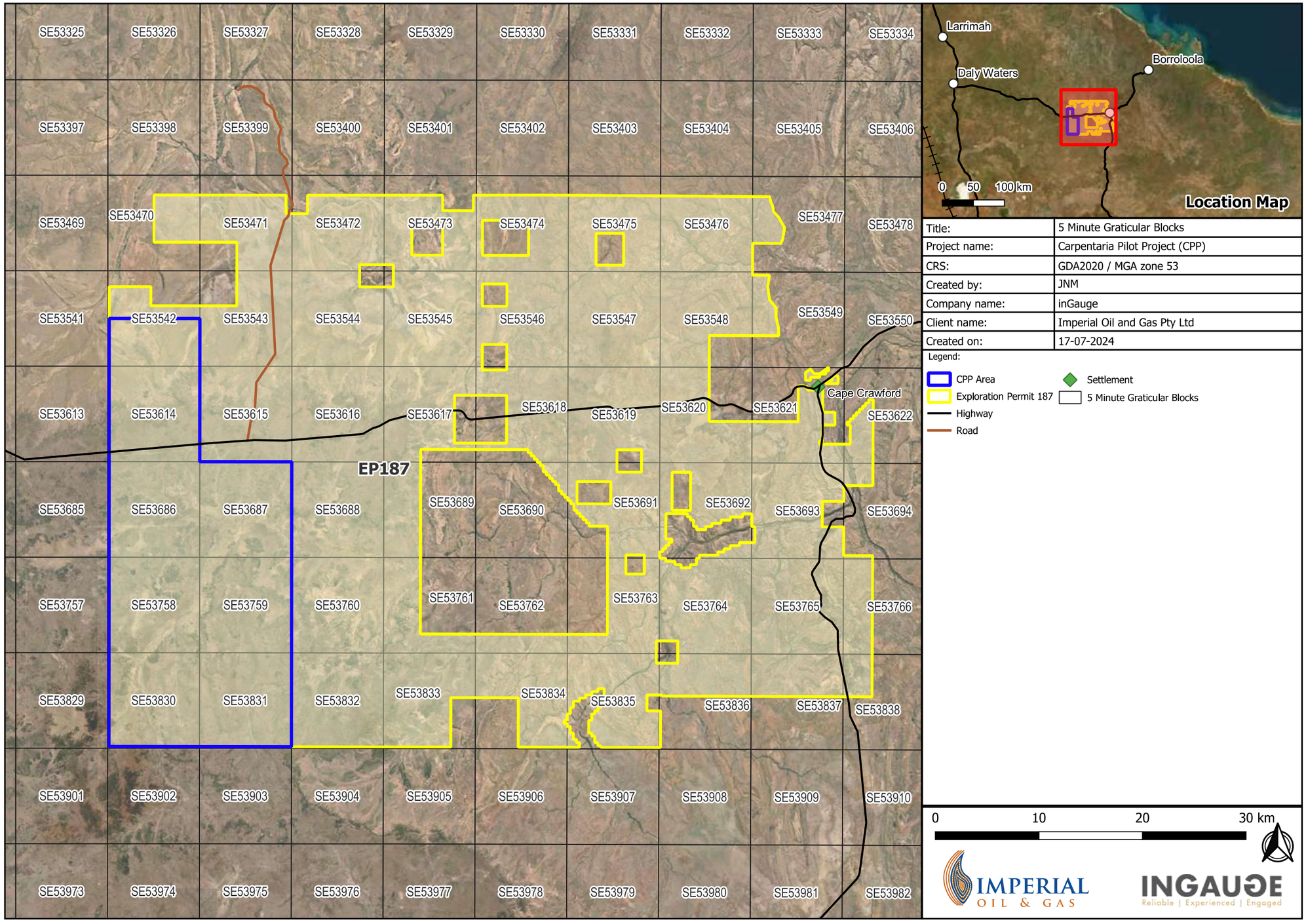

Figure 1.4—1 CPP Area Boundary on EP 187 Graticular Blocks

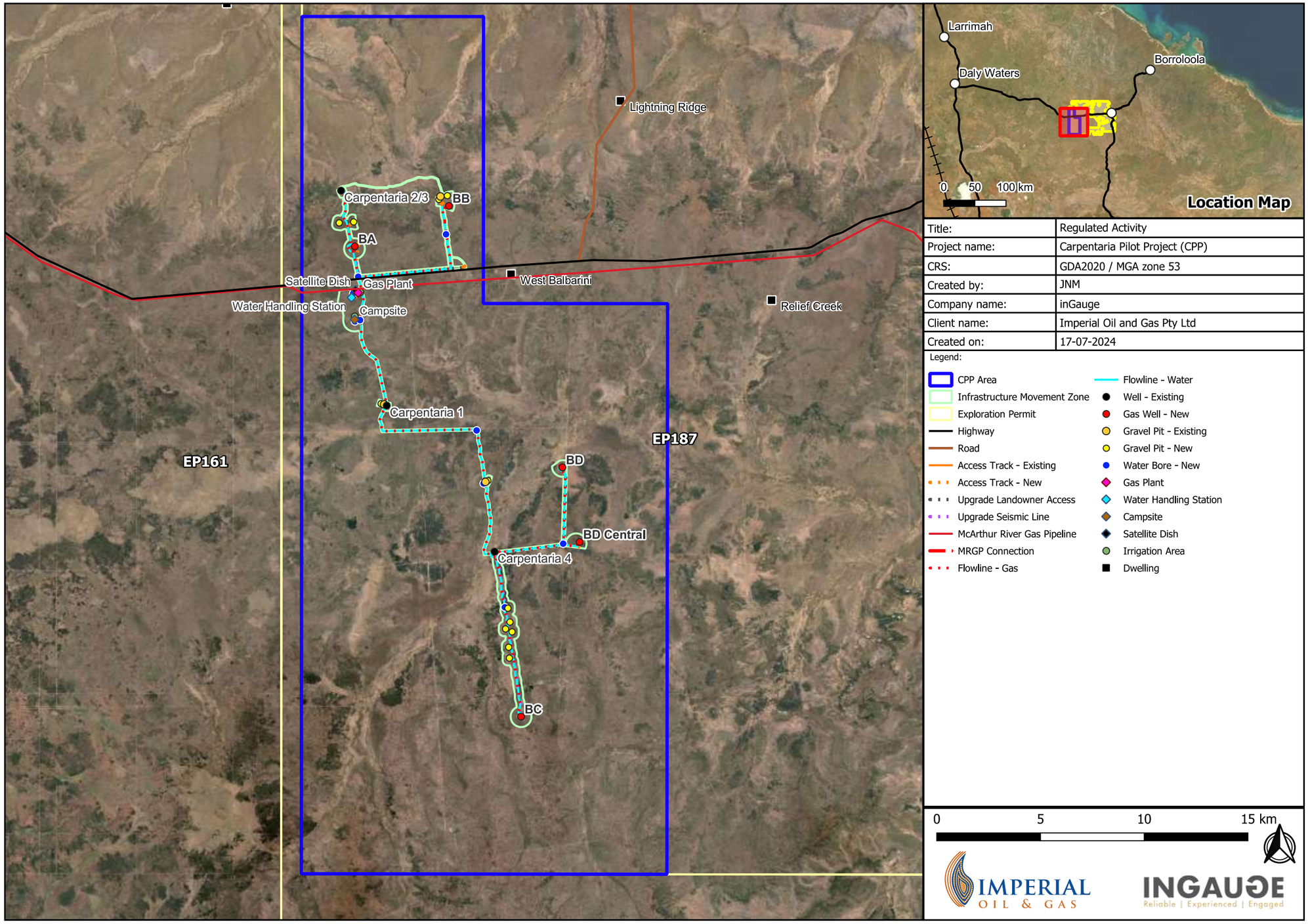

Figure 1.4—2 Location and Layout of the Activity

1.5 Scope

The Activity covered by this EMP includes:

- Land clearing and earthworks.
- Drilling, hydraulic facture, completion, testing, maintenance, suspension, and abandonment of wells.
- Construction, operation, modification of facilities, and gas and wastewater flowlines used to recover petroleum, treat water, and treat gas.
- Decommissioning and rehabilitation.

The key components of the Activity are listed in **Table 1.5—1**.

Table 1.5—1 Key Components of the Activity

Aspect	Component	Size / Capacity
Carpentaria Pilot Project	Construction period	Up to 5 years
	Existing disturbed area	43.4 ha
	Proposed Disturbed area	~226 ha
	Number of well pads	Up to 4 new and 2 existing
	Life of each well pad	Up to 50 years
	Estimated Workforce (FTE)	Civils: 20 Drilling: 40 Hydraulic Fracturing: 25 CGP: 6
	Petroleum Production	~25 TJ/day
Petroleum	Number of wells	Up to 9 new plus 3 existing
	Tonnes of proppant sand	Up to 14,000 tonnes per well
	Gas gathering network	Up to 60 km
	Estimated Groundwater Extraction (ML)	~950 ML

Aspect	Component	Size / Capacity
Water Management	Water handling site (WHS) (assumed configuration)	110 ML capacity – array of tanks
	HF Flowback (HF flowback Water/wastewater) flowlines	Up to 60 km
	Groundwater Bores (production)	Up to 9
	Grey water - domestic	< 3 ML/year
Estimated Solid Waste	Drilling cuttings (per well)	600 m^3
	HF Residual Flowback Sludge (per well)	~1.7 ML
Gravel Requirement	CPP gravel pits	Up to 100,000 m^3
Activity Infrastructure	Well Pads	62.1 ha
	Water handling station (WHS)	10.6 ha
	Carpentaria Gas Plant (CGP)	5.7 ha
	Access Tracks (including contingency)	24.2 ha
	Flowline corridor (including contingency)	60 ha
	Gravel pits	57.6 ha
	Camp	1.2 ha
	Water bore pads	1.1 ha
	Laydown (existing)	7.6 ha
	Pipeline (including contingency)	3.2 ha
	Communication Satellite Dish	0.3 ha

1.6 Timing and Phasing of the Activity

An indicative timetable for the Activity is presented in **Figure 1.6—1**. Appraisal gas exports to the McArthur River Gas Pipeline are proposed to commence in 2025.

Note: Decommissioning and rehabilitation are not included in the schedule as they will occur at the cessation of the Activity. In a success case this will be beyond the life span of the approved EMP (5-years).

The estimated annual workforce requirements and site accommodation based on the indicative schedule are shown in **Figure 1.6—2**. The Activity will be carried out in phases subject to project sanction, capital, personnel and operational resourcing, and stakeholder and regulatory approval.

Table 1.6—1 provides an outline of the indicative team size required for each major component of the Activity, the level of skill required, and the anticipated contract length. These indicative crew sizes are the minimum required to complete a phase of the Activity. Where several phases are scheduled in parallel, i.e. if two water bores are to be drilled and constructed at the same time, two crews (of four) will be contracted.

Short-term contracts refer to roles or crews required for less than six consecutive months. These contracts are typically utilised for specific phases of the Activity that demand specialised skills for a limited duration.

Permanent contracts refer to roles or crews required for more than six consecutive months. For this Activity, the term "permanent" applies to those roles or crews needed for the long-term duration of the Activity, starting April 2025 and concluding in 2029. These contracts are essential to maintain continuity and ensure the completion of extended phases of the Activity.

Activity phases vary significantly in their duration, which leads to a combination of contracted lengths and potential delays. Such delays may be due to factors outside of the initial work scope, including but not limited to abnormal drilling formations and unexpected environmental conditions. It is essential to plan for these contingencies to ensure the smooth progression of the project.

Specialised teams work in cohesive units to take on specific tasks within each Activity phase. These teams are composed of industry professionals with the necessary expertise to handle the unique challenges presented by each phase of the Activity.

The length of contracts for team members will vary based on the demands of each Activity phase. Contracts range from short-term engagements to long-term commitments, ensuring the right expertise is available when needed and maintaining flexibility within the Activity's workforce.

EP187 - EMP IMP5.1 Indicative Schedule

ID	Task Name	Start	Duration	Finish
1	Carpentaria 4H (4); Civil Construction	1/08/2024	14 days	14/08/2024
2	Carpentaria 4H (4); IMB Drilling	1/08/2024	14 days	14/08/2024
4	**Drilling Program - 2024**	**25/08/2024**	**128 days**	**30/12/2024**
5	Carpentaria 4H (4); Drilling	25/08/2024	25 days	18/09/2024
6	Carpentaria 5H (4); Drilling	22/09/2024	45 days	5/11/2024
7	Rig Shift - Infield	6/11/2024	10 days	15/11/2024
8	Carpentaria 6H (2/3); Drilling	16/11/2024	45 days	30/12/2024
9	**Wellpad Facilities Installation - 2024**	**19/09/2024**	**62 days**	**19/11/2024**
13	**Hydraulic Fracturing Program - 2026**	**18/08/2024**	**190 days**	**23/02/2025**
14	Carpentaria 4H (4); HF Sand Delivery	18/08/2024	90 days	15/11/2024
16	Carpentaria 4H (4); HF	16/11/2024	30 days	15/12/2024
17	Carpentaria 5H (4); HF Sand Delivery	17/09/2024	90 days	15/12/2024
18	Carpentaria 5H (4); HF	16/12/2024	30 days	14/01/2025
20	Carpentaria 6H (2/3); HF Sand Delivery	27/10/2024	90 days	24/01/2025
21	Carpentaria 6H (2/3); HF	25/01/2025	30 days	23/02/2025
23	**Facilities Construction**	**1/08/2024**	**243 days**	**31/03/2025**
33	Gas Export	1/04/2025	60 mons	4/05/2030
34	**CS to MRM Tie in; Pipeline**	**16/01/2025**	**31 days**	**15/02/2025**
40	**Carpentaria Highway Crossing; Gas and Wastewater Flowlines**	**1/08/2024**	**28 days**	**28/08/2024**
43	**Carpentaria East A (4); Gas & Wastewater Flowlines**	**31/08/2024**	**42 days**	**11/10/2024**
49	**Carpentaria North A (2/3); Gas & Wastewater Flowlines**	**10/09/2024**	**42 days**	**21/10/2024**
55	**Civil Construction Program - 2024**	**4/08/2024**	**90 days**	**1/11/2024**
56	Carpentaria BD; Civil construction, Wellpad and access	4/08/2024	45 days	17/09/2024
57	Carpentaria BB; Civil construction, Wellpad and access	18/09/2024	45 days	1/11/2024
58	**Water Bore Drilling Program - 2025**	**18/09/2024**	**314 days**	**28/07/2025**
65	**Carpentaria East B (BD); Gas & Wastewater Flowlines**	**8/04/2025**	**42 days**	**19/05/2025**
71	**Carpentaria North B (BB); Gas & Wastewater Flowlines**	**18/04/2025**	**42 days**	**29/05/2025**
77	**Drilling Program - 2025**	**10/05/2025**	**165 days**	**21/10/2025**
79	Carpentaria 7H (BD); Drilling	20/05/2025	45 days	3/07/2025
80	Carpentaria 8H (BD); Drilling	4/07/2025	45 days	17/08/2025
82	Carpentaria 9H (BB); Drilling	28/08/2025	45 days	11/10/2025
84	**Hydraulic Fracturing Program - 2025**	**12/04/2025**	**244 days**	**11/12/2025**
85	Carpentaria 7H (BD); HF Sand Delivery	12/04/2025	120 days	9/08/2025
87	Carpentaria 7H (BD); HF	24/08/2025	30 days	22/09/2025
88	Carpentaria 8H (BD); HF Sand Delivery	12/05/2025	120 days	8/09/2025
89	Carpentaria 8H (BD); HF	23/09/2025	30 days	22/10/2025
91	Carpentaria 9H (BB); HF Sand Delivery	21/06/2025	120 days	18/10/2025
92	Carpentaria 9H (BB); HF	2/11/2025	30 days	1/12/2025
94	**Civil Construction Program - 2025**	**18/09/2025**	**45 days**	**1/11/2025**
95	Carpentaria BA; Civil construction, Wellpad and access	18/09/2025	45 days	1/11/2025
96	**Water Bore Drilling Program - 2025**	**3/11/2025**	**28 days**	**30/11/2025**
99	Carpentaria BA; Water Baseline	1/12/2025	6 mons	4/06/2026
100	**Carpentaria North C (BA); Gas & Wastewater Flowlines**	**2/05/2026**	**42 days**	**12/06/2026**
106	**Drilling Program - 2026**	**10/05/2026**	**165 days**	**21/10/2026**
108	Carpentaria 10H (BB); Drilling	20/05/2026	45 days	3/07/2026
109	Carpentaria 11H (BA); Drilling	4/07/2026	45 days	17/08/2026
111	Carpentaria 12H (BA); Drilling	28/08/2026	45 days	11/10/2026
113	**Hydraulic Fracturing Program - 2026**	**12/04/2026**	**244 days**	**11/12/2026**
114	Carpentaria 10H (BB); HF Sand Delivery	12/04/2026	120 days	9/08/2026
116	Carpentaria 10H (BB); HF	24/08/2026	30 days	22/09/2026
117	Carpentaria 11H (BA); HF Sand Delivery	12/05/2026	120 days	8/09/2026
118	Carpentaria 11H (BA); HF	23/09/2026	30 days	22/10/2026
120	Carpentaria 12H (BA); HF Sand Delivery	21/06/2026	120 days	18/10/2026
121	Carpentaria 12H (BA); HF	2/11/2026	30 days	1/12/2026
123	**Civil Construction Program - 2026**	**18/09/2026**	**45 days**	**1/11/2026**
124	Carpentaria BC; Civil construction, Wellpad and access	18/09/2026	45 days	1/11/2026
125	**Water Bore Drilling Program - 2026**	**3/11/2026**	**214 days**	**4/06/2027**
129	**Carpentaria East C (BC); Gas & Wastewater Flowlines**	**20/05/2027**	**42 days**	**30/06/2027**
135	**Drilling Program - 2027**	**1/07/2027**	**45 days**	**14/08/2027**
136	Carpentaria 13H (BC); Drilling	1/07/2027	45 days	14/08/2027
137	**Hydraulic Fracturing Program - 2027**	**3/03/2027**	**216 days**	**4/10/2027**
138	Carpentaria 13H (BC); HF Sand Delivery	3/03/2027	120 days	30/06/2027
139	Carpentaria 13H (BC); HF	5/09/2027	30 days	4/10/2027

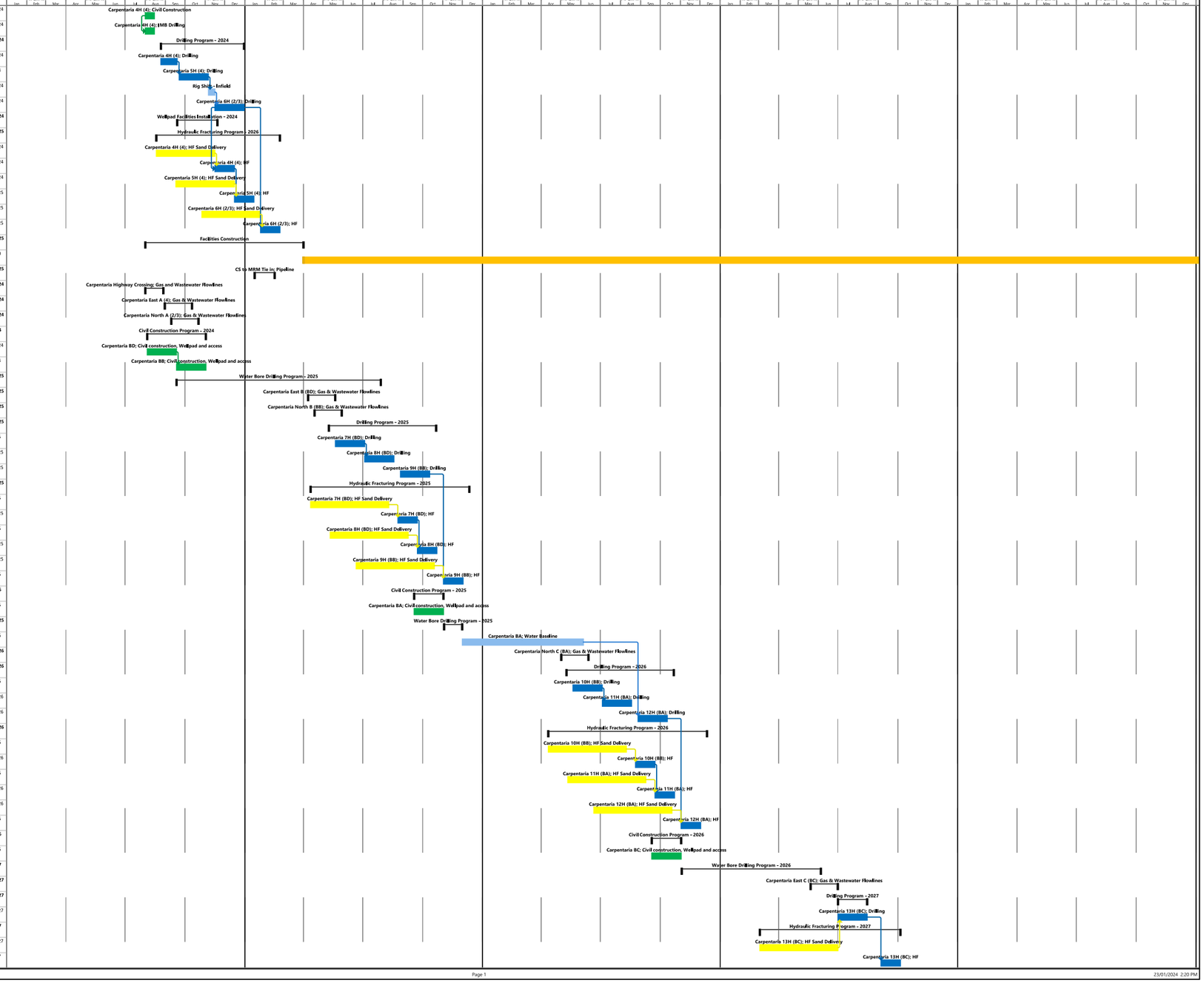

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Figure 1.6—1 Indicative CPP Schedule for the Activity

Due to the location of the CPP, all personnel except for operational staff (CGP) will be FIFO and housed onsite in temporary modular camps. Permanent operational staff will be housed in Heartbreak Hotel. Vehicle movements associated with personnel transport, campsite mobilisation, consumable deliveries, and waste removal have been included in the traffic impact assessments (**Appendix 11**).

Training opportunities will be provided to a portion of personnel involved in the construction phases of the Activity, with contracts award on an aptitude/ability basis. Drilling, HF, and operation of the compressor station will be undertaken by highly skilled or specialised contractors. Sourcing of contractors, services, and resources starts locally, expanding to regional, NT wide, and possible interstate locations. The composition of the workforce is anticipated to be a combination of local, regional, Territorian, and interstate personnel.

A peak of 274 personnel has been modelled to occur in October 2024, a result of several Activity phases overlapping (**Figure 1.6—1**).

Table 1.6—1 Indicative Crew Requirements per Activity Component

Activity Component	Crew Skill Levels		Total	Employment Term
	Specialists / Highly Skilled	Skilled / Potential Training Provided*		
Construction				
Water Bore Drilling & Construction	4	0	4	Short-term
Civil Construction	6	6	12	Short-term
Well Pad Equipment Construction	6	0	6	Short-term
Facility Civil Construction	15	5	20	Short-term
Flowline Civil Construction	3	1	4	Short-term
Flowline Construction	15	5	20	Short-term
	49	**17**	**66**	

Activity Component	Crew Skill Levels		Total	Employment Term
	Specialists / Highly Skilled	Skilled / Potential Training Provided*		
Drilling & HF				
Drilling Mobilisation / Demobilization	40	0	40	Short-term
Drilling	40	0	40	Short-term
HF Mobilisation / Demobilization	25	0	25	Short-term
HF	25	0	25	Short-term
	130	**0**	**130**	
Operations				
Compressor Station Operation	6	0	6	Permanent
	6	**0**	**6**	

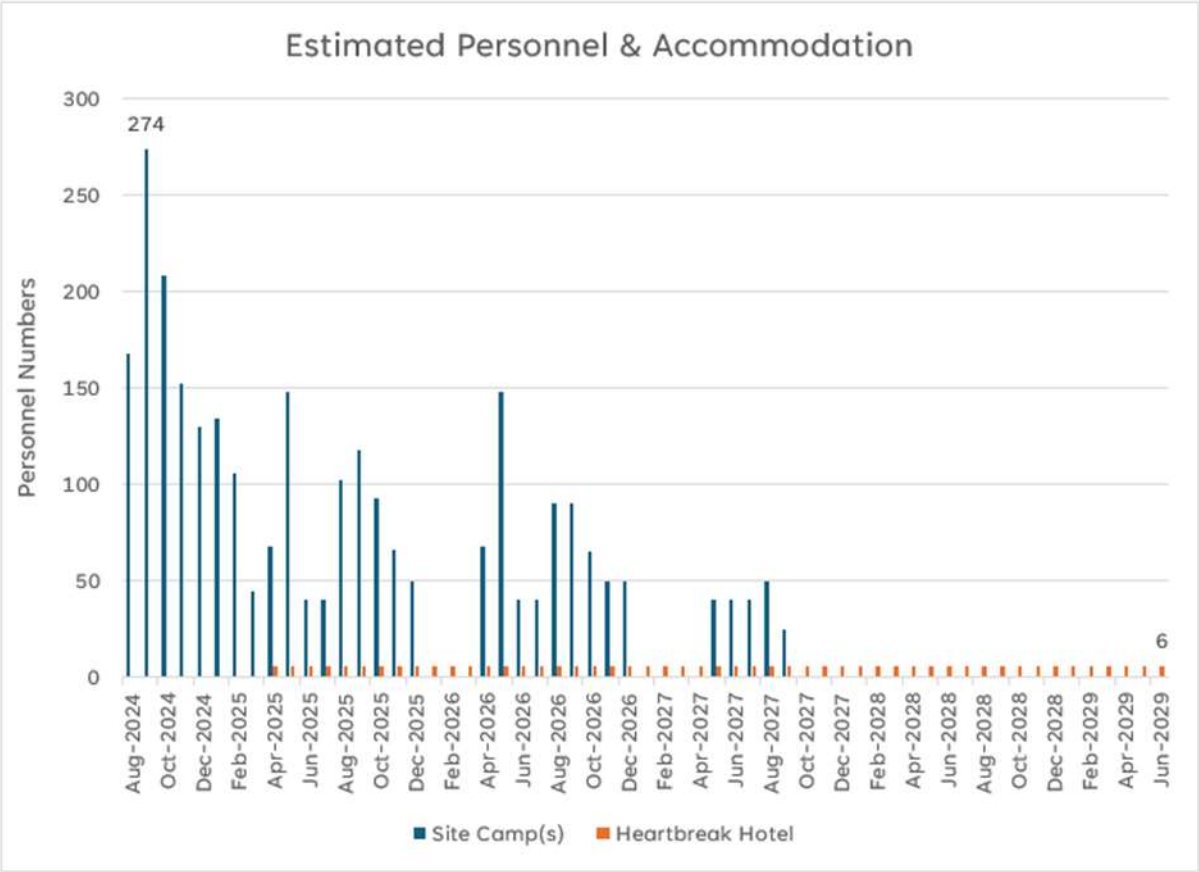


Figure 1.6—2 Annual Estimated Activity Workforce

The primary construction operations will be undertaken during the low rainfall period between April and November inclusive, when < 8% of the annual average total rainfall is received (**Figure 1.6—3**). On average, the CPP Area has 195 days with no rain per year. However, this arid period is also highly variable, as the rainfall analysis in **Section 4.2** highlights.

Appraisal operations may occur 24 hours a day, 365 days per year, including the wetter months (December to March). Forecast weather conditions will be monitored daily during the local Wet Season to allow risks to operational needs to be addressed. See **Section 4.2.6** (Extreme Rainfall Analysis) and **Appendix 06** (Wastewater Management Plan) for further information on rainfall design analysis.

The highest total annual rainfall records of 1,323 mm, 1,588 mm, and 1,606 mm for Daly Waters (DW - BOM 14618), Tanumbirini Station (TAN – BOM 14628) and McArthur River Mine (MRM – BOM 14074). MRM, which is located 105 km to the east of the CPP area and nearer the coast, has been selected for rainfall design analysis because it is the most conservative BOM station in the region. Variability shows a less marked trend with increasing distance inland than the other rainfall characteristics as discussed in **Section 4.2**.

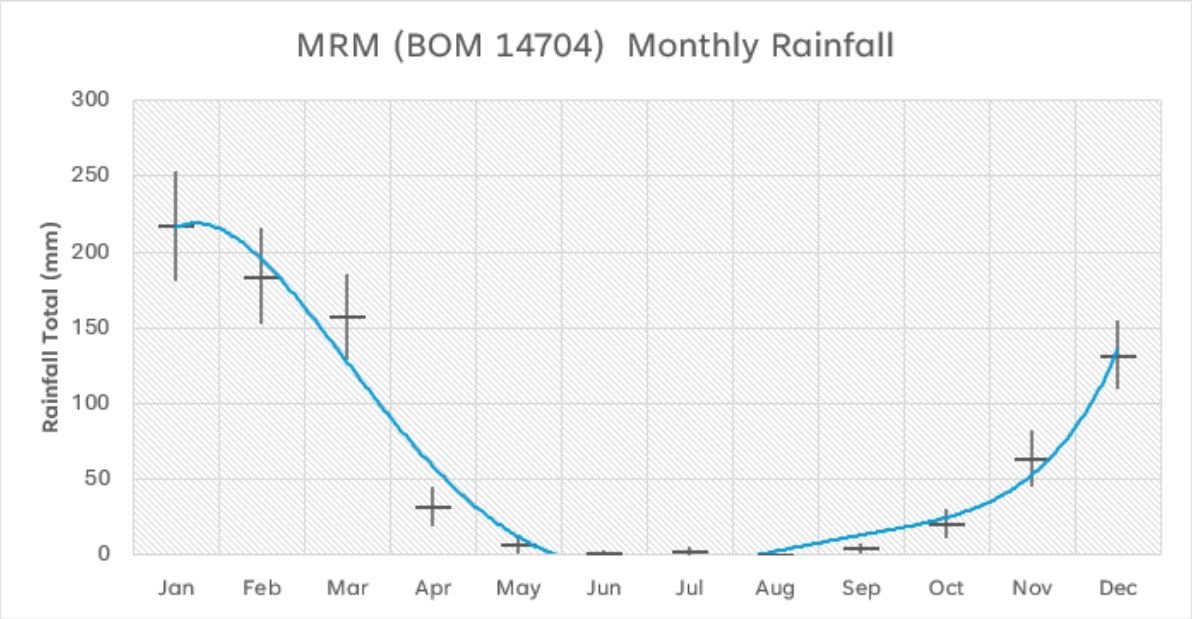


Figure 1.6—3 MRM (BOM 1474) Monthly Rainfall and 95% Confidence Limits – 66 years

2 Legislative Requirements

2.1 Summary of Key Legislative Requirements

A summary of legislation and approval requirements and Imperial's actions to meet the requirements are provided in **Table 2.1—1**.

Table 2.1—1 Summary of Legislation Requirements

Legislation	Requirements	How Imperial Meets the Requirements	Administrator
Northern Territory			
Petroleum Act 1984 (NT)	• **Section 44** – A petroleum exploration permit is required before applying for a production licence.	• Exploration permit EP 187 has been obtained and applies to the CPP Area and the Activity.	Department of Industry, Tourism and Trade (DITT)
	• **Section 5(12)** - For this Act, petroleum is recovered or produced on an appraisal basis if it is recovered or produced under a process intended to establish the extent and nature of a discovery of petroleum.	• This EMP has been developed to satisfy this requirement.	
	• **Section 57AAA – Recovery of petroleum on appraisal basis** *(1) This section applies to a person who is:* *(a) a permittee; or* *(b) a retention licensee* *(2) The person may apply to the Minister for approval to recover petroleum on an appraisal basis under the relevant petroleum interest.*	• To recover petroleum on an appraisal basis, Imperial is progressing with the requirement of Section 57AAA (5)(d) to obtain approval, consent, or agreement with the NLC and Traditional Owners for the sale or other beneficial use of petroleum recovered. • If the application under Section 57AAA is unsuccessful and the Activity proceeds on a basis different to the one described, this EMP will be modified or revised under the *PER* to account for any new or increased environmental impacts or risks.	
	• **Sections 81 and 82** - Compensation to be paid to native title holders and owners/occupiers of land where petroleum activity is proposed.	• NLC Exploration Deed executed with Imperial on 5 February 2014 on behalf of the Mambaliya Rrumburriya Wuyaliya Aboriginal Land Trust, and subsequently approved by the Commonwealth Minister, pursuant to Section 45 of the *Aboriginal Land Rights (Northern Territory) Act, 1976 (Cth)*.	
Petroleum Regulations 2020 (NT)	• **Regulation 12** – Requires a land access agreement before conducting regulated petroleum operations.	• NLC Exploration Deed executed with Imperial on 5 February 2014 on behalf of the Mambaliya Rrumburriya Wuyaliya Aboriginal Land Trust, and subsequently approved by the Commonwealth Minister, pursuant to Section 45 of the *Aboriginal Land Rights (Northern Territory) Act, 1976 (Cth)*.	DITT
Petroleum (Environment) Regulations 2016 (NT)	• **Regulation 6(1)** – Submission of plan for approval *'An interest holder who proposes to carry out a regulated activity must first submit to the Minister, for approval, an environment management plan relating to the activity'.*	• This EMP has been developed to satisfy this requirement.	Department of Environment, Parks, and Water Security (DEPWS)
	• **Item 11(1), Schedule 1 – Recording, monitoring and reporting** *(1) 'A plan must specify arrangements for* *(a) recording, monitoring and reporting information about the regulated activity to which the plan relates in a manner that will enable the Minister to determine whether the*	• Imperial has developed Environmental Performance Standards in **Section 6.3** and will provide an Annual Environmental Performance Report (AEPR) for the Activity as committed to in **Table 8.3—2** Routine Reporting Requirements.	

Legislation	Requirements	How Imperial Meets the Requirements	Administrator
	environmental outcomes and environmental performance standards in the plan are being met; and *(b) giving the Minister a report about the matters mentioned in paragraph (a), at approved intervals, but not less often than annually.'*		
	• **Regulation 17** – EMP Revision required for new or increased environmental impact or environmental risk. • **Regulation 18** – EMP revisions are required before the end of each five-year period.	• A revision of this EMP will be submitted to the Minister for approval if there has been a new or increased environmental impact or risk that is not provided for in this EMP. • This EMP will be revised every five years.	
	• **Regulation 7** – Stakeholder Engagement must be undertaken for the Activity during the preparation of an EMP.	• Imperial is undertaking stakeholder engagement in accordance with the *PER*. See **Section 5** and **Appendix 10** for details on the stakeholder engagement and consultation plan, and log.	
	• **Regulation 37A (1)** – If the Activity includes hydraulic fracturing, the interest holder must provide a report about flowback within 6 months of flowback occurring. The report must comply with Reg 37A(2) and be accompanied by a full human health risk assessment relating to any chemical found in the flowback fluid [Reg 37A's external (2A]). • **Regulation 37B (1)** - If the Activity includes hydraulic fracturing, the interest holder must provide a report about produced water within six months of produced water being extracted. The report must comply with Reg 37B (2) and be accompanied by a full human health risk assessment relating to any chemical found in the produced water [Reg 37B (2A)]).	• Imperial will comply with Regs 37A and 37B.	
	• **Item 10, Schedule 1 – Legislative requirements** *(1) A plan must:* *(a) specify any legislative requirements applicable to the regulated activity described in the plan that are relevant to the protection of the environment; and* *(b) demonstrate how those requirements will be met.* *(2) In this clause:* *legislative requirements includes the requirement to comply with an approved code of practice.'* *Code of Practice: Onshore Petroleum Activities in the Northern Territory 2019, (NT) (the Code)* is an approved code of practice.	• This EMP includes a Legislative Requirements section. • The EMP has been developed following *the Code*, including all mandatory requirements applicable to the Activity. • Cross-references to the clauses in *the Code* are included in the EMP as relevant and summarised in relevant Environmental Outcomes and Performance Standards in **Section 6.3**.	

Legislation	Requirements	How Imperial Meets the Requirements	Administrator
	• **Regulations 33-37, Part 3 - Reportable incidents, recordable incidents and records:** ○ Reportable incident means an incident, arising from a regulated activity, that has caused or has the potential to cause material environmental harm or significant environmental harm. ○ Details the requirements for incident reporting to the Minister and record keeping.	• **EMP Section 8.3**. • **Appendix 07** Spill Management Plan. • **Appendix 09** Emergency Response Plan.	
	• **Schedule 1** – Information to be included in the environmental management plan: details the Information to be included in an environment management plan.	• This EMP has been drafted to comply with Schedule 1.	
Code of Practice: Onshore Petroleum Activities in the Northern Territory 2019	• *The Code* applies to all conventional and unconventional oil and gas exploration, appraisal, development, production and ancillary works in the Northern Territory.	• This EMP and its appendices have been prepared in accordance with *the Code* and cross-references to the clauses in *the Code* are included in the EMP as deemed relevant.	DEPWS DITT
Bushfires Management Act 2016 (NT)	• **Section 90 (1-2) – Duty of owner or occupier to control fires** *(1) Requires owners and occupiers to take all reasonable steps:* *(a) to protect property on the land from fire; and* *(b) to prevent or inhibit fire from spreading from the land to other land.* *(2) If the owner or occupier of land is unable to control a fire on the land, the owner or occupier must take all reasonable steps to notify the following of that fact:* *(a) a fire control officer or fire warden;* *(b) the occupier of any land to which the fire is likely to spread or a person apparently over the age of 16 years present on that land.*	• Imperial used the NT Government's *Bushfire Management Planning Guide: Onshore Petroleum Projects (2020)* [DENR, 2020] to develop the **Appendix 12** (Bushfire Management Plan) • **Appendix 09** Emergency Response Plan.	DEPWS Bushfires NT
Environment Protection Act 2019 (NT) **Environment Protection Regulations 2020 (NT)**	Environmental Protection Act, 2019: • **Section 48** - Referral of proposed action. *A proponent must refer to the NT EPA for assessment (a standard assessment) a proposed action that:* *(a) has the potential to have a significant impact on the environment; or* *(b) meets a referral trigger.* Environmental Protection Regulations, 2020:	• Imperial referred the proposed action to the NT EPA (EP2024/033) and received a Notice of Decision and Statement of Reasons. The conclusion: The NT EPA has determined that the Carpentaria Pilot Project proposed by Imperial Oil & Gas Pty Ltd does not have the potential for a significant impact on the environment. Environmental impact assessment is not required.	Northern Territory Environment Protection Authority (NT EPA) DEPWS

Legislation	Requirements	How Imperial Meets the Requirements	Administrator
	• **Regulation 79** - Lists the matters to be included in an environmental impact assessment. The environmental impact assessment may include all or any of the listed matters. • **Regulation 265** – Details the form in which submissions to the EPA may be made including, in writing.		
Waste Management and Pollution Control Act 1998 (NT)	• **Section 12 (1) – General environmental duty** *(1) 'A person who:* *(a) conducts an activity that causes or is likely to cause pollution resulting in environmental harm or that generates or is likely to generate waste; or* *(b) performs an action that causes or is likely to cause pollution resulting in environmental harm or that generates or is likely to generate waste,* *must take all measures that are reasonable and practicable to:* *(c) prevent or minimise the pollution or environmental harm; and* *(d) reduce the amount of the waste.'*	Imperial has drafted the below sections and appendices to meet these requirements: • **EMP Section 6.3** Environmental Outcomes, Performance Standards and Measurement Criteria • **EMP Section 7** Management Plans and Procedures • **Appendix 03** Rehabilitation Management Plan • **Appendix 04** Weed Management Plan • **Appendix 05** Erosion Sediment Control Plan • **Appendix 06** Wastewater Management Plan • **Appendix 07** Spill Management Plan • **Appendix 09** Emergency Response Plan	
	• **Section 14** – Duty to notify if an incident causes, or is threatening or may threaten to cause, pollution resulting in material environmental harm or serious environmental harm as soon as practicable and in any case within 24 hours of becoming aware of the incident.	• EMP **Section 8.3** includes the duty to notify.	
Territory Parks and Wildlife Conservation Act 1976 (NT)	• Powers to set aside areas that cannot be developed and includes provisions to protect wildlife.	• The CPP Area does not overlap with any areas protected under the *Territory Parks and Wildlife Conservation Act, 1976 (NT)*.	DEPWS
Weed Management Act 2001 (NT)	• **Section 9 – General duties for potential weeds** <u>Section 9 (1)</u> *(1) 'A person has a duty to:* *(a) comply with any weed management plan for a potential weed; and'* • **Section 9C - General duties of owner or occupier of land for potential weeds** <u>Section 9C (1)</u> *(1) An owner or occupier of land has a duty to:*	• Imperial will comply with the requirements of this Act through the implementation of weed prevention, detection, and eradication controls as detailed in the Weed Management Plan (**Appendix 04**).	Weed Management Branch, DEPWS

Legislation	Requirements	How Imperial Meets the Requirements	Administrator
	(a) take all reasonable measures to prevent the spread of a potential weed on the land; and *(b) take all reasonable measures to prevent a potential weed on the land spreading to other land.* • **Section 9E – General duties for declared weeds** Section 9E (1) *(1) 'A person has a duty to:* *(a) comply with any weed management plan for a declared weed; and* *(b) ensure that, if the person uses a declared weed, the declared weed is used in accordance with any classification of the declared weed under section 7(4)(b), (c) or (d).'* • **Section 9K - General duties of owner or occupier of land for declared weeds** Section 9K (1) *(1) An owner or occupier of land has a duty to:* *(a) take all reasonable measures to prevent the spread of a declared weed on the land; and* *(b) take all reasonable measures to prevent a declared weed on the land spreading to other land; and* *(c) if the owner or occupier of the land becomes aware of the presence on the land of a declared weed that was not previously present on the land – within 14 days after first becoming aware of the presence on the land of the declared weed, notify an officer (appointed under Section 24) of the presence of the declared weed.*		
Water Act 1992 (NT) and Water Regulations 1992 (NT)	• **Section 59** - A licence is required to take groundwater.	• Imperial has a Ground Water Extraction Licence (GWEL) – GRF10316 for 85 ML p.a. A new GWEL application for the estimated CPP water usage of 950 ML will be applied for. The application will be to increase the Imperial GWEL to 750 ML p.a.	Water Resources Division, DEPWS
	• **Sections 40 (1) Interfering with waterway without authorisation** *(1) A* person commits an offence if the person: *(a) engages in conduct that interferes with a waterway; and*	• Work that interferes with a waterway is not planned under this EMP. If during the carrying out of the Activity, it becomes necessary to interfere with a waterway an application for a permit will be made under Section 41 before any work is carried out.	

Legislation	Requirements	How Imperial Meets the Requirements	Administrator
	(b) is not authorised under this Act to interfere with the waterway.		
	• **Section 48 (1) - Doing bore work without licence** *(1) A person commits an offence if the person:* *(a) does bore work; and* *(b) does not hold a drilling licence that authorises the bore work.*	• Imperial will only conduct bore work under an appropriate bore work permit using suitably qualified water bore drilling contractor(s).	
	• **Sections 60A (1), (2)**, and **(3)** - If an application for a licence, or a licence proposed to be granted on the Controller's own initiative, to take water from a bore is for a petroleum activity that includes hydraulic fracturing and there are designated bores within 1 km, a licence will not be issued unless the designated bore owners consent or the Controller is satisfied that hydrogeological investigations and groundwater modelling indicate that the activities under the licence will not have any adverse effect on the supply of water to any designated bore. Section 60A (3) defines 'designated bore'.	• No existing or proposed CPP water bores are within 1 km of existing designated water bores.	
	• **Section 45A** - No licence will be granted to take surface water for petroleum activity.	• No surface water take is proposed under the Activity.	
	• **Section 62** – Establishes levels of offences for unlicensed disposal of waste by means of a bore that causes material or serious environmental harm.	• No disposal of waste by means of a bore is planned under this EMP.	
	• **Section 66** - Establishes levels of offences for engaging in unlicensed conduct that results in the increase of the volume of water in an aquifer.	• No works that increase the volume of water in an aquifer are planned under this EMP. • The Activity will be conducted under an approved WOMP including aquifer protection measures.	
	• **Section 16** – Establishes levels of offences where an unauthorised person wilfully or otherwise causes waste to come into contact with surface, ground or tidal water or (otherwise) causes water to be polluted, causing serious or material environmental harm. • **Section 17A** – Establishes levels of offences where a person intentionally or unintentionally engages in conduct that directly or indirectly results in hydraulic fracturing waste coming into contact with surface, ground or tidal water and it results in serious or material environmental harm.	Imperial will comply: • **EMP Section 6.3** Environmental Outcomes, Performance Standards and Measurement Criteria • **Section 7** Management Plans • **Appendix 06** Wastewater Management Plan • **Appendix 07** Spill Management Plan • **Appendix 09** Emergency Response (Contingency) Plan.	

Legislation	Requirements	How Imperial Meets the Requirements	Administrator
	• **Section 17B** - Section 17A does not apply if hydraulic fracturing waste is produced water or flowback fluid and it comes into contact with water that is contained in the geological formation being targeted by the process of hydraulic fracturing.		
Food Act 2004 (NT)	• **Section 70** - A person must not conduct a food business unless the food business is registered under Part 7.	• Catering services will be provided by third party contractors that are registered under Part 7 and they will comply with all the requirements of the *Food Act, 2004 (NT)*.	NT Health
Work Health and Safety (National Uniform Legislation) Act 2011 (NT) (WHS Act) **Work Health and Safety (National Uniform Legislation) Regulations 2011 (NT)**	• **Section 17** – Management of Risks *A duty imposed on a person to ensure health and safety requires the person:* *(a) to eliminate risks to health and safety, so far as is reasonably practicable; and* *(a) if it is not reasonably practicable to eliminate risks to health and safety, to minimise those risks so far as is reasonably practicable. **Section 18** defines "reasonably practicable".* • **Section 19** – Primary duty of care *(1) A person conducting a business or undertaking must ensure, so far as is reasonably practicable, the health and safety of:* *(a) workers engaged, or caused to be engaged, by the person; and* *(b) workers whose activities in carrying out work are influenced or directed by the person; while the workers are at work in the business or undertaking.* *(2) A person conducting a business or undertaking must ensure, so far as is reasonably practicable, that the health and safety of other persons is not put at risk from work carried out as part of the conduct of the business or undertaking.* • **Section 20 (2)** - The person with management or control of a workplace must ensure, so far as is reasonably practicable, that the workplace, the means of entering and exiting the workplace and anything arising from the workplace are without risks to the health and safety of any person. • **Section 21 (2)** - The person with management or control of fixtures, fittings or plant at a workplace must ensure, so far as is reasonably	• Imperial's Health Safety Environment Management System (HSEMS). • Registers and safety data sheets at the workplace are maintained by Imperial's contractors. • Imperial will notify NT WorkSafe if required under the legislation.	NT WorkSafe, Department of the Attorney-General and Justice

Legislation	Requirements	How Imperial Meets the Requirements	Administrator
	practicable, that the fixtures, fittings and plant are without risks to the health and safety of any person. • **Section 38 (1)** - A person who conducts a business or undertaking must ensure that the regulator is notified immediately after becoming aware that a notifiable incident arising out of the conduct of the business or undertaking has occurred. • **Section 39 (1)** - The person with management or control of a workplace at which a notifiable incident has occurred must ensure so far as is reasonably practicable, that the site where the incident occurred is not disturbed until an inspector arrives at the site or any earlier time that an inspector directs.		
Transport of Dangerous Goods by Road and Rail (National Uniform Legislation) Act 2010 (NT) and Regulations 2011	• Requires implementing all ADG Code compliant signage, spill management, reporting and licensing requirements for chemical transportation. • **Regulations Part 15** - Road vehicles must be licensed, and the drivers must hold a dangerous goods driver's licence to transport dangerous goods over 500 L or 500 kg in a single container.	• The transportation of any dangerous goods for the Activity will comply with these requirements.	NT WorkSafe, Department of the Attorney General and Justice
Heritage Act 2011 (NT) **Heritage Regulations 2012 (NT)**	• **Part 5.5** - Establishes offences for causing damage to heritage places or objects. • **Section 72 (1)** - A person may apply to the CEO for an approval (a work approval) to carry out work on a heritage place or object. • **Section 114** – Discovery of archaeological places and objects *(1) A person commits an offence if the person:* *(a) discovers a place or object the person knows is an Aboriginal or Macassan archaeological place or object; and* *(b) does not, as soon as practicable after the discovery, give the CEO a written report stating the following:* *(i) a description of the place or object;* *(ii) its location;* *(iii) the person's name and address;* *(iv) if known by the person – the name and address of the owner or occupier of the place or place where the object is located.*	• Imperial has commissioned a desktop study and field scout (**Appendix 02** Cultural and Heritage Assessment report). Imperial will comply with the following recommendations: ○ A systematic survey to be conducted to establish artefact distributions, with possible relocation of finds elsewhere on [redacted] • [redacted] Imperial will engage with the Heritage Branch to ensure necessary approvals are in place prior to any clearing. • Traditional Owner stakeholder engagement has included: ○ Grant of a petroleum exploration permit over Aboriginal Land vested in the NT Portion 5706 – Mambaliya Rrumburriya Wuyaliya Aboriginal Land Trust in the Bauhinia Downs/OT Downs/Mallapunyah map sheets. Pursuant to Section 41 of ALRA, Imperial applied to the NLC for consent to the NTG grant of petroleum Exploration Permit (EP) 187. ○ An NLC Exploration Permit was executed with Imperial on 5 February 2014 and approved by the Commonwealth Minister for ALRA. The EP 187 NLC Exploration Deed describes the petroleum shale resource of	Heritage Branch, Department of Territory Families, Housing and Communities

Legislation	Requirements	How Imperial Meets the Requirements	Administrator
	(2) It is a defence to a prosecution for an offence against subsection if the defendant establishes a reasonable excuse. *(3) A person is taken to have complied with subsection (1) if the person gives the report to the CEO within 7 days after the discovery.*	interest and sets out the terms and conditions agreed upon by the NLC and Imperial under Part IV of ALRA. ○ Proposed disturbance site surveys (**Appendix 02**- Archaeological Survey) ○ **Section 5** of this EMP for details on Stakeholder Engagement and Consultation Plan. ○ **Appendix 10** of this EMP for Stakeholder Engagement Report and Communications Log • Prior to and during construction, Imperial's *Unexpected Finds Procedure* (**Section 7.9**) will be implemented for unexpected finds. • Imperial has assessed the risks in **Section 6**: Environmental Risks and Mitigation Measures and will implement the mitigation measures detailed in the EMP and associated Management Plans (**Section 7**) and comply with the Implementation Strategy (**Section 8**).	
Radiation Protection Act 2004 (NT)	• Manage harmful effects of radiation for the protection of people and the environment.	• If analysis of gas infrastructure indicates NORM levels that exceed the National standard for limiting occupational exposure to ionizing radiation, Schedule 1 [NOHSC:1013(1995)] levels, a Radiation Protection Plan will be developed and implemented and a licence under this Act will be applied for with the Department of Health.	Department of Health (DoH)
Northern Territory Aboriginal Sacred Sites Act 1989	• Requires a person to obtain an AAPA Authority Certificate to carry out work on land adjacent to or encompassing a sacred site.	• Imperial's application for an AAPA Authority Certificate for the Activity was accepted on 7th September 2023. • This EMP will be assessed for revision under the PER, if the AAPA Authority Certificate contains conditions that introduce a new or increase an existing environmental impact or risk or the Minister will be notified if the AAPA Authority Certificate requires a modification to the Activity that does not require a revision.	Aboriginal Areas Protection Authority (AAPA)
Public and Environmental Health Act 2011 (NT) **Public and Environmental Health Regulations 2014 (NT)**	• Sewage and grey water treatment systems are subject to the requirements of the Act and Regulations. • **Regulation 96** - Notification of installation of wastewater management system *(1) This regulation applies in relation to the installation of either of the following at a place where the Building Act 1993 does not apply:* *(a) a wastewater management system that treats more than 2 000 L per day;*	• Imperial will ensure that the Wastewater treatment systems meet the requirements of the Act and Regulations and that the sewerage plants meet the *NT Code of Practice for Small Onsite Sewage and Sullage Treatment Systems* and the *Disposal or Reuse of Sewage Effluent and the NT Code of Practice for Wastewater Management, 2020*. • Imperial will comply with **Appendix 06** (Waste and Wastewater Management Plan).	Department of Health (DoH)

Legislation	Requirements	How Imperial Meets the Requirements	Administrator
	(b) a series of wastewater management systems that treat more than 2 000 L per day. *(2) The owner or occupier of a place must notify the CHO of the owner or occupier's intention to install the wastewater management system or series of wastewater management systems at least 7 days before the start of the installation.* *(3) The wastewater management system notification must:* *(a) be made in the approved form; and* *(b) be accompanied by the prescribed fee*	• Imperial will notify the NT Chief Health Officer in the approved form accompanied by the prescribed fee if a treatment system or series of systems with a capacity > 2,000 L/day are proposed.	
Agricultural and Veterinary Chemicals (Control of Use) Act 2004. (NT) **Agricultural and Veterinary Chemicals (Control of Use) Regulations 2005. (NT)**	• Detail requirements for the safe storage, handling, and use of agricultural (weed control) and veterinary chemicals.	• Imperial will use suitably licensed and qualified personnel or contractors and will comply with the Act and Regulations when storing, handling, and using weed control chemicals.	
Commonwealth			
Environment Protection and Biodiversity Conservation Act 1999 (Cth)	• The proponent must determine if the Activity is likely to have a significant impact on a matter of national environmental significance or the environment of Commonwealth land and refer the proposal to the Minister if the proponent thinks the proposal requires referral. • Since 2014, the NT Environmental Protection Agency (EPA) has been accredited to assess proposed actions on behalf of the Commonwealth.	• No Threatened Ecological Communities (TEC), World Heritage Properties, National Heritage Places, Wetlands of International Importance, Great Barrier Reef Marine Park or Commonwealth Marine Areas occur within the study area. • A Protected Matters Search Tool (PMST) (Appendix A of **Appendix 01** Environmental Assessment Report) and a Significant Impact Assessment (SIA) has been undertaken by suitably qualified person (**Appendix 01** Environmental Assessment Report). • Imperial has determined that the Activity is not likely to have a significant impact on a matter of national environmental significance (and is not being carried out on Commonwealth land) and, as such, does not need to be referred to the Commonwealth Minister for the Environment and Water for determination.	Commonwealth Department of Climate Change, Energy, the Environment and Water NT EPA (Assessor)
National Greenhouse and Energy Reporting Act 2007 (Cth)	• Registration and reporting under the National Greenhouse and Energy Reporting Scheme where emission thresholds are exceeded.	• Imperial is registered and reports all relevant emissions under the National Greenhouse and Energy Reporting Scheme (NGERS).	Department of Industry, Science, Energy and Resources

Legislation	Requirements	How Imperial Meets the Requirements	Administrator
Aboriginal Land Rights (Northern Territory) Act 1976 (Cth)	• **Section 45** - A mining interest shall not be granted to an intending miner in respect of Aboriginal land unless: (b) the relevant Land Council and the intending miner have entered into an agreement under section 46 as to the terms and conditions to which the grant of the mining interest will be subject; and (c) the Minister has consented, in writing, to the grant of that mining interest.	• Imperial has an agreement (NLC Exploration Deed) for EP 187, under Section 46 terms and conditions executed on 5 February 2014. This deed was approved by the Minister. • To recover petroleum on an appraisal basis, Imperial is progressing with the requirement of Section 57AAA (5)(d) of the *Petroleum Act, 1984 (NT)* to obtain approval, consent, or agreement with the NLC and Traditional Owners for the sale or other beneficial use of petroleum recovered.	Minister for Indigenous Affairs (Cth)

3 Description of the Activity

3.1 The Activity

The Regulated Activity and associated works covered by this EMP includes:

- Land clearing to establish up to four new well pads out of five locations being considered, as well as the potential expansion of the existing well pads at Carpentaria 2/3 and 4.
- Clearing for new access tracks, and the expansion of existing landowner tracks.
- Clearing for gas and water/wastewater flowlines and a connection to the McArthur River Gas Pipeline (MRGP).
- Clearing for up to nine new gravel pits plus the expansion of three existing gravel pits at Carpentaria 1, 2/3 and 4.
- Clearing to establish a gas plant, water handling station, campsite, ground water extraction and control monitoring bores, and a communications satellite dish.
- Earthworks associated with excavating drilling sumps, turkey's nests, trenching for gas, and water flowline and MRGP connection.
- Construction of new groundwater extraction bores, above ground tanks, the Carpentaria Gas Plant (CGP) (inc. office warehouse, workshop), Water Handling Station (WHS), gas and water/wastewater flowlines.
- Drilling hydraulic fracturing completion and workover of up to 9 new wells (including the re-entry of the existing well at Carpentaria 4), and the tie in and testing of up to 9 new wells plus the existing wells at Carpentaria 2/3 and 1 additional well from IMP 4-3.
- Operation and Maintenance of up to 12 (up to 9 new and 3 existing) gas wells, new and existing well pads, laydown yard and helipad location at Carpentaria 1, groundwater extraction bores, above-ground tanks, the Carpentaria Gas Plant (CGP), Water Handling Station (WHS), gas and water/wastewater flowlines and camps (including irrigation of treated sewage effluent and grey water).
- The storage and transportation of petroleum from up to 12 gas wells through flowlines and gas plant to the MRGP.
- The storage, transfer, reuse, use, and disposal of wastewater or hazardous substances via flowline and heavy vehicle.
- The recovery of petroleum on an appraisal basis.

- Suspension or abandonment of the wells and decommissioning, of facilities.

The total area expected to be cleared for the Activity within the CCP Area is detailed in **Table 3.3—1** and presented in **Figure 3.3—1**.

Table 3.1—1 New Disturbance Area

Area	Quantity & Indicative Dimensions (up to)	Total New Clearing (ha)
Well Pads		
New Well Pads	4	45.6
Expansion of Existing Well Pads Carpentaria 2/3 Carpentaria 4	2	16.5
Access Tracks		
New Access Tracks (8 m width)	16.2 km	13.0
Landholder Access Tracks (4 m width to be widened by 4 m)	11.9 km	4.75
Contingency Access Tracks (8 m width)	8.1 km	6.5
Gravel Pits		
New Gravel Pits	9	37.3
Expansion of Existing Gravel Pits	3	20.3
Groundwater		
Water Bore Pads	9	1.1
Flowlines and MRGP Connection		
Gas and Water / Wastewater Flowlines (Co-located 8m width otherwise 16m width)	53 km	49
Contingency Gas and Water / Wastewater Flowlines (16m width)	7 km	11
MRGP Connection (16m width)	0.12 km	0.2
Contingency MRGP Connection (16m width)	18.8 km	3

Area	Quantity & Indicative Dimensions (up to)	Total New Clearing (ha)
Additional Facilities and Infrastructure		
Gas Plant	1	5.7
Water Handling Station	1	10.6
Campsite	1	1.2
Pipeline Communications Satellite Dish	1	0.25
Total (inc. contingency) (ha)		**226**

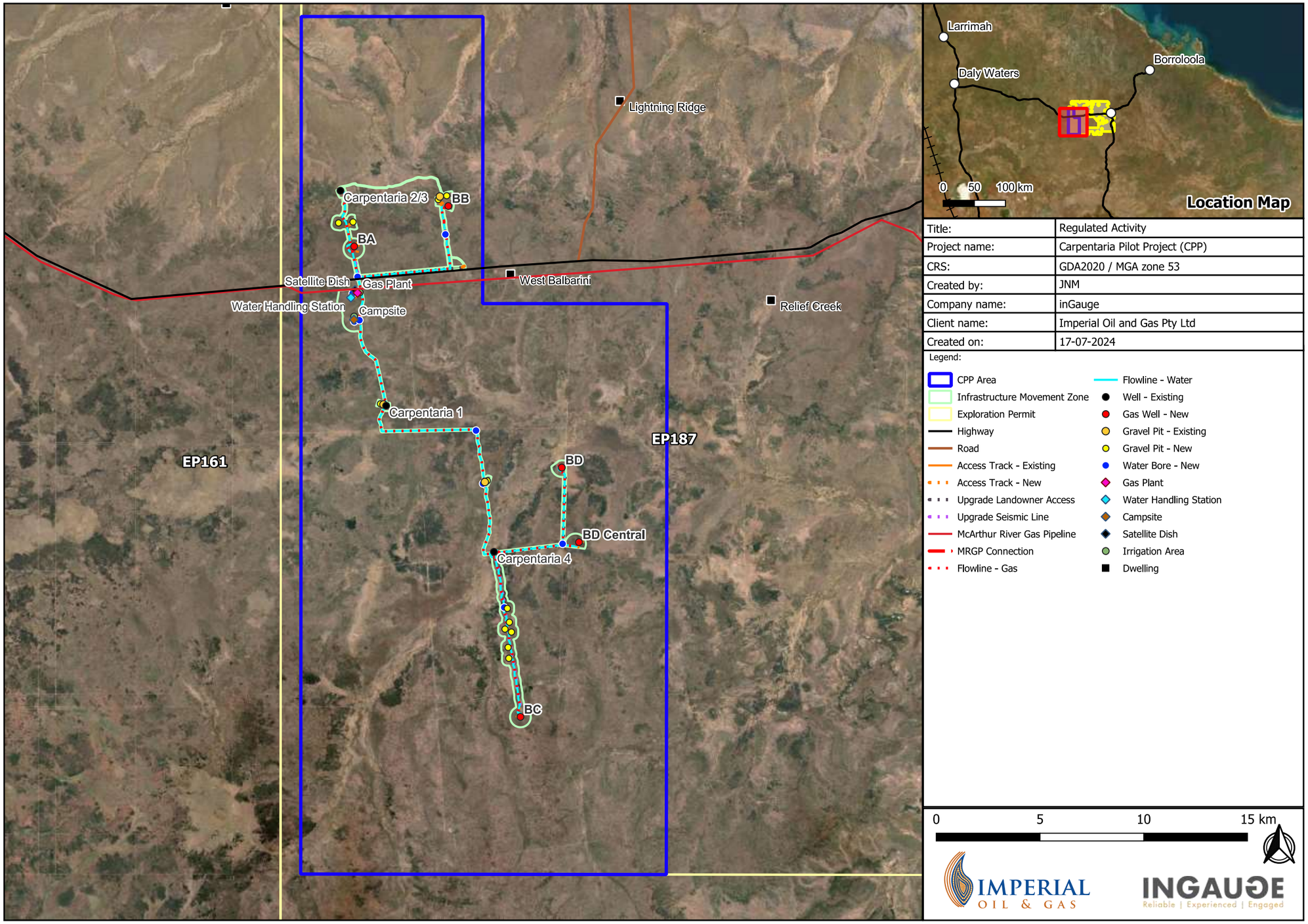


Figure 3.1—1 CPP Area and Location of Activity

3.2 Site Selection and Planning

The CPP site selection and planning process conforms with *the Code* requirement that the planning, design, location, and construction of petroleum infrastructure must have regard to the considerations of the *Land Clearing Guidelines* [DEPWS, 2021B], and specific consideration must be given to the following site selection features:

- Cultural heritage.
- Suitability of site, including flooding risk, sheet flow pathways, soil drainage and slope constraints, proximity to watercourses, and erosion and sediment controls.
- Must minimise interference with Wet Season water flow paths and exposure of infrastructure to flooding.
- Impacts to sensitive receptors; wildlife movement; biodiversity protection; water; weeds.
- Landscape and regional scale impacts assessed, including baseline ecological studies of areas to be disturbed.
- Critical habitats and important habitats are identified and avoided.
- The area of vegetation to be cleared for infrastructure development has been minimised.
- Potential environmental nuisance has been avoided and minimised with a setback distance of at least 2 km from an existing or proposed habitable dwelling for well pads, flowlines, and MRGP Connection.
- Requirements of *the Code.*
- AAPA Authority Certificate conditions.

Well pad selection in unconventional gas developments, such as shale, has some flexibility in optimising well pad surface locations due to the extended reach of the horizontal wells. Analysis of seismic reflection acquisition surveys, drilling results from existing wells, offset to other well pads, and other factors are considered by the geologists and engineers in selecting the preferred location and alignment in the target shale formation for directional drilling and HF at each proposed well pad area.

Initial site selection for the new well pads and facilities was conducted using desktop assessment within the assessment zone and refined by on-ground assessment.

A map of the location of the Activity assessment area is presented in **Figure 3.2—1**. Following the on-ground assessments, the Infrastructure Movement Zone was delineated within this assessment area. This is discussed further in **Section 3.3**.

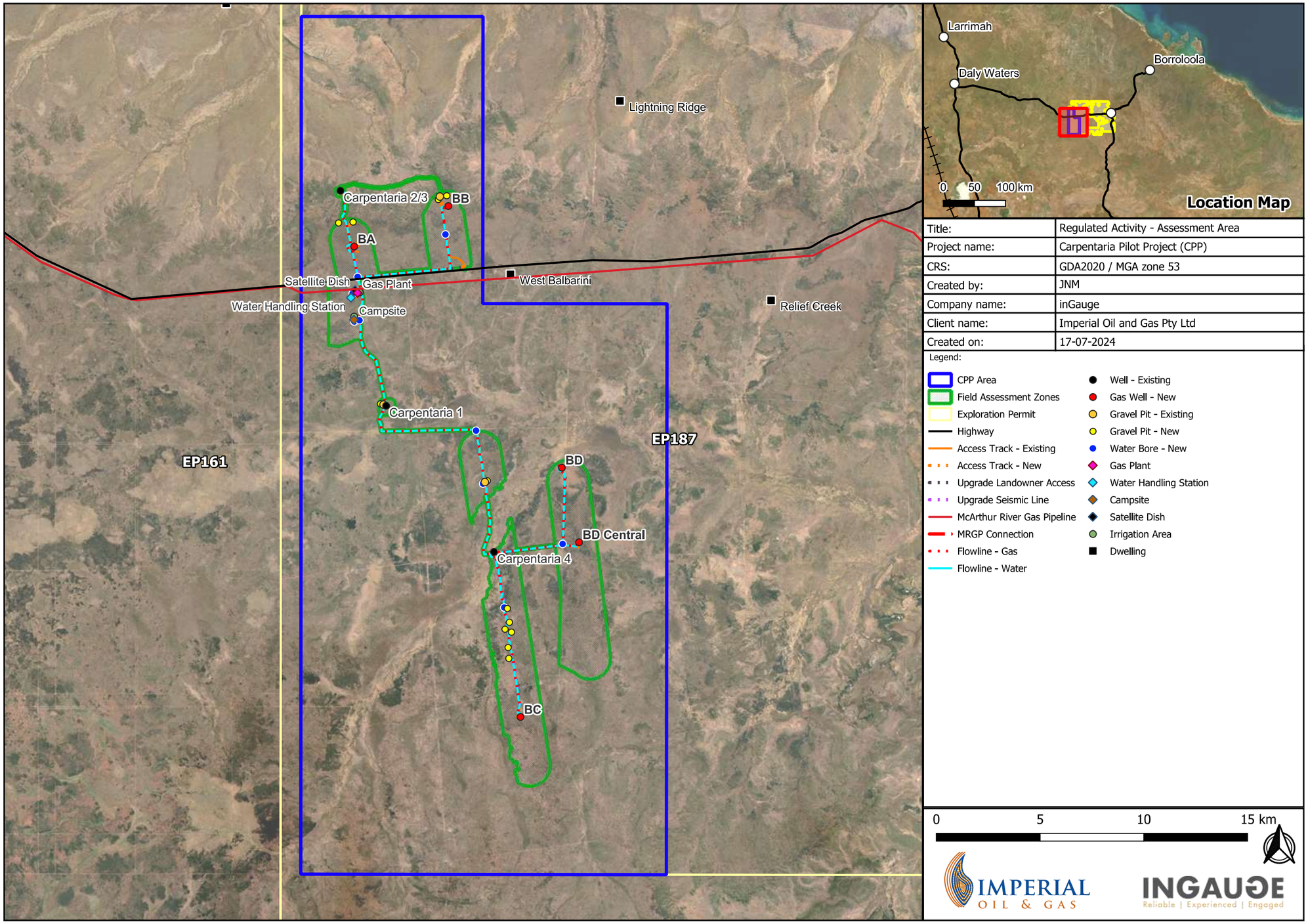


Figure 3.2—1 Regulated Activity - Assessment Area Map

3.3 Site Location Optimisation

To assist with environmental impact assessment and concentrate discussions specifically on the environmental aspects in the in the immediate vicinity of the Activity, as opposed to the entire extent of EP 187, the CPP Area (**Table 3.3—1**) has been defined.

The NT EPA Environmental Factors and Objectives have been used as a framework for assessing the suitability of the CPP Area layout and site selection. This detail and GIS analysis is presented in **Section 4**.

A total of 18 environmental features were used to assist in the environmental risk assessment, including SREBA vegetation features, surface water features, NRM GIS layers, SRTM elevation, predicted flood level, offsets from local infrastructure and existing water bores, and compliance with *the Code*. The mapping of this information for CPP sites is presented in **Section 4**, and the environmental risk assessment and mitigation measures are presented in **Section 6**.

In addition, desktop and field studies have assisted in site selection and assessment process. These include:

- Engineering surveys with drone topographical mapping.
- Environmental site survey (**Appendix 01** Environmental Assessment Report).
- Anthropological surveys in combination with Traditional Owner representatives (**Appendix 02** Cultural and Heritage Assessment).
- Topographic analysis (**Section 4.4**).
- CPP Area flood modelling (**Section 4.9.4**).
- Creek crossing detail and georeferenced imagery (**Section 4.9.2**).
- Vegetation disturbance and georeferenced imagery (**Section 4.11.2**).
- CPP Erosion and Sediment Control Plan (**Appendix 05**).
- Current Imperial AAPA Authority Certificate.

Imperial's AAPA Authority Certificate application was submitted and accepted on 7 September 2023. When received, the Authority Certificate will be checked against the sites and movement zones detailed in this EMP. If there are any discrepancies, site locations may need to be moved to comply with the AAPA Authority Certificate. If site selection changes are required that impose or increase environmental impacts or risks not already covered, this EMP will be revised under Regulation 17 of the *PER*. If site selection changes do not require a revision of this EMP, notification will be provided to the Minister under Regulation 22 of the *PER* before the change is implemented.

Finally, the environmental factor risk assessment approach has been adopted in the Risk Source-Pathway-Receptor Analysis presented in **Section 6** (Environmental Risks and Mitigation Measures), and in the design of the Environmental Performance Standards in **Section 6**. The proposed new site locations are listed in **Table 3.3—2**.

The indicative Activity locations have been chosen based on the above assessment and are illustrated in **Figure 3.1—1** to **Figure 3.3—5**.

Table 3.3—1 CPP Area

Location Point	Easting*	Northing*
Point 1	517766.6	8148096.18
Point 2	526648.6	8148087.18
Point 3	526613.5	8120581.95
Point 4	508998.6	8120606.61
Point 5	509026.2	8161929.73
Point 6	517778.3	8161924.24

* GDA2020 Zone 53

Table 3.3—2 General Well Information

General Well Information		
Carpentaria 2/3 (Existing well pad) (GDA2020, Zone 53)	Latitude Longitude Easting Northing	S 16.700855° E 135.102435° 510911.90 8153534.52
Carpentaria 4 (Existing well pad) (GDA2020, Zone 53)	Latitude Longitude Easting Northing	S 16.858110° E 135.171877° 518308.90 8136133.52
Well Pad BA* (New well pad) (GDA2020, Zone 53)	Latitude Longitude Easting Northing	S 16.725115° E 135.108585° 511574.90 8150850.52
Well Pad BB* (New well pad) (GDA2020, Zone 53)	Latitude Longitude Easting Northing	S 16.707470° E 135.151124° 516110.90 8152799.52
Well Pad BC* (New well pad) (GDA2020, Zone 53)	Latitude Longitude Easting Northing	S 16.929991° E 135.183944° 519586.89 8128180.52
Well Pad BD* (New well pad) (GDA2020, Zone 53)	Latitude Longitude Easting Northing	S 16.821372° E 135.202545° 521579.90 8140194.52
Well Pad BD (Central)* (New well pad) (GDA2020, Zone 53)	Latitude Longitude Easting Northing	S 16.853843° E 135.210352° 522407.90 8136601.52

* Indicative location.

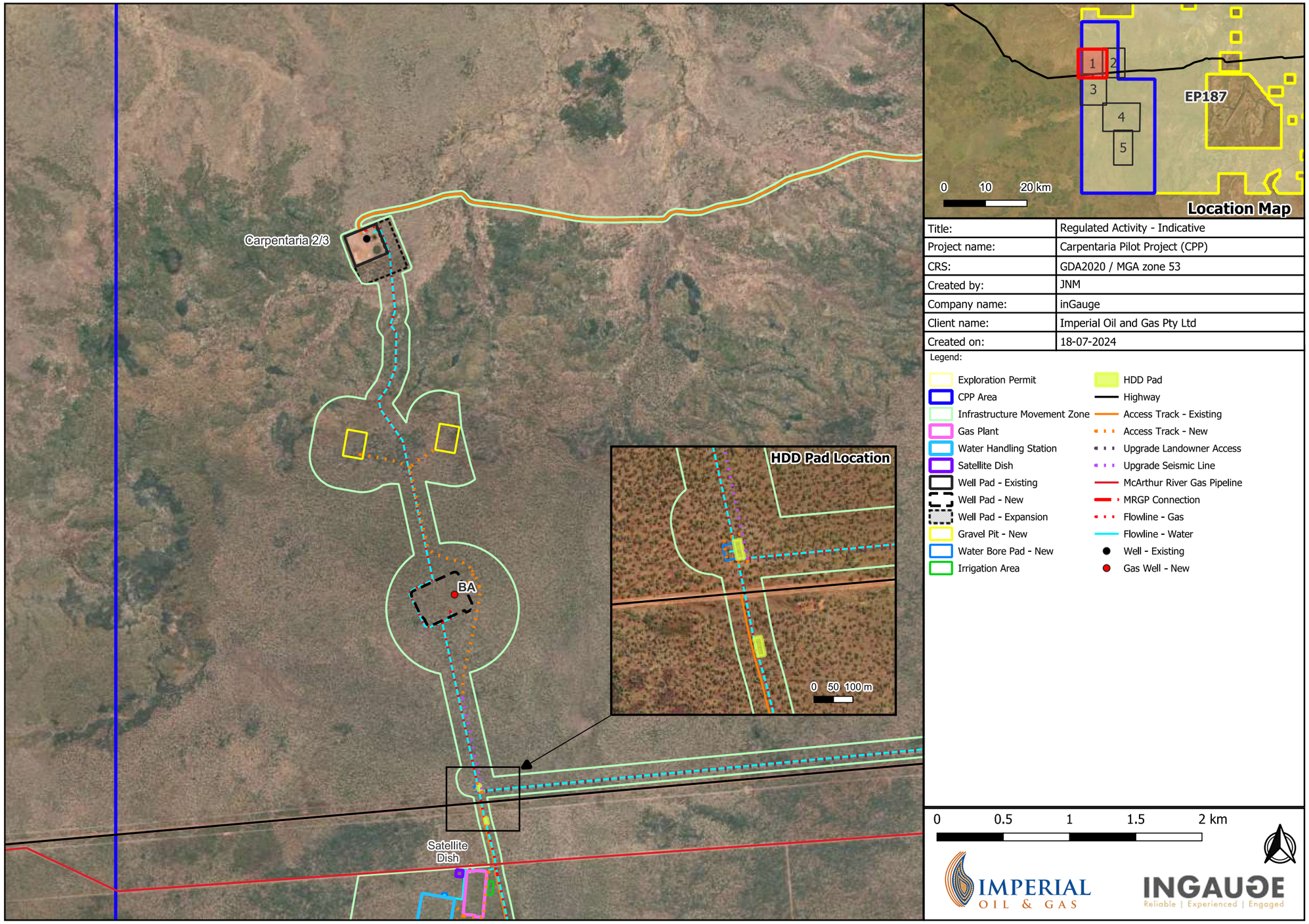


Figure 3.3—1 Regulated Activity - Indicative - Map 1

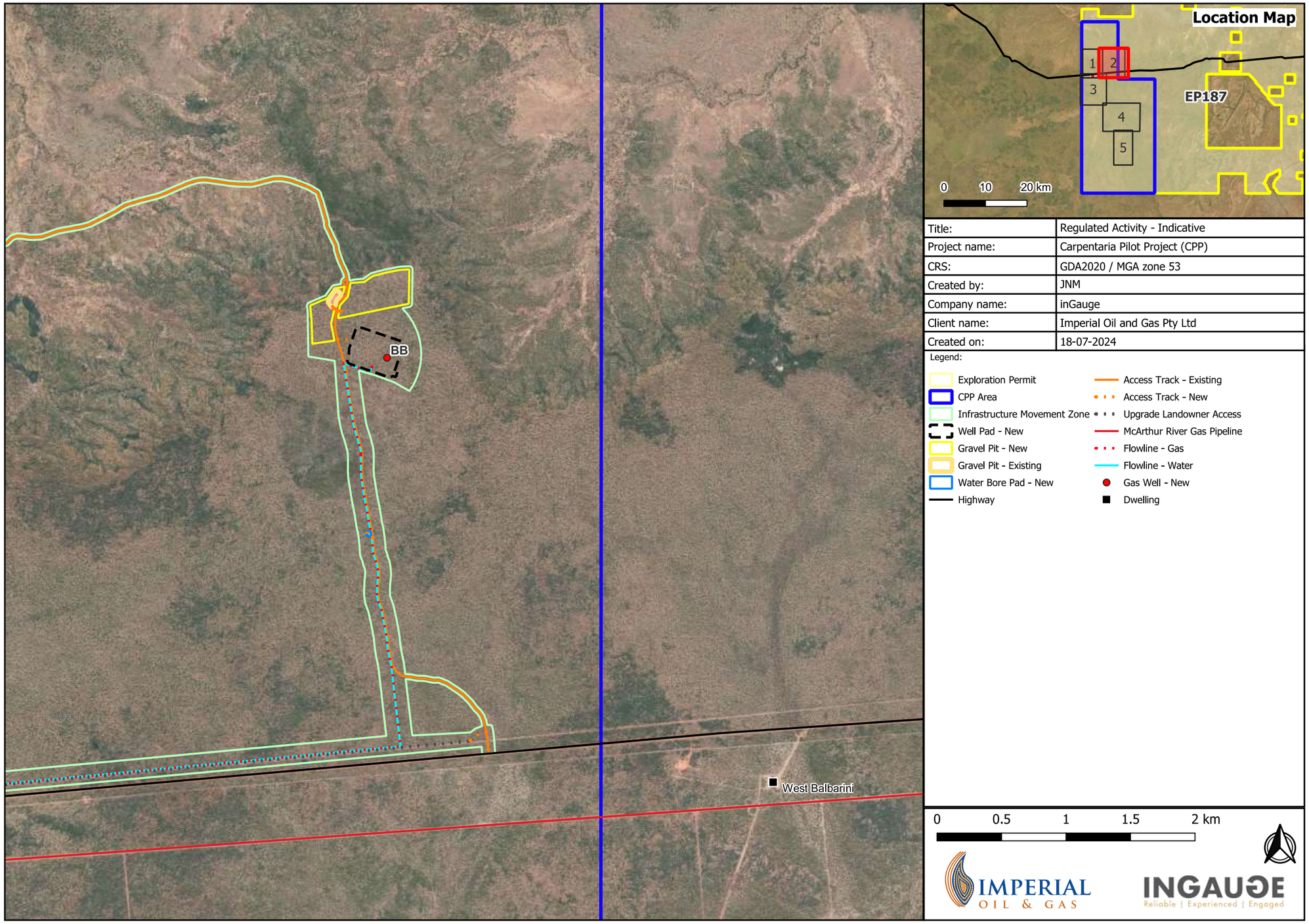


Figure 3.3—2 Regulated Activity - Indicative - Map 2

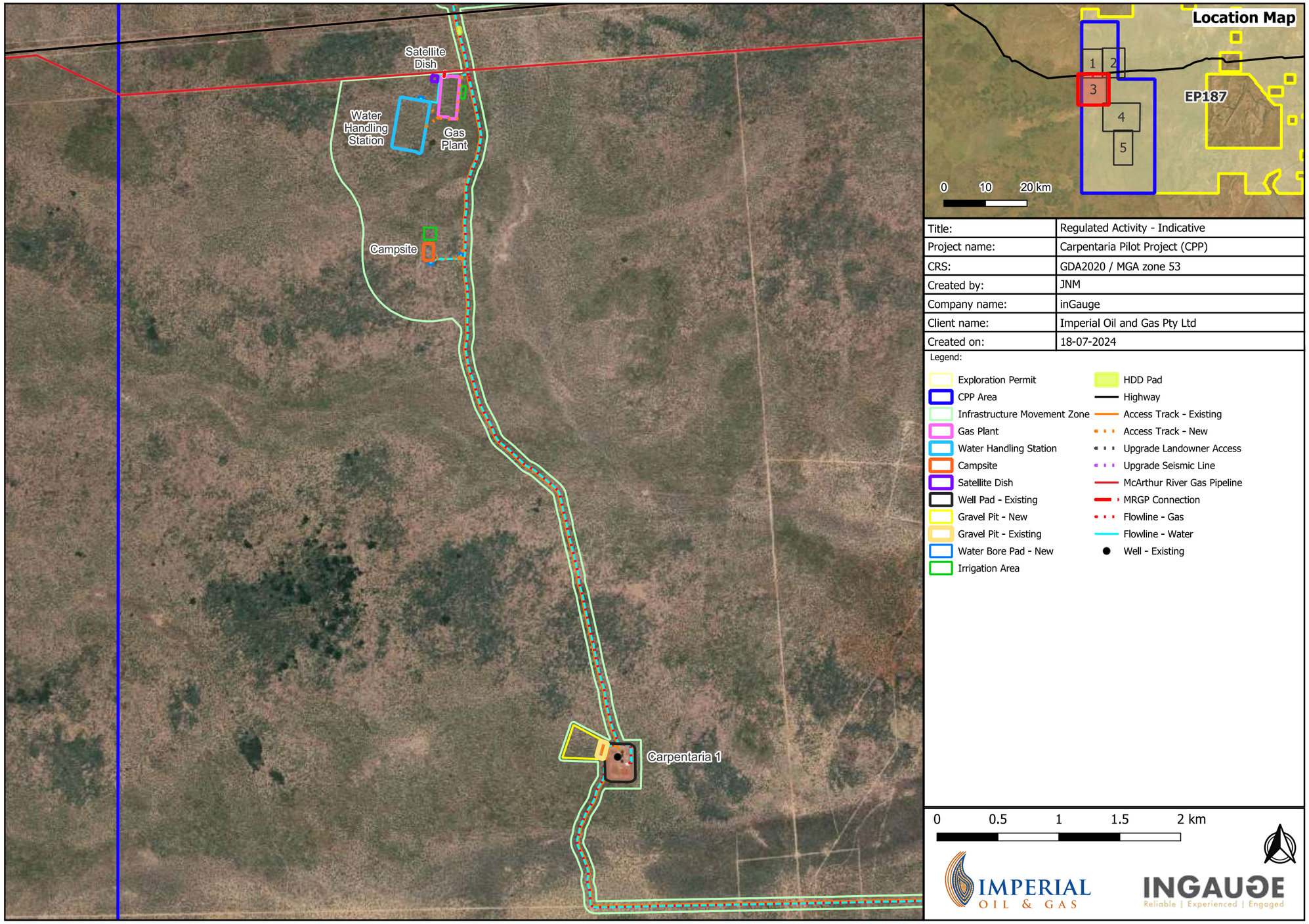


Figure 3.3—3 Regulated Activity - Indicative - Map 3

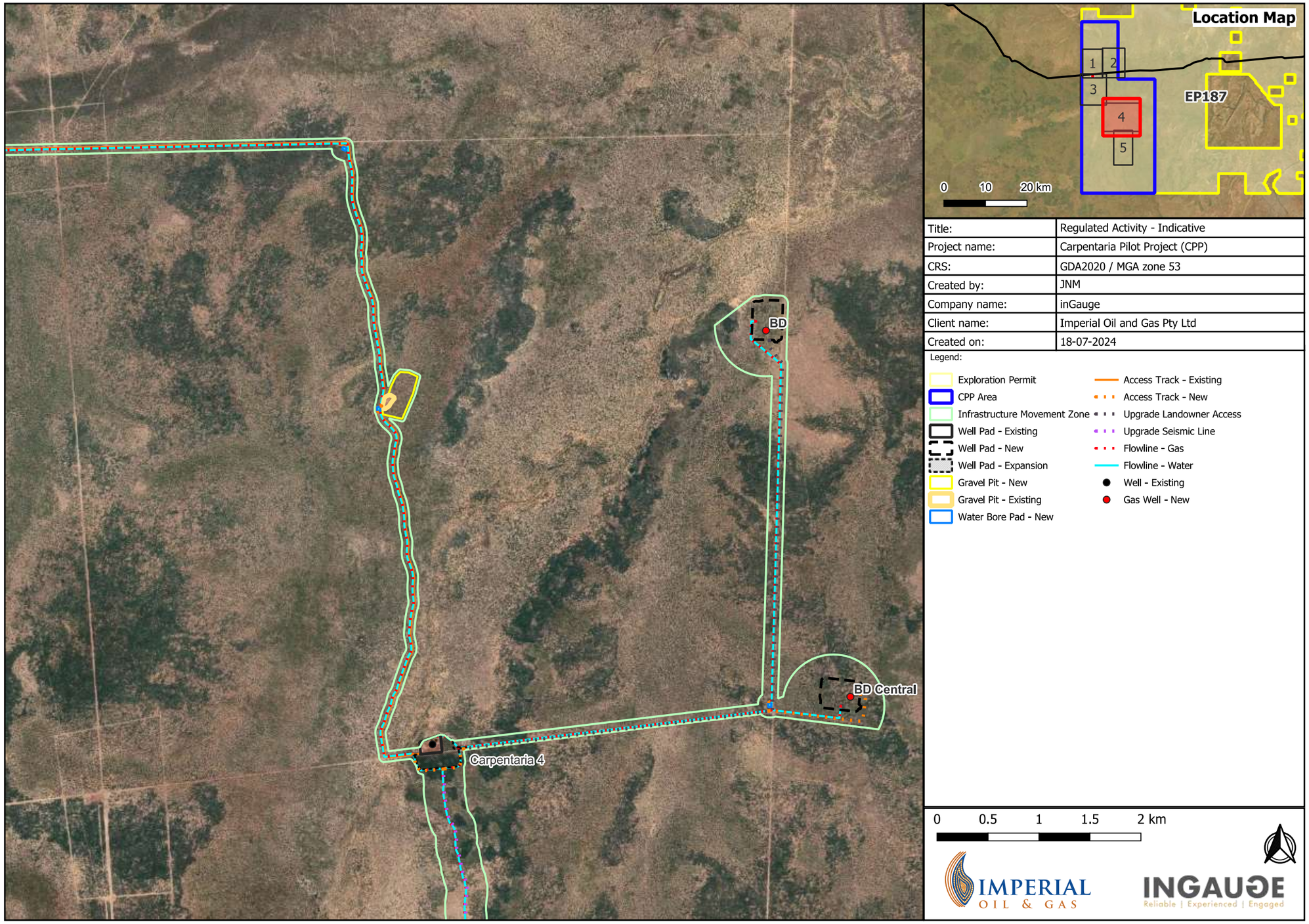


Figure 3.3—4 Regulated Activity - Indicative - Map 4

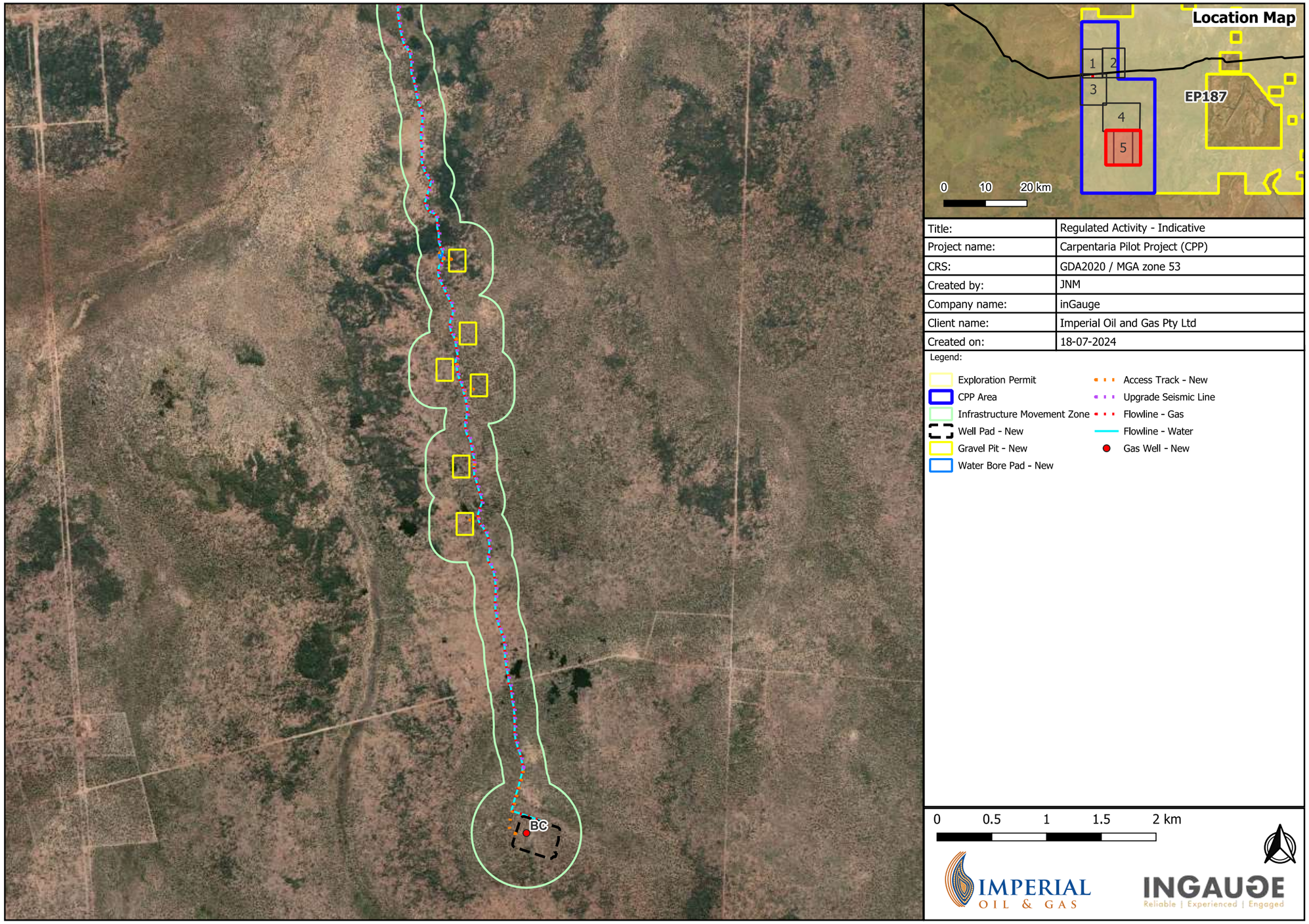


Figure 3.3—5 Regulated Activity - Indicative - Map 5

3.3.1 Indicative Locations

The indicative locations for all well pads, CGP, WHS, and Campsite have been ground-truthed post the desktop assessment to verify the on-ground conditions to avoid flood-prone areas, riparian zones, and sensitive vegetation and to account for slope. The initial desktop assessment area is shown in **Figure 3.2—1** has been refined to the Infrastructure Movement Zone post-ground-truthing. The results from this on-ground assessment are shown in the Environmental Assessment Report (**Appendix 01**) and Archaeological Assessment Report (**Appendix 02**).

Each well pad and associated facility locations were adjusted based on ground conditions. For example, for the well pad BD:

- An initial proposed well pad location for BD was considered unsuitable due to the area being in a low-lying monoculture of *Eucalyptus pruinosa* (Silver Box). The E. *pruinosa* on EP 187 tends to favour low-lying flat areas that may become seasonally inundated. The vegetation, therefore, assists in providing insights into what the area is like during the Wet Season.
- The soil at the original location for BD consisted of light brown/black clays, which are also typical of low-lying floodplain areas.
- A new location for BD was chosen in a mixed eucalypt (*Corymbia dichromophloia*, *Grevillea parallela*) woodland with patches of lancewood (*Acacia shirleyi*). The soil at the new location is red loam. These species and soil types suggest the new area is not within a flood-prone area.
- The new location for BD still appears to be within the modelled flood zone, but the ground assessment (as per above points) verified that the modelling in this location is not reflective of the site conditions.

Similarly, the [redacted] well pad proposed expansion was adjusted to exclude areas to the north and east near Relief Creek, which were originally being considered.

The indicative locations and Infrastructure Movement Zone based on the results of the desktop and on-ground assessment for each of the potential infrastructure locations are shown in the following figures:

- The 1 in 100-year flood modelling is shown in **Figure 3.3—6** to **Figure 3.3—10**.
- The indicative elevations are shown in **Figure 3.3—11** to **Figure 3.3—15**.
- The ordered streams, GDEs, water bores and sinkholes are shown in **Figure 3.3—16** to **Figure 3.3—20**.
- The SREBA vegetation mapping is shown in **Figure 3.3—21** to **Figure 3.3—25**.

Although the identified locations for the Activity are indicative, they will likely represent the actual placement of the infrastructure. The purpose of the Infrastructure Movement Zone is to accommodate potential shifts in the Activity locations at the time of clearing. These adjustments may arise due to changes in the local environment, discussions with local landowners and/or project planning considerations. Locations can be moved or rotated to optimise the flowline network, reduce water run-on or run-off, or to circumvent environmental features, such as habitat trees. Any relocation of infrastructure within this movement zone will be carried out in consultation with a Field Environmental Advisor. If infrastructure is required to be located outside of the Infrastructure Movement Zone, it will be done after being ground-truthed by both an ecologist and archaeologist and adhere to the management of change requirements in **Section 8.6**.

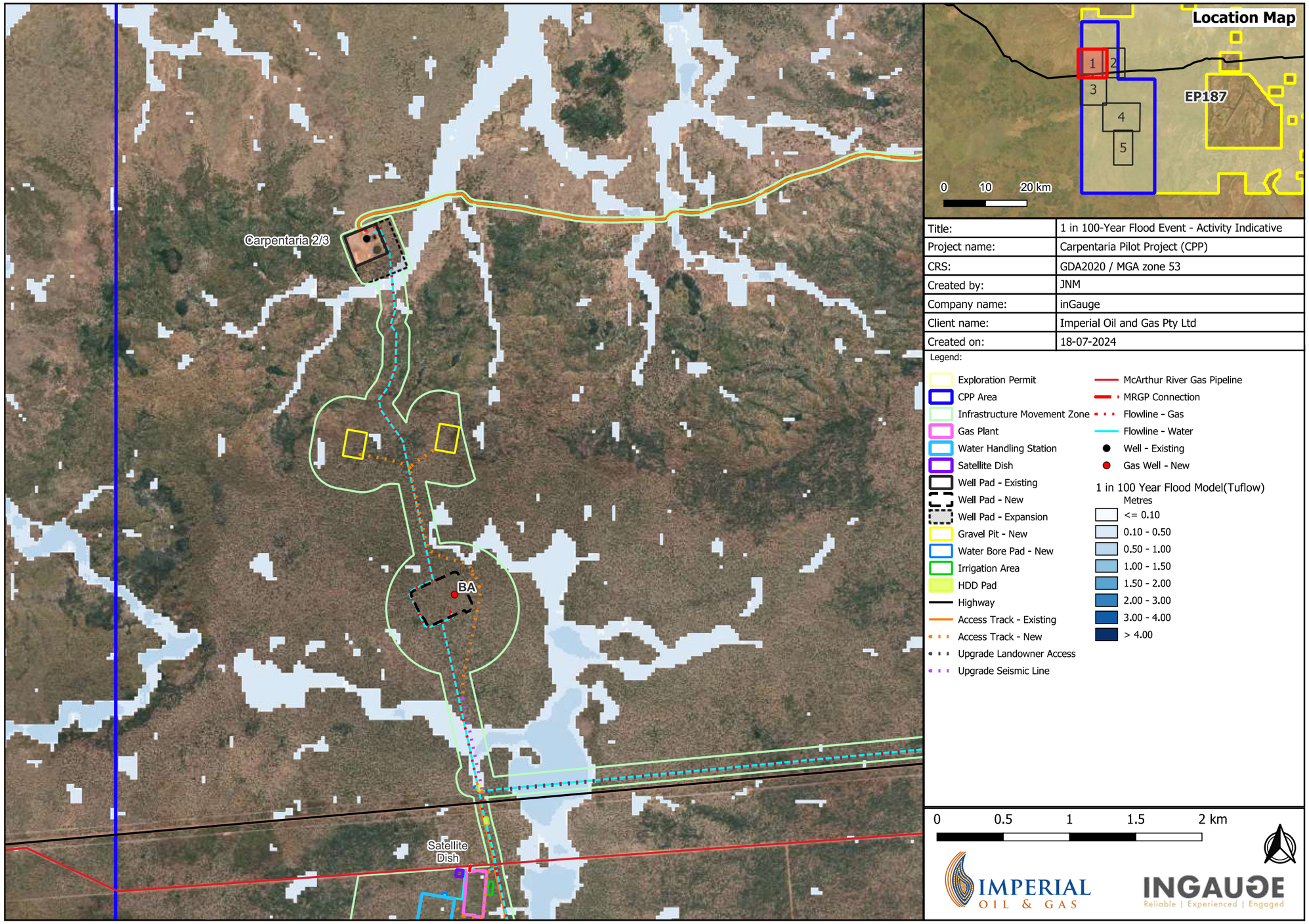


Figure 3.3—6 Regulated Activity 1 in 100-year Flood Modelling - Map 1

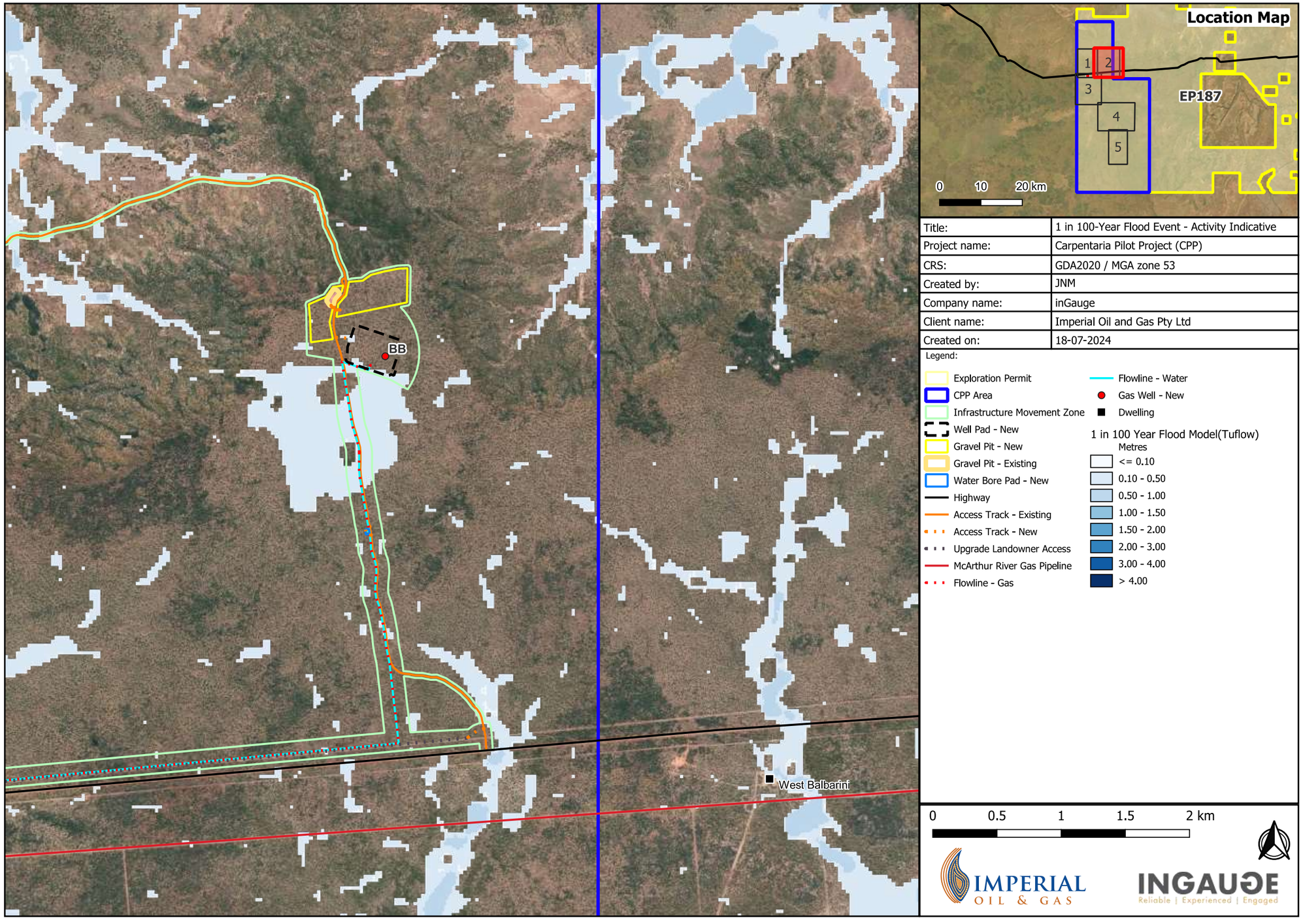


Figure 3.3—7 Regulated Activity 1 in 100-year Flood Modelling - Map 2

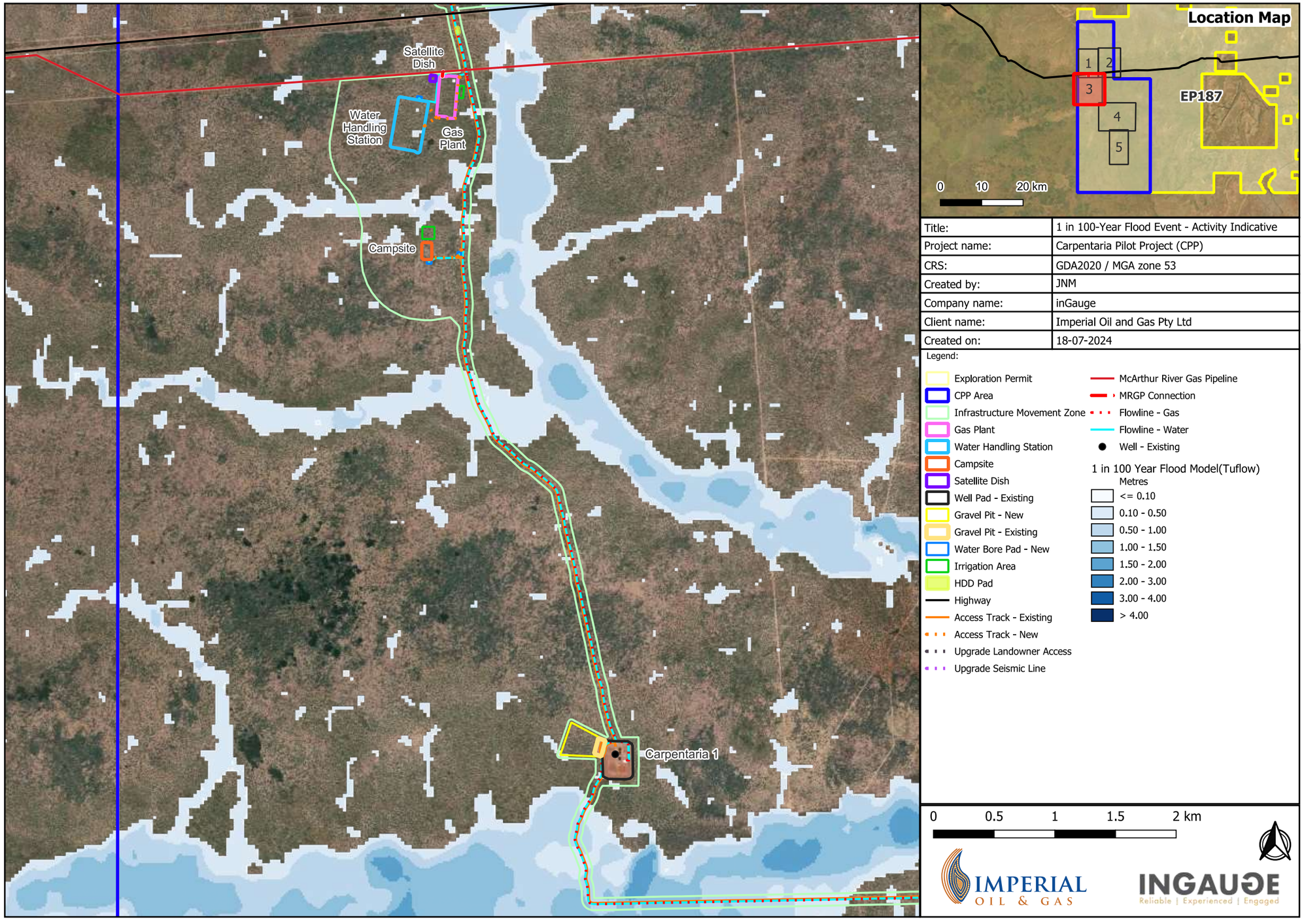


Figure 3.3—8 Regulated Activity 1 in 100-year Flood Modelling - Map 3

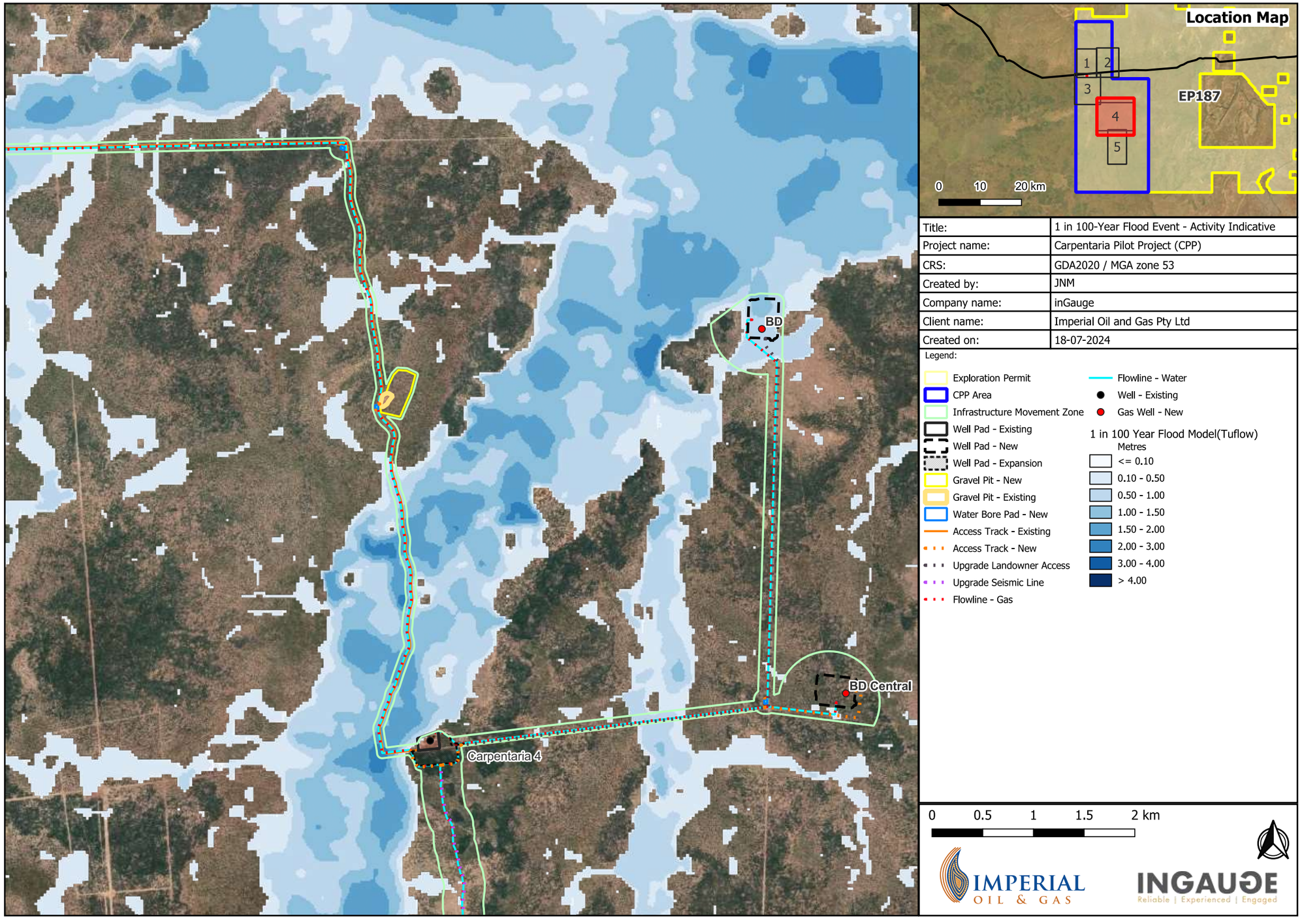


Figure 3.3—9 Regulated Activity 1 in 100-year Flood Modelling - Map 4

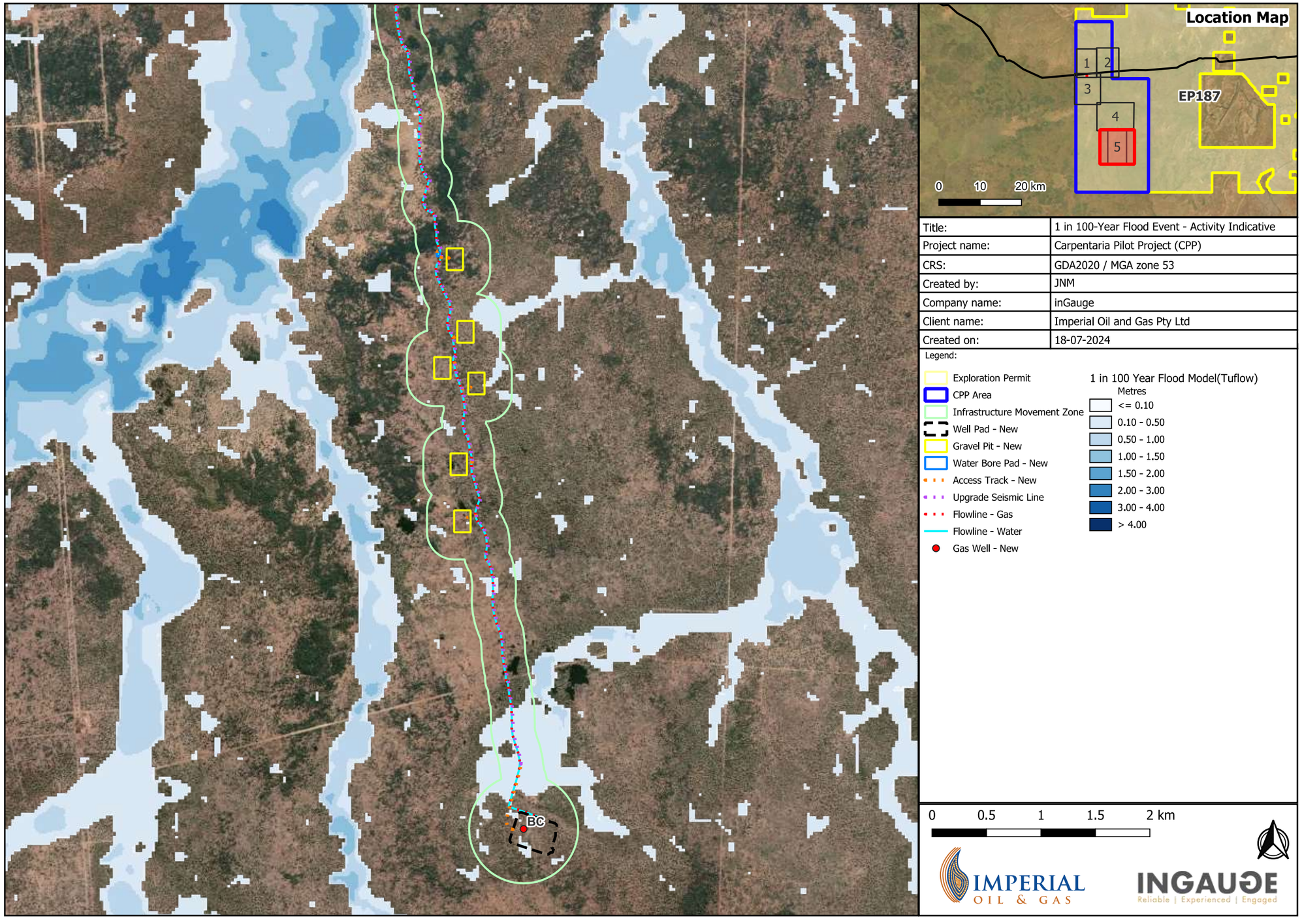


Figure 3.3—10 Regulated Activity 1 in 100-year Flood Modelling - Map 5

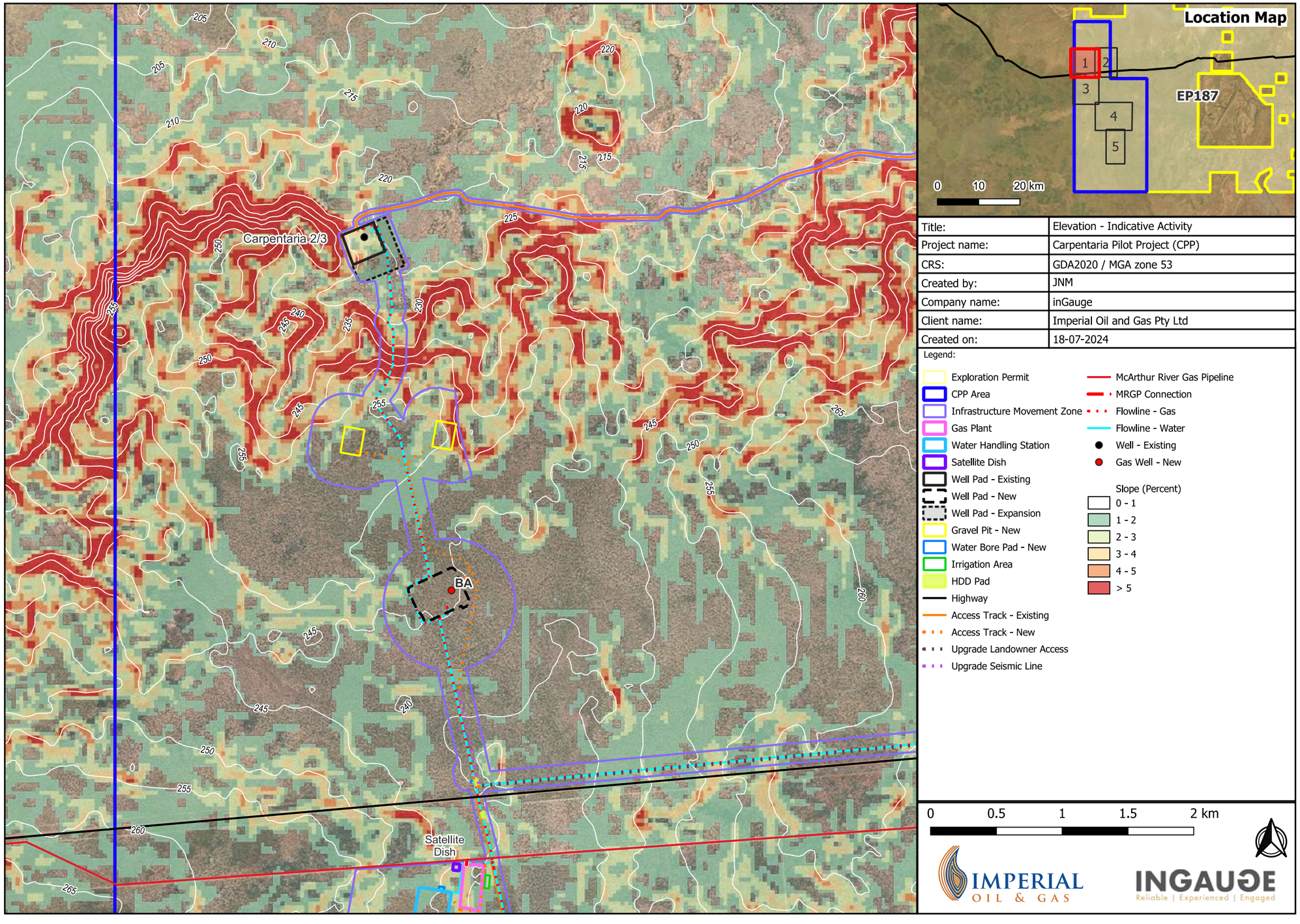


Figure 3.3—11 Regulated Activity Indicative Elevation – Map 1

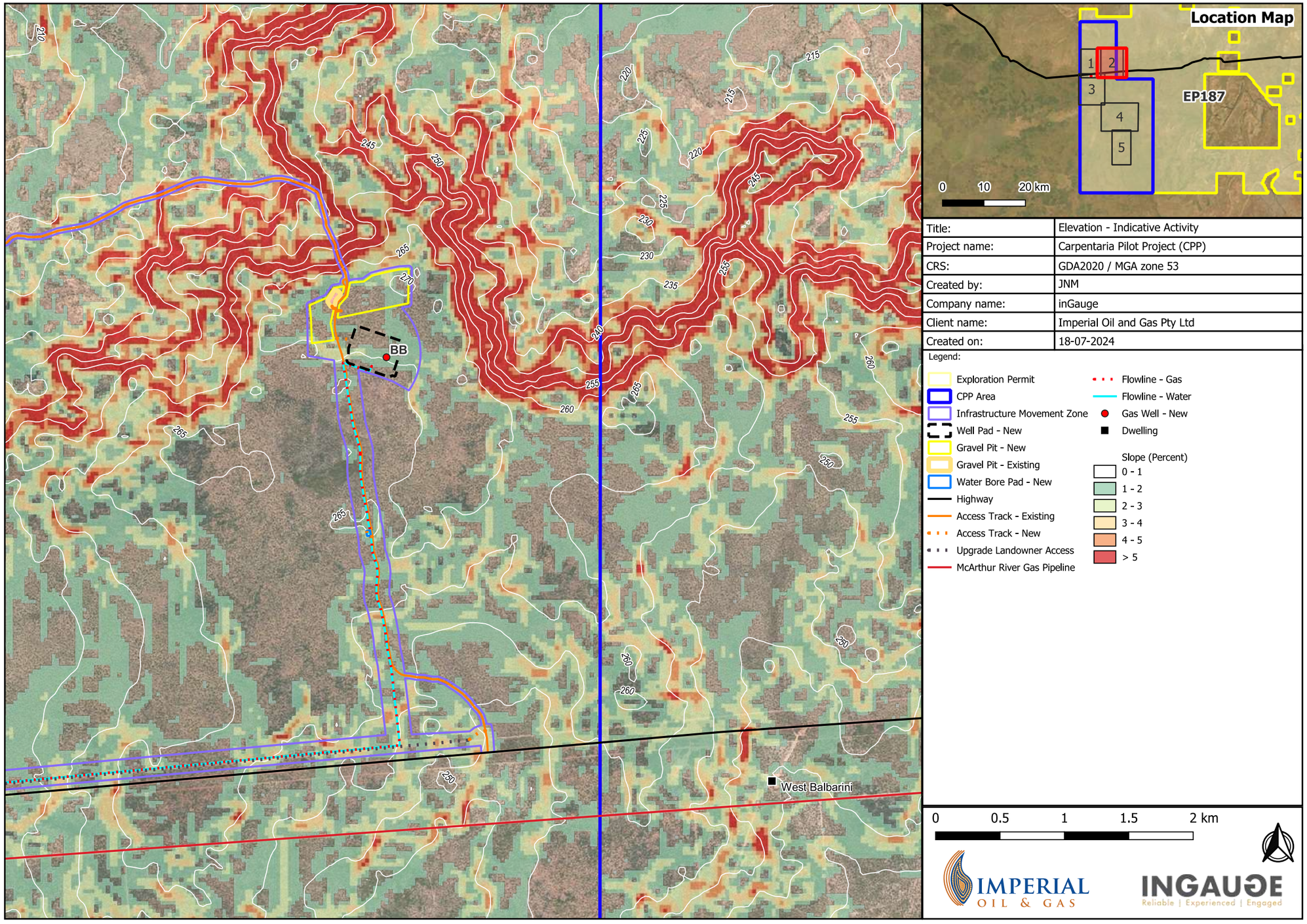


Figure 3.3—12 Regulated Activity Indicative Elevation – Map 2

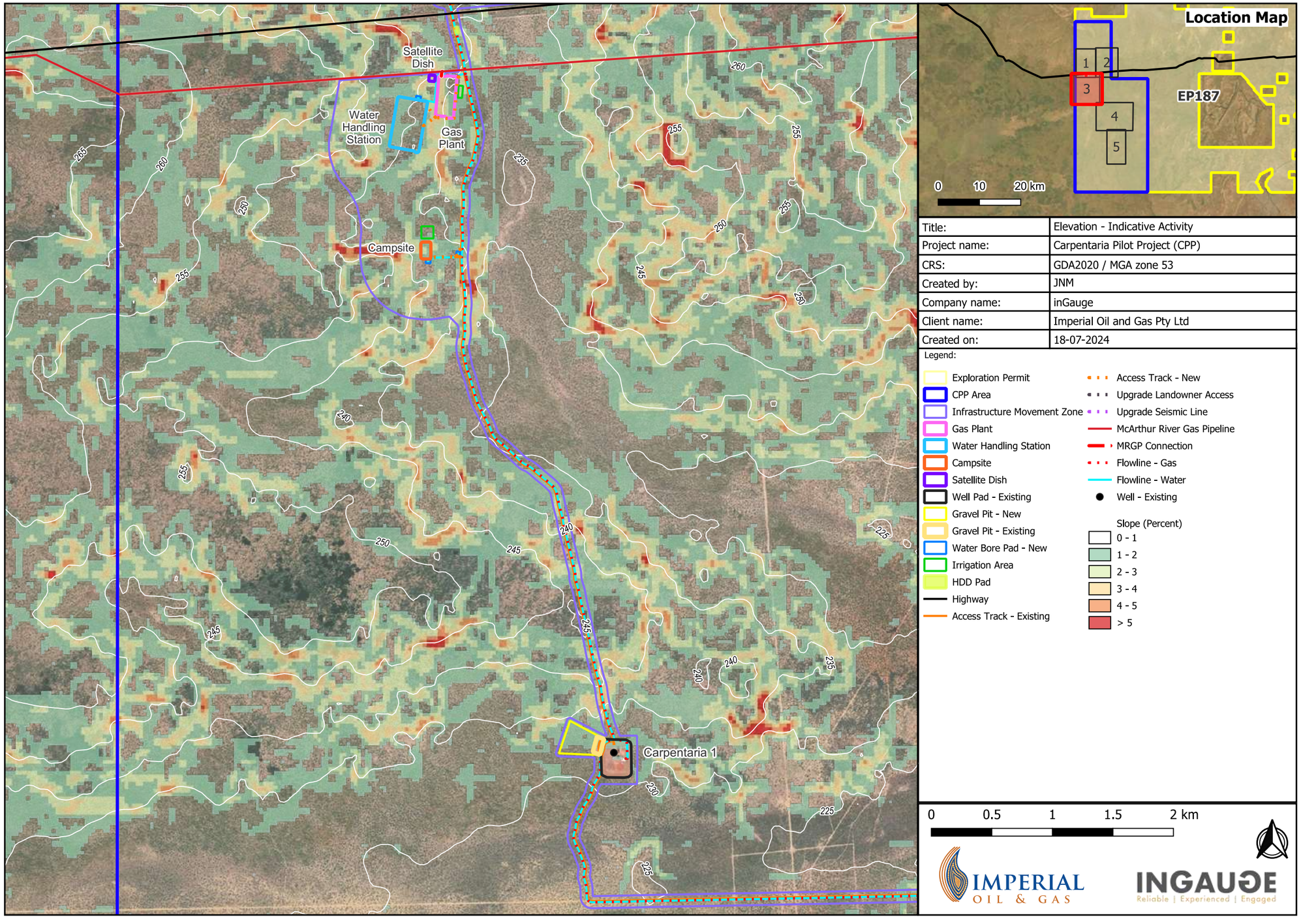


Figure 3.3—13 Regulated Activity Indicative Elevation – Map 3

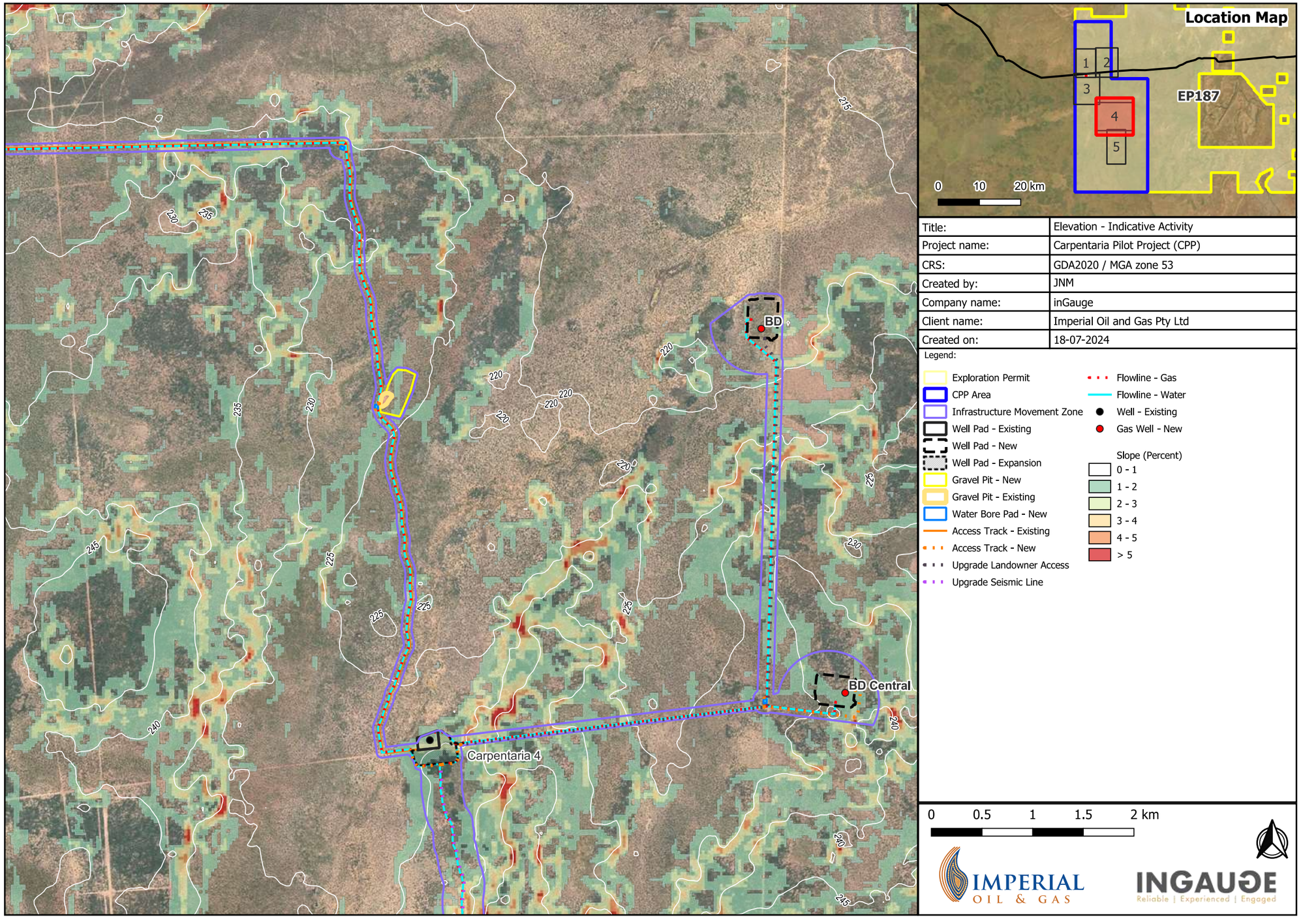


Figure 3.3—14 Regulated Activity Indicative Elevation – Map 4

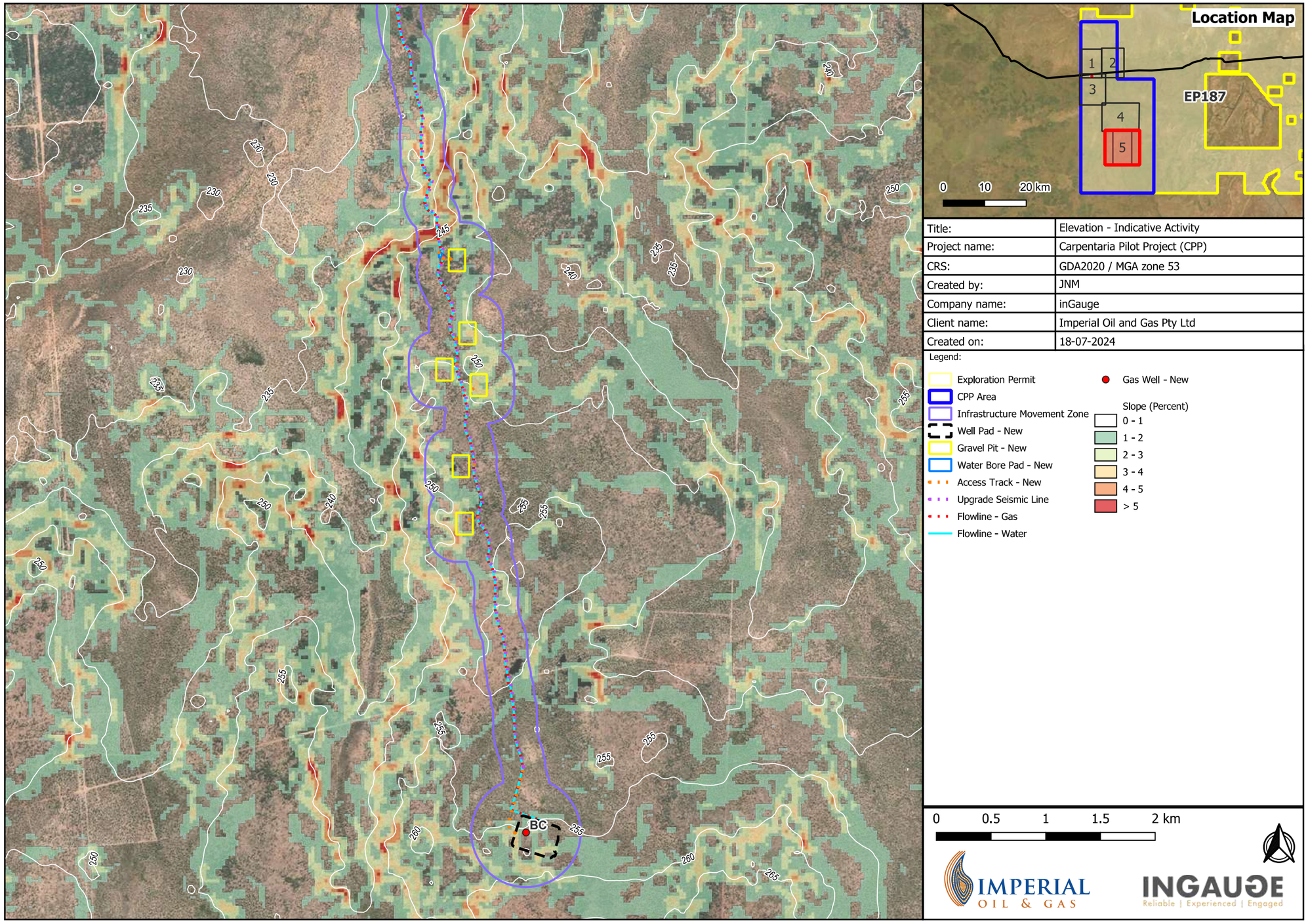


Figure 3.3—15 Regulated Activity Indicative Elevation – Map 5

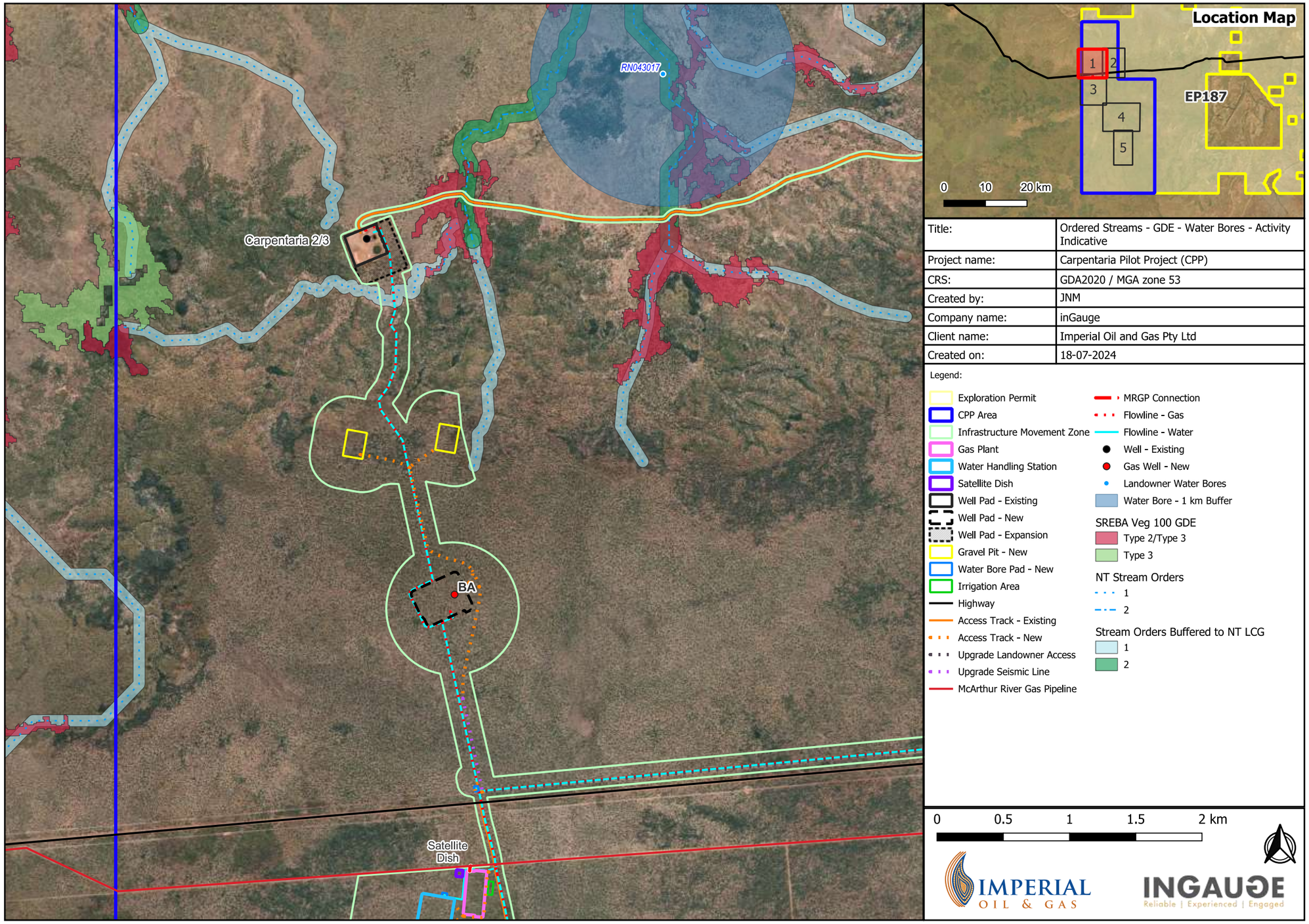


Figure 3.3—16 Regulated Activity Ordered Streams, GDEs, Water Bores– Map 1

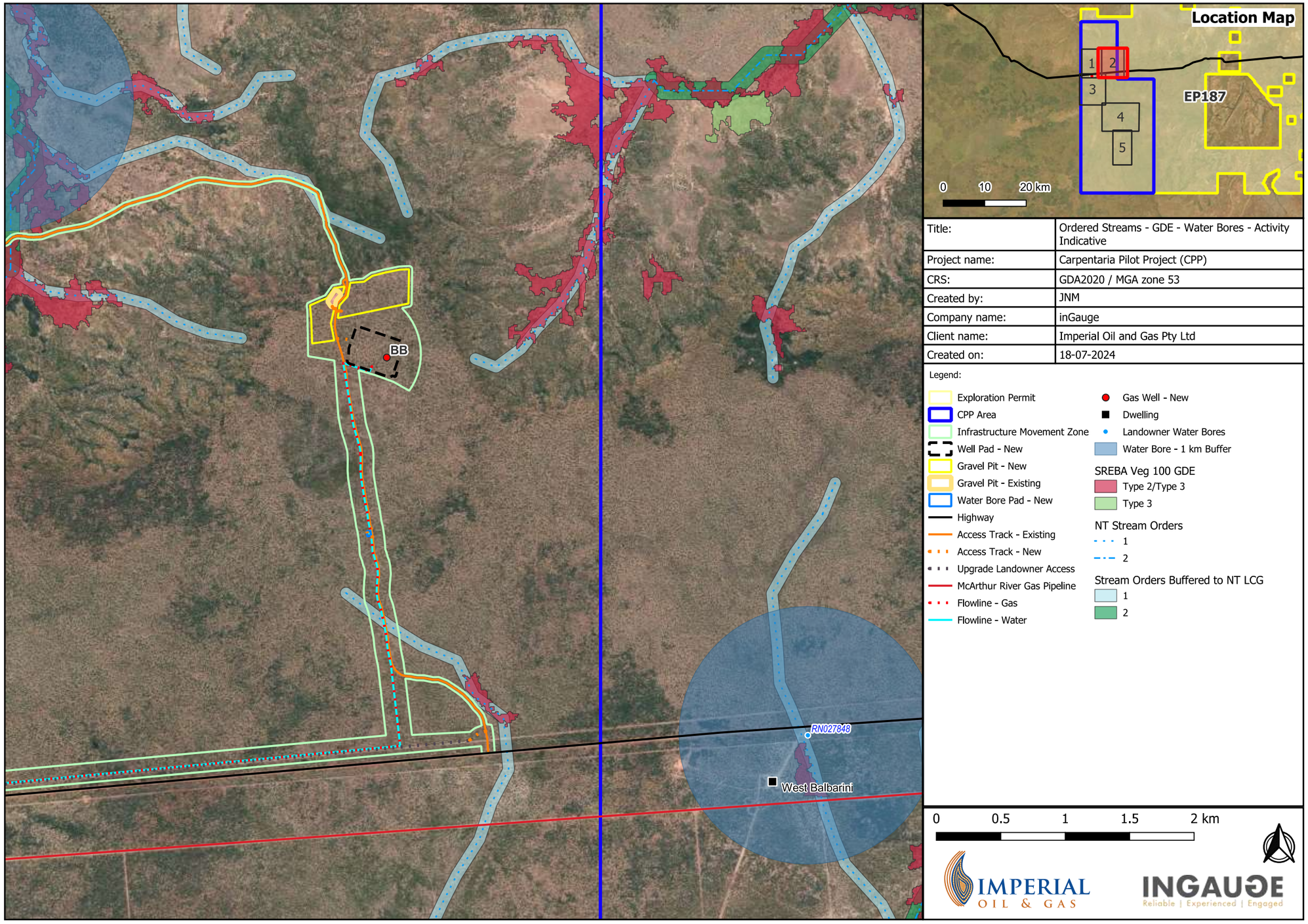


Figure 3.3—17 Regulated Activity Ordered Streams, GDEs, Water Bores, Sinkholes – Map 2

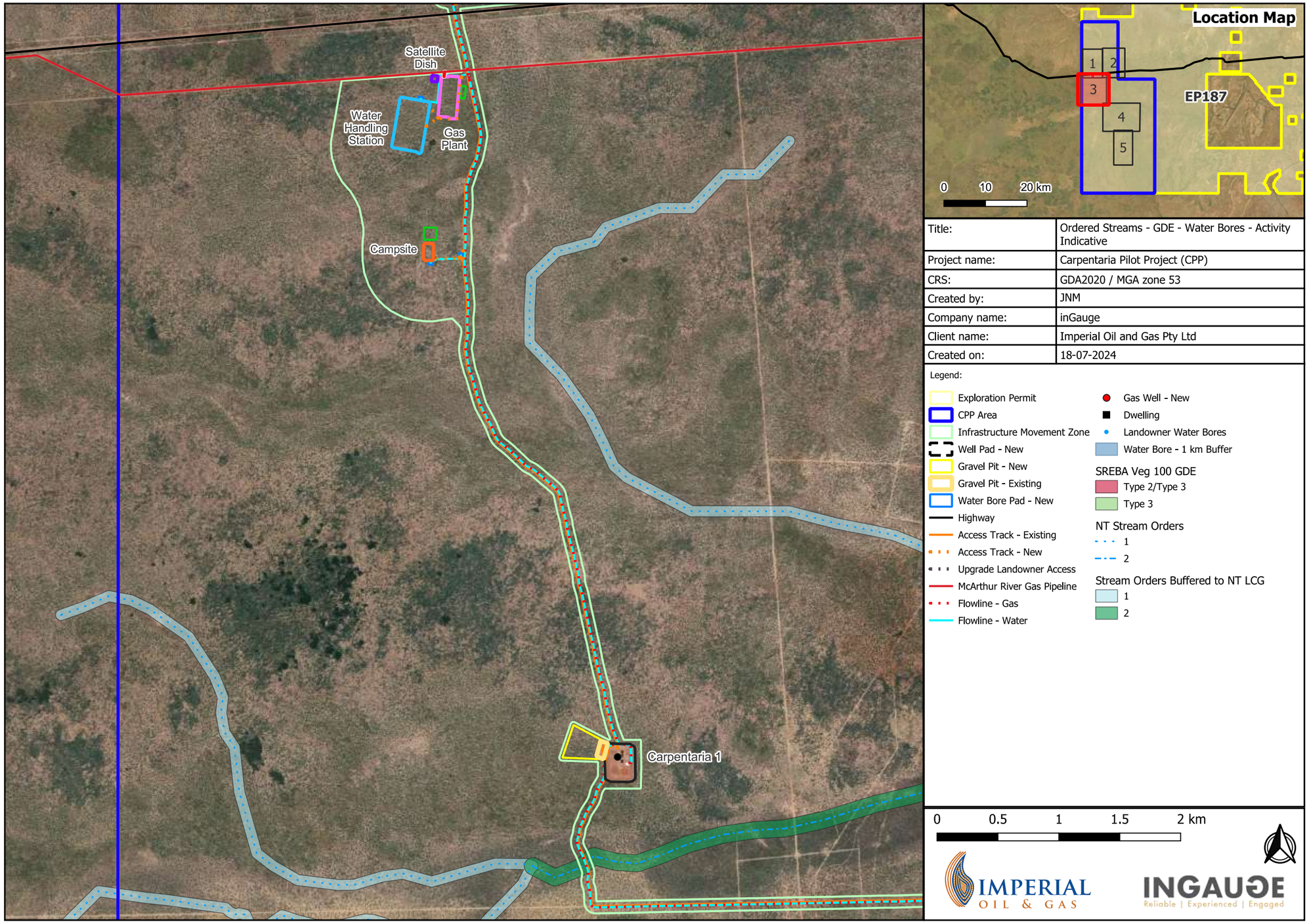


Figure 3.3—18 Regulated Activity Ordered Streams, GDEs, Water Bores, Sinkholes – Map 3

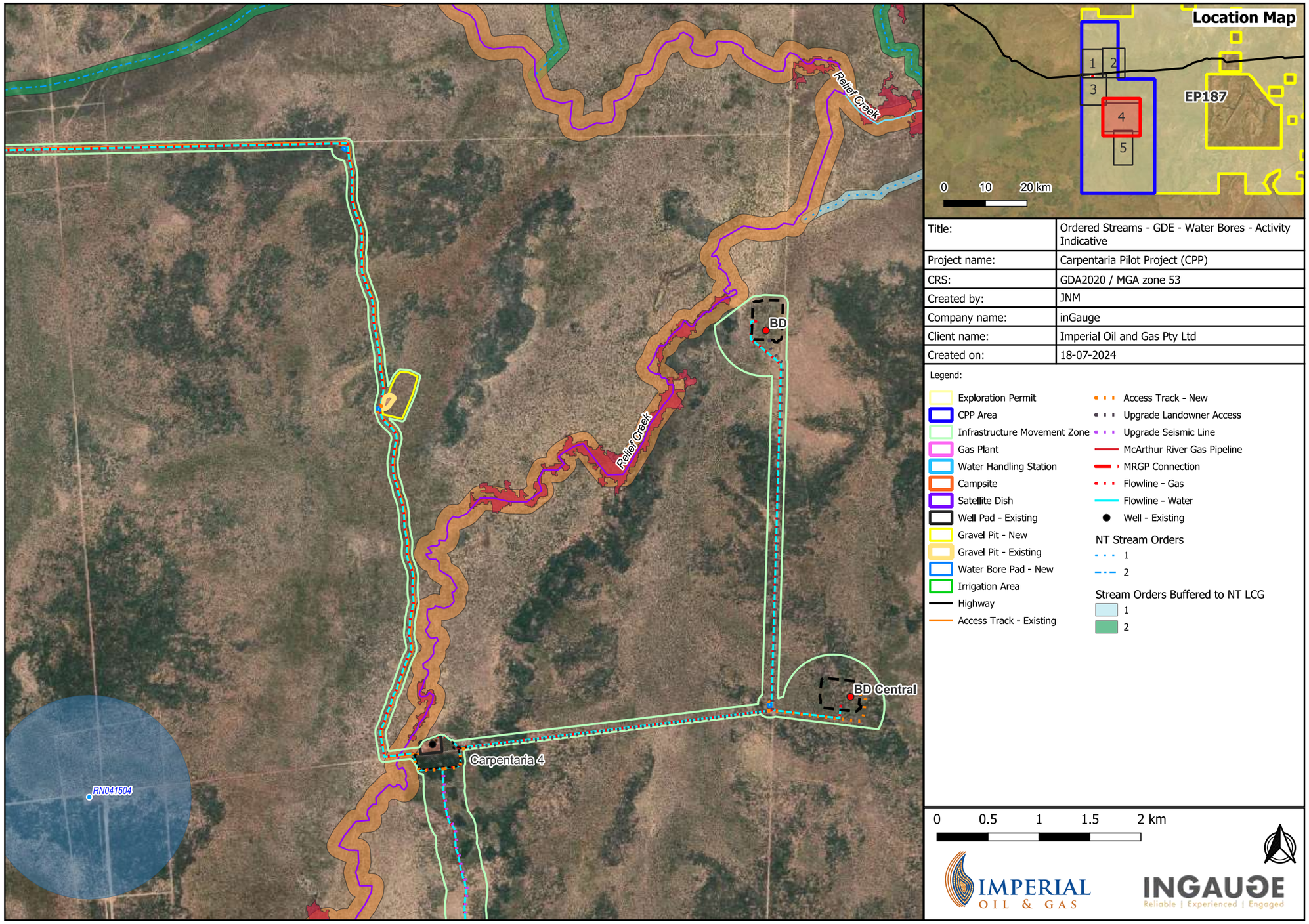


Figure 3.3—19 Regulated Activity Ordered Streams, GDEs, Water Bores, Sinkholes – Map 4

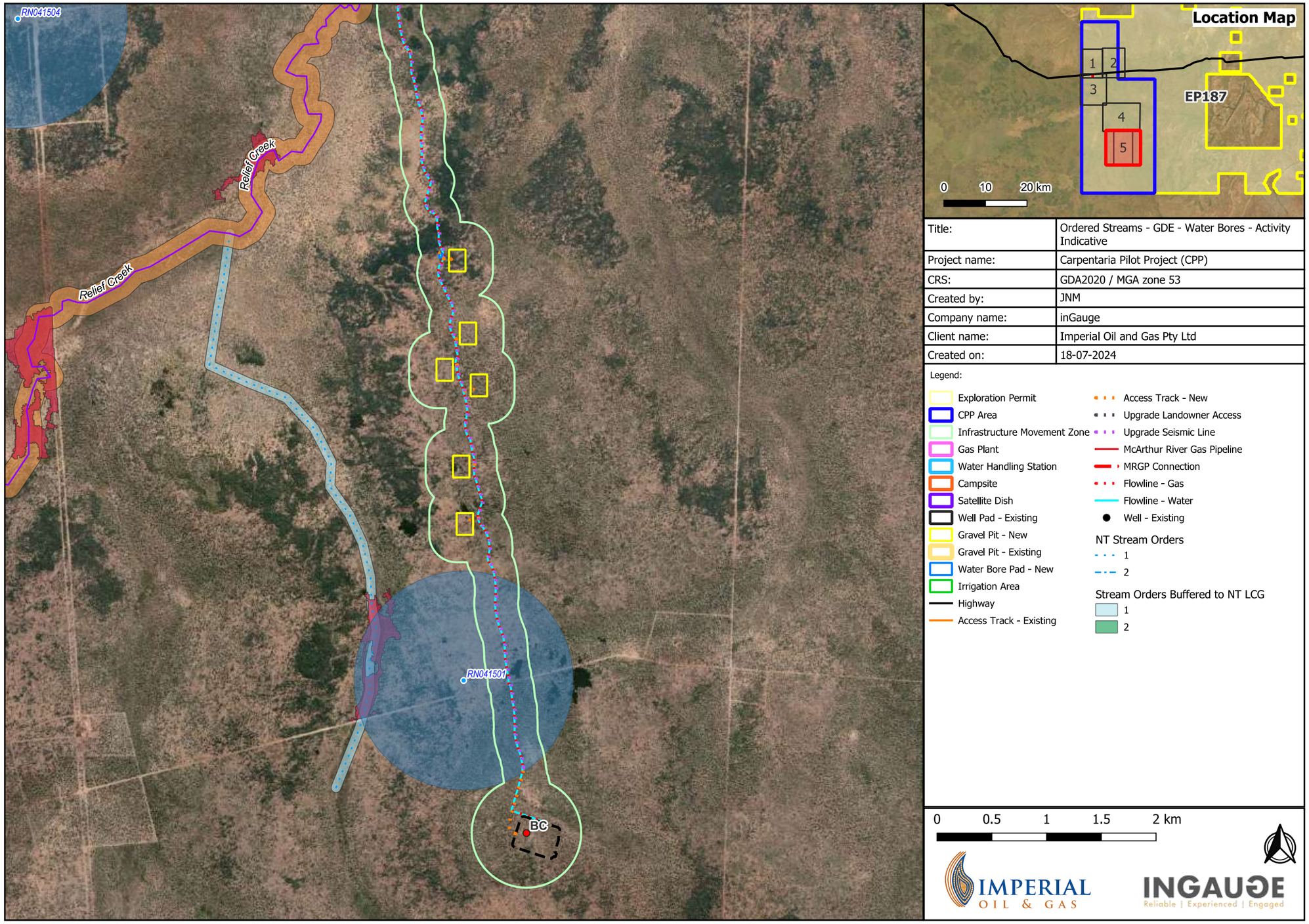


Figure 3.3—20 Regulated Activity Ordered Streams, GDEs, Water Bores, Sinkholes – Map 5

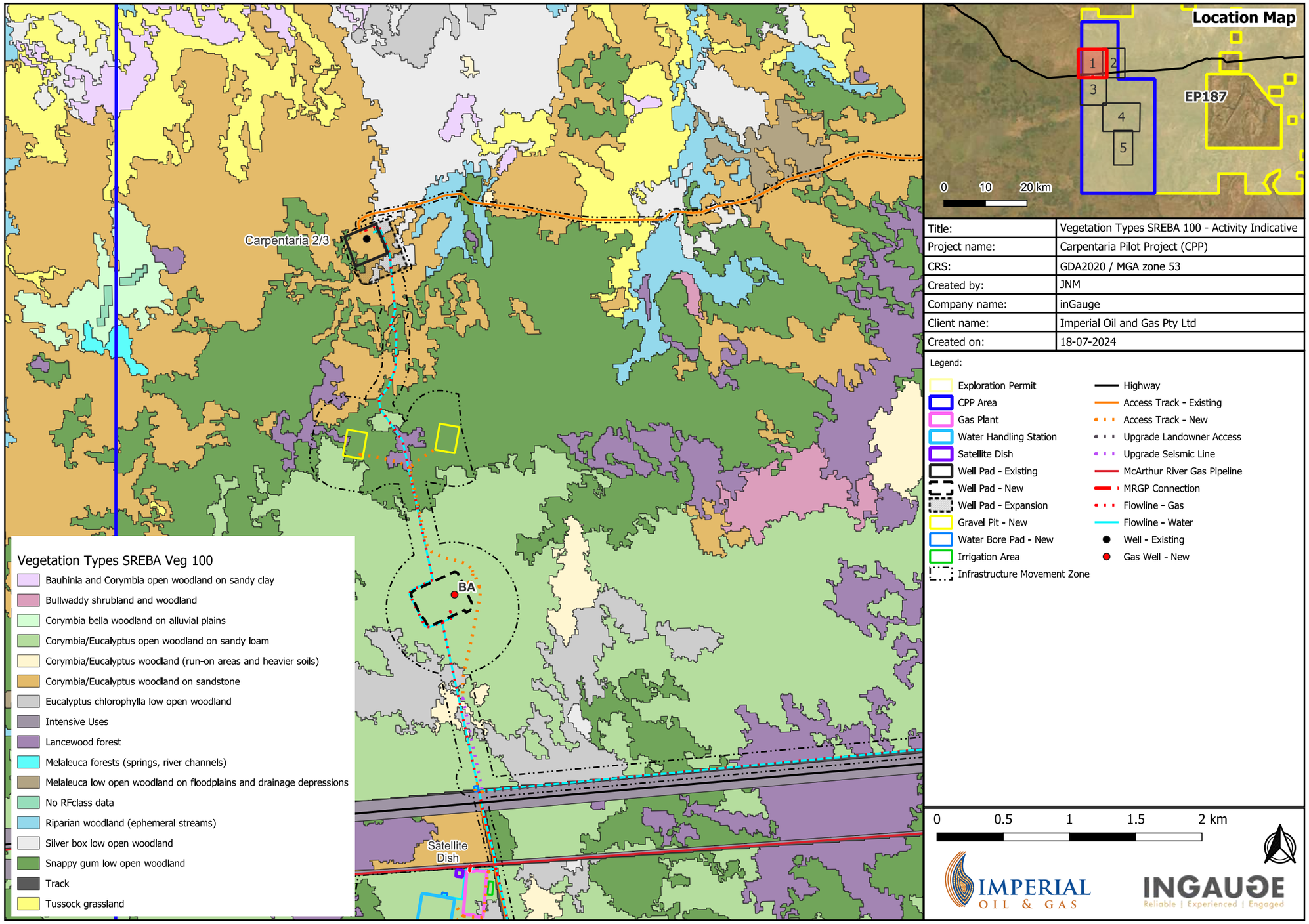


Figure 3.3—21 Regulated Activity – Vegetation – Map 1

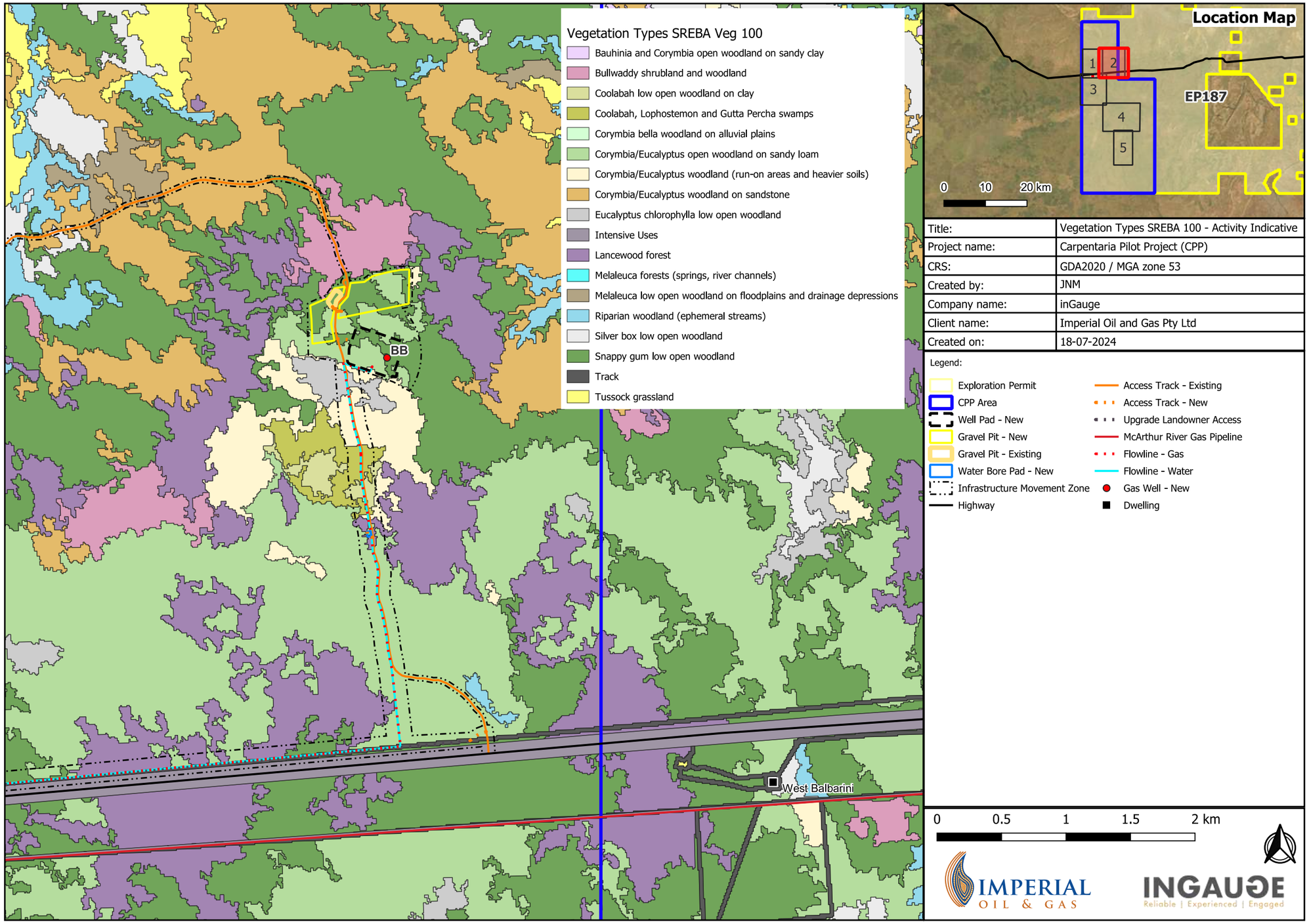


Figure 3.3—22 Regulated Activity – Vegetation – Map 2

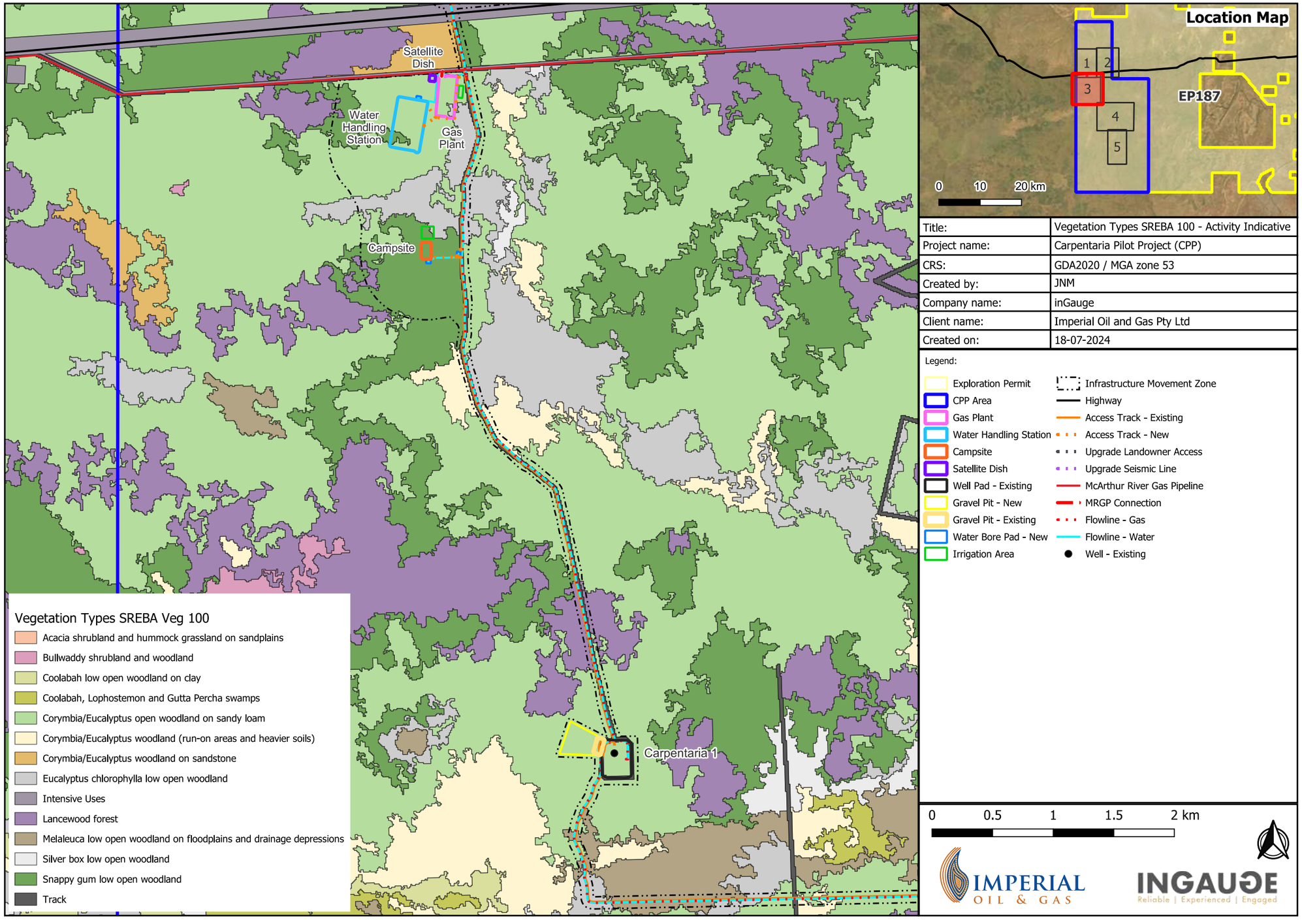


Figure 3.3—23 Regulated Activity – Vegetation – Map 3

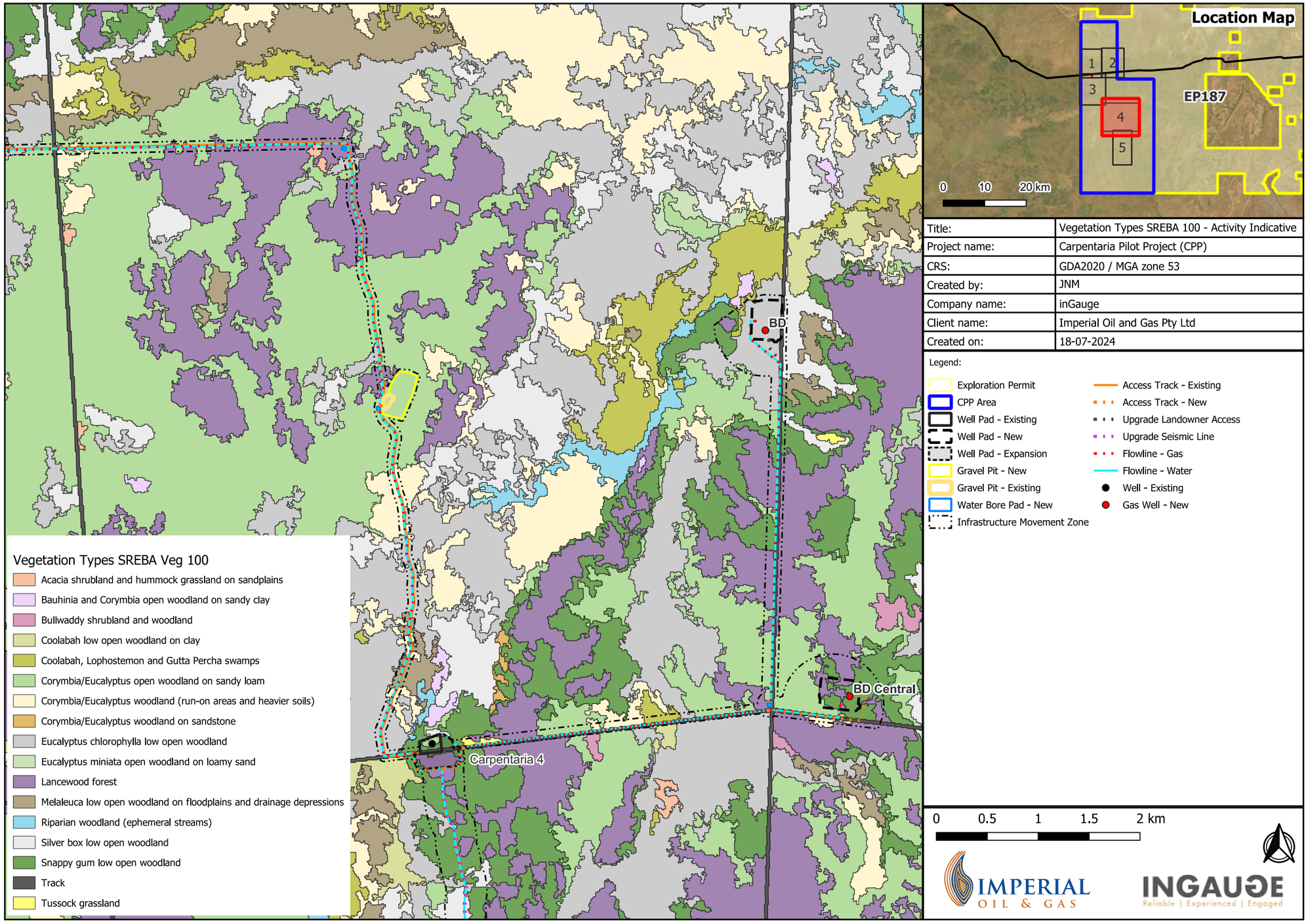


Figure 3.3—24 Regulated Activity – Vegetation – Map 4

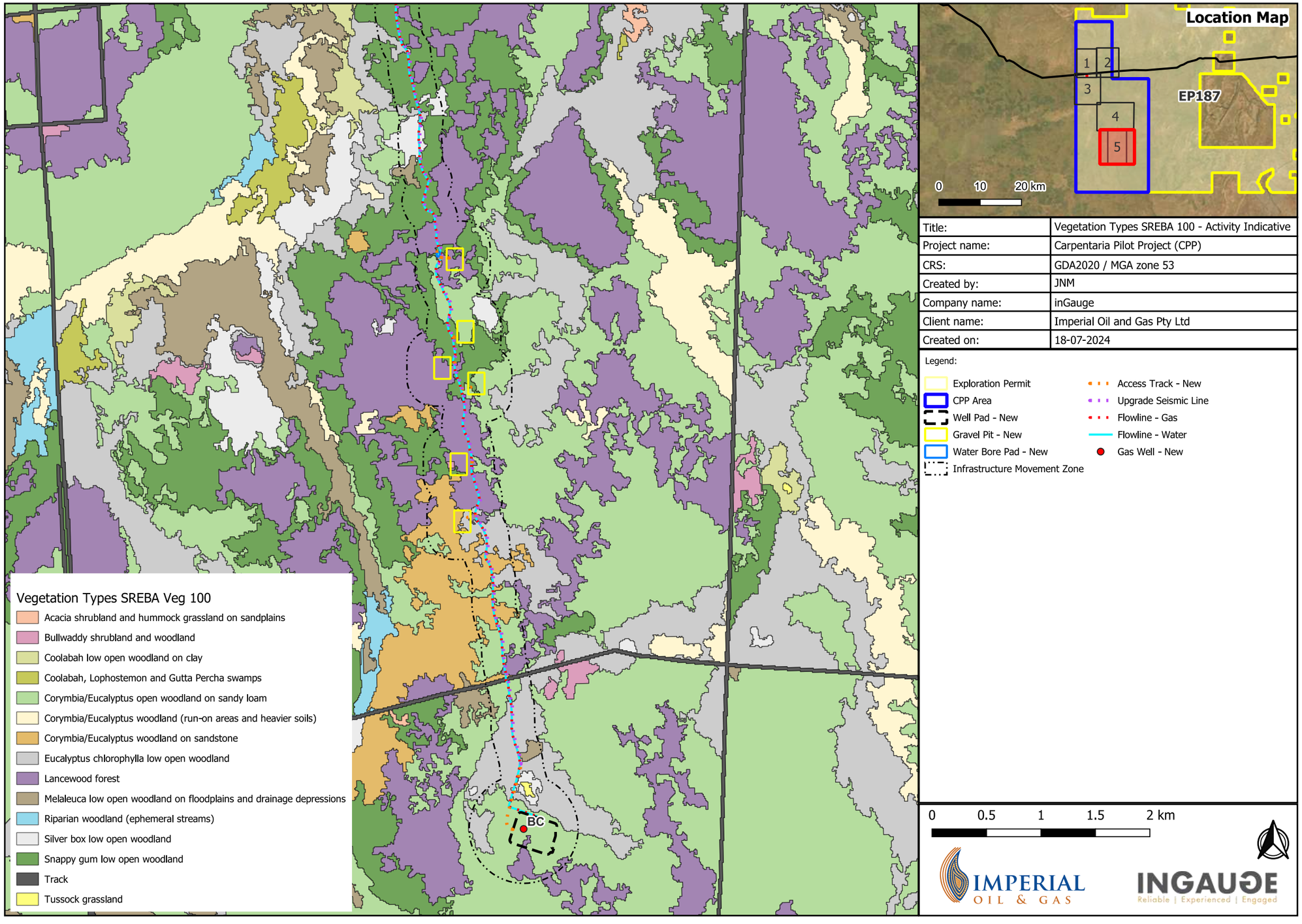


Figure 3.3—25 Regulated Activity – Vegetation – Map 5

3.4 Civil Construction and Maintenance Work

The civil construction and maintenance work are outlined in **Table 3.4—1**. This indicative scope may vary based on the ongoing appraisal program, along with capital expenditure availability. The estimated max disturbance clearing for the Activity is summarised in **Table 3.1—1**.

Table 3.4—1 Indicative Activity Civil Construction and Maintenance Work

Work	Examples of Scope of Work
Access Track Construction and Maintenance	• Construct new access tracks, including intersections and passing/turnaround areas. • Install erosion and sediment controls required by the Erosion and Sediment Control Plan (**Appendix 05**). • Maintain new and existing access tracks to allow access via light and heavy vehicles. • Rehabilitate
Gravel Pits	• Establish and operate new gravel pits. • Extend existing gravel pits. • Extract raw materials from new and existing gravel pits to support well pad, gas plant, water handling station, and access track construction, upgrades, and maintenance. • Stockpile raw or recovered materials for future use. • Rehabilitate
Well Pads	• Construct new well pads. • Expand existing well pads. • Install well cellars and conductors. • Construct and line well pad sumps and turkey's nests. • Construct hard stands. • Construct above-ground tanks (if required). • Install well pad fencing. • Install erosion and sediment controls required by the Erosion and Sediment Control Plan (**Appendix 05**). • Maintenance • Rehabilitate

Work	Examples of Scope of Work
Project Infrastructure Construction and Maintenance	• Install and maintain erosion and sediment controls as required by the Erosion and Sediment Control Plan. • Construct campsite. • Construct new flowlines and MRGP Connection with associated infrastructure. • Maintain flowline and MRGP Connection right of ways. • Construct WHS and CGP facilities. • Construct the satellite dish at the communications area. • Progressive rehabilitation and decommissioning. • Environmental and groundwater monitoring. • Rehabilitate
Land and Vegetation Management	• Clear vegetation to allow the construction of new well pads, access tracks, flowline/MRGP Connection, right of ways, water/wastewater facilities, compressor station, campsite, gravel pits, and water bore pads. • Maintain vegetation clearing along the flowline and pipeline right of ways. • Maintain vegetation boundaries and fire breaks at well pads and facilities as required by Bushfire Management Plan. • Maintain erosion and sediment control works, particularly after wet weather events, as required by the Erosion and Sediment Control Plan (**Appendix 05**). • Reinstate waterway crossings where erosion or sedimentation has occurred, including from flooding or vehicle movements. • Maintenance of fencing/gates/grids.

3.4.1 Access Tracks

All new access tracks for the Activity will be approximately 8 m wide and will be located within a movement zone (as shown in **Figure 3.3—1** to **Figure 3.3—5**) to account for any deviations around sensitive environmental features and to account for any vehicle turnarounds and stormwater turn-outs, as well as erosion and sediment control measures and the stockpile of cleared vegetation. Vegetation will be cleared from new access tracks and stockpiled or mulched for rehabilitation.

As the Activity locations are indicative, as discussed in detail in **Section 3.3**, to account for the movement of infrastructure (well pads, Gas Plant, etc.) contingency, access tracks have been

accounted for in clearing calculations. The contingency access tracks account for the maximum amount of clearing necessary if the infrastructure was to be moved to the farthest point of the Infrastructure Movement Zone. If the infrastructure is moved, it is unlikely to move a significant distance. Therefore, the calculations for clearing of contingency access tracks are conservative, reflecting a worst-case scenario, as they may not need to be constructed to their full extent or at all. For clearing calculations, contingency access tracks are assumed to be 8 m wide.

Existing landowner tracks will be utilised but widened from 4 m to 8 m.

Cleared vegetation and topsoil will be stockpiled in naturally clear areas where available in the immediate vicinity. Stockpiling on naturally cleared areas will reduce the need for additional clearing. New access tracks will be formed and compacted using on-site materials and materials sourced from existing and new gravel pits where required.

3.4.2 Highway Intersections

The Activity does not require the construction of any highway intersections. Imperial will utilise the existing intersections off the Carpentaria Highway; these intersections have been constructed for road train access under previous EMPs and are, therefore, suitable for the heavy vehicles required for regulated activities (refer to **Appendix 11** Traffic Impact Assessment).

Horizontal directional drilling will be used under the Carpentaria Highway to install the water/wastewater flowlines and gas-gathering flowlines from the north of the highway.

Previous approvals from the Transport and Civil Services Division (TCSD) of the Department of Infrastructure Logistics and Planning (DIPL) for the existing accesses (EP 187 and SL-4) are subject to the completion of asset acceptance requirements as specified under condition No. 7 of the approvals.

Imperial will submit all relevant documents for the TCSD's acceptance and approval prior to utilising the accesses for the proposed drilling and operations program.

Prior to commencement of the Activity, an Operational Traffic Management Plan (OTMP) will be submitted to the TCSD, if deemed required, to address the operational risks associated with the two-way movement of heavy vehicles along the subject section of the Carpentaria Highway and all other relevant matters.

3.4.3 Gravel Pits

Imperial will use on-site material for much of the civil construction works. The local soil type at the CPP Area is primarily sandy-clay (SC) Red Kandosol, as discussed in **Section 4.7**. This soil type has been widely used as a suitable basecourse and sub-base on roads across the region.

However, for the management of dust emissions and to improve trafficability, coarser granular surfacing gravel may be required for access tracks, well pads and facilities in the CPP Area.

Areas with potential gravel suitable for extraction have been identified on EP 187 and are shown in **Figure 3.1—1**, the indicative layout of gravel pits is shown in **Figure 3.4—1**. If suitable gravel at the required volume cannot be sourced at these locations, alternative sites will be scouted within the Infrastructure Movement Zone (refer to **Section 3.3.1**). In these instances, the total area used for gravel pits will not be exceeded, nor will the predicted volume.

It is estimated that up to 100,000 m^3 of coarser granular surfacing gravel, locally sourced on EP 187, will be required to provide a better running surface for the access tracks and surfacing infrastructure pads.

The establishment of gravel pits will include the following:

- A site selection process similar to the one described in **Section 3.2** and **3.3** will be used.
- The stockpiling of cleared vegetation around the perimeter of cleared areas for rehabilitation.
- The stockpiling of soil around the upslope side of gravel pits to divert overland flow from entering the pits.
- The stockpiling of stripped-off soil no greater than 1.5 m in height.
- Whoa boys/earth banks constructed at access points where there is a chance for water to flow from the track into the gravel pit.
- The design of batters at ~1:1 to allow safe passage for animals and people.
- The construction using bulldozers and excavators, with bund/berms consolidated by watering and compaction.
- Gravel pits will be kept wide and shallow to facilitate excavation of the gravel horizon and rehabilitation.
- Gravel pits will not be fenced.

An indicative gravel pit layout is shown in **Figure 3.4—1**. Some of the sites selected incorporate previous gravel pit locations that may be expanded and then managed under this EMP.

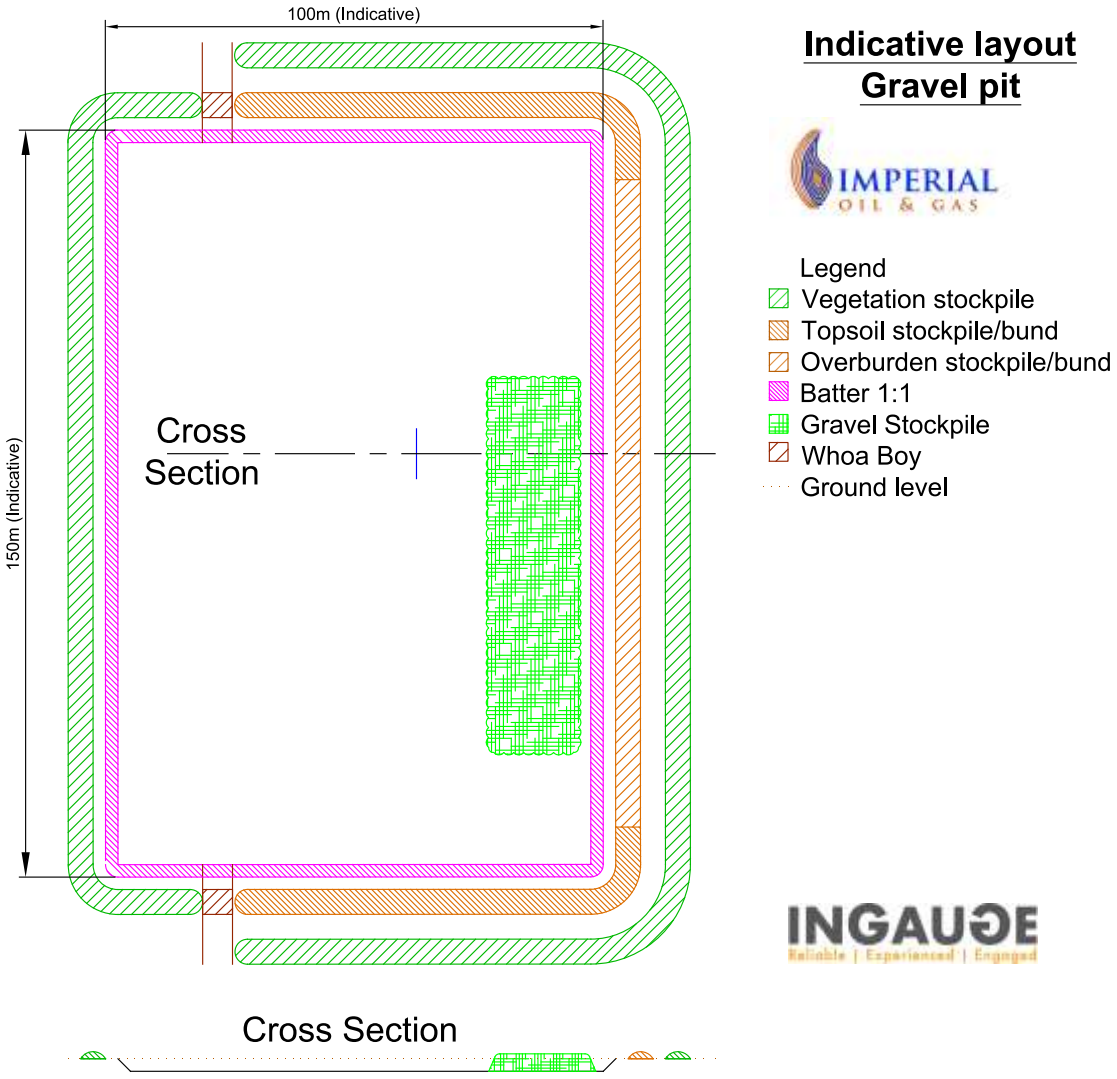


Figure 3.4—1 Indicative Gravel Pit Layout

3.4.4 Well Pad Construction

Well Pad construction will be based on the indicative well pad design (**Figure 3.4—2**). As discussed in **Section 3.3**, desktop and field-based assessments of the proposed locations for ground-disturbing activities has been completed in consideration of the LCG and *the Code*. For example, well pad sites will be selected to ensure riparian zone buffers and potential hollow-bearing trees that may be nesting habitat for the Gouldian Finch are avoided where possible.

The CPP well pad will:

- Be located out of potential 1 in 100-year flood zones.
- Have an approximate disturbance area of 12 ha, including firebreaks.
- Incorporate separate stockpiling locations for vegetation and topsoil horizon for subsequent site rehabilitation.
- Have an approximate 8 m firebreak.
- Be surrounded by stock-proof fencing.
- Have diversion berms on the upslope side of the pad and around sumps and above-ground tanks to divert rainwater around the pad, sumps, and tanks.
- Be designed so rainwater on the well pad will be diverted to erosion and sediment control measures on the downslope side of the well pads.
- Have a bunded and compacted tank pad to prevent surface water flow from undermining above-ground tanks and to help contain overflow.
- Account for multiple wells, as shown in (**Figure 3.4—2**) to minimise the potential requirement for new well pads for more wells in accordance with ESD principles (*Environmental Protection Act, 2019 (NT)*).

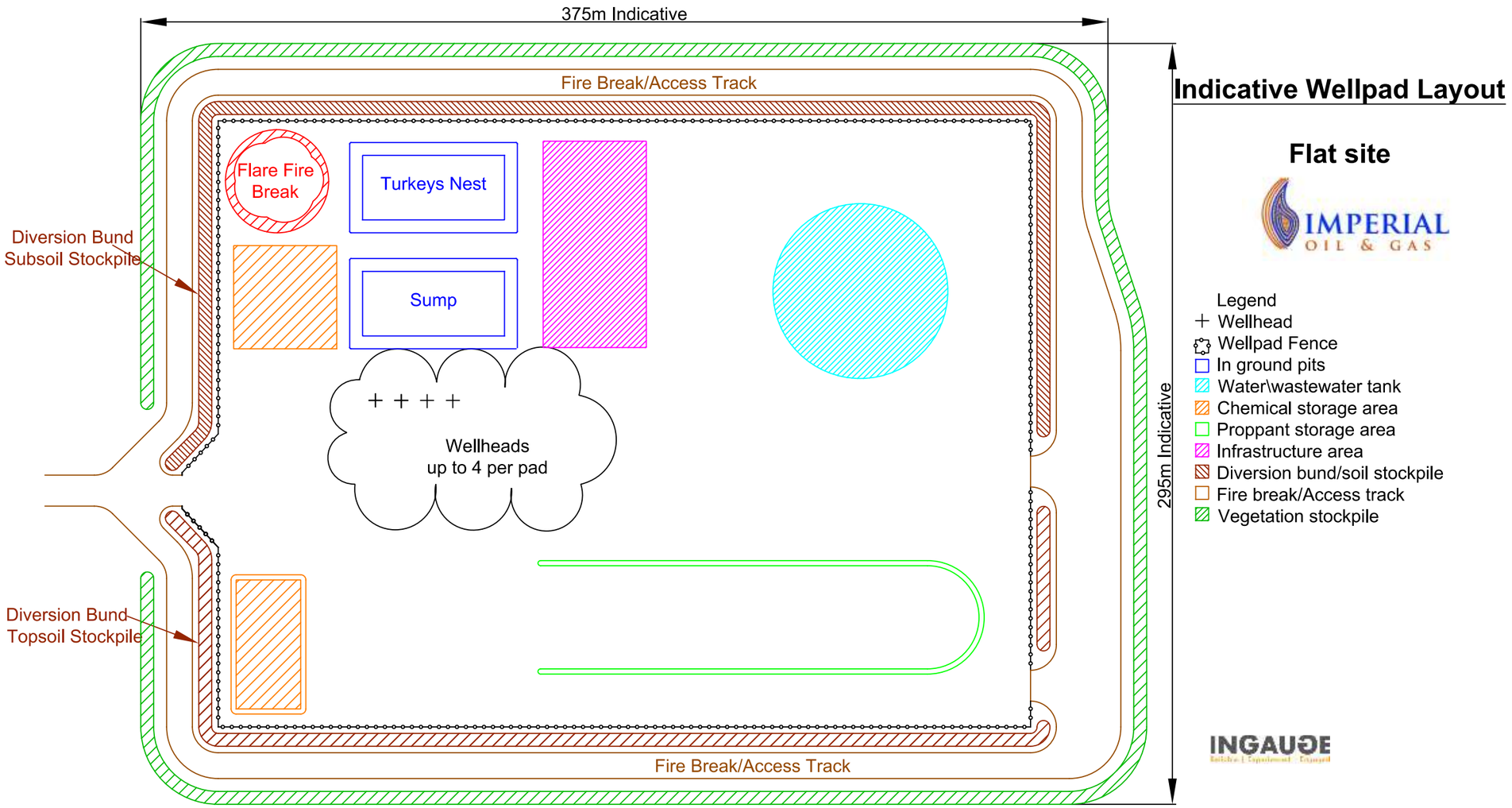


Figure 3.4—2 Indicative Well Pad Layout

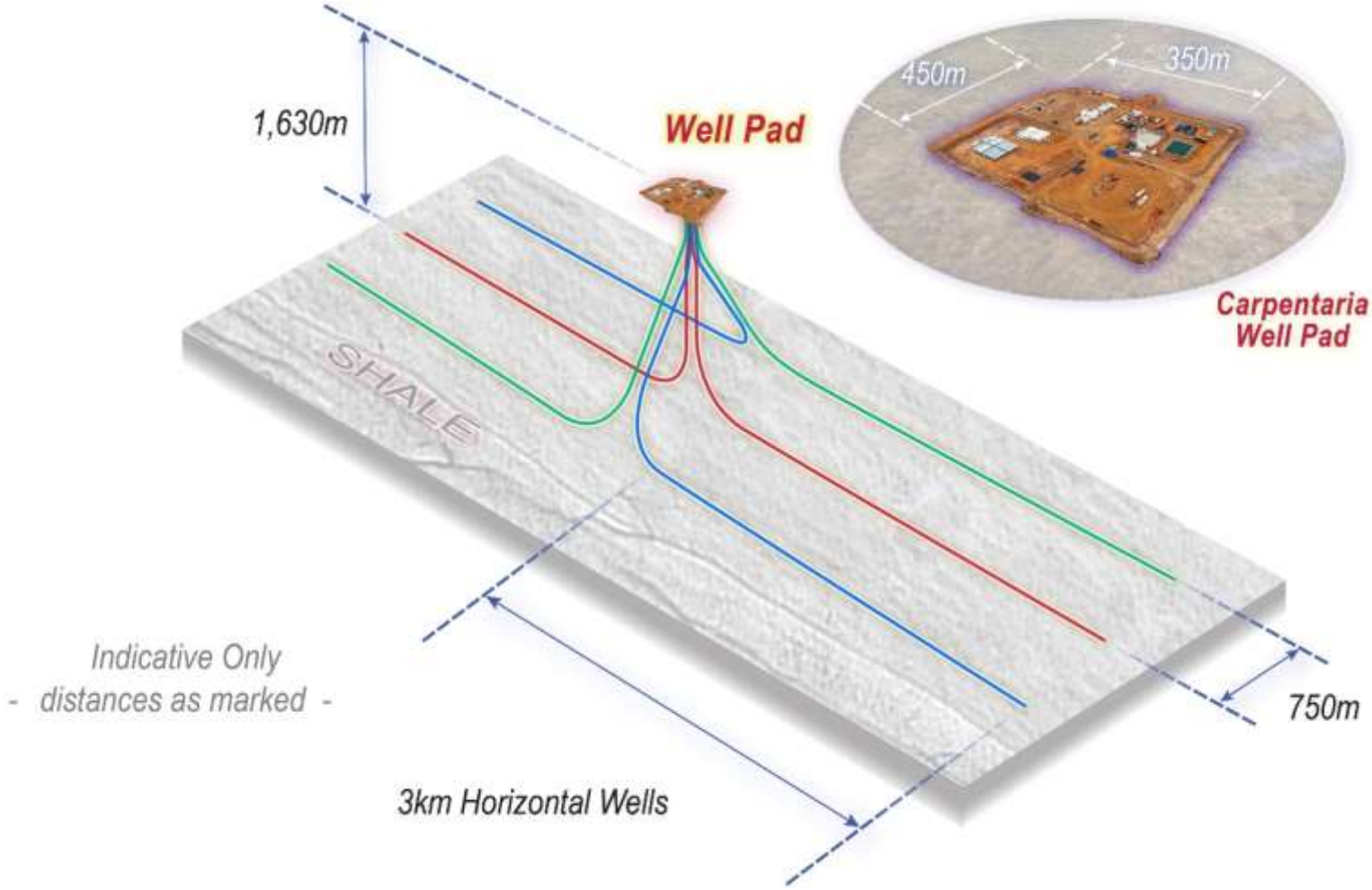


Figure 3.4—3 Schematic View of Multiple Horizontal Wells from a Single CPP Well Pad

Note: laterals may be drilled up to 5 km long, but it is expected that the final length of laterals will be ~ 3 km.

3.4.4.1 Cut and Fill Well Pad Methodology

Where the slope is too great for a drilling rig to operate safely on the natural slope, the well pad will be cut and filled to level using the following methodology:

- Vegetation will be stripped from the site and windrowed along the downslope section of the well pad and fire access track.
- Soil from the site will be stripped and windrowed above the cut batter on the upslope extent of the site.

The well pad will be cut and filled to balance the on-site material volumes to avoid as far as possible the need to bring material onto the site or remove material from the site. The well pad will be compacted to provide a good working surface and crowned along the centreline to achieve a ~2% fall back to the well pad edge draining downslope to the batters.

The cut batters will be protected from erosion by the soil stockpile/clean water diversion bund, preventing significant water volumes from washing over them. The fill batters will be protected by constructing a bund at the top to prevent water from the well pad from running down the batter's face.

Significant volumes of water are expected to run from the compacted pad during heavy tropical storm events in the Wet Season. This stormwater will be drained from the well pad to erosion and sediment controls on the downslope perimeter constructed in accordance with the Erosion and Sediment Control Plan (**Appendix 05**).

Figure 3.4—4 Topsoil Windrow to Divert Clean Water Away from the Well Pad

3.4.5 Campsites, Laydown Yard, and Helipad

There is only one (main) campsite location proposed for the Activity that requires land clearing. An indicative campsite layout is outlined in **Figure 3.4—5**. The site is designed for temporary or semi-permanent living quarters for operations, civils/facility construction camps, and/or rig camps. The campsite has been chosen based on site selection criteria similar to those used for well pads and will utilise a comparable construction methodology. An area has also been set aside to the north as a dedicated treated sewage effluent irrigation area.

In addition, constructed well pads within the CPP Area may also be used as temporary campsites for the rig or civil-related activity.

The existing cleared well pad at Carpentaria 1 will be a dedicated laydown yard, contingency campsite location and helicopter landing zone. An indicative layout is provided in **Figure 3.4—6**.

Contingency camps (if used) will be constructed, operated, and maintained as follows:

- All camp kitchen grey water and sewage will be treated by a fully self-contained Sewage Treatment Plant (STP) and irrigated in a designated surface irrigation disposal area.
- Bushfire risk will be managed by the Bushfire Management Plan (**Appendix 12**).
- All putrescible waste stored at the campsite in fauna-proof containers with lids.
- All waste will be managed and removed by licensed contractors.
- Fuel for generators and pumps (if any stored at contingency camp) will be stored in accordance with AS 1940:2017 The storage and handling of flammable and combustible liquids.
- Helicopter landing area will be located a safe distance from the C1 shut in wellhead, which is protected by bollards to prevent impacts.
- Refer to **Appendix 07** (Spill Management Plan) and **Appendix 06** (Waste and Wastewater Management Plan) for more information about chemical storage and handling and waste management.

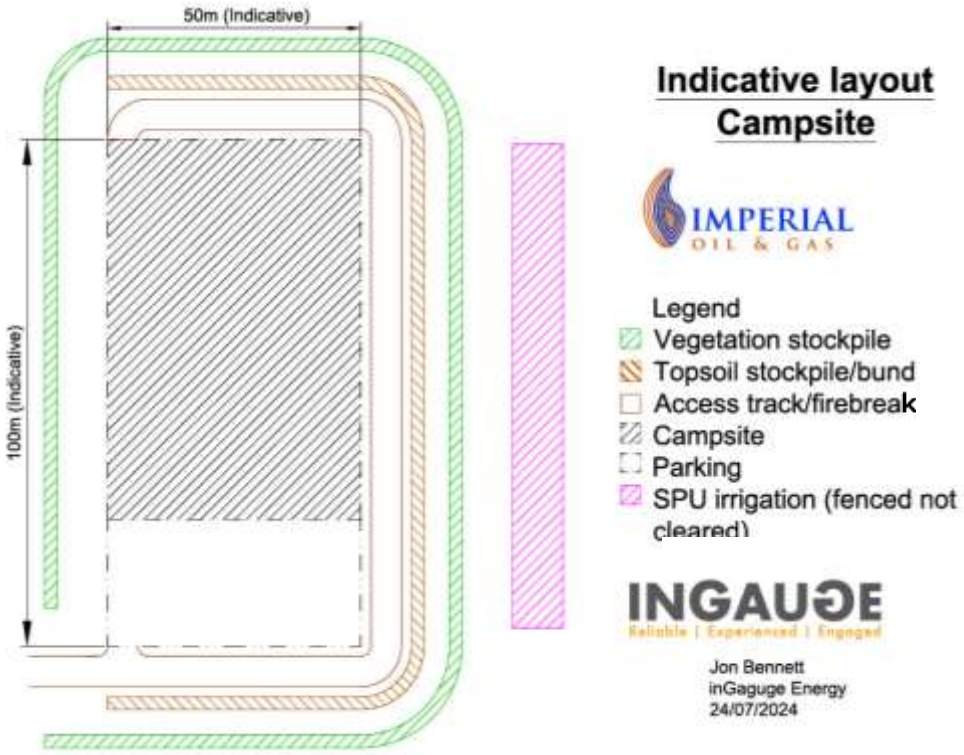


Figure 3.4—5 Indicative Campsite Layout Firebreak

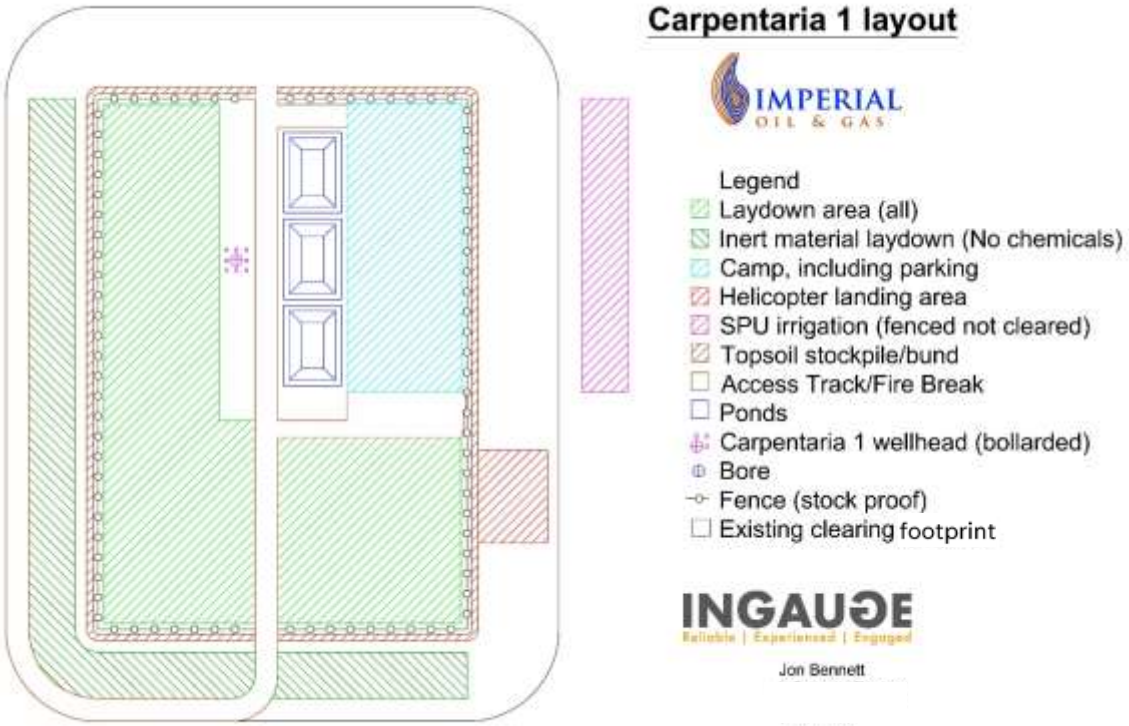


Figure 3.4—6 Carpentaria 1 Indicative Layout

3.4.6 Water Bore Pads

The default location for groundwater production bores will be on the well pad, with further details provided in **Section 3.8.2.1**. Should additional production bores be necessary for the Activity, nine supplementary indicative locations have been identified, adhering to the same site selection criteria as the well pads. The construction methodology for establishing water bore pads will mirror the bores drilled on the well pads. The actual configuration of each water bore pad outside the well pad will be based on the unique characteristics of the selected site.

Standard design features, including storage volume, diversion berms, HDPE lining, and generator-powered bore pumps, will be consistently applied across all bore pads. Regardless of the final location, the erosion control measures, and rehabilitation processes outlined in this EMP will be implemented. **Figure 3.4—7** provides an indicative layout of a groundwater production bore designed to include the following key features:

- The freshwater pond (turkey's nest) will be lined with HDPE or a similar material to prevent water seepage.
- The turkey nest capacity will be approximately 4.5 ML to ensure adequate storage for the stimulation phases.
- The area will be enclosed with a stock-proof fence to reduce interactions with large fauna.
- Fauna ladders will be installed to aid wildlife in safely exiting the pond.
- A 0.5 m surrounding berm will be constructed to prevent surface water inflow.
- Diesel to supply the generator may be stored on each site in a self-bunded tank conforming to AS1940.
- Vegetation and topsoil (bund) stockpiles will be strategically located on the high side of the slope to divert runoff around the bore pad.
- A fire break will be incorporated into the access track to minimise the need for additional clearing.
- An optional flowline may be installed to transport water to the well pads, thereby reducing road transport requirements.

These standardised design features ensure consistency and reliability across all bore pads. The uniformity of these measures, coupled with the comprehensive risk assessment, confirms that risks are managed to As Low As Reasonably Practicable (ALARP) and acceptable.

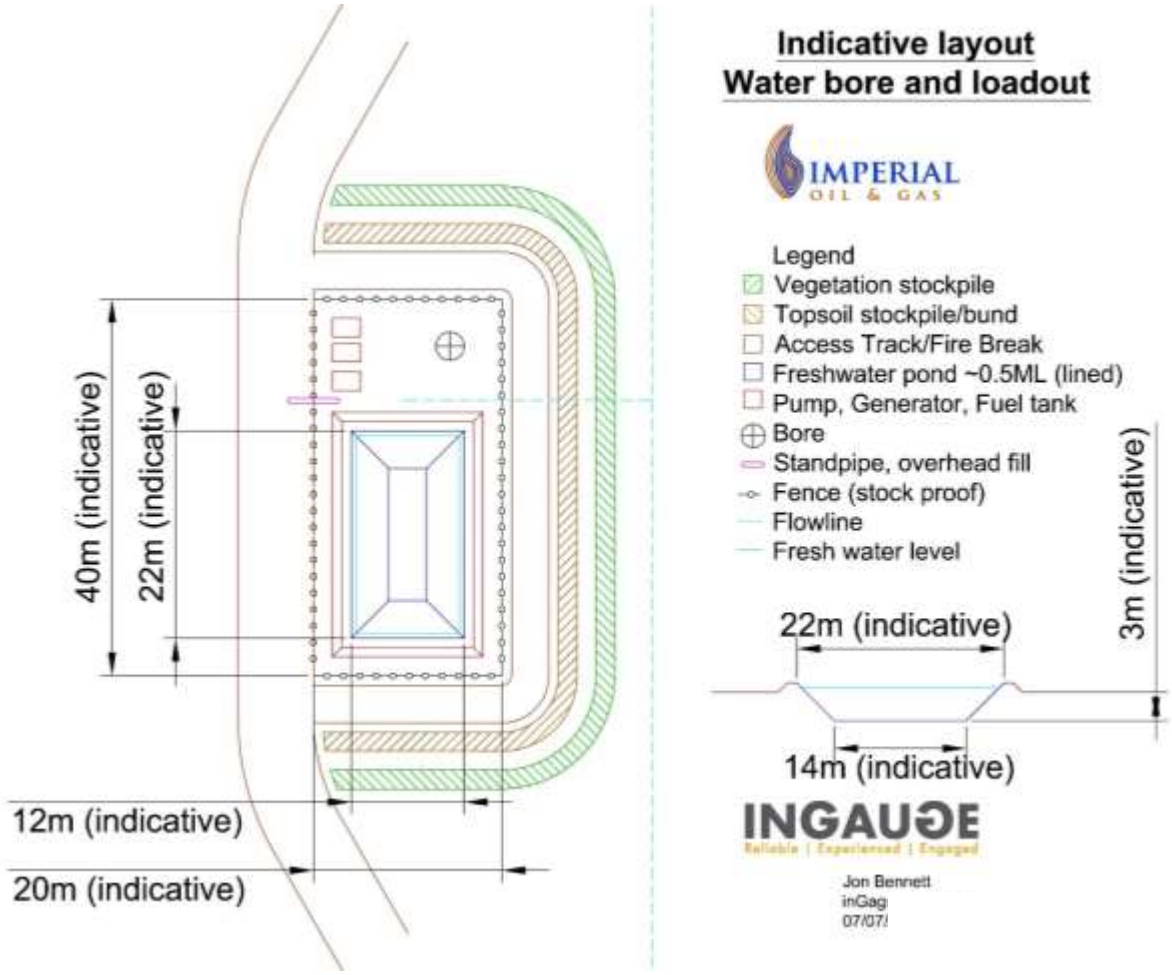


Figure 3.4—7 Indicative Water Bore Pad Layout

3.4.7 Water Handling Station, Carpentaria Gas Plant and Communication Dish

A centralised WHS, the CGP and a communications satellite dish will be required for the Activity. All three facilities require cleared pads. These areas have been chosen based on site selection criteria like those used for well pads and will utilise a comparable construction methodology.

The WHS will be the primary storage for flowback for potential treatment and/or reuse for hydraulic stimulation of subsequent wells. The indicative layout for the WHS is shown in **Figure 3.4—8**. Above-ground tanks will be double-lined and have leak detection sensors placed between liners that can be monitored remotely. Where tanks are linked together, they will be designed and operated to prevent the uncontrolled discharge of multiple tanks should one tank fail. Level sensors will be installed in the above-ground tanks and wastewater sumps to measure freeboard and will be calibrated to ensure accuracy.

The precise details of the treatment potentially required for reuse (e.g., iron removal) cannot be determined at this stage of exploration and appraisal. A similar experience has occurred in the various North American shale formations during the last two decades where the quality of

flowback can vary widely between different regions and shale formations. As the appraisal phase progresses, the precise details of flowback treatment for re-use will be elucidated. The indicative tank layout provides for smaller treatment/storage tanks and a large storage tank reservoir. Further design details can be found in the Waste and Wastewater Management Plan (**Appendix 06**). Stormwater from the tank covers will be directed to level spreaders or rock dissipater as per the as-built ESC measures as per the ESCP (**Appendix 05**).

The CGP is discussed further in **Section 3.7.3** and will take gas from the low-pressure gathering network discussed further in **Section 3.4.8** and **Section 3.7** and export via the MRGP Connection discussed in **Section 3.4.8**.

The satellite communication dish will be a small area used to facilitate communication with the pipeline.

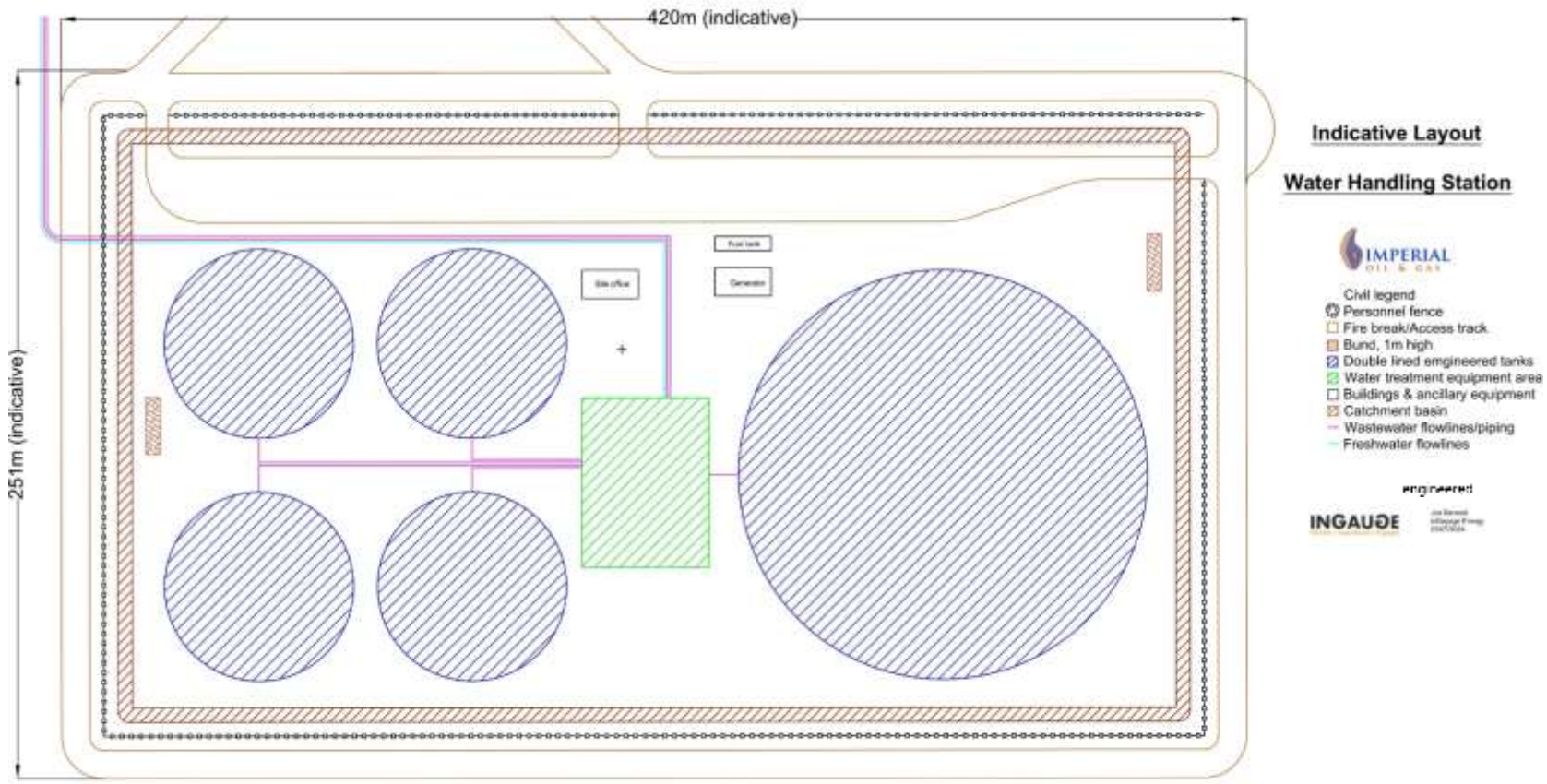


Figure 3.4—8 Indicative Layout for Water Handling Station

3.4.8 Flowlines and MRGP Connection

Flowlines and a MRGP Connection will be established for the Activity.

The MRGP is approximately 330 km long, running from Daly Waters to the MRM. The MRGP Connection will be from the from the CGP to the MRGP tie-in. The tie-in to the MRGP will be located approximately 200 km from Daly Waters. The flange set at the CGP fence line is the proposed designated battery limit between the Imperial-owned plant gas piping and the MRGP.

Flowlines will be connected between the CGP, the well pads and the WHS. engineered

These areas for these facilities have been chosen based on site selection criteria similar to those used for access tracks and will utilise a comparable construction methodology. The establishment of the flowlines and potentially the MRGP Connection will require a 16 m Right-of-Way (ROWs).

However, where practical, these ROWs can be co-located alongside access tracks. In such instances clearing for the ROW would only need to be ~8 m wide.

To accommodate the potential movement of infrastructure to avoid sensitive receptors, the clearing calculations for the MRGP Connection and flowlines include a contingency. The contingency has been calculated to account for the maximum amount of clearing that would be necessary if infrastructure was relocated to the farthest point within the Infrastructure Movement Zone from their current indicative location (refer to **Section 3.3**). Even though, it is unlikely that infrastructure would be moved a significant distance, the contingency calculations for clearing of MRGP Connection and flowlines are conservative. Therefore, the contingency calculations reflect a worst-case scenario.

For the purpose of clearing contingency calculations, both MRGP Connection and flowline are assumed to have a width of ~16 m.

Imperial will bury any flowlines outside of fenced areas to protect them from fire, flood, and damage from livestock and human activity; this aligns with industry best practice.

3.4.8.1 Trenching and Bedding Corridor

The flowlines will be installed in a trench excavated to a depth that will give 750 mm Depth of Cover (DOC). Where the flowline crosses an access track or watercourse, DOC will be increased to at least 1,200 mm. If the trench bottom cannot be cleared of angular material, bedding material will be applied in the trench. Flowlines that cross the Carpentaria Highway will be installed utilising horizontal directional drilling (HDD).

Clause A.3.4(f) of *the Code* mandates that directional drilling under a watercourse must be preferred over trenching for all buried infrastructure unless geomorphic and hydrological investigations confirm that trenching will not adversely affect water flow patterns and waterhole water retention timing. Prior to crossing a watercourse, the decision tree in **Figure 3.4—9** will be used to determine if trenching is safe or HDD is required.

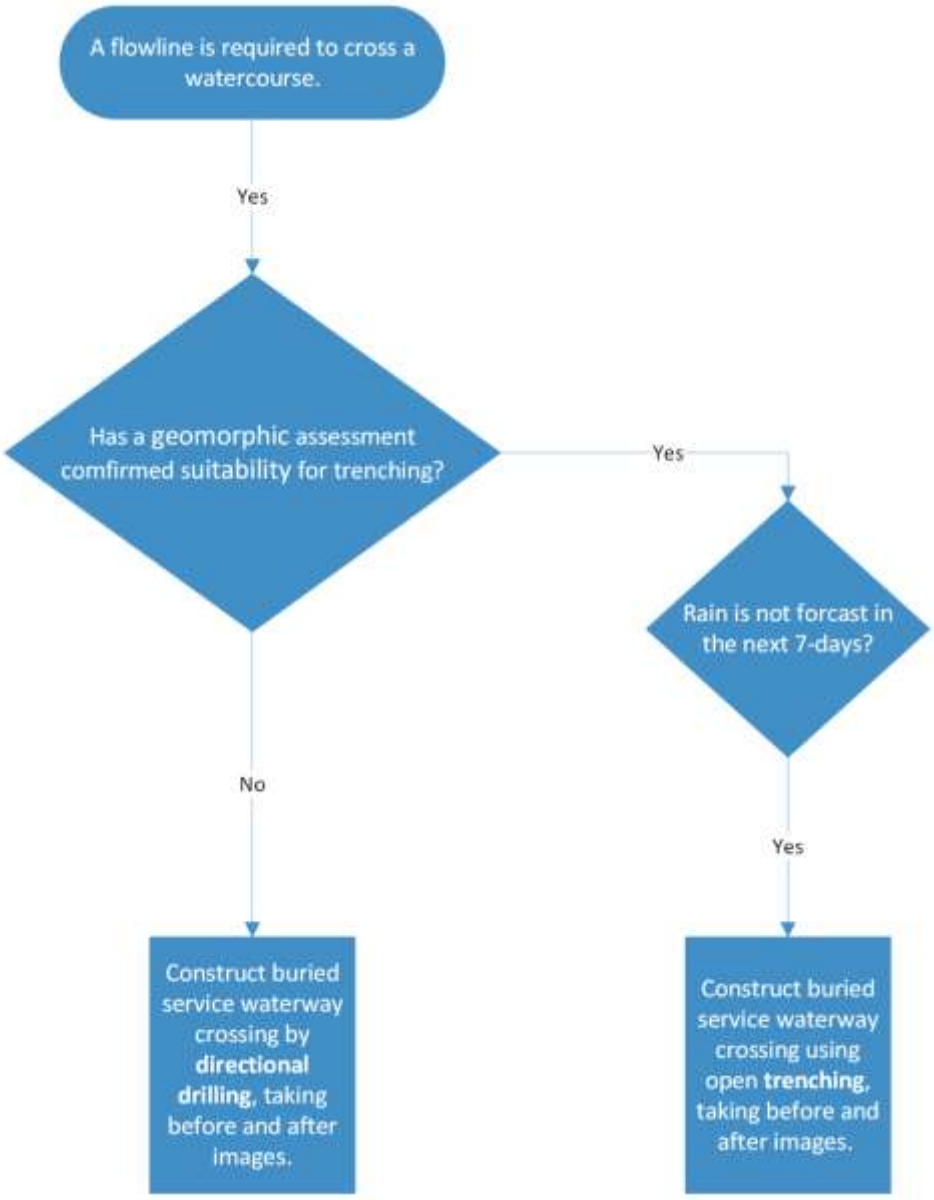


Figure 3.4—9 Decision Tree for Buried Service Waterway Crossing

A pre-investigation desktop analysis informed by on-site creek knowledge (refer to **Section 4.9.2**) has been conducted. An environmental description and mapping of the indicative creek crossing locations and the associated riparian and fluvial characteristics with georeferenced

imagery is provided in (**Table 4.9—1**). This provides a "first pass" in the site selection process for the proposed corridor.

GIS data has determined that up to five (flowline) water crossings are possible, whether these crossings can be co-located with existing or other disturbances, and the slope percentage of the surrounding landforms. This initial assessment has determined that a geomorphic assessment for these creeks would be a sufficient investigation to determine suitability for trenching and rehabilitation.

Prior to trenching, a baseline geomorphic assessment will be undertaken at each crossing to define the fluvial features of the stream bed and banks including riparian zone and levees, if present. Following rehabilitation of the trenched crossings, a similar process can be undertaken at any time to compare the creek crossing area to baseline conditions. This will ensure existing hydraulic flow patterns, during periods of variable stream flow, are maintained at each crossing; and that the respective hydrologic, fluvial geomorphic and ecological functions are being maintained.

The geomorphic assessment will include drone acquisition of baseline High Resolution Ortho Photography with corresponding high precision Digital Surface Model (DSM) at each of the creek crossing locations prior to the trenching operations. This information enables high precision mapping of topographic contour lines with sufficient vertical resolution (typically 25 cm intervals) that can identify and map site specific baseline fluvial geomorphic features at each creek crossing location. This topographic layer is overlaid on high-resolution ortho imagery of creek line vegetation and soil gradients in the derived baseline map. Rehabilitation of the creek crossing area can be monitored against these fluvial geomorphic baseline conditions in each location.

For trenching to occur, the geomorphic assessment must confirm that:

- There is no flowing water.
- The proposed location doesn't contain any pools, alluvial GDEs or retention basins within 15 m downstream of the trenching location.
- The bank being trenched has gradual sloping (≤30 degrees) and no steep, vertical or undercut banks.
- The proposed location is not on an outside bend but on a straight section.
- The proposed location minimises the construction footprint and proposed extent of disturbance (to soil and vegetation).
- No large trees (DBH > 25 cm, height > 1.3 m) will be cleared.

If the geomorphic assessment does not identify an appropriate trenching location within a creek, buried flowlines will be installed via horizontal directional drilling (HDD). If trenching is suitable, the following will be ensured:

- Before and after trenching GPS photo points and drone acquisition of High-Resolution Ortho Photography with corresponding high precision DSM of the trench location will be taken. This will allow a before and after comparison of the fluvial geomorphic features and ensure the existing hydraulic, hydrologic, and ecological functions of the watercourse have been maintained.
- Imperial will check the 7-day forecast to ensure an adequate window for the trenching, installation, backfill, and stabilisation works to be carried out.
- Trenches across creeks will not be left open overnight. Backfilling and rehabilitation will occur immediately after trenching. Although not anticipated, as all the creek widths are small, staging the trench across the channel to minimise the time involved in stopping or intercepting flows may be necessary.
- Where possible, trenching will be co-located with previous disturbances (e.g. where an access track already crosses a watercourse).
- The trenched location will be visited after the first run-off producing rainfall and after the first Wet Season to ensure stable condition.

To comply with Sections A.3.4 (e) and (f) of *the Code*, Imperial will implement additional controls outlined in **Table 6.2—3**, with **Risks Codes TE-5**, **TE-8**, **TE-14**, **IW-1**, and **IW-4**, and will monitor and report as per **Table 8.2—2**, **Item #8**. Appropriate Performance standards and measurement criteria can be found in **Table 6.3—7**, standard **EPS-SS1**. Rehabilitation works will be conducted as per the Rehabilitation Management Plan (**Appendix 03**).

3.4.8.2 Backfilling

Backfilling will commence using excavated material as soon as practicable after the pipe is laid into the trench. Trenches across creeks will not be left open overnight.

3.4.8.3 ROW Reinstatement

Areas disturbed by the installation will be reinstated as soon as practicable, including pulling stockpiled timber back over the ROW. Appropriate measures from the Erosion and Sediment Control Plan (**Appendix 05**) will be implemented. Fences that have been removed be re-erected.

3.5 Drilling, Completion, Workovers, Hydraulic Fracturing

The Activity includes multi-well pads, where more than one wellbore is drilled from a well pad. Up to four horizontal/highly deviated cased wells may be drilled and constructed on each well pad under this EMP over time, as illustrated in **Figure 3.4—3**. This may result in a scenario where only a few well pads are required, resulting in the total amount of clearing required under this EMP to be significantly less than would otherwise be the case.

There are four potential well designs to be carried out under this EMP:

- A cased vertical well.
- A cased horizontal appraisal/exploration well with a plugged-back open-hole vertical pilot.
    - The vertical pilot section in this design would be drilled and logged to confirm the prognosed formations depth before being plugged back into the open hole horizontal kick-off point, and the horizontal section drilled and cased.
- A cased horizontal appraisal/exploration well from a plugged back cased vertical pilot.
    - The bottom cased section of the vertical pilot in this design would be plugged back to the horizontal kick-off point, a whipstock set, and an exit is milled through the casing to allow a horizontal section to be drilled and cased.
- A cased horizontal appraisal/exploration well without a vertical pilot.
    - A scaled schematic that shows the rock formations from the surface to the target Velkerri shale and the proposed horizontal wellbore is shown in **Figure 3.5—1**.

3.5.1 Drilling, Completion and Workovers

There are up to 9 new wells to be drilled, completed, and worked over under this EMP.

Drilling is a generic term for placing a well in the ground. The wells have steel casing and circulated cement for isolation purposes and directionally drilled into the target formation. The wells will be drilled in accordance with *the Code*.

Completion is a generic term used to describe the events and equipment necessary to access the formation and encourage it to flow to surface.

Workover is a generic term describing future interventions in the well bore. In this case it is likely that tubing will be installed at a future time to assist with production once drilling operations have been concluded.

Parallel to this EMP, Imperial is compiling a WOMP to cover the works associated with drilling, hydraulic fracture, completions, and workovers to be carried out under this EMP. The WOMP will be submitted to DITT for approval before those works are carried out.

Multiple wells may be drilled off each well pad. The well's true vertical depth (TVD) to the target shale is approximately 1,600 m; the lateral length of the horizontal section can reach up to 5 km, although are typically 3 km.

Drilling and completions fluids are comprised of ground water and fluids additives (listed and hazard assessed in the Spill Management Plan – **Appendix 07**). By-products from these works include residual fluids, cuttings and cement returns that will be managed in accordance with the Waste and Wastewater Management Plan (**Appendix 06**).

3.5.2 Hydraulic Fracturing

Hydraulic Fracturing is a commonly used oil and gas well completion process first used in Oklahoma, USA, in 1947. It typically involves injecting a viscous slurry of water and sand under high pressure into a target formation via the well. This process is intended to create new fractures in the rock and increase the size, extent, and connectivity of existing natural fractures. HF is a well-stimulation technique used commonly in low-permeability rocks like tight sandstone, shale, and some coal beds to increase oil and/or gas flow to a well from petroleum-bearing rock formations.

Up to 14,000 tonnes per well of sand is expected to be used per well.

Fluid management is discussed in **Section 3.6**, Chemicals are discussed in **Section 3.8.1** and a Human Health Risk Assessment is includes as **Appendix 08**.

3.5.3 Aquifer Protection

Protection of aquifers is an integral consideration in petroleum well design. The accepted approach is to design the petroleum well to be a pressure vessel with a life span that far exceeds the life of the well, including the decommissioning phase.

The objectives of the Activity's well barrier design are to protect the integrity of aquifers. Barriers protect against forces within the well design parameters, referred to as maximum allowable operating pressure (MAOP), during drilling, HF pumping, and well operations. The well barrier design will comply with the requirements for aquifer isolation detailed in *the Code*.

The Precautionary Principle is a mandate to address uncertainty and ensure that potential, though not well-defined or understood, hazards are taken into account in decision-making. This principle has been applied to Imperial's previous campaigns in EP 187.

The precautions applied to aquifer protection include the following:

- Aquifer isolation was fully considered during the well design and program planning processes.
- Demarcated stratigraphic definition to the base of the deepest recognised aquifer unit was confirmed at each well pad during the installation of a groundwater control monitoring/production bore prior to drilling the first petroleum well on that well pad.
- Top of Cement (ToC) was brought to surface for all casing annuli, where practicable. In the event the surface casing cementation did not achieve cement to surface, a top-up cement job was performed.
- All aquifer units not in communication were isolated from each other at the wellbore.
- Permeable hydrocarbon-bearing zones were isolated from aquifers by two verified well barriers.
- A completed and/or revised Well Barrier Integrity Validation Report (WBIV) was submitted to the Mining and Energy Division of DITT for approval.
- Groundwater monitoring at each existing well pad has been conducted in accordance with relevant regulations since 2019 (see **Section 4.10**). There has been no detectable change in groundwater quality or the level of the Gum Ridge Aquifer on EP 187 at any of the groundwater bore monitoring bores since operations began in 2019. The Gum Ridge Aquifer is part of the larger Cambrian Limestone Aquifer.

3.5.4 Aquifer Protection Zones

The risk of the CLA being polluted from surface infiltration is low because there is more than 60 m of low permeability, indurated and weathered Kandosols, and a kaolin (non-cracking) type sandy clay soil above the water table at the CPP Area (see **Section 4.74.7** for further details).

A worst-case numerical modelling approach was used to assess the potential area and depth of soil infiltration from spill scenarios at a well pad. This assessment is provided in **Appendix 08** (Human Health and Environment Chemical Risk Assessment), which includes Appendix B (Potential Risk to Groundwater from Hypothetical Water Releases).

The results of modelling indicate that HF chemicals that are organic constituents of potential concern (e.g., methanol and glutaraldehyde) would theoretically take approximately 100 years to infiltrate the soil to 20 m below ground level. As methanol and glutaraldehyde are both readily biodegradable, this is not a potential groundwater contamination scenario.

The potential for chloride contamination of the well pad soil in the event of a spill is a key consideration in onshore gas developments. Chloride soil contamination arising from spills of HF

flowback is the most frequently reported pollution problem at shale well pads in North America. The elevated chlorides in HF flowback are primarily from geogenic (earth-origin) sources in the target shale formation. The spill modelling results show that predicted soil chloride concentration rapidly attenuates with depth.

The predicted chloride concentrations in the surface soil exceed 25 mg/kg. Chloride, at a concentration such as in HF flowback, has been used in infiltration modelling simulations as a conservative indicator of soil infiltration. The resultant cumulative increase in potential chloride concentrations (40 mg/kg) in surface soil at the well pad would likely significantly impact future plant growth without appropriate soil remediation (see **Appendix 07** - Spill Management Plan, **Section 4.1.2**).

Similarly, a sub-surface aquifer protection zone sits below the CLA aquifer basement at the CPP Area and the target Velkerri formation. This aquifer protection zone comprises rock greater than 900 m thick, which is 150% of *the Code*'s protection zone requirement of 600 m [clause B.4.13.2 (l)]. This protection zone ensures there is no potential for a connection between the much deeper shale hydraulic fracture operation and the base of the overlying CLA aquifer.

The potential HF chemicals to be used in the Activity have been risk assessed (see **Appendix 08** Human Health and Environment Chemical Risk Assessment). Ongoing groundwater monitoring at each well pad and the implementation of the ongoing well integrity management system ensures lasting protection of the CLA aquifer from the Activity.

The decommissioning processes for the wells will include ongoing groundwater monitoring in down-gradient production/monitoring bores at all well sites once the petroleum wells and well sites are decommissioned to ensure that there is no impact on groundwater quality from the Activity.

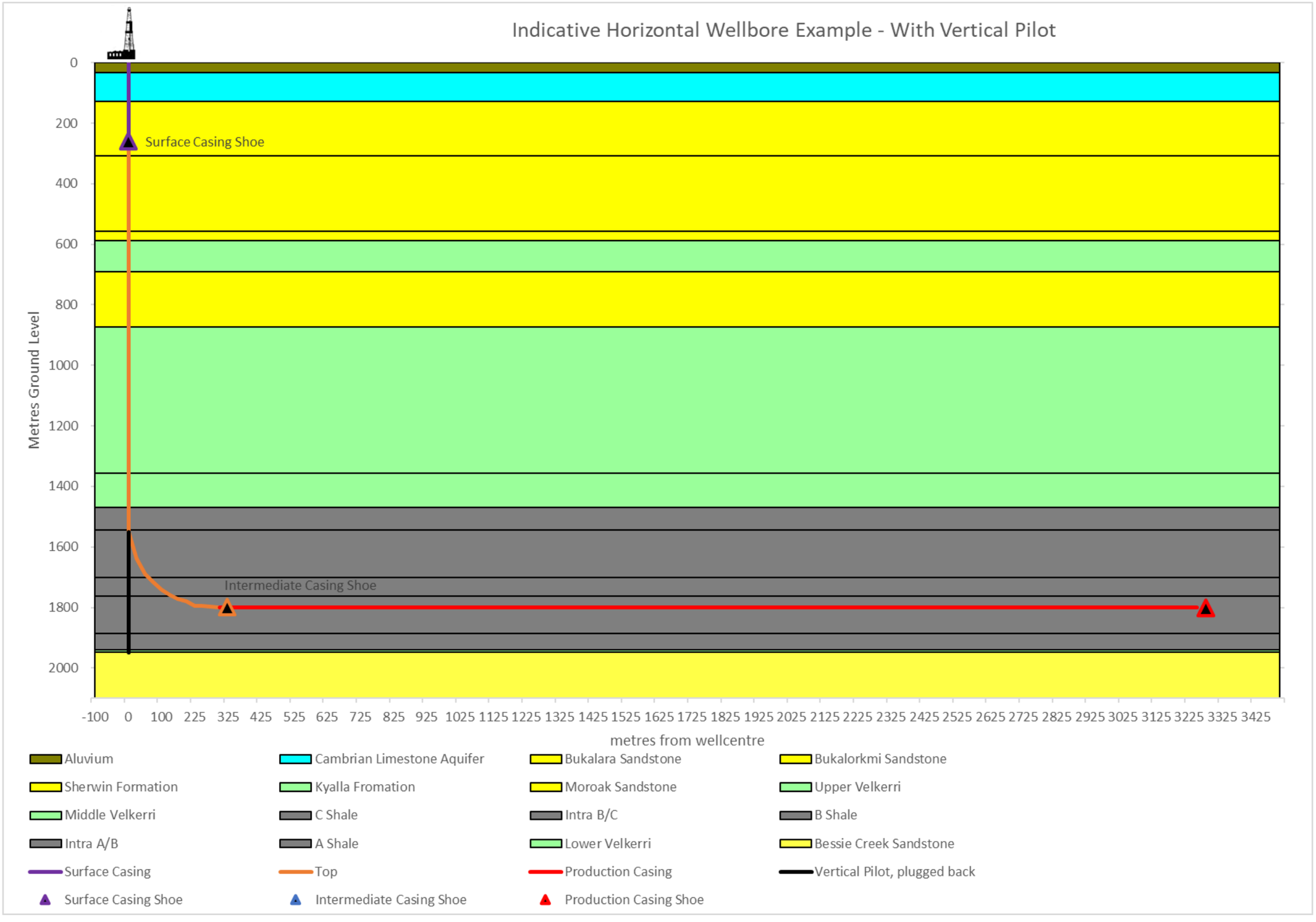


Figure 3.5—1 Scaled Well Schematic

3.6 Well Operations

3.6.1 Flowback and Appraisal Testing Equipment

Flowback is carried out to remove the HF fluid from the formation. Initially, fluid from each well passes through an atmospheric pressure open separator to separate sand and fluid until the gas rate increases and fluid flow stabilises.

After this very early flowback, flow is routed through pressurised de-sanding equipment to flow measurement and control equipment dedicated to each well. The pressurised desander will be removed once sand production reduces to a low level.

Fluids from multiple wells are then combined and routed to a two-phase low-pressure separator with gas and water streams split by gravity separation. Gas from the two-phase separator is metered and flows to the gas-gathering network. Water from the separator is metered and pumped into the combined water/wastewater network.

A generic layout of a flowback and testing package is shown in **Figure 3.6—1**.

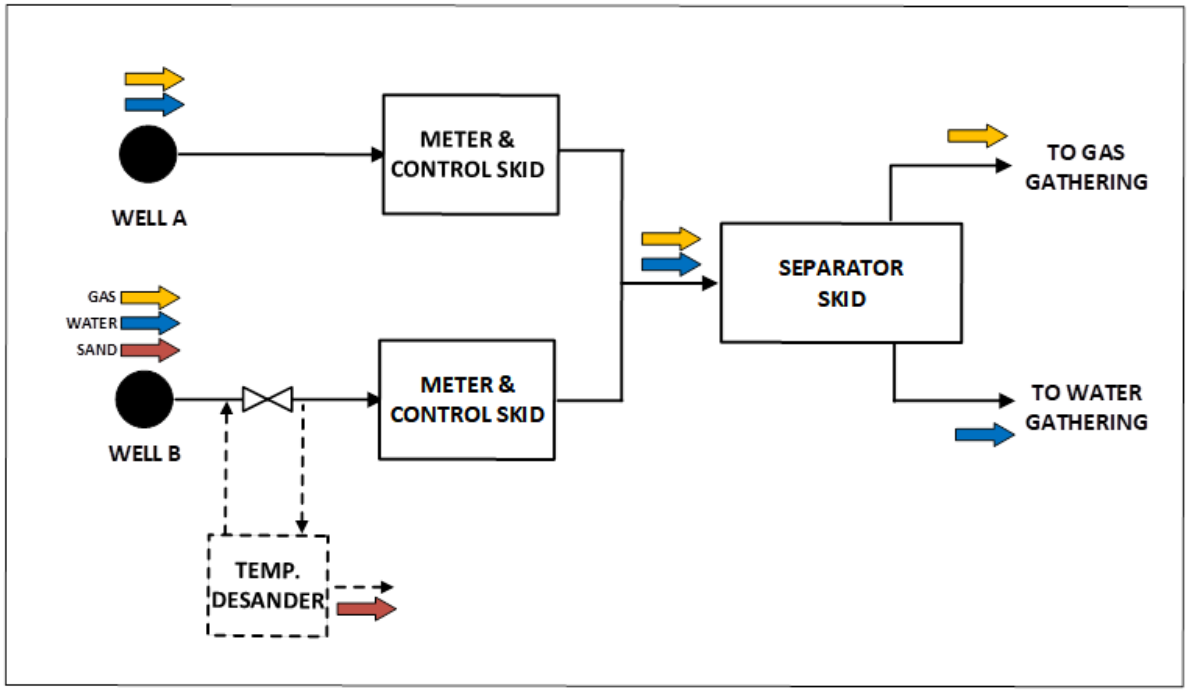


Figure 3.6—1 Generic Example of Well Test Equipment Schematic

3.6.2 Separator

When the well is initially opened after stimulation, the process flow is via an atmospheric open separator to separate water, sand and small volumes of gas. Once the fluid flow stabilises and gas flow increases, the process flow is directed to a pressurised separator.

The pressurised separator package splits the comingled flow from the wellbore into gas and water. All gas and water flow volumes are measured and recorded.

The separated water is transferred to above-ground tanks to be managed in accordance with **Appendix 06** (Waste and Wastewater Management Plan).

The separated gas is transferred to the CGP.

3.6.3 Venting and Flaring

Produced gas during well appraisal will be sent to the CGP via the gas gathering network.

During the initial wellbore cleanup after HF, sand needs to be removed from the well fluids. De-sanding equipment will be installed temporarily on the well, consisting of an initial atmospheric pressure open separator where large slugs of sand are removed. The gas content of the well fluids is very low during this stage of well operation. Therefore, the quantity of gas vented will be minimal.

As the sand production reduces and gas starts to increase, a pressurised desander unit will be installed to remove smaller quantities of sand. This allows the entrained gas to be directed to the pressurised separator and recovered to the gathering system to be sent to the CGP.

While the well is cleaning up, gas separated in the pressurised separator may be flared via a local flare rather than recovered to the gas gathering system if the CGP cannot accept gas at the time of flowback. This well pad flaring will not continue for the full gas appraisal period and is only for initial wellbore cleanup. The well pad flare will maintain Imperial's current EP 187 flare exclusion radius of 20 m. Flare validation modelling (EPS CE-3) will be conducted to confirm appropriateness of the exclusion radius for the flare used.

3.7 Flowline Networks

3.7.1 Background

Imperial will install wastewater and gas gathering networks utilising low-pressure (less than 1,670 kPa MAOP) high-density Polyethylene (HDPE) flowlines. These will be designed to transfer large volumes of water/wastewater safely and efficiently between well pads and the WHS and to gather gas for transfer to the CGP.

Fluids transferred in the water/wastewater network include:

- Groundwater
- Wastewater
- Mixture of groundwater and wastewater
- Trace quantities of gas

Gaseous hydrocarbons will be transferred in the gas flowline network.

The motivation for Imperial to install and operate the gas flowline network back to the CGP is to achieve beneficial use of recovered gas by recovering it on an appraisal basis under section 57AAA of the *Petroleum Act, 1984 (NT)* instead of flaring. If the application under Section 57AAA is unsuccessful and the CPP proceeds on a basis different to the one described, this EMP will be revised or modified under the *PER* to account for any new or increased environmental impacts or risks. This revision would include a greenhouse gas abatement plan if Imperial's estimated scope 1 emissions exceed 100,000 tCO_2-e in any financial year over the life cycle of the project.

The motivation for Imperial to install and operate the Wastewater Gathering Network is to:

- Reduce the land clearing requirements for large above-ground storage tanks at each well pad by connecting to a central WHS.
- Provide the capability for reuse of fluids between well pads and thus significantly reduce the volume of groundwater required.
- Optimise in-field HF flowback fluid and wastewater treatment in a centralised location.
- Reduce trucking requirements.
- Reduce the volume of wastewater for final disposal.

3.7.2 Flowline Design, Installation, and Operations

3.7.2.1 Methodology

The methodology used to design, install, and operate the flowlines is based on the Australian Pipelines and Gas Association (APGA) *Code of Practice for Upstream Polyethylene Gathering Networks, 2019 (PEGN Code)* [APGA, 2019].

3.7.2.2 Installation

As described in **Section 3.4.8**, flowlines will be installed in trenches in ROWs which follow access tracks where practicable to reduce the need for clearing. This design decreases clearing requirements by reducing the need for access tracks to inspect flowlines and a dedicated flowline ROW.

3.7.2.3 Pipe Jointing

Under the PEGN Code, PE pipe or fittings can only be joined by heat fusion (welding) or mechanical fittings for water and gas applications. There are three types of heat fusion joints - butt fusion, electrofusion and saddle fusion welding. All operators carrying out welded pipe jointing will be trained by registered training organisations (RTOs) and be qualified to the PMBWELD 301 standard.

When jointing of PE pipe is required to other materials, mechanical joints will be used.

3.7.2.4 Pressure and Leak Testing

The flowline networks will be subject to testing to validate mechanical strength and to detect leaks before commissioning. Safety precautions will be implemented during testing.

3.7.2.5 Pipe Survey

A survey will be carried out to locate the flowlines and related infrastructure relative to permanent marks and benchmarks that conform to the Mapping Grid of Australia (MGA 94) or other approved Datum. All buried flowlines will have a detectable tracer wire installed.

3.7.2.6 Commissioning

Commissioning will ensure that the PE pipes and all associated facilities are checked and verified to ensure that they are fit for the nominated operating envelopes.

3.7.2.7 Operations

Both flowline networks will be fitted with manifolds and valves so they can be isolated into sections (see **Figure 3.7—1**). These valves will be locked to prevent unauthorised operation unless they are within a fenced facility with restricted access.

Isolation valves will be installed in the gas and water gathering networks at the following locations:

- Risers at well pads (above ground valves)
- Risers at CGP/WHS (above ground valves)
- At pipeline connection junctions (buried valves)
- Isolation valves will also be installed in straight run gathering near Carp 1 to reduce the maximum pipeline volume in between isolation valves.

The gas gathering network will have LPDs installed to prevent line blockage due to condensed water and the wastewater network will have HPVs installed to prevent air locks.

Finalising the location of high point vents (HPVs) and low point drains (LPD's) is a detailed engineering activity that will occur in-situ during network installation. Pipeline designers will incorporate HPVs into water gathering networks based on design criteria, primarily elevation and pipe slope, to efficiently remove accumulated gas. LPD's are positioned where significant water volumes are likely to accumulate whilst not impinging on watercourses or crossings.

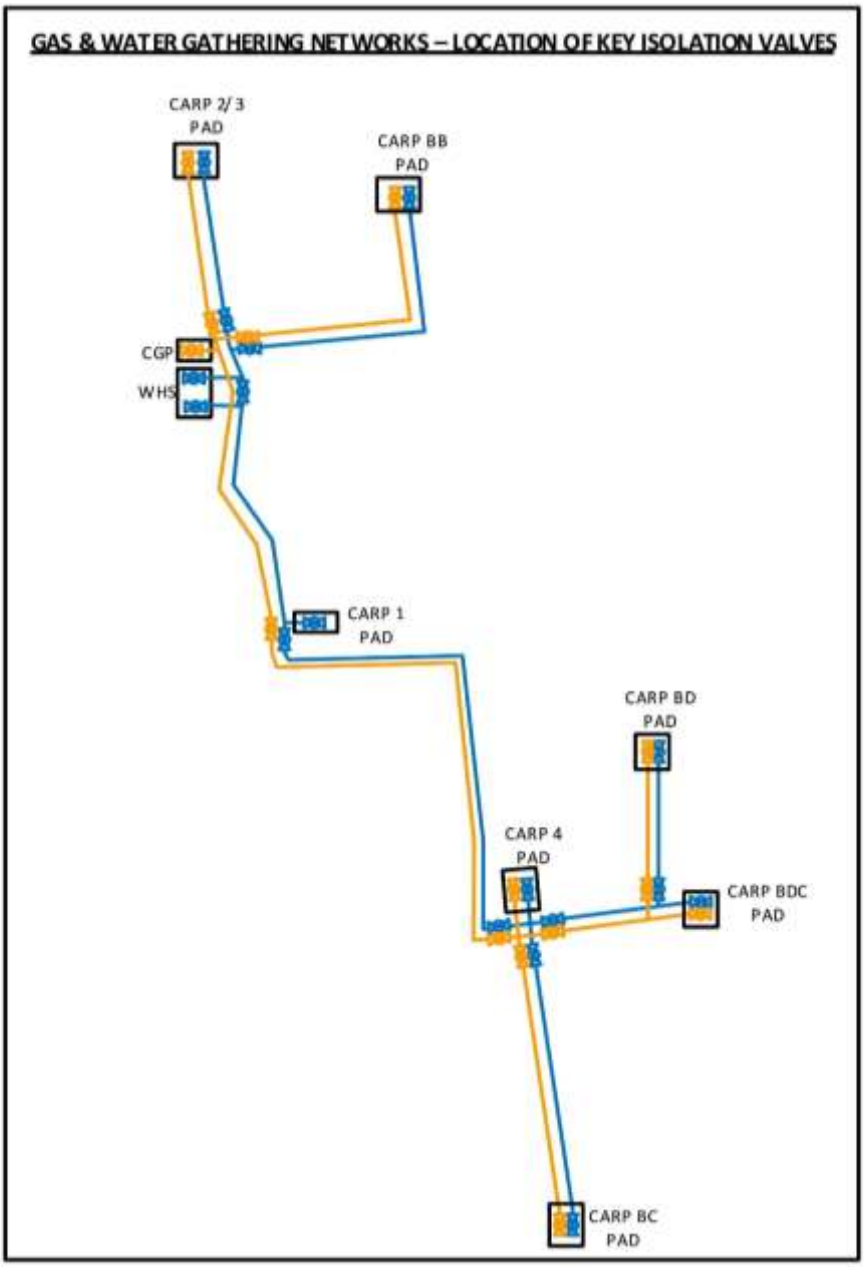


Figure 3.7—1 Location of Isolation Valves in the Gathering Networks Gas Plant

3.7.3 Carpentaria Gas Plant

A gas plan/compressor station will be installed and operated as part of the Activity. The CGP will take gas from the low-pressure gathering network, condition it and increase the pressure for export to the MRGP. Except for maintenance downtimes, the CGP is anticipated to run 24 hours/day, seven days/week.

The technical specifications of the CGP include

- Design maximum throughput – 25 TJ/day.

- Fuel gas consumption (% of Sales Gas) – 3.9%.
- Inlet pressure – 70-300 kPag.
- Outlet pressure – sufficient to enter McArthur River Mine Pipeline – 7,500 kPag (without booster compressor), 10,200 kPag (with booster compressor).
- Configuration:
    - Primary compression – 2 Ariel JGK/4 reciprocating compressors with Waukeshea L7400 GSI gas engine drivers.
    - Booster compression – planned to be installed downstream to boost pressure to 10,200 kPag.

The following subsections provide more detail of the process flow that may be used at the CGP.

3.7.3.1 Water Removal Upstream of the Compressor

Gas from the field gathering network enters a slug catcher to capture any entrained slugs of free water. Downstream of the slug catcher, filter/coalescer vessel/s are installed to remove additional water from the gas stream.

3.7.3.2 Gas Compression

Gas from the filter/coalescer vessel/s will be compressed in self-contained compressor packages. Each package will include a fin-fan cooler to reduce the gas temperature after each stage of compression, interstage scrubber vessels and a lubricating oil recirculation system. Each compressor package will have its own control system. Key operating data from each compressor package will be available in the control room.

3.7.3.3 Water Removal Downstream of the Compressor

The cooled gas leaving the compressor packages will pass through a scrubber vessel, where any condensed water/lube oil will be removed from the gas stream. This vessel is provided with a system to drain water. A demister pad is included to reduce liquid carryover in mist form.

The gas from the scrubber vessel will enter a Tri-Ethelyne Glycol (TEG) dehydration unit. The key components of the TEG dehydration unit are the contactor, reboiler, and pumps. TEG liquid is pumped through the contactor, where water vapor transfers from the gas to the TEG liquid. The TEG liquid flows from the contactor to the reboiler, where the water is removed by heating. The TEG is then cooled before returning to the contactor.

3.7.3.4 Sales Gas Metering

Gas from the TEG dehydration unit is to be sent to the Sales Gas Metering Skid comprised of a filter vessel to remove fine particulate matter and liquids (particularly TEG), a gas chromatograph unit/s to measure gas composition, and a custody transfer flowmeter.

3.7.3.5 Booster Compressor

A booster compressor unit may be installed downstream of the sales gas metering. If fitted, the booster compression unit will contain equipment like that of the main gas compression units.

The rod packing on each reciprocating compressor will be changed before 26,000 hours and on or before each 36 calendar months, or as part of the compressor's maintenance program.

Whilst no wet seal centrifugal compressors are envisaged in the current design, if they are installed as part of a future plant modification emissions will be captured and routed to a control device. If wet seal centrifugal compressors are used a Regulation 22 will be submitted to provide details of the control device.

3.7.3.6 Pneumatic Systems

All pneumatic pumps and controllers at the CGP will be driven by an instrument air system with zero natural gas emissions. Similarly, any pneumatic controllers on the wellsite will have a natural gas bleed rate not greater than 0.17 m^3 per hour and will have pump emissions routed to a control device that achieves greater than 95% emission reduction.

3.7.3.7 Power Supply

Gas-fired power generation infrastructure will be installed to supply the electricity demand of the CGP. This will include gas engine generators, a low-voltage switch room, load banks, and a backup diesel generator with fuel storage.

3.7.3.8 Fuel Gas Use

The CGP will use produced gas as fuel for the power generator, compressor engine, TEG reboiler burner, and flare pilot.

3.7.3.9 Wastewater Treatment

Rainwater runoff from the CGP skid will be collected and then pumped to the oil/water separation tank. Waste oil will be disposed of offsite by licensed contractors. The water from the separation tank will be transferred to the oily water treatment package.

The liquids removed from the gas stream at the CGP inlet and compressor scrubbers will be drained into a process water tank and then transferred to the oily water treatment package. The oily water treatment package will remove oils and greases, suspended solids, and surfactants. The treated water will be pumped to the treated water storage tanks and then to the WHS or the existing above ground tanks on the well pads if the WHS is not online. The solid waste will be collected in a skip for offsite disposal by a licensed contractor.

3.7.3.10 CGP Flare System

A flare system will be used to safely dispose of gas during CGP plant upsets or abnormal conditions.

The CGP flare will be in a 60 m x 60 m exclusion zone as detailed in **Figure 3.7—2**. The relationship between radiant heat flux and vegetation ignition is well understood and indicates continuous exposure above 12.6 kW/m² can ignite dry vegetation. Flare exclusion zones, designed per API 521 and standard industry practice, mitigate the risk by keeping radiant heat below 6.31 kW/m² (at 2 m height) outside the exclusion zone. This threshold, at 50% of the ignition flux, reduces the ignition risk to ALARP. Validation modelling (EPS CE-3) will be conducted to confirm the thermal radiation design assumptions and the appropriateness of the exclusion zone for the flare used.

3.7.3.11 Control

The CGP will be controlled by a Programmable Logic Controller (PLC) system. The PLC can provide outputs to alarms, control the function of process equipment, and provide logging and trending data.

The plant control system also includes the following components:

- Burner management system for the TEG unit.
- Ability to provide custody transfer calculations.
- An uninterruptible power supply (UPS) for the control system and emergency lighting.
- SCADA system.
- A system to switch over to an emergency generator.

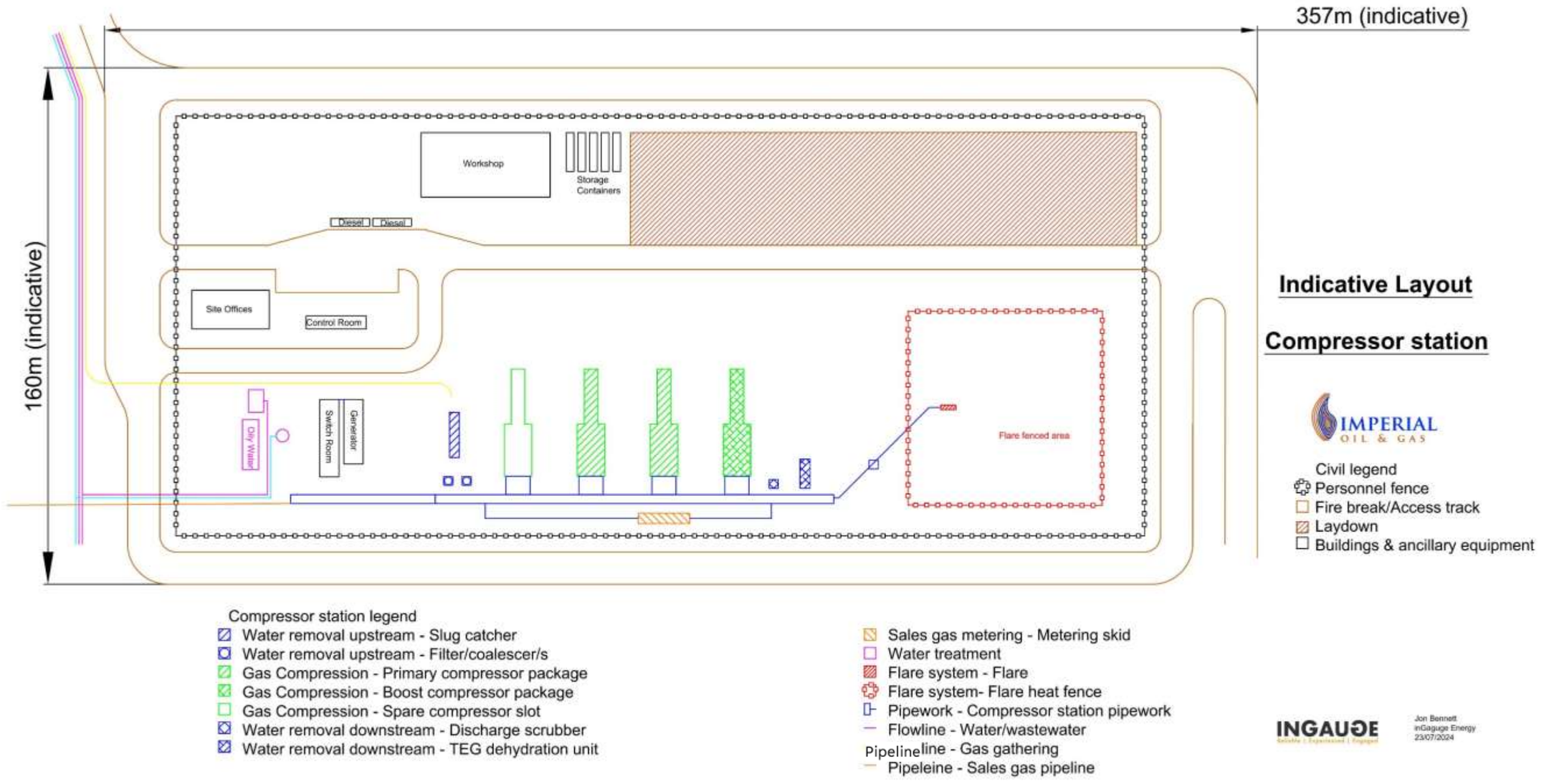


Figure 3.7—2 Indicative Layout for Carpentaria Gas Plant

3.8 Supporting Operations

3.8.1 Chemicals

Chemicals that may be used in wells for hydraulic fracturing are disclosed (in compliance with the DEPWS EMP Content guideline) in **Appendix 08** (Human Health and Environment Chemical Risk Assessment – Table 2) and risk assessed in accordance with the national regulatory requirements for human health and the environment. Assessment of HF chemicals that may be used downhole during the Activity did not identify any Persistent-Bio-accumulative-Toxic (PBT) chemicals in terms of measured PBT criteria that may pose a risk to human health. In addition, the concentration of CoPC in the HF fluid system is extremely low (mg/L or ppm) and any potential toxicity effects to local fauna are therefore negligible.

In addition to the requirements under this EMP, the storage, handling and use of chemicals will comply with the NT's workplace, health and safety legislation, relevant Australian Standards, *the Code* (including clause A.3.8) and the safety data sheets (SDS) for each chemical. **Appendix 07** (Spill Management Plan) provides specific details on risk assessment and mitigation measures relating to the storage of chemicals and other materials, with regards to secondary containment and the requirements of A 3.8.(g) of *the Code*.

3.8.2 Groundwater Use

3.8.2.1 Groundwater Bore Installation

Water bores are required for both groundwater monitoring and water extraction as part of the Activity.

Control and impact monitoring bores will be installed on each well pad as required by *the Code and the Preliminary Guideline for Groundwater Monitoring* [DENR, 2018].

It is anticipated that up to 9 additional production groundwater bores may be required to be established outside of the well pad locations to provide water for the Activity as outlined in **Section 3.4.6**.

Groundwater bores at existing CPP wells intersect and monitor/extract water from local aquifers, as discussed in **Section 4.10**.

The purposes of water bores in the CPP Area are to:

- Provide access to aquifers that could be impacted by the Activity to establish baseline water qualities.
- Provide access to aquifers that could be impacted by the Activity to measure any impacts.

- Produce water required to carry out the Activity.

Where water bores are to be drilled for the above purposes:

- A Bore Work Permit will be sought and issued by Water Resources for all water bores drilled.
- All bores will be drilled, commissioned, and tested according to the issued Bore Work Permit conditions by appropriately licensed drillers.
- Where a water bore is co-located with a well pad, no additional clearing will be done beyond the extent required for the well pad, including fire access trails and breaks.

3.8.2.2 Groundwater Monitoring

Groundwater from any control and impact monitoring bores will be monitored as per the *Preliminary Guideline for Groundwater Monitoring* and B.4.17.2 of *the Code*. Additionally, any mandatory requirements outlined in the GWEL, such as meter readings, will be monitored and reported as required.

3.8.2.3 Water Use

The estimated sustainable yield (ESY) in the Georgina Wiso basins is 210 GL annually. The ESY in the plan is ~33% of the estimated recharge rate [DEPWS, 2023A].

The CPP Area is in the Georgina Basin. The Cambrian Limestone Aquifer (CLA) is the recognised aquifer system in the CPP Area. It is comprised of near flat-lying layers of mainly carbonate rocks with an estimated age of 500-510 million years. It comprises two main layers: an upper siltstone-dominated layer (Anthony Lagoon) and a lower limestone/dolostone-dominated layer (Gum Ridge). Both contain significant aquifers, but the lower of the two is the most productive and the most widespread [S TICKELL, 2022B]. The groundwater source in the CPP Area is the Gum Ridge Formation (GRF) aquifer.

The volume of groundwater stored in the GRF aquifer is between 1,819,000 GL and 3,690,000 GL [A KNAPTON, 2020]. The GRF occurs as a vast vuggy limestone aquifer across the Beetaloo, which can often be cavernous. Time-series hydrographs in Anthony Lagoon and GRF measured at five locations showed a variance of less than ± 0.1 m [S TICKELL, 2022B]. No clear trends are apparent within or between hydrograph sites.

The ESY for the Georgina Basin in the *Georgina Wiso Water Allocation Plan 2023-2031* (GWWAP) is approximately 186 GL/a, or ~ 0.03% of the estimated Georgina Basin storage volume of 660,000 GL and underscores the conservative approach of the GWWAP [DEPWS, 2023A]. The GWWAP establishes the proportion of water from the resource that can be sustainably allocated

for drinking water, commercial uses, including petroleum, and reserve water for Aboriginal economic development.

The petroleum activity groundwater extraction allocation from Georgina Basin is capped at 8 GL/a, which is approximately 4.3% of the Georgina Basin ESY. Imperial will apply for an increased water allocation in Groundwater Extraction Licence (GWEL) GRF10316 from 85 ML/a to 750 ML/a for the Activity. This is less than 10% of the Georgina Basin petroleum activity cap of 8 GL/a and approximately 0.4% of the Georgina Basin beneficial groundwater allocation of 186.154 GL/a.

This maximum potential increased groundwater extraction (0.75 GL/year) by Imperial is not considered to have a significant impact on available groundwater in the GRF aquifer (see **Figure 3.8—1**). Any reuse of HF flowback will significantly reduce overall potential groundwater requirements by up to 40%. The quality of the Activity's HF flowback is discussed in **Appendix 06** (Waste and Wastewater Management Plan).

The estimated groundwater consumption for the Activity is provided in **Table 3.8—1** and **Table 3.8—2**. An additional margin factor in the proposed GWEL (750 ML/a) provides for years when the groundwater extraction may exceed this annual estimate. Water requirement for HF accounts for almost 90% of overall annual Activity water requirements **Table 3.8—1**. Groundwater will be sourced from existing and new groundwater bores.

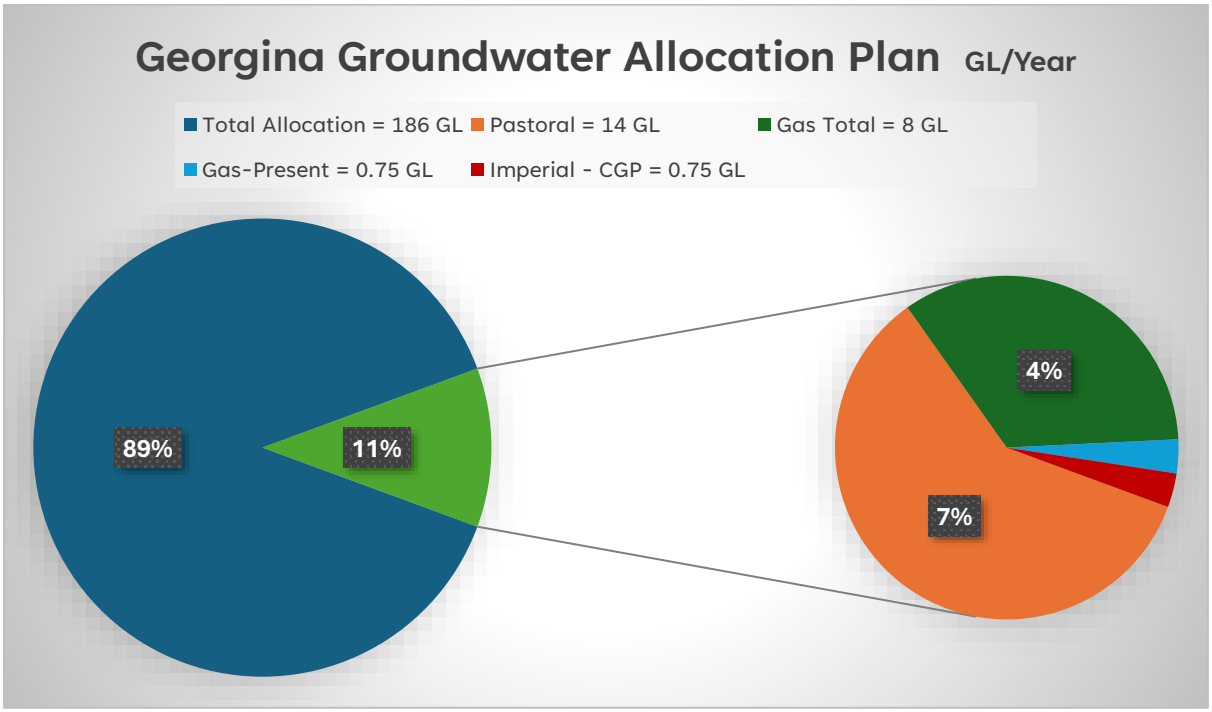


Figure 3.8—1 Estimated Sustainable Yield Georgina Water Allocation Plan

Table 3.8—1 Estimated Potential Groundwater Extraction (by Activity)

Use	Scope	Total Use (~ML)
Civil Construction	• Land clearing • Construction	20
Drilling & Completions	5 ML / well* (noting Carpentaria 4 re-entry will require less water)	48
Hydraulic Fracturing	85 ML / well*	850
Operational Activities	Dust suppression, general use, road, and site maintenance	14
Camp Usage	200 L per person per day on-site. Note: Potable water will be trucked to the camp.	18
Estimated Total		**950**

*Planned per well values are presented. However, to account for potential variations in water usage for the drilling and HF programs, an additional volume has been included. As a result, the Total Use volumes represent a maximum estimate, reflecting a worst-case scenario.

Table 3.8—2 Estimated Potential Groundwater Extraction (by Year)

Year	Indicative Quantity (~ML)
2024	162
2025	414
2026	278
2027	94
2028	1
2029	1

3.8.3 Wastewater

The wastewater sources (**Table 3.8—3**) identified in the Activity are detailed in **Appendix 06** (Waste and Wastewater Management Plan). The primary source of wastewater is HF flowback, estimated to be 40% of the pumped HF fluid, which will be preferentially re-used in HF operations at subsequent wells. If wastewater cannot be reused, wastewater volume may be reduced by evaporation in open-topped tanks before offsite disposal.

Appendix 06 (Waste and Wastewater Management Plan) provides details of the assessment of these waste streams and how they will be managed in the Activity.

The recent development of high-chloride tolerant and environmentally friendly friction reducers has enabled the successful recycling of HF flowback with seawater-level concentrations of chloride in the international shale industry [J PAKTINAT et al., 2011; B YANG et al., 2019].

However, a significant impediment to the recycling of HF flowback in several major shale developments in North America has been the extremely high level of chlorides in the flowback, more than ten times seawater concentrations. This project will test recycled fluids and expects to be able to extend this capability as the project develops.

An assessment of the key *CoPC* in CPP HF flowback can be found in **Appendix 06** (Waste and Wastewater Management Plan).

Table 3.8—3 Waste Sources and Types

Waste Source	Example Waste Types
Domestic Activities: • Camp • Offices	• Treated sewage effluent • Putrescible and municipal waste • Greywater (laundry, showers, sink wastes, etc.) • Recyclables (glass and cans)
Construction Activities	• General waste (i.e. batteries, plastics, cardboards) • Chemical bags and cardboard packaging materials • Scrap metals • Timber pallets (skids) • Vehicle tyres • Oily rags, filters

Waste Source	Example Waste Types
Drilling	• Drilling fluids • Drilling cuttings • Cement returns
Hydraulic Fracture Stimulation	• Flowback fluid • Produced water (potential)
Appraisal Testing	• Flowback fluid • Produced water (not anticipated)
CGP Operation	• Chemical bags and cardboard/plastic packaging materials • Scrap metals • Timber pallets (skids) • Vehicle tyres • Oily water • Chemical wastes
Ancillary Works associated with: • Drilling • Hydraulic Fracturing • Production Testing • CGP Operation	• Chemical bags and cardboard packaging materials • Scrap metals • Used chemical containers and fuel drums • Chemical wastes • Timber pallets (skids) • Vehicle tyres • Oily rags, filters

3.8.4 Greenhouse Gas Emissions

Flaring produced gas made up over 90% of total annual GHG emissions in the previous Imperial campaigns. To eliminate these Scope 1 GHG emissions, Imperial proposes to export the appraisal gas to customers via the MRGP that bisects the CPP Area. If the application under Section 57AAA is unsuccessful and the CPP proceeds on a basis different to the one described, this EMP will be revised or modified under the PER to account for any new or increased environmental impacts or risks. This revision would include a greenhouse gas abatement plan if Imperial's estimated scope 1 emissions exceed 100,000 tCO2-e in any financial year over the life cycle of the project.

This EMP proposes to export an estimated 25 TJ/day from the wells during the Appraisal Phase, primarily to evaluate the decline curve on well production over an extended period of three years or more across the CPP Area.

The annual average GHG estimated emissions from the Activity are approximately 30,000 tCO2-e over the period covered by the EMP. In no financial year covered by the EMP do the estimated emissions exceed the 'large greenhouse gas emitters' Industrial project annual threshold of 100 000 tCO_2-e [NT EPA, 2022A]. See **Table 3.8—4** for the indicative financial year greenhouse gas emissions for the Activity. An indicative breakdown of these emission sources is provided in **Table 3.8—5**.

The main source of greenhouse gas emissions for the Activity, with gas recovered on an appraisal basis, is fuel combustion by the gas engines running the CGP compressors. Approximately 3-5% of the total sales gas throughout is consumed by the engines as fuel gas.

A permanent flare installed at the CGP is designed to safely dispose of gases that would otherwise need to be vented during abnormal operations and emergency events (see **Section 3.7.3.10**). A small quantity of fuel gas is continuously burned at the flare tip by pilot burners, which ensures that any process gases that are released via the flare are immediately ignited at the flare tip.

Table 3.8—4 Estimated Greenhouse Gas Emissions for the Activity per Financial Year

Source of Emissions	2024/25	2025/26	2026/27	2027/28	2028/29	2029/30	Total
Vegetation Clearing	8,193	6,338	-	-	-	-	**14,531**
Diesel Fuel Combustion	13,070	10,955	9,815	1,459	248	21	**35,567**
Gas fuel combustion	2,384	9,561	28,980	29,059	28,980	2,461	**101,425**
Fugitive Emissions	2,465	3,191	3,862	4,144	4,142	1,888	**19,693**
Flaring	1,833	1,833	1,833	1,833	1,833	-	**9,166**
Total	**27,944**	**31,878**	**44,491**	**36,495**	**35,203**	**4,370**	**180,381**

Table 3.8—5 Greenhouse Gas Emissions Estimates (tonnes CO_2-e/a) for the Activity for this EMP

	Units	Inputs & Assumptions	Total Units	Total	2024/25	2025/26	2026/27	2027/28	2028/29	2029/30
Vegetation Clearing	Veg Clearing (Ha)	226	Ha	**226.0**	127.4	98.6	0.0	0.0	0.0	0.0
	tCO_2-e / Ha	64.31	tCO_2-e	**14,533**	6,817	3,537	0	0	0	0
	Vegetation Clearing Total		**tCO_2-e**	**14,531**	**8,193**	**6,338**	**0**	**0**	**0**	**0**
Diesel Fuel Combustion	**Water Bore Drilling**									
	Days	See schedule	Days	**126**	70	56	0	0	0	0
	Litres / day	250	Litres	**31,500**	17,500	14,000	0	0	0	0
	tCO_2-e / Litre Burnt	0.00272	tCO_2-e	**86**	48	38	0	0	0	0
	Well Pad and Access Civil Construction									
	Days	See schedule	Days	**201**	111	90	0	0	0	0
	Litres / day	1,000	Litres	**201,000**	111,000	90,000	0	0	0	0
	tCO_2-e / Litre burnt	0.00272	tCO_2-e	**546**	302	245	0	0	0	0
	Well Pad Equipment Construction									
	Days	See schedule	Days	**62**	62	0	0	0	0	0
	Litres / day	100	Litres	**6,200**	6,200	0	0	0	0	0
	tCO_2-e / Litre burnt	0.00272	tCO_2-e	**17**	17	0	0	0	0	0
	Facilities Civil Construction									
	Days	See schedule	Days	**170**	170	0	0	0	0	0
	Litres / day	1,000	Litres	**170,000**	170,000	0	0	0	0	0
	tCO_2-e / Litre burnt	0.00272	tCO_2-e	**462**	462	0	0	0	0	0
	Facilities Equipment Construction									
	Days	See schedule	Days	**263**	263	0	0	0	0	0
	Litres / day	250	Litres	**65,750**	65,750	0	0	0	0	0
	tCO_2-e / Litre burnt	0.00272	tCO_2-e	**179**	179	0	0	0	0	0
	Flowline Civil Construction									
	Days	See schedule	Days	**144**	104	40	0	0	0	0

	Units	Inputs & Assumptions	Total Units	Total	2024/25	2025/26	2026/27	2027/28	2028/29	2029/30
	Litres / day	1,000	Litres	**144,000**	104,000	40,000	0	0	0	0
	tCO_2-e / Litre burnt	0.00272	tCO_2-e	**392**	283	109	0	0	0	0
	Flowline Construction									
	Days	See schedule	Days	**153**	109	44	0	0	0	0
	Litres / day	1,000	Litres	**153,000**	109,000	44,000	0	0	0	0
	tCO_2-e / Litre burnt	0.00272	tCO_2-e	**416**	296	120	0	0	0	0
	Drilling Mobilisation/Demobilisation/Rig Shift									
	Days	See schedule	Days	**110**	40	30	34	6	0	0
	Litres / day	2,500	Litres	**275,000**	100,000	75,000	85,000	15,000	0	0
	tCO_2-e / Litre burnt	0.00272	tCO_2-e	**748**	272	204	231	41	0	0
	Drilling									
	Days	See schedule	Days	**430**	157	135	138	0	0	0
	Litres / day	8,000	Litres	**3,440,000**	1,256,000	1,080,000	1,104,000	0	0	0
	tCO_2-e / Litre burnt	0.00272	tCO_2-e	**9,353**	3,415	2,936	3,002	0	0	0
	Hydraulic Fracturing Mobilisation/Demobilisation/Rig Shift									
	Days	See schedule	Days	**100**	30	30	30	10	0	0
	Litres / day	2,500	Litres	**250,000**	75,000	75,000	75,000	25,000	0	0
	tCO_2-e / Litre burnt	0.00272	tCO_2-e	**680**	204	204	204	68	0	0
	Hydraulic Fracturing Sand Delivery									
	Days	See schedule	Days	**1110**	410	360	307	33	0	0
	Litres / day	5,000	Litres	**5,550,000**	2050000	1800000	1535000	165000	0	0
	tCO_2-e / Litre burnt	0.00272	tCO_2-e	**15,089**	5,573	4,894	4,173	449	0	0
	Hydraulic Fracturing									
	Days	See schedule	Days	**300**	90	90	90	30	0	0
	Litres / day	8,000	Litres	**2,400,000**	720,000	720,000	720,000	240,000	0	0
	tCO_2-e / Litre burnt	0.00272	tCO_2-e	**6,525**	1,958	1,958	1,958	653	0	0
	Appraisal Operations									

	Units	Inputs & Assumptions	Total Units	Total	2024/25	2025/26	2026/27	2027/28	2028/29	2029/30
	Days	See schedule	Days	**1,583**	91	365	365	366	365	31
	Litres / day	250	Litres	**395,750**	22,750	91,250	91,250	91,500	91,250	7,750
	tCO_2-e / Litre burnt	0.00272	tCO_2-e	**1076**	62	248	248	249	248	21
	Diesel Fuel Combustion Total		**tCO_2-e**	**35,567**	**13,070**	**10,955**	**9,815**	**1,459**	**248**	**21**
Gas Fuel Combustion	**Compressor Fuel Gas**									
	Days	See schedule	Days	**1583**	91	365	365	366	365	31
			(mmscf/d)		0.36	0.36	1.09	1.09	1.09	1.09
	tCO_2-e / m^3	0.00272	tCO_2-e	**37,305,581**	876,805	3,516,854	10,659,141	10,688,344	10,659,141	905,297
	Gas Fuel Combustion Total		**tCO_2-e**	**101,425**	**2,384**	**9,561**	**28,980**	**29,059**	**28,980**	**2,461**
Fugitive Emissions	**Well Heads**									
			Tonnes of gas throughput		14,013	56,206	170,355	170,821	170,355	14,468
	CO_2-e / t	0.00132	787	**18**	**74**	**225**	**225**	**225**	**19**	**150**
	Completions									
			Wells		-	-	-	2	2	-
			CO_2-e / t (CH_4)		-	-	-	273	273	-
	CO_2-e / t	13.67	CO_2-e / t (CO_2)		-	-	-	7	7	-
			tCO_2-e	**560**	**0**	**0**	**0**	**280**	**280**	**0**
	Cleanup Sand to Atmospheric Separator									
			mmscfd		0.6	0.6	0.6	0.6	0.6	-
			Days		2	2	2	2	2	-
			wells		2	2	2	2	2	-
			CO_2-e/t (CO_2)		4	4	4	4	4	-
			CO_2-e/t (CH_4)		1,074	1,074	1,074	1,074	1,074	-
			tCO_2-e	5,393	1,079	1,079	1,079	1,079	1,079	-
	Flowlines									
			km of gathering (cumulative)		30	50	60	60	60	60

	Units	Inputs & Assumptions	Total Units	Total	2024/25	2025/26	2026/27	2027/28	2028/29	2029/30
			CO_2-e / t (CH_4)		196	326	391	391	391	391
			CO_2-e / t (CO_2)		325	542	650	650	650	650
			CO_2-e / t	**5,554**	**521**	**868**	**1,041**	**1,041**	**1,041**	**1,041**
	Flowback Water									
			ML of flowback		68	68	68	68	68	-
	tCO_2-e / m^3	23.80000	scm gas		9,520	9,520	9,520	9,520	9,520	-
			CO_2-e / t	**129**	**26**	**26**	**26**	**26**	**26**	**-**
	Compressor Stations									
	CH_4 Emission factor	Tonnes CO_2-e per tonne of natural gas			0.05	0.02	0.01	0.01	0.01	0.05
	CO_2 Emission factor	Tonnes CO_2-e per tonne of natural gas			0.00	0.00	0.00	0.00	0.00	0.00
			CO_2-e / t (CH_4)		654	912	1,188	1,189	1,188	659
			CO_2-e / t (CO_2)		167	233	303	303	303	168
			CO_2-e / t	7,268.79	821.10	1,144.38	1,491.65	1,492.62	1,491.65	827.40
	Fugitive Emissions Total		**tCO_2-e**	**19,693**	**2,465**	**3,191**	**3,862**	**4,144**	**4,142**	**1,888**
Flaring	**Wells Initial Cleanup**									
					2	2	2	2	2	-
			mmcf gas		24	24	24	24	24	-
			tonne gas		488	488	488	488	488	-
			CO_2 tCO_2-e		1366	1366	1366	1366	1366	0
			CH_4 tCO_2-e		455	455	455	455	455	0
			N_2O tCO_2-e		13	13	13	13	13	0
			tCO_2-e	**9,166**	**1,833**	**1,833**	**1,833**	**1,833**	**1,833**	**-**
	Flaring Total		**tCO_2-e**	**9,166**	**1,833**	**1,833**	**1,833**	**1,833**	**1,833**	**-**
			Estimated Project Total	**~180,381**	**27,944**	**31,878**	**44,491**	**36,495**	**35,203**	**4,370**

3.8.5 Transportation

A Traffic Impact Assessment (TIA) carried out for the Activity (**Appendix 11**) did not require Imperial to prepare an Operational Traffic Management Plan as no additional works to the Carpentaria Highway or intersections are necessary.

For the initial civil construction works, equipment is likely to be sourced locally, which will minimise traffic and transport impacts on the broader area. Similarly, crews will have on-site accommodation, significantly reducing movements along Carpentaria Highway after initial mobilisation. **Table 3.8—5** and **Table 3.8—6** outline the estimated quantity and frequency of light and heavy vehicle movements during key stages, e.g. drilling, HF, operations, and facilities establishment.

As outlined in the schedule depicted in **Figure 1.6—1**, the Activity will experience a surge of action during its initial phase. This period will be marked by the commencement of civil works, and facility construction, and laying the foundational infrastructure for the Activity. Following closely, we will see the arrival of materials necessary for drilling and HF. The onset of the drilling and HF programs will shortly ensue. As these programs progress, there will be a gradual decline in overall traffic volumes. This trend is further illustrated in **Figure 3.8—2**, which offers an indicative overview of the estimated truck movements throughout the Activity, correlating these movements with the planned schedule.

Table 3.8—6 Estimated Initial Mobilisation and Services Traffic

Stage	Light Vehicle Movements per Day During initial Mobilisation per Stage	Truck Movements per Week During initial Mobilisation per Stage
Civil and Facility Construction	4	10
Drilling Rig Mobilisation	4	20
HF Spread Mobilisation	4	20

Table 3.8—7 Estimated Operational Requirements

Stage	Light Vehicle Movements per Day per Stage*	Truck Movements per Week per Stage*
Civil and Facility	4	2
Drilling	4	4
HF	4	16
Operational (food, rubbish/waste, fuel, etc.)	4	5

*As stages finish estimates will decrease.

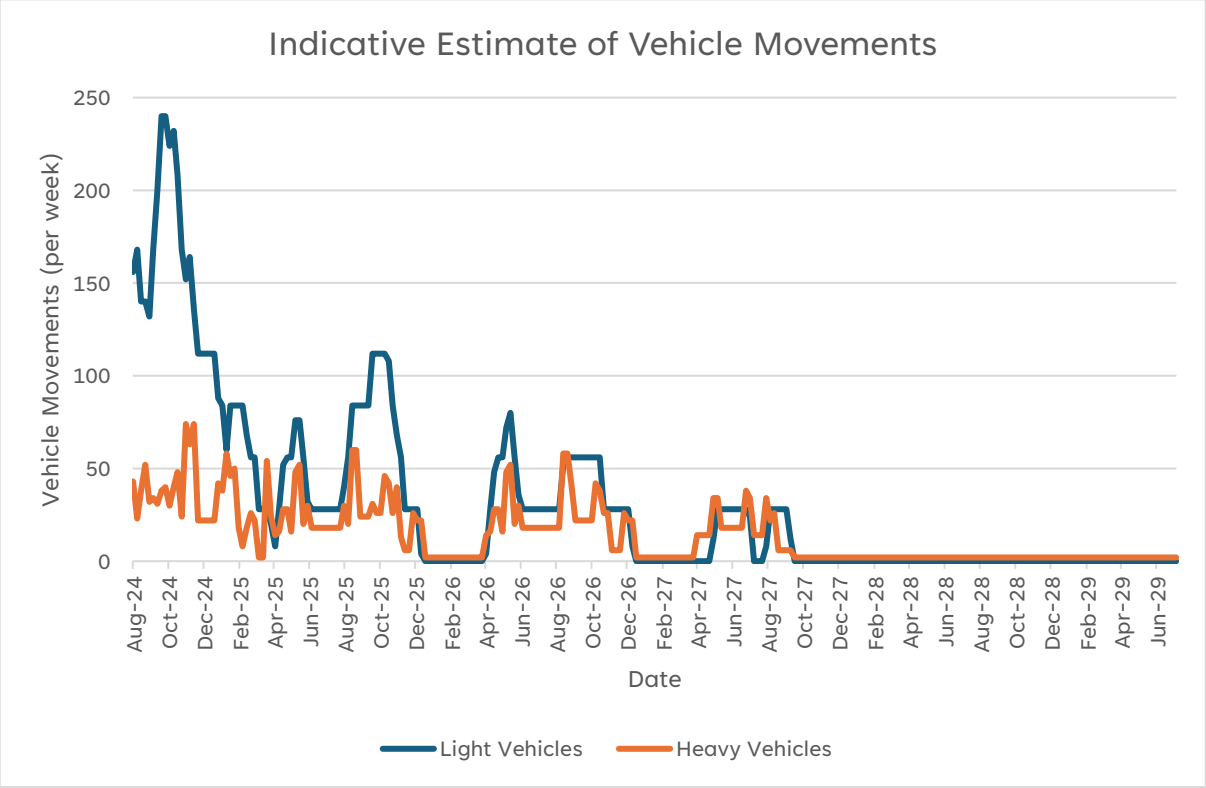


Figure 3.8—2 Indicative Estimated Traffic Volume for the Activity

A traffic impact assessment (TIA) was undertaken for the Activity (**Appendix 11**) for 2024-2025 inclusive. The predicted traffic volumes were compared against the Austroad's 2021 *Guide to Road Design* – Part 3: Geometric Design, which identifies that on roads '... where traffic volumes are less than 150 vehicles per day and, particularly, where the terrain is open, single carriageways may be used' [AUSTROADS, 2021].

The TIA determined that:

- Traffic volumes on the Carpentaria Highway currently exceed 150 motor vehicles per day (MVD) from June to August. During the drilling and operations program, the 150 MVD figure would be exceeded from May to September (**Figure 3.8—3**).
- Taking account of the fluctuations in traffic volumes (i.e., an Annual Average Daily Traffic [AADT] volume basis), the AADT was modelled to be 151 MVD, i.e. within the vicinity of the 150 MVD guideline figure.
- The modelled peak traffic period is June to October. The baseline traffic is highest from June to August, corresponding to the regional cattle muster season. Activity trucking would peak in August-September when the bulk of trucking sand to the CPP Area is scheduled.

Although AADT may just exceed the Austroads guideline of 150 MVD, upgrade (widening) works are being undertaken by DIPL independently of the subject drilling and operations program. The TIA concluded that 'appropriate actions are in place to improve the operational conditions of the Carpentaria Highway'.

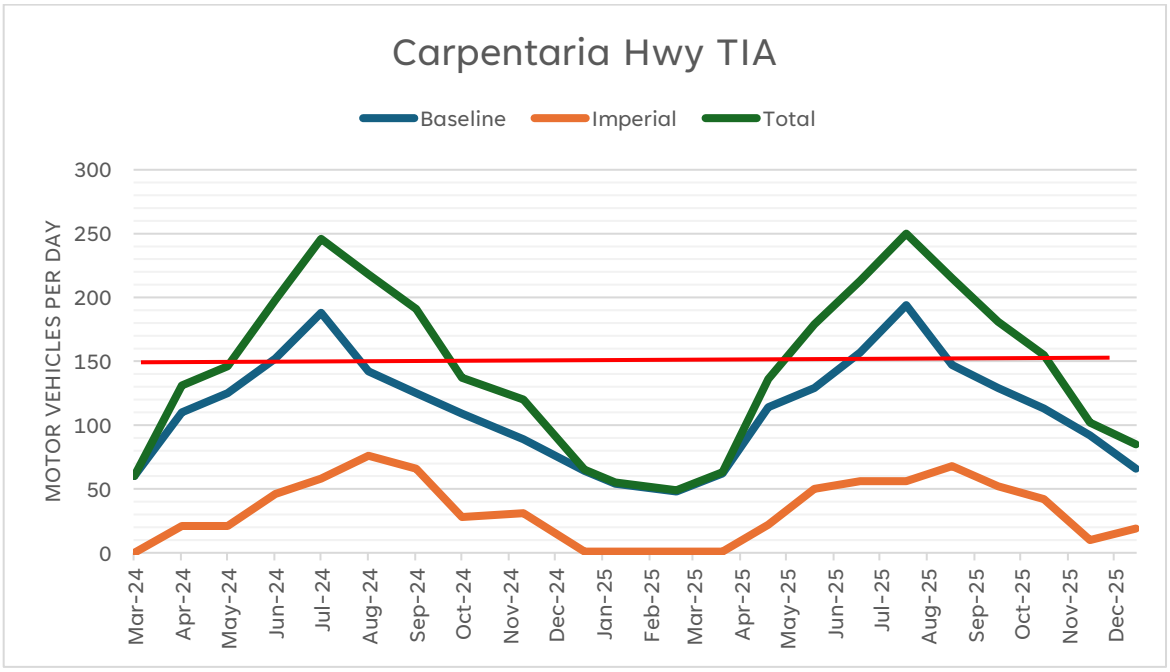


Figure 3.8—3 Traffic Impact Assessment Carpentaria Highway

3.9 Cumulative Impacts Assessment

Cumulative impacts have been calculated for EP 187, and the exploration permits within a 50 km radius of EP 187 (EP 136, 161, 169, 171, 176, 184, 187, 190, and 191), hereafter referred to as the Cumulative Study Area. Projects that commenced before 2013 have been excluded based on the assumption that the land has been fully rehabilitated and no additional monitoring is required.

Since 2019, an estimated 260.6 ha of land has been approved to be cleared by Imperial in EP 187, with 70 ha undergoing rehabilitation and 43.4 ha of the remaining 190.6 ha being reused for the Activity outlined in this EMP.

The existing disturbed areas proposed to be reused for this EMP include:

- Well pads
- Access tracks
- Gravel pits

The CPP Footprint, including existing well sites and surrounding tenements, is shown in **Figure 3.9—1**.

Since 2019, Imperial has conducted 2D seismic programs (2019 and 2021), drilled four exploration wells (Carpentaria 1, 2, 3, and 4 [2021 to 2022]), and hydraulically fractured three of those wells (Carpentaria 1, 2, and 3). **Table 3.9—1** presents the cumulative impacts across the Cumulative Study Area. Several values for previous works have been estimated due to changes in regulatory frameworks.

Where values were not presented in the relevant EMP submitted at the time, estimates have been calculated based on similar projects, and the following assumptions have been made:

- All seismic lines are 5 m wide
- All seismic lines have been cleared unless explicitly stated
- Assumed clearing requirements, where unavailable:
    - Campsite: 1 ha
    - Gravel pit: 1 ha
    - Water bore and core hole pad: 1.2 ha
    - Well pad: 7 ha
- The area of EP 187 is 442,700 ha
- The Cumulative Study Area is 9,419,700 ha

An estimated 969.6 ha (0.01% of the Cumulative Study Area) of land has been cleared since 2013, with some partial rehabilitation. Many of the projects outlined in **Table 3.9—1** are still ongoing.

Imperial has opted to reuse 43.4 ha of land cleared under previous EMPs, which includes existing gravel pits, access tracks, and well pads. New clearing will account for a 0.0024% increase in disturbance of the cumulative study area, bringing the new total disturbance due to petroleum activities within the cumulative study area to 0.0124%. Greenhouse gases associated with the Activity are anticipated to be greatly reduced via the exportation of appraisal gas to the McArthur River Gas Plant. The average annual GHG estimated emissions from the Activity are approximately 30,000 tCO2-e over the period covered by the EMP. In no financial year covered by the EMP do the estimated emissions exceed the *Large Emitter's* industrial project annual threshold of 100,000 tCO2-e [NT EPA, 2022a]. The GHG emissions associated with the Activity account for 12.7% of the total cumulative petroleum exploration emissions undertaken in the cumulative study area.

The petroleum activity groundwater extraction allocation from Georgina Basin is capped at 8 GL/a, which is approximately 4.3% of the Georgina Basin ESY. Water use for the duration of the Activity is estimated to be 950 ML, yet Imperial will apply for an increased water allocation in Groundwater Extraction Licence (GWEL) GRF10316 from 85 ML/a to 750 ML/a for the Activity. This is less than 10% of the Georgina Basin petroleum activity cap of 8 GL/a, and approximately 0.4% of the Georgina Basin beneficial groundwater allocation of 186.154 GL/a.

A Traffic Impact Assessment (**Appendix 11**) has been conducted to assess the impact of traffic associated with the Activity, in conjunction with current traffic volumes, on the Carpentaria Highway and surrounding road network. The assessment concluded that no further upgrades were required and that appropriate sight distances could be established at access points. Stakeholder engagement feedback (**Appendix 10**) highlights local businesses' interest in the economic opportunities the Activity will bring to the region. Whilst the Activity does include a camp for personnel, there will be opportunities for local employment and economic growth for the community.

As the Activity continues, Imperial will continue to work with Aboriginal people and the community to explore the opportunities to consider how local employment can be maximised.

3.9.1 Mineral Exploration Titles

EP 187 intersects two mineral exploration licenses, both currently under application. EL 33478 (Green Critical Minerals) and EL 24203 (Red Metal Limited) are not within the CPP Area and as a result, are not considered stakeholders. However, both Interest Holders have been notified of the Activity.

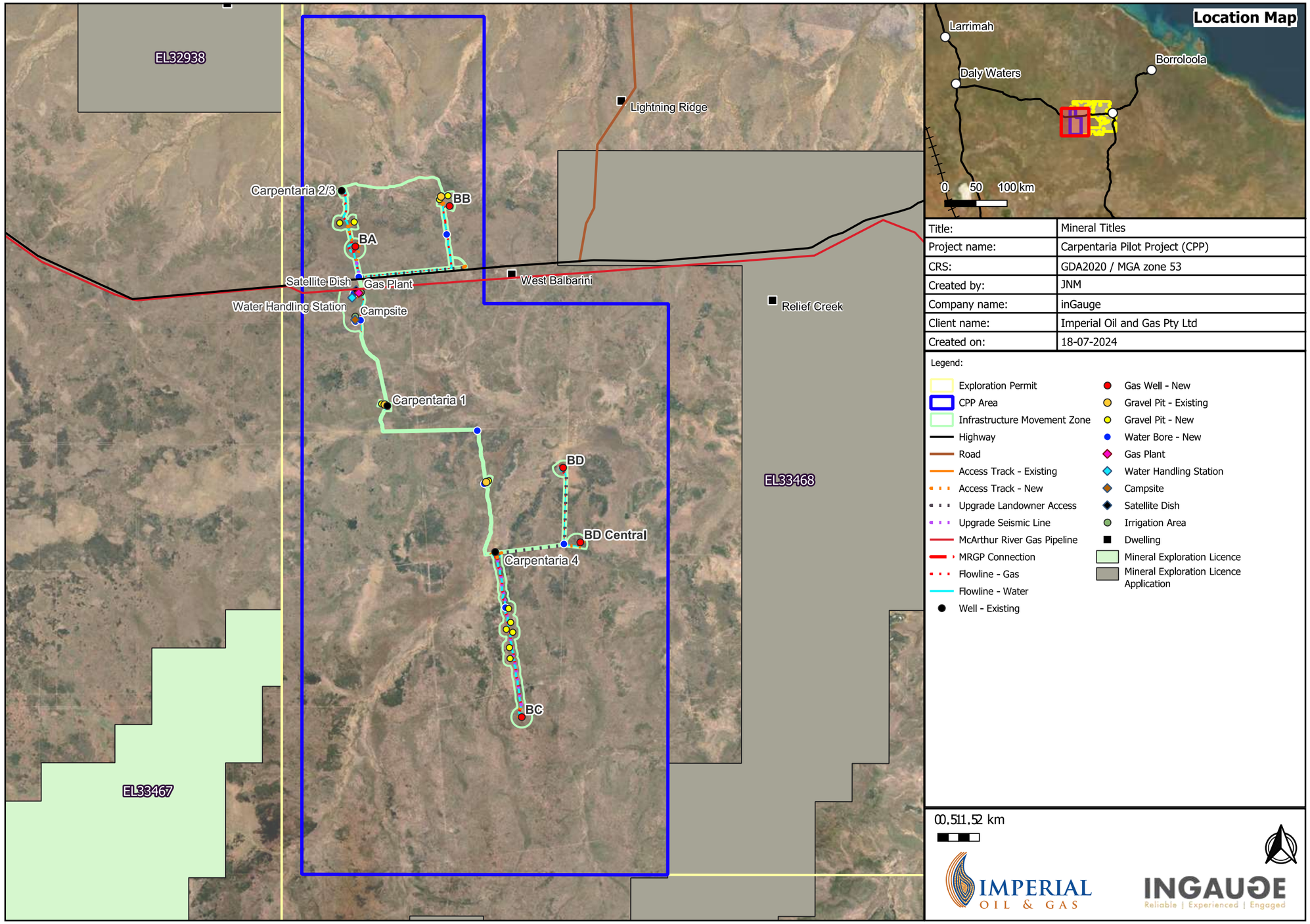


Figure 3.9—1 Mineral Tenements

Table 3.9—1 Estimated Cumulative Impacts for Approved Activities

Interest Holder		Site / EMP Number	Land Cleared		Groundwater	GHG	Traffic	Social	Rehabilitation
			Clearing (ha)	**Disturbance ** (%)**	**Total** (ML)	**Total** (tCO2-e)	**Peak Vehicle No.** (per day)	**Personnel No.** (peak)	**Rehabilitation Stage**
Santos	EP 161	Tanumbirini & Inacumba	297		171	146,726	~ 50	~ 100	Seismic lines rehabilitated. Drilling sites still active.
		Marmbulligan	22		22	4,881	~ 50	~ 40	Currently rehabilitating.
		Total	**319**	**0.0034**	**193**	**152,000**			
Sweetpea	EP 136	SWP 4-3	2		578	728,399	44	100	Project still active.
		SWP 2-3	2		578	728,399	44	100	Project still active.
		SWP 1-4	279		1	5,377	30 - 40	50 - 60	Partial rehabilitation (~ 72 ha).
		Total	**454**	**0.0048**	**897**	**749,000**			
Amour Energy / McArthur NT	EP 171	EP171-190-ENV-GEN-PLN-003	0		0	1	4	8	Rehabilitated.
	EP 190	NT-ENV-GEN-REP-002	1		1	4,000	30 - 40	30	Rehabilitated.
		Total	**1**	**0.000012**	**1**	**4,001**			
Imperial Oil & Gas	EP 184	Core Hole Drilling ***	5		0.5	1,392	8	8	Rehabilitated.
	EP 187	IMP 1-3‡‡	70†		0	6,638	~ 30 (per week)	~ 27	Rehabilitated; awaiting acceptance by the Minister.
		IMP 2-6.1	14		5	4,158	~ 50 (per week)	~ 30	N/A Project ongoing.
		IMP 3-4	10.6		7.5	10,619	~ 50 (per week)	~ 30	N/A Project ongoing.
		IMP 4-3	166		434	249,892.4	~ 50 (per week)	~ 40	N/A Project ongoing.
		Total	**195.6**	**0.0021**	**447**	**272,699.4**			
Cumulative Total (Existing)			**969.6**	**0.01**	**1,538**	**1,177,700**			
Imperial Oil & Gas (indicative values)	**EP 187**	**IMP 5-1**	**Up to ~226**	**0.0024**	**Up to ~950**	~180,381 ~	~ 4 LV per day †† ~ 2-16 HV per week (project stage dependant) ††	~ 51 average	Yet to commence.

Interest Holder	Site / EMP Number	Land Cleared		Groundwater	GHG	Traffic	Social	Rehabilitation
		Clearing (ha)	**Disturbance ** (%)**	**Total** (ML)	**Total** (tCO2-e)	**Peak Vehicle No.** (per day)	**Personnel No.** (peak)	**Rehabilitation Stage**
Cumulative Total (New)		**1195.6**	**0.0124**	**2,488**	**1,358,081**			

* Value rounded to two significant figures. **Percentage of Cumulative Study Area (9,419,700 ha). *** Labelled as (EP184 BCFSC02-05-XPN-EMP-SUM-001 Rev 3).

† Imperial assumes this area to be fully rehabilitated and awaiting acceptance by the Minister; as a result, this has been excluded from the total current cleared area. Any clearing which is parallel or intercepts these seismic lines is considered to be new clearing. ‡ Labelled as EP187-EMP-XPN-REP-007 on DEPWS EMP decisions page. ‡‡ Labelled as EP187-EMP-XPN-REP-007 on DEPWS EMP decisions page. †† Excluding mobilisation / demobilisation.

3.9.2 Social Impacts

A description of socio-economics of the region can be found in **Section 4.16**. The Activity poses numerous potential positive benefits to the region including trade-based employment opportunities (**Section 1.6** and **Table 1.6—1**), local procurement contracts (**Appendix 10 – Section 2.4.4**), as on the job well training and employment (**Table 1.6—1**).

The recent publication of SREBAs Social, Cultural, and Economic (SCE) study of the Beetaloo Sub-basin [K. WITT et al., 2023] surmised that people interviewed in Borroloola (~150 km east of the CPP Area) were mostly against the idea of onshore gas development in the Beetaloo, citing several social reasons including a lack of consideration of Aboriginal peoples' (and other stakeholders) voices and interests, impacts to the culture and cultural responsibilities (and the ramifications for present and future custodians), and an increased disparity in wealth, education, and privilege in the region.

In response to SREBAs SCE study and as part of the construction and approval process of this EMP, Imperial has engaged and consulted with local Aboriginal people and other stakeholders, both locally and in the wider community. Consideration will be given to these people's voice and interests. To aid in preserving culture and cultural responsibilities, Imperial is in the process of applying for an AAPA certificate, which includes an assessment of whether Activity works will directly affect areas of cultural heritage and the ability of Traditional Owners carrying out their cultural responsibilities. Imperial's presence in the region has the ability to increase employment opportunities and traineeships, both directly and via service companies that will support the project. The Activity is unlikely to negatively impact existing disparities in wealth, education, and privilege distributions within the region.

The study also highlighted hopes that the oil and gas industry would bring access to education and training opportunities for local people, contracts and custom for local businesses, improved roads, and better internet services, in addition to supporting young people to learn about culture and traditional ways of living, access to traditional lands, and increased cohesion in tackling emerging issues between Aboriginal leaders.

Imperial intends to offer employment opportunities and anticipates that sourcing and procurement will start at the local level prior to moving regionally, territory-wide, and finally nationally. Imperial's Activity in the region is not envisaged to influence education surrounding culture and traditional ways of living, access to traditional lands, or cohesion between Aboriginal leaders.

4 Existing Environment

4.1 Introduction

The following subsections describe the existing environment of the CPP Area and environs. The information presented in this section uses the NT EPA's *Environmental Factors and Objectives* [NT EPA, 2022B] and the Source-Pathway-Receptor conceptual site model in *Guidelines On Conceptual Site Models* [NT EPA, 2013] to focus the risk assessment of the Activity.

The recently completed *Terrestrial Ecosystems Baseline Report: Strategic Regional Environmental and Baseline Assessment for the Beetaloo Sub-basin* (SREBA Report) was undertaken following the recommendations of the *Scientific Inquiry into Hydraulic Fracturing in the Northern Territory* (the Inquiry) [A. ANDERSON et al., 2018; L YOUNG, J PATYKOWSKI, I LEIPER, C NANO, A FISHER, et al., 2022]. The purpose of the SREBA Report is to provide the information necessary to support appropriate decisions about the development of onshore shale gas development in the Beetaloo region. This report includes the assessment of water and biodiversity resources to inform land-use planning and the collection of baseline data to provide a reference point for ongoing monitoring [DEPWS, 2022].

The CPP Area is wholly within the Beetaloo SREBA Biophysical Study Area (refer to **Figure 4.1—1**).

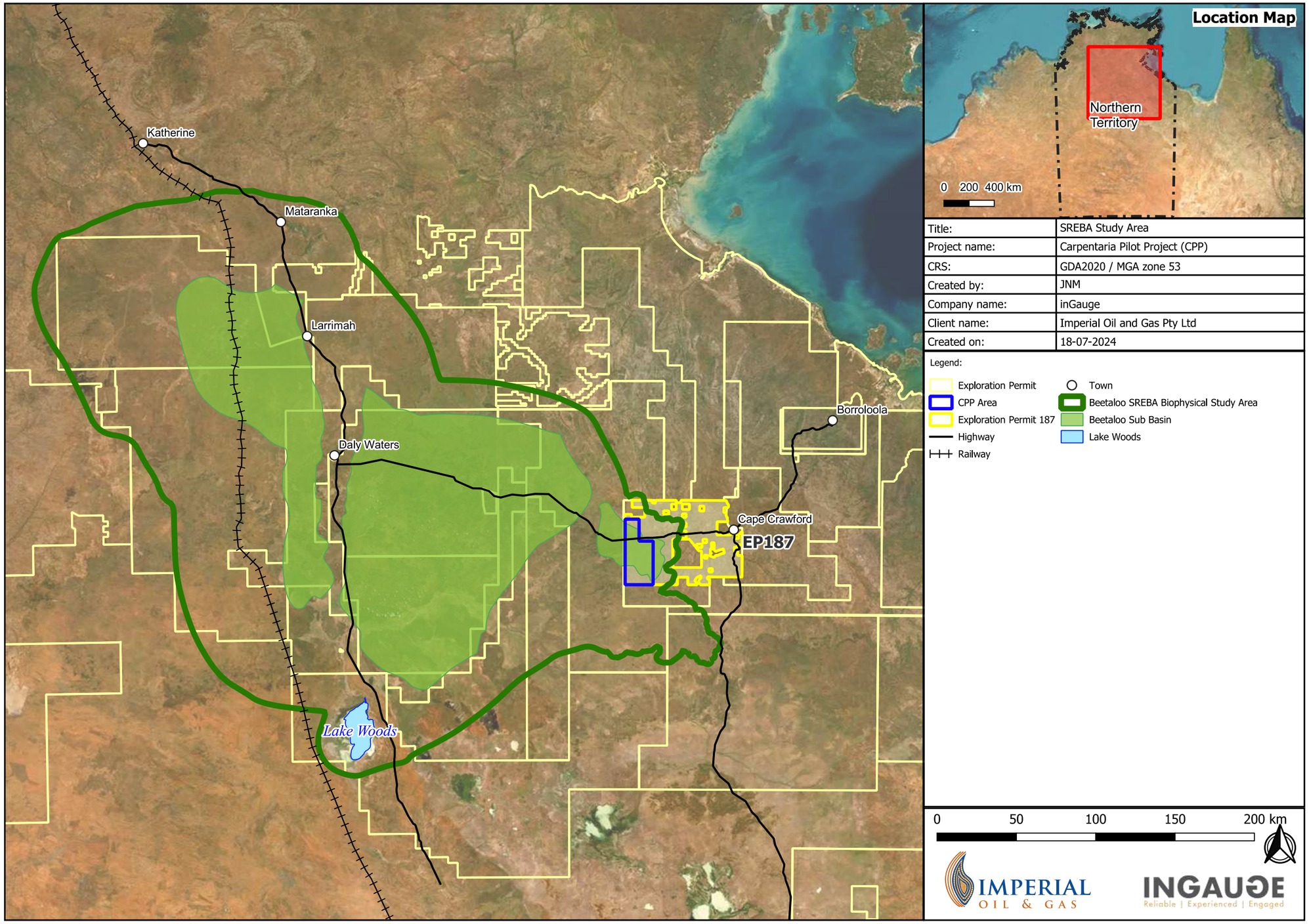


Figure 4.1—1 Beetaloo SREBA Study Area and CPP Area Location

4.2 Climate

4.2.1 Overview

The CPP Area is in the Australian tropical savannah zone, which occurs at annual rainfall totals greater than 600 mm and extends from the Gulf of Carpentaria in north Queensland, across the northern half of the NT, to the Kimberley region of north-west Western Australia and encompasses the Beetaloo Sub-basin (**Figure 4.2—1**). In this figure, the CPP Area is north of the 600 mm Isopleth.

The Beetaloo Sub-basin is buried beneath younger sediments within a savannah biome of almost 2 million km^2. The region's soils are ancient, highly weathered and leached and are dominated by low-nutrient kandosols [M HILL, & N HANAN, 2010].

Australian savannah ecosystems experience one of the most seasonal of the world's savannah climates. Approximately 85% of the average annual rainfall in the CPP Area occurs between December and March.

This seasonality is driven by the annual movement of the Intertropical Convergence Zone, which drives the Australian summer monsoon [M HILL, & N HANAN, 2010]. Each year, there are an average of 195 days with no rain in the CPP Area. However, this annual arid period is highly variable.

The main sources of rainfall in the region are the north- west monsoon, which provides the bulk of the rainfall, and the thunderstorms that precede and follow it. Tropical cyclones constitute an additional minor and erratic source of rainfall. During the monsoonal period, the rain mostly falls in periods of successive wet days interspersed by longer periods of dry weather. The wet periods are more frequent near the coast, where the intensity of rainfall is higher. Over much of the Barkly region, the annual total rainfall is satisfactory to maintain a pastoral industry of an extensive nature, although nowhere is it sufficient for intensive pastoral development [C.S CHRISTIAN, & STEWART, 1953].

Savannahs function as tree–grass systems from an ecosystem function viewpoint and as savannahs from a region-scale land cover viewpoint [M HILL, & N HANAN, 2010]. Savannahs occur at varying spatial scales and occupy the continuum between forest and grassland steppe with a variable mixture of trees and grassland; they are defined as 'a mixed physiognomy of grasses and woody plants in any geographical area, naturally occurring at landscape or regional scale' [M HILL, & N HANAN, 2010]. At a biome level, savannahs include classical open woodland with grassland and complicated patch arrangements of grassland, woodland, and forest [M HILL, & N HANAN, 2010].

Climate statistics for the CPP Area are shown in **Table 4.2—1**. These climate data are derived from historical daily recordings of 140 years of continuous records at Daly Waters station (BOM14618), approximately 195 km to the west on the Sturt Plateau bioregion; 58 years of

almost continuous records at Tanumbirini Station (BOM14628) 60 km to northwest; and 60 years of recording at McArthur River Mine (BOM14704) in the coastal Gulf Falls and Uplands bioregion, approximately 110 km to the east of the CPP Area.

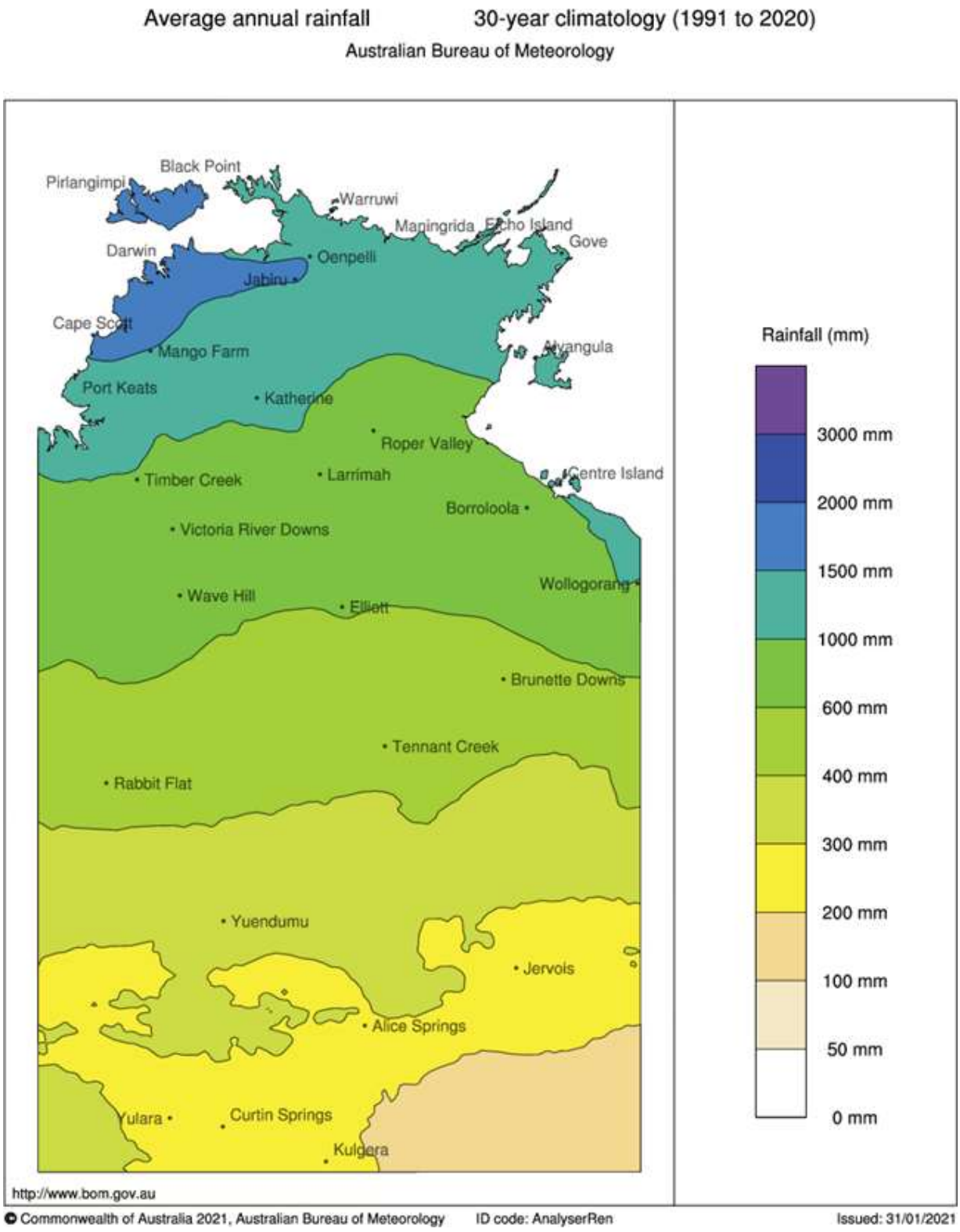


Figure 4.2—1 Average Annual Rainfall in the Northern Territory - CPP Region

Table 4.2—1 Climate Statistics East and West of the CPP Area (Source: BOM, 2023)

Climate Statistic	Daly Waters BOM14618	McArthur Mine BOM14704
Number Years Daily Observations	140 years	60 years
Annual Total Average Evaporation (E)	2,650 mm	2,600 mm
Annual Total Average Rainfall (P) (± 95% confidence interval)	650 ± 430 mm	880 mm ± 670 mm
Total annual rainfall - coefficient of variation	33%	38%
Annual average period no-rain (± 95% confidence interval)	195 ± 171 days	190 ± 160 days
Precipitation/Evaporation (P/E)	0.23	0.34
10 percentile Evaporation – 90-days	440 mm	450 mm
Maximum Historic 72-hour Total	270 mm	330 mm
Maximum Historic 7-day Total	380 mm	600 mm
Maximum Annual Recorded Total Rainfall	1323 mm - 2011	1606 mm - 2011
Minimum Annual Recorded Total Rainfall	203 mm - 1900	250 mm - 1961
Average Daily Max Temperature	34.0°C	35.1°C

4.2.2 Precipitation and Evaporation

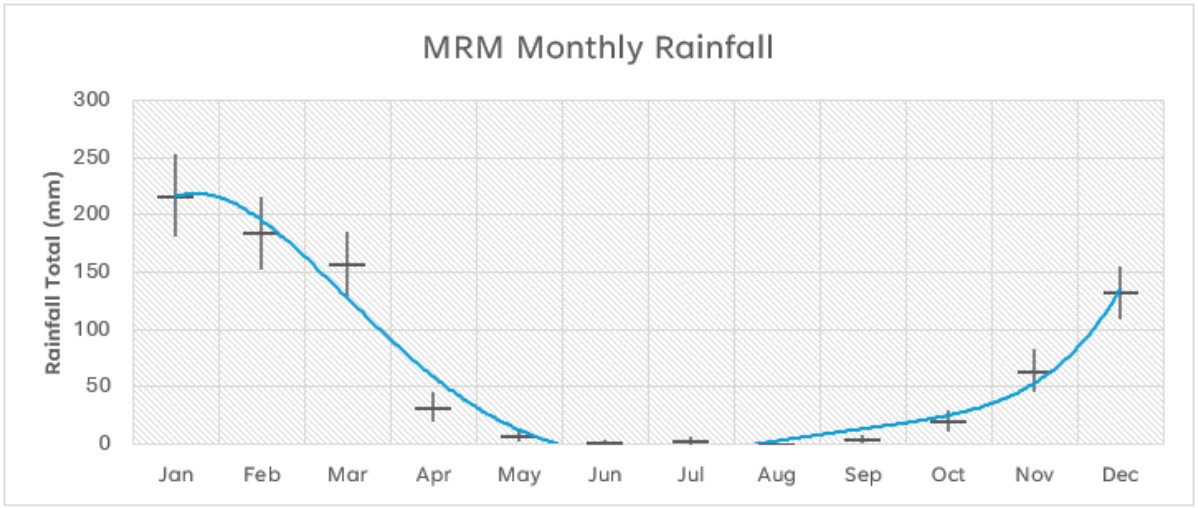
Total annual rainfall in the region is highly variable, with a coefficient of variation greater than 30% of the average yearly total during the last 140 years of records at DW. The climate within the CPP Area is arid to semi-arid, with an average total annual rainfall (P) of 650 mm and average total annual evaporation (E) of 2,650 mm, resulting in a P/E ratio of approximately 0.25, which is borderline arid.

Typically, over 90% of rainfall in the CPP Area occurs between November and April (inclusive) (**Figure 4.2—2**) and is associated with monsoonal influences from the north. As noted, during this period, the rain mostly falls in periods of successive wet days interspersed by longer periods of dry weather. Historically, the total amount of rainfall in the Beetaloo in any year has been highly variable, as indicated for Daly Waters (**Figure 4.2—3**) with the longest regional rainfall records, as it is influenced by several continental weather systems in the annual movement of the Intertropical Convergence Zone.

The average annual total rainfall from 1993-2024 was 773 mm, 767 mm and 849 mm for Daly Waters (DW - BOM 14618), Tanumbirini Station (TAN – BOM 14628) and McArthur River Mine (MRM – BOM 1474), respectively. Recorded Annual total rainfalls compared between TAN and MRM are not significantly different ($p > 0.90$); however, DW is significantly different ($p < 0.02$) than TAN and MRM. As noted, DW is located approximately 195 km to the NW, TAN approximately 60 km to the NW and MRM approximately 110 km to the NE from CPP Area.

Skewness of annual total rainfalls between 1993-2024 for DW (skew = -0.03) has an almost normal distribution, whereas MRM (skew = 0.73), and to a lesser degree TAN (skew = 0.21) are positively skewed (right tail), where the median is less than average. This reflects the variable effect of coastal rain systems that can bring significant rain to the region in different years. As noted previously, the wet periods are more frequent near the coast, where the intensity of rainfall is higher. However, goodness-of-fit test (Jacques-Bera test) of the annual rainfall totals at each of the stations is not significantly different from the normal distribution during the period 1993-2024 indicating the absence of extreme annual total outliers. Respective chi-test probabilities are DW ($p = 0.98$); TAN ($p = 0.87$); MRM ($p = 0.24$).

The highest total annual rainfall records of 1,323 mm, 1,588 mm and 1,606 mm for DW (BOM 14618), TAN (BOM 14628) and MRM (BOM 1474), respectively, occurred in 2011. Conversely, a near-record minimum total annual rainfall of approximately 277 mm, 226 mm, and 470 mm was recorded at DW, TAN and MRM, respectively, in the region in 2019.



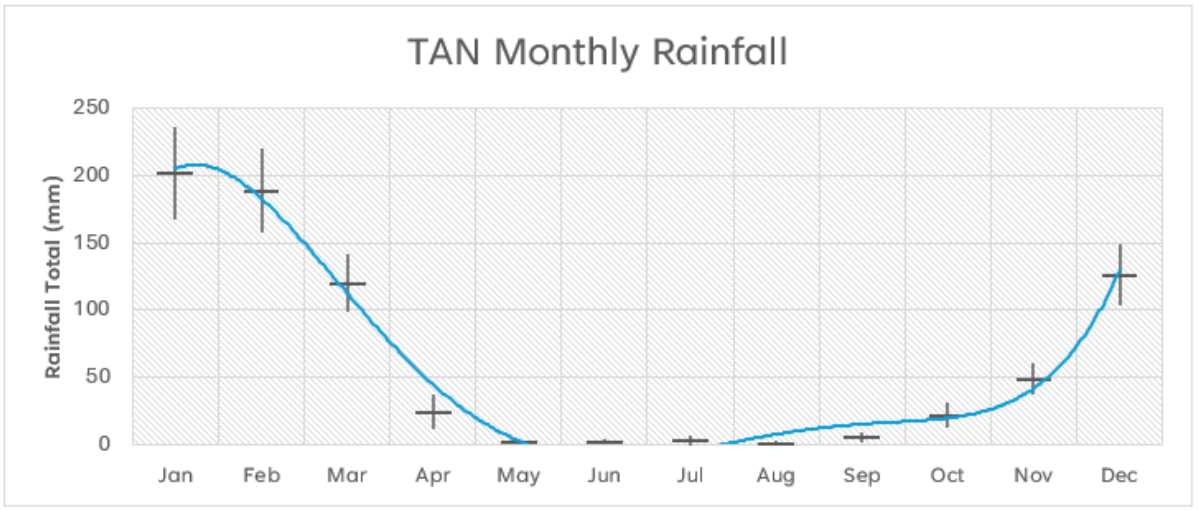


Figure 4.2—2 Monthly Average Rainfall (± CI 95%) – MRM and TAN Since 1969 (BOM 2024)

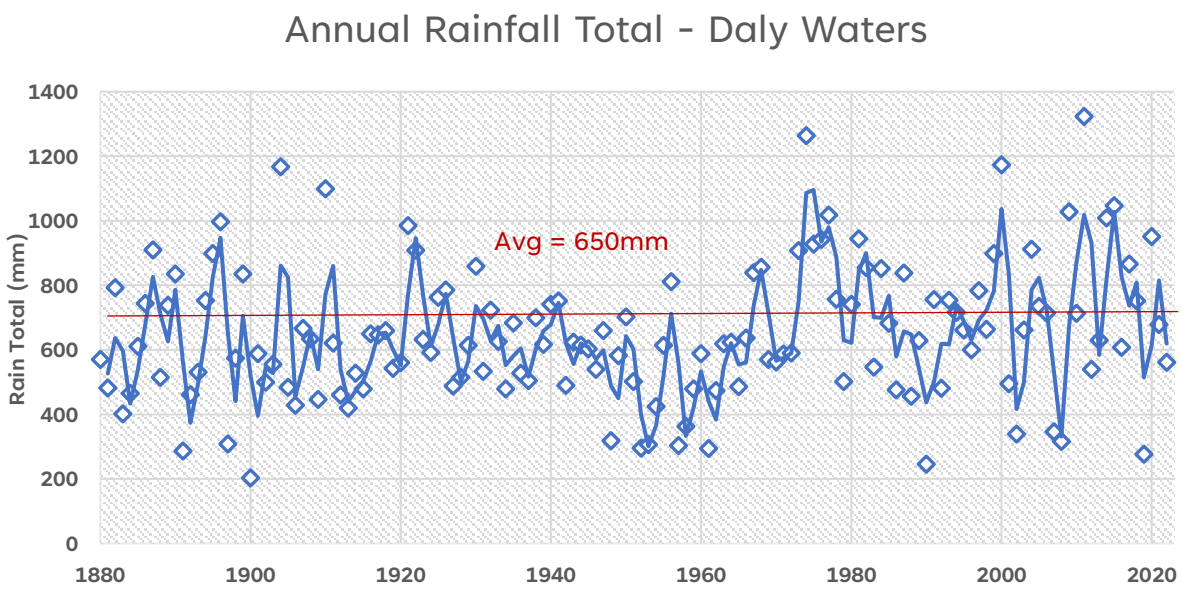


Figure 4.2—3 Annual Total Rainfall and 2-yr Moving Average at Daly Waters Since 1880

4.2.3 The Pulse Reserve Model

Plant growth in the Australian rangeland savannah, like other arid and semi-arid regions of the world, is strongly pulsed [J LUDWIG et al., 1996]. Peaks in plant growth are rapid and followed by periods of quiescence (i.e., little growth). Occasionally, growth persists for months rather than days or weeks. Discontinuous and variable amounts of rain cause the pulsed nature of plant production and its irregularity.

Growth will pause when water stores in the root zone drop below a critical level [J LUDWIG et al., 1996]. The pulse-reserve model characterises climate and ecology within the CPP Area and wider Sturt Plateau bioregion. The pulse-reserve model describes arid ecosystem functions as water-controlled ecosystems that exhibit infrequent, discrete, and largely unpredictable water input [W. G. WHITFORD, & B. D. DUVAL, 2019].

The Pulse Reserve model has the following characteristics:

- Precipitation is so low that water is the dominant controlling factor for biological processes.
- Precipitation is highly variable and occurs in infrequent discrete events.
- Variation in total rainfall is unpredictable in any year.

According to the pulse-reserve model, a precipitation event triggers a pulse of activity, such as the rapid growth of vegetation, followed by a deposit of biological matter (such as seeds) into reserves. An example of this model in the CPP Area would be topographic depressions, where rainfall run-off accumulates as ephemeral soaks. This allows vegetation in the surrounding area

to grow following the rainfall event. The magnitude of a pulse varies as a function of the size of the trigger event, the duration of the trigger event, and the season of the year. Variance in annual total rainfall can lead to significant variation in the subsequent Dry Season fuel load, as discussed in **Section 4.11.4** and **Appendix 12** (Bushfire Management Plan). Approximately 50 mm of rain is required to produce a useful response in these pastures. Substantial growth will result from 100 mm, but more is beneficial. Once sufficient rain is recorded, growth is rapid, and the bulk of the season's feed is usually produced in a period of 2-3 months. The total length of useful pasture growth, on average year rainfalls, was estimated to be approximately 19 weeks in this region of the Barkly [C.S CHRISTIAN, & STEWART, 1953].

Perennial tussock grass species in the CPP Area are a dominant vegetative ground layer. The grasses of this biome must maintain an extensive root system and tap water at depths up to 2 m and close to the soil surface to rapidly capture water from showers that moisten only the upper soil horizon.

Consequently, established tussock grasses are deeply rooted. Living root systems and dormant meristems are a significant part of a tussock grass landscape's reserve, its ability to function and recover from regular bushfires, i.e., the landscape's capacity to respond rapidly to soil moisture [J LUDWIG et al., 1996].

Analysis of storm events of less than seven days that were greater than 100 mm at McArthur River Mine was totalled for each decade since daily rain records commenced in 1955, reflecting an inter-decadal trend (see **Figure 4.2—4**).

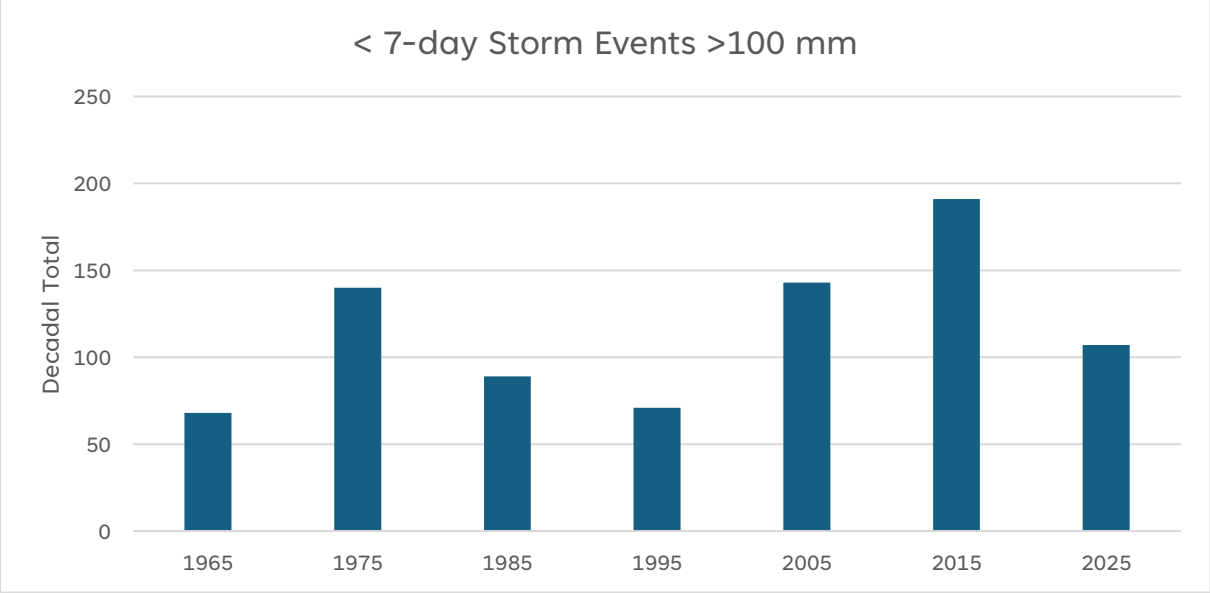


Figure 4.2—4 Number of Storm Events >100 mm in < 7-days at McArthur River Mine

Another indicator of the pulse nature of rainfall in the SREBA region is the highly variable amount of water held in Lake Woods, as demonstrated in **Figure 4.2—5**. The location of Lake Woods is approximately 200 km to the southwest of CPP Area as shown in **Figure 4.1—1**. Lake Woods is an endorheic (sink lake or terminal lake) basin that drains most of the catchments in the SREBA, south of the Carpentaria Highway. The Lake Woods Basin has a catchment area of approximately 40,820 km^2 up to the discharge point into Lake Woods, which becomes inundated during extended periods of high rainfall and then produces a burst of productivity, encouraging wildlife (particularly avifauna) to the area. This period of growth is followed by periods of drying and a subsequent reduction in wildlife at the lake. The Lake Woods catchment is outside the CPP Area. The size of Lake Woods rarely exceeds 500 km^2, but in its mega-lake stages, it has expanded to an area greater than 5,000 km^2 [J. M BOWLER et al., 1998].

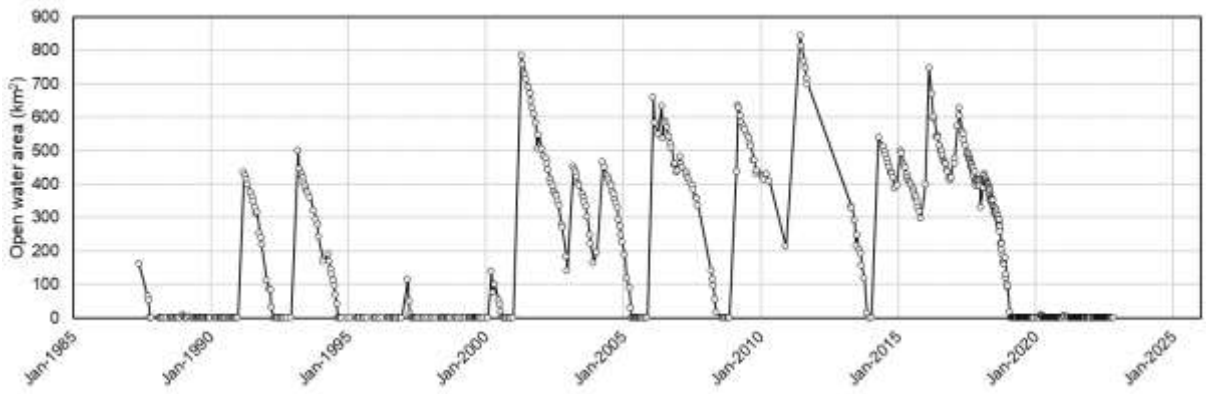


Figure 4.2—5 Open Water Area of Lake Woods Estimated by Landsat and Sentinel Satellite Imagery [DEPWS, 2022]

Distinctive lithic artifact types are found at Lake Woods that are characteristic either of tropical northern Australia or arid southern Australia, suggesting the lake was an inter-regional locus for human activity and a potential zone of interaction between different Traditional Owner groups at various times in the past [C SHIPTON et al., 2021].

On average, there are 105 days with no rain each year in the CPP Area. However, this arid period is also highly variable, as the analysis in **Figure 4.2—6** shows. The coefficient of variation for this arid indicator is almost half (greater than 40%) of the annual regional average arid period. There is no statistical relationship between wet years and arid periods.

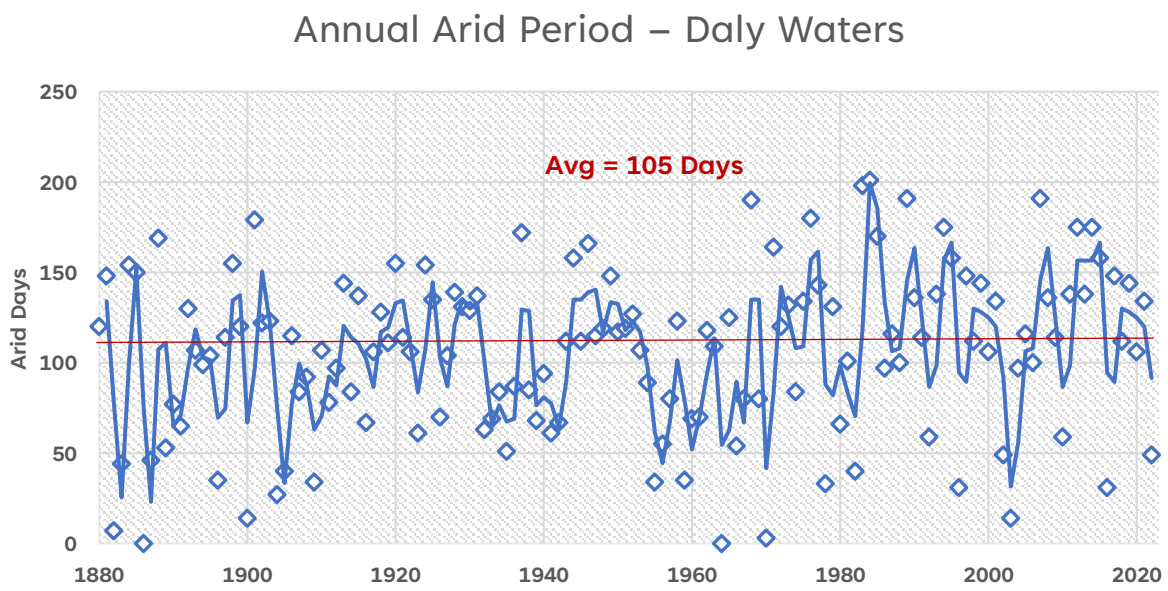


Figure 4.2—6 Annual Arid Period and 2-Year Moving Average at Daly Waters Since 1880

4.2.4 Seasonal Aridity

Plant production pulses in the savannah rangeland of the Barkly region are largely consumed by large native herbivores (e.g., Macropods) and periodic fire. This has been the case for millennia. Large native herbivores dominated this landscape due to their ability to survive prolonged periods between the brief and unpredictable pulses of plant production, characteristic of Australia's arid and semi-arid lands.

In the case of introduced rangeland herbivores, the ability to survive climatic extremes is an evolutionary response to the increasing aridity of the Australian continent and elsewhere. It has led to pastoralism becoming a dominant form of land use in the savannah rangelands of Australia, which introduced large feral herbivores such as cattle and water buffalo [J LUDWIG et al., 1996].

Periodic collapses in native herbivore numbers arising from severe drought and plant dieback (including whole-plant death) are essential elements in the long-term persistence of the landscape function in tropical Australian arid savannah. The collapse in herbivore numbers, as a response to long periods of low plant productivity, is an evolutionary means by which individual plants escape grazing long enough to recover, build up root reserves, grow, and produce seeds in Australian tropical arid savannah [J LUDWIG et al., 1996].

Cattle stocking density on pastoral properties in the region is reduced by mustering, primarily during the early Dry Season from May to July, while green forage is more abundant. During extremely prolonged arid periods, the destocking of breeders (cows) by trucking to other regions may also be implemented [SAMANTHA CAPON et al., 2016; J LUDWIG et al., 1996; J RUSSELL-SMITH

et al., 2009]. This seasonal schedule in pastoral management controls is a key activity in the region.

Variance in annual total rainfall can lead to significant variation in the subsequent Dry Season fuel load as discussed in **Section 4.11.3** and **Appendix 12** (Bushfire Management Plan).

4.2.5 Evaporation

Evaporation rates within the CPP Area follow a defined seasonal trend where daily rates are lowest in winter and highest in summer, with an average annual evaporation rate of 7.5 mm/day (see **Figure 4.2—7**).

The 10th percentile for daily evaporation rate has been calculated for Daly Waters (4.9 mm) and McArthur River Mine (4.4 mm). There has been no discernible trend in overall annual average evaporation at Daly Waters or McArthur River Mine during the periods of weather station records, which are 140 years and 60 years, respectively.

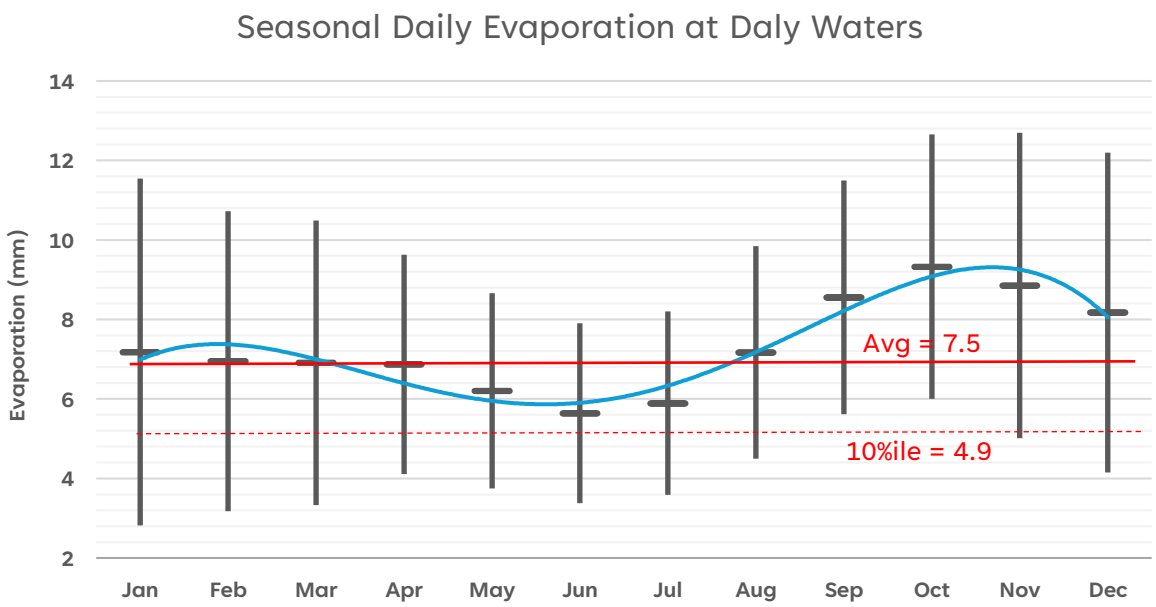


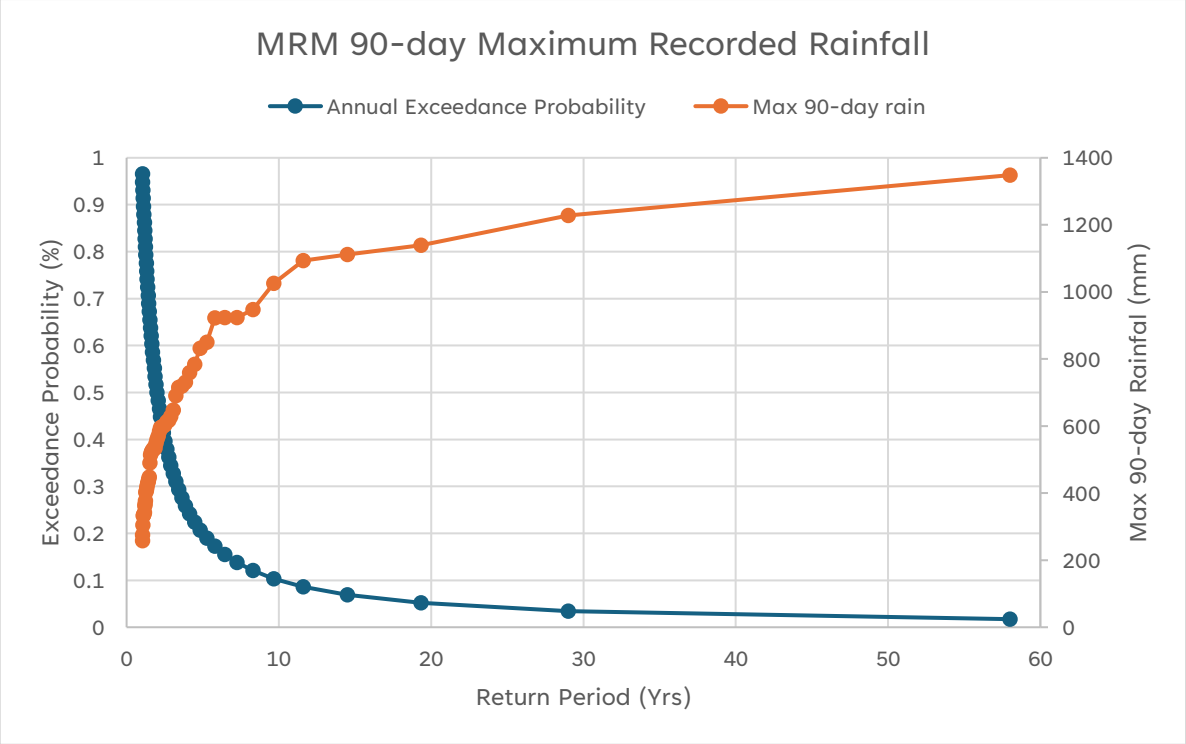
Figure 4.2—7 Average Daily Evaporation (± CI 95%) by Month at Daly Waters Since 1880

4.2.6 Extreme Rainfall Analysis

To capture extreme rainfall events for local rainfall, the annual maximum 90-day and 4-day cumulative total rainfalls for last ~ 60 years, inclusive of 2024, were calculated for MRM and TAN.

The results presented in **Figure 4.2—8** and **Figure 4.2—9** show the return period and associated exceedance probability for maximum recorded 90-day rainfall and maximum 4-day rainfall, respectively, during the years of recorded rainfall at MRM and TAN during the last 60 years.

Appendix 09 (Waste and Wastewater Management Plan) has used Scientific Information for Landowners (SILO) data to interpolate rainfall data from 1900 to the present day to provide actual rainfall design characteristics for freeboard in the CPP Area. This is consistent with industry accepted *Australian Rainfall and Runoff* methodologies associated with practices such as dam risk assessments which calculate the Wet Season based on geographical location [AUSTRALIAN GOVERNMENT, 2019].



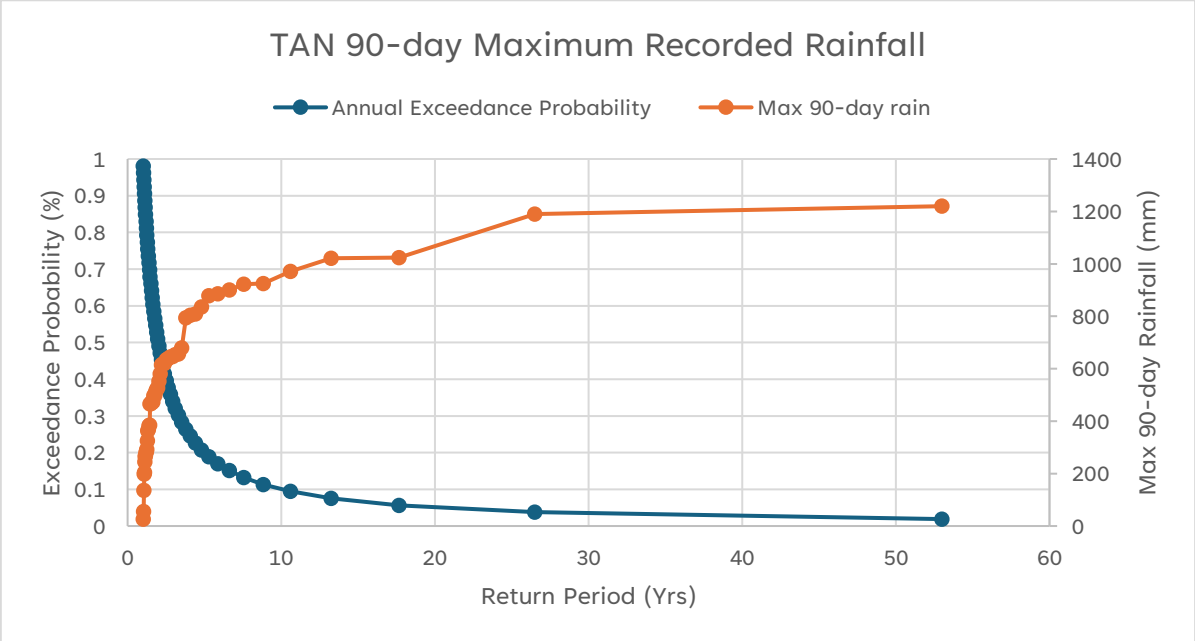
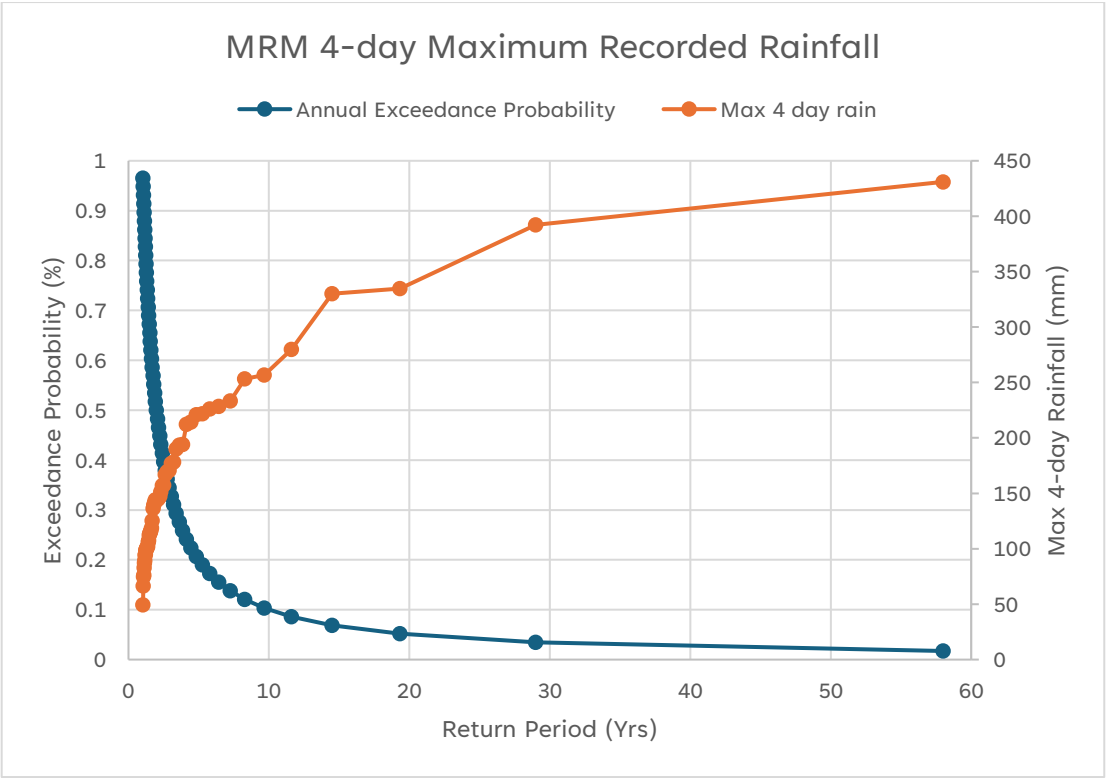


Figure 4.2—8 Maximum Annual 90-day Total Rainfall Exceedance Probabilities at MRM and TAN During Last 60 Years



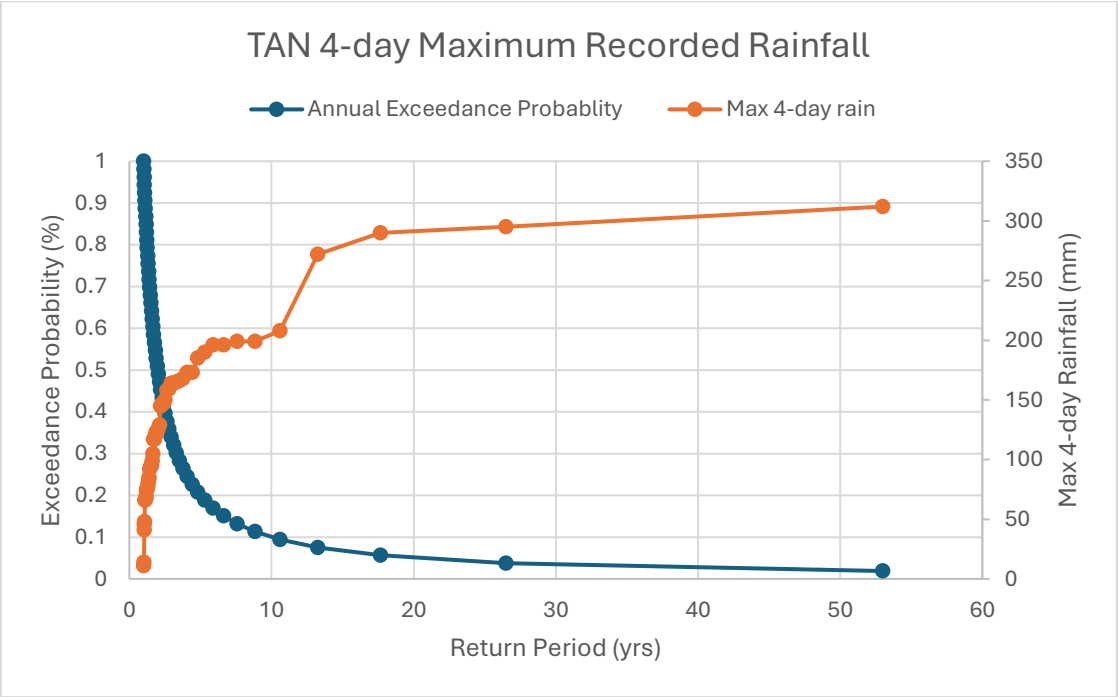


Figure 4.2—9 Maximum Annual 4-day Total Rainfall Exceedance Probabilities at MRM and TAN During Last 60 Years

4.2.7 Temperature

The annual temperature pattern is regular and changes slowly from season to season. As distance from the coast increases, the moderating effect of the sea is less pronounced,

temperatures are more extreme, and atmospheric conditions more arid [C.S CHRISTIAN et al., 1954].

Daily mean maximum temperature and confidence intervals for each month at MRM and DW were calculated. **Figure 4.2—10** shows a defined seasonal trend with wider winter temperature ranges in DW compared to MRM, which is closer to the coast.

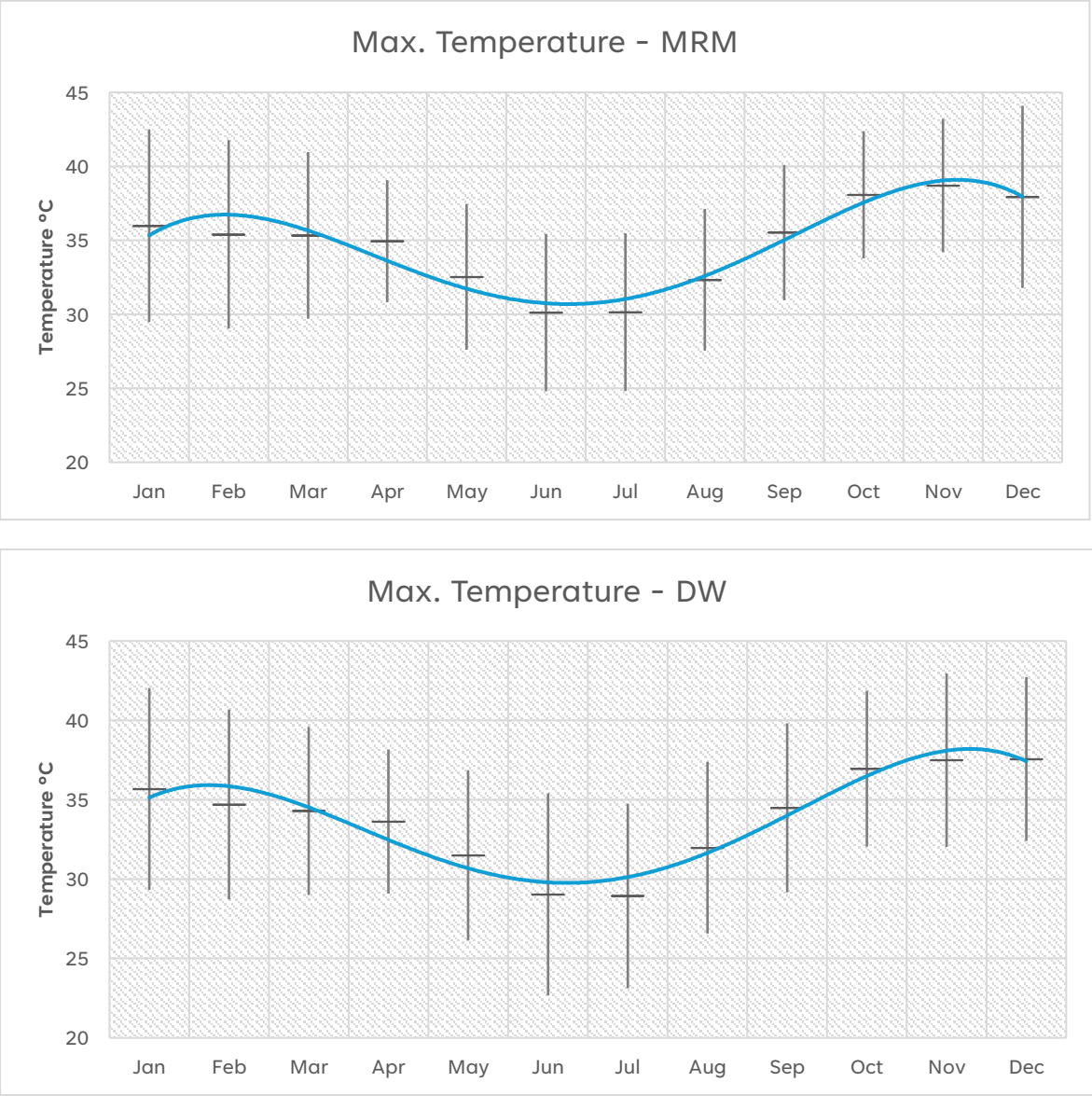


Figure 4.2—10 Average Monthly Minimum Temperature ± CI 95% at Daly Waters since 1940 MRM and DW

4.2.8 Wind Climate

Wind speeds can vary significantly within the Sturt Plateau bioregion (**Figure 4.2—11**). Seasonal variation and patterning in wind climate is also evident. During the Dry Season, wind direction

is predominantly from the east in the morning and from a southeasterly direction in the afternoon. However, the morning wind direction is generally from the northwest during the Wet Season.

As temperatures increase throughout the day, the wind direction reverses and comes from a southeasterly and easterly direction. Compared with wind speed during the Wet Season, the Dry Season wind speed in the CPP Area (i.e., between April and November) is significantly higher and diurnally more consistent. This period coincides with wind gust velocities that may exceed 60 kph and pose a significant risk in bushfire monitoring and management. Wind climate has several important implications for the Activity:

- Monitoring and predicting bushfire risk impacts in the region during the Dry Season.
- The erodibility of bare soils due to saltation (wind) effects and consequent dust emissions, particularly on roads and well pad areas with bare soil.
- The management and handling of significant quantities of sand at well pads and potential HSE risks due to silicosis.
- Tussock grass curing and haying-off as the Dry Season progresses with a consequent increase in bushfire risk.
- Increase in daily evaporation rates and consequent potential impacts on hardstand soil area compaction and structural stability due to soil moisture content falling below optimal levels.
- Geogenic dust accumulation on tank covers results in false positives for heavy metals such as nickel, manganese, and iron in stormwater run-off analysis.

It is also noted that episodic events may significantly impact on the region's broad-scale savannah ecosystems and landscapes more than the cumulative effect of 25–30 years of events within the average range [W. G. WHITFORD, & B. D. DUVAL, 2019].

Episodic events may be windstorms with wind velocities more than two standard deviations above the long-term mean wind velocities for a season and location. Physical infrastructure and vegetation damage can be significant in areas impacted by these intense but usually brief windstorm events in this savannah country [W. G. WHITFORD, & B. D. DUVAL, 2019].

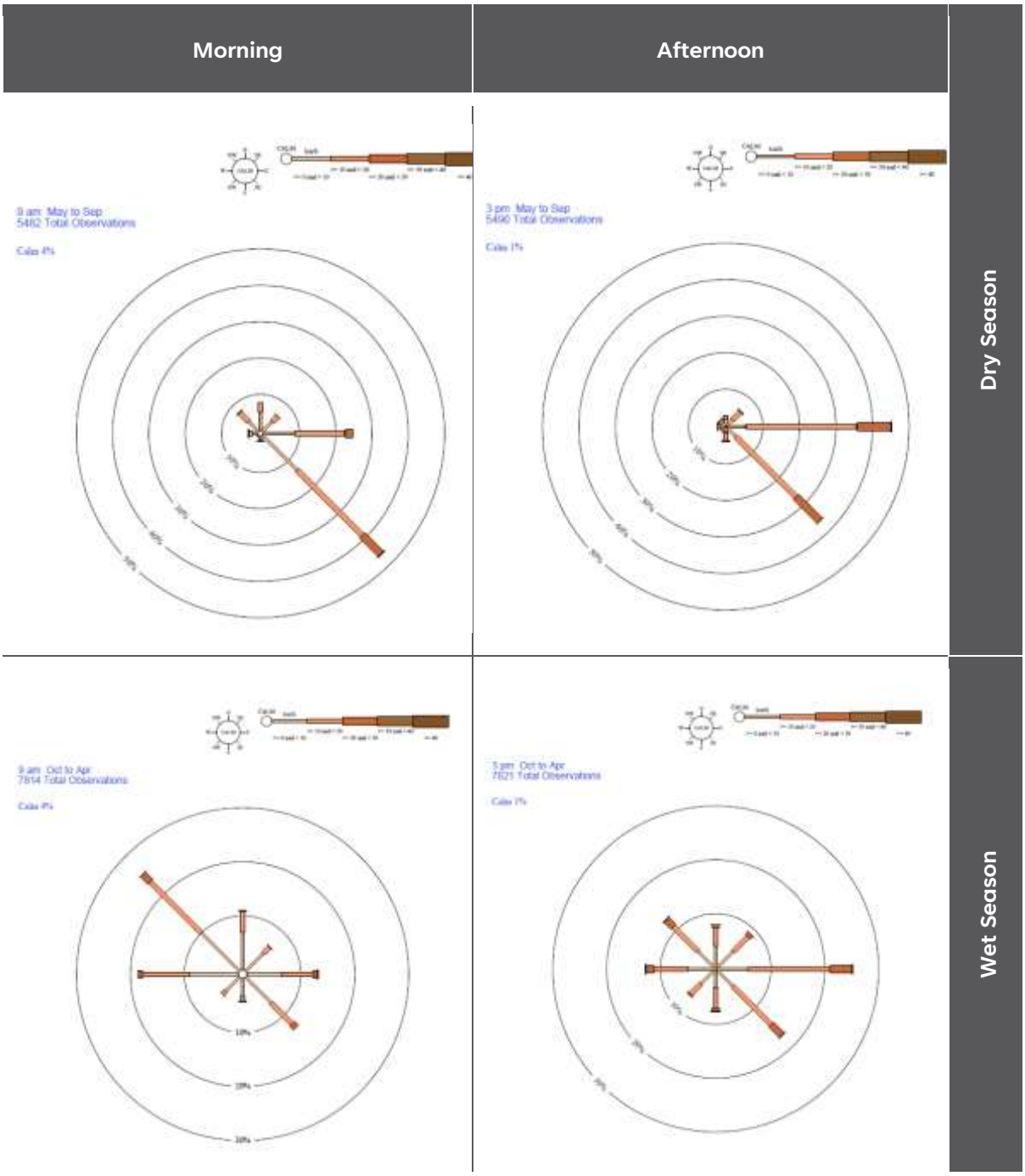


Figure 4.2—11 Seasonal Wind Direction and Speed (as Measured at Tindall Airbase)

4.2.9 Air Quality

Baseline air quality monitoring results for an array of SREBA air quality monitoring stations deployed in the Beetaloo region at the end of the Dry Season in October and November 2022 are reported in the SREBA [DEPWS, 2022].

Due to the location's remote nature, measuring particulate matter in accordance with the relevant Australian Standards was not practicable. The measurements were carried out using a light scattering, portable particle sensor with a low power demand that does not require samples to be taken and does not have excessive maintenance requirements.

To overcome the limitations of the remote location, instruments of the same type were co-located at the Daly Waters site alongside conforming instruments to allow correction factors to be developed. The limitations of remote PM monitoring are acknowledged.

The monitoring results at Bullwaddy for October – November 2022 are shown in **Table 4.2—2**, together with the NEPM standards. Bullwaddy is located approximately 90 km west of the CPP (refer to **Figure 4.1—1**). The measured average concentration for PM10 (Particulate Matter $\leq$ 10 µm) for October – November 2022 was 14 µg/m^3, well within the NEPM PM10 standard of 25 µg/m^3. The measured maximum 24-hour PM10 concentration was 31 µg/m^3, also well within the NEPM PM10 standard of 50 µg/m^3.

However, PM2.5 (Particulate Matter $\leq$ 2.5 µm), which is of more concern to human and animal health as this particle size can reach deep into the lungs, was 13 µg/m^3 for October – November 2022, compared with the NEPM annual average standard of 8 µg/m^3, and the measured maximum 24-hour PM10 concentration of 30 µg/m^3, corresponds with the current daily NEPM limit of 25 µg/m^3.

The report notes that the maximum 24-hour average PM10 and PM2.5 concentrations regularly exceed the NEPM standards across the NT due to seasonal conditions and bushfires. The PM2.5 to PM10 ratio is unusually high compared with international figures and most likely reflects the high smoke levels that arise during bushfires and burn-offs. Bushfire occurrence in the region is discussed further in **Section 4.11.4**.

Table 4.2—2 Bullwaddy PM10 and PM2.5 Concentrations and NEPM Limits

	Bullwaddy (Average October – November)	**Bullwaddy** (24-hour maximum)	**NEPM** (Annual Average)	**NEPM** (Daily Limit)
PM10	14 µg/m3	31 µg/m3	25 µg/m3	50 µg/m3
PM2.5	13 µg/m3	30 µg/m3	8 µg/m3*	25 µg/m3**

* Reducing to 7 µg/m^3 in 2025. **Reducing to 20 µg/m^3 in 2025.

Wind direction analysis during the SREBA air quality monitoring period indicated that the greatest percentage contribution of PM particles at the Bullwaddy monitoring station came from the north-northeast. This reflects the dominant Wet Season wind direction and likely reflects the major bushfires reported in the Gulf Falls and Uplands bioregion during this period in 2022, as discussed in **Section 4.11.4**.

Ongoing air quality monitoring at the Bullwaddy site will provide a focused regional level of surveillance and air quality in the environs of the CPP Area and neighbouring Beetaloo petroleum operators [R BROWELL, & J POTGIERTER, 2022].

The primary sources of air pollutants arising from the Activity are:

- Management of sand for HF at well pads.
- Dust from construction activities and bare earth CPP Areas.
- Activity road traffic.
- Gaseous emissions from onsite equipment and machinery.
- Gas flaring.

4.3 Sub-surface Geology

The Beetaloo Sub-basin is a structural component of the Proterozoic greater McArthur Basin. It consists of two discrete subsurface volumes of sedimentary rock, typically bounded by faults, containing the thickest preserved formations that host significant hydrocarbon resources. It includes the historical OT Downs Sub-basin to the north of the CPP Area, which now relates to petroleum depocentres within the Beetaloo Sub-basin, including the CPP Area [C. R. HUDDLESTONE-HOLMES et al., 2020].

The most prospective source rocks for hydrocarbon resources in the Beetaloo are the organic-rich shales of the Velkerri formation (Roper Group). The Velkerri Formation is the primary source of facies[1] in the region, and it has been the subject of considerable hydrocarbon resource assessments in the basin, including the CPP Area. The age at which the thermal maxima were reached in the Velkerri Formation was estimated to be 980 ± 23 million years ago at the nearby Tanumbirini-1 well [C. R. HUDDLESTONE-HOLMES et al., 2020]. It is a dominantly fine-grained unit of interbedded claystone and siltstone with minor fine-grained sandstone.

The modelled economic basement of the basin on which the CPP Area is located and the synclinal boundary of prospective resources to the west of the Batten Fault zone are shown in **Figure 4.6—1**. The Activity's target shale in the Velkerri formation is approximately 1,600 m-

[1] Facies: the characteristics of a rock unit that reflect the conditions of its depositional environment.

1,700 m below ground level (BGL) across the CPP Area. A sub-surface aquifer protection zone sits below the aquifer basement at the CPP Area (see **Section 4.10.2** - Hydrostratigraphy) and the target Velkerri formation.

This aquifer protection zone is approximately 900 m thick rock, which is 150% of *the Code* requirement of 600 m [clause B.4.13.2 (l)]. This protection zone ensures there is no potential for a connection between the much deeper shale hydraulic fracture operation and the base of the overlying CLA aquifer.

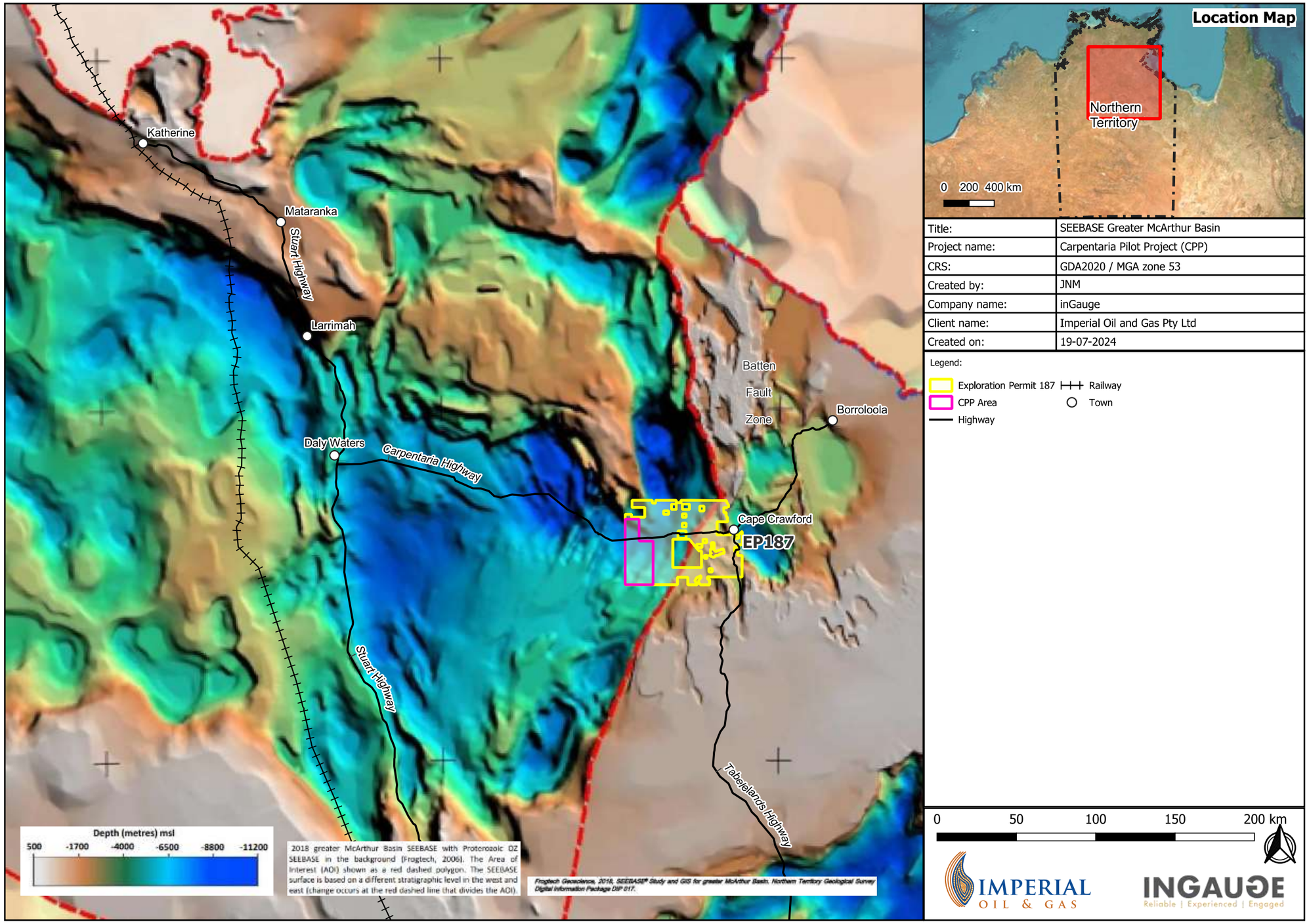


Figure 4.3—1 Model of Economic Basement of the Beetaloo Sub-basin and CPP at the East

4.4 Topography

The Sturt Plateau Bioregion is mostly comprised of deeply weathered, gently undulating plains on laterised Cretaceous sandstones, including at the CPP Area. Within the CPP Area, elevations are in a bandwidth from approximately 220m m to 265 m AHD (**Figure 4.4—2**). The Carpentaria Highway bisects the CPP Area from east to west and is aligned generally following topographic high points in the landscape at approximately 250 m AHD (**Figure 4.4—1**).

The elevation and slope for key CPP infrastructure sites are shown in **Table 4.4—1**. The Carpentaria Highway elevation traversing the CPP area is shown in **Figure 4.4—1**. The elevation range DEM, and slope of the CPP Area is shown in **Figure 4.4—2** and **Figure 4.4—3**, respectively. The topographical data has been interpolated as 2 m contours from the Shuttle Radar Topography Mission (SRTM) ~ 1s (30 m). Validation of the derived elevations using differential GPS (DGPS) for critical surface infrastructure (see Section **4.11.2**) shows close agreement with the slope estimates; and also measured elevations reported for Carpentaria 1, Carpentaria 2/3 and Carpentaria 4 as shown in **Table 4.4—1**. The lowest elevation is at the proposed BD well pad location. However, georeferenced DGPS site photos at this location show the presence of numerous termite mounds, confirming the proposed site is not at risk of flood inundation/submergence (see **Figure 4.11—1**). The proposed new gravel pits are situated on an ascending ridge line as shown in **Figure 4.4—2** and **Figure 4.4—3** where suitable lateritic gravel deposits are most likely to occur.

Table 4.4—1 CPP Surface Infrastructure Elevations

Infrastructure	SRTM AHD (m)	Measured AHD (m)	Slope (%)
BA - well pad	245	255	0.5
BB – well pad	265	245	0 - 2.5
BC – well pad	255	268	0 - 3
BD – well pad	216	228	0.5 – 1.6
BD Central - well pad	237	255	0 - 2
Carp 1 - well pad	230	**231**	
Carp 2/3 – well pad	229	**229**	0.4 -4
Carp 4 - well pad	227	**227**	0 -2
Satellite Dish	244		2.5
Campsite	243		1.5

Infrastructure	SRTM AHD (m)	Measured AHD (m)	Slope (%)
Irrigation Area - 1	240		0.5 – 1.8
Irrigation Area - 2	239.5		1.3 – 2.5
Gas Plant	242	245	0 - 4
Water Handling Station	247	251	0 – 1.5

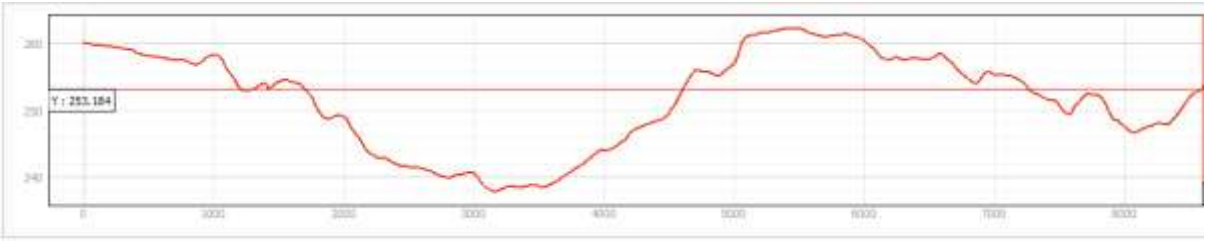


Figure 4.4—1 Carpentaria Highway Elevation Traversing CPP Area

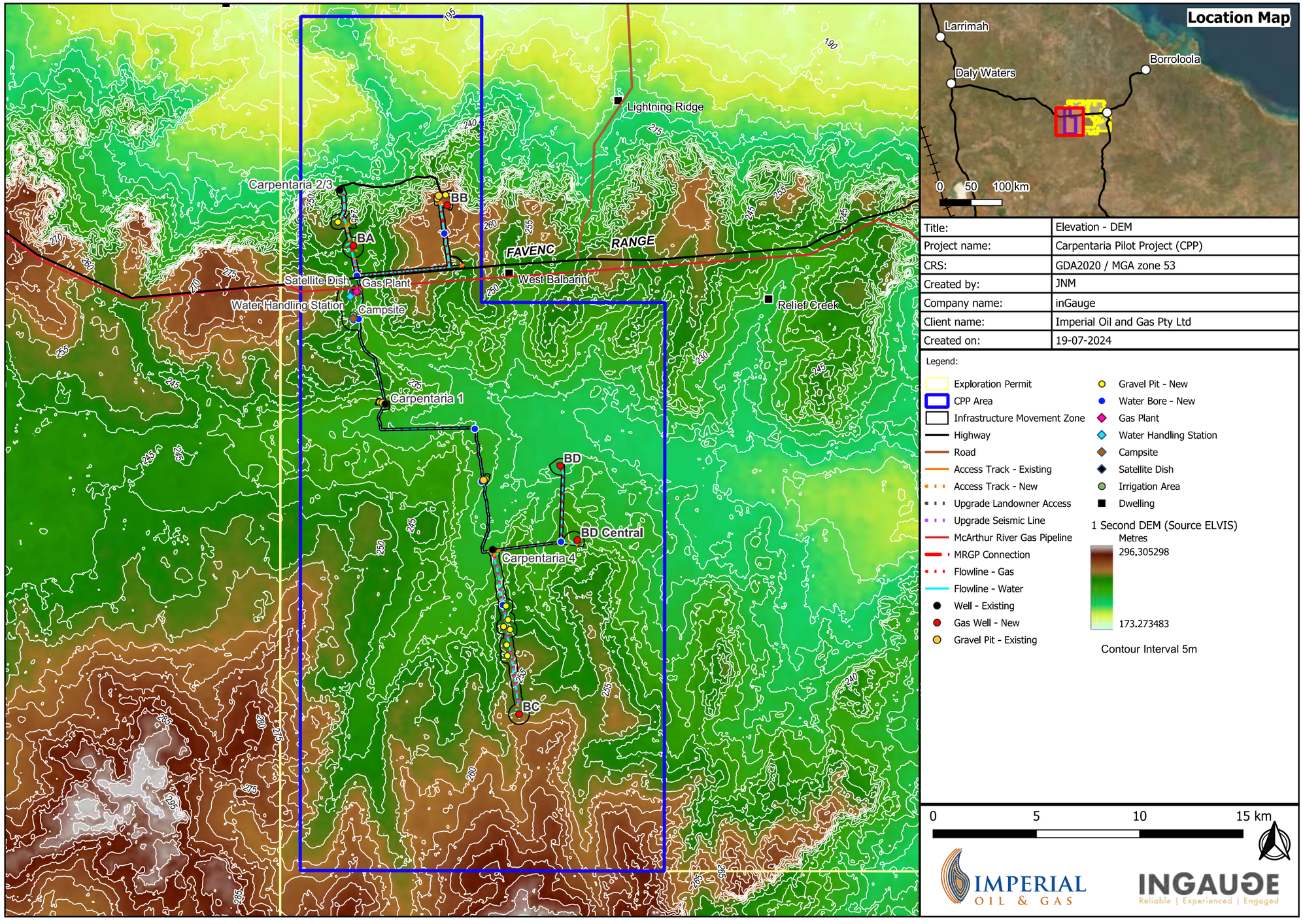


Figure 4.4—2 Elevation Range in the CPP Area

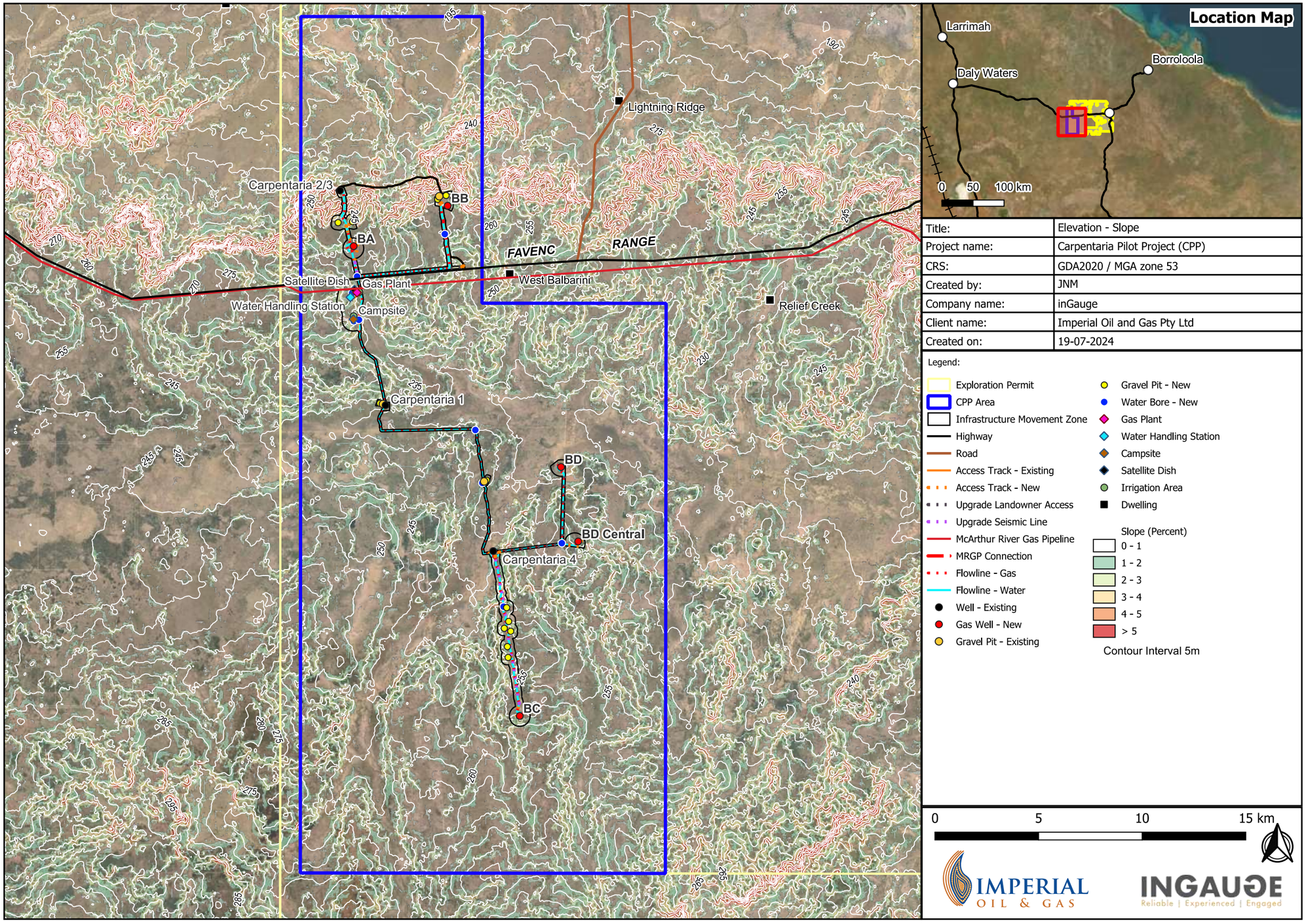


Figure 4.4—3 Slope Within the CPP Environs and the Crest of the Favenc Range Visible to North of Carpentaria Highway

This topographic crest feature, known locally as the Favenc Range, can be seen above in **Figure 4.4—3** on the northern side of the Carpentaria Highway. In this portion of the CPP Area, the land is mapped as fine-grained sedimentary plains and rises. In contrast, the south of the Highway is mapped as coarse-grained sedimentary hills and ranges [C. R. Huddlestone-Holmes et al., 2020]. The geologist Ernest Favenc mapped the Favenc Range in 1883 accompanied by the local Aboriginal people who guided him east towards the coast along this hilly country (refer to **Section 4.16** – Cultural Environment) and is displayed on local topographic map in **Figure 4.5—2**.

East of CPP, a broad anticlinal structure referred to as the Batten Fault Zone (refer to **Section 4.5**) has resulted in erosion that locally removed much of the Upper Roper group package, as evident in surface geology in the Gulf Falls and Uplands bioregion, and the termination of the Cambrian Limestone Aquifer (CLA) unit to the east of the CPP Area.

Owing to the scale of the low-relief terrain of the Sturt Plateau, localised topographic depressions may occur at varying scales, including above the local catchment flood-line elevation (see below). These depressions may become ephemeral soaks where standing water pools from the surrounding area and resides for extended periods until lost to evaporation and infiltration. The canopy in these depressions is low and open and often consists of coolabah (*Eucalyptus microtheca*), with fringing river red gum (*E. camaldulensis*) (**Appendix 01** Environmental Assessment). However, such habitat won't be impacted by the proposed Activity.

From an operational perspective, the ephemeral waterways, streams, and associated low-lying areas that are subject to seasonal inundation and submergence have been assessed (**Appendix 01** Environmental Assessment). These areas will be avoided in proposed exploration and production facility areas, and any disturbance buffers will be measured from the outer edge of the riparian vegetation and aligned with recommendations from the *Land Clearing Guidelines* [DEPWS, 2021b].

4.5 Bioregions

Bioregions are defined through physical and environmental features, including watershed boundaries and soil and terrain characteristics. *The Interim Biogeographic Regionalisation of Australia* (v 5.1) (IBRA) [DCCEEW, 2000] classifies Australia's landscapes into 89 large geographically distinct bioregions based on common climate, geology, landform, native vegetation, and species information [N McKenzie et al., 2004].

The CPP Area is located on the north-eastern boundary of the Sturt Plateau bioregion (**Figure 4.5—1**). The bioregion covers an area of approximately 98,500 km^2. To the north and east in the CPP Area, the Gulf Fall & Uplands bioregion is present, covering an area of 112,500 km^2. The Sturt Plateau bioregion mostly comprises deeply weathered, gently undulating plains on laterised Cretaceous sandstones [DEPWS, 2022], which includes the CPP Area.

The CPP Area is at the top of both the Limmen Bight River and the McArthur River upper sub-catchment creek lines. The east-west Carpentaria Highway is aligned generally following a regional topographic high point, known locally as the Favenc Range, that dissects the CPP Area (**Figure 4.5—2**).

The Beetaloo Sub-basin has uplifted erosional margins with bounding faults to the east of the CPP Area in the OT Downs region, as shown in the SEEBASE[2] basin architecture (refer to **Figure 4.6—1**). A broad anticlinal structure, east and north of the CPP Area at the Batten Fault Zone, has resulted in erosion that locally removed much of the Upper Roper formation group[3].

This is evident in surface geology in the Gulf Fall and Uplands bioregion, the eastern termination of the Sturt Plateau bioregion, and the southern terminus of the Anthony Lagoon aquifer system (refer to **Figure 4.10—2**), which was intercepted at the Carpentaria 2 well pad.

The abrupt change in observed geomorphology at this bioregion boundary is consistent with the recording of significant groundwater-dependent ecosystems (riparian woodland and *Melaleuca Forest*) at elevations below 200 m AHD in this bioregion. These ecosystems are associated with dissected sandstone ranges and plateau escarpments such as the Limmen Sandstone outcrops shown in **Figure 4.13—5** beyond the eastern margin of the SREBA study area, where the Sturt Plateau and Gulf Fall and Uplands bioregions converge [DEPWS, 2022].

[2] Structurally enhanced depth-to-basement model that defines the 3D geometry of sub-surface basin systems

[3] The Roper group is the sedimentary package that is host to primary unconventional hydrocarbon plays of the Velkerri and Kyalla formations in the Beetaloo

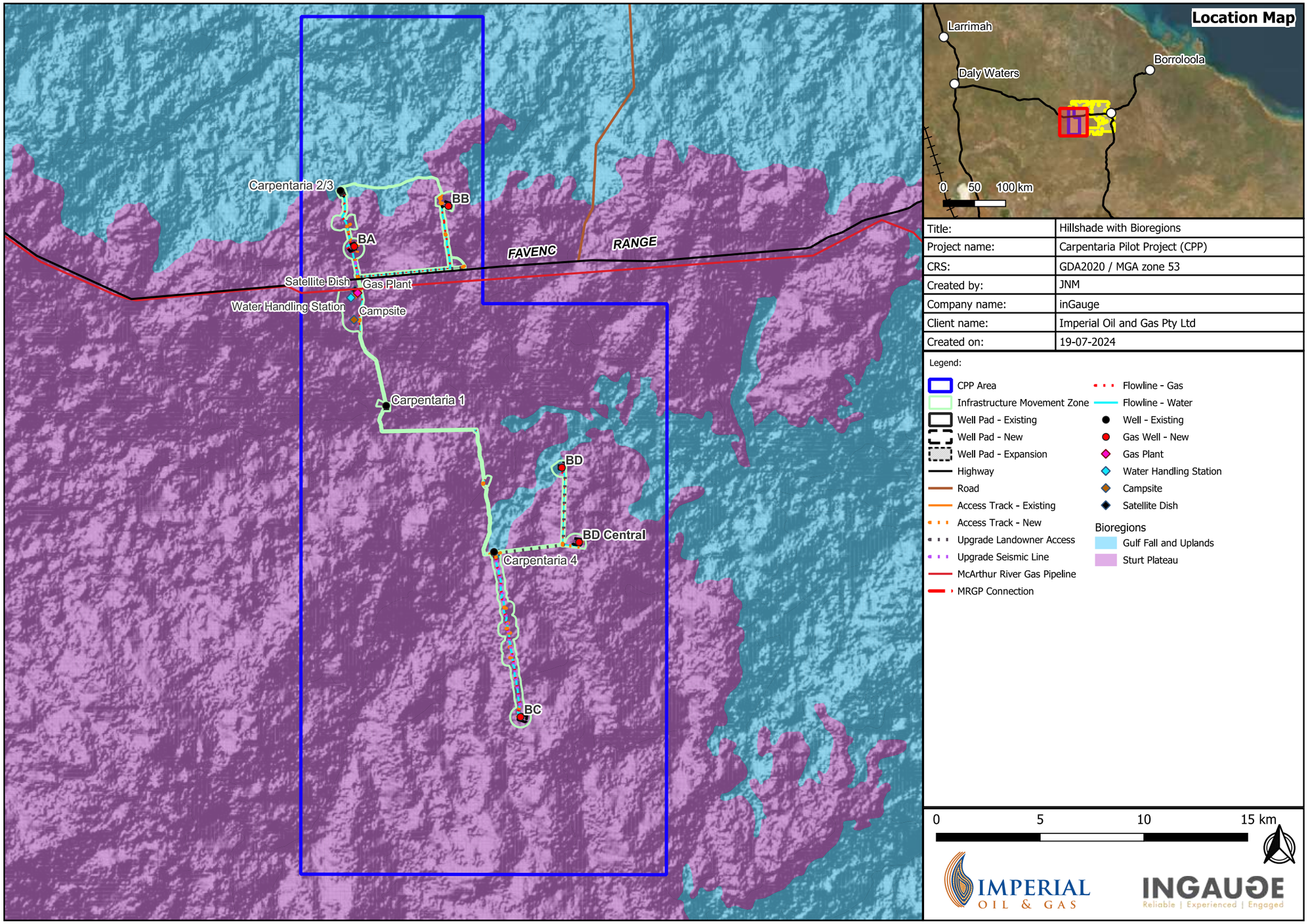


Figure 4.5—1 Sturt Plateau Bioregion and the Gulf Falls and Upland Bioregion Convergence

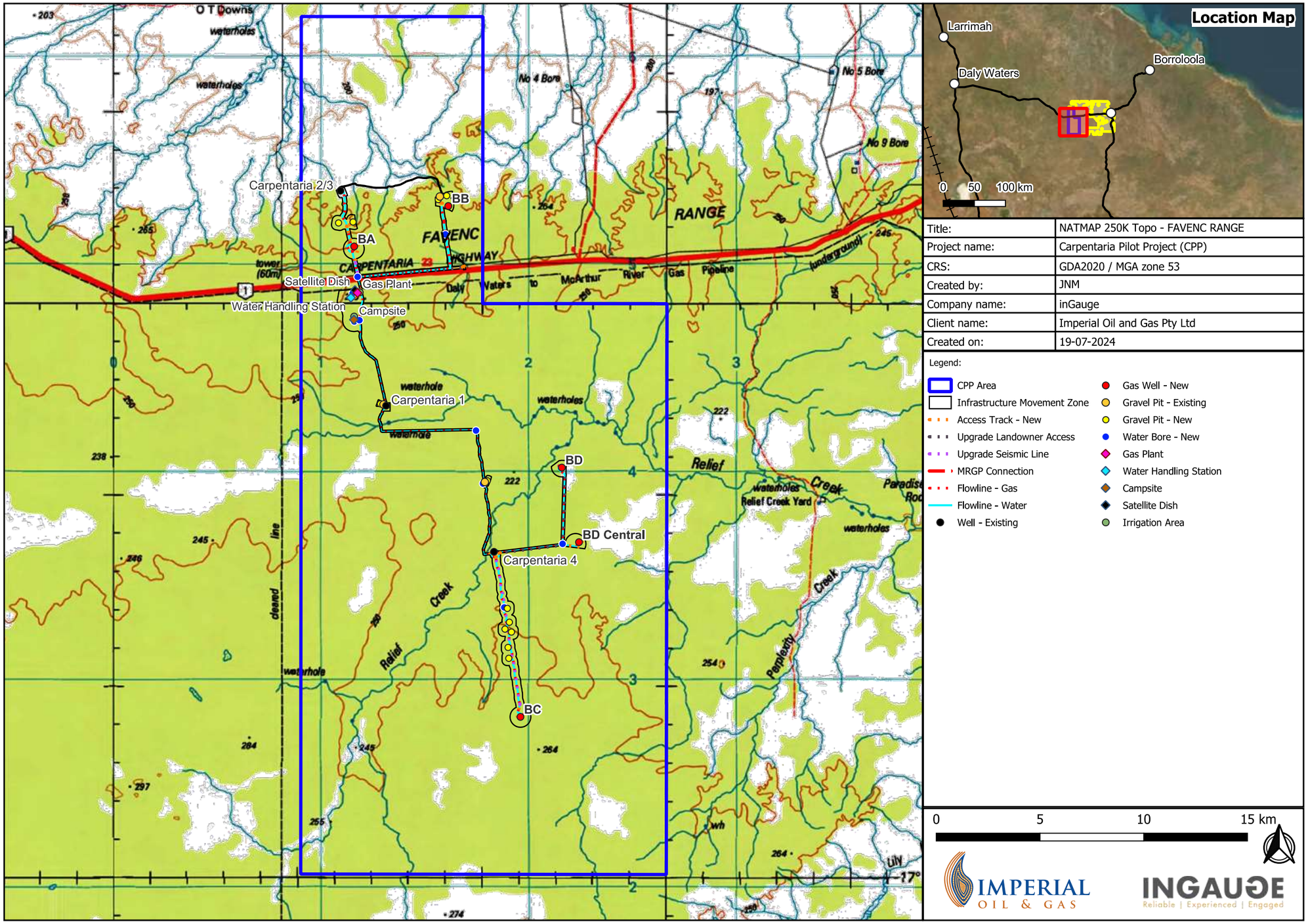


Figure 4.5—2 Favenc Range Topographic Map at the CPP Area

4.6 Land Systems

The environmental baseline assessment for the CPP Area also uses the CSIRO Land Systems (LS) mapping repository, which provides detailed descriptions for a range of environmental attributes in each discrete LS area or group of areas with a recurring pattern of topography, soils and vegetation based on geomorphology. The framework for the principles and practice of Land System mapping was first described by CSIRO soil scientists [C.S CHRISTIAN, & STEWART, 1953] involving the then revolutionary concept of using air photographs as an analogue model of the land resource to identify broad-scale recurring patterns of land units, and then determining their characteristics by stereoscopic examination and field traverse sampling across the Barkly region including the CPP Area. It was further developed by the Division of Land Research and Regional Survey that merged into Rangeland Research in arid zones of northern Australia, at Katherine and Alice Springs, in the subsequent decades. CSIRO Land Research Surveys Land System mapping [M. A RANDAL, 1966] integrates environmental features resulting from the interactions of geology, landform, and hydrology, which influence the distribution of markedly different soil types and, hence, vegetation species across the landscape, as shown in **Table 4.6—1**.

Land Systems (LS) are distinct areas or groups of areas with a recurring pattern of topography, soils, and vegetation based on geomorphology. LS mapping integrates environmental features resulting from geology, landform, and hydrology interactions, which influence the distribution of markedly different soil types and, hence, vegetation species across the landscape. The framework broadly recognises that geomorphic factors in a landscape result in distinct stable tertiary land surface, erosional land surface, and depositional land surface, within a landscape based on proximal elevation and hydrology. These geomorphic factors control the soil pedology and consequent soil types in each distinct LS area and related environmental covariates.

The Land Systems in the Project Area provide a useful and important ‘first-pass’ in selecting sites for well pads, the WHS, Gas Plant and other surface infrastructure because of the civil engineering requirements for soil stability and hydrology, and LS areas with unsuitable soil types and hydrology are excluded.

Six land systems are mapped using the LS framework, in the CPP Footprint (disturbance area), including flowlines and access tracks (**Figure 4.6—1**), and described in detail in **Table 4.6—1**. The proposed new well pads, WHS and Gas Plant are located in the land system of lateritic plains and rises referred to in the land system key as Creswell LS, Creswell K-2 LS, and TP LS. These land system classes are characterised by erosionally stable areas on gently undulating plains, comprising Leptic Rudosols, Leptic Tenosols, and Red and Yellow Kandosols.

Table 4.6—1 Land System Descriptions in the CPP Disturbance Area

Land System	Landscape Class	Land system Description	Landform	Soil Origin	Soil Class	Vegetation
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.	Leptic Rudosols, Leptic Tenosols, Red and Yellow Kandosols	Mid-high open woodland of *Corymbia dichromophloia, Corymbia bleeseri*, *Eucalyptus tetrodonta*, *Erythrophleum chlorostachys* with isolated stands of *A.cacia shirleyi* on crests over *Chrysopogon fallax*, *Plectrachne pungens*, *Sorghum plumosum.*
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.	Leptic Rudosols and Leptic Tenosols	Open forest of *A. shirleyi* and woodland of *C. dichromophloia*, *Eucalyptus luecophloia* over *C. fallax*, *P. pungens.*
Lancewood 2	Lateritic plateaux	Plateaux, scarps and some rises on deeply weathered sediments; shallow soils with rock outcrop.	Plateau margins, escarpments and rugged low hills and plateaux.	Lateritic lithosols	Leptic Rudosols	Mid-high open forest of *A. shirleyi* over *Schizachyrium fragile*, *C. fallax*, *Triodia bitextura.*
Lancewood 3	Sandstone plains and rises	Plains, rises and plateaux on mostly on sandstone, siltstone, claystone, shale and some limestone; commonly shallow soils with surface stone and rock outcrop.	Gently undulating plains and drainage floors on claystone.	Grey and brown clays	Grey and Brown Vertosols	Tall open grassland of *C. fallax*, *Eulalia aurea*, *Iseilema vaginiflorum.*
Miller	Clay plains	Level to gently undulating clay plains (black soil plains); cracking clay soils.	Almost level, more distal portions of pediplains below but isolated from lateritic escarpments.	Brown clays, some yellow earths.	Brown Vertosols, some Yellow Kandosols	Mid-high open woodland of *Eucalyptus pruinosa* over *Eulalia fulva*, *C. fallax*, *Aristida inaequiglumis.*
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.	Shallow to moderately deep Ferric Yellow Kandosols.	Woodland of *Eucalyptus tectifica* over *C. fallax* and *Dicanthium fecundum* and low open woodland of *E. pruinosa* over *D. fecundum* and *Sehima nervosa.*

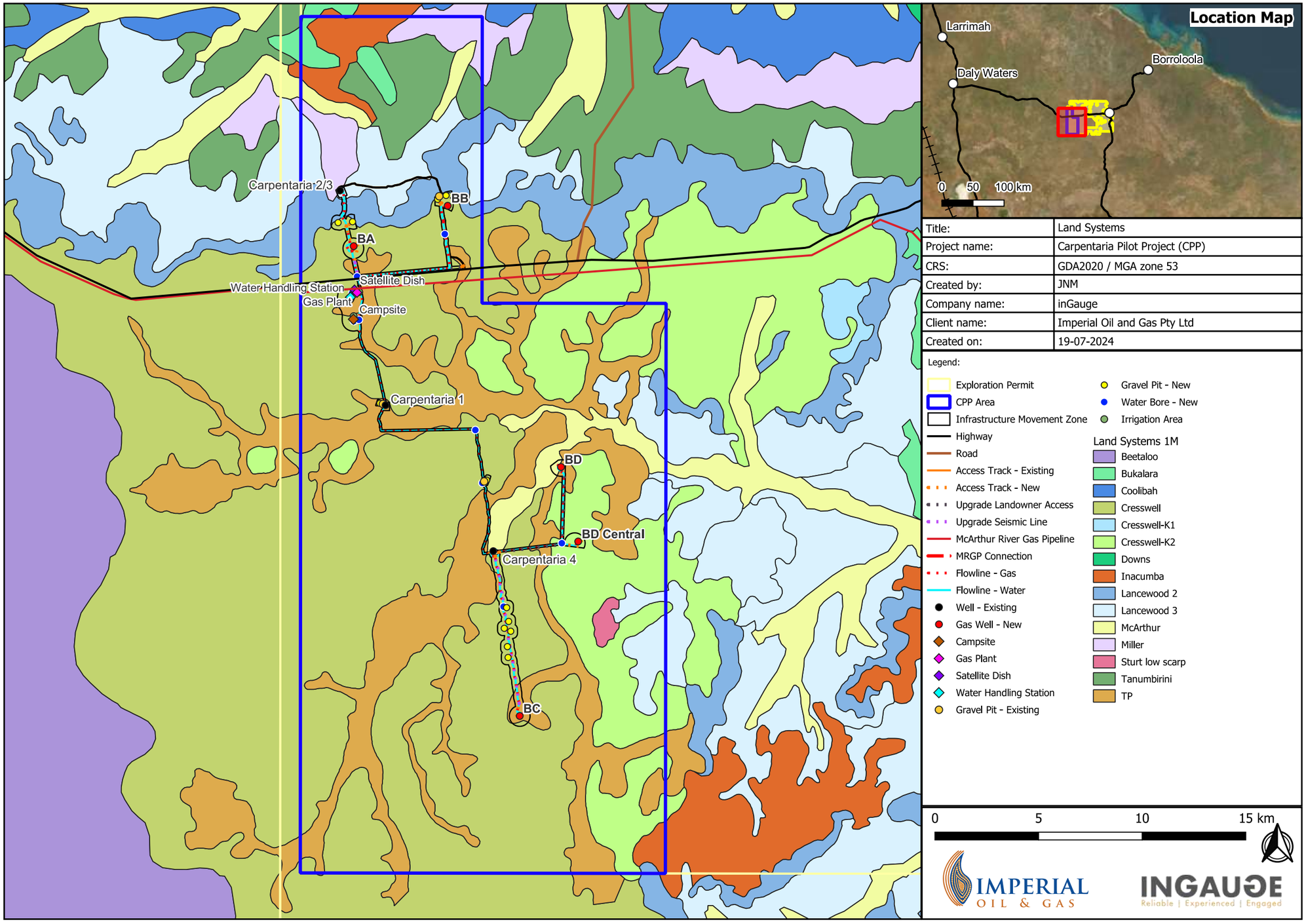


Figure 4.6—1 Land Systems in CPP Environs

4.7 Soils

Soil mapping in the environs of the CPP Area broadly reflects topographic and ground elevation features, as evident in **Figure 4.7—1**. The CPP Area disturbance area has soils that are predominantly neutral sandy clay and red and yellow earths dominated by deep Red Kandosols. This iconic soil type in the Northern Territory supports the vast savannah grassland of much of the Sturt Plateau.

The soils result from prolonged, intense, deep weathering of parent rock material, high in iron and/or aluminium oxides and kaolin clays, which gives them their characteristic profile and Red Kandosol colour. This soil profile has primarily occurred as substrate weathering of laterites and sedimentation caused by overland flow and deposition of coarse bedload and finer colloids.

Laterites are the surficial accumulations of the products of vigorous chemical selection, developing where conditions favour greater mobility of alkali earths and silicon than iron and aluminium [K. S RICHARDS et al., 1985].

Leptic Rudosols appear to occur at the crest of the Favenc Range at elevations greater than 250 m AHD, north of the CPP Area. These are mostly shallow sandy profiles overlying hard or weathered sandstone. They are soils in which the profile is not, or only slightly, gravelly (<10% >2 mm), either loose or only weakly coherent, both moist and dry, the texture is dominantly sandy, and there is no layer with a clay content of >15%.

In terms of well pad selection, the more problematic vertosol soil groups are characterised by deep cracking clays, commonly referred to locally as black soil country. These appear to be confined to the north of the CPP Area, at the hinterland of the Favenc Range, and in the Macarthur LS, at ground elevations below 200 m AHD. These areas have been avoided in the Activity site selection process (see **Section 3.2**).

The upper drainage line extent of the Relief Creek sub-catchment on the eastern side of the CPP Area is evident in the soil mapping as ferric yellow kandosols. These form surface erosional features from channel incision in the formation of first and second-order stream networks present in the CPP Area (**Figure 4.1—1**).

The key qualities of these two soil types are presented in **Table 4.7—1**. Notably, both soil types have low salinisation potential, and both are likely to be highly erodible in slope conditions, underscoring the need for appropriate site-specific erosion and sediment controls. These are outlined in **Appendix 05** (Erosion and Sediment Control Plan).

Within the soil profile present in EP 187, a gravelly horizon that contains common to abundant ironstone gravel seams occurs in confined areas. Rounded ironstone pea gravel may be observed at the soil surface where these localised accumulations appear, associated with outcrops of ironstone and/or ferruginous sandstone. The sites typically consist of elevated local features, crescent-shaped lateritic ridgelines, and spurs that support sparse spinifex or shrub heath.

The lateritic gravel material occurs as seams approximately 1 m thick. These areas can be surrounded by belts of thicket or dense, low shrubland that take advantage of water that is shed from the steeper slopes. Slopes within these areas generally range between 1 - 6%. The proposed gravel pit sites are in these soil profiles. The proposed new gravel pits are located on a ridge line which is evident in **Figure 4.4—2**.

Table 4.7—1 Qualities of Red and Yellow Kandosols at the CPP Area

Soil Quality	Red Kandosol	Yellow Kandosol
Coverage	Widespread at the CPP Area	Confined to paleochannels
Infiltration	Well drained	• Poorly drained • Saturated short periods in wet years
Available Water Store	Moderate	Small
Permeability	High	Moderate
Physical Root Limitations	Favourable	Unfavourable due to gravel content
Erosion Hazard	Slopes likely to be highly erodible.	Slopes likely to be highly erodible
Nutrient Availability	Moderate	Low throughout profile
Salinisation Potential	Low	Low

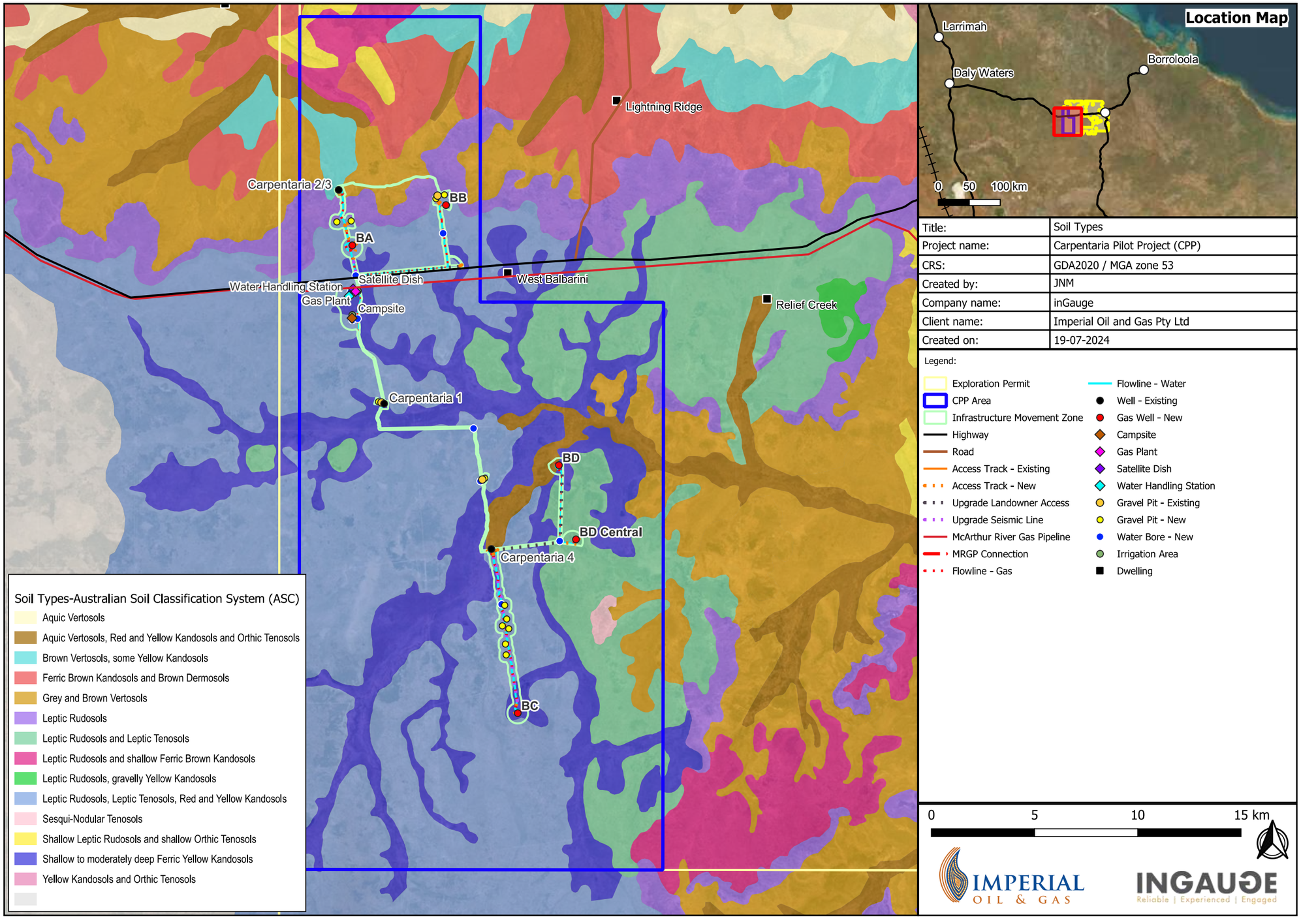


Figure 4.7—1 Soil Types in the CPP Area

4.7.1 Soil Moisture

Soil horizon profiles can be described as follows:

- The surface layer - includes overland flows and surface water channels, and bodies.
- The vadose layer - includes soil moisture stored in soil voids or in transit toward groundwater, plant roots, or back to the surface.
    - Vadose water is characterised by capillary tension (soil water potential).
    - Vadose water supports plant growth and provides the hydraulic head for maintaining stream base flow.
- The phreatic layer - includes water in any subsurface saturated zone either being stored or in transit toward deeper indurated soil horizons.

A simplified water balance for a landscape can be expressed by the following formula:

$$\boldsymbol{Precipitation} = \boldsymbol{Evapotranspiration} + (\boldsymbol{Runoff}) + \boldsymbol{Storage}$$

Plant-available water in a soil can vary greatly; a sandy clay loam, predominant in the CPP Area, has more than three times the comparable water storage of coarse sands [N McKenzie et al., 2004]. Soil water storage is also an important consideration in the rehabilitation of the CPP Area, as it is necessary for the maintenance of tussock grassland pasture, throughout the Dry Season.

Soil water storage capacity is also important in maintaining optimal moisture conditions (OMC) for structural integrity for heavy load-bearing pavement surfaces and hardstand areas and, more generally, for managing dust emissions. The relative proportions of sand, silt, and clay determine how tightly the soil holds water.

Water potential is expressed in megapascals (MPa). Soil at field capacity (pore space saturated) has a soil water potential of approximately – 0.03 MPa. The wilting point for agronomic species is generally considered to be – 0.15 MPa. Arid soils may dry to water potentials of – 0.6 MPa (no gravimetric water present) [W. G. Whitford, & B. D. Duval, 2019].

4.7.2 Soil Suitability for Surface Infrastructure

As noted, the Land Systems in the Project Area provide a useful and an important 'first-pass' in selecting sites for well pads and access tracks because of the civil engineering requirements for soil stability and hydrology; and excluding LS areas with unsuitable soil types and hydrology. The framework broadly recognises that geomorphic factors in a landscape result in distinct Stable Tertiary Land Surface, Erosional Land Surface, and Depositional Land Surface, within a landscape based on proximal elevation and hydrology. The proposed new well pads, WHS and Gas Plant are in the land system of lateritic plains and rises referred to in the land system key

as Creswell LS, Creswell K-2 LS, and TP LS. These land system classes are characterised by erosionally stable areas on gently undulating plains, comprising Leptic Rudosols, Leptic Tenosols, Red and Yellow Kandosols.

Kandosols are also susceptible to severe erosion on high-gradient slopes. The erosion risk is low in sandier soils as infiltration is rapid. The site-specific mitigation measures for erosion and sediment control at the CPP Area are provided in **Appendix 05** (Erosion and Sediment Control Plan).

Subsoil horizons are generally weak to non-structured reddish clay loams and medium clays. Kandosols characteristically have rapid liquid infiltration due to the surface soil having a relatively high sand content and, therefore, larger pore spaces than cracking clays. [C RICHARDS et al., 2023].

The well pad soils (Carp 1, 2/3 and 4) are weakly acidic with an average pH = 6.5 ± 0.2 at 30 cm depth and pH = 6.7 ± 0.4 at 90 cm depth. The well pad soil is classified as sand-clay (SC) with a relatively high clay content, > 30%. Proposed new surface infrastructure including new ell pads, gas plant and water handling station on located on red Kandasol soils as evidenced by georeferenced imagery provided in **Figure 4.11—1**.

Reduction in vegetation cover, coupled with the disruption of the soil surface (e.g., by clearing or by intense cattle presence), especially during extended arid periods that occur frequently in the region, can create small erosion cells in this sandy clay soil type. Continued movement (saltation) of soil particles across an erosion cell will bury or abrade vegetation on the downwind side of the barren patch.

Compact grass tussocks provide more wind resistance than large, multi-stemmed shrubs with open canopies. Removing vegetation by burning reduces the aerodynamic roughness by two orders of magnitude and reduces the average shear velocity by about 60%, exacerbating saltation effects [W. G. WHITFORD, & B. D. DUVAL, 2019].

Barren patches in these arid landscapes are also subject to water erosion, exacerbating the cell's increase in size. Eventually, erosion cells will coalesce into a large barren area unless colonised by vegetation. Erosion and sediment control is critical to management (refer to **Appendix 05** - Erosion Sediment Control Plan). Grasses have a more sheltering effect than shrubs.

Tussock grasses, dominant in the CPP Area, are structurally capable of breaking up the large, high-energy drops of intense, short-duration rainstorms, characteristic of summer convectional storm events in the Sturt Plateau Bioregion. The density of foliage and/or fine branches of such plants close to the soil surface ensures that fragments of leaves and vegetative debris will be trapped under the canopy.

Rainfall intercepted by such canopies will enter the soil because of either leaf drip or stemflow, with little or no transmission loss. These are all important landscape factors to consider in the

ongoing erosion control of disturbed areas and in land rehabilitation management required for the proposed Activity.

4.7.2.1 Badlands

Some areas that are degraded by livestock overgrazing or poor engineering design of disturbed areas may be subject to rapid gulley formation during rain events and the resultant development of Badlands. Badlands form where sediments are loosely consolidated and develop in semiarid zones. They are characterised by erosion features, slope failures, deeply incised dry stream beds, and highly dissected slopes [W. G. WHITFORD, & B. D. DUVAL, 2019]. Previous landscape surveys have observed these impacts in the vicinity of the CPP Area (see **Figure 4.7—2**).

Figure 4.7—2 Badland Areas in the Vicinity of the CPP Area

4.7.3 Soil Quality

The soils in the CPP Area result from prolonged, intense, deep weathering of parent rock material high in iron and/or aluminium oxides and kaolin clays. Clay mineralogy at the CPP Area is the

iron-kaolinite (Fe-kaolinite) type, red in colour, that is a layered silicate mineral with a tetrahedral silica layer (SiO_4) bonded to an octahedral layer of alumina [H SMOLINSKI et al., 2019], evidenced by the relatively high Aluminium (Al) levels in soil cores of approximately 10 g/kg.

Kaolinite is the clay present in the sandy clay loam, Red Kandosol soil, and is dominant within the CPP Area. Kaolinite is a non-expanding clay, and this characteristic is important in assessing the suitability of this material for road base for operational purposes, both at the well pads and on the well pad access tracks, which are required to carry repeated heavy loads, and the mitigation of infiltration in the event of a spill.

The soils present at key surface infrastructure including proposed well pads, water handling station and gas plant are red Kandasol soil type and this is evident in the georeferenced imagery for these sites in **Figure 4.11—1**.

Sand-clay Kandosol soils have evident self-cementation properties after dryback during gravel road construction, with a substantial strength gain in dry moisture conditions. This strength is lost upon re-wetting, and it is not re-gained if compacted significantly dry of optimal moisture content (OMC). However, if the material is wetted, then compacted and dried back, self-cementation can re-occur [S EMERY et al., 2007].

Agricultural, industrial, and domestic operations may add a lot of material to soils. Some of the compounds are hazardous to humans and animals, as they may leach into the percolating waters and pollute the groundwater. However, the presence of clays with their cation exchange capacity (CEC) provides a buffering effect.

Because of the electrical charges and high surface areas, clays adsorb various chemical compounds entering the soils. Many toxic metals are immobilised or precipitated by adsorption to clay surfaces into less harmful solid compounds. The clay will intercept various pollutants trickling down the soil with the percolating water [N MCKENZIE et al., 2004].

Soils dominated by variable charge surfaces are typically strongly weathered and contain clay minerals such as kaolinite (e.g., Kandosols). Soils with variable charge effectively exhibit a decrease in fertility when pH is reduced. Such acidification can be induced by clearing and agricultural practices and, unfortunately, can be challenging to ameliorate [N MCKENZIE et al., 2004].

4.7.3.1 CPP Area Soil Profiles

The results of a range of key analytes of interest in soil profile cores and drill cuttings taken at the well pads have been analysed and averaged (**Figure 4.7—3**). There was limited variation in soil physical profiles through depth in any of the 60 cm deep cores, except that cnlay content was significantly higher in the phreatic horizon, which would limit infiltration to the deeper vadose horizon.

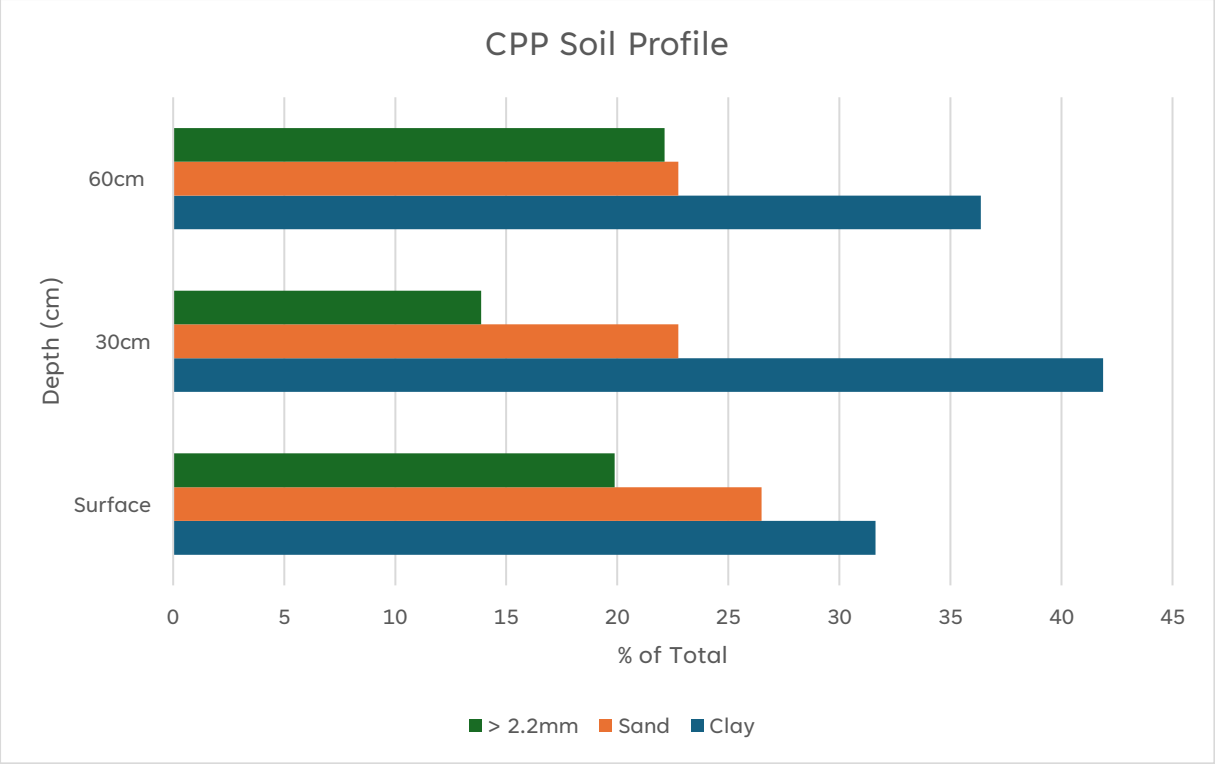


Figure 4.7—3 Soil Profile Analysis of Well Pads in the CPP Area

The average analysis of key soil nutrients with soil profile depth and in drill cuttings at CPP is shown in **Table 4.7—2**. The Cation Exchange Capacity (CEC) is the capacity of clay to adsorb and exchange cations. CEC is a crucial soil property that plays a significant role in soil health and nutrient availability in rehabilitation works. It is an inherent soil characteristic and is difficult to alter significantly. A CEC less than 5 cmol(+)/kg is considered low, while a value greater than 15 cmol(+)/kg is high [N McKenzie et al., 2004].

Results of CEC analysis of the well pad soil core profiles found a significant difference between topsoil with elevated CEC and deeper soils with much lower CEC (**Table 4.7—2**). This result reflects the benefits of stockpiling the more fertile topsoil in the well-pad design during land clearing for subsequent site rehabilitation purposes.

Table 4.7—2 Key Nutrients in CPP Soil Profile

Soil Sample Source	Cation Exchange Capacity ($cmol(+).kg^{-1}$)	Carbon Total ($g.kg^{-1}$)	Phosphorus Total ($g.kg^{-1}$)	Nitrogen Total ($g.kg^{-1}$)
Surface	20	0.8	0.1	0.3
30 cm Depth	5.8	0.5	0.1	0.3

Soil Sample Source	Cation Exchange Capacity (cmol(+).kg^{-1})	Carbon Total (g.kg^{-1})	Phosphorus Total (g.kg^{-1})	Nitrogen Total (g.kg^{-1})
90 cm Depth	6.0	0.3	0.1	0.3
Drilling Cuttings > 200 mm Depth	7.5	1.3	0.3	0.35

4.7.4 Soil Contamination

The Code's analytical methodology for Drilling Waste (DW) assessment is based on nationally used solid waste classification methods that utilise both Total Concentrations (TC) and Leachable Concentrations (LC) for specific *COPC* in the DW material (e.g. NEPM, 2011 [VICTORIAN ENVIRONMENT PROTECTION AGENCY, 2021; NEPC, 2011]). *The Code* specifies 80 analytes that are required to be measured in the DW assessment. *The NEPM Assessment of Site Contamination Measure, (1999*) refers to the *Industrial Waste Resources Guideline* (IWRG) published by Victorian EPA. The total concentrations and leachable concentrations are compared to published solid waste classification screening criteria [VICTORIAN ENVIRONMENT PROTECTION AGENCY, 2021]) for leachable and total concentrations contaminants of Potential Concern (COPC) to determine the appropriate classification and methodology required for contamination assessment and associated containment of the soil material.

Figure 4.7—4 provides the threshold total concentrations for COPC for fill material. Fill material is industrial waste, but not priority waste, with extremely low levels of contamination. It's considered safe to use without containment [VICTORIAN ENVIRONMENT PROTECTION AGENCY, 2021. It has been selected because it is the most conservative solid waste classification criteria.

Drilling waste from the stockpile of DW at Carpentaria 1, Carpentaria 2/3, and Carpentaria 4 have been assessed. None of the COPC at the 95% upper confidence limit (UCL) exceeded the screening criteria listed in **Table 4.7—3**. The results of this Carpentaria DW assessment are shown in **Figure 4.7—4**. For comparative purposes, the 95% UCL for Carpentaria well pad soils, where detected, is provided in **Figure 4.7—5**.

The screening criteria listed in **Figure 4.7—5** also provide useful and specific measurement criteria for assessing potential Activity-attributable soil contamination resulting from spills or unintended releases, and for assessing soil status during the rehabilitation of disturbed areas [C RICHARDS et al., 2023].

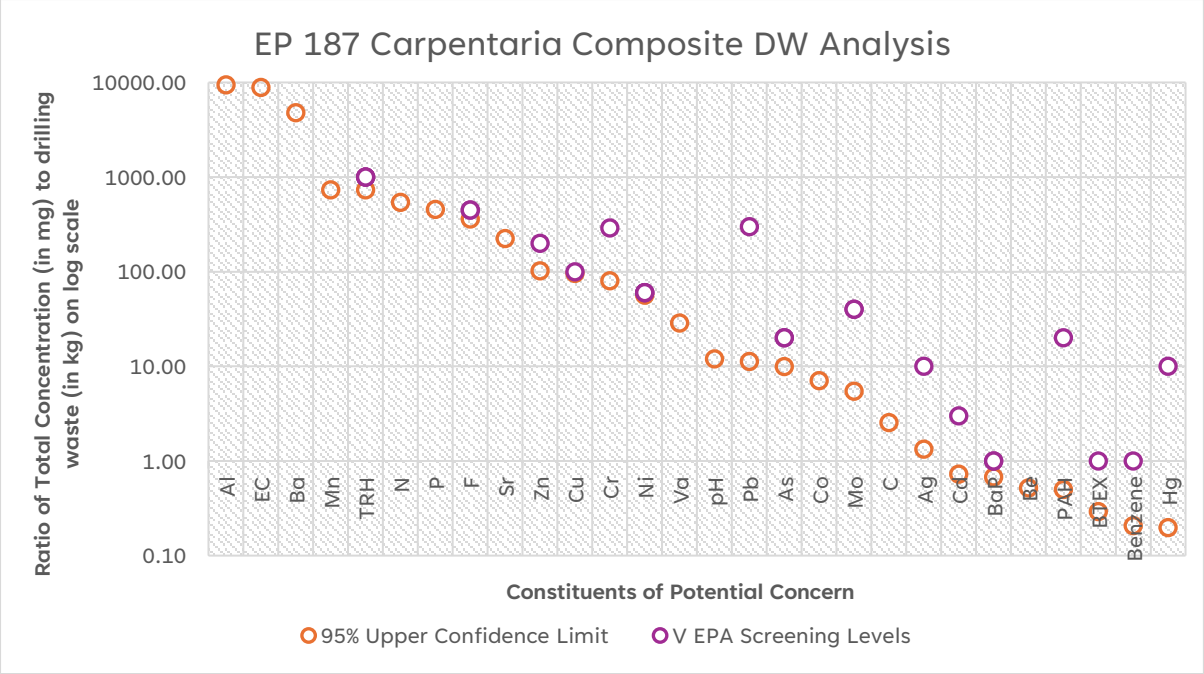


Figure 4.7—4 Carpentaria Composite DW COPC Total Concentration 95% UCL (n = 18)

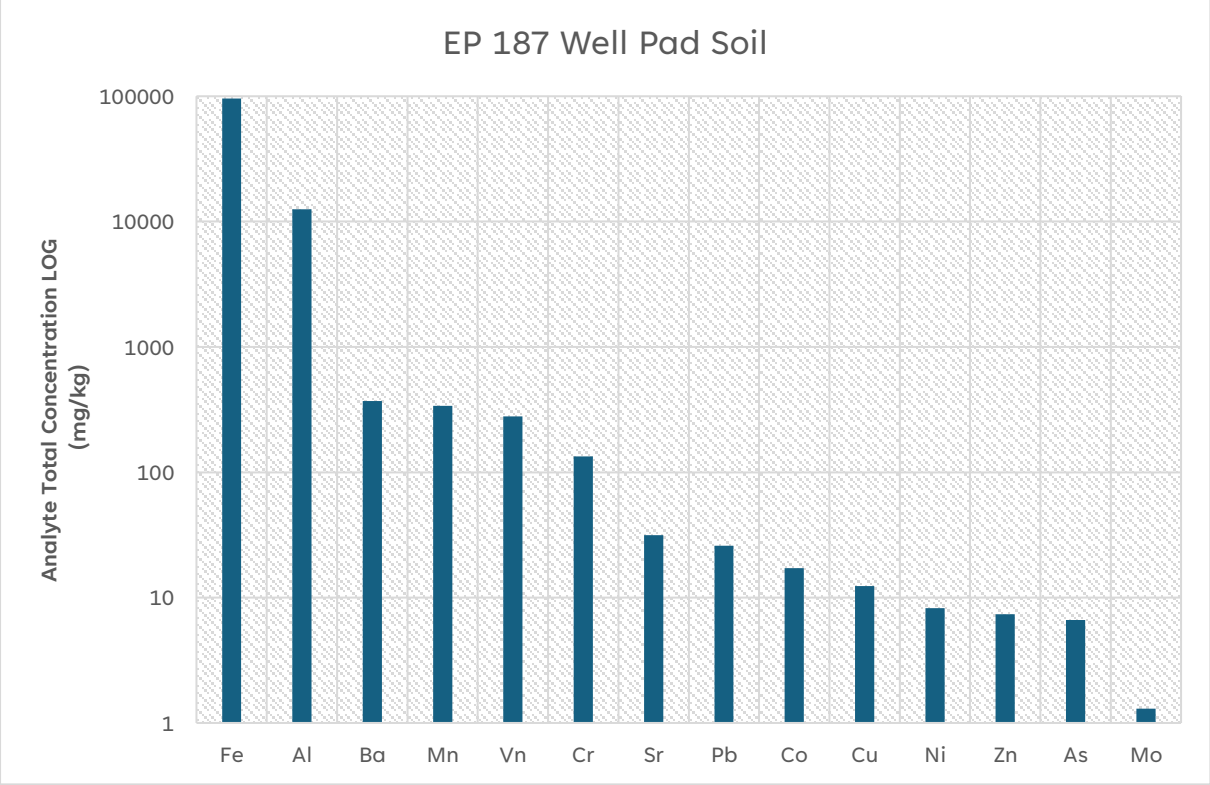


Figure 4.7—5 Carpentaria Well Pad Soil Metals Total Concentration 95% UCL (n = 27)

The potential for chloride contamination of well pad soil in the event of a spill is a key consideration in onshore gas developments. It is noted that the Red Kandosols in the Sturt Plateau contain very low salt levels [C RICHARDS et al., 2023], and this was confirmed in baseline

chloride levels in the surface soils at the well pads. The potential impact on soil and plant sensitivity to soil chloride pollution is shown in **Figure 4.7—6**. Consideration of this contaminant in spill scenario modelling at the CPP Area is presented in **Appendix 07** (Spill Management Plan).

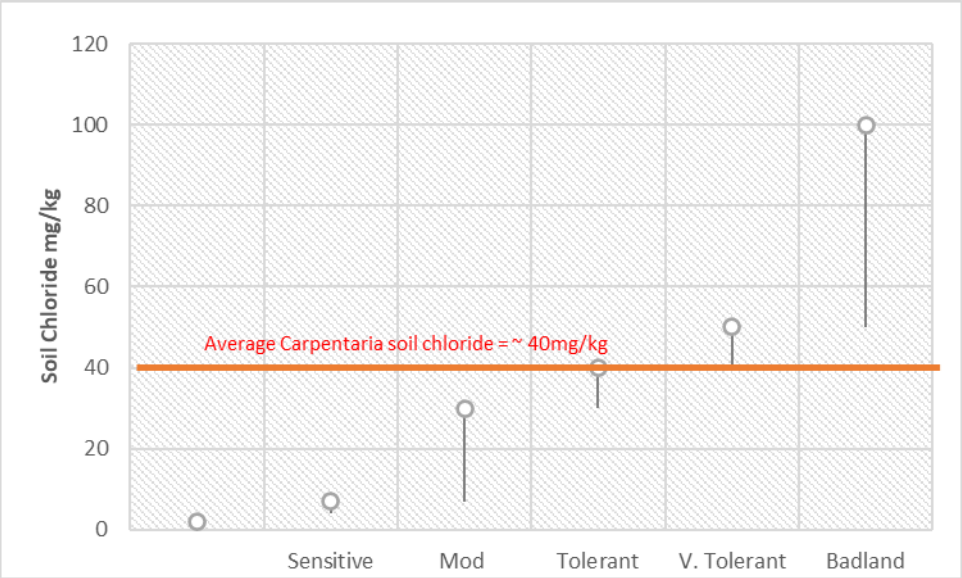


Figure 4.7—6 Soil Chloride Average in Carpentaria Well Pad Soil Profile

4.7.5 Soil Infiltration

The measured standing groundwater level (SWL) across the CPP Area is relatively consistent at 68 m bgl (± 2 m). Because a sandy clay soil horizon and laterised siltstone Cretaceous material (average thickness 63 m) is present across the CPP Area, surface connectivity with the underlying CLA is likely to be a highly restricted potential pathway for surface infiltration. The results of the Darcy infiltration modelling (see **Appendix 08**) conservatively assumed that water is available in the surface to act as a driving head (i.e., a consistent leak). The results indicate water will take approximately 80 years to move through the initial 50 m (clay/siltstone).

Table 4.7—3 Fill Material Contamination Total Concentration Upper Limit for Industrial Waste that Is Soil ([VICTORIAN ENVIRONMENT PROTECTION AGENCY, 2021])

Contaminant	Fill Material Upper Limit TC as Dry Weight (mg/kg)
Inorganic Species	
Arsenic	20
Cadmium	3

Contaminant	Fill Material Upper Limit TC as Dry Weight (mg/kg)
Chromium (VI)	1
Copper	100
Lead	300
Mercury	1
Molybdenum	40
Nickel	60
Tin	50
Selenium	10
Silver	10
Zinc	200
Anions	
Cyanide	50
Fluoride	450
Organic Species	
Phenols (halogenated)	1
Phenols (non-halogenated)	60
Monocyclic aromatic hydrocarbons	7
Benzene	1
Polycyclic aromatic hydrocarbons	20
Benzo(a)pyrene	1
C6-C9 petroleum hydrocarbons	100
C10-C36 petroleum hydrocarbons	1,000
Polychlorinated biphenyls	2
Chlorinated hydrocarbons	1
Pesticides	
Organochlorine pesticides	1

4.8 Land Use

As noted previously, the CPP Area lies wholly within NT Portion 5706, which is an Indigenous estate of freehold land for the Mambaliya Rrumburriya Wuyaliya Aboriginal Land Trust as landowners. The CPP Area also encompasses several cattle agistments, under Section 19 *Aboriginal Land Rights (Northern Territory) Act, 1976 (Cth) (ALRA)* lease holdings, that are leased from the Mambaliya Rrumburriya Wuyaliya Aboriginal Land Trust, allowing livestock access to savannah grassland, watercourses, and riparian areas within respective Section 19 agistment leasehold areas.

During the last 30,000 years, riverine vegetation has responded to the complex and interactive effects on fluvial processes, including a dramatic global climate transition from the last glacial maximum (LGM) to the Holocene, substantial sea level changes, subsequent Holocene climate fluctuations and the influence of Aboriginal people. Australia has undergone massive land-use changes since human settlement, including biota and forest structure transformation by Aboriginal peoples going back as far as 75,000 years ago [C. J. A BRADSHAW, 2012]. Perhaps most significant are the profound land use and hydrological changes wrought by agri-industrial society in the past 200 years [SAMANTHA CAPON et al., 2016].

The European colonists' discovery of the Barkly region's extensive tussock grasslands in the 19th century and the invention of barbed wire brought the first cattle from Queensland in 1884. The famous Mitchell tussock grass, confined to the cracking clay soils to the south and east of the CPP Area, was the main attraction. Since then, the cattle industry has expanded and flourished in the region. From a vegetation perspective, the most significant impact of the arrival of cattle was the almost complete loss of riparian vegetation around waterholes and creek lines where the cattle were able to access and graze [SAMANTHA CAPON et al., 2016; J LUDWIG et al., 1996].

Consequently, the tendency to use the current state of the land as an environmental baseline impedes comprehending the full effects of riparian vegetation or environmental management on ecosystem processes. Although most stock grazing occurs on unimproved pastures of native vegetation at low stocking rates, intensive cattle grazing in riparian zones can have several degrading impacts, such as the loss of native plant cover and diversity, soil compaction and bank erosion.

This results in changed faunal composition and the introduction and spread of weeds [SAMANTHA CAPON et al., 2016; J LUDWIG et al., 1996]. In recent history, poor grazing practices and unregulated cattle access to streams in the Ord, Fitzroy, and Victoria River catchments of northern Australia have led to significant losses of riparian vegetation, especially understorey species, and severe bank erosion exacerbated by seasonal floods [SAMANTHA CAPON et al., 2016; J LUDWIG et al., 1996].

As surface water diminishes throughout the Dry Season, many seasonal waterholes become Dry-Season water refuges, thus putting additional pressure on riparian vegetation and bank stability

[SAMANTHA CAPON et al., 2016]. In the prolonged absence of rain, the availability of green leaf matter is very low. Under these conditions, animal condition declines as animal growth is dependent on plant growth. In the absence of rain, herbivores attempt to survive through complex strategies. Overgrazing, an inherent risk of pastoralism, is a result of too many of certain plant species being removed in certain places and at certain times.

Beef production depends on animal growth and the sale (harvesting) of progeny. As forage quality declines, so does carcass quality. Hence, there is a stronger incentive to harvest progeny during post-pulse declines in plant productivity. Livestock sales in the region and elsewhere across the northern savannah biome reflect the decline in available green forage in the Dry Season.

Mustering reduces cattle stocking density primarily during the early Dry Season from May to July. During extreme prolonged arid periods, the destocking of breeders (cows) by trucking to other regions may also be implemented [SAMANTHA CAPON et al., 2016; J LUDWIG et al., 1996; J RUSSELL-SMITH et al., 2009].

4.9 Surface Water

Overland flow forms the main component of Sturt Plateau runoff that reaches the creek line network. Flash flooding is a common phenomenon due to long seasonal dry periods followed by periods of high-intensity rainfall. Flash floods are characterised by high turbulence and the transportation of large amounts of sediments and organic matter from the surrounding landscape.

Runoff as sheet flow from lithic slopes under intense storm conditions may be initiated in the Sturt Plateau. Due to the scale of the low-relief land, significant volumes of run-on water may travel down sheet flow pathways to reach the drainage channels, as shown in the flood modelling discussed below.

The distribution of northern Australian riverine communities generally follows a topographic sequence related to the landform elevation [SAMANTHA CAPON et al., 2016]. There is a notable shift in community richness around a specific elevation within most catchments, which coincides with a change in functional process zones.

Community richness is relatively high below a defined catchment elevation, where the streams are categorised as anabranch and distributary functional process zones. Community richness is relatively lower above that elevation, where the streams are categorised as being in armoured, meandering, confined, and mobile zones with relatively high slopes, moderate to high stream power, active drainage networks, and coarse, unstable sediments.

The drainage lines in the CPP Area correspond with the upper catchment, riverine morphological zones in the riverine topographic sequence described above [S CAPON et al., 2016]. This coincides

with a change in functional process zones for surface water run-off: the crest of the Favenc Range has active drainage networks and coarse, unstable sediments on armoured slopes. The Favenc Range forms the headwaters of the Limmen Bight River catchment to the north of the CPP Area and Relief Creek, which is a sub catchment of the McArthur River to the east of the CPP Area.

4.9.1 Ephemeral Streams

Ephemeral stream examples in the savannah country at the CPP Area are shown in **Figure 4.9—1**. In this region, the drainage channels cut through alluvium and are bounded on both sides by one or more deposition-erosion benches. The larger channels develop benches because the drainage channel represents flooding by average storms, and the benches are flooded only by low-frequency episodic events.

The deep sediments of ephemeral stream channels are mostly sand and gravel. The sediments are characterised by exceedingly high infiltration rates. Water entering ephemeral stream channels that rapidly infiltrate the stream bed is called transmission loss. Transmission losses are often sufficiently high that only the very large, intense rainstorms produce floods of sufficient depth to reach the terminus of the stream channel [S CAPON et al., 2016].

The mapping of the ordered streams that intersect the CPP Area is shown in **Figure 4.9—2**. The highest stream order (3) in the CPP Area occurs at the headwaters of Relief Creek, and the armoured stream morphology reflects the general site elevation at the top of two catchments, coinciding with the crest of the Favenc Range, which follows the Carpentaria Highway at this location. Relief Creek flows eastward where it merges into Toonganginie Creek. approximately 38 km east of well pad BD. which then joins the Macarthur River at an elevation of approximately 83 m AHD, approximately 48 km east of well pad BD.

4.9.2 Creek Crossings

The proposed new well pads and other surface infrastructure will not be located on or near creek lines, with buffers measured from the outer edge of riparian vegetation as outlined in the *Land Clearing Guidelines* [DEPWS, 2021C].

The proposed site layout avoids crossing creek lines where possible. The nine creek crossings for linear corridors for access tracks, flowlines, and gathering lines for the Activity are also depicted in **Figure 4.9—2**. Seven of them are existing access tracks and a new creek crossing (ID# 6) is proposed in the Lancewood 2 land system north of the Carpentaria highway. Three of the creek crossings could not be identified (non-existent) in the field surveys and may be anomalies in the drainage map spatial layer.

There are nine mapped creek crossings in total for the flowline corridor and access track in the CPP Area. Eight of these are presently existing crossings for access tracks. Five of the creek crossings are north of the Favenc range catchment divide (Lancewood 2 land system) and are upper catchment tributaries of Balbirini Creek which is part of the Limmen River catchment flowing northeast. Four of the creek crossings are in upper catchment tributaries of Relief Creek (TP land system) which is part of the Macarthur River catchment flowing east. One of the creek crossings (Photo ID #9) in the Creswell land system is not presently mapped. Three of the mapped creek lines (Photo ID #5, #6, and #7) were not identified during the field surveys and are likely anomalies in the drainage features spatial map layer. The details of the creek crossings, stream order, status, location, elevation and associated land system and catchment are provided in **Table 4.9—1**.

Table 4.9—1 Summary of Creek Crossings in CPP Area

Crossing ID #	Stream Order	Status	Easting	Northing	Elevation AHD (m)	Slope (%)	Land System	Catchment	Possible Co-Location	Description
1	1	Existing	511647	8153863	220	1 – 2 %	Lancewood 3	Balbirini Ck	Yes	Riparian snappy gum.
2	1	Existing	513249	8153742	221	0 – 1 %	Lancewood 3	Balbirini Ck	Yes	Riparian snappy gum.
3	1	Existing	515501	8154120	240	3 – 4 %	Lancewood 3	Balbirini Ck	Yes	Riparian snappy gum – same image as #4.
4	1	Existing	515614	8153947	244	1 – 2 %	Lancewood 3	Balbirini Ck	Yes	Riparian snappy gum – same image as #4.
5	1	Existing	516103	8150670	256	0 - 1 %	TP	Relief Ck	Yes	Not found in survey.
6	1	New	511119	8153059	227	0 - 1 %	Lancewood 2	Balbirini Ck	No	Not found in survey.
7	2	Existing	512852	8142311	229	0 - 1 %	TP	Relief Ck	Yes	Not found in survey.
8	3	Existing	517982	8136018	227	1 - 2%	TP	Relief Ck	Yes	Red gum and coolabah – cobbles.
9	Unmapped	Existing	518406	8135720	231	0 - 1 %	Creswell	Relief Ck - tributary	No	Small riparian snappy gum – ribbon grass possible Gouldian Finch habitat in Wet Season.

Imagery has been provided nearby each of the creek crossings in **Figure 4.9—4**. Based on elevations for creek crossings and the general hydrology of CPP Area, the most significant crossing is situated at Relief Creek (SO3) at a high elevation in the upper catchment of Relief Creek as evident in **Figure 4.4—2**. If flooding of the creek line occurs it, is of short duration and associated with storm fronts as evident in the extreme rainfall analysis provided in **Section 4.2.6**.

Appendix 05 (Erosion and Sediment Control Plan) provides site-specific detail for the proposed well pads, the Relief Creek crossing (Stream Order 3) near the existing Carpentaria 4 well pad (Photo ID 8a and 8b), and the Stream Order 2 crossing south of the existing Carpentaria 1 well pad.

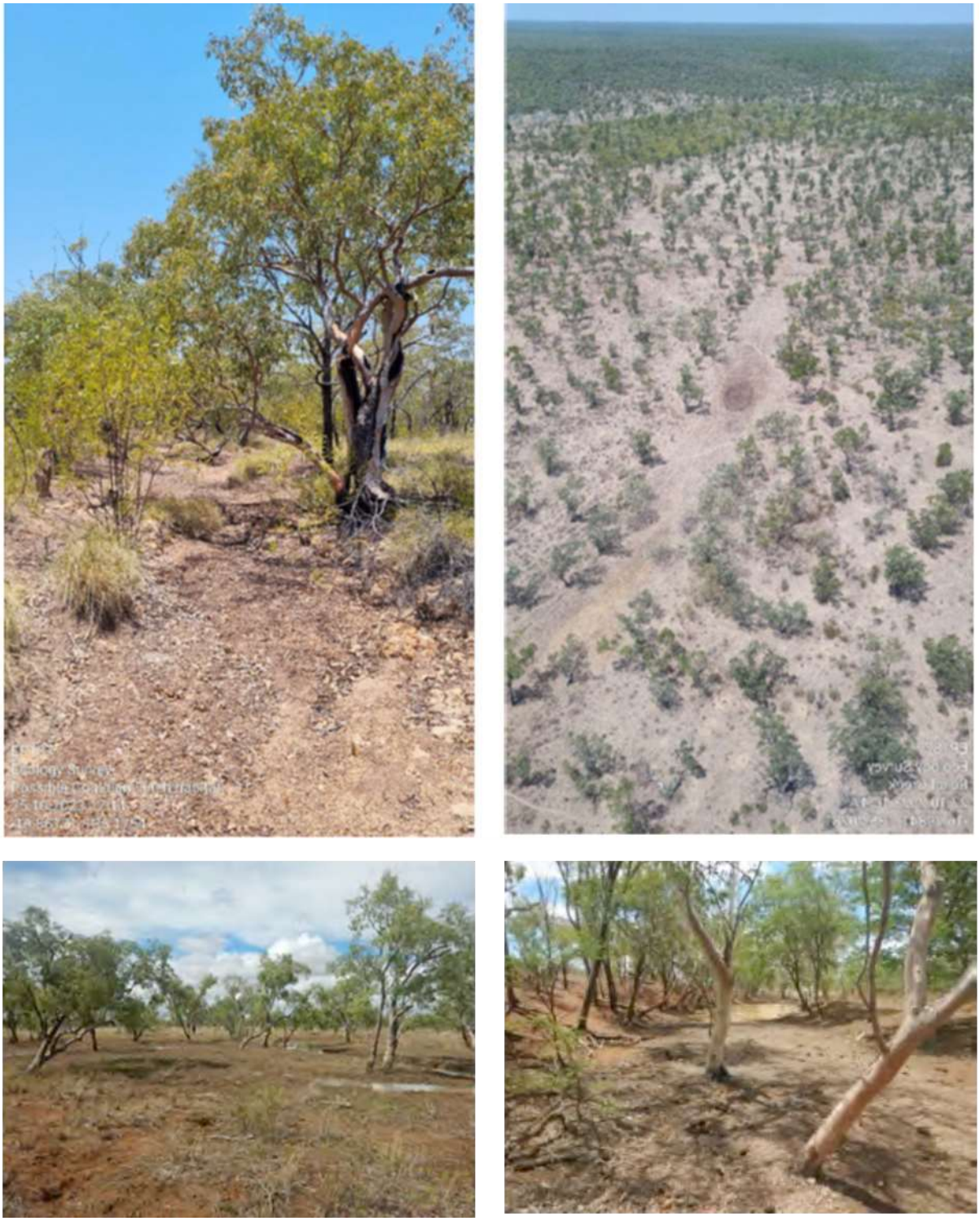


Figure 4.9—1 Views of Ephemeral Streams in the Savannah Region

(Left images shows a drainage line and soak in the CPP Area. Right images shows aerial and ground view of Relief Creek (downstream from Carp 4)

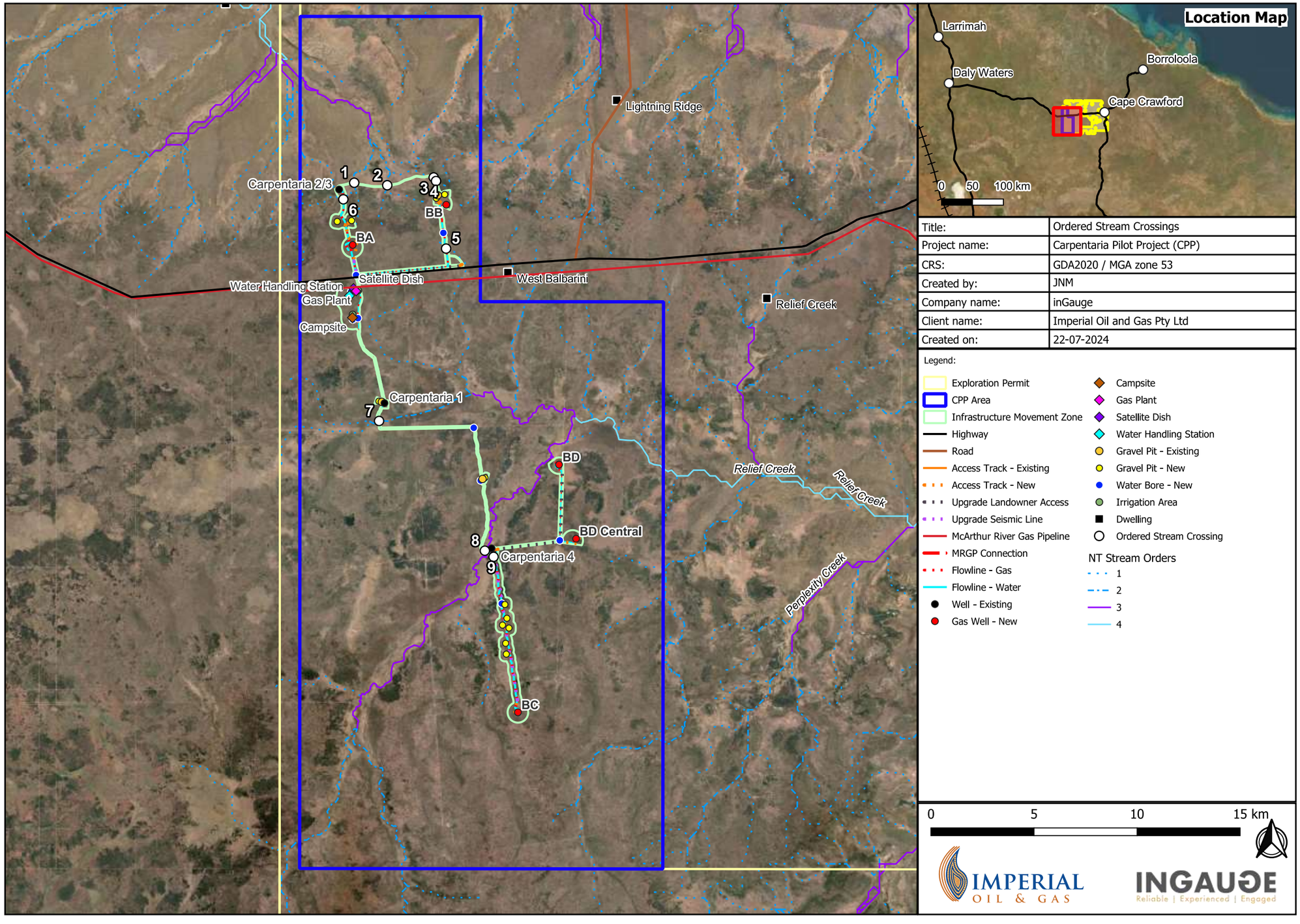
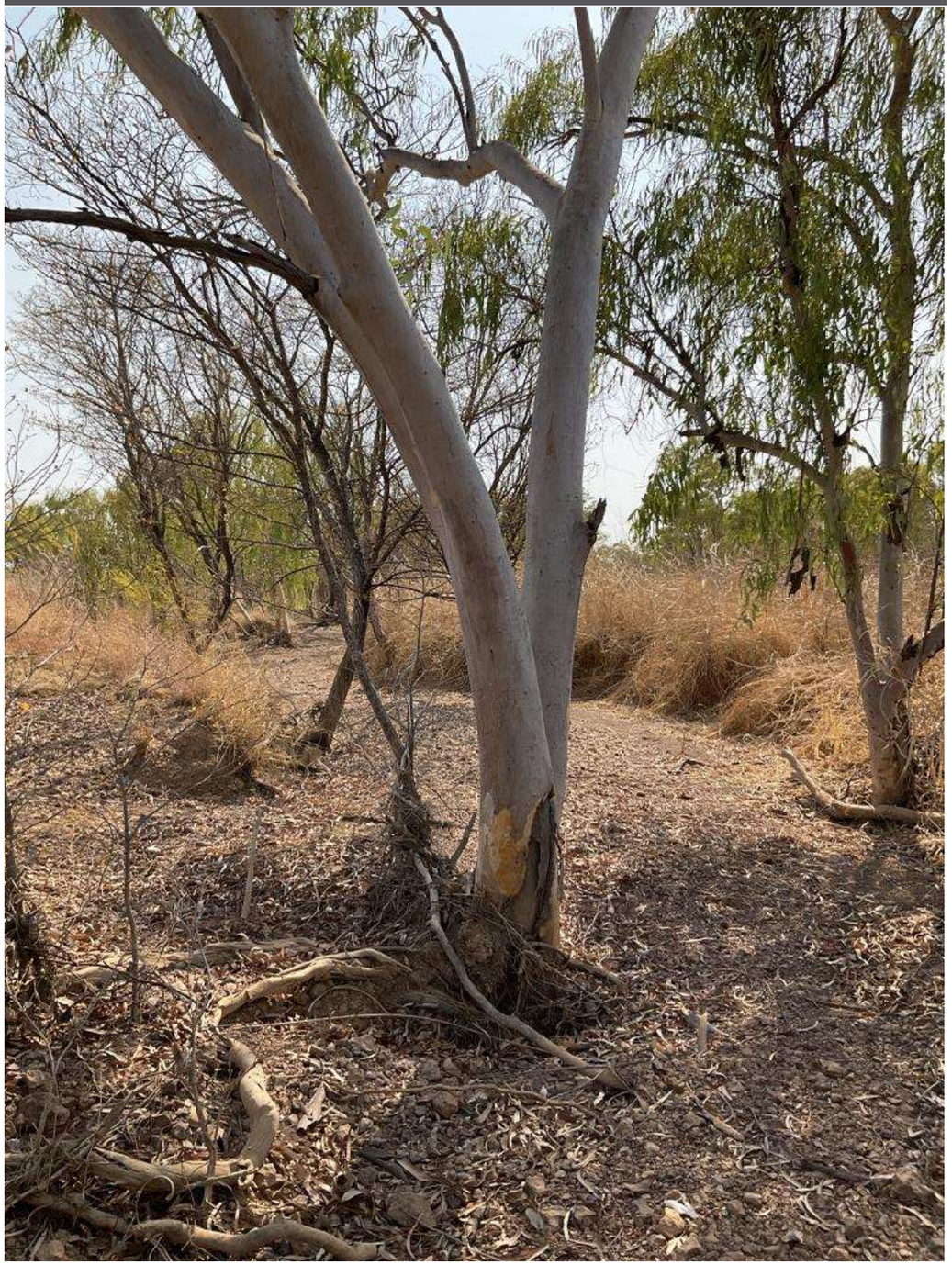


Figure 4.9—2 Ordered Streams in CPP Environs Draining from the Crest of the Favenc Range and Creek Crossings

#1: SO1. 220 m AHD. Lancewood 3 - with riparian snappy gum. 80 m from crossing.



#2: SO1. 221 m AHD. Lancewood 3 - DL with riparian snappy gum. 20 m from crossing.

#3: SO1. 240 m AHD. Lancewood 3 – near crossing.

#4: SO1. 244 m AHD. Lancewood 3 – near crossing.

#5: SO1. 256 m AHD. TP. No sign of mapped stream order. No defined bed or banks.

#7: SO2. 229 m AHD. Relief Ck Tributary. No sign of mapped stream order. No defined bed or banks.

#8a: SO3. Relief Creek. 227 m AHD. TP - upstream near creek crossing. Red Gum and Coolabah. Cobbles.

#8b: SO3. Relief Creek. 227 m AHD. TP - downstream near creek crossing – Red Gum. Cobbles.

#9a: Unmapped. Relief Creek tributary. 231 m AHD. Creswell– upstream near creek crossing.

#9b: Unmapped. Relief Creek tributary. 231 m AHD. Creswell – downstream near creek crossing.

Figure 4.9—3 Imagery at Creek Crossings for Flowlines and Access Track Identified in the CPP Area

4.9.3 Stream Flows

The average monthly stream flow in the McArthur River is shown in **Figure 4.9—4**. The average monthly stream flow is measured at the Baileys Grave stream gauging station on the Tablelands Highway, 60 km east of the headwaters of Relief Creek/Toonganginie Creek, where the CPP Area is located. Flows in the Dry Season typically register near zero.

At this location, the ground level elevation is approximately 83 m AHD. This is approximately 140 m lower than the CPP Area and drains a vast network of topographic regional sub-catchments, including Relief Creek. The average monthly stream flow is highest in February at this location and exceeds 70 m^3/s. The average flow from year to year may vary by more than two orders of magnitude (**Figure 4.9—5**) and reflects the erratic nature of rainfall quantity in the region, discussed in **Section 4.2**.

The gauging station has recorded over 36,000 stream flow events during almost 60 years of records. Approximately 4% of these measurements exceeded the maximum measurable stream gauge flow rate of 960 m^3/s. These exceedance events occurred in 20 of the last 60 years of records.

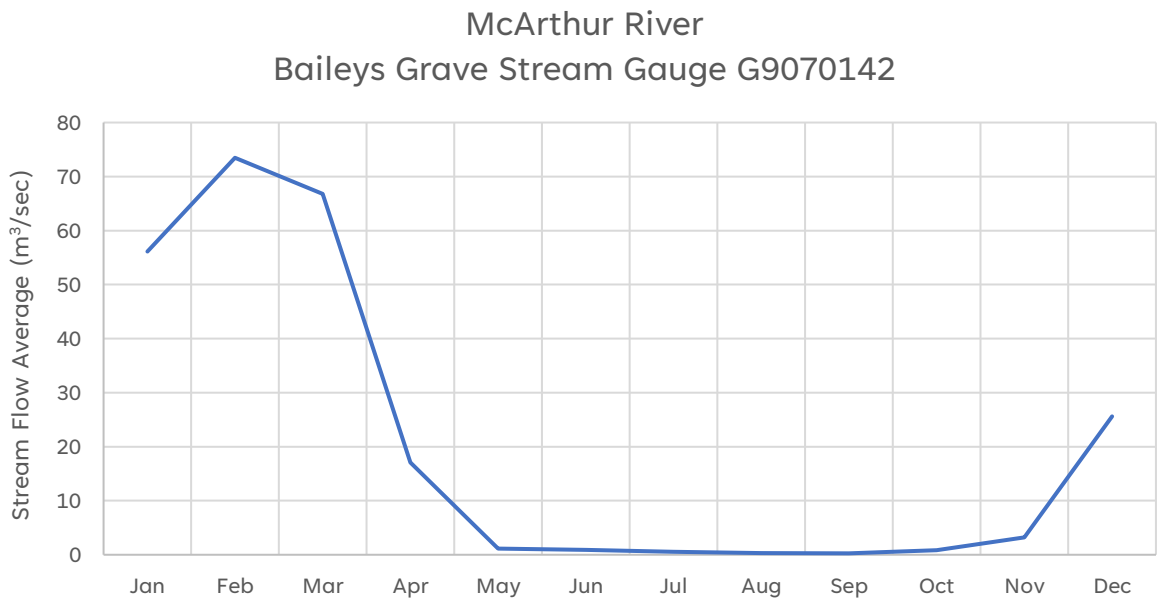


Figure 4.9—4 Average Monthly Stream Flow at McArthur River 1966 - 2023

(Source: Baileys Grave Stream Gauge G9070142 – elevation 83 m AHD)

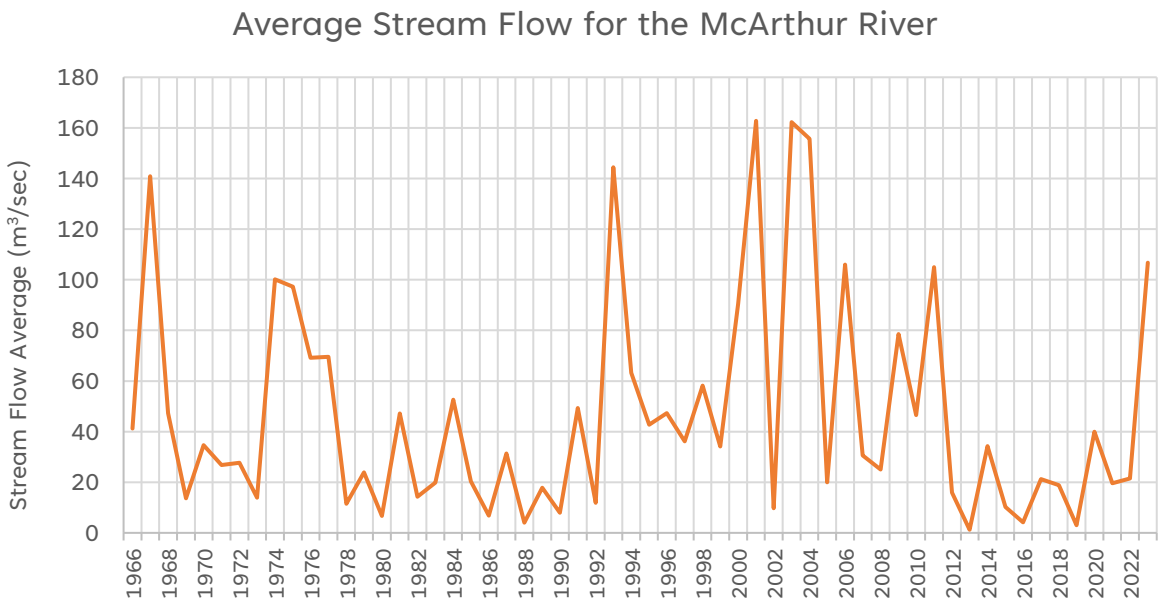


Figure 4.9—5 Average Measured Annual Stream Flow in McArthur River, East of the CPP Area

(Source: Baileys Grave Stream Gauge G9070142 – elevation 83 m AHD)

4.9.4 Flooding

Overland flow forms the major component of basin runoff that rapidly reaches the channel network in the region. Flash floods can occur when rainfall intensity and duration conditions are met, namely high volumes of rain within short periods of time.

A hydrological analysis was carried out to estimate the 1 in 100-year peak design stream flow rates required for flood modelling in the CPP Area. The estimated 1% Annual Exceedance Probability (AEP) flows were then used to route flows through creeks and rivers, including floodplains and the corresponding flood depths were estimated.

Hydraulic modelling and floodplain mapping results were analysed and subsequently validated by ground-truthing at proposed new well pads and other key sites (**Appendix 01** Environmental Assessment Report). The proposed sites, shown in **Figure 4.9—6** demonstrate how this key risk has been mitigated in the well pad and other key surface infrastructure site selection by preferentially avoiding areas of potential inundation in this segment of the catchment.

However, it is noted that food modelling in CPP Area is reliant on the DEM derived from SRTM data. Validation of the DEM shows good alignment with existing areas but in other locations there is likely to be error in the predicted flood model. Ground truthing of proposed new key infrastructure georeferenced imagery together with measured elevation and slope, shown in **Figure 4.11—1** and discussed further in **Section 4.11.2**, confirms these sites are not in a flooding area.

With the risk of floodwater inundation to well pads and key sites mitigated to ALARP as detailed in **Appendix 01**, general flooding across the Activity footprint within the CPP Area may potentially result in damage to infrastructure, including roads, access tracks, stormwater management infrastructure, fencing and the gas handling network.

Initial emergency response and site evacuation have been considered in the Emergency Response (contingency) Plan (**Appendix 09**), which includes recovery actions aimed at safely returning the site to full operational status as soon as practicable. The WOMP provides detail on emergency shutdown and isolation procedures for fixed plant and machinery in the event of a controlled site evacuation and a safe start procedure if the plant has been shut down.

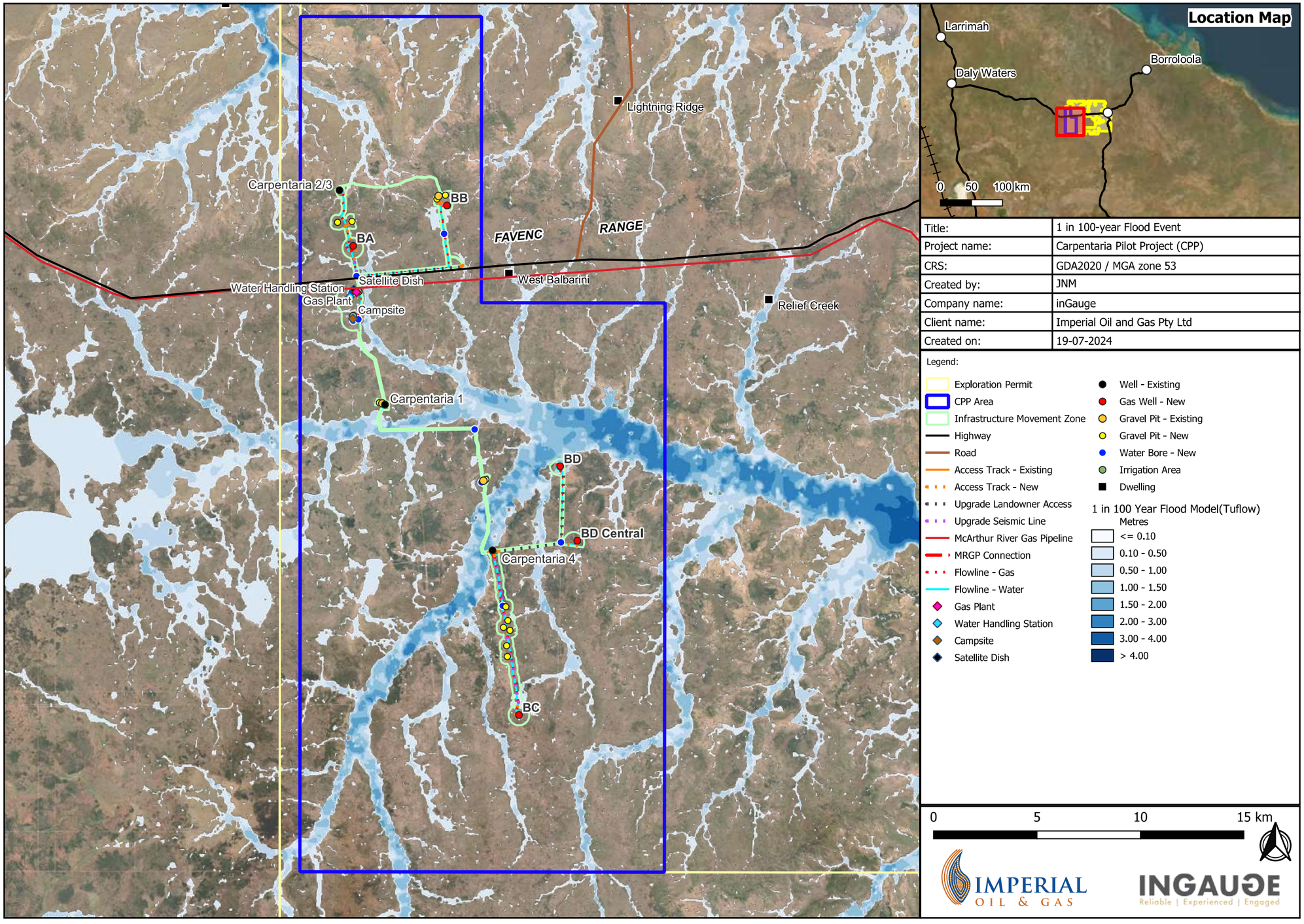


Figure 4.9—6 Flood Modelling within the CPP Area, Draining to the North and South from the Crest of Favenc Range on Carpentaria Highway

4.10 Groundwater

4.10.1 Regional Overview

The Cambrian Limestone Aquifer (CLA) is the recognised aquifer system in the CPP Area. It is comprised of near-flat-lying layers of mainly carbonate rocks with an estimated age of 500-510 million years [S TICKELL, 2022B].

In the Beetaloo SREBA area, the CLA extends up to approximately 700 km from Mataranka in the north to the Barkly Highway in the south. In an east-west direction, it spans a maximum distance of approximately 400 km across the Beetaloo. Despite the large area of the CLA in the arid south, including the Beetaloo, its contribution to the total throughflow to the rivers is minor compared to the northern regions of the CLA, outside the Beetaloo [S TICKELL, 2022B].

It comprises two main layers: an upper siltstone-dominated layer (Anthony Lagoon) and a lower limestone/dolostone-dominated layer (Gum Ridge). Both contain significant aquifers, but the lower layer is the most productive and the most widespread.

The CLA reaches a maximum known thickness of 400 m, but in most areas, it is less than 150 m thick. The main aquifer development is associated with the limestone beds, forming regional to intermediate scale fractured and karstic aquifers in the Gum Ridge formation that are utilised for stock and domestic purposes across the study area. Groundwater is of calcium sulfate-bicarbonate type, which is characteristic of carbonate aquifers. Chloride mass balance shows a clear relationship of increasing recharge from south to north, consistent with the climate gradient [S TICKELL, 2022B].

Sinkholes are vertical pipe-like solution features commonly developed in carbonate rocks. They can provide rapid recharge pathways to aquifers. Sinkholes are most common west of the Stuart Highway, most likely because Cretaceous strata are generally thinner there. Recharge via sinkholes was considered by Yin Foo and Matthews (2001) to be a major source of recharge on the Sturt Plateau. There are no identified sinkholes in the CPP Area.

4.10.2 Hydrostratigraphy

The Hydrostratigraphy in the CPP Area, based on previous drilling at Carpentaria 1 and Carpentaria 2 is summarised in **Table 4.10—1**. The following definitions apply [S TICKELL, 2022A]:

- An aquifer is ‘a formation, group of formations, or part of a formation that contains sufficient saturated permeable material to yield significant quantities of water to wells and springs’.
- An aquiclude is ‘a hydrogeologic unit which, although porous and capable of storing water, does not transmit it at rates sufficient to furnish an appreciable supply for a well or spring’.

- An aquitard is 'a confining bed that retards but does not prevent the flow of water to or from an adjacent aquifer, a leaky confining bed. It does not readily yield water to wells or springs but may serve as a storage unit for ground water'.

Table 4.10—1 Indicative Hydrostratigraphy in CPP Area

Province	Formation	Aquifer Status	Depth (Mbgl)	Yield (L/S)	Avg EC (µs/Cm)
Carpentaria Basin	Laterised Siltstone and Undifferentiated Alluvium	Perched Aquifer	0 – 48	N.A.	N.A.
Georgina Basin	Cambrian Limestone Aquifer (Cla)	Regional Aquifer	48 - 108	1.0 – 10.0	1,080
	Bukalara Sandstone	Regional Aquifer	108 - 178	0.3 – 5.0	1,080
	Kiana Group	Aquiclude	178 - 439	-	-
Beetaloo Sub-Basin (Roper Group)	Kyalla Formation	Regional Aquitard	439 - 538	Id	Id
	Moroak Sandstone	Aquiclude	538 - 769	0.5 – 5.0	131,000
	Velkerri Formation	Regional Aquitard	769 - 1,733	–	–
	Bessie Creek Sandstone	Aquiclude	1,733	0.5 – 5.0	–

4.10.3 Aquifers in CPP Area

The aquifers identified in the CPP Area are discussed below. A key requirement of *the Code* in relation to groundwater monitoring in the Beetaloo is the guideline requirement for an accurate lithological log of rock from the water supply bore at a well pad during the implementation of the required well pad monitoring bore layout. Groundwater extraction bores in the CPP Area access the CLA.

The measured top and base of the CLA interval and measured standing water level relative to ground level at different existing well pads in the CPP Area are shown in **Table 4.10—2**.

Table 4.10—2 Well Pad Water Bores CLA Aquifer and Screen Interval

Bore Owner	RN	Top (mbgl)	Base (mbgl)	Thickness (m)	Screen Interval (mbgl)	Standing Water Level (mbgl)
Imperial	RN041800	72	96	24	72 - 96	69.3
Imperial	RN042461	64	76	12	103 - 234	65.5
Imperial	RN042462	60	100	12	76 - 100	65.5
Imperial	RN042463	78	100	16	71 - 100	65.5
Imperial	RN042464	78	106	16	103 - 228	65.5
Imperial	RN041678	60	96	36	74 - 96	69
Imperial	RN043012	47	82.5	35.5	67 - 125	65.5
AVERAGE		**63.4**	**88.1**	**24.7**	**-**	**68**

4.10.4 Anthony Lagoon Aquifer

Regionally, the Anthony Lagoon aquifer has a similar south-east to north-west hydraulic gradient as the underlying Gum Ridge aquifer, and the water table is generally too deep to permit surface discharge. [S TICKELL, 2022B].

The Anthony Lagoon Formation comprises interbedded maroon dolomitic siltstone and pale grey dolostone with fine-grained dolomitic sandstone-siltstone and minor chert concretions, nodular and bedded gypsum/anhydrite and karstic dissolution features throughout [M. L ORR et al., 2020].

The Anthony Lagoon formation was interpreted to be encountered in RN042461 at the existing Carpentaria 2 well site in the north of the CPP Area [IMPERIAL, 2021]. It has not been identified elsewhere in the CPP Area where water bores have been installed. This finding resulted adjusting the interpreted aquifer mapping for this region (refer to fractured and karstic rock area boundary, shown in **Figure 4.10—2**).

Consequently, additional monitoring bores were established on Carpentaria 2/3 on the advice of DEPWS [IMPERIAL, 2021]. RN042462 and RN042643 are shallow bores screened in the interval 71 - 100 mbgl; RN042461 and RN042463 were screened in the deeper interval from 103 - 224 mbgl, as shown in **Table 4.10—2**. The average measured EC and 95% confidence limits for the four monitoring bores at Carpentaria 4 was 1080 ± 7.4 µS/cm (n = 40). Anova analysis was conducted on laboratory EC measurements taken from each of these bores (n = 10) as shown in **Table 4.10—3**. The sampling data was taken before, during, and after drilling and HF at the Carpentaria 2/3 well pad per *the Code*. There was no statistical difference ($p > 0.05$) in

measured EC among the bores, indicating the groundwater has a similar EC in the deeper bores and shallower bores, and that groundwater quality has been unaffected by drilling and HF of Carpentaria 2/3 well. These observations indicate that the two intervals have hydraulic connection. Other analytes specified in the Cod are also compared in these monitoring bores and the 95% confidence limits and the overlap between each bore demonstrate no significance difference for all analytes as shown in **Figure 4.10—7**, **Figure 4.10—8**, **Figure 4.10—9**, and **Figure 4.10—10** except iron (which has a high local variance in the Beetaloo region). Similar water levels measured in both intervals supports this conclusion. See **Section 4.10.7** for further information on the connectivity of groundwater in the CPP Area. See **Section 4.10.9** for further information on baseline assessment of groundwater in the CPP Area.

Table 4.10—3 Anova Analysis for EC at Carpentaria 2 Well Pad

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	3,850	3	1283	2.45	0.08	2.87
Within Groups	18,940	36	526			
Total	**22,790**	**39**				

4.10.5 Gum Ridge Aquifer

The volume of groundwater stored in the Gum Ridge aquifer is significant and is estimated at 660,000 GL [DEPWS, 2023B]. This volume is equivalent to more than 1,000 Sydney Harbours. The majority (96%) of that is in the Gum Ridge Formation, a vast cavernous limestone aquifer across the Beetaloo. Because of this large storage, measured groundwater levels are very stable. Time-series groundwater levels in both Anthony Lagoon and Gum Ridge, measured at five locations in the Beetaloo, showed a variance of less than ± 0.1 m over three years and no clear trends within or between hydrograph sites [S TICKELL, 2022B].

Because of this large storage, measured groundwater levels are very stable. Time-series groundwater levels in both Anthony Lagoon and Gum Ridge measured at five locations in the Beetaloo showed a variance of less than ± 0.1 m over three years and no clear trends within or between hydrograph sites [S TICKELL, 2022B].

4.10.6 Bukalara Sandstone

The Bukalara sandstone formation lies directly below the Gum Ridge formation at CPP. The formation is characterised by intergranular spaces mainly filled with white kaolinitic clay, but minor sections have moderately good intergranular porosity. Porosities range from poor to fair

(6 to 18%), and permeability is commonly low at less than a few millidarcies (md). Bore logs indicate the strata consists of a firm to hard, white, fine to medium-grained quartz sandstone.

The only relatively deep water bore to intersect the Bukalara Sandstone beneath the CLA in the eastern Beetaloo region is RN041679 at the Carpentaria 1 well site, constructed by Imperial for monitoring the Bukalara at the request of DEPWS. The formation was encountered between 108 and 178 m and only yielded 0.5 L/s. The drill cuttings and gamma log indicated that the sandstone is interbedded with numerous shale beds at that site [S TICKELL, 2022B].

4.10.7 Aquifer Connectivity

Aquifer connectivity refers to the ability of groundwater to move from one aquifer to another (inter-aquifer connectivity) or between different parts of the same aquifer (intra-aquifer connectivity). It is dependent upon the lithology of aquitards and aquifers and their integrity and spatial continuity. Faults and fractures can form preferential flow paths that can connect aquifers [S. Tickell, 2022b].

Individual siltstone beds in the Anthony Lagoon Formation likely act as aquitards for the interbedded dolostone aquifers of the same formation. They are also likely to restrict or prevent vertical movement of groundwater between the Anthony Lagoon Formation and the underlying Gum Ridge Formation [S TICKELL, 2022A].

An analysis was conducted of the presence of aquitards in the CLA using gamma logs to establish the lithologies responsible for the gamma signatures and to determine the actual thickness of the high gamma rocks [S TICKELL, 2022A].

Nine borehole gamma log cross-sections were developed across the Beetaloo SREBA area. Two focused on the siltstone-dominated Anthony Lagoon Formation. An interpretive graphic log was developed to show the lithology and associated gamma signal. The example in **Figure 4.10—1** indicates the presence of an approximately 2 m thick siltstone layer between the overlying Anthony Lagoon limestone (less than 80 m bgl) and the deeper Gum Ridge limestone (greater than 82 m), similar to that inferred at Carpentaria 2/3.

Groundwater chemistry from the seven Beetaloo SREBA monitoring locations, which have separate monitoring bores in both the Anthony Lagoon and Gum Ridge aquifer at each site, show both aquifers have similar ionic compositions and concentrations of major ions. Similarities in water quality properties and minor differences in water elevations at each location suggest that the two aquifers are connected [S TICKELL, 2022B].

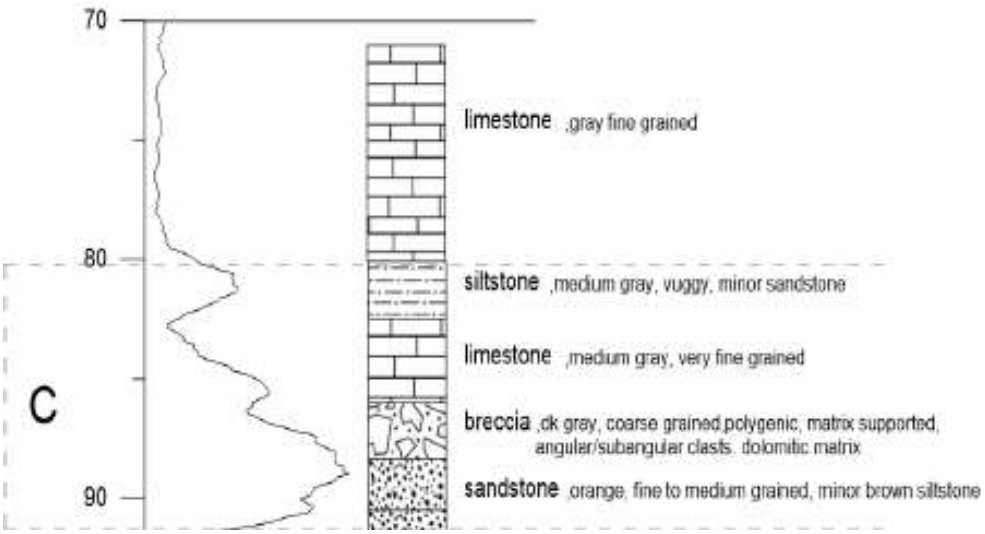


Figure 4.10—1 Interpretive Graphic Log of Siltstone Aquitard at the Base of Anthony Lagoon

Source: [Tickell, 2022b]

A similar result has been observed at the Carpentaria 2/3 well pad, as discussed in **Section 4.10.4**. Groundwater in both the Gum Ridge and Anthony Lagoon at Carpentaria 2/3 well pad are magnesium bicarbonate types, and the measured analyte concentrations of the 67 analytes prescribed in *the Code* are not statistically different (refer to later discussion in **Section 4.10.9** and **Figure 4.10—9**. Similar water levels measured in both formations support the conclusion that the aquifers are most likely to be hydraulically connected in this location.

Only a small number of inter-aquifer pumping tests have been undertaken to help establish the degree of connection between the Anthony Lagoon and Gum Ridge Formations [S TICKELL, 2022A]. Tests at Hayfield Station in 2015 and Tanumbirini Station in 2019 showed no connection. Pump tests at Carpentaria 2/3 have also been inconclusive to date.

Additional tests to investigate connectivity between these formations are scheduled for 2023 [S TICKELL, 2022A]. The use of an organic biodegradable water tracing dye (e.g., Rhodamine WT), which is widely used in environmental water studies, in combination with pump tests, could provide further understanding of probable aquifer connectivity.

At the Carpentaria 1 location, groundwater in both the Gum Ridge Formation and Bukalara Sandstone are magnesium bicarbonate types and have comparable total dissolved solids (TDS) values. The Gum Ridge Formation has a TDS of 686 mg/L, and the Bukalara Sandstone has 576 mg/L. That difference is due to higher calcium and bicarbonate concentrations in the CLA. These observations indicate that the two formations have a good hydraulic connection. Similar water levels measured in both formations support this conclusion [S TICKELL, 2022B].

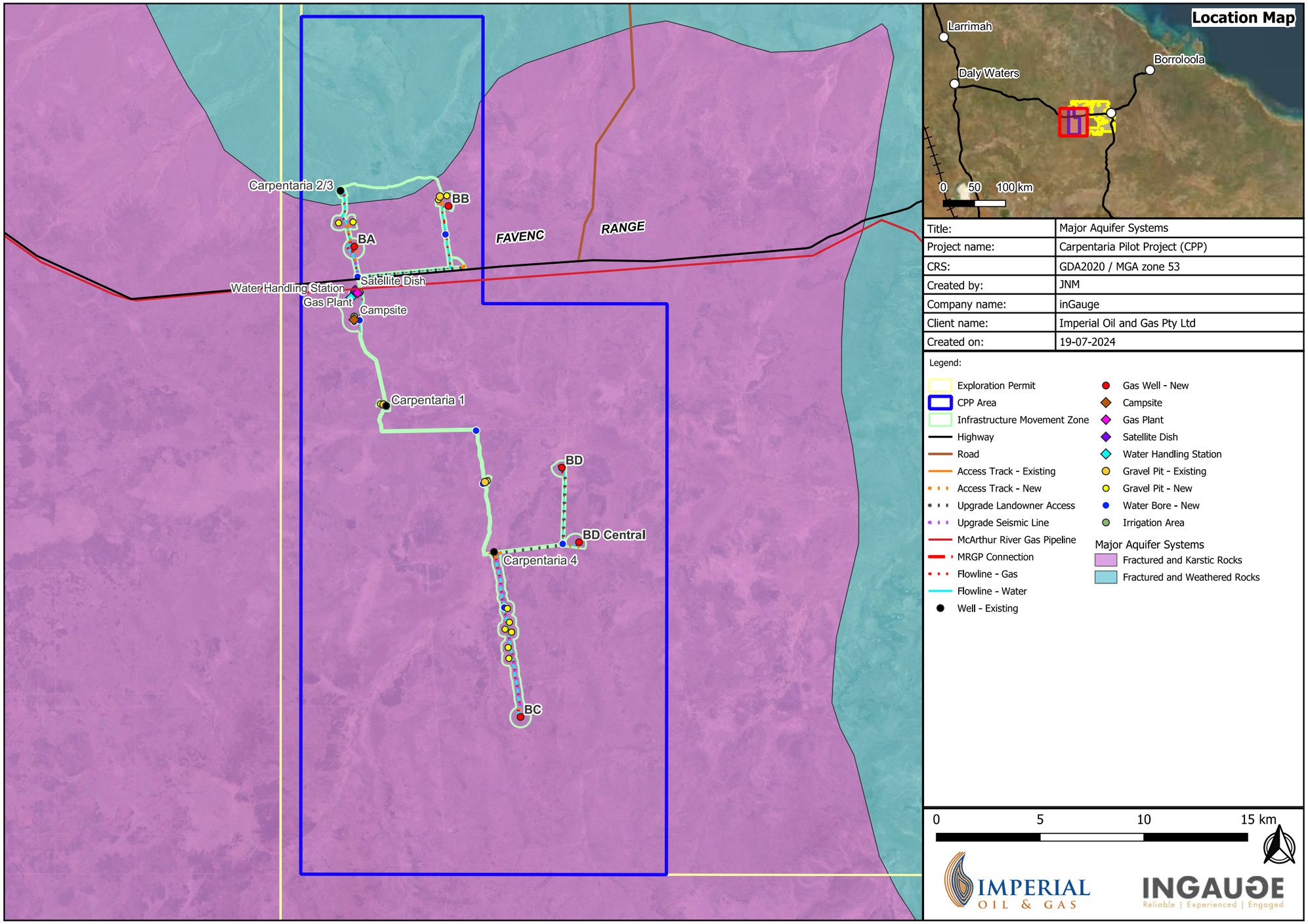


Figure 4.10—2 Cambrian Limestone Aquifer in the CPP Area

4.10.8 Gum Ridge Aquifer Cumulative Extraction

The *Scientific Inquiry into Hydraulic Fracturing* (HFI) made recommendations for the NT Government's management of water in areas of onshore petroleum development. Recommendation 7.7 requires that Water Allocation Plans (WAPs) (the Government's primary water resource management mechanism) be developed for the Beetaloo Sub-basin before granting of any production-level groundwater extraction licences for the petroleum industry. WAPs controls the rate and volume of any water extraction by petroleum companies.

The *Georgina-Wiso Water Allocation Plan 2023-2031* (*Georgina-Wiso WAP)* was released for public comment in late 2022 [DEPWS, 2023B]. The zone covers the CLA and relates to the management of the groundwater resources of the Wiso Basin and Georgina Basin (Gum Ridge Formation) underlying the southern Sturt Plateau and north-western Barkly region, including at the CPP Area. The ESY for the Georgina Basin in the *Georgina-Wiso WAP* is 186.1 GL/a. The estimated sustainable yield is based on understanding the inflows and outflows of the water resource, including the volumes of water in storage, combined with the inputs (recharge, inflow) and outputs (discharge, outflow, and evapotranspiration) and throughflow.

The *Georgina-Wiso WAP* establishes the proportion of water from the water resource that can be sustainably allocated for drinking water, a range of commercial uses, including Beetaloo petroleum, and to reserve water for Aboriginal economic development.

The allocation to Beetaloo petroleum activity is capped at 8 GL, which is approximately 4% of the annual allocation from the Georgina in the WAP. The present estimated total stock and domestic groundwater extraction for the Georgina Basin is approximately 14 GL/a (DEPWS 2022b). The present GWEL in the Gum Ridge aquifer are listed in **Table 4.10—4** and shown in **Figure 4.10—3**.

Table 4.10—4 GWEL Issued for Gum Ridge Aquifer

Company	GWEL #	Volume (ML) p.a.
Santos	GRF 10280	193.5
Origin	GRF 10285	175
Sweetpea	GRF 10346	299
Imperial	GRF 10316	85
TOTAL Petroleum	-	0.75 GL
Power & Water	-	0.4 GL
Imperial (this EMP)	GRF 10316 (to be applied for)	~128 (p.a Median) (0.95 ML estimated Total for the Activity) 0.75 GL/a extraction licence

Imperial will apply for an increased water allocation in GWEL GWR 10316 from 85 ML/a up to 750 ML p.a. for the proposed Activity. This is not considered to significantly impact available groundwater in the Gum Ridge aquifer (see **Figure 4.10—3**). It is a modest 7.5% of the 8 GL cap on Beetaloo petroleum production in the Georgina WAP and less than 0.3% of the overall Georgina ESY = 186 GL/a. It is noted that the estimated ~950 ML of groundwater extraction for the Activity is significantly less. The potential reuse of HF flowback may reduce overall potential annual Activity groundwater extraction requirements by up to 40%.

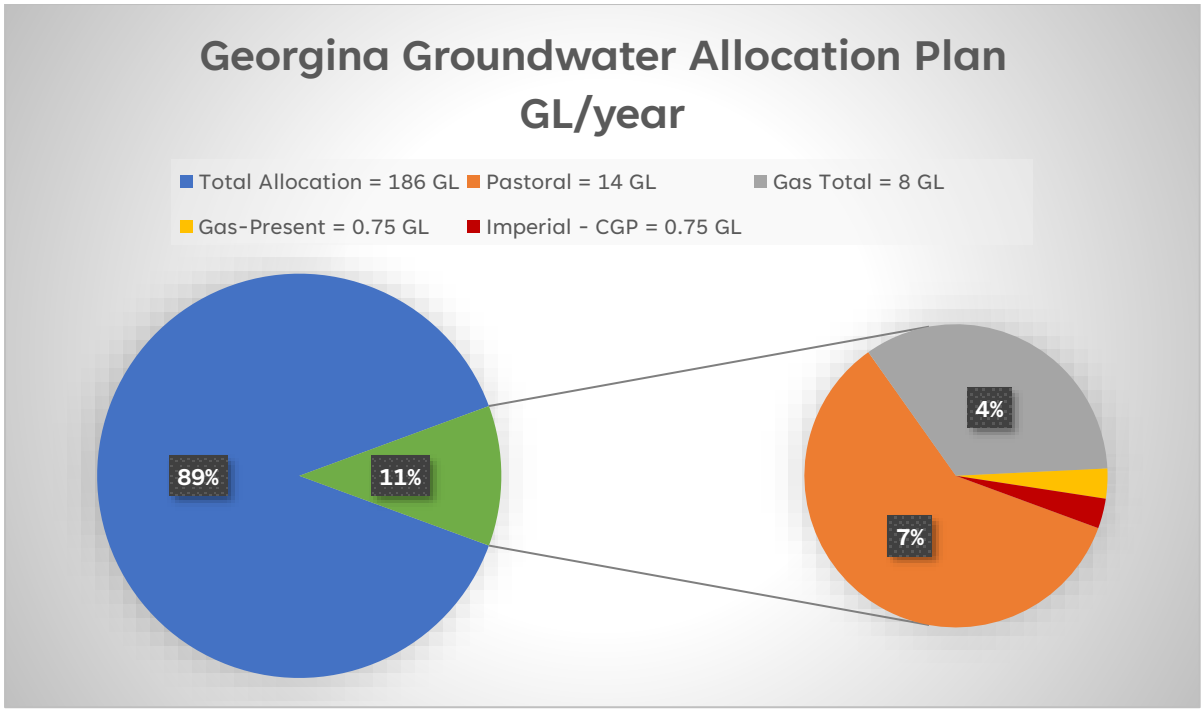
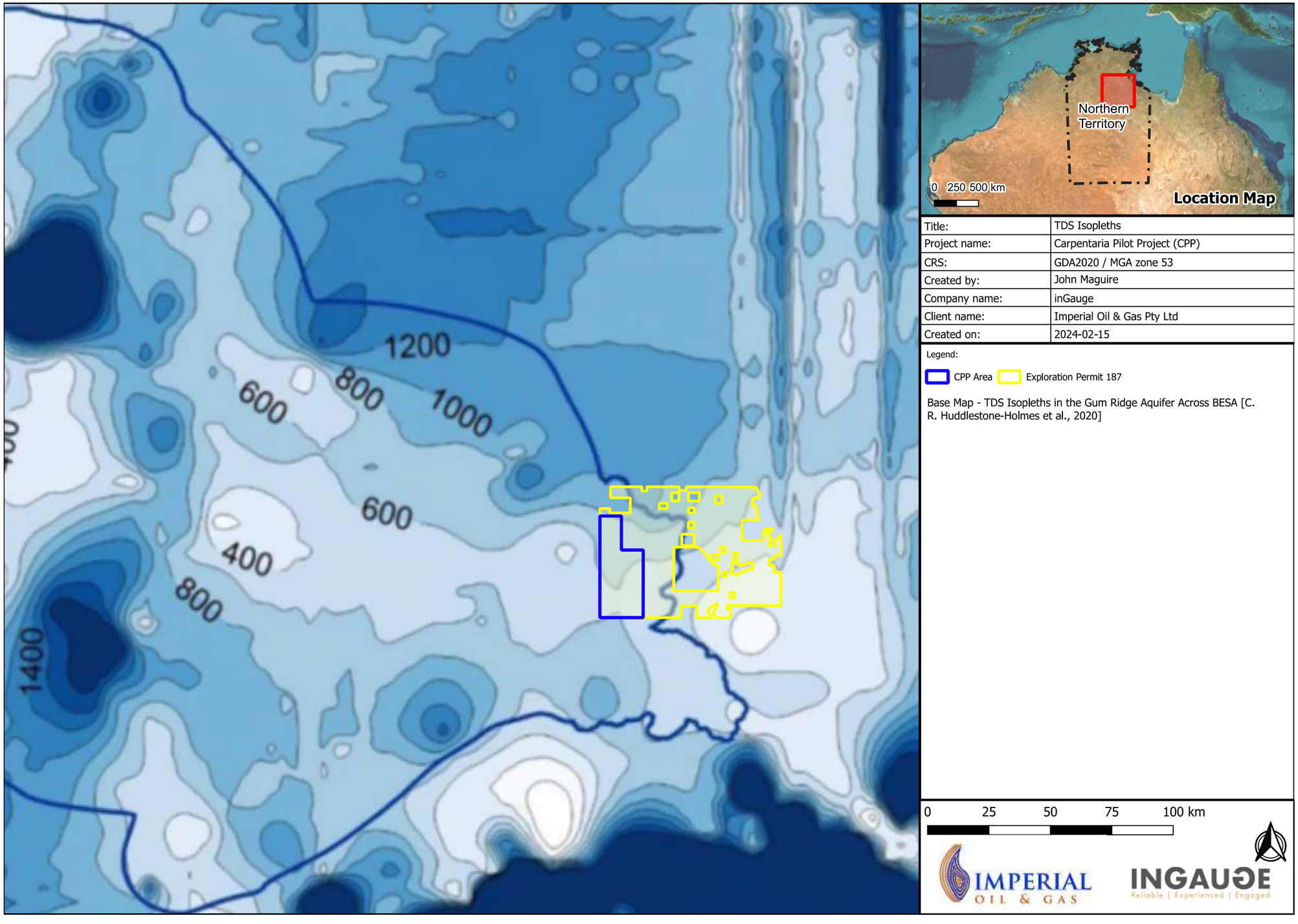


Figure 4.10—3 Georgina Water Allocation Plan Components

4.10.9 CPP Groundwater Monitoring Network

The total dissolved solids (TDS) isopleth mapping of the CLA derived for the SREBA studies [C. R. HUDDLESTONE-HOLMES et al., 2020] has been overlaid with the CPP Area boundaries, as shown in **Figure 4.10—4**. The results of the baseline groundwater monitoring (measured TDS = 705 ± 80 mg/L) are consistent with the eastern boundary of the SREBA in a TDS contour bandwidth of 600 - 800 mg/L.



Title:	TDS Isopleths
Project name:	Carpentaria Pilot Project (CPP)
CRS:	GDA2020 / MGA zone 53
Created by:	John Maguire
Company name:	inGauge
Client name:	Imperial Oil & Gas Pty Ltd
Created on:	2024-02-15

Legend:

CPP Area Exploration Permit 187

Base Map - TDS Isopleths in the Gum Ridge Aquifer Across BESA [C. R. Huddlestone-Holmes et al., 2020]

Figure 4.10—4 Total Dissolved Solids Isopleths in the Gum Ridge Aquifer at CPP [C. R. Huddlestone-Holmes et al., 2020]

A baseline assessment of groundwater quality from the Gum Ridge aquifer commenced in 2019 on EP 187 in the CPP Area. Several station bores, as well as Control Monitoring Bore (CMB) and Impact Monitoring Bores (IMB) bores at the three respective well pads established in the CPP Area, were assessed (**Figure 4.10—5**). The baseline assessment complied with *the Code* and the *Preliminary Guideline for Groundwater Monitoring*, promulgated by DEPWS in 2018 [DEPWS, 2018].

The design of the groundwater monitoring program is based on BACI (Before/After and Control/Impact) sampling, which is widely used in investigations of environmental impacts on water pollution, among others. The groundwater monitoring layout and design, which includes quarterly sampling at the monitoring bore on the well pad, provides the ability to detect any statistically significant impact on groundwater quality at each well pad over the long term.

The existing bores in the CPP Area and environs are shown in **Figure 4.10—5**. The existing groundwater monitoring network in the CPP Area is shown in **Figure 4.10—6**. The groundwater direction in the CLA, indicated in the figures, is to the northwest in this region [S TICKELL, 2022A]. The CMB at the well pads are up-gradient (~southeast) of the respective petroleum wells and the IMB is located down-gradient of the petroleum wells at each well pad as specified in the *Preliminary Guideline for Groundwater Monitoring*. The Guideline permits the extraction of groundwater from both the CMB and the IMB.

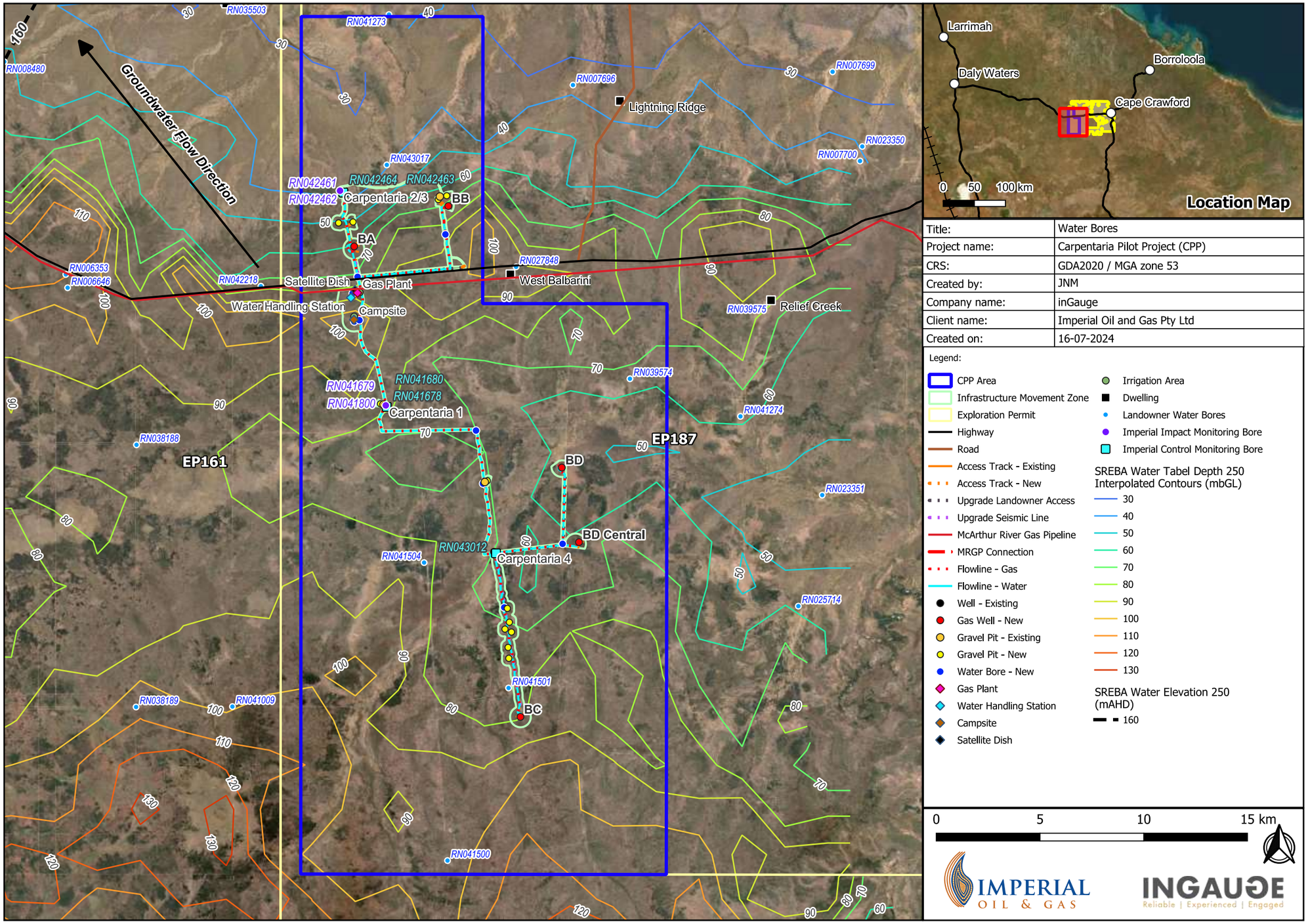


Figure 4.10—5 Existing Groundwater Monitoring Bores

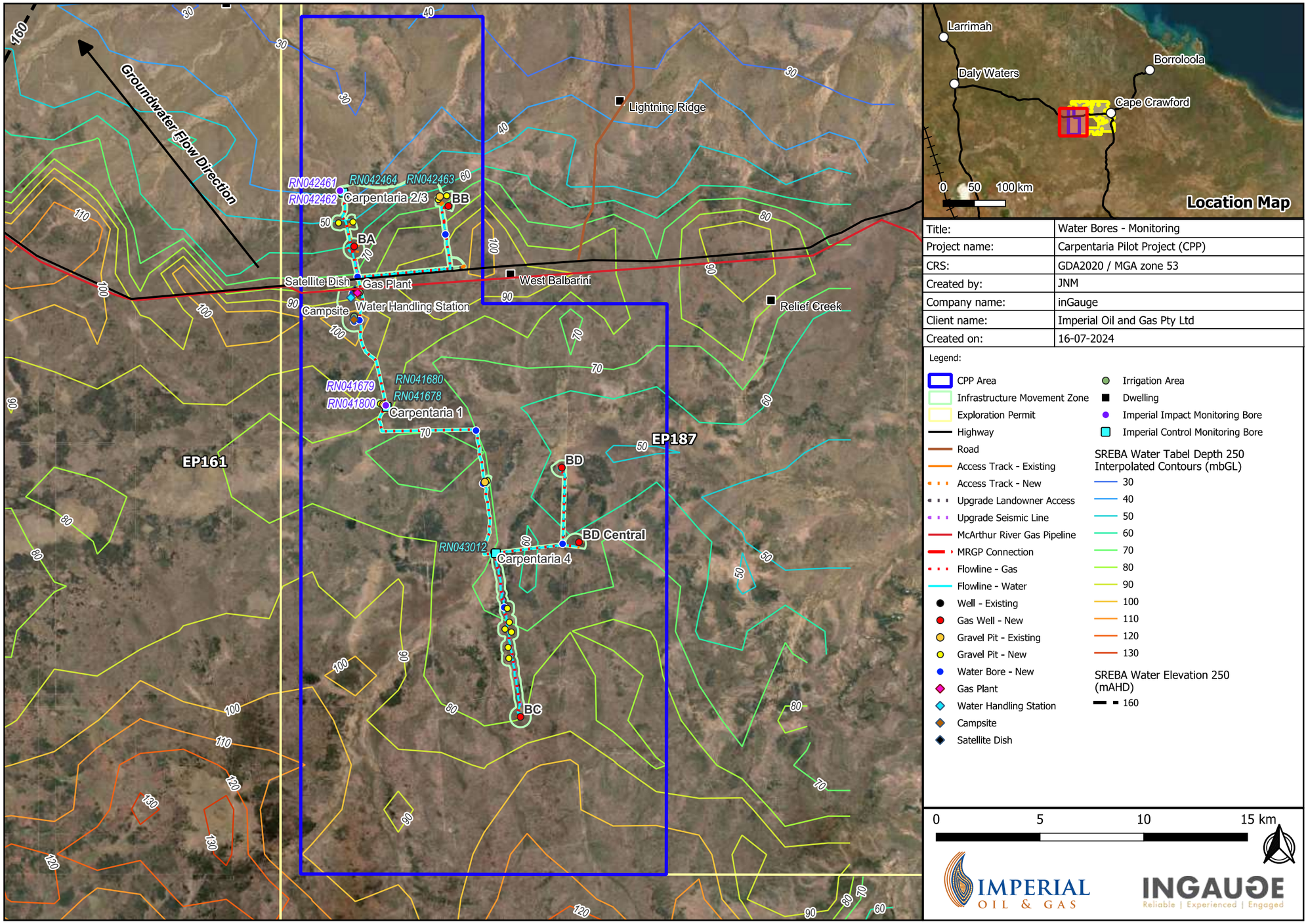


Figure 4.10—6 Existing Groundwater Monitoring Network at CPP with Groundwater Contours and Indicative Flow Direction

A statistical re-analysis and compilation of the time series data of groundwater quality sampling on ten occasions at the Carpentaria 2 well pad[4] was undertaken on Control and Impact Bores (RN042461, RN042462 and RN042463, RN042464) that intercept the Anthony Lagoon and Gum Ridge aquifers respectively. The key results are presented in **Figure 4.10—7** to **Figure 4.10—10**.

The data for each bore and analyte[5] above the Limits of Reporting (LoR) is presented as the mean, and the confidence intervals are computed as ± 1 standard deviation. The data shows that none of the measured levels of key analytes, major cations and anions, pH and metals, or trace metals significantly differ statistically ($p < .05$) between any of the monitoring bores at the well pad.

This confirms that aquifer protection methods in Imperial operations (see **Section 3.5.3**) are effective. The results provide confidence in the statistical ability to detect effects in groundwater across the CPP Area into the future, and that a robust baseline for the 67 specified groundwater analytes is established at well pads. Therefore, this method can detect any anomalous variations in groundwater quality at the well pads in the future.

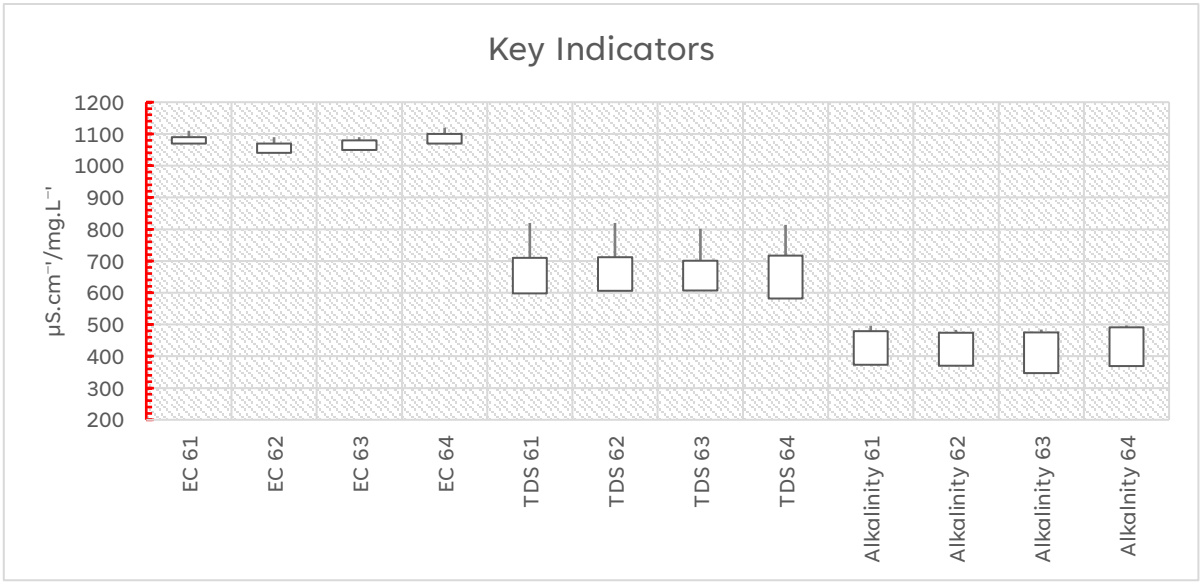


Figure 4.10—7 Salinity and Alkalinity Confidence Intervals at Each Bore (n = 10)

[4] **2022-01-31-imp4.3-gw-quarterly-submission-comparison-carp-2-1.xlsm (live.com)**

[5] There are 67 analytes in the *Preliminary Guideline*

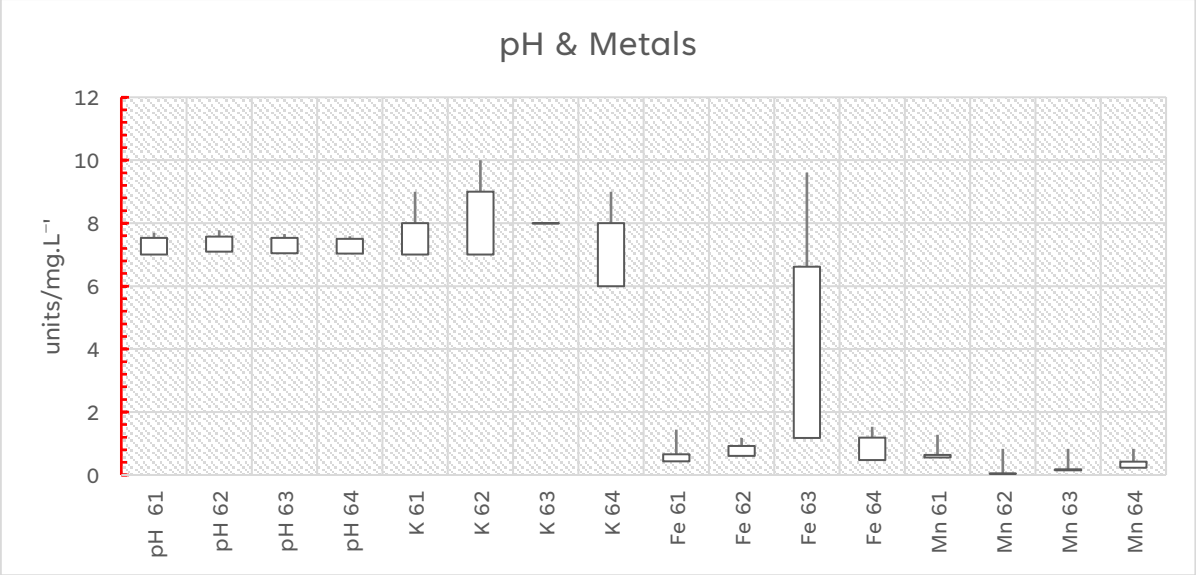


Figure 4.10—8 pH and Metals Confidence Intervals at Each Bore (n = 10)

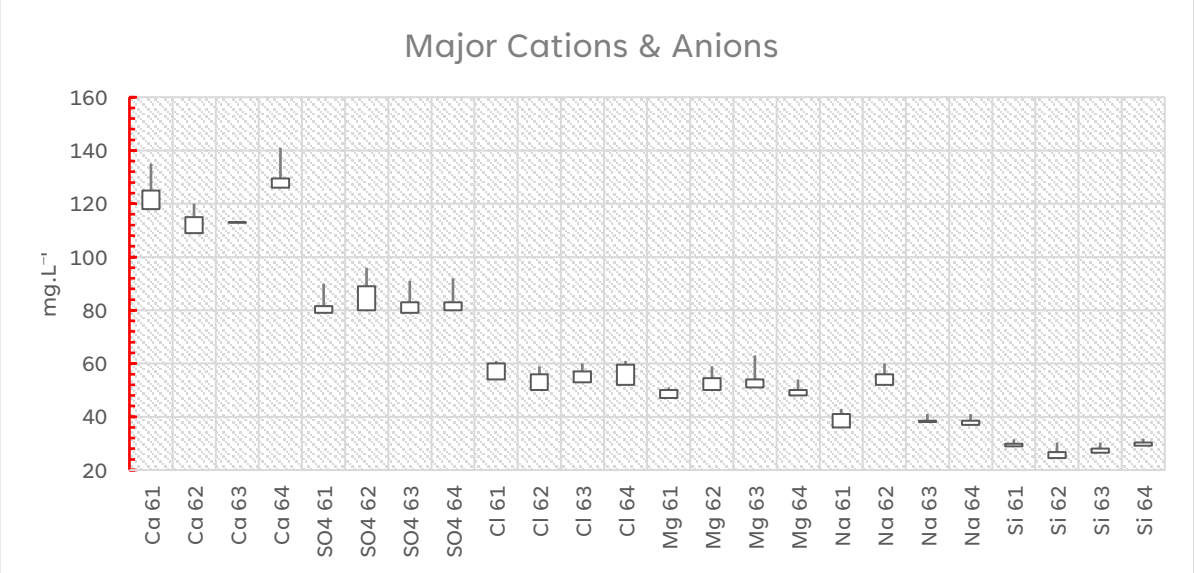


Figure 4.10—9 Major Cations and Anion Confidence Intervals at Each Bore (n = 10)

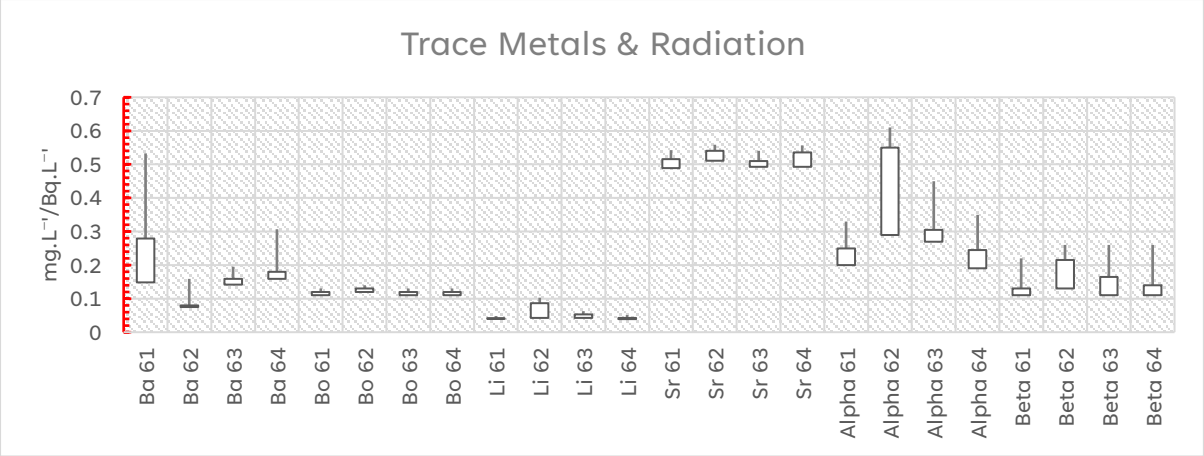


Figure 4.10—10 Trace Metals and Radiation Confidence Intervals at Each Bore (n = 10)

4.10.10 Station and Highway Bores in the CPP Area

All bores in the vicinity of the Infrastructure Movement Zone are either Imperial-owned, for the highway, or station bores (**Figure 4.10—11**). None of the existing non-Imperial bores are within 1 km of potential well pads as required by *the Code*.

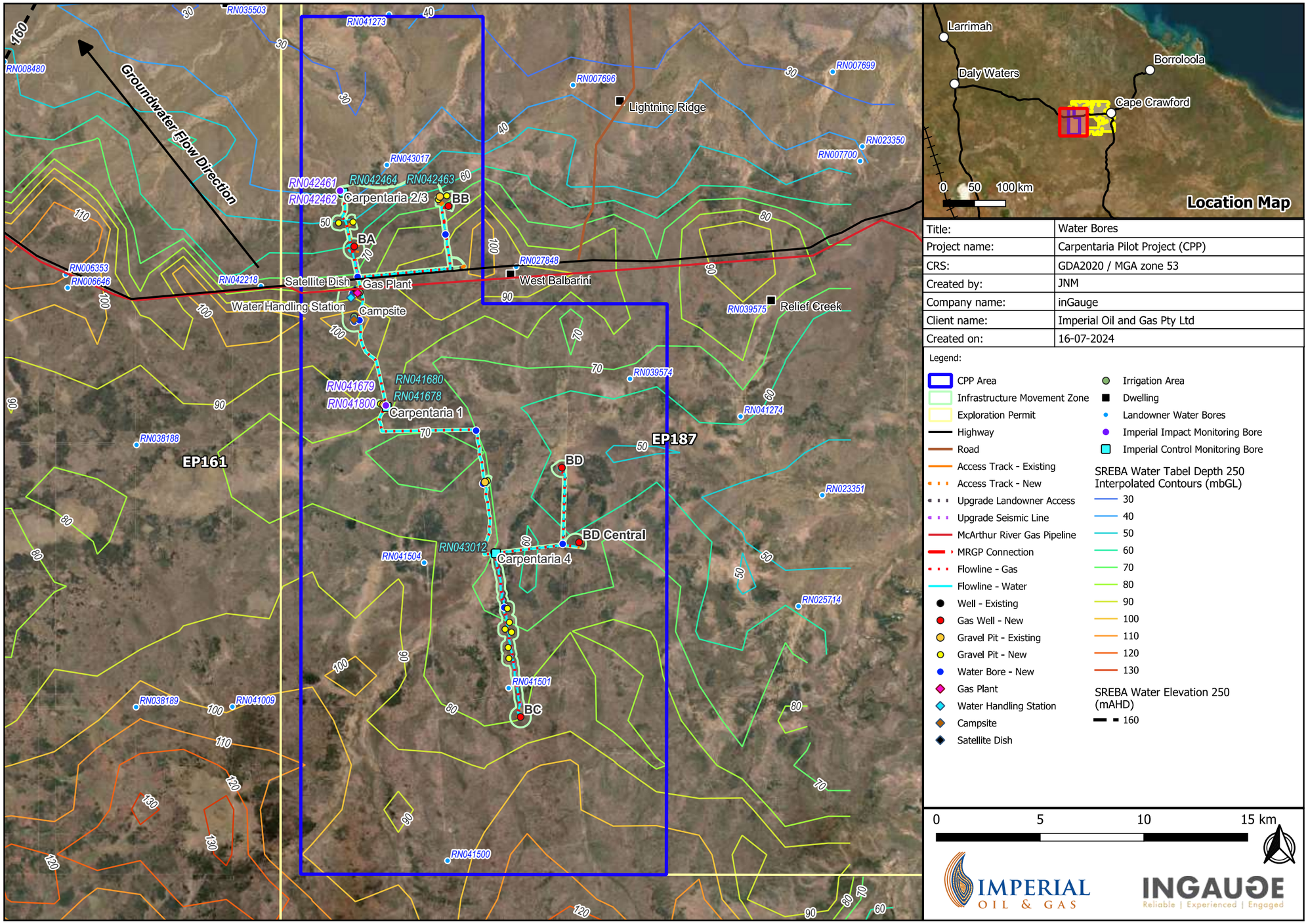


Figure 4.10—11 Groundwater Bores in the Vicinity of CPP Area

4.11 Vegetation

Australian tropical savannah typically consists of three strata:

- An overstorey dominated by evergreen Eucalyptus and Bloodwood tree species.
- A mid-storey of pantropical semi- to fully deciduous tree and shrub species.
- An understorey dominated by annual and perennial tussock grasses.

Although biomass tends to be modest when compared with temperate woodlands and forests of southern Australia, due to their extensive area, these savannahs store about one-third of Australia's terrestrial carbon [M HILL, & N HANAN, 2010]. Edaphic factors are recognised as important in determining the distribution of the plant communities in the region, and this underpinned the development of the Land System classification (previously described) in the CPP Area [C. S CHRISTIAN et al., 1954]. The most important factor influencing the distribution of plant communities is the supply of water. This is a complex of factors, which includes topography (as it affects drainage), internal drainage and permeability of the soils, water-holding capacity and wilting point of the soils, and amount of water received, including rainfall and water contributed by run-off from other areas. The following vegetation communities were identified within or near the CPP Area from SREBA GIS data layers [DEPWS, 2022]:

- Silver Box (*Eucalyptus pruinosa*) low open woodland on imperfectly drained clay soils with tussock grass understorey - monoculture stands are found on low-lying floodplain areas.
- Glossy leaved box (*E. chlorophylla*) low open woodland where clay content becomes lighter loam with tussock grass understorey.
- Bloodwood (*Corymbia* spp.) open woodland on sandy clay with tussock grass understorey.
- Woollybutt (*E. miniata*) open woodland on rapidly draining, deep sandy soils.
- Snappy gum (*E. leucophloia*) low open woodland on rocky, gravelly soils on the margins and slopes of Cainozoic duricrust in Gulf Falls and Uplands.
- River Red Gum (*E. camaldulensis*) riparian vegetation along ephemeral waterways and fringing topographic depressions, which form ephemeral soaks.
- Lancewood (*Acacia shirleyi*) provide the thickest vegetation cover in the landscape.

The dominant vegetation community in the Sturt Plateau and at the CPP is Bloodwood/ Eucalyptus open woodland with mixed tussock grass species [L YOUNG, J PATYKOWSKI, I LEIPER, C NANO, A FISHER, et al., 2022].

In the north of the CPP Area, the vegetation shows marked change from bloodwoods and eucalypts, distributed in open forest on clay loam soils, to a sandstone basement of Eucalypts, demarcating the crest of the Favenc Range and the rapid drop in elevation to the north and east, as discussed in **Section 4.3**.

A site-specific field environmental assessment was undertaken in October 2023 by a qualified ecologist (**Appendix 01** Environmental Assessment Report) and a civils specialist. The site visit included the assessment, and adjustment of the five new proposed well pad locations (BA, BB, BC, BD, and BD central); linear corridors for access to well pads including flowline/gathering network and access track; and the infrastructure area which encompasses CGP, WHS and the campsite. Imagery of the vegetation types identified in the field survey in the CPP area are shown in **Table 4.11—1**.

Table 4.11—1 Vegetation types in the CPP Area

CPP Area Photo 2023	Vegetation Description
	Eucalypt woodland with native tussock grassland groundcover. Dominant canopy species include silver box (*Eucalyptus pruinosa*) and coolabah (*E. microtheca*). Some areas contain monoculture stands of silver box.
	Eucalypt floodplains / ephemeral soaks. Canopy is low and open and often consists of coolabah (*E. microtheca*), with fringing *E. camaldulensis*.
	Low rocky undulating rises. Snappy gum (*E. leucophloia*) and spinifex (*Triodia* sp.).

CPP Area Photo 2023	Vegetation Description
	Riparian vegetation along ephemeral waterways. Riparian vegetation is sparsely scattered and consists of river red gum (*E. camaldulensis*) or snappy gum (*E. leucophloia*).
	Lancewood (*Acacia shirleyi*) This species can provide the thickest vegetation cover in the landscape and therefore provides: • Shade and refuge for a variety of fauna species. • Fallen branches provide ground cover and refugia for small mammals and reptiles.

The site ground-truthing identified low-lying ephemeral soaks and other environmental features that have now been avoided at two of the proposed well pad locations, as discussed in **Appendix 01** (Environmental Assessment Report).

4.11.1 SREBA Vegetation Disturbance Analysis

Eighteen broad vegetation groups (BVG) identified in the SREBA report [L YOUNG, J PATYKOWSKI, I LEIPER, C NANO, A FISHER, et al., 2022] and their associated indicative cumulative total areas were identified in the CPP Area. Three of the BVG are classified as groundwater-dependent ecosystems (GDE) and two of these are considered riparian vegetation. The proposed new vegetation disturbance areas in the CPP Footprint occur in thirteen BVG as shown in **Table 4.11—2**. None of the BVG in the CPP footprint are identified as GDE/riparian. As noted previously, the proposed new well pads and other surface infrastructure will not be located on or near creek lines, with buffers measured from the outer edge of riparian vegetation as outlined in the *Land Clearing Guidelines* [DEPWS, 2021C].

Table 4.11—2 Summary of Cumulative BVG in CPP Area and Totals for CPP Footprint Disturbance

BVG #	Broad Vegetation Description	Landform	GDE	CPP Area	CPP Footprint
1	Corymbia/Eucalyptus open woodland on sandy loam			22,494	86.95
2	Corymbia/Eucalyptus woodland (run-on heavier soil)	Run-on		2,583	1.91
3	Corymbia bella woodland on alluvial plains	Floodplain - Seasonal		23	
4	Eucalyptus miniata open woodland on loamy sand			17	
5	Riparian woodland (ephemeral streams)	Riparian - Seasonal	GDE - Type 2/3	959	
6	Melaleuca forests (springs, river channels)	Riparian/wetland - Permanent	GDE - Type 2/3	4	
8	Snappy gum low open woodland			8,855	44.99
9	Lancewood forest			6,235	23.3
10	Bullwaddy shrubland and woodland			372	0.23
11	Bauhinia and Corymbia open woodland on sandy clay			651	
12	Eucalyptus chlorophylla low open woodland			6,196	19.26
13	Silver box low open woodland			3,855	4.25
14	Coolabah low open woodland on clay	Floodplain		420	0.15
15	Coolabah, Lophostemon and Gutta Percha swamps	Wetland/floodplain		522	0.34
16	Melaleuca low open woodland on floodplains and drainage depressions	Floodplain/drainage depression		22,494	1.43

BVG #	Broad Vegetation Description	Landform	GDE	CPP Area	CPP Footprint
17	Tussock grassland			2,583	0.02
20	Corymbia/Eucalyptus woodland on sandstone			23	6.81
21	Acacia shrubland and hummock grassland on sandplains			17	0.06
999	Intensive Uses/Tracks			959	20.3
			TOTAL	**60,613**	**189.7**

The breakdown of the BVG disturbance indicative areas (rounded) associated with each of the different infrastructure types for the CPP Area is shown in **Table 4.11—3**.

Table 4.11—3 BVG and Associated Infrastructure in Proposed Disturbance Areas

Indicative Vegetation Types	BVG	Area (ha)
Well Pads		
Corymbia/Eucalyptus open woodland on sandy loam	1	29.2
Snappy gum low open woodland	8	15.9
Eucalyptus chlorophylla low open woodland	12	11
Lancewood forest	9	9.27
Corymbia/Eucalyptus on sandstone	20	4.1
Silver box low open woodland	13	3.63
Corymbia/Eucalyptus open woodland run-on	2	0.15
Coolabah, Lophostemon and Gutta Percha swamps	15	0.05
		73.3
Camp Site		
Snappy gum low open woodland		**1.14**
Flowlines		
Corymbia/Eucalyptus open woodland on sandy loam	1	9.2
Eucalyptus chlorophylla low open woodland	12	4.4
Lancewood forest	9	4.3
Snappy gum low open woodland	8	3.7
Corymbia/Eucalyptus open woodland run-on	2	1.67
Melaleuca low open woodland on floodplains drainage depressions	16	1.4
Corymbia/Eucalyptus woodland on sandstone	20	0.8
Silver box low open woodland	13	0.29
Coolabah, Lophostemon and Gutta Percha swamps	15	0.29
Coolabah low open woodland on clay	14	0.15
Acacia shrubland and hummock grassland on sandplains	21	0.06

Indicative Vegetation Types	BVG	Area (ha)
Tussock grassland	17	0.02
		26.3
Gas Plant		
Corymbia/Eucalyptus open woodland on sandy loam		4.6
Eucalyptus chlorophylla low open woodland		0.43
		5.1
Irrigation Area		
Snappy gum low open woodland	8	0.8
Corymbia/Eucalyptus open woodland on sandy loam	1	0.37
Eucalyptus chlorophylla low open woodland	12	0.2
		1.37
Gravel Pits		
Corymbia/Eucalyptus open woodland on sandy loam	1	29.3
Snappy gum low open woodland	8	20
Lancewood forest	9	7.4
Corymbia/Eucalyptus woodland on sandstone	20	1.5
Eucalyptus chlorophylla low open woodland	12	1.5
Bullwaddy shrubland and woodland	10	0.23
Corymbia/Eucalyptus open woodland run-on	2	0.03
		59.9
Water Bore Pads		
Corymbia/Eucalyptus open woodland on sandy loam	1	0.53
Snappy gum low open woodland	8	0.26
Lancewood forest	9	0.25
		1.0
Sales Gas		
Corymbia/Eucalyptus open woodland on sandy loam	1	**0.04**

Indicative Vegetation Types	BVG	Area (ha)
Satellite Dish		
Corymbia/Eucalyptus open woodland on sandy loam	1	**0.25**
Access Tracks		
Corymbia/Eucalyptus open woodland on sandy loam	1	3.91
Snappy gum low open woodland	8	3.3
Lancewood forest	9	2.06
Eucalyptus chlorophylla low open woodland	12	1.73
Corymbia/Eucalyptus woodland on sandstone	20	0.43
Silver box low open woodland	13	0.27
Corymbia/Eucalyptus open woodland run on	2	0.08
Melaleuca low open woodland on floodplains and drainage depressions	16	0.01
		11.8
WHS		
Corymbia/Eucalyptus open woodland on sandy loam	1	9.5
Snappy gum low open woodland	8	1.05
		10.55

4.11.2 Georeferenced Imagery of Proposed Key Surface Infrastructure

The field survey conducted in October 2023 included georeferenced imagery of the indicative proposed key infrastructure sites in the four cardinal directions as shown in **Figure 4.11—1**. The imagery also provides approximate slope and elevation measurements for each of the sites.

The soil types for each of the proposed well pad sites is evident as red kandasol, confirming engineering suitability for well pad construction and operations (see **Section 4.7**). The indicative locations for the Water Handling Station and Gas Plant are on gravelly lateritic soils which will provide good drainage in the surface horizon.

Termite mounds are evident in several of the well pad sites, including BD well pad which is the lowest elevation in the proposed new well pad locations. Termite mounds have longevity, and

their distribution has been used in tropical savanna as a proxy for determining local flooding risks and an indicator of surface geology and hillslope morphology. The presence of termite mounds confirms the area is not subject to flood inundation or submergence. Termites are detritivores, aided by microbial symbionts present in the gut, which dissimilate cellulose, enabling the absorption of the end products by the termites. With an almost endless amount of grass and its corresponding litter in these savannas, mound-building species like *A. laurensis*, *N. magnus*, and *D. rubriceps* have become dominant, feeding on these substrates [R. A CLEMENT et al., 2021].

The associated BVG vegetation classes associated with each of the sites is also listed. The vegetation associated with the indicative well pad areas consist of almost complete cover of cured tussock grass (late in the Dry Season), minimal midstory woody shrubs consisting largely of turpentine and open canopy of eucalypts and bloodwoods. Lancewood where present is open and mainly juvenile or semi-mature. In contrast, the Water Handling Station and Gas Plant have more limited tussock grass cover and turpentine (*Acacia lysiphloia*), which favours gravelly areas, is more prevalent. There is no evidence of canopy fires in any of these locations, likely due to the low fuel loads present in the understory and the open nature of the canopy. There is very limited fallen timber, and no litter accumulation is evident.

Well Pad BA - Corymbia/Eucalyptus Open Woodland On Sandy Loam

Well Pad BB - Corymbia/Eucalyptus Open Woodland on Sandy Loam + Snappy gum Low Open Woodland

Well Pad BC - Corymbia/Eucalyptus Open Woodland on Sandy Loam + Lancewood Forest

Well Pad BD - Eucalyptus Chlorophylla Low Open Woodland + Snappy Gum Low Open Woodland

Well Pad BD Central - Corymbia/Eucalyptus Open Woodland on Sandy Loam + Lancewood Forest

Carpentaria Gas Plant - Corymbia/Eucalyptus Open Woodland + Eucalyptus chlorophylla Low Open Woodland

Water Handling Station - Corymbia/Eucalyptus Open Woodland + Eucalyptus Chlorophylla Low Open Woodland

Figure 4.11—1 Indicative CPP Infrastructure Locations Georeferenced Imagery

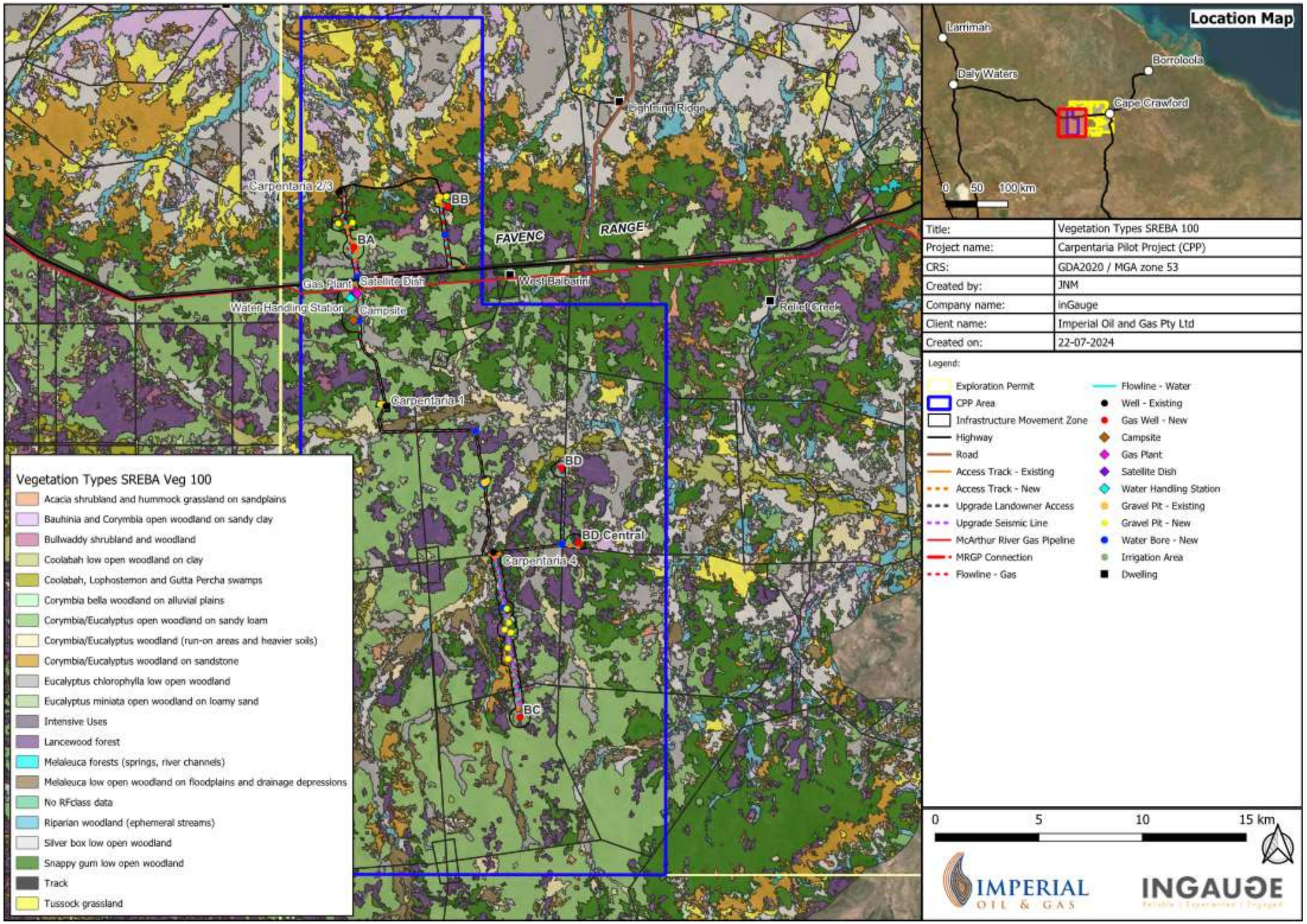


Figure 4.11—2 Vegetation Types in the Region Aligned with the Crest of the Favenc Range (from SREBA)

4.11.3 Tussock Grassland

In this savannah tree-grass system, tussock grassland dominates the understorey vegetation in the Sturt Plateau bioregion, including in the CPP Area [DEPWS, 2022]. This vegetation is characterised by large perennial tussock grasses, broad-leaved and lilioid herbs in the inter tussock spaces and sparse presence of woody plants. In localised areas of higher soil moisture, such as ephemeral topographic depressions, common in the region, forbs may dominate over tussock grasses. Following rains the annuals are the main source of feed. As the pastures mature the tussock grass seed heads become important and later still, when the annuals have disintegrated, the tussock grass clumps are heavily grazed throughout the Dry Season. Beef cattle are the main animals grazing the pastures of the region; the pastures are unsatisfactory for sheep, being tall and of wide protein-carbohydrate ratio for the greater part of the year [C. S CHRISTIAN et al., 1954].

The vegetation is seasonally fire-prone due to the curing of the annual grasses during the dry monsoonal winters. Key tussock grass species in the CPP Area are identified in **Table 4.11—4**. Savannah tussock grasses are considered resilient perennial vegetation that is relatively unproblematic to rehabilitate in the CPP Area's deep loam clay sand and Red Kandosol soil, provided erosion control is managed, and is has seasonally synchronous seed production.

This hardiness is evidenced by Sturt Plateau savannah's recovery after drought, fire, and overgrazing effects. The topsoil from the CPP Area is used in the re-vegetation of bare areas, as evidenced by the ongoing monitoring of the Imperial EP 187 seismic line rehabilitation [IMPERIAL, 2023] (see **Appendix 03** Rehabilitation Management Plan).

Tussock grasses have modular growth forms that grow as single plants in clumps, tufts, or bunches rather than forming a continuous lawn or meadow [S MORTON, 2022]. These grasses are deep-rooted (~2 m) when mature and structurally capable of breaking up the large, high-energy drops of rain in intense, short-duration rainstorms, characteristic of summer convectional storm events in the Sturt Plateau Bioregion.

Table 4.11—4 Key Tussock Grasses Identified Within the CPP

Name	Scientific Name	Description
Kangaroo Grass 	**Themeda triandra**	• Widespread Australian native grass; grows as a tussock tufted perennial to 1.5 m tall and up to 1 m wide. • Grows in sandy soils to heavy clays; common in areas where moisture collects. • Most common in situations where grazing disturbance is low, water is periodically available and where fire occurs. Associated with a wide range of other grasses and herbaceous species. • Persistent under low soil nitrogen conditions. • Very palatable to livestock pre-flowering; rapid early Wet Season growth. • Seed can be harvested from native pasture stands. • Can gain high biomass and block out other grasses and forbs. • Most healthy when occasionally reduced by burning, grazing, or mowing, but it declines if overgrazed. Highly flammable. • Seeds are eaten by birds, and leaves used as nesting material. • Seeds generally begin to ripen in early December.
Ribbon Grass 	**Chrysopogon fallax**	• Drought resilient and tolerant to periodic grazing pressure. • Reliable indicator of good pasture condition. • Occur in depressions in red soil country and along creek lines. • Seeds of this species are eaten by the Gouldian finch.
Plume Sorghum 	**Sorghum plumosum**	• Tufted, perennial grass 1–3 m tall. • Stems have distinctive bearded nodes. • Sands, red earths and heavy loams, swamps, claypans, watercourses, and waterholes. • Seeds of this species are eaten by the Gouldian finch.
White Grass 	**Sehima nervosum**	• Intermediate species in most pasture types following fire. • Perennial (lives for more than two years). • Tussocks grow up to 1 m high. • Sandy, loam, and red clay soils; not on deep sands (dunes) or cracking clays. • Where fire is absent, moribund growth forms a thick mat on the ground, which seems to reduce germination and establishment of other grasses and forbs.
Water Grass 	**Eulalia aurea**	• Found in clay loam soils, good pioneer species. • Dense, Wet Season, tussocky perennial to 90 cm tall. • Found in moist areas on flats and along creeks. • Moderate drought tolerance; low frost tolerance. • Decreases in abundance under heavy, Wet Season grazing.

Name	Scientific Name	Description
Feathertop Threeawn 	**Aristida inaequiglumis**	• Leafy, erect, long-lived perennial grass that grows to 60–90 cm tall, forming dense tussocks. • Indicator of poor pasture condition, where this species is dominant. • Considered to be an undesirable pasture species. • Tends to be an increaser on light soils where it can withstand heavy pasture grazing pressure because it is unpalatable.
Giant Spear Grass 	**Heteropogon triticeus**	• The plant grows to over 2 metres in height. • Favoured in most environments by frequent burning. • Ideal drought-tolerant revegetation species. • Important food source and nesting site for native birds and small mammals. • Seeds are eaten by Gouldian Finch.

Tussocks are formed, which create considerable horizontal obstruction to surface flow and provide habitat for diverse guilds of soil organisms that build and maintain biopores. Surface obstructions and biopores increase the potential for local capture and storage of runoff.

Tussock patches in runoff zones build on themselves and persist in more favourable habitats due to depressions in terrain; they are thus likely to lead to greater infiltration. The patch itself, through its structure and biota, also increases the potential for infiltration [J LUDWIG et al., 1996]. These features of tussock grass biomes are important to consider in erosion control on sandy-clay soils, and in land rehabilitation associated with proposed CPP activities.

A tussock grass ecosystem is resilient and dynamic; it grows, matures, and senesces in response to weather and soil conditions. Animals feed on the foliage, seeds, and roots, eliciting physiological responses of the grass species [S MORTON, 2022].

The extremely high biodiversity of termites and ant species reported in the Sturt Plateau [DEPWS, 2022], the "keystone" animal groups in this ecosystem, reflect the very significant biomass and carbon turnover available in the tussock grass vegetation of tropical arid savannah systems [S MORTON, 2022]. The soil microflora and microfauna change the physical and chemical properties of the soil, generating feedback that modifies the state of the system through time and in the surface soil profile, as evidenced by the high CEC at the CPP well pads (**Section 4.7.3**).

4.11.4 Bushfires

Worldwide, tropical savannah biomes are intrinsically maintained by fire; however, these fires are also a major contributor to global GHG emissions. Australian tropical savannah bushfires burn approximately 200 Mt of carbon annually and release an estimated 750 Mt CO_2-e into the atmosphere, contributing to approximately 5% of global emissions [M HILL, & N HANAN, 2010].

However, to date, CO_2 typically has not been accounted for in savannah burning emissions inventories on the assumption that CO_2 produced by savannah burning during the Dry Season is re-absorbed by plant growth the following Wet Season [J RUSSELL-SMITH et al., 2009].

With the arrival of the pastoral industry to northern Australian savannah regions in the late 19th century, the temporal and spatial patterns of annual deliberate burning that had been developed and applied by Aboriginal people over millennia were replaced by episodic, and random fire regime in just a few short generations [J RUSSELL-SMITH et al., 2009].

A critical salient feature of contemporary savannah fire regimes in Northern Australian concerns the predominance of fires occurring in the latter part of the Dry Season from August until November. For example, of the annual mean 351,000 km^2 of the tropical savannah region affected by large fires from 1997–2007, 67% occurred in the late Dry Season months of August–November [J RUSSELL-SMITH et al., 2009].

The majority of savannah fires typically occur under severe fire weather conditions, periodically strong southeasterly winds, high temperatures, low humidities, and fully cured fuels [Russell-Smith et al, 2009]. Riparian vegetation can be sensitive to fire, especially in the late Dry Season, when fires can reduce the abundance and diversity of riparian vegetation by increasing mortality of established trees [SAMANTHA CAPON et al., 2016]. This late Dry Season fire pattern is apparent in the 2023 fire history in the Beetaloo region.

A fire history report (2001-2023) was generated from the NAFI database[6] Linked Area for the CPP Area, which encompasses the Sturt Plateau bioregion (~ 98,500 km^2) to the west and the Gulf Fall and Uplands bioregion (~112,500 km^2) to the east and north. The bioregional burn history is shown in **Figure 4.11—3**. This report reveals that large-scale fires occur roughly every five to six years in the region. On average, during the last decade, approximately 6,500-8,000 km^2 were burnt each year in each bioregion. This equates to approximately 7% of the total area in each bioregion burned annually. Bushfires in both bioregions in 2023 were particularly widespread.

The potential fuel load is a key driver of fire behaviour, fire-line intensity, and bushfire hazard. Fire-line intensity is a standardised measure of the rate that an advancing fire would consume fuel energy per unit time per unit length of fire front introduced by [GM BYRAM, 1959]. Potential fuel loads represent the approximate mass (measured in tonnes/ha) of combustible fuel material that would typically accumulate if vegetation were not regularly burnt or subject to fuel reduction practices. Numerically, it is equal to the product of the fuel low heat of combustion (kJ/kg), quantity of fuel consumed in the flaming front (kg/m^2), and the linear rate of fire spread (m/s). Criteria for assessment of fuel load are provided in the CSIRO's *Bushfire Best Practice Guideline* [CSIRO, 2024] and includes:

- Fuel quantity (tonnes of fuel per ha).
- Vegetation assessment i.e. grassland, shrubland, scrub, open woodland or forest.
- Fuel size and shape, e.g. fine fuel such as tussock grass that burns quickly, woody shrubs that burn moderately (e.g. Turpentine) and coarse fuel (fallen logs, trunks) that burn more slowly.
- Fuel vertical structure i.e. height and density of tussock grass and mid-story shrubs, closed or open canopy, separation of understorey to canopy.
- Moisture content including time since last rain, strong winds, high temperatures, and low humidity which will decrease moisture level.

[6] **https://www.firenorth.org.au/**

Bushfires in the region are restricted to ground cover consisting of cured tussock grasses and mid story woody shrubland regrowth, such as Turpentine (*Acacia lysiphloia*), common in the CPP Area, which can significantly add to the potential fuel load. Canopy fires are generally uncommon in the region's tussock grass savannah open woodland. Vegetation in the CPP area is described in **Section 4.11**. **Appendix 12** is the Bushfire Management Plan for the CPP Area**.**

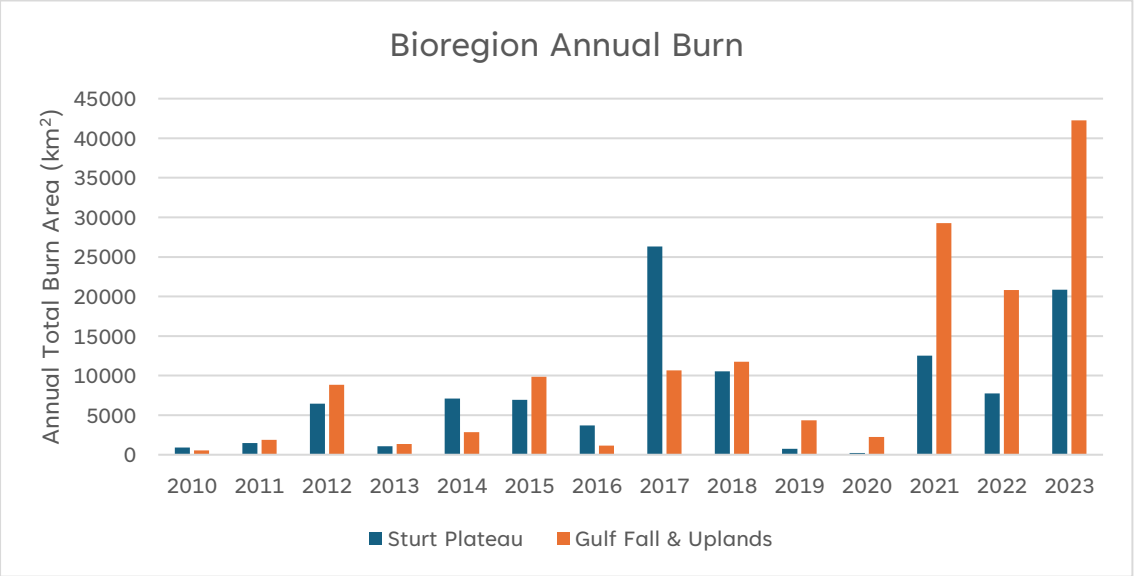


Figure 4.11—3 Bioregion Annual Burn History

The time since the most recent bushfire within the CPP Area differs between the north and south of the Carpentaria Highway (see **Figure 4.11—4**). North of the highway, the most recent bushfire in the CPP Area was in 2021, whereas south of the highway, it has been up to five to six years since the last fire. South of the highway where the location of new proposed infrastructure is located, fire frequency during the last decade is three/two times, whereas north of the highway it is more frequent and five times (see **Appendix 12** – Bushfire Management Plan).

Fire rapidly recycles plant material into the soil reserve through nutrient-laden ash, and rapidly recycles lignified cellulose in wood that may otherwise take decades to break down. However, fires naturally reduce plant material to carbon dioxide, representing, in turn, a net loss of above-ground organic carbon to the reserve [J LUDWIG et al., 1996].

Tussock grasslands (common throughout the CPP Area) are fire-prone and can regrow rapidly after being burnt. Cattle and sheep grazing have been the major land use in tussock grasslands since European settlement. Fire is a useful management tool in pastoral regions and is used strategically for several reasons. Grazing distribution and pasture quality are improved by livestock being attracted to the new native pasture growth that comes after fire.

Producers can improve grazing distribution and pasture utilisation by burning areas under-utilised by livestock or affected by patch grazing. Fire also benefits production by removing scrub growth, rank, and poor-quality feed and promoting nutritious regrowth, which is highly digestible and produces increased livestock weight gain.

Fire can also be used to modify pasture composition by timing burns to coincide with critical phases in a target species growth cycle, such as at seeding or as part of an integrated approach to a broader weed control program [J RUSSELL-SMITH et al., 2009].

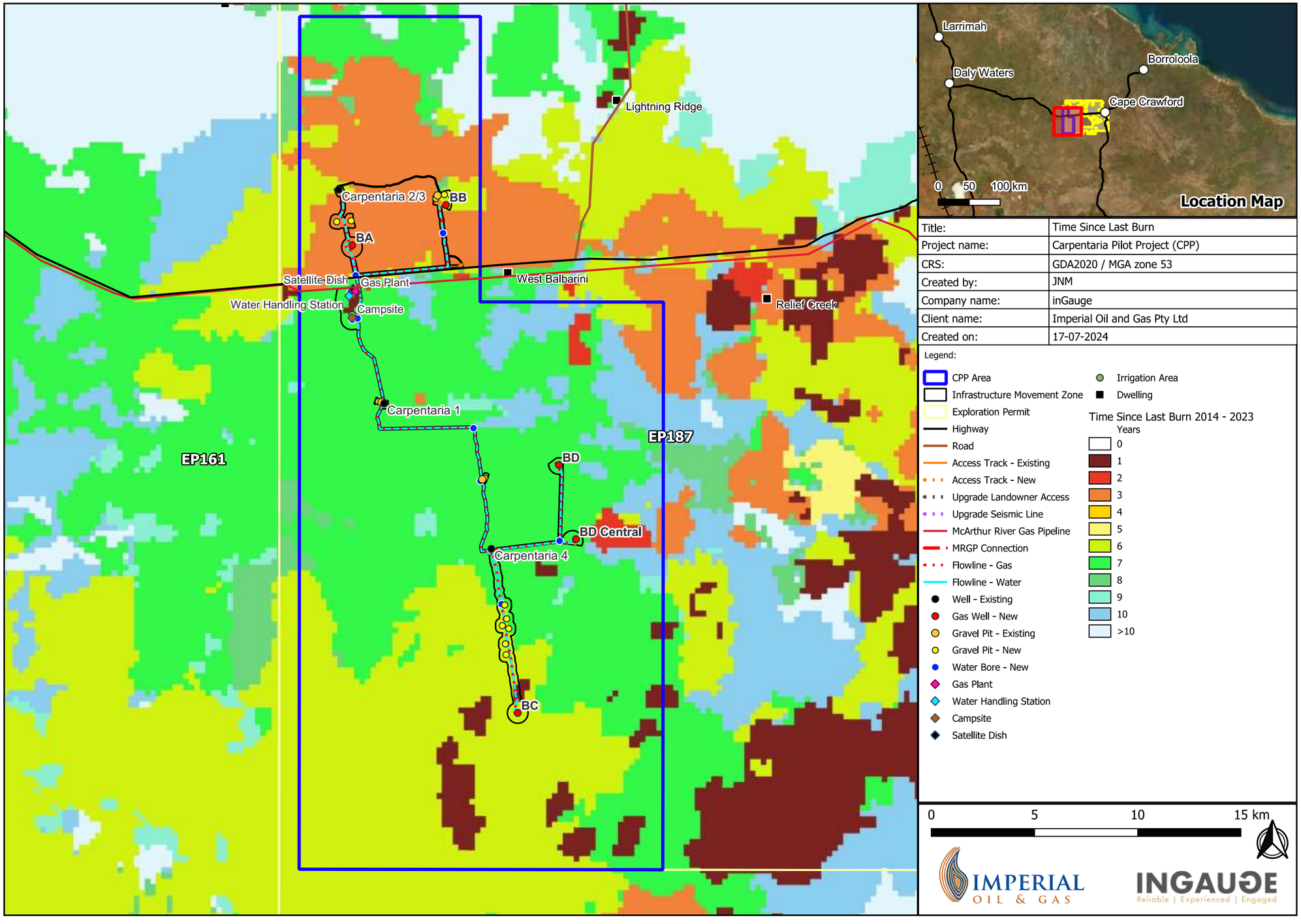


Figure 4.11—4 Time Since Last Burn 2014-2023

4.12 Fauna and Flora

The SREBA reports [L YOUNG, J PATYKOWSKI, I LEIPER, C NANO, A FISHER, et al., 2022] were analysed to identify records of threatened flora and fauna in the CPP Area and surrounds, during previous baseline assessments. This search included both the *Environment Protection Biodiversity Conservation Act 1999* (EPBC Act) and *Territory Parks and Wildlife Conservation Act 1976* (TPWC) listed species (**Appendix 01** Environmental Assessment Report).

A total of six threatened or significant fauna species were previously recorded within a 1 km radius near the study area during the targeted 2021-2022 SREBA surveys. Those observed were the threatened Grey Falcon (*Falco hypoleucos*), marine listed Fork-tailed Swift (*Apus pacificus*) and Rainbow Bee-eater (*Merops ornatus*), the near threatened Australian Bustard (*Ardeotis australis*) and Pictorella Mannikin (*Heteromunia pectoralis*) and the data deficient Northern Blue-tongued skink (*Tiliqua scincoides intermedia*) (**Appendix 01** Environmental Assessment Report).

Subsequent to the environmental assessments associated with the Environmental Assessment Report (**Appendix 01**) (which was finalised in October 2023), the Northern Blue-tongued skink was uplisted to Critically Endangered and the Merten's Water Monitor (*Varanus mertensi)* was listed as Endangered, in December 2023 [DCCEEW, 2023]. Previously the Northern Blue-tongued skin was listed as Data Deficient, and Merten's water Monitor was not listed under the EPBC Act. Hence, these two species were not identified in the following EPBC listings (PMST and SIA) detailed below, as well as in the Environmental Assessment Report (**Appendix 01**). An addendum to **Appendix 01** has been made to include Significant Impact Assessments for these two species.

Controls for the protection of threatened species, including the Northern Blue-tongued skink are discussed in **Section 6** (Environmental Risks and Mitigation Measures).

There were no threatened fauna (EPBC or TPWC) species observed within the study area during on-ground surveys in October 2023; however, one near threatened fauna species was identified, the Spectacled Hare-wallaby (*Lagorchestes conspicillatus*) (**Appendix 01** Environmental Assessment Report). Wallabies are highly mobile, inherently shy, and are unlikely to be impacted by the Activity as they can readily avoid Activity disturbance areas, which occupy a very small percentage of the overall landscape.

Additionally, one species of conservation significance under the EPBC was recorded in the October 2023 survey, the Whistling Kite (*Haliastur sphenurus*). While habitat exists for some conservation-significant species in the area, given the location of disturbance areas, species habitat requirements and likelihood of occurrence, impacts from proposed activities are considered low.

Vehicle collisions are unlikely to impact threatened fauna on roads in the CPP Area due to speed controls, linear layout, and visibility on road shoulders. Site inductions will specify speed limits

across the CPP, enforcing 60 km/hr during daylight and 40 km/hr during night, dawn, and dusk. Within the CPP Area, potential habitat exists for some of the conservation significant species mentioned above. However, given the location of disturbance areas, species habitat requirements and the likelihood of occurrence, impacts from the proposed Activity are considered low.

In addition, two significant flora species have previously been recorded within the study area during SREBA baseline assessments [L YOUNG, J PATYKOWSKI, I LEIPER, C NANO, A FISHER, et al., 2022]. These were *Chamaecrista deserti* and *Synostemon trachyspermus*, which are listed as data deficient under the *TPWC Act*. (**Appendix 01** Environmental Assessment Report). These species were not recorded during on-ground assessments for threatened flora in October 2023, nor were any other threatened flora.

The assessments carried out for threatened fauna based on *EPBC* requirements are discussed below in **Section 4.13.1**.

4.13 Protected Matters

4.13.1 Protected Areas

Protected matters in the region are shown in **Figure 4.13—1**. The nearest protected areas are Limmen National Park, approximately 40 km to the northeast; Bullwaddy Conservation Reserve, approximately 90 km to the west; the Borroloola area Caranbirini Conservation Reserve, approximately 110 km to the east; and the Longreach Waterhole Protected Area (Lake Woods) approximately 200 km to the south-west.

No Threatened Ecological Communities (TEC), World Heritage Properties, National Heritage Places, Wetlands of International Importance, Great Barrier Reef Marine Park or Commonwealth Marine Areas occur within EP 187.

4.13.2 EPBC Protected Matters

Eight birds, three mammals and four reptile species that potentially occur in the study region are listed under the *EPBC Act* and/or the *TPWC Act*, and 18 species are listed as migratory under the *EPBC Act* (**Appendix 01** Environmental Assessment Report). No terrestrial vertebrate species are endemic to the study area.

The Commonwealth Department of Climate Change, Energy, the Environment and Water (DCCEEW) Protected Matters search tool (PMST) was used to identify threatened species and vegetation communities listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999* (EPBC) that could occur within a search area of 50 km radius of the CPP Area.

The results of this search are detailed in **Appendix 01** (Environmental Assessment Report). The EPBC PMST identified potential habitat for 13 threatened species and 13 migratory species listed under the *EPBC Act* that are known to or could potentially occur in the study area (**Table 4.13—1**). The Freshwater Sawfish (*Pristis pristis*) and the migratory wetland birds were excluded from further assessment due to lack of suitable habitat within the study area.

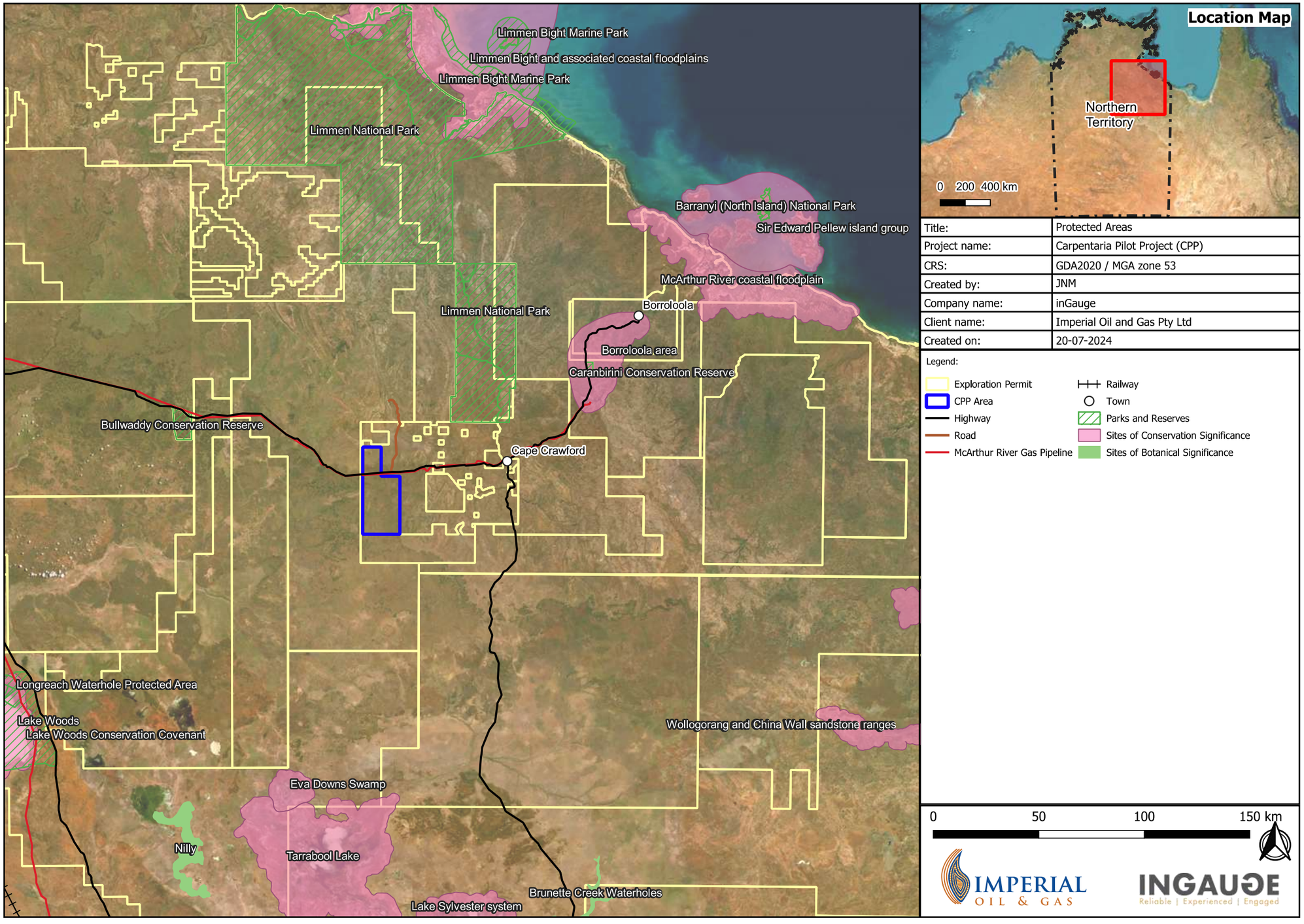


Figure 4.13—1 Protected Areas Within the Region and Exclusion Areas Excised on EP 187

Table 4.13—1 EPBC Protected Matters - Threatened and Migratory Species in the CPP Area (October 2023)

Listed Threatened Species			
Common Name	**Scientific Name**	**Threat Category**	**Presence**
Birds			
Curlew Sandpiper	*Calidris ferruginea*	Critically Endangered	Species or species habitat may occur within area.
Red Goshawk	*Erythrotriorchis radiatus*	Endangered	Species or species habitat may occur within area.
Gouldian Finch	*Erythrura gouldiae*	Endangered	Species or species habitat known to occur within area.
Grey Falcon	*Falco hypoleucos*	Vulnerable	Species or species habitat may occur within area.
Crested Shrike-tit (northern)	*Falcunculus frontatus whitei*	Vulnerable	Species or species habitat likely to occur within area.
Painted Honeyeater	*Grantiella picta*	Vulnerable	Species or species habitat may occur within area.
Australian Painted Snipe	*Rostratula australis*	Endangered	Species or species habitat may occur within area.
Masked Owl (northern)	*Tyto novaehollandiae kimberli*	Vulnerable	Species or species habitat likely to occur within area.
Mammals			
Ghost Bat	*Macroderma gigas*	Vulnerable	Species or species habitat may occur within area.
Greater Bilby	*Macrotis lagotis*	Vulnerable	Species or species habitat may occur within area.
Northern Brushtail Possum	*Trichosurus vulpecula arnhemensis*	Vulnerable	Species or species habitat may occur within area.
Reptiles			
Gulf Snapping Turtle	*Elseya lavarackorum*	Endangered	Species or species habitat may occur within area.
Fish			
Freshwater Sawfish	*Pristis pristis*	Vulnerable	Species or species habitat may occur within area.
Listed Migratory Species			
Migratory Marine Birds			
Fork-Tailed Swift	*Apus pacificus*	-	Species or species habitat likely to occur within area.
Migratory Marine Species			
Freshwater Sawfish	*Pristis pristis*	Vulnerable	Species or species habitat may occur within area.
Migratory Terrestrial Species			
Red-rumped Swallow	*Cecropis daurica*	-	Species or species habitat may occur within area.
Oriental Cuckoo/ Horsfields Cuckoo	*Cuculus optatus*	-	Species or species habitat may occur within area.
Barn Swallow	*Hirundo rustica*	-	Species or species habitat may occur within area.
Grey Wagtail	*Motacilla cinerea*	-	Species or species habitat may occur within area.
Yellow Wagtail	*Motacilla flava*	-	Species or species habitat may occur within area.
Migratory Wetland Species			
Common Sandpiper	*Actitis hypoleucos*	-	Species or species habitat may occur within area.
Sharp-tailed Sandpiper	*Calidris acuminata*	-	Species or species habitat may occur within area.
Curlew Sandpiper	*Calidris ferruginea*	Critically Endangered	Species or species habitat may occur within area.
Pectoral Sandpiper	*Calidris melanotos*	-	Species or species habitat may occur within area.
Oriental Plover/ Oriental Dotterel	*Charadrius veredus*	-	Species or species habitat may occur within area.
Oriental Pratincole	*Glareola maldivarum*	-	Species or species habitat may occur within area.

No species identified in the PMST were observed during on-ground surveys of the study area from 2021-2023 (**Appendix 01** Environmental Assessment Report). However, two of the species were detected previously in the SREBA surveys [L YOUNG, J PATYKOWSKI, I LEIPER, C NANO, A FISHER, et al., 2022]. These were the vulnerable Grey Falcon (*Falco hypoleucos*) and the migratory/marine listed Fork-tailed Swift (*Apus pacificus*).

The Grey Falcon occurs at low densities in arid and semi-arid inland Australia, where annual rainfall is less than 500 mm. They frequent timbered lowland plains, particularly Acacia shrublands, that are crossed by tree-lined water courses. The Fork-Tailed Swift is a summer migrant (October – April) and is almost entirely aerial. The previous observation was likely a 'fly-over', and they are unlikely to utilise the terrestrial of the study area, based on their behaviour (**Appendix 01** Environmental Assessment Report).

A Significant Impact Assessment (SIA) was also undertaken in accordance with *Matters of National Environmental Significance* (MNES) - *Significant Impact Guidelines* [DEWHA, 2013]. The SIA includes an assessment of EPBC-listed species that are either known to occur or are considered likely to occur in the study area. The results of this assessment are reported further in **Appendix 01** Environmental Assessment Report.

The focus of the SIA was on listed threatened species, significant species and listed migratory birds that may potentially occur in the CPP Area. In summary, a total of eight threatened, significant, or listed migratory birds were assessed in accordance with the guidelines. This included the EPBC-listed Grey Falcon, Gouldian Finch (*Erythrura gouldiae*) and Painted Honeyeater (*Grantiella picta*), as well as the EPBC migratory or marine birds Glossy Ibis (*Plegadis falcinellus*), Great Egret (*Ardea alba*), Cattle Egret (*Bulbulcus ibis*), Whistling Kite (*Haliastur sphenurus*), and Rainbow Bee-eater (*Merops ornatus*).

Based on the impact criteria and assessment of each of these identified species, the proposed Activity will not pose a significant impact (**Appendix 01** Environmental Assessment Report).

No MNES mammals, reptiles, threatened invertebrates or threatened flora were found during desktop searches or field surveys within the disturbance area that may potentially be impacted by the Activity (**Appendix 01** Environmental Assessment Report).

4.13.3 EPBC Listed Birds and Bats

Of the species identified in the SIA, three threatened EPBC-listed bird species are considered moderately to highly likely to occur in the study area based on suitable habitat and previous records within the study area or proximate to it. These are the vulnerable Grey Falcon and Painted Honeyeater and the endangered Gouldian Finch. The impact assessment for these species is further detailed in **Appendix 01** (Environmental Assessment Report).

No Grey Falcons, Gouldian finches or Painted Honeyeaters were observed within the study area during field surveys undertaken over a 2-year period between 2021-2023. Eight Gouldian finches were observed (-16.7031, 135.3667) in March 2021, approximately 22 km east of the study area (**Appendix 01** Environmental Assessment Report). However, there are historical records of the species within 6 km of the study area, and as such, they are deemed to have a high likelihood of occurrence (DEPWS, 2022).

4.13.3.1 Gouldian Finch

Gouldian Finches feed almost exclusively on grass seed and depend on a relatively small number of grass species that seed at different times throughout the year. In the Wet Season, they rely on a small number of perennial grass species, consuming the seeds directly from plants as they ripen. In the Dry Season, they depend on the large volume of annual grass seed that is produced towards the end of the previous Wet Season and lies dormant on the ground.

They nest in tree hollows during the Dry Season, between April-July (although this period is extended in some years), lay an average clutch of five eggs, and may raise several clutches in a season, with productivity averaging 1.5 fledglings per adult per season [THREATENED SPECIES SCIENTIFIC COMMITTEE, 2016] When breeding they use small patches of open woodland, usually on ridges dominated by cavity bearing trees.

The most common dominant overstorey tree species in the woodland on rocky flat habitat near the CPP Area, is the snappy gum species (*Eucalyptus leucophloia*), which is known to readily form hollows and provides breeding habitat for the Gouldian Finch [J DAVIS et al., 2021; DEPWS, 2022]. Mapping this habitat in the CPP Area together with water holes shows, necessary for access to surface water during the Dry Season, shows that the CPP Area does not intersect with or encroach significantly on the snappy gum open woodlands to the east of the CPP Area (see **Figure 4.13—2**). However, opportunistic feeding during the Wet Season, may potentially occur near drainage lines on Relief creek. Possible Gouldian Finch feeding habitat during the Wet Season, consisting of juvenile snappy gum and ribbon grass on an unmapped creek line is shown in **Figure 4.9—3** – photo ID #9a and #9b**.**

Substantial growth of tussock grasses (discussed in **Section 4.11.3**), which are the key food resource for Gouldian Finches and other finch species present in the area, will result from 100 mm, but more is beneficial. Once sufficient rain is recorded, growth is rapid, and the bulk of the season's feed is usually produced in 2-3 months. The total length of useful pasture growth, on average year rainfalls, was estimated to be approximately 19 weeks in this region of the Barkly [C.S CHRISTIAN, & STEWART, 1953].

Heavy grazing by cattle is known to reduce seed yields in grasses important to the finches. Key Gouldian Finch Wet Season grasses, such as favoured golden beard/ribbon grass (*Chrysopogon fallax*) are present in the CPP Area. Although *Chrysopogon fallax* grows on several soil types, it

is usually most abundant on moister, heavier soils areas near creeks and soaks and on floodplains and soaks. These areas have been avoided in the site selection for key surface infrastructure as shown in georeferenced imagery in **Figure 4.11—1**. It is also an indicator of good pasture condition [DPIR, 2021].

As the pastures mature, the tussock grass seed heads become important for cattle and later still, when the annuals have disintegrated, the tussock grass clumps are heavily grazed throughout the Dry Season. Tussock grass curing and haying-off occurs as the Dry Season progresses. This is evident in the georeferenced imagery of the key surface infrastructure (see **Figure 4.11—1**) taken late in the season (October) and discussed in **Section 4.11.2**.

In addition, fire interacts with rainfall to cause staggered grass seeding events across the landscape, and regular extensive fires homogenise vegetation age and thus reduce the spatial-temporal complexity of seed availability that Gouldian Finches rely on [Threatened Species Scientific Committee, 2016].

The Activity will avoid typical Gouldian Finch habitat (snappy gum woodland with hollows) as shown in the SREBA Gouldian Finch species distribution model (SDM), shown in **Figure 4.13—3**. Based on these factors and assessment criteria for the SIA the Activity will not have a significant impact on Gouldian Finch population size, health, or habitat (**Appendix 01** Environmental Assessment Report).

4.13.3.2 Northern Shrike-tit

The Northern Shrike-Tit is generally associated with open Eucalypt woodlands. In the SREBA study area high-quality habitat, particularly in BVG 1 (*Corymbia/Eucalyptus* open woodland on sandy loam) was identified. Although this is the predominant habitat to be disturbed in the CPP Area (see **Table 4.11—2**), the total disturbance is approximately 87 ha, which when compared to the total BVG-1 habitat in the CPP Area which is 22,494 ha, represents < 0.4% loss which is most unlikely to present a significant loss of this widespread habitat. Seasonally waterlogged areas may attract the species, but these areas have been avoided as is evident in the Broad Vegetation analysis provided in **Table 4.11—2**. Extensive areas of woodland habitat on the plains throughout the northern half of the study area are predicted by the SREBA species distribution model (see **Figure 4.13—4**) SDM to be suitable for the species.

4.13.3.3 Ghost Bat

The Ghost Bat is a nocturnal carnivorous species that roosts in caves, rock shelters and deep rock cracks. The SREBA study noted that the distribution of the Ghost Bat within the study area could not be modelled; however, spatial information relating to geological features for the Ghost Bat roosting sites is identified as outcropping Tindall Limestone. Although Tindall Limestone

outcroppings are not identified in the EP 187 environs, the Bauhinia Downs Limmen Sandstone outcropping has been identified as a potential surface geology feature that contains a rock shelter and possibly deep rock cracks and is mapped in **Figure 4.13—5**.

As further confirmation that these features may exist in the Limmen Sandstone, a rock shelter was identified at Balbirini-1 during archaeological study conducted on EP 187 (Jung, 2019). This feature is on the escarpment of the Limmen Sandstone and is also mapped in **Figure 4.13—5**. However, this outcropping is more than 23 km northwest from the nearest disturbance area (well pad BD) and therefore potential impacts to this species is considered unlikely. There has been no investigation conducted of the Balbirini-1 rock shelter to determine if Ghost Bats are present. As **Figure 4.13—5** confirms, the Balbirini-1 rock shelter and the Limmen Sandstone outcrop feature in general at this location, has been excluded from the EP 187 permit area under the *Petroleum Act*, for cultural reasons by the Traditional landowners of the Mambaliya Rrumburriya Wuyaliya Aboriginal Land Trust.

4.13.3.4 Grey Falcon

Grey Falcons breed from June to November and nest in the tallest available trees, typically along watercourses, with a preference towards River Red Gum (*Eucalyptus camaldulensis*) and Coolibah (*E. coolibah*). Given that areas with ongoing activity (e.g. pads, gravel pits and etc.) will avoid riparian vegetation, there is a low likelihood of impacting Grey Falcon nesting sites.

Grey Falcons often lay eggs in the stick nests (large) of other species, particularly raptors and corvids. This makes the positive identification of Grey Falcon nests purely on physical characteristics difficult, however nests are readily identifiable. All large stick nests in tall trees along drainage channels and near water bodies will be treated as suspected active Grey Falcon nests.

Suspected nests will be considered active if adult birds are present, there is fresh whitewash (excrement), prey remains or pellet casts (undigested material regurgitated by raptors) at the base of the tree. An active nest will be frequently visited by the adult birds during all stages of nesting including nest building, laying, incubating, hatching and rearing. Therefore, identification of active Grey Falcon nests is expected to not be an extensive exercise. If Grey Falcons are nesting in the proposed disturbance area, they will be readily detectable.

A 300 m vehicle-free buffer will be applied to all Grey Falcon nests and suspected nests during the breeding season, until it is determined that it is not an active Grey Falcon nest. An ecologist will assess all suspected nests to confirm it is being actively used by Grey Falcons.

The buffer around all suspected nests will stay in place until the species utilising the active nest is identified as another species or the end of the confirmed Grey Falcon nesting activity.

4.13.3.5 Ecologist Pre-clearing Inspection

To mitigate potential risks to fauna species caused by the Activity, a qualified ecologist will be on-site prior to any clearing to identify threatened flora and fauna, as well as significant habitat trees (DBH >25 cm, height 1.3 m). This will allow for sensitive breeding areas to be avoided by adjusting the locations within the Infrastructure Movement Zone.

Detail on risk mitigation for flora and fauna is found in **Section 6.2** (Risk Assessment).

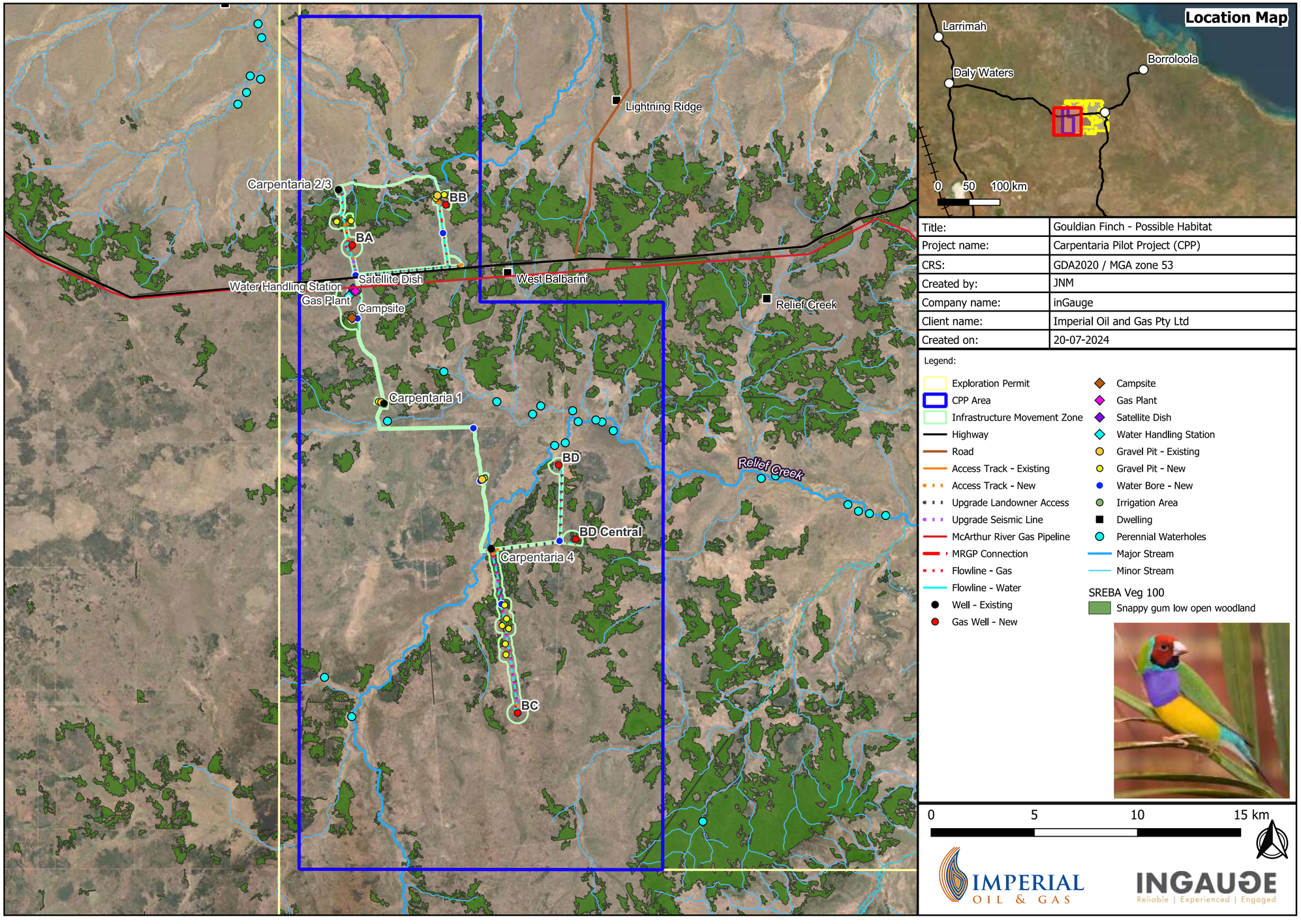


Figure 4.13—2 Potential Gouldian Finch Potential Roosting Habitat and Perennial Waterholes in the CPP Area

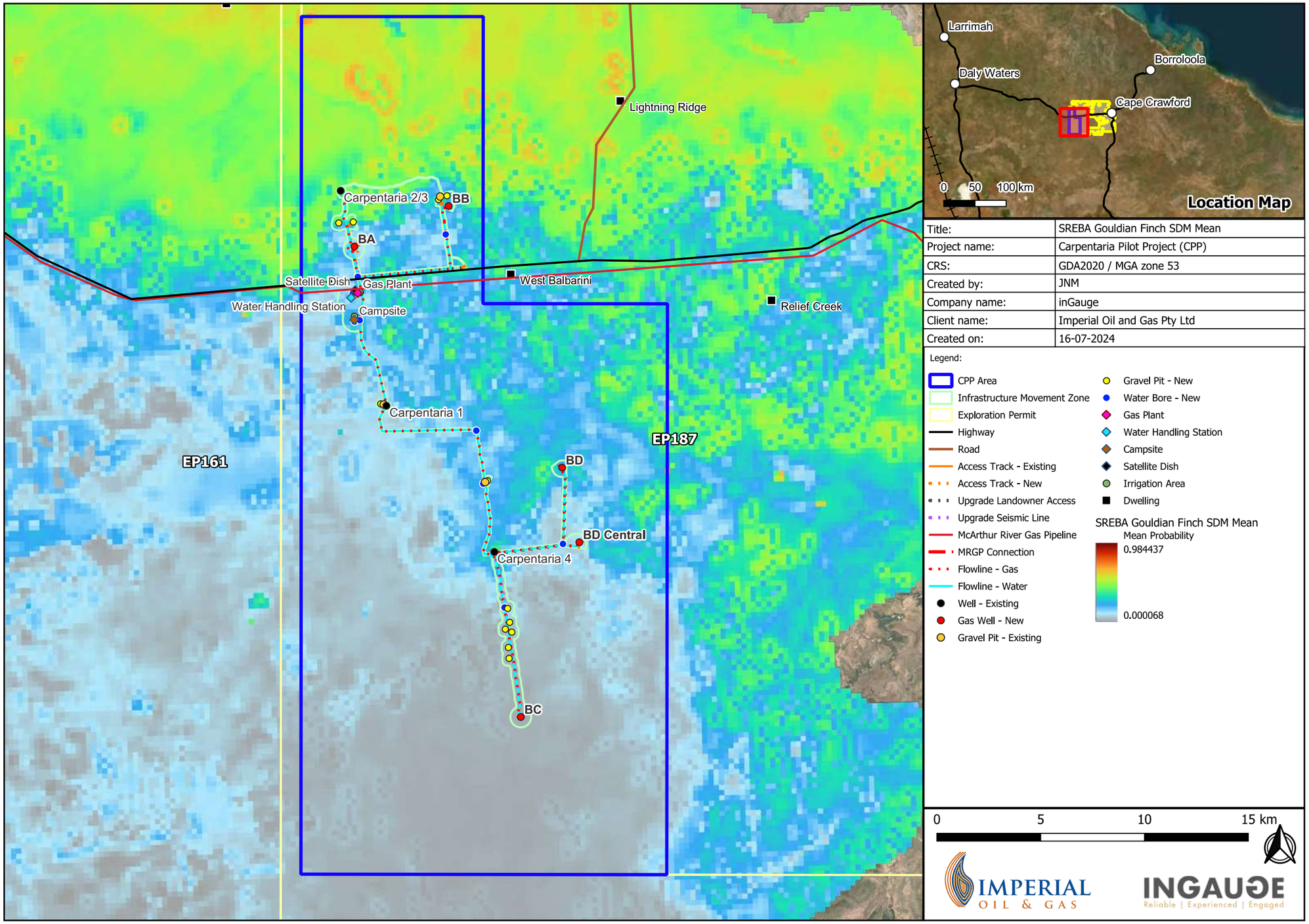


Figure 4.13—3 SREBA Gouldian Finch Species Distribution Model

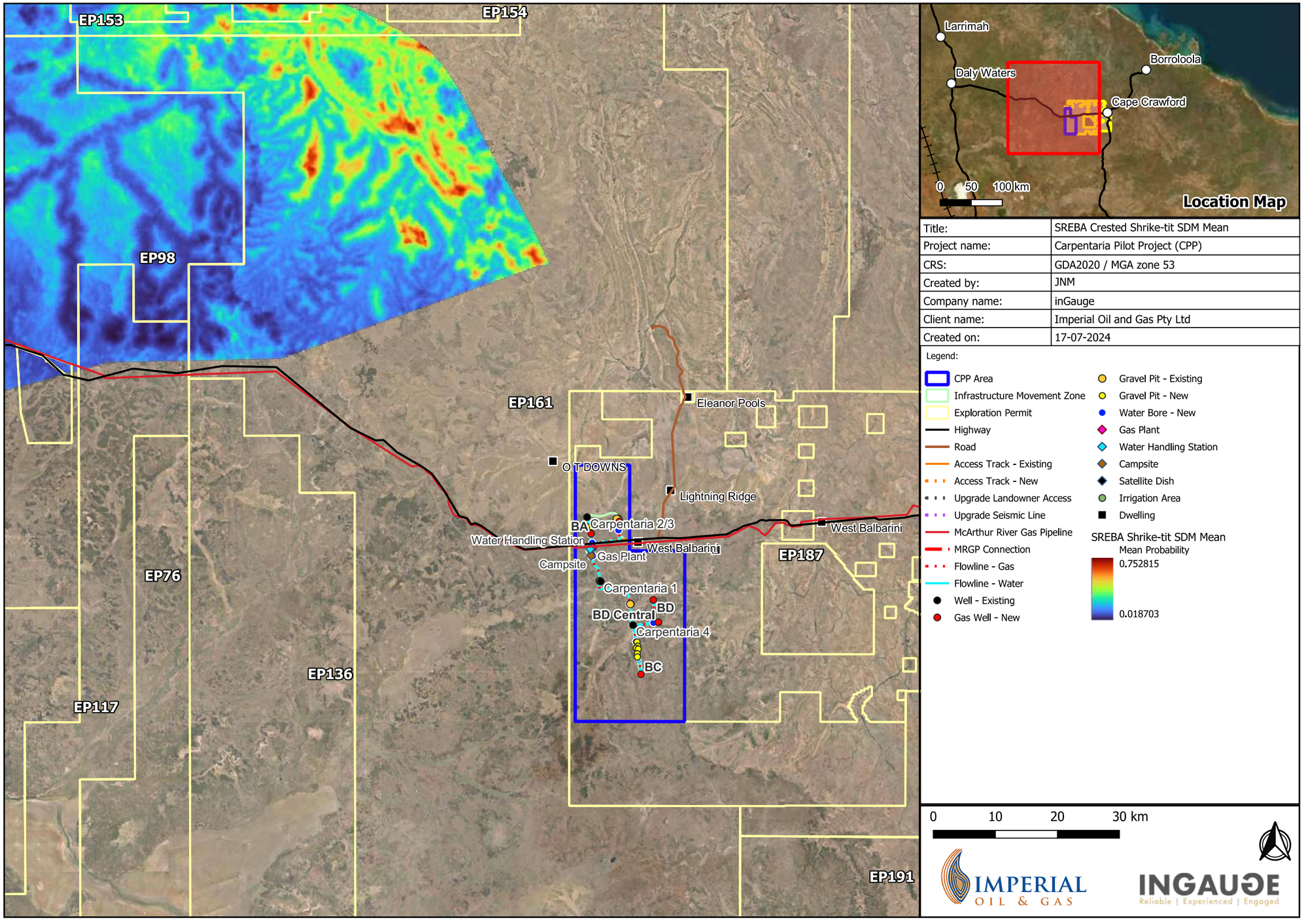


Figure 4.13—4 SREBA Northern Shrike-tit Species Distribution Model

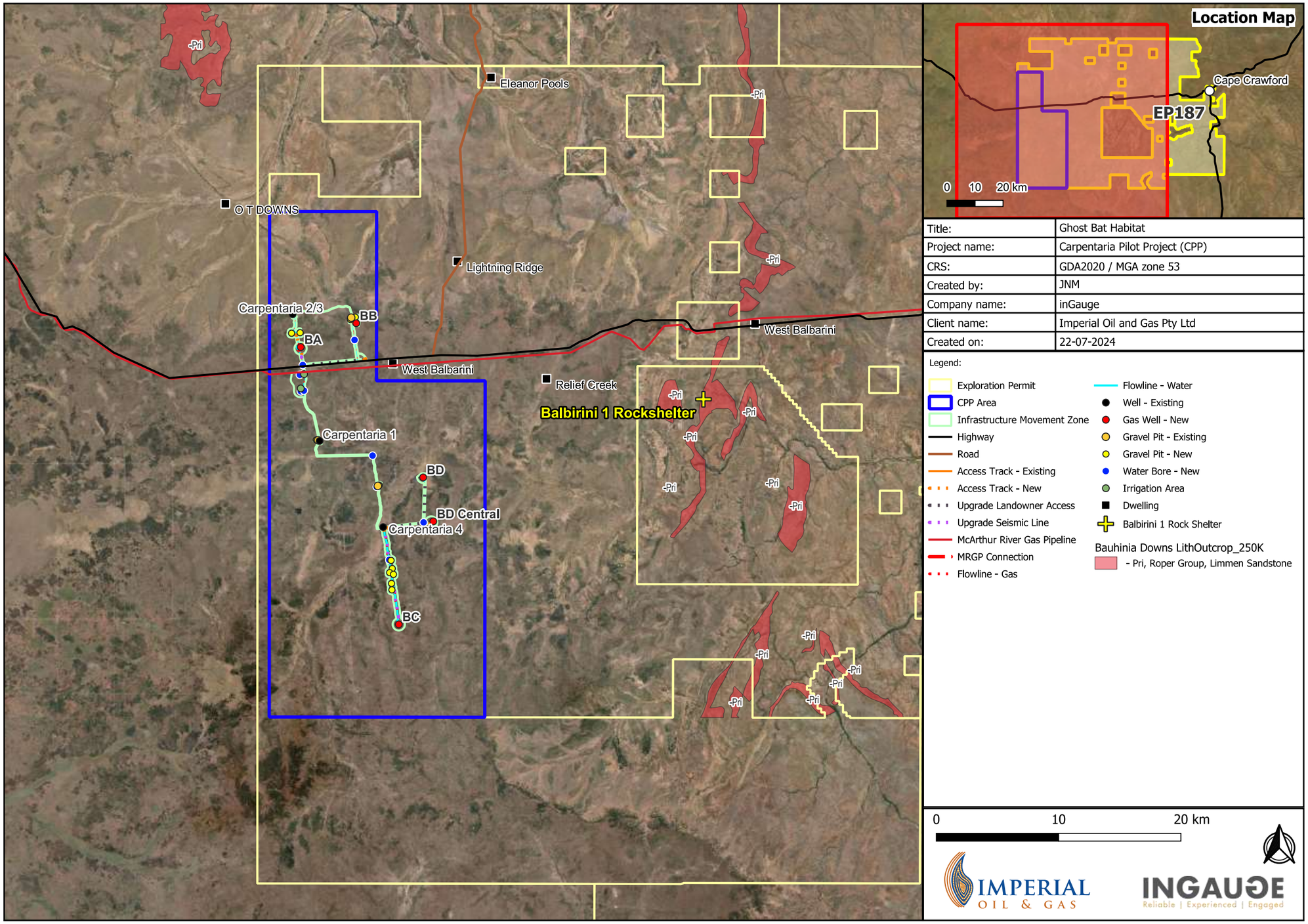


Figure 4.13—5 Potential Ghost Bat Limmen Sandstone Outcropping Habitat at Balbirini -1

4.14 Pest Flora

There were 111 weed species identified to occur within the CPP Area during the SREBA assessments [DEPWS, 2022]. This included 32 species listed under the *Weeds Management Act 2001*, 12 of which are Class A weeds (to be eradicated) and 20 are Class B weeds (growth and spread to be controlled). Weed occurrence was greatest in the more mesic vegetation types (floodplain woodland, riparian woodland, woodland on black soil plain, Brushbox (*Lophostemon* sp.) swamps and Paperbark (*Melaleuca* sp.) woodland), as well as Bullwaddy woodland. These habitats are not present in the CPP Area.

Weed surveys were undertaken annually on EP 187 from 2019 to 2023. The results are detailed in the Weed Management Plan (WMP) in **Appendix 04**.

A desktop analysis was used to identify historical (pre-2018) weed records within the study area (ref needed), as well as species listed as a 'priority' by the Northern Territory Government [DEPWS, 2021A]. Following this, on-ground weed surveys took place in both Dry and Wet Season conditions over consecutive years.

Previous records of two Class A weeds, Prickly Acacia (*Vachellia nilotica*) and Bellyache bush (*Jatropha gossypiifolia*), were identified from desktop analysis within the area of assessment. Prickly Acacia was detected north of the Carpentaria highway, while Bellyache bush was recorded east of the CPP Area on the Carpentaria Highway. Both observations were outside of the CPP Footprint, and no records of either species, nor any other Class A weeds, were made during on-ground surveys from 2019 to 2023.

A further six Class B weeds were identified in the area during desktop analysis, as shown in **Table 4.14—1**. Subsequent on-ground surveys from 2019 to 2023 detected four of these species in the surrounding environment; however, no records were made within the CPP Area of disturbance (and hence the management area).

Two of these species, Grader grass (*Themeda quadrivalvis*) and Parkinsonia (*Parkinsonia aculeata*) are also Weeds of National Significance (WONS). Grader grass was detected on the road verge alongside the CPP Area, while Parkinsonia was detected further north of the Carpentaria Highway. Monitoring and mitigation measures will be in place to reduce the risk of weed growth and spread, management will be in accordance with the Northern Territory Weed Management Handbook [DEPWS, 2021D].

The results of the weed survey for new well pad locations, conducted in October 2023, together with the summary of results from all previous weed surveys on EP 187, are included in the WMP.

Table 4.14—1 Known Weeds in EP 187

#	Weed Identified in CPP Environs	Weed Class	Observation
1	**Cobbler's peg** *(Bidens pilosa)*	Nil	On ground record (2023). Identified within CPP management area.
2	Prickly Acacia **(*Vachellia nilotica*)**	A, WONS	Previous desktop record. Outside of CPP management area.
3	**Bellyache bush (*Jatropha gossypiifolia*)**	A, WONS	Previous desktop record. Outside of CPP management area, on Carpentaria Highway.
4	**Hyptis** (*Hyptis suaveolens*)	B	Previous desktop records and on ground records (2018 – 2021). Located on Carpentaria Highway.
5	**Grader grass** (*Themeda quadrivalvis*)	B, WONS	On ground records (2020 – 2021). Located on Carpentaria Highway.
6	**Caltrop** (*Tribulus sp.*)	B	On ground record (2019), outside of CPP management area.
7	**Parkinsonia** (*Parkinsonia aculeata*)	B, WONS	Previous desktop record and on ground records (2018). Outside of CPP management area.
8	**Khaki Weed** (*Alternanthera pungens*)	B	Previous desktop record. Outside of CPP management area.
9	**Sida** (*Sida acuta/cordifolia/rhombifolia*)	B	Previous desktop records. Outside of CPP management area.

4.15 Groundwater Dependent Ecosystems

Ground dependent ecosystems (GDE) require groundwater access 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'.

The presence of obligate and facultative riparian species along mid-segment creek lines in and adjacent to the CPP Area, probably reflects the volume of long-term average flows. Where these species are absent on creek lines probably reflects the degree of impact caused by cattle and other hooved feral animals which are common in the area. The obligate and facultative riparian species in and adjacent to the CPP Area have access to the large volume of transmission water stored in the sediments in the creek lines.

Significant alluvial GDE vegetation (riparian woodland and *Melaleuca* Forest) associated with sandstones ranges and escarpments where the Sturt Plateau and Gulf Falls & Uplands bioregions converge, was identified in the SREBA [L YOUNG, J PATYKOWSKI, I LEIPER, C NANO, A FISHER, et al., 2022](DEPWS 2022a). However, this is to the east of the CPP Area (**Figure 4.15—1**). Comparison with Ordered streams in the CPP Environs (**Figure 4.9—2**) suggests that GDE are primarily restricted to Stream Order 3 drainage lines or greater, which occur to the east and north of the CPP, and which are lower in elevation in the respective catchments. This is confirmed in georeferenced imagery provided for existing creek crossings in **Figure 4.9—3**. **Section 4.11.1** SREBA vegetation analysis confirms the avoidance of GDE in the CPP Area.

As noted previously, the CPP Area encompasses the crest of the Favenc Range. The Favenc Range forms the headwaters of the Limmen Bight River catchment to the north of CPP and the McArthur River to the east of the CPP. The water table at CPP well pads has consistently been measured to be > 50 m BGL, dependent on topography. Generally, where groundwater is within 20 m of the land surface, some native plants may access and use groundwater [DEPWS, 2022].

The Environmental Assessment report, for the proposed CPP disturbance area (**Appendix 01** Environmental Assessment Report), conducted in November 2023 noted the following:

- Riparian vegetation at the CPP Area is primarily centred around Relief Creek and is the closest > 3rd order watercourse to the location of the CPP Area.
- Riparian areas often have significantly higher fauna diversity than surrounding areas.
- River red gum vegetation along Stream Order 2 and 3 waterways, is likely a GDE, which is typical in highly monsoonal environments with prolonged Dry Seasons.
- These will not be impacted as CPP site selection has complied with LCG buffer areas associated with waterways and drainage lines.
- Whilst the riparian vegetation in the study area is predominantly sparse, woodland habitat values include:

- Provides water (in Wet Season) and larger pools in the Dry Season. Supports flowering and seeding vegetation as well as prey (aquatic species, invertebrates, and small vertebrates) for small mammals, birds, and reptiles.
- Provides refuge, sheltered movement corridors for fauna.
- Includes sparse river red gum which form hollows, providing important habitat for hollow-dependent animals (e.g. parrots, bats, finches).
- Potential habitat for Gouldian Finch where eucalypt and paperbark woodlands, usually with a grassy understorey, occur in the vicinity during the Wet Season.
- Potential habitat for Grey Falcon where waterways intersect open woodland areas.

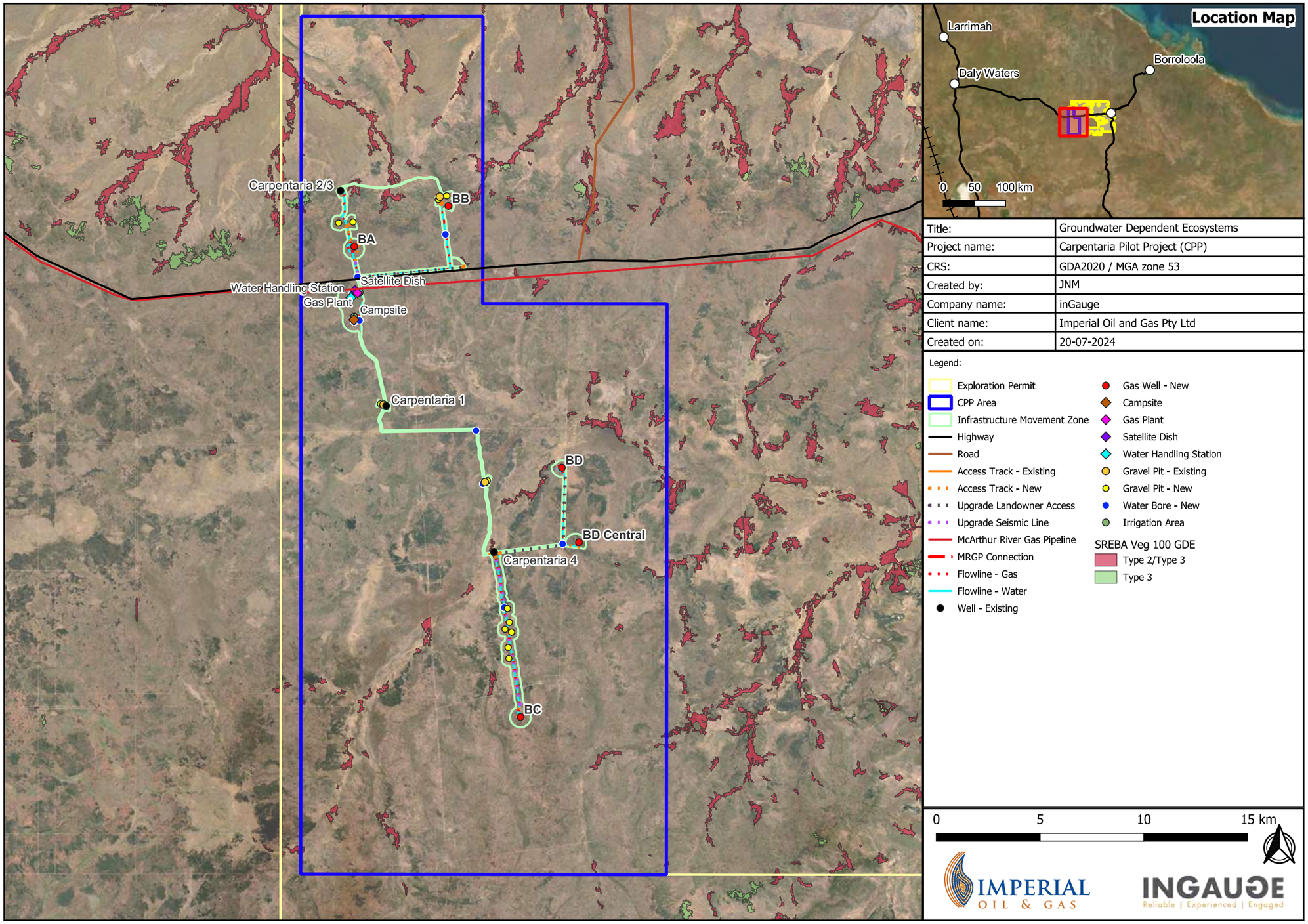


Figure 4.15—1 GDE in CPP Area and Environs – Catchment Drainage from Favenc Range

4.16 Cultural Environment

4.16.1 Land Tenure and Native Title Agreements

The Activity will be carried out entirely on freehold land owned by Traditional Owners through the Mambaliya Rrumburriya Wuyaliya Aboriginal Land Trust.

The Native Title Petroleum Exploration Agreement between Imperial and the NLC includes clauses for the protection of sacred sites, objects and sensitive areas related to Aboriginal activities in the area, including cultural, hunting and foraging activities. There will be ground-truthing before any clearing for infrastructure occurs. The Native Title Agreement also includes clauses for the protection of the environment and site rehabilitation.

4.16.2 Areas of Aboriginal Cultural Significance

The geologist Ernest Favenc mapped the Favenc Range in 1883. The main concentrations of Aboriginal People that Favenc 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; cited in Jung, 2019) and was accompanied by the local Aboriginal people who guided him east towards the coast along this hilly country.

There are multiple registered and recorded [redacted]

There are presently no registered sacred sites in the CPP Area; [redacted].

Previous Activities undertaken in EP 187 were approved by the Aboriginal Areas Protection Authority in AAPA Authority Certificate C2021/065. Imperial is in the process of obtaining an AAPA Authority Certificate for the proposed work, which, when issued, will inform the location of Activities that occur under this EMP. Changes to this EMP may be required to comply with the AAPA Authority Certificate issued to Imperial, and if so, they will be assessed and the EMP will be revised or modified as per the *PER*.

No places listed under the *Aboriginal and Torres Strait Islander Heritage Protection Act, 1984 (Cth)* are present within EP 187 or the location of the Activity.

4.16.3 Non-Aboriginal Heritage Sites

A search of the Australian Heritage database revealed no statutory heritage places are present within EP 187 or the location of the Activity.

4.16.4 Archaeological Assessment

Prior to the grant of the tenement, the Anthropology Division of the Northern Land Council (NLC) and the Traditional Owners conducted an extensive anthropological survey of the area in May 2015. This was undertaken to determine excision (exclusion) areas on EP 187 which are shown in **Figure 4.13—1**. These exclusions areas ("Swiss cheese") are more than 15 km from the CPP Area, in the east/northeast of EP 187, in the Gulf Falls and Uplands bioregion, and are statutorily excised from the EP 187 permit area under the *Petroleum Act*.

Imperial has contracted for a series of archaeological surveys [S Jung, 2019; S Jung, 2021; 2023] (**Appendix 02**) in areas of petroleum exploration interest on EP 187, primarily within the CPP Area. The most recent survey was conducted in September and October 2023 to inform the location of the proposed five new well pads, access corridors and related CPP facilities including the WHS, CGP, and campsite area.

The survey crew included three Traditional Owners and an environmental ecologist. The survey was conducted over a three-day period utilising aviation and ground resources. The proposed CPP disturbance areas were cleared and comply with the requirements of the *Northern Territory Heritage Act 2011 (NT)*, as no archaeological material was found at the proposed new CPP disturbance areas (**Appendix 02** – Archaeological Survey Report EP 187).

[redacted]. [redacted] (**Figure 4.16—1**). [redacted]. None of these sites are located near the CPP Area.

Figure 4.16—1 Aerial View of [redacted] at the base [redacted] (Jung, 2019)

The results of the archaeological survey conducted [redacted] in the CPP Area in 2021 [JUNG S, 2021] found [redacted] as shown in **Figure 4.16—2**.

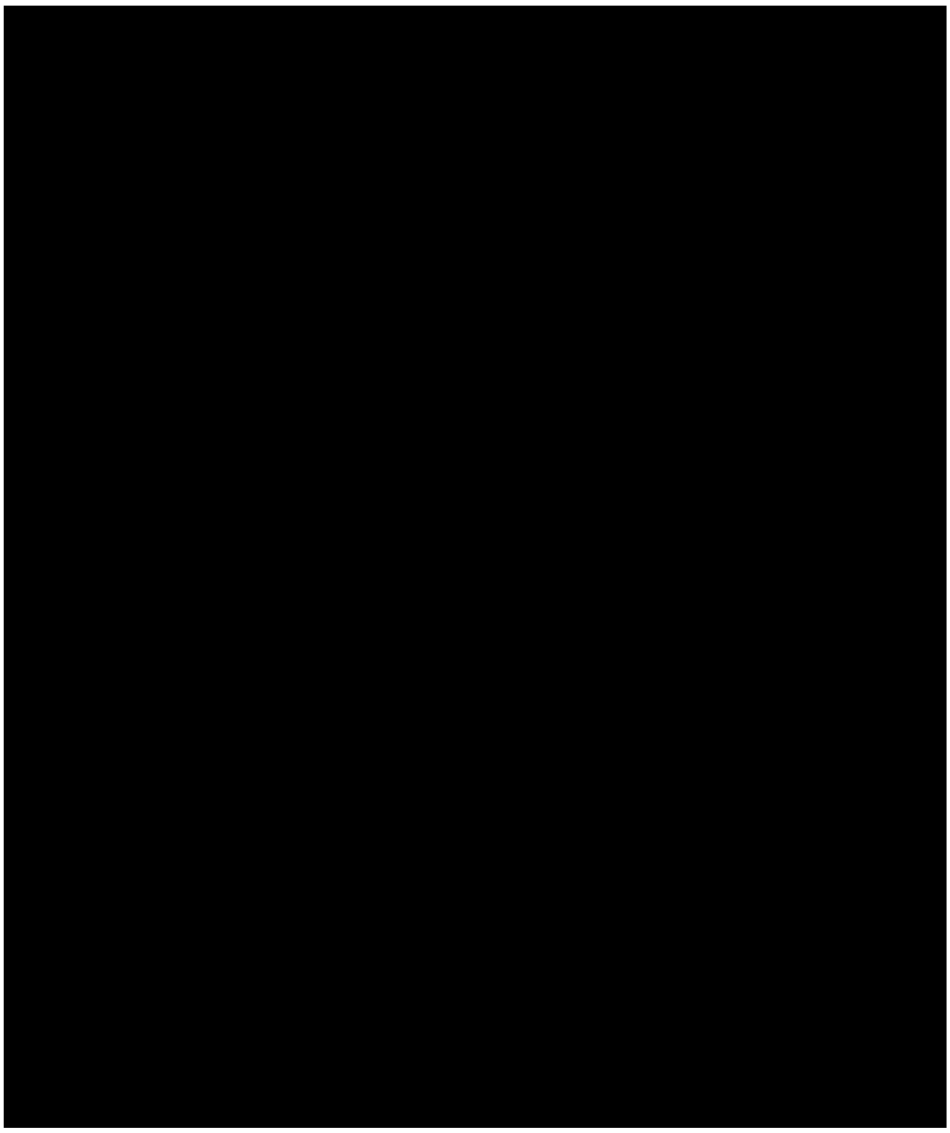


Figure 4.16—2 [redacted] **[JUNG S, 2021]**

Imperial has committed to having Traditional Owners present during clearing activities. During clearing activities at the [redacted] in August 2022, Traditional Owners, appointed by the NLC, and with an NLC supervisor accompanying the team, were engaged for a 2-week period for cultural heritage monitoring during the clearing activities. [redacted] (**Appendix 02**).

The focused [redacted] archaeological site assessment was completed in December 2023 (**Appendix 02** – Archaeological Survey Report EP 187). [redacted]

[redacted] **Figure 4.16—3**. There will be appropriate signage, and induction and ongoing training that will be delivered in relation to the exclusion zone.

Additionally, [redacted] before operational activities can occur and Imperial will consult with the Heritage Branch regarding an additional systematic survey prior to clearing and development of a Cultural Heritage Management Plan.

Figure 4.16—3 [redacted]

4.17 Socio-economic Environment

4.17.1 Overview

A brief summary of the regional industry and socioeconomics, and land demographics is provided below. For a complete social Cultural and Economic baseline description, refer to the *SREBA (2022) Social, Cultural and Economic (SCE) studies of the Strategic Regional Environment and Baseline Assessment* (SREBA) for the Beetaloo Sub-basin [K. WITT et al., 2023].

The CCP Area is in a remote area on the Carpentaria Highway in the Barkly region, the second-largest local government area in Australia. Barkly Regional Council covers 325,514 square kilometres, an area 42% larger than Victoria [BARKLY REGIONAL COUNCIL]. The region includes many small communities and is home to an estimated 7,392 people, of whom ~72% are Aboriginal from 16 language groups [BARKLY REGIONAL DEAL].

Barkly's general demographic is relatively young, with approximately 40% of the population under the age of 24 [B. DE VINCENTIIS et al., 2021]. The region has a high unemployment rate (12%) and a lower proportion of working-age residents with a Certificate III or higher (26.5%), compared with the Northern Territory (51.8%) and Australia (56.9%). The beef industry is the largest employer in the region, employing 15.1% of the labour force (1% - NT and 0.4% - Nationally) [AUSTRALIAN BUREAU OF STATISTICS, 2021B].

Aboriginal people form approximately ~72% of the Barkly region population, with the closest Aboriginal community to the CCP Area being Garrinjinny, approximately 50 km to the east. In-line with the region's general demographic, the 2021 census indicated that most Aboriginal people living in region are below the age of 24 (48.2%). The region has a high unemployment rate (36.5%); yet the proportion of first nations people who hold a Certificate III or higher (18.4%), is larger than that for the Territory as a whole (15.5%). A third of the Aboriginal workforce is employed as labourers, 22.6% as community and personal service workers, 16.1% as machinery operators and drivers, and 11.3% as technicians and trade workers. Analogous with the general regional population, the largest employer is the beef industry, employing approximately 33% of Aboriginal labour force, whilst the metal ore and mining industry accounts for less than 10%. These proportions are at least an order of magnitude higher than that reported for Territory and the nation as a whole [AUSTRALIAN BUREAU OF STATISTICS, 2021A].

4.17.2 Settlements and Access

There are no settlements within the CPP Area. The closest dwelling is West Balbirini, which is 1.3 km to the East and over 5 km from CPP Activity area. The settlements in the surrounding region of the CPP Area are shown in **Figure 4.17—2**.

Northern Territory Noise Management Framework Guideline 2018 refers to offensive noise that may cause an environmental nuisance [NT EPA, 2018]. This is an assessment of noise

disturbance described under Section 3.2 of the *Northern Territory Noise Management Framework Guideline 2018*, it has not been conducted for noise disturbance [NT EPA, 2018].

Noise sources within the CPP Area are centred on the well pads, access tracks, and gas processing facility. The operation of compressors and power generation units at these industrial facilities occurs 24-hours/day. In the first instance, all facilities and operations at the CPP work sites must comply with exposure standards for noise defined in the *Work Health and Safety Regulation 2011*, which provide a much stricter threshold for noise sources, thereby mitigating any potential off-site nuisance noise.

The distance to the nearest receptor, West Balbirini homestead, is located approximately 2.12 km east of the existing Carpentaria Highway turnoff to the north of the CPP Area. Increased truck movements at this turn-off, coming from the west, as a result of the Activity may be a potential noise source to this receptor. All other potential noise sources generated within CPP will not plausibly exceed “nuisance noise tests”.

The proposed CGP site indicative location is shown in **Figure 4.17—1**. A 500 m buffer between the Carpentaria Highway and the plant site provides visual screening from the highway. Visual assessment has concluded that the light glow from the CGP will be visible to potential nighttime highway traffic.

As noted in **Section 4.2.9**, the SREBA [DEPWS, 2022] baseline air quality monitoring results at Bullwaddy, approximately 90 km west of CPP Area, measured average concentration for PM10 (Particulate Matter $\leq$ 10 µm) in October – November 2022 of 14 µg/m^3, well within the NEPM PM10 standard of 25 µg/m^3. The measured maximum 24-hour PM10 concentration was 31 µg/m^3, also well within the NEPM PM10 standard of 50 µg/m^3. The Activity is unlikely to significantly impact particulate background concentrations at sensitive receptors from primary sources of air pollutants identified in **Section 4.2.9** because of the controls identified in **Section 6** and remoteness of the operations.

Figure 4.17—1 500 m Buffer between Carpentaria Highway (left) and proposed CPP Carpentaria Gas Plant Site which is South (right) of the McArthur River Gas Pipeline corridor (right)

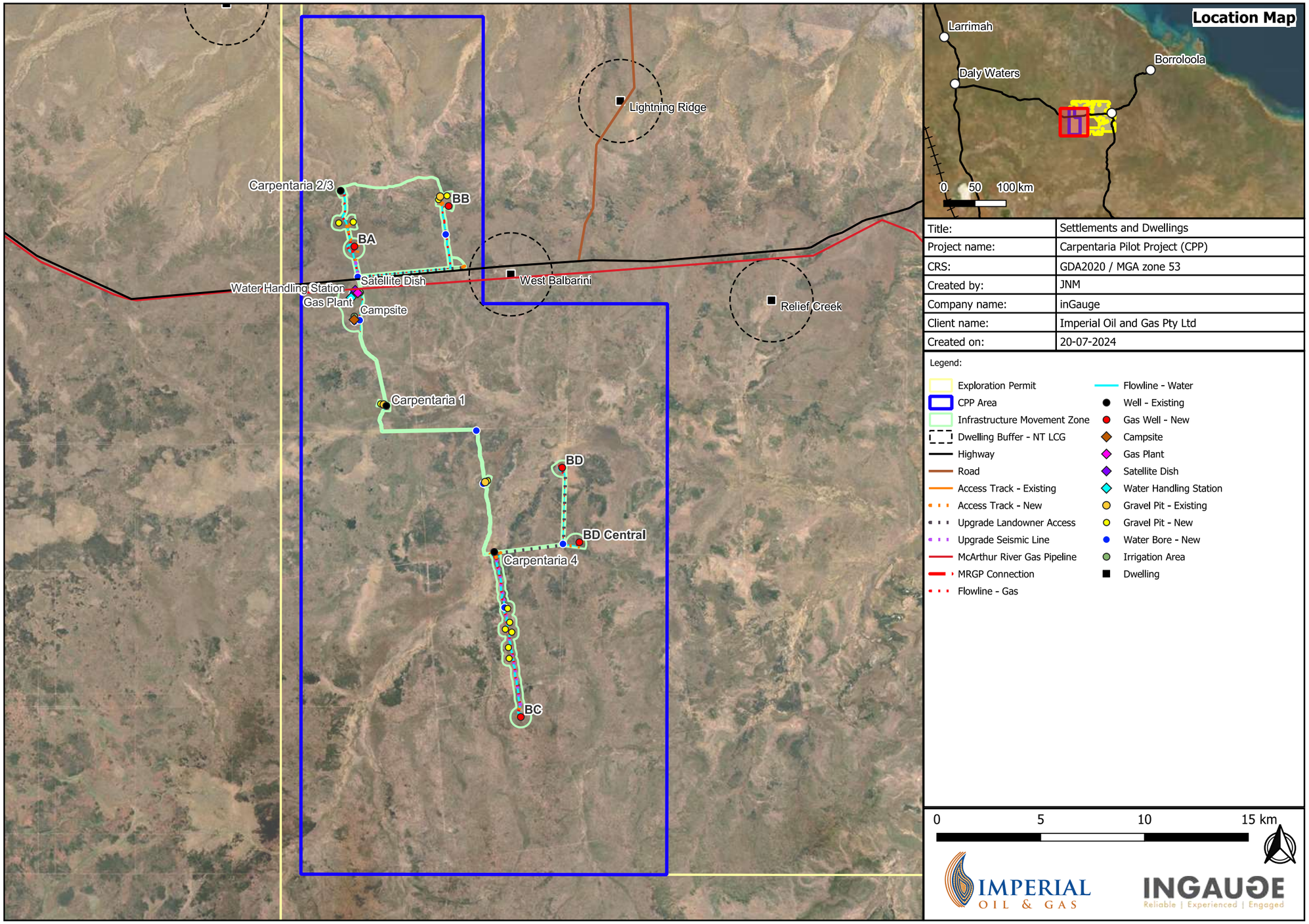


Figure 4.17—2 Settlements and Dwellings in Vicinity of the CPP Area

The Carpentaria Highway, which bisects the CPP Area, is a key access road to the town of Borroloola and surrounding regions to the east, and an important service route for the pastoral, tourism, agricultural and mining sectors, including the Beetaloo Sub-basin.

The Australian and Northern Territory governments have invested $150 million to deliver upgrades on the Carpentaria Highway over 4 years [DIPL, 2023]. The upgrades involve sealing, reconstructing, widening, and lifting as well as flood immunity improvements, commencing at the intersection with the Stuart Highway at Hi-Way Inn.

The Carpentaria Highway will be sealed to a two-lane standard. The 2 km to 50 km section of the upgrade was completed in 2023. The next stage of construction will take place between chainage 50 km and chainage 109 km east of Stuart Highway. Construction will commence in early October 2023 and be completed in late 2024. Subsequent upgrades from 109 km to 140 km and from 140 km to 175 km are likely to be caried out in 2025 and 2026 respectively.

Construction will take place seven days a week between the hours of 6 am to 6 pm. Some night works may be required. Detours and traffic management will be in place at times throughout the Activity. This work would leave approximately 27 km of the Carpentaria Highway with a single central seal to the turn-off of the southern part of the CPP.

A traffic impact assessment (TIA) was undertaken for the proposed CPP activity (**Appendix 11**) for 2024 - 2025 inclusive using the most conservative CPP trucking schedule. The TIA determined that:

- The modelled peak traffic period is expected June-October with baseline traffic highest in June, July and August which is also when the regional cattle muster is in operation. CPP trucking will peak in August-September when the bulk of trucking sand to the CPP is scheduled to occur.
- “Whilst volumes are likely to exceed the theoretical 150 vpd ‘limit’ identified by the Austroads Guidelines, upgrade (widening) works are being undertaken by DIPL independently of the subject drilling and operations program. It is therefore considered that appropriate actions are in place to improve the operational conditions of the Carpentaria Highway” (p.29).

5 Stakeholder Engagement

5.1 Overview

As noted in **Section 1.3**, the aim of environmentally sustainable development (ESD) for Imperial in this EMP is to:

- Document and promote environmental, social, and economic best practice for the Carpentaria Pilot Project and ensure that the principles of ecological sustainable development, community expectations, and the needs of other user groups are integrated into the management and operation of the Activity.
- Formalise Imperial's commitment to environmentally sustainable practices and a general duty of care for the environment and heritage in which the CPP Activity is located.

Imperial's approach to stakeholder engagement is designed to ensure good communication in achieving this aim so that key stakeholders are fully informed of Imperial's activities, that they are consulted and involved and that their aspirations and concerns are considered in a timely and meaningful manner.

Imperial seeks to establish and maintain enduring and mutually beneficial relationships with the communities of which it is a part, ensuring that activities generate positive economic and social benefits for and in partnership with these communities.

Various tools have been developed to implement, demonstrate, and maintain records of stakeholder engagement for the purpose of this EMP, including:

- **A Stakeholder Engagement and Consultation Plan** – This plan has been developed to facilitate the delivery of effective stakeholder engagement proactively meeting the requirements of the *NT Petroleum (Environment) Regulations, 2016 (PER)*. The plan outlines the analysis, process and standards for engagement and communicates Imperial's commitments to its stakeholders. Refer to **Section 5.3**.
- **A Stakeholder Engagement Report** – This report details engagement and consultation activities relevant to this EMP that have been undertaken during the drafting process prior to submission. Refer to **Appendix 10**.
- **Communications Log** – This log provides a summary of communications with stakeholders. Refer to **Appendix 10**.

5.2 Stakeholder Engagement Activities

Imperial consults and communicates regularly with directly affected stakeholders of EP 187 as key relevant stakeholders defined by the *PER*. Imperial has taken a proactive approach to early and ongoing engagement with a diverse range of other stakeholders and the wider community using various forums and methodologies.

The purpose of the consultation is to give each stakeholder information about:

- The Activity Imperial proposes to carry out; and
- The location (or locations) where Imperial proposes to carry out the Activity; and
- The anticipated environmental impacts and environmental risks of the Activity; and
- The proposed environmental outcomes in relation to the Activity; and
- The possible consequences of carrying out the Activity to the stakeholder's rights or activities.

The Stakeholder Engagement Report (SER) and Communications Log document stakeholder engagement associated with the proposed activities under this EMP; they are provided in **Appendix 10**.

5.3 Stakeholder Engagement and Consultation Plan

5.3.1 Purpose

This Stakeholder Engagement and Consultation Plan (Plan) has been developed to facilitate the delivery of effective stakeholder engagement specific to the Activity.

The Plan outlines the analysis, process and standards for engagement and communicates Imperial's commitments to its stakeholders. Through early and ongoing consultation, Imperial aims to gain an understanding of the values, opinions, and aspirations of stakeholders by creating opportunities for meaningful dialogue.

Imperial believes stakeholder engagement is a fundamental component of environmentally sustainable project development, to build transparent and respectful relationships with stakeholders and the community. Investing in effective engagement will help inform project planning and development decisions as well as ongoing communication strategies relevant to interested parties.

Proactive consultation has been undertaken, and the list of engagement activities is tabled in the SER (**Appendix 10**). This report documents the timing, methodology, feedback received and appropriate response to the various engagement activities completed to meet the requirements and expectations of relevant legislation and guidelines.

The Plan provides an overview of the engagement implementation that has and will contribute to informing the development of the Activity. Ongoing engagement activities will be delivered to maintain communication with stakeholders and communities in the longer term.

5.3.2 Regulatory Requirements for Stakeholder Engagement

The *PER* requires an interest holder to undertake stakeholder engagement during the preparation of an EMP.

The *PER* defines a stakeholder as being:

- a person or body whose rights or activities may be directly affected by the environmental impacts or environmental risks of the regulated activity proposed to be carried out; or
- an agent or representative of a person or body mentioned above.

5.3.3 Engagement Approach

Imperial is committed to early and ongoing stakeholder engagement across all phases of the Activity lifecycle. The development of the Stakeholder Engagement Plan has referred to the core values and standards developed by the International Association for Public Participation [IAP2, 2015] for the purpose of stakeholder engagement. Meaningful engagement provides stakeholders with essential information about the Activity and an opportunity to communicate concerns and aspirations with Imperial.

The feedback from stakeholder consultation is consolidated to assist with decision-making, where there is an opportunity to influence project decisions and determine processes to meet community expectations.

Imperial has assigned dedicated company representatives to deliver consistent interactions throughout the engagement process. The engagement approach has focused on ensuring communication with stakeholders has been respectful and transparent.

5.3.4 Objectives and Outcomes

Imperial has proactively considered its approach to implementing this Plan to align with legislative requirements and guidelines to continue building on its relationships with stakeholders and the wider community.

The fundamental objectives of the Plan are designed to create a framework for consultation throughout the project lifecycle, including:

- Building trust and transparency with stakeholders.

- Ensuring stakeholders have access to project information.
- Demonstrating commitment to engagement with stakeholders and how their feedback is considered and incorporated into project development.
- Managing stakeholder expectations and aspirations.
- Monitoring and reviewing the Plan for continued improvement.
- Meeting legislative requirements effectively.
- Listening to stakeholders and community to understand their expectations and values.
- Ensuring Traditional Owners and other Aboriginal stakeholders are engaged throughout the process and providing culturally appropriate methods of communication.
- Working with the relevant organisations, such as the Northern Land Council (NLC) who have a legislated role in Traditional Owners and Aboriginal engagement.
- Collating stakeholder feedback to inform the project decisions for environmental assessments.
- Working with local communities to promote awareness of business and employment opportunities relevant to the project.
- Working with communities to consider opportunities for long-term community investment and ensuring benefits are shared.
- Communicating with stakeholders to build understanding as to why and how the company operates.

The expected outcomes of the Plan include:

- Stakeholders are identified and informed of project details appropriate to the stakeholder mapping and analysis matrix.
- Stakeholders are provided an opportunity to consult and provide feedback to ensure meaningful engagement throughout the project lifecycle.
- Traditional Owners and Aboriginal people are informed in a manner that respects and documents cultural values.
- Consultation has informed the environmental assessment process and demonstrates consideration of stakeholder feedback.

5.3.5 Engaging with Aboriginal Stakeholders

Imperial's undertakings in the Northern Territory are predominantly based in remote areas and require special attention to engage effectively with Aboriginal stakeholders and communities in a culturally appropriate manner.

As the Activity is located on Aboriginal freehold Land, Imperial has an obligation to formally engage with:

- Directly affected Traditional Owners as decision-makers; and
- Any other Aboriginal community or groups that may be affected by the Activity.

Imperial will engage through the NLC as the representative body under the *Aboriginal Land Rights (Northern Territory) Act, 1976* (Cth) (ALRA).

Imperial believes it is incumbent on proponents to demonstrate to communities how their land, environment and culture are being protected and to ensure local knowledge is documented to inform project activities and development plans. Imperial respects the principle of Full, Prior and Informed Consent (FPIC) as recognised in the United Nations Declaration on the Rights of Indigenous Peoples [UNITED NATIONS, 2016].

When considering potential project development, Aboriginal custodian representatives are engaged wherever possible to undertake sacred site clearance surveys across activity areas. No ground disturbing activities are undertaken on EP 187 without an Authority Certificate issued by the Aboriginal Areas Protection Authority under the *Northern Territory Aboriginal Sacred Sites Act, 1989* (NT). This information informs of any potential areas of sacred sites and how they will be avoided.

Imperial has a strong track record of engaging with Aboriginal people and has attended more than 35 On-Country meetings facilitated by the NLC across its petroleum permits since 2011. Materials for engagement include presentations, pictures, models, and videos to explain various stages of activity, facilitating open dialogue with company representatives present to listen to concerns and answer questions. Imperial has built strong connections with Aboriginal people within the activity area and surrounding and provided a direct line of communication to support open dialogue.

Imperial has facilitated multiple field visits for Traditional Owners and the wider community to offer further opportunities to see what activity is being undertaken. Feedback from stakeholders who have participated has been very positive providing an understanding of the scale and impact of project activities. Field visits will continue to be an important part of ongoing engagement as requested by Traditional Owners.

5.3.6 Stakeholder Analysis and Mapping

Stakeholder mapping is an important tool used to identify levels of stakeholder involvement and determine the most effective methods of communication across various demographics.

The IAP2 Spectrum [IAP2, 2015] is an internationally recognised standard designed to assist with demonstrating various levels of participation for stakeholders. The IAP2 Spectrum includes a matrix outlining the participation goal and the proponent's commitment to the level of engagement for each stakeholder group. This standard identifies the levels of engagement as *Inform, Consult, Involve, Collaborate and Empower*.

While recognising that stakeholders and community must have access to project information, the level of detail, consistency and style of communication may vary according to the level of engagement. It is important that stakeholders have appropriate opportunity to provide input into how often and how much consultation is suitable to meet their expectations.

Imperial has undertaken a mapping exercise to identify initial stakeholder cluster groups to be considered by the Plan. This analysis for the purpose of the Plan includes stakeholders directly affected by the Activity and the wider community. Stakeholders for the purpose of this Plan have been allocated to the primary clusters as indicated below:

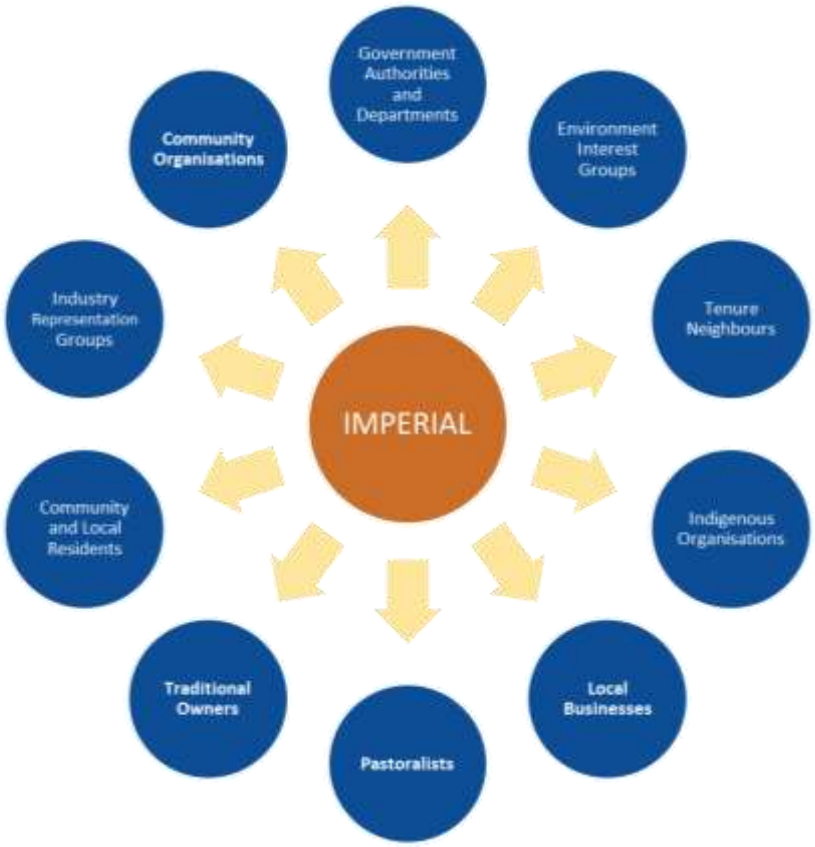


Figure 5.3—1 Identified Clusters of Stakeholders for Analysis and Mapping Process

Stakeholder mapping is an ongoing process, and it should be noted that stakeholder identification may be updated, or the level of consultation and participation may change, throughout the project lifecycle.

To achieve effective stakeholder engagement, is important to ensure stakeholders are aware of the decisions they can influence, what they cannot influence, and that this information is communicated as early as possible throughout various stages of the Activity. This ensures that stakeholder expectations can be managed while meeting the requirements of the project, which may include governance, statutory and regulatory obligations.

To manage consultation and engagement implementation, stakeholders have been allocated to tiers within each cluster group based on their relevance, level of interest, potential impact, proposed engagement method and alignment with the IAP2 Spectrum. The assessment and allocation of stakeholders is detailed in the SER (**Appendix 10 - Section 2.2**).

As noted previously, the CPP Area lies wholly within NT Portion 5706, which is an Indigenous estate of freehold land for the Mambaliya Rrumburriya Wuyaliya Aboriginal Land Trust as landowners. In 2013, Imperial applied for the grant of a petroleum exploration permit. Pursuant to Section 41 of the Aboriginal Land Rights Act 1986 (NT), Imperial applied to the Northern Land Council (NLC) for consent to the NTG grant of petroleum Exploration Permit (EP) 187.

The CPP Area also encompasses several cattle agistments, under Section 19 Aboriginal Land Rights (Northern Territory) Act 1976 (Cth) (ALRA) lease holdings, that are leased from the Mambaliya Rrumburriya Wuyaliya Aboriginal Land Trust, allowing livestock access to savannah grassland, watercourses, and riparian areas within respective Section 19 agistment leasehold areas.

5.3.7 Identified Key Stakeholders

Using the stakeholder definition of the *PER*, Imperial has identified the following as key relevant stakeholder groups for EP 187:

- Traditional Owners, as the traditional Aboriginal owners of the land the subject of the CPP (through the Mambaliya Rrumburriya Wuyaliya Aboriginal Land Trust).
- The Northern Land Council as the relevant Land Council under ALRA and as the representative and agent of traditional Aboriginal owners.
- Leaseholders of the land subject of the Activity in accordance with section 19 of ALRA.
- Other authorised land users within the Location of the Activity.

Other community members who do not meet the definition of stakeholder under the *PER* but are consulted more broadly by Imperial to implement the Plan have been identified through

stakeholder mapping and analysis. The extended list of stakeholders is provided in the SER (**Section 2.2** of **Appendix 10**).

5.3.8 Contact Details of Key Stakeholders

Table 5.3—1 Contact Details of Key Stakeholders

Stakeholder	Contact Details
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]

5.3.9 Stakeholder Engagement Methodologies

Stakeholder engagement for the Activity has commenced and will continue to be undertaken using various methodologies according to the level of participation required as identified by Imperial's stakeholder mapping and analysis.

A range of tools for engagement will continue to be employed to deliver effective information sharing with various groups of stakeholders as required. Where possible, Imperial will consider how methodologies can be improved, or alternative techniques developed to meet the expectations of various stakeholders and community groups. This may include:

- Targeted presentations.
- One-on-one stakeholder meetings.
- Community information forums.
- Field visits as appropriate for various project activities.
- Participation in regional conferences and business network events.
- Participation in regional community events and shows days.

- Development of website content with updated project information.
- Fact sheets and email briefings.
- Content distributed by third-party networks e.g. local business associations and membership organisations.
- Contact portal through the website providing a feedback mechanism.
- Local supply chain briefings and engagement.
- Advertising and media.

5.3.10 Monitoring and Evaluation

Imperial will provide stakeholders with avenues to capture their feedback throughout the Activity's lifecycle. Imperial intends to maintain a dedicated online consultation portal providing an open mechanism for sharing information and receiving feedback. All key relevant stakeholders will be provided with direct contact details for appropriate company representatives to ensure an open line of communication.

Throughout the implementation of the Plan, feedback initiated from various forums and methodologies will be documented to maintain a register of interactions related to the Activity. Feedback received from stakeholders and community members will be considered and followed up appropriately.

Responding to stakeholder feedback may include:

- Targeted meetings to discuss feedback and response.
- Emails or phone calls to discuss feedback and response.
- Regular community visits to keep stakeholders informed.
- Sharing announcements, newsletters or alerts relevant to the stakeholder.
- Other communications methods as requested by stakeholders.
- Ongoing consultation program planning to maintain consistent engagement.

Feedback and communication received from stakeholders will be recorded in the stakeholder interaction database and where relevant, documented in the Communications Log (**Appendix 10**).

Imperial is committed to reviewing the Plan annually to determine the effectiveness of engagement and how stakeholders need to remain informed throughout the process. The ongoing review will consider:

- Feedback from stakeholders and the community, the Regulator, contractors, and employees.
- Changes to potential environmental, cultural and community impacts.
- Suggestions, objections or complaints received regarding Activity operations.
- Any changes to legislation and regulatory requirements that may affect engagement or community expectations.

5.4 Assessment of Merit of Objections and Claims

Objections and complaints received from stakeholders about the anticipated environmental impact from the conduct of the Activity covered by this EMP are recorded on a register and acknowledged in writing.

Imperial assesses the merit of any objections or complaints made and responds accordingly.

5.5 Ongoing Engagement Plan

Imperial has been undertaking consultation with stakeholders for over a decade in the Northern Territory. Imperial views stakeholder engagement as an ongoing commitment and will continue to consult with relevant stakeholders throughout the progression of the Activity. This will include employing the methodologies assigned to stakeholders in the Plan and considering the evolution of how engagement with different stakeholder groups may change throughout the course of development.

The Stakeholder Engagement and Consultation Plan will be monitored and reviewed on a regular basis to continue to meet the requirements to share updated information, track any changes to stakeholder mapping, record feedback and concerns from the community and provide a mechanism to respond to any issues that may arise.

Imperial will prepare a draft plan for engagement activities annually to meet stakeholder and community objectives and comply with legislative requirements. Where stakeholders have requested, or Imperial believes it would be beneficial, stakeholders will be engaged on an ongoing basis, and communications will continue until the activity has concluded.

A detailed stakeholder engagement log will be maintained to continue to capture information relating to consultation, methodologies, and responses to stakeholder concerns.

Imperial commits to continuing regular stakeholder engagement which may include:

Traditional Owners:

- Communications with NLC to determine information requirements of Traditional Owners for regular updates.
- Contact with Traditional Owners representatives with direct contact to an Imperial representative to be available.
- Field visit opportunities provided while activities are being undertaken.
- Annual Work Program meetings to report on activities undertaken over the previous 12 months and upcoming over the following 12 months.

Directly affected pastoralists and other authorised land users:

- Regular provision of information related to activity updates and progress.
- Direct contact with field representatives to manage any day-to-day operational issues.

Other stakeholders and the community:

- Continued participation in local community events and show days.
- Annual regional community drop-in day across various locations.
- Coordination of field visits as appropriate.
- Updating the online consultation portal with current information.
- Continued engagement with Industry Capability Network to promote local business engagement opportunities.

Engagement activities may change or be updated to meet expectations of stakeholders and to conform with the requirements of the Activity.

6 Environmental Risks and Mitigation Measures

6.1 Environmental Risk Assessment Methodology

6.1.1 Approach

An Environmental Risk Assessment (ERA) involves determining the likelihood of occurrence and severity of consequences of a potential risk event. A risk is the potential for aspects of the Activity to result in a "consequence" ("environmental impact") and "consequence" refers to the outcomes or impacts if the undesirable event ("risk event") occurs.

The *PER* Schedule 1 Item 3 requires details of all environmental impacts and environmental risks of the Regulated Activity and an assessment of those impacts and risks to be included in an EMP.

To assist with effective environmental impact assessment, the NT EPA has developed the *NT EPA Environmental Factors and Objectives; Environmental Impact Assessment; General Technical Guidance* [NT EPA, 2022B]. Imperial has used this document to inform the development of the ERA.

The risk assessment methodology described in this document is aligned to both AS ISO 31000 Risk Management series and HB203:2012 Managing environment-related risk, detailed by NT EPA [2022B].

The steps followed in developing this ERA include:

- Identification of key environmental factors in the CPP Area
- Source-Pathway-Receptor (S-P-R) Analysis
- Classification of consequences
- Determination of likelihood
- Pre-treatment risk ranking
- Control measure identification
- Residual risk ranking
- Scientific certainty.

The S-P-R model is used to identify the potential impact linkages between the source, pathway, and receptor. The model looks at the source, pathways, and receptors for pollution - It starts with the source, i.e. where pollution can come from, the next step is to determine how the pollution can travel through the environment, the pathway. Finally, consider the receptor of the

pollution, who or what could be affected. This model is used to assess the potential risks associated with these linkages to determine whether the risks are acceptable or unacceptable. The model is used in a tiered approach to risk assessment, which includes a preliminary risk assessment and a detailed quantitative residual risk assessment based on the risk control measures that are to be implemented in the proposed Activity.

The risk assessment process combines the likelihood and consequence of an event occurring to give a relative indication of risk ranking associated with that event. Risk ranking is determined using the Risk Matrix in **Table 6.1—1**.

The Consequences Classification (**Table 6.1—2**) is used across Imperial HSE operations and considers the following:

- Health and safety
- Environment
- Reputation
- Financial.

The components within the 5 tiers are measured from Negligible to Critical. The Likelihood Classification (**Table 6.1—3**) is used to provide a ranking of the likelihood that a risk event will occur. The Residual Risk Ranking and Response (**Table 6.1—4**) provides graduated responses for each of the five tiers of risk.

Table 6.1—1 Environmental Risk Assessment: Risk Matrix

Consequence / Likelihood		Negligible I	Minor II	Moderate III	Major IV	Critical V
Almost Certain	a	3	4	4	5	5
Likely	b	2	3	4	4	5
Possible	c	2	2	3	4	4
Unlikely	d	1	2	2	3	4
Remote	e	1	1	2	2	3

Table 6.1—2 Environmental Risk Assessment: Consequences Classification

Level		Health & Safety	Environment	Reputation	Financial
Critical	**V**	Fatality	Destruction of sensitive environmental features. Severe impact on the ecosystem. Regulatory and high-level Government intervention/action.	Critical impact on business reputation /or international media exposure.	Financial loss of $500,000 or over.
Major	**IV**	Permanent disabling injury and/or long-term off work.	Long-term impact of regional significance on sensitive environmental features (e.g., wetlands). Likely to result in regulatory intervention/action.	Significant impact on business reputation and/or national media exposure.	Financial loss from $300,000 to $400,000.
Moderate	**III**	Injury requiring medical treatment, time off work and rehabilitation.	Short-term impact on sensitive environmental features (e.g., Gibber Plain). Triggers regulatory investigation.	Moderate to small impact on business reputation.	Financial loss from $200,000 to $300,000.
Minor	**II**	Injury requiring medical treatment with no lost time.	Impact on fauna, flora and/or habitat but no negative effects on the ecosystem. Requires regulator notification.	Some impact on business reputation.	Financial loss from $100,000 to $200,000.
Negligible	**I**	Minor injury - first aid treatment.	Negligible impact on fauna/flora, habitat, aquatic ecosystem, or water resources. Incident reporting according to routine protocols.	Minimal impact to reputation.	Financial loss from $0 to $100,000.

Table 6.1—3 Environmental Risk Assessment: Likelihood Rankings and Criteria

Ranking	Reference	Criteria
Almost Certain	a	Almost certain to occur within the foreseeable future or the Activity lifecycle.
Likely	b	Likely to occur within the foreseeable future or the Activity lifecycle.
Possible	c	May occur within the foreseeable future or the Activity lifecycle.
Unlikely	d	Not likely to occur within the foreseeable future or the Activity lifecycle.
Remote	e	Will only occur in exceptional circumstances.

Table 6.1—4 Environmental Risk Assessment: Residual Ranking and Response

Residual Risk Ranking	Response
5	• Intolerable risk ranking. • Following verification of the residual risk at ranking 5, the works must stop. • Activity cannot recommence until controls are implemented to reduce the residual risk to ranking 4 or lower. • Detailed multi-disciplinary incident investigation team required if risk event occurs. • Management involvement in the investigation if risk event occurs.
4	• Re-assess risk to determine if as low as reasonably practicable (ALARP). • If ALARP, activities related to maintenance of controls/barriers prioritised and managed. • If not ALARP, improve existing controls and/or implement new controls. • Detailed multi-disciplinary incident investigation team required if risk event occurs.
3	• Assess risk to determine if ALARP.

Residual Risk Ranking	Response
	• If ALARP, works related to maintenance of controls/barriers will be prioritised and managed. • If not ALARP, improve existing controls and/or implement new controls. • Full incident investigation required if risk event occurs.
2	• Assess risk to determine if ALARP. • If ALARP, activities related to maintenance of controls/barriers prioritised and managed. • If not ALARP, improve existing controls and/or implement new controls. • Incident investigations using simple tools required if risk event occurs.
1	• Managed as stipulated by the related work processes. • No incident investigation required if risk event occurs.

6.1.2 Scientific Certainty

The scientific certainty of each risk assessment has been assessed using **Table 6.1—5.**

Imperial has five years of active petroleum exploration and environmental monitoring within EP 187. This monitoring, coupled with substantive international technical experience of shale gas development, provides a strong foundation for assessing scientific certainty.

6.1.3 ALARP Decision Making Tools

When determining whether the risk or impact has been reduced to ALARP, it must be determined whether environmental risks can be lowered further without a disproportionate increase in cost. Whether the proposed control creates unintended additional risks must also be considered.

The following tools provide a framework for deciding if a risk has been reduced to ALARP.

- **Good Regulatory Compliance:** The requirements of legislation, codes and standards that must be complied with for the Activity have been identified and addressed.
- **Good Industry Practice**: Industry and engineering standards and guidelines that may effectively reduce risk have been identified and considered.
- **Professional Judgement**: Personnel with relevant knowledge and experience to identify and develop the most effective controls have been used.

- **Hierarchy of Controls:** Control measures have been developed by applying the hierarchy of controls philosophy.
- **Risk-based Tools**; Controls have been developed using risk-based tools such as cost-benefit and probabilistic analyses.
- **Precautionary Principle**: Controls have been developed applying the precautionary principle.

Table 6.1—5 Environmental Risk Assessment: Scientific Certainty Scoring

Category	Description	Decision Making Tools
High	• Control/mitigation measures are well understood and established within the industry to ensure the risk is effectively controlled. • Information available to assess the risk is current.	• Legislation, codes, and standards exist to regulate the Activity. • Good industry practice includes additional controls beyond legislation, codes, and standards.
Medium	• Control/mitigation measures exist and have been demonstrated as effective in other similar projects. • Information used to assess the risk is still valid but is either starting to date or there are information gaps.	• Risk based assessment tools are available for use (e.g., modelling, quantitative risk assessment, cost benefit analysis etc).
Low	• Scarce or no data available to support the assessment of the risk.	• No guidance material available. The precautionary approach to management of the risk is required.

6.2 Risk Assessment

6.2.1 Risk Assessment Outcomes

The environmental, heritage, and community risks associated with the Activity covered under this EMP have been assessed using the Imperial risk assessment framework described in **Section 5.1**. The risk assessment matrix (**Table 6.1—1**) presents the range of potential impact-causing sources, initial risk ranking, corresponding control measures and residual risk ranking based on their assessed worst-case consequence and likelihood of occurrence. Site-

specific conditions for proposed disturbance areas have also been considered during the assessment, in relation to controls. The risk assessment is environmentally focused on isolation-containment-integrity and monitoring with an emphasis on site selection. Cumulative impact assessment regionally has also been included.

A total of 67 Risk Source and Potential Impacts were identified in the risk assessment using SPR Analysis scenarios. Before controls were put in place as reflected in **Table 6.2—1**, one risk was ranked as very high, eight were ranked as high, eighteen were ranked as medium and the rest were ranked low or remote. All risks ranked medium or higher, before control, have corresponding Environmental Performance Standards and Measurement Criteria listed in **Section 6.3**.

Table 6.2—1 Summary of Environmental Risks for the Activity

Environmental Risk Rating with Applied Controls					
Remote	**Low**	**Medium**	**High**	**Very high**	**Total**
20	39	8	0	0	67

The remaining medium residual risks sources are summarised in **Table 6.2—2** below.

Table 6.2—2 Summary of Medium Risk Source and Potential Impacts for the Activity

#	Risk ID	Risk Source and Potential Impacts
1	AP-5	Flaring or venting gas during appraisal phase contributes to anthropomorphic climate change.
2	CH-1	Damage to cultural and heritage places and objects – Site Selection.
3	CH-2	Damage to cultural and heritage places and objects – Land Clearing.
4	TE-17	HF flowback water loss of containment from above ground tank impacting soil.
5	TE-14	Wastewater flowline leaks impact soil.
6	HH-3	HF Sand Dust Silicosis Impacts.
7	IW-4	Wastewater flowline leaks impacting Inland surface water.
8	IW-6	HF flowback water loss of containment from above ground tank impacting inland surface water.

The level of Scientific Certainty for each Potential Risk Source/Impact and associated Controls was assessed in the Risk Assessment Table below). The baseline information and operational experience derived for the CPP Area since petroleum exploration recommenced on EP 187 in 2019 following the HFI; the recent completion of the Beetaloo SREBA studies; the Wiso Water Allocation Plan; relevant information and experience derived from onshore gas operations in Queensland and elsewhere, provide a good deal of baseline information to quantitatively assess overall Activity risks with a high level of scientific certainty. of the 65 risks and related controls that were assessed, 42 were classified as having a High Scientific Certainty and 23 with Medium Scientific Certainty. None were classified as having Low Scientific Certainty.

6.2.1.1 Risk Assessment Table

An environmental risk assessment was undertaken for the Activity using the methodology outlined in the sections above. The results are presented in **Table 6.2—3**.

Table 6.2—3 Risk Assessment Table

Risk #	Environmental Factor	Risk Code	Source	Potential Impact	Initial Risk Ranking*			Key Controls and Code Reference		Residual Risk Ranking			Controls Reduce Risk to ALARP (Y/N)	Scientific Certainty Ranking
					L	C	R	Controls	Code of Practice Reference	L	C	R		
1	**Atmospheric Processes**	**AP-1**	**Vehicle Movements in CPP Area**	Greenhouse gas emissions contribute to anthropomorphic climate change.	**b**	**I**	**2**	• Maintain vehicles to OEM specifications.	Not applicable	**d**	**I**	**1**	YES	Medium
2	**Atmospheric Processes**	**AP-2**	**Operation of Plant and Equipment**	Greenhouse gas emissions contribute to anthropomorphic climate change.	**b**	**I**	**2**	• Plant and equipment operated and maintained by qualified personnel to OEM specifications.	Not applicable	**d**	**I**	**1**	YES	High
3	**Atmospheric Processes**	**AP-3**	**Drilling of Petroleum Wells**	Fugitive greenhouse gas emissions contribute to anthropomorphic climate change.	**b**	**II**	**3**	• Overbalanced drilling (i.e., well pressure maintained above reservoir pressure). • Wellheads specified in API standards. • Well construction includes multiple barriers in accordance with the approved WOMP. • Well control training completed by those in control of drilling.	B.3 Well Operations Management Plans	**d**	**II**	**2**	YES	High
4	**Atmospheric Processes**	**AP-4**	**Operation of Petroleum Wells**	Fugitive greenhouse gas emissions contribute to anthropomorphic climate change.	**b**	**III**	**3**	• Automatic over-pressure control on flowlines. • Wells completed with multiple barriers in accordance with the approved WOMP. • Wellhead pressure monitoring. • Personal Gas Detectors used to check high point vents, flanges, and valves. • Wellheads are designed per the *NT Code of Practice* and API standards to minimise loss of methane containment [DENR, 2019]. • Personal Gas Detectors (PGD) used on-site where signed or inductions require. Should a methane leak be identified by PGD monitoring, leak classification,	Part D - Methane emissions monitoring, leak management, detection, and reporting B.3 Well Operations Management Plans	**d**	**III**	**2**	YES	High

Risk #	Environmental Factor	Risk Code	Source	Potential Impact	Initial Risk Ranking*			Key Controls and Code Reference		Residual Risk Ranking			Controls Reduce Risk to ALARP (Y/N)	Scientific Certainty Ranking
					L	C	R	Controls	Code of Practice Reference	L	C	R		
								remediation and notification requirements as described in the MEMP will be implemented (**Appendix 13**). • Routine wellhead maintenance, in accordance with the well Integrity Management System, will be carried out. • Wells are designed and constructed to be gas tight with multiple barriers to flow. • Each well and equipment on a well pad will be inspected every six months for leaks using a United States Environmental Protection Agency (US EPA) Method 21 [United States Environmental Protection Agency, 2017] compliant monitoring device. • Remotely controlled shutdown valves exist on all wells connected to CGP in case of a leak event or process upset. • Plant and equipment operated and maintained by qualified personnel. • Refer also to the Methane Emissions Management Plan for leak detection monitoring and management.						
5	**Atmospheric Processes**	**AP-5**	**Operation of Petroleum Wells**	Flaring or venting gas during appraisal phase contributes to anthropomorphic climate change.	**a**	**IV**	**5**	• Gas recovery on an appraisal basis (approval currently being sought under Section 57AAA of the *Petroleum Act, 1984 (NT)*. • If the application under Section 57AAA is unsuccessful and the CPP proceeds on a basis different to the one described, this EMP will be revised or modified under the *PER* to account for any new or increased environmental impacts or risks. This revision would include a greenhouse gas abatement plan if Imperial's estimated scope 1 emissions exceed 100,000 tCO_2-e in any financial year over the life cycle of the project.	Not applicable	**d**	**IV**	**3**	YES	High

Risk #	Environmental Factor	Risk Code	Source	Potential Impact	Initial Risk Ranking*			Key Controls and Code Reference		Residual Risk Ranking			Controls Reduce Risk to ALARP (Y/N)	Scientific Certainty Ranking
					L	C	R	Controls	Code of Practice Reference	L	C	R		
								• Flaring gas volumes recorded and do not result in an exceedance of scope 1 emissions of greater than 100,000 tCO2-e in any financial year over the life cycle of a project.						
6	**Atmospheric Processes**	**AP-6**	**Gas Gathering Network**	Fugitive greenhouse gas emissions contribute to anthropomorphic climate change.	**b**	**III**	**3**	• Automatic over-pressure control on flowlines. • Flowline pressure monitoring. • Flowlines designed, installed, and operated in accordance with Australian Pipelines and Gas Association (APGA) *Code of Practice for Upstream Polyethylene Gathering Networks, 2019* (*PEGN Code*) [APGA, 2019]. • Personal Gas Detectors used to check used to check high point vents, flanges, and valves. • Remotely controlled shutdown valves exist on all wells connected to CGP in case of a leak event or process upset. • PGD used on-site where signed or inductions require. Should a methane leak be identified by PGD monitoring, leak classification, remediation and notification requirements as described in the MEMP will be implemented. • Plant and equipment operated and maintained by qualified personnel. • Flowlines will be inspected weekly by visual inspection of the ROW. • Regular visits will be made to operational well sites, gathering systems and processing facilities in accordance with the MEMP. • All persons completing emission detection activities will be properly trained and competency assured.	Part D - Methane emissions monitoring, leak management, detection and reporting	**d**	**III**	**2**	YES	High

Risk #	Environmental Factor	Risk Code	Source	Potential Impact	Initial Risk Ranking*			Key Controls and Code Reference		Residual Risk Ranking			Controls Reduce Risk to ALARP (Y/N)	Scientific Certainty Ranking
					L	C	R	Controls	Code of Practice Reference	L	C	R		
								• Leak inspections will be conducted on the minimum frequencies detailed in **Table 6—1** of **Appendix 13** – (MEMP). • Where the operator uses optical gas imaging for leak detection, an annual inspection using US EPA Method 21 will also be performed on the facility. • Weekly visual inspection of MRGP Connection. • Remotely controlled shutdown valves exist on all wells connected to CGP in case of a leak event or process upset.						
7	**Atmospheric Processes**	**AP-7**	**Carpentaria Gas Plant**	Fugitive greenhouse gas emissions contribute to anthropomorphic climate change.	**b**	**II**	**3**	• Plant and equipment operated and maintained by qualified personnel. • CGP is designed to allow for the flaring of gas due to process upsets. • Construction of plant includes leak testing at all leak points and pressure testing of the facility. • 24-hour monitoring of Gas Plant and emergency alarm system. • PGD used on-site where signed or inductions require. Should a methane leak be identified by PGD monitoring, leak classification, remediation and notification requirements as described in the MEMP will be implemented. • Plant designed and installed to Australian standards including HAZOP assessments, leak testing, pressure testing, and appropriate commissioning.	Part D - Methane emissions monitoring, leak management, detection, and reporting	**d**	**II**	**2**	YES	High
8	**Terrestrial Ecosystems**	**TE-1**	**Land Clearing**	Mobile plant starts a that impacts ecosystems	**d**	**III**	**2**	• Fire extinguishers in all operating plant and in Imperial Site Supervisor's vehicle. • All machinery and vehicles will be parked in areas of low fire risk free of combustible material.	A.3.7 Fire Management	**e**	**III**	**2**	YES	Medium

Risk #	Environmental Factor	Risk Code	Source	Potential Impact	Initial Risk Ranking*			Key Controls and Code Reference		Residual Risk Ranking			Controls Reduce Risk to ALARP (Y/N)	Scientific Certainty Ranking
					L	C	R	Controls	Code of Practice Reference	L	C	R		
								• All personnel are trained and informed about: ○ Restricted smoking areas and requirements. ○ Firefighting equipment operation and communication. ○ Emergency Response Plan and procedures. • Maintain fire breaks and fire access trails. • Monitor trails for grassy weeds and control where appropriate.						
9	**Terrestrial Ecosystems**	**TE-2**	**Land Clearing**	Damage to important and critical habitat for fauna species.	**c**	**III**	**3**	• Ground truthing environmental assessment (**Appendix 01**) of proposed infrastructure. • Use of infrastructure movement zones to adjust infrastructure placement to avoid critical habitat. • To mitigate risks associated with clearing, Imperial will: ○ A qualified ecologist will be on-site to prior to clearing to identify threatened flora and fauna that could be impacted by the Activity. ○ A qualified ecologist will undertake pre-clearance surveys prior to clearing works to identify significant habitat trees (DBH >25 cm, height 1.3 m) that could be avoided by adjusting locations within the infrastructure movement zone. ○ Undertake post-works weed and rehabilitation surveys. • If a suspected Grey Falcon nest is identified during pre-clearing assessments, a 300 m buffer will be applied to establish a vehicle free exclusion zone until a positive identification confirms the nest is not an active Grey Falcon nest.	A.3.1 Site Selection and Planning A.3.5 Biodiversity Protection	**d**	**III**	**2**	YES	High

Risk #	Environmental Factor	Risk Code	Source	Potential Impact	Initial Risk Ranking*			Key Controls and Code Reference		Residual Risk Ranking			Controls Reduce Risk to ALARP (Y/N)	Scientific Certainty Ranking
					L	C	R	Controls	Code of Practice Reference	L	C	R		
								• A 300 m buffer around identified active Grey Falcon nests will be maintained. (Refer to **Section 4.13.3.4** for details).						
10	**Terrestrial Ecosystems**	**TE-3**	**Land Clearing**	Land clearing operations start a bushfire.	**d**	**III**	**2**	• Fire extinguishers in all operating plant and in Imperial Site Supervisor's vehicle. • All machinery and vehicles will be parked in areas of low fire risk free of combustible material. • All personnel are trained and informed in regard to: ○ Restricted smoking areas and requirements. ○ Firefighting equipment operation and communication. ○ Emergency Response Plan and procedures. • Maintain fire breaks and fire access trails. • Monitor trails and flare exclusion zones for grassy weeds and control where appropriate. • Create and maintain firebreaks /access trails for fire management by grading, spraying, or slashing. • The Site Supervisor will monitor the NAFI website and Secure NT website daily in the Dry Season and weekly in the Wet Season and liaise with relevant land holders/pastoralists about potential fire control measures if a fire threatens the CPP Area or infrastructure. • All hot work completed under a permit to work system. • Hot work restricted and controls defined prior to work during moderate and high fire rating days. • Hot work permit revoked on extreme and catastrophic fire hazard days.	Terrestrial Ecosystems	**e**	**III**	**2**	YES	Medium

Risk #	Environmental Factor	Risk Code	Source	Potential Impact	Initial Risk Ranking*			Key Controls and Code Reference		Residual Risk Ranking			Controls Reduce Risk to ALARP (Y/N)	Scientific Certainty Ranking
					L	C	R	Controls	Code of Practice Reference	L	C	R		
11	**Terrestrial Environmental Quality**	**TE-4**	**Land Clearing**	Land clearing operations introduce or spread weeds	**c**	**III**	**3**	• Rehabilitation Management Plan (**Appendix 03**): ○ Annual post-Wet Season weed surveys of access tracks, flowlines, well pads, facilities and infrastructure areas will determine whether any new weed introductions have occurred. ○ Identified weeds will be controlled in line with the *Northern Territory Weed Management Handbook* [Northern Territory Government, 2021]. • Weed Management Plan (**Appendix 04**): ○ All vehicles to undertake and complete Weed Hygiene self-declaration prior to arriving onsite. Records will be retained. • All equipment/machinery is clean of plant and soil matter before demobilising from one site and working on another. • Restrict movement of topsoil from sites where significant or declared weeds are known to exist. • Control declared weeds in accordance with NT Government's Weeds in the NT database. • Develop weed identification material to be made available to staff and contractors while working on the lot. Problem weeds can be defined during pre-work toolboxes. • Compulsory site inductions will include information on problem weed species and protocols to minimise risk of introduction and reporting procedures. • Restrict access to areas outside of the cleared footprint to limit the disturbance area to within the approved footprint.	Terrestrial Environmental Quality	**d**	**III**	**2**	YES	High

Risk #	Environmental Factor	Risk Code	Source	Potential Impact	Initial Risk Ranking*			Key Controls and Code Reference		Residual Risk Ranking			Controls Reduce Risk to ALARP (Y/N)	Scientific Certainty Ranking
					L	C	R	Controls	Code of Practice Reference	L	C	R		
								• Conduct post-Wet Season weed surveys to determine whether any weed introductions have occurred and to monitor existing weed populations. • Take the appropriate and government authority preferred corrective actions where necessary. • Monitoring data of weed populations (and/or weed free areas) based on pre-construction data. • Progressive rehabilitation of significantly disturbed areas commenced as soon as practicable and no later than 12 months after the cessation of the Activity. • Vehicles will stay on cleared/formed access tracks, post-civil construction works.						
12	**Terrestrial Environmental Quality**	**TE-5**	**Land Clearing**	Increased erosion impacts the land	**c**	**III**	**3**	• Low-level watercourse crossings for access tracks to be excavated and backfilled with rock to watercourse bed level. • Decision tree developed (EMP **Section 3.4.8.1**) to determine type of watercourse crossing to be used (directional drilling or trenching), in conjunction with a high resolution fluvial geomorphic baseline assessment. ○ Drone acquisition of baseline High Resolution Ortho Photography with corresponding Digital Surface Model (DSM) prior to the trenching operations for high precision topographic mapping of baseline fluvial geomorphic features at each location. ○ Prior to trenching, Imperial will check the 7-day forecast to ensure an adequate window for the trenching, installation, backfill, and stabilisation works to be carried out. ○ Report of flowline trench geomorphic conditions pre- and post-construction. Includes GPS	A.3.1 Site Selection and Planning A.3.4 Erosion and Sediment Control and Hydrology	**d**	**III**	**2**	YES	High

Risk #	Environmental Factor	Risk Code	Source	Potential Impact	Initial Risk Ranking*			Key Controls and Code Reference		Residual Risk Ranking			Controls Reduce Risk to ALARP (Y/N)	Scientific Certainty Ranking
					L	C	R	Controls	Code of Practice Reference	L	C	R		
								identifiable before and after photos to ensure backfilling restores channel shape and bed level to a preconstruction condition. ○ Monitoring as per **Table 8.2—2**. • New well pads will not be in areas prone to 1 in 100-year flooding. • Site inspections and monitoring (may be done with camera) is to be undertaken in accordance with the ESCP (**Appendix 05**) and will include: ○ Daily site inspections (during rainfall) during construction works. ○ Monthly site inspections (even if works are not occurring on-site). ○ Inspection of sediment controls during construction following rainfall events of 20 mm. • Progressive rehabilitation of significantly disturbed areas commenced as soon as practicable and no later than 12 months after the cessation of the Activity.						
13	**Terrestrial Environmental Quality**	**TE-6**	**Vehicle Movements in CPP Area**	Dust impacts on flora	**c**	**II**	**2**	• Use water truck during operations to suppress dust during dry and windy weather.	Not applicable	**e**	**II**	**1**	YES	Medium
14	**Terrestrial Environmental Quality**	**TE-7**	**Vehicle Movements in CPP Area**	Vehicle impacts on fauna and stock	**c**	**II**	**2**	• Speed limits signposted on all access tracks. • Site inductions will specify speed limits across the CPP Area, enforcing 60 km/hr during daylight and 40 km/hr during night, dawn, and dusk.	Not applicable	**e**	**II**	**1**	YES	Medium
15	**Terrestrial Environmental Quality**	**TE-8**	**Installation of Buried Flowlines**	Wildlife and stock falling in open trenches during construction	**c**	**II**	**2**	• Any trenches that are left open overnight will be: ○ Fenced to exclude large fauna and livestock. ○ Fitted with fauna ladders.	Not applicable	**e**	**II**	**1**	YES	High

Risk #	Environmental Factor	Risk Code	Source	Potential Impact	Initial Risk Ranking*			Key Controls and Code Reference		Residual Risk Ranking			Controls Reduce Risk to ALARP (Y/N)	Scientific Certainty Ranking
					L	C	R	Controls	Code of Practice Reference	L	C	R		
								○ Inspected by a Fauna Spotter before starting work the next day, and any fauna removed. ○ Trenches will not be left open overnight across watercourses or non-Imperial access tracks. • Flowline design, installation, and operation in accordance with APGA*PEGN Code* [APGA, 2019].						
16	**Terrestrial Environmental Quality**	**TE-9**	**Low Point Drains (LPD) in Gas Flowline**	Loss of containment of condensed LPD water	**c**	**I**	**2**	• Transfer from low point drain to storage IBC completed manually. • LPD water disposed of in accordance with **Appendix 06** WWMP - **Section 4.5** Low Point Drain Water.	C.7.2 Spill Management Plan	**e**	**I**	**1**	YES	Medium
17	**Terrestrial Environmental Quality**	**TE-10**	**Drilling of Petroleum Wells**	Drilling fluid spills impacting the land (any volume)	**c**	**II**	**2**	• Drilling fluids are generated and stored on the well pad. Any spills will be transferred to drilling sump for future treatment/evaporation. • The drilling sumps will be: ○ Constructed with a 500 mm high perimeter bund to prevent overland flow from entering the sumps. ○ Lined with an impermeable membrane (Aquacon 345, HDPE or equivalent) as per Section C.4.1.2 (b) i of *the Code*. ○ Marked with the Dry Season freeboard of 500 mm and Wet Season freeboard of 1,100 mm. • Spill kits will be readily available at each worksite while operational and on all mobile service trucks or vehicles where hydrocarbons, chemicals or wastewater are stored, used, or transported.	C.7.2 Spill Management Plan	**e**	**II**	**1**	YES	High
18	**Terrestrial Environmental Quality**	**TE-11**	**Drilling of Petroleum Wells**	Fauna interaction with drilling sump	**c**	**I**	**2**	• Open sumps monitored via remote telemetry until closed.	C.4.1.2 (g)	**e**	**I**	**1**	YES	High

Risk #	Environmental Factor	Risk Code	Source	Potential Impact	Initial Risk Ranking*			Key Controls and Code Reference		Residual Risk Ranking			Controls Reduce Risk to ALARP (Y/N)	Scientific Certainty Ranking
					L	C	R	Controls	Code of Practice Reference	L	C	R		
								• High Total Dissolved Solids (salt) in sump deters avifauna. • Fitted with fauna ladders after drilling completed. • Well pads fenced to restrict access.						
19	**Terrestrial Ecosystems**	**TE-12**	**Operation of Petroleum Wells**	Fires started by operation of flares impacts ecosystems	**d**	**III**	**2**	• Allowance made on each well pad for the installation of a stick flare designed and installed to meet the requirements of API 521. • A minimum exclusion radius of 20 m from flammable material at each well pad has been included in design to maintain a radiant heat level below 6.31 kW/M^2, which is 50% of the continuous heat flux rate required to ignite dry vegetation. Well pads designed with surrounding ~8 m wide firebreak.	B.3 Well Operations Management Plans	**e**	**III**	**2**	YES	Medium
20	**Terrestrial Ecosystems**	**TE-13**	**Operation of Petroleum Wells**	Fluid or chemical spill from process equipment	**c**	**II**	**2**	• Spill Management Plan (**Appendix 07**): ○ The atmospheric open separator will have secondary containment including bunding to 110% of its capacity. ○ Dedicated/segregated area for chemical storage and handling with secondary containment. ○ Spill kits stocked and available where chemicals are stored and handled. ○ Secondary containment is to be inspected weekly during the Dry Seasons and daily during the Wet Season for damage, spills, or water for management in accordance with A.3.8.(i) of *the Code*. Inspection may be by remote camera or visual inspection. • Storage of chemical in accordance with relevant SDS requirement.	C.7.2 Spill Management Plan	**e**	**II**	**1**	YES	High

Risk #	Environmental Factor	Risk Code	Source	Potential Impact	Initial Risk Ranking*			Key Controls and Code Reference		Residual Risk Ranking			Controls Reduce Risk to ALARP (Y/N)	Scientific Certainty Ranking
					L	C	R	Controls	Code of Practice Reference	L	C	R		
								• Off-site disposal will be undertaken considering the *Waste Management and Pollution Control Act, 1998 (NT)*. • All listed waste transportation will be undertaken by licenced contractors and be tracked and disposed of at approved waste management facilities. • Waste containers will be labelled in accordance with Globally Harmonized System of Classification and Labelling of Chemicals (GHS) based on type of hazard spill material [United Nations, 2023]. • Quantities of contaminated material too large for sealed containers must be dealt with by engaging licensed contractors as soon as practicable. • Tank design and construction will be in accordance with the relevant Australian Standards, including AS1554 Series (Structural Steel Welding), AS3990 (Mechanical Equipment - Steel Work), and AS1170 Series (Structural Design Actions, including hydrostatic loading and cyclonic wind rating). On-site construction will adhere to manufacturer-supplied installation and QC/QA procedures. In addition, tanks are placed on pads (well pads, WHS, etc.) cleared of vegetation and surrounded by firebreaks.						
21	**Terrestrial Environmental Quality**	**TE-14**	**Wastewater Flowlines**	Wastewater flowline leaks impact soil	**c**	**IV**	**4**	• Flowline installation will be carried out in a manner to reduce the risks of loss of containment with the following controls: ○ All operators carrying out welded pipe jointing will be trained by registered training organisations (RTOs) and be qualified to PMBWELD 301 standard.	Not applicable	**d**	**IV**	**3**	YES	Medium

Risk #	Environmental Factor	Risk Code	Source	Potential Impact	Initial Risk Ranking*			Key Controls and Code Reference		Residual Risk Ranking			Controls Reduce Risk to ALARP (Y/N)	Scientific Certainty Ranking
					L	C	R	Controls	Code of Practice Reference	L	C	R		
								○ Flowlines designed, installed, and operated in accordance with *APGA PEGN Code* [APGA, 2019]. ○ The flowlines will be installed in a trench excavated to a depth that will give 750 mm Depth of Cover (DOC). Where the flowline crosses an access track or watercourse, DOC will be increased to at least 1,200 mm. ○ Decision tree developed (EMP **Section 3.4.8.1**) to determine type of watercourse crossing to be used (directional drilling or trenching), in conjunction with a high resolution fluvial geomorphic baseline assessment. ○ The flowline networks will be subject to testing to validate mechanical strength and to detect leaks before commissioning. Safety precautions will be implemented during testing. ○ Commissioning will ensure that both the PE pipes and all associated facilities are checked and verified by a competent and qualified inspector to ensure that they are fit for the nominated operating envelopes. ○ Flowline pressures monitored during pumping. ○ The flowline network will be fitted with manifolds and valves (see **Section 3.7.2.7** for details) so they can be isolated into sections. These valves will be locked to prevent unauthorised operation where they are not inside a fenced facility.							
22	**Terrestrial Ecosystems**	**TE-15**	**Hydraulic Fracturing Sand**	Weeds Introduced with HF Sand	**c**	**II**	**2**	• Contracted supplier will be required to provide biosecurity/weed hygiene certificates.	A.3.6 Weeds	**d**	**II**	**2**	YES	High

Risk #	Environmental Factor	Risk Code	Source	Potential Impact	Initial Risk Ranking*			Key Controls and Code Reference		Residual Risk Ranking			Controls Reduce Risk to ALARP (Y/N)	Scientific Certainty Ranking
					L	C	R	Controls	Code of Practice Reference	L	C	R		
23	Terrestrial Environmental Quality	TE-16	HF Flowback Water Storage	HF flowback water loss of containment by overtopping impacting soil	c	III	3	• Imperial will ensure that freeboard will be maintained as follows: ○ Enclosed tanks marked and managed with a freeboard level of 500 mm. ○ Monitor the stored volume and available freeboard of all open-topped treatment tanks in line with Section C.5.5(b) of *the Code*. ○ Subtract the Significant Rainfall Event (SRE) forecast from the current freeboard; this will become the "calculated post significant event freeboard". ○ If the "calculated post significant event freeboard" is less than the 1,100 mm Wet Season freeboard requirement, Imperial will install engineered tank covers on open-top treatment tanks at least 8 hours before the forecast SRE (*Code* C.7.1.1 (a) ii and iii). ○ Above ground tanks will be placed on a compacted tank pad surrounded by an overland flow bund to prevent stormwater undermining the tank and provide some contingency for an overtopping event. ○ Above ground tanks include secondary containment system, level sensors and alarms for 24 hr monitoring during operation and for the management of freeboard.		d	III	2		High
24	Terrestrial Environmental Quality	TE-17	HF Flowback Water Storage	HF flowback water loss of containment from above ground tank impacting soil	c	IV	4	• Tank design and construction will be in accordance with the relevant Australian Standards, including AS1554 Series (Structural Steel Welding), AS3990 (Mechanical Equipment - Steel Work), and AS1170 Series (Structural Design Actions, including hydrostatic	B.4.13 Hydraulic stimulation and flowback operations	d	IV	3	YES	Medium

Risk #	Environmental Factor	Risk Code	Source	Potential Impact	Initial Risk Ranking*			Key Controls and Code Reference		Residual Risk Ranking			Controls Reduce Risk to ALARP (Y/N)	Scientific Certainty Ranking
					L	C	R	Controls	Code of Practice Reference	L	C	R		
								loading and cyclonic wind rating). On-site construction will adhere to manufacturer-supplied installation and QC/QA procedures. • Tanks are placed on pads (well pads, WHS, etc.) cleared of vegetation and surrounded by firebreaks. • Tanks designed to meet local wind loading conditions and installed on compacted pads to ensure stability. • Double lined above ground tanks for secondary containment or bunded with 110% capacity of largest single lined tank in that area. • Leak detection sensors placed between liners that can be monitored remotely. • Level sensors installed in the storage and treatment tanks to measure freeboard. • Overland flow managed by fluid control berm to avoid washouts at tank base. Tanks include secondary containment system, level sensors and alarms for 24 hr monitoring during operation and for the management of freeboard. HF system designed and operated to prevent overtopping. • Enclosed tanks marked and managed with a freeboard level of 500 mm. • Above ground tanks utilised for treatment (open topped tanks) marked with a Dry Season freeboard 500 mm and Wet Season freeboard 1,100 mm limit. • Freeboard will be maintained as follows: • Monitor the stored volume and available freeboard of all open-topped treatment tanks in line with Section C.5.5(b) of *the Code*.						

Risk #	Environmental Factor	Risk Code	Source	Potential Impact	Initial Risk Ranking*			Key Controls and Code Reference		Residual Risk Ranking			Controls Reduce Risk to ALARP (Y/N)	Scientific Certainty Ranking
					L	C	R	Controls	Code of Practice Reference	L	C	R		
								• Subtract the Significant Rainfall Event (SRE) forecast from the current freeboard; this will become the calculated post significant event freeboard. • If the "calculated post significant event freeboard" is less than the 1,100 mm Wet Season freeboard requirement, Imperial will install engineered tank covers on open-top treatment tanks at least 8 hours before the forecast SRE (*the Code* C.7.1.1 (a) ii and iii).						
25	**Terrestrial Environmental Quality**	**TE-18**	**HF Flowback Water Storage**	Faunal interactions with above ground tanks	**D**	**II**	**2**	• Vertical above-ground tank walls to prevent non avian fauna access.	Not applicable	**e**	**II**	**1**	YES	High
26	**Terrestrial Environmental Quality**	**TE-19**	**Chemical Storage**	Loss of containment and chemicals impact soil	**c**	**II**	**2**	• Spill Management Plan (**Appendix 07**): ○ Dedicated/segregated area for chemical storage and handling with secondary containment. ○ Spill kits stocked and available where chemicals are stored and handled. ○ Secondary containment, when in use, is to be inspected weekly during the Dry Season and daily during the Wet Season for damage, spills, or water for management in accordance with A.3.8.(i) of *the Code*. Inspection may be by remote camera or visual inspection. • Storage of chemical in accordance with relevant SDS requirement. • Tank design and construction will be in accordance with the relevant Australian Standards, including AS1554 Series (Structural Steel Welding), AS3990 (Mechanical Equipment - Steel Work), and AS1170 Series (Structural Design Actions, including hydrostatic loading and cyclonic wind rating). On-site construction	C.7.2 Spill Management Plan	**d**	**II**	**2**	YES	High

Risk #	Environmental Factor	Risk Code	Source	Potential Impact	Initial Risk Ranking*			Key Controls and Code Reference		Residual Risk Ranking			Controls Reduce Risk to ALARP (Y/N)	Scientific Certainty Ranking
					L	C	R	Controls	Code of Practice Reference	L	C	R		
								will adhere to manufacturer-supplied installation and QC/QA procedures. • Tanks are placed on pads (well pads, WHS, etc.) cleared of vegetation and surrounded by firebreaks.							
27	**Terrestrial Environmental Quality**	**TE-20**	**Chemical Handling**	Spills impact soil	**c**	**II**	**2**	• Spill Management Plan (**Appendix 07**): ○ Dedicated / segregated area for chemical storage and handling with secondary containment. ○ Spill kits stocked and available where chemicals are stored and handled. ○ Secondary containment, when in use, is to be inspected weekly during the Dry Season and daily during the Wet Season for damage, spills, or water for management in accordance with A.3.8.(i) of *the Code*. Inspection may be by remote camera or visual inspection. • Storage of chemical in accordance with relevant SDS requirement. • Tank design and construction will be in accordance with the relevant Australian Standards, including AS1554 Series (Structural Steel Welding), AS3990 (Mechanical Equipment - Steel Work), and AS1170 Series (Structural Design Actions, including hydrostatic loading and cyclonic wind rating). On-site construction will adhere to manufacturer-supplied installation and QC/QA procedures. • Tanks are placed on pads (well pads, WHS, etc.) cleared of vegetation and surrounded by firebreaks.	C.7.2 Spill Management Plan	**d**	**II**	**2**	YES	High
28	**Terrestrial Environmental Quality**	**TE-21**	**Chemical Transport**	Spills impact soil	**c**	**II**	**2**	• Spill Management Plan (**Appendix 07**): ○ During the Wet Season, chemicals or wastewater are not to be transported on unsealed roads if	C.7.2 Spill Management Plan	**d**	**II**	**2**	YES	High

Risk #	Environmental Factor	Risk Code	Source	Potential Impact	Initial Risk Ranking*			Key Controls and Code Reference		Residual Risk Ranking			Controls Reduce Risk to ALARP (Y/N)	Scientific Certainty Ranking
					L	C	R	Controls	Code of Practice Reference	L	C	R		
								significant rainfall (>300 mm over 4 days) is forecast. ○ Emergency response measures (e.g. spill kit, communication tools) are available and functional. ○ Chemicals and wastewater will not be transported via road across flowing water. ○ Wet Season transport of chemicals or wastewater will not be authorised until the Site Supervisor has completed transport of chemicals or wastewater checklist. ○ If a chemical or wastewater transport vehicle becomes bogged, the response scenario outlined in **Appendix 09** Emergency Response (Contingency) Management Plan, **Table 4—1** is to be followed. ○ If there is a spill incident that is not a bogged transport vehicle, refer to **Section 8** of the Spill Management Plan (**Appendix 07**) for details of the spill response.						
29	**Terrestrial Ecosystems**	**TE-22**	**Flares**	Bushfire started by operation of flare impacting ecosystems	**d**	**III**	**2**	• The CGP Flare will be in a 60 m x 60 m exclusion zone to ensure the radiant heat level remains below 6.31 kW/M^2 at 2 m height, which is 50% of the continuous heat flux rate required to ignite dry vegetation. • Well pad flares (if any) will be in a 20 m exclusion zone. • Modelling of flares undertaken to validate that the established exclusion zones are appropriate.	Not applicable	**e**	**III**	**2**	YES	Medium
30	**Terrestrial Ecosystems**	**TE-23**	**Accommodation Camp**	Faunal interactions with waste	**c**	**II**	**2**	• All putrescible waste stored at the campsite in fauna proof containers with lids.	Not applicable	**e**	**II**	**1**	YES	High

Risk #	Environmental Factor	Risk Code	Source	Potential Impact	Initial Risk Ranking*			Key Controls and Code Reference		Residual Risk Ranking			Controls Reduce Risk to ALARP (Y/N)	Scientific Certainty Ranking
					L	C	R	Controls	Code of Practice Reference	L	C	R		
31	**Terrestrial Environmental Quality**	**TE-24**	**Accommodation Camp**	Sewage and greywater impact on soil	**c**	**II**	**2**	• All camp wastewater produced from the laundry, showers, kitchen, and sewage will be treated by a fully self-contained Sewage Treatment Plant (STP) and irrigated in a designated surface irrigation disposal area. • The STP will be installed by qualified contractors and meet the requirements of the Regulations and the *Code of Practice for Wastewater Management, 2020 (NT)*. • The designated surface irrigation disposal areas will comply with *the Code of Practice for Wastewater Management, 2020 (NT)*.	C.7.1 Wastewater Management Plan	**e**	**II**	**1**		High
32	**Terrestrial Ecosystems**	**TE-25**	**Accommodation Camp**	Bushfire started by camp operations impacting ecosystems	**d**	**III**	**2**	• Fire extinguishers in all operating plant and in Imperial Site Supervisor's vehicle. • All machinery and vehicles will be parked in areas of low fire risk free of combustible material. • All personnel are trained and informed about: ○ Restricted smoking areas and requirements. ○ Firefighting equipment operation and communication. ○ Emergency Response Plan and procedures. • Maintain fire breaks and fire access trails. • Monitor trails for grassy weeds and control where appropriate. • Create and maintain ~8 m wide firebreak for management by grading, spraying, or slashing. • The Site Supervisor will monitor the NAFI website and Secure NT website daily in the Dry Season and weekly in the Wet Season and liase with relevant land holders/pastoralists about potential fire control	Not applicable	**e**	**III**	**2**		Medium

Risk #	Environmental Factor	Risk Code	Source	Potential Impact	Initial Risk Ranking*			Key Controls and Code Reference		Residual Risk Ranking			Controls Reduce Risk to ALARP (Y/N)	Scientific Certainty Ranking
					L	C	R	Controls	Code of Practice Reference	L	C	R		
								measures if a fire threatens the CPP Area or infrastructure. • Annual fire mapping with NAFI to monitor changes to fire frequency in the CPP Area.						
33	**Culture and Heritage**	**CH-1**	**Infrastructure Site Selection**	Damage to cultural and heritage places and objects.	**C**	**IV**	**4**	• Site selection for infrastructure placement within designated AAPA subject land types in accordance with the AAPA Authority Certificate. [redacted] • [redacted] • Engage Cultural Monitors from the Northern Land Council to monitor land-clearing activity. • Site induction to cover the importance of complying with Imperial's Unexpected Finds Procedure (**Section 7.9**). • Training for construction personnel will be completed on Imperial's Unexpected Finds Procedure (**Section 7.9**) for identifying, recording and reporting any possible archaeological places or objects or cultural heritage sites if discovered during construction. • Use of infrastructure movement zones to adjust infrastructure placement to avoid unexpected finds if possible.	A.3.1 Site Selection and Planning	**e**	**IV**	**3**	YES	High
34	**Community and Economy**	**CE-1**	**Land Clearing**	Mobile plant starts a bushfire that impacts pastoralists and residents	**d**	**III**	**2**	• Fire extinguishers in all operating plant and in the Imperial Site Supervisor's vehicle. • All machinery and vehicles will be parked in areas of low fire risk, free of combustible material.	A.3.7 Fire Management	**e**	**III**	**2**	YES	Medium

Risk #	Environmental Factor	Risk Code	Source	Potential Impact	Initial Risk Ranking*			Key Controls and Code Reference		Residual Risk Ranking			Controls Reduce Risk to ALARP (Y/N)	Scientific Certainty Ranking
					L	C	R	Controls	Code of Practice Reference	L	C	R		
								• All personnel are trained and informed about: ○ Restricted smoking areas and requirements. ○ Firefighting equipment operation and communication. ○ Emergency Response Plan and procedures. • Maintain fire breaks and fire access trails. • Monitor trails for grassy weeds and control where appropriate. • The Site Supervisor will monitor the NAFI website and Secure NT website daily in the Dry Season and weekly in the Wet Season and liase with relevant land holders/pastoralists about potential fire control measures if a fire threatens the CPP Area or infrastructure. • Annual fire mapping with NAFI to monitor changes to fire frequency in the CPP Area. • All hot work completed under a permit to work system. • Hot work restricted and controls defined prior to work during moderate and high fire rating days. • Hot work permit revoked on extreme and catastrophic fire hazard days.						
35	**Culture and Heritage**	**CH-2**	**Land Clearing**	Damage to cultural and heritage places and objects	**c**	**IV**	**4**	• Site selection for infrastructure placement within designated AAPA subject land types in accordance with the AAPA Authority Certificate. [redacted] • [redacted]	A.3.1 Site Selection and Planning	**e**	**IV**	**3**	YES	High

Risk #	Environmental Factor	Risk Code	Source	Potential Impact	Initial Risk Ranking*			Key Controls and Code Reference		Residual Risk Ranking			Controls Reduce Risk to ALARP (Y/N)	Scientific Certainty Ranking
					L	C	R	Controls	Code of Practice Reference	L	C	R		
								• Engage Cultural Monitors from the Northern Land Council to monitor land clearing activity. • Site induction to cover the importance of complying with Imperial's Unexpected Finds Procedure (**Section 7.9**). • Training for construction personnel will be completed on Imperial's Unexpected Finds Procedure (**Section 7.9**) for identifying, recording and reporting any possible archaeological places or objects or cultural heritage sites if discovered during construction. • Use of Infrastructure Movement Zones to adjust infrastructure placement to avoid unexpected finds if possible.						
36	**Human Health**	**HH-1**	**Vehicle Movements in CPP Area**	Dust impacts on human health	**c**	**II**	**2**	• Use water truck to suppress dust as necessary during operations. • Site induction includes instruction on speed limits.	Not applicable	**e**	**II**	**1**	YES	Medium
37	**Community and Economy**	**CE-2**	**Vehicle Movements in CPP Area**	Noise nuisance	**c**	**II**	**2**	• The nearest sensitive receptor is approximately 2.2 km to the nearest highway turn off point and 4.4 km from the nearest well pad.	A.3.3 Noise	**d**	**II**	**2**	YES	High
38	**Community and Economy**	**CE-3**	**Vehicle Movements in CPP Area**	Light nuisance	**c**	**II**	**2**	• The nearest sensitive receptor is approximately 2.2 km to the nearest highway turn off point.	Not applicable	**d**	**II**	**2**	YES	High
39	**Community and Economy**	**CE-4**	**Vehicle Movements in CPP Area**	Vehicle impacts on fauna and stock	**c**	**II**	**2**	• Sign posted speed limits on access tracks. • Site inductions will specify speed limits across the CPP Area, enforcing 60 km/hr during daylight and 40 km/hr during night, dawn, and dusk.	Not applicable	**d**	**II**	**2**	YES	Medium
40	**Community & Economy**	**CE-5**	**Vehicle Movements on Public Roads**	Increased traffic on public roads	**C**	**III**	**3**	• CPP Traffic Impact Assessment Report (**Appendix 11**) mitigations:	Not applicable	**d**	**III**	**2**	YES	Medium

Risk #	Environmental Factor	Risk Code	Source	Potential Impact	Initial Risk Ranking*			Key Controls and Code Reference		Residual Risk Ranking			Controls Reduce Risk to ALARP (Y/N)	Scientific Certainty Ranking
					L	C	R	Controls	Code of Practice Reference	L	C	R		
								○ Radio call ups between Carpentaria 1 and Carpentaria 2/3 Highway intersections. ○ Speed limit reduction communicated to contractors and visitors. ○ Prior to commencement of the Activity, Imperial will engage with the Transport and Civil Services Division (TCSD) of the Department of Infrastructure Logistics and Planning (DIPL) about the installation of advanced warning signage on the Carpentaria Highway.						
41	**Community & Economy**	**CE-6**	**Vehicles Accessing CPP Area from Public Roads**	Noise nuisance	**c**	**III**	**3**	○ Imperial will submit all relevant documents for the Transport and Civil Services Division (TCSD) of the Department of Infrastructure Logistics and Planning (DIPL) for acceptance and approval prior to utilising the accesses for the proposed drilling and operations program. ○ Prior to commencement of the Activity, an Operational Traffic Management Plan (OTMP) will be submitted to the TCSD, if deemed required.	Not applicable	**d**	**III**	**2**	YES	High
42	**Community & Economy**	**CE-7**	**Operation of Petroleum Wells**	Bushfires started by operation of flares impacts pastoralists and residents	**d**	**III**	**2**	• Allowance made on each well pad for the installation of a stick flare designed and installed to meet the requirements of API 521. • A minimum exclusion radius of 20 m from flammable material at each well pad has been included in design to maintain a radiant heat level below 6.31 kW/M², which is 50% of the continuous heat flux rate required to ignite dry vegetation. • Well pads, designed with surrounding ~8 m wide firebreak.	B.3 Well Operations Management Plans	**e**	**III**	**2**	YES	Medium

Risk #	Environmental Factor	Risk Code	Source	Potential Impact	Initial Risk Ranking*			Key Controls and Code Reference		Residual Risk Ranking			Controls Reduce Risk to ALARP (Y/N)	Scientific Certainty Ranking
					L	C	R	Controls	Code of Practice Reference	L	C	R		
43	Human Health	HH-2	Hydraulic Fracturing	HF Chemical Impact on Human Health	d	II	2	• HF chemicals have been risk assessed in compliance with the regulatory requirements (**Appendix 08** – HHERA).	Not applicable	e	II	1	YES	High
44	Human Health	HH-3	Hydraulic Fracturing	HF Sand Dust Silicosis Impacts	c	V	4	• Required PPE/JHA with contractors and onsite sand handling protocols to mitigate silicosis risk.	Not applicable	e	V	3	YES	Medium
45	Human Health	HH-4	HF Flowback Water Storage	Chemicals in HF flowback water that escapes containment impacting human health	d	II	2	• HF chemicals have been risk assessed in compliance with the regulatory requirements (**Appendix 08** – HHERA). • Tank design and construction will be in accordance with the relevant Australian Standards, including AS1554 Series (Structural Steel Welding), AS3990 (Mechanical Equipment - Steel Work), and AS1170 Series (Structural Design Actions, including hydrostatic loading and cyclonic wind rating). On-site construction will adhere to manufacturer-supplied installation and QC/QA procedures. • Tanks are placed on pads (well pads, WHS, etc.) cleared of vegetation and surrounded by firebreaks.	Not applicable	e	II	1	YES	High
46	Community and Economy	CE-8	Carpentaria Gas Plant	Nuisance noise from operation of CGP	c	III	3	• The nearest sensitive receptor is more than 7 km from the CGP.	Not applicable	e	III	2	YES	High
47	Community and Economy	CE-9	Flares	Bushfire started by operation of flare impacting pastoralists and residents	d	III	2	• The CGP flare has been designed to meet the requirements of API 521 and sized to meet maximum field production. • The CGP Flare will be in a 60 m x 60 m exclusion zone to ensure the radiant heat level remains below 6.31 kW/M^2 at 2 m height, which is 50% of the continuous heat flux rate required to ignite dry vegetation.	Not applicable	e	III	2	YES	Medium

Risk #	Environmental Factor	Risk Code	Source	Potential Impact	Initial Risk Ranking*			Key Controls and Code Reference		Residual Risk Ranking			Controls Reduce Risk to ALARP (Y/N)	Scientific Certainty Ranking
					L	C	R	Controls	Code of Practice Reference	L	C	R		
								• Well pad flares (if any) will be in a 20 m exclusion zone. • Modelling of flares undertaken to validate that the established exclusion zones are appropriate.						
48	**Community and Economy**	**CE-10**	**Accommodation Camp**	Noise nuisance	**d**	**III**	**2**	• CPP Area is in a sparsely populated region. The nearest sensitive receptor is more than 7 km from camp noise sources.	Not applicable	**e**	**III**	**2**	YES	High
49	**Community and Economy**	**CE-11**	**Accommodation Camp**	Light nuisance	**d**	**III**	**2**	• CPP area is in a sparsely populated region. The nearest sensitive receptor is more than 7 km from camp light sources.	Not applicable	**e**	**III**	**2**	YES	High
50	**Community and Economy**	**CE-12**	**Accommodation Camp**	Bushfire started by camp operations impacting pastoralists and residents	**d**	**III**	**2**	• Fire extinguishers in all operating plant and in Imperial Site Supervisor's vehicle. • All machinery and vehicles will be parked in areas of low fire risk free of combustible material. • All personnel are trained and informed about: ○ Restricted smoking areas and requirements. ○ Firefighting equipment operation and communication. ○ Emergency Response Plan and procedures. • Maintain fire breaks and fire access trails. • Monitor trails for grassy weeds and control where appropriate. • Create and maintain minimum ~8 m firebreak for management by grading, spraying, or slashing. • The Site Supervisor will monitor the NAFI website and Secure NT website daily in the Dry Season and weekly in the Wet Season and liase with relevant land holders/pastoralists about potential fire control	Not applicable	**e**	**III**	**2**	YES	Medium

Risk #	Environmental Factor	Risk Code	Source	Potential Impact	Initial Risk Ranking*			Key Controls and Code Reference		Residual Risk Ranking			Controls Reduce Risk to ALARP (Y/N)	Scientific Certainty Ranking
					L	C	R	Controls	Code of Practice Reference	L	C	R		
								measures if a fire threatens the CPP Area or infrastructure. • Annual fire mapping with NAFI to monitor changes to fire frequency in the CPP Area.						
51	**Inland Water Environmental Quality**	**IW-1**	**Land Clearing**	Increased erosion impacts the inland water quality	**c**	**III**	**3**	• Low-level watercourse crossings for access tracks to be excavated and backfilled with rock to watercourse bed level. o Decision tree developed (EMP **Section 3.4.8.1**) to determine type of watercourse crossing to be used (directional drilling or trenching), in conjunction with a high resolution fluvial geomorphic baseline assessment. o Prior to trenching, Imperial will check the 7-day forecast to ensure an adequate window for the trenching, installation, backfill, and stabilisation works to be carried out. o Report of flowline trench geomorphic conditions pre- and post-construction. Includes GPS identifiable before and after photos to ensure backfilling restores channel shape and bed level to a preconstruction condition. o Monitoring as per **Table 8.2—2**. • New well pads will not be in areas prone to 1 in 100-year flooding. • Site inspections and monitoring (may be done with camera) is to be undertaken in accordance with the ESCP (**Appendix 05**) and will include: o Daily site inspections (during rainfall) during construction works. o Monthly site inspections (even if works are not occurring on-site).	A.3.1 Site Selection and Planning A.3.4 Erosion and Sediment Control and Hydrology	**d**	**III**	**2**	YES	High

Risk #	Environmental Factor	Risk Code	Source	Potential Impact	Initial Risk Ranking*			Key Controls and Code Reference		Residual Risk Ranking			Controls Reduce Risk to ALARP (Y/N)	Scientific Certainty Ranking
					L	C	R	Controls	Code of Practice Reference	L	C	R		
								○ Inspection of sediment controls during construction following rainfall events of 20 mm. • Progressive rehabilitation of significantly disturbed areas commenced as soon as practicable and no later than 12 months after the cessation of the Activity.						
52	**Hydrological Processes**	**HP-1**	**Drilling, of Petroleum Wells**	Loss of well control or drilling fluid chemicals impacting the aquifer	**c**	**III**	**3**	• Approved Well Operations Management Plan (WOMP) including *Code* compliant aquifer protection controls summarised in **Section 3.5.1**. • Groundwater monitoring using control and impact monitoring bores (as required) at existing, and proposed well pads, in compliance with *the Code*. • Drilling reports include details of all additives utilised when drilling through freshwater aquifers and demonstrate that they were not considered ecologically toxic. • Well control training completed by those in control of drilling.	B.4.2 Aquifer Protection	**d**	**III**	**2**	YES	High
53	**Inland Water Environmental Quality**	**IW-2**	**Drilling of Petroleum Wells**	Drilling fluid spills impacting inland water	**c**	**II**	**2**	• All drilling, and completion fluids, liquid chemicals additives, hazardous chemicals, oil, and fuel will be stored on the well pad in a dedicated area with secondary containment. • The drilling sump/s will be lined with Aquacon345, HDPE, or equivalent, which meets *the Code* requirements for an impermeable membrane. • The drilling sump/s, and above ground open tanks will be constructed and/or operated with enough freeboard to manage a 1:1,000 ARI event during the Wet Season. • Dry Season freeboard of 500 mm. • Wet Season freeboard of 1,100 mm.	C.7.2 Spill Management Plan	**e**	**II**	**1**	YES	High

Risk #	Environmental Factor	Risk Code	Source	Potential Impact	Initial Risk Ranking*			Key Controls and Code Reference		Residual Risk Ranking			Controls Reduce Risk to ALARP (Y/N)	Scientific Certainty Ranking
					L	C	R	Controls	Code of Practice Reference	L	C	R		
								• The drilling sump/s will have a raised bund around the perimeter of 500 mm to prevent rainwater from flowing into the sump. • Spill kits will be readily available at each worksite while operational and on all mobile service trucks or vehicles where hydrocarbons, chemicals or wastewater are stored, used, or transported.						
54	**Hydrological Processes**	**HP-2**	**Hydraulic Fracturing**	HF fluid chemicals impacting the aquifer	**c**	**III**	**3**	• Approved Well Operations Management Plan (WOMP) including Code compliant aquifer protection controls summarised in EMP **Section 3.5.1**. • HF chemicals have been risk assessed in compliance with the regulatory requirements (**Appendix 08** – HHERA). • Groundwater monitoring using control and impact monitoring bores (as required) at existing, and proposed well pads, in compliance with *the Code*.	B.3 Well Operations Management Plans B.4.17 Groundwater Monitoring	**d**	**III**	**2**	YES	High
55	**Hydrological Processes**	**HP-3**	**Hydraulic Fracturing**	HF operations increase the volume of water in the aquifer	**d**	**III**	**2**	• No works that increase the volume of water in an aquifer are planned under this EMP. • The Activity will be conducted under an approved WOMP including aquifer protection measures described in EMP **Section 3.5.1**. • Groundwater monitoring using impact monitoring bores (as required) at existing, and proposed well pads, in compliance with *the Code*.	B.3 Well Operations Management Plans B.4.17 Groundwater Monitoring	**e**	**III**	**2**	YES	High
56	**Inland Water Environmental Quality**	**IW-3**	**Hydraulic Fracturing**	HF Fluid spills impacting inland surface water (localised spill)	**c**	**II**	**2**	• All HF liquid chemicals additives, hazardous chemicals, oil, and fuel will be stored on the well pad in a dedicated area with secondary containment. • Spill kits will be readily available at each worksite while operational and on all mobile service trucks or	C.7.2 Spill Management Plan	**e**	**II**	**1**	YES	High

Risk #	Environmental Factor	Risk Code	Source	Potential Impact	Initial Risk Ranking*			Key Controls and Code Reference		Residual Risk Ranking			Controls Reduce Risk to ALARP (Y/N)	Scientific Certainty Ranking
					L	C	R	Controls	Code of Practice Reference	L	C	R		
								vehicles where hydrocarbons, chemicals or wastewater are stored, used, or transported. • Tank design and construction will be in accordance with the relevant Australian Standards, including AS1554 Series (Structural Steel Welding), AS3990 (Mechanical Equipment - Steel Work), and AS1170 Series (Structural Design Actions, including hydrostatic loading and cyclonic wind rating). On-site construction will adhere to manufacturer-supplied installation and QC/QA procedures. • Tanks are placed on pads (well pads, WHS, etc.) cleared of vegetation and surrounded by firebreaks.						
57	**Inland Water Environmental Quality**	**IW-4**	**Wastewater Flowline**	Wastewater flowline leaks impacting inland surface water	**c**	**IV**	**4**	• Flowline installation will be carried out in a manner to reduce the risks of loss of containment with the following controls: ○ All operators carrying out welded pipe jointing will be trained by registered training organisations (RTOs) and be qualified to PMBWELD 301 standard. ○ Flowlines designed, installed, and operated in accordance with APGA *PEGN Code* [APGA, 2019]. ○ The flowlines will be installed in a trench excavated to a depth that will give 750 mm Depth of Cover (DOC). Where the flowline crosses an access track or watercourse, DOC will be increased to at least 1,200 mm. ○ Decision tree developed (EMP **Section 3.4.8**) to determine type of watercourse crossing to be used (directional drilling or trenching), in conjunction with a high resolution fluvial geomorphic baseline assessment.	Not applicable	**d**	**IV**	**3**	YES	Medium

Risk #	Environmental Factor	Risk Code	Source	Potential Impact	Initial Risk Ranking*			Key Controls and Code Reference		Residual Risk Ranking			Controls Reduce Risk to ALARP (Y/N)	Scientific Certainty Ranking
					L	C	R	Controls	Code of Practice Reference	L	C	R		
								○ The flowline networks will be subject to testing to validate mechanical strength and to detect leaks before commissioning. Safety precautions will be implemented during testing. ○ Commissioning will ensure that both the PE pipes and all associated facilities are checked and verified by a competent and qualified inspector to ensure that they are fit for the nominated operating envelopes. ○ Flowline pressures monitored during pumping. ○ The flowline network will be fitted with manifolds and valves (see **Section 3.7.2.7** for details) so they can be isolated into sections. These valves will be locked to prevent unauthorised operation where they are not inside a fenced facility. ○ Flowline pressures monitored during pumping. ○ Flowline buried to 750 mm depth of cover (DOC) to reduce risks from fire and vehicle impacts.						
58	**Inland Water Environmental Quality**	**IW-5**	**HF Flowback Water Storage**	HF flowback water loss of containment by overtopping impacting inland surface water	**c**	**III**	**3**	• Imperial will ensure that freeboard will be maintained as follows: ○ Enclosed tanks marked and managed with a freeboard level of 500 mm. ○ Monitor the stored volume and available freeboard of all open-topped treatment tanks in line with Section C.5.5(b) of *the Code*. ○ Subtract the Significant Rainfall Event (SRE) forecast from the current freeboard; this will become the calculated post significant event freeboard. ○ If the calculated post significant event freeboard is less than the 1,100 mm Wet Season freeboard		**d**	**III**	**2**		High

Risk #	Environmental Factor	Risk Code	Source	Potential Impact	Initial Risk Ranking*			Key Controls and Code Reference		Residual Risk Ranking			Controls Reduce Risk to ALARP (Y/N)	Scientific Certainty Ranking
					L	C	R	Controls	Code of Practice Reference	L	C	R		
								requirement, Imperial will install engineered tank covers on open-top treatment tanks at least 8 hours before the forecast SRE (*Code* C.7.1.1 (a) ii and iii). • Above-ground tanks will be placed on a compacted tank pad surrounded by an overland flow bund to prevent stormwater undermining the tank and provide some contingency for an overtopping event. • Above-ground tanks include secondary containment system, level sensors and alarms for 24 hr monitoring during operation and for the management of freeboard. • Where tanks are linked together, they will be designed and operated to prevent the uncontrolled discharge of multiple tanks should one tank fail.							
59	**Inland Water Environmental Quality**	**IW-6**	**HF Flowback Water Storage**	HF flowback water loss of containment from above ground tank impacting inland surface water	**c**	**IV**	**4**	• Tanks designed to meet local wind loading conditions and installed on compacted pads to ensure stability. • Double lined above ground tanks for secondary containment or bunded with 110% capacity of largest single lined tank in that area. • Where tanks are linked together, they will be designed and operated to prevent the uncontrolled discharge of multiple tanks should one tank fail. • Leak detection sensors placed between liners that can be monitored remotely. • Level sensors installed in the storage and treatment tanks to measure freeboard. • Overland flow managed by fluid control berm to avoid washouts at tank base. • Tanks include secondary containment system, level sensors and alarms for 24 hr monitoring during	B.4.13 Hydraulic simulation and flowback operations	**d**	**IV**	**3**	YES	Medium

Risk #	Environmental Factor	Risk Code	Source	Potential Impact	Initial Risk Ranking*			Key Controls and Code Reference		Residual Risk Ranking			Controls Reduce Risk to ALARP (Y/N)	Scientific Certainty Ranking
					L	C	R	Controls	Code of Practice Reference	L	C	R		
								operation and for the management of freeboard. HF system designed and operated to prevent overtopping. • Enclosed tanks marked and managed with a freeboard level of 500 mm. • Above-ground tanks utilised for treatment (open-topped tanks) marked with a Dry Season freeboard of 500 mm and a Wet Season freeboard 1,100 mm limit. • Tank design and construction will be in accordance with the relevant Australian Standards, including AS1554 Series (Structural Steel Welding), AS3990 (Mechanical Equipment - Steel Work), and AS1170 Series (Structural Design Actions, including hydrostatic loading and cyclonic wind rating). On-site construction will adhere to manufacturer-supplied installation and QC/QA procedures. • Tanks are placed on pads (well pads, WHS, etc.) cleared of vegetation and surrounded by firebreaks. • Freeboard will be maintained as follows: o Monitor the stored volume and available freeboard of all open-topped treatment tanks in line with Section C.5.5(b) of *the Code*. o Subtract the Significant Rainfall Event (SRE) forecast from the current freeboard; this will become the “calculated post significant event freeboard”. o If the calculated post significant event freeboard is less than the 1,100 mm Wet Season freeboard requirement, Imperial will install engineered tank covers on open-top treatment tanks at least 8 hours before the forecast SRE (*the Code* C.7.1.1 (a) ii and iii).						

Risk #	Environmental Factor	Risk Code	Source	Potential Impact	Initial Risk Ranking*			Key Controls and Code Reference		Residual Risk Ranking			Controls Reduce Risk to ALARP (Y/N)	Scientific Certainty Ranking
					L	C	R	Controls	Code of Practice Reference	L	C	R		
60	**Inland Water Environmental Quality**	**IW-7**	**Chemical Storage**	Loss of containment of chemicals impact inland surface water	**c**	**II**	**2**	• Spill Management Plan (**Appendix 07**): ○ Dedicated / segregated area for chemical storage and handling with secondary containment. ○ Secondary containment, when in use, is to be inspected weekly during the Dry Season and daily during the Wet Season for damage, spills, or water for management in accordance with A.3.8.(i) of the Code. Inspection may be by remote camera or visual inspection. ○ Inspection may be by remote camera or physical inspection. ○ Storage of chemical in accordance with relevant SDS requirement. ○ Spill kits will be readily available at each worksite while operational and on all mobile service trucks or vehicles where hydrocarbons, chemicals or wastewater are stored, used, or transported. ○ Tank design and construction will be in accordance with the relevant Australian Standards, including AS1554 Series (Structural Steel Welding), AS3990 (Mechanical Equipment - Steel Work), and AS1170 Series (Structural Design Actions, including hydrostatic loading and cyclonic wind rating). On-site construction will adhere to manufacturer-supplied installation and QC/QA procedures. ○ Tanks are placed on pads (well pads, WHS, etc.) cleared of vegetation and surrounded by firebreaks.	C.7.2 Spill Management Plan	**d**	**II**	**2**	YES	High
61	**Inland Water Environmental Quality**	**IW-8**	**Chemical Handling**	Chemical spills impact inland surface water (localised)	**c**	**II**	**2**	• Spill Management Plan (**Appendix 07**): ○ Dedicated / segregated area for chemical storage and handling with secondary containment.	C.7.2 Spill Management Plan	**d**	**II**	**2**	YES	High

Risk #	Environmental Factor	Risk Code	Source	Potential Impact	Initial Risk Ranking*			Key Controls and Code Reference		Residual Risk Ranking			Controls Reduce Risk to ALARP (Y/N)	Scientific Certainty Ranking
					L	C	R	Controls	Code of Practice Reference	L	C	R		
								○ Secondary containment, when in use, is to be inspected weekly during the Dry Season and daily during the Wet Season for damage, spills, or water for management in accordance with A.3.8.(i) of *the Code*. Inspection may be by remote camera or visual inspection. ○ Inspection may be by remote camera or physical inspection. ○ Storage of chemical in accordance with relevant SDS requirement. ○ Spill kits will be readily available at each worksite while operational and on all mobile service trucks or vehicles where hydrocarbons, chemicals or wastewater are stored, used, or transported.						
62	**Inland Water Environmental Quality**	**IW-9**	**Chemical Transport**	Spills impact surface water	**c**	**II**	**2**	• Spill Management Plan (**Appendix 07**): ○ During the Wet Season, chemicals or wastewater are not to be transported on unsealed roads if significant rainfall (>300 mm over 4 days) is forecast. ○ Emergency response measures (e.g., spill kit, communication tools) are available and functional. ○ Chemicals and wastewater will not be transported via road across flowing water. ○ Wet Season transport of chemicals or wastewater will not be authorised until the Site Supervisor has completed transport of chemicals or wastewater checklist. ○ If a chemical or wastewater transport vehicle becomes bogged, the response scenario outlined in the Emergency Response (Contingency) Management Plan, **Table 4—1** is to be followed.	C.7.2 Spill Management Plan	**d**	**II**	**2**	YES	Medium

Risk #	Environmental Factor	Risk Code	Source	Potential Impact	Initial Risk Ranking*			Key Controls and Code Reference		Residual Risk Ranking			Controls Reduce Risk to ALARP (Y/N)	Scientific Certainty Ranking
					L	C	R	Controls	Code of Practice Reference	L	C	R		
								○ If there is a spill incident that is not a bogged transport vehicle, refer to **Section 8** of the Spill Management Plan for details of the spill response.						
63	**Hydrological Processes**	**HP-4**	**Groundwater Extraction**	Reduced groundwater quantity	**d**	**IV**	**3**	• Groundwater will only be extracted in accordance with the terms of Groundwater Water Extraction License.	B.4.17 Groundwater Monitoring	**e**	**IV**	**2**	YES	High
64	**Inland Water Environmental Quality**	**IW-10**	**Accommodation Camp**	Sewage and greywater impact on inland surface water	**c**	**II**	**2**	• The STS will be installed by qualified contractors and meet the requirements of the Regulations and the *NT Code of Practice for Wastewater Management, 2020*. • **Appendix 06** (Waste and Wastewater Management Plan): ○ All camp wastewater produced from the laundry, showers, kitchen, and sewage will be treated by a fully self-contained Sewage Treatment Plant and irrigated in a designated surface irrigation disposal area. ○ The designated surface irrigation disposal areas will comply with the *Code of Practice for Wastewater Management, 2020 (NT)*.	C.7.1 Wastewater Management Plan	**e**	**II**	**1**	YES	High
65	**Terrestrial Environmental Quality**	**TE-26**	**Floodwater Inundation**	Extreme flood event across the Activity site	**c**	**iv**	**3**	• Activate Emergency Response (Contingency) Plan – **Appendix 09**. • New well pads and infrastructure locations have been located outside areas of potential inundation. • Wet Season monitoring of weather to anticipate the possibility of a significant rainfall event in time to enact a response. • Weekly Wet Season forecast calculations to determine the available storage capacity of tanks and pits as part of freeboard management. • Should Wet Season weather monitoring indicate floodwater inundation is possible, ensure freeboard is	A.3.1 Site Selection and Planning A.3.4 Erosion and Sediment Control and Hydrology Part C: Well site water management.	**e**	**iv**	**2**	yes	Medium

Risk #	Environmental Factor	Risk Code	Source	Potential Impact	Initial Risk Ranking*			Key Controls and Code Reference		Residual Risk Ranking			Controls Reduce Risk to ALARP (Y/N)	Scientific Certainty Ranking
					L	C	R	Controls	Code of Practice Reference	L	C	R		
								in place, the transfer of fluids has been completed if required and the safe shutdown of ancillary equipment has been completed. • If access to the well pad/s by light vehicle is not possible, Imperial will mobilise a helicopter to facilitate the movement of both personnel and pumping equipment as required. This can happen within 24 hours of a request by Imperial. • Once flood waters recede and access becomes available, all environmental controls will be inspected and reinstated where required prior to restart.							
66	**Community and Economy**	**CE-13**	**Personnel Numbers**	Increased demand for labour and resource; competition with local businesses and agriculture	**b**	**ii**	**3**	• Temporary nature of the work associated with the Activity will limit demand. • Ongoing stakeholder engagement to assess potential impacts on local labour and resource competition.	N/A	**d**	**i**	**1**	Yes	Medium
67	**Community and Economy**	**CE-14**	**Personnel Numbers**	Adverse impact of community adhesion	**c**	**ii**	**2**	• High labour influx is temporary; primarily associated with the initial phases of the Activity. • Where available, local contractors will be engaged. • Majority of personnel will be accommodated at campsite(s). • Campsite(s) will be serviced by regional contractors.	N/A	**d**	**i**	**1**	Yes	Low

6.3 Environmental Outcomes, Performance Standards and Measurement Criteria

Six environmental outcomes have been identified as relevant for the Activity based on EPA Environmental Factors:

1. Air Quality and Atmospheric Processes
1. Community and Economy (inc. Human Health)
2. Cultural Heritage
3. Soil and Surface Water Quality
4. Groundwater Environmental Quality
5. Terrestrial Environmental Quality

The environmental outcomes and associated environmental objectives detailed in the **Table 6.3—1** to **Table 6.3—11**, are what will be achieved by reducing the environmental impacts and risks to levels that are to ALARP and acceptable. The environmental performance standards relate to environmental impacts and risks of the Regulated Activity and apply to persons, systems, equipment or procedures involved in carrying out the Activity. The measurement criteria is what will be used to determine whether an environmental outcome or environmental performance standard is met.

A total of 33 Environmental Performance Standards with associated SMART Measurement Criteria have been developed for the Environmental Outcomes in **Table 6.3—1** to **Table 6.3—11**. Each Environmental Performance Standard has been designed to ensure that construction, operations and rehabilitation across the CPP Area are environmentally focused on Isolation-Containment-Integrity and Monitoring through the life cycle of the Activity, including in the atmospheric and subsurface environments.

Each Environmental Outcome has a listed risk source evaluation table. All risks with a pre-control assessment risk level of medium or greater are covered in the table. Relevant records for measurement criteria are provided to demonstrate whether the relevant controls have been effective during the Activity and that the stated environmental outcomes and performance standards are being achieved.

A summary list of the relevant codified risks for each environmental outcome is also included together with instrument calibration controls where appropriate.

6.3.1 Air Quality and Atmospheric Processes

Table 6.3—1 Environmental Outcomes, Performance Standards & Measurement Criteria – Air Quality and Atmospheric Processes

Environmental Outcome	EPS Number	Environmental Performance Standard	Measurement Criteria	Records
No unnecessary greenhouse gas emissions generated from the Activity.	**EPS-AQ1**	Flaring or venting of gas during appraisal phase occurs only when wells are being flowed to clean up or due to CGP process upset.	• Approval of gas recovery on an appraisal basis in place. • Flaring events recorded and records demonstrate that the volume of gas flared does not result in an exceedance of scope 1 emissions of greater than 100,000 tCO2-e in any financial year over the life cycle of a project.	• Approval document • Process data logs • Gas to flare volumes (Mmcf) • NGRS reports
	EPS-AQ2	No uncontrolled leak (fugitive emissions) from the CGP and connection line to the McArthur River Gas Pipeline.	• Pressure tests demonstrate CGP and connection line integrity. • Alarm testing records demonstrate emergency response protocol functionality in case of an emergency event. • Leak inspections demonstrate that the identified leaks are managed. • Maintenance records demonstrate plant and equipment maintained in accordance with OEM specifications. • Emergency response drill reports demonstrate emergency response protocol functionality in case of an emergency event. • The incident register shows no significant loss of containment events and that minor leaks are identified and actioned.	• Testing reports • Site inspection reports • Leak Inspection reports • Maintenance reports • Training matrices • Emergency response drills reports • Incident register • Corrective action register
	EPS-AQ3	No uncontrolled leaks (fugitive emissions) from the wells or well heads.	• Records of well head inspections every six months until the well is decommissioned to demonstrate that there are no leaks and/or identified leaks are managed. • The Well Barrier Integrity Validation Report (WBIV) demonstrates compliance with DITT requirements. • Well construction reports demonstrate that well heads were designed to API standards. • Emergency response drill reports demonstrate emergency response protocol functionality in case of an emergency event.	• Leak inspection checklists • WBIV reports • Well reports/files • Maintenance reports • Training matrices • Incident register • Emergency response drills summary reports

Environmental Outcome	EPS Number	Environmental Performance Standard	Measurement Criteria	Records
			• Review of emergency response drill reports identifies learnings and areas for improvement. • The incident register shows no loss of containment events that resulted in material or serious environmental harm and that minor leaks identified and actioned.	
	EPS-AQ4	No uncontrolled leaks (fugitive emissions) from gas gathering flowlines.	• Flowline pressure monitoring, visual inspections and leak monitoring reports demonstrates flow line integrity. • Emergency response drill reports demonstrate emergency response protocol functionality in case of an emergency event. • The incident register shows no significant loss of containment events and that minor leaks identified and actioned.	• Site inspection reports • Pressure monitoring reports • Leak inspection checklists • Emergency response drills • Incident register • Corrective action register
	EPS-AQ5	Vehicle emissions do not exceed manufacturer's specifications.	• Vehicle maintenance records show all vehicles serviced to OEM standards and schedules.	• Vehicle maintenance records

Table 6.3—2 Air and Atmospheric Processes Risk Sources

Air Quality and Atmospheric Process Risk Sources			
	Risk Code	**Risk Source**	**Risk Description**
Risk Source	**AP-3**	**Drilling of petroleum wells**	Fugitive greenhouse gas emissions contribute to anthropomorphic climate change.
	AP-4	**Operation of petroleum wells**	Fugitive greenhouse gas emissions contribute to anthropomorphic climate change.
	AP-5	**Operation of petroleum wells**	Flaring or venting gas during appraisal phase contributes to anthropomorphic climate change.
	AP-6	**Gas Gathering Network**	Fugitive greenhouse gas emissions contribute to anthropomorphic climate change.
	AP-7	**Carpentaria Gas Plant**	Fugitive greenhouse gas emissions contribute to anthropomorphic climate change.
Instrument Calibration	• Personal gas detector calibrated as per OEM specifications. • Alarm sensors calibration as per the OEM specifications.		

6.3.2 Community and Economy

Table 6.3—3 Environmental Outcomes, Performance Standards & Measurement Criteria – Community and Economy

Environmental Outcome	EPS Number	Environmental Performance Standard	Measurement Criteria	Records
No significant negative impact on community.	**EPS-CE1**	Site access and speed limits are reiterated to visitors and workers.	• Site induction records show that speed limits and approved access points are covered for visitors and workers travelling to site. • Signage is in place.	• Induction register • Site inspection checklists • CPP Traffic Procedure and access track advisory signs
	EPS-CE2	No unmanaged biosecurity risk from declared and priority weeds within cleared footprint.	• Records demonstrating that vehicles have completed weed self-declarations prior to entering CPP Area or have been removed from site. • Records of annual weed surveys demonstrate that the work area is free of declared weeds, or that identified declared and priority weeds are being managed/controlled. • Final assessment report demonstrates that no priority or declared weeds are present.	• Incident register • Weed declaration register • Induction register • Site weed identification posters • Annual weed reports • Annual rehabilitation inspection reports
	EPS-CE3	No bushfires from conduct of the Activity in the CPP Area.	• Fire break inspection and maintenance records demonstrate that fire breaks / access trails are checked and cleared of fire-risk material until progressive rehabilitation commences. • The annual environmental performance report to the NT Government demonstrates that annual mapping has been conducted for the CPP Area to monitor changes to fire frequency (https://www.firenorth.org.au/). • The Activity records demonstrate that permits under Section 46 of the *Bushfires Management Act, 2016 (NT)* during NT declared fire danger periods have been obtained prior to flaring. • Records of flare exclusion zones modelling results for any flares demonstrate the exclusion zones will be effective in the management of radiant heat risk. • The site inspection checklist validates that the flare's exclusion zone is in accordance with validation modelling.	• Site inspection checklists • Fire break maintenance work orders • NAFI Fire mapping • Fire permits • Hot Work Permits • Bushfire Management Plan one pager on site • Flare exclusion zones validation modelling results.
	EPS-CE4	No impacts to human health from use of hydraulic fracturing chemicals or hydraulic fracturing sand.	• Job Hazard Assessments records demonstrate the controls to prevent silicosis are in place where sand is being handled are in place.	• Job Hazard Assessments • Human Health Risk Assessment for hydraulic fracturing fluids

Environmental Outcome	EPS Number	Environmental Performance Standard	Measurement Criteria	Records
			• HF chemicals risk assessment demonstrates acceptable risk levels for hydraulic fracturing chemical use.	
	EPS-CE5	No significant negative impact on community from light, noise and traffic.	• Complaints register shows no unresolved local stakeholder complaints regarding light, noise and traffic.	• Complaints Register
	EPS-CE13	No significant negative impacts on resources availability to local community.	• Complaints register shows no unresolved local stakeholder complaints regarding local labour & resource competition.	• Complaints Register
	EPS-CE14	No significant deterioration in local community cohesion.	• Complaints register shows no unresolved local stakeholder complaints regarding loss of community adhesion.	• Complaints Register

Table 6.3—4 Community and Economy Risk Sources

Community and Economy Risk Sources			
	Risk Code	**Risk Source**	**Risk Description**
Risk Source	**HH-2**	Hydraulic Fracturing	HF Chemical Impact on Human Health.
	HH-3	Hydraulic Fracturing	HF Sand Dust Silicosis Impacts.
	HH-4	HF Flowback Water Storage	Chemicals in HF flowback water that escapes containment impacting human health.
	CE-1	Land Clearing	Mobile plant starts a bushfire that impacts pastoralists and residents.
	CE-4	Vehicle Movements in CPP Area	Vehicle impacts on fauna and stock.
	CE-5	Vehicle Movements on Public Roads	Increased light, noise and traffic impacting on the community.
	CE-6	Vehicles Accessing CPP Area from Public Roads	Noise nuisance.
	CE-7	Operation of petroleum wells	Bushfires started by operation of flares impacts pastoralists and residents.
	CE-8	Carpentaria Gas Plant	Nuisance noise from the operation of CGP.
	CE-9	Carpentaria Gas Plant	Bushfire started by operation of flare impacting pastoralists and residents.
	CE-12	Accommodation Camp	Bushfire started by camp operations impacting pastoralists and residents.
	CE-13	Personnel Numbers	Increase demand for labour and resources.
	CE-14	Personnel Numbers	Adverse effects on community adhesion.
Instrument Calibration	N/A		

6.3.3 Cultural Heritage

Table 6.3—5 Environmental Outcomes, Performance Standards & Measurement Criteria – Cultural Heritage

Environmental Outcome	EPS Number	Environmental Performance Standard	Measurement Criteria	Records
No significant impact on Indigenous and non-indigenous artefacts, sacred or heritage sites.	**EPS-CH1**	No unauthorised disturbance to Aboriginal or Macassan archaeological places or objects, sacred sites, cultural heritage sites or non-indigenous cultural heritage sites by the Activity.	• Before any new clearing, a systematic archaeological survey will be conducted by a SQP in the proposed disturbance area. The initial survey will guide the development of a cultural heritage management plan, and any subsequent surveys will provide updates as required. • Induction records, or toolbox talks, show that civils construction personnel have received training on where the limits of civils earthworks can occur within the infrastructure movement zone, what is and how to identify cultural heritage, what to do when unexpected cultural heritage is encountered (7.10.1 and 7.10.2), awareness of the conditions of the AAPA Authority Certificate including location and boundaries of restricted work areas, the obligation to comply with the *Aboriginal Sacred Sites Act NT (1989)*, and the requirement to have consent, approval or permission for the proposed work or use of land which may be required under other legislation. • Records demonstrate that cultural monitors were engaged to scout locations prior to clearing. • Records demonstrate construction personnel have received guidelines in the process developed for identifying, recording, and reporting any possible archaeological places or objects or cultural heritage sites if discovered during construction. • Civils records demonstrate [redacted] with systematic survey completed on [redacted] in consultation with the Heritage Branch has occurred before any clearing. • The incident register shows that Aboriginal or Macassan archaeological places or objects if discovered during construction, are recorded, and reported to the CEO of the Northern Territory Heritage Office as soon as practical after discovery.	• Baseline archaeological survey reports • Induction register • Toolbox Talks/ Prestart meetings • Training matrices • Time sheets • GPS coordinates and shape files of as-built infrastructure • Systematic survey report • Incident Register

Table 6.3—6 Cultural Heritage Risk Sources

Cultural Heritage Risk Sources			
Risk Source	**Risk Code**	**Risk Source**	**Risk Description**
	CH-1	Infrastructure site selection	Damage to cultural and heritage places and objects.
	CH-2	Land clearing	Damage to cultural and heritage places and objects.
Instrument Calibration	N/A		

6.3.4 Soil and Surface Water Quality

Table 6.3—7 Environmental Outcomes, Performance Standards and Measurement Criteria – Soil and Surface Water Quality

Environmental Outcome	EPS Number	Environmental Performance Standard	Measurement Criteria	Records
No significant long-term impact on soil stability, quality, or surface water.	**EPS-SS1**	No uncontrolled or unremedied sediment releases from constructed infrastructure during operations.	• Inspection records of ESC measures demonstrate the ESC measures are operating in accordance with the ESCP (**Appendix 05**), and that ESC measure maintenance work is occurring where required. • Records demonstrate that ESC measures are checked post a rain event of 20 mm during construction. • The incident register demonstrates that there are no uncontrolled or unremedied sediment release during operations. • Decision tree developed (**Section 3.4.8.1**) to determine type of watercourse crossing to be used (directional drilling or trenching), in conjunction with a geomorphic assessment. • Decision tree developed (**Section 3.4.8.1**) to determine type of watercourse crossing to be used (directional drilling or trenching), in conjunction with a high resolution fluvial geomorphic baseline assessment. • Geomorphic assessment completed and assessment criteria met. • Report containing pre-trenching, and post-trenching rehabilitation at each of the creek crossing locations including drone acquisition of High-Resolution Ortho Photography with	• Site inspection checklists • ESC maintenance work orders • Weather forecasts • Incident register • Corrective action register • HDD decision tree checklists • Geomorphic assessment results • Report of pre- and post-trenching construction geomorphic conditions

Environmental Outcome	EPS Number	Environmental Performance Standard	Measurement Criteria	Records
			corresponding high precision Digital Surface Model (DSM) for baseline geomorphic fluvial features.	
	EPS-SS2	No over-topping of above-ground tanks.	• Weekly monitoring checklists demonstrate that there is freeboard availability. • Spill register demonstrates that no spills occurred from overtopping events.	• Site inspection checklists • Spill register • Corrective action register • Significant spill investigation report
	EPS-SS3	No leaks, or loss of containment, of flowback water from above-ground tanks that cause serious environmental harm to the sub-soil.	• Above-ground tank location on site demonstrates consideration of potential impacts from bushfire. • Above ground tanks are double lined or bunded with 100% capacity of largest single lined tank in the areas to demonstrate secondary containment in place. • Leak detection monitoring records for above-ground tanks, when containing flowback, demonstrate that tanks are maintaining integrity. • Where tanks are linked together, they have been designed and operated to prevent the uncontrolled discharge of multiple tanks should 1 tank fail. • The incident register shows that any alarms from level sensors, or leak detection devices between liners are recorded, investigated, and actioned for learning purposes.	• Site inspection checklists • Tank integrity checks • Telemetry monitoring reports • Leak detection alarm reports • Level sensor alarms reports • Incident register • Corrective action register • Significant spill investigation report
	EPS-SS4	No leaks from the flowback flowlines that cause serious environmental harm to the sub-soil.	• Records demonstrate that flowlines are buried to a depth of 750 mm or 1,200 mm where they cross an access track or flowline. • Pressure testing records demonstrate flowline integrity and mechanical strength. • Flowline design records demonstrate that flowlines can be isolated into sections to reduce volume of spills. • The incident register shows no loss of containment events that resulted in material or serious environmental harm and that minor leaks are identified and actioned.	• Incident register • Testing reports • Training matrices • As-built construction reports • Flowback and leak detection report • Significant spill investigation report
	EPS-SS5	No over-topping of drilling by-products from sump/s.	• Weekly monitoring checklists demonstrate that there is freeboard availability that accounts for wet weather. Records demonstrate that drilling sumps have been constructed with a	• Site inspection checklists • Telemetry monitoring reports • Spill register

Environmental Outcome	EPS Number	Environmental Performance Standard	Measurement Criteria	Records
			500 mm raised bund to prevent overland flow from entering the sumps. • Spill register demonstrates no spills occurred from overtopping events.	• Significant spill investigation report
	EPS-SS6	No leaks of drilling by-products that cause serious environmental harm to sub-soils from use sump/s.	• Monitoring records demonstrate that fluid level changes are consistent with operational Activity, and no wet patches are observed near the sump. • Records demonstrate that drilling sumps are lined with Aquacon345 HDPE or equivalent. • The incident register shows no leaks or that identified leaks are remedied as soon as possible.	• Site inspection checklists • Construction records • Telemetry monitoring reports • Incident register • Corrective action register • Drilling waste assessment reports • Quarterly Recordable Incident Reports
	EPS-SS7	No fluid additive, chemical, or fuel spills escape storage and handling areas during operations.	• Hazardous chemicals stored in a dedicated area and inspection records of secondary containment, when in use, demonstrate that the integrity of containment/storage is maintained and repaired if found damaged. • Records show spill kits are stocked and available for use on site where chemicals are stored. • Spill register confirms that no spills resulted in material or serious environmental harm.	• Site inspection checklists • Maintenance reports • Spill register • Corrective actions register • Significant spill investigation report
	EPS-SS8	Spills do not result in serious environmental harm.	• Records of Imperial's Transport of Chemicals or Wastewater Checklist demonstrates that the risk of spills during transport has been assessed prior to transport during the Wet Season. • Records of flowline commissioning demonstrate infrastructure integrity. • The maintained spill register does not contain any occurrences of spills which resulted in serious environmental harm.	• Transport of chemicals or wastewater checklist • Site inspection checklists • Spill register • Corrective action register • Flowline pre-commissioning tests • Wastewater assessment reports • Significant spill investigation reports • Listed waste transportation records • Quarterly Recordable Incident Reports

Environmental Outcome	EPS Number	Environmental Performance Standard	Measurement Criteria	Records
	EPS-SS9	No runoff of grey water and treated sewage effluent out of designated irrigation area.	• Inspection checklists demonstrate irrigation is by use of dispersion hoses and/or sprinklers to prevent pooling within a fenced, vegetated area on a slope <5%. • The incident register shows that any pooling, fencing, or run off from the designated area are actioned.	• Site inspection checklists • Incident register • Corrective action register
	EPS-SS10	Progressive rehabilitation of significantly disturbed areas commenced within 12 months of no longer being required for the Activity.	• Rehabilitation records show that progressive rehabilitation of significantly disturbed areas commenced as soon as practicable and no later than 12 months after the cessation of the Activity. • Annual inspection report once rehabilitation has commenced in accordance with **Appendix 03**.	• Annual rehabilitation inspection reports

Table 6.3—8 Soil and Water Quality Risk Sources

Soil and Water Quality Risk Sources			
	Risk ID	**Risk Source**	**Risk Description**
Risk Source	**IW-1**	Land Clearing	Increased erosion impacts the inland water quality.
	IW-2	Drilling of Petroleum Wells	Drilling fluid spills impacting inland water.
	IW-3	Hydraulic Fracturing	HF Fluid spills impacting inland surface water (localised spill).
	IW-4	Wastewater Flowline	Wastewater flowline leaks impacting inland surface water.
	IW-5	Flowback Water Storage	HF flowback water loss of containment by overtopping impacting inland surface water.
	IW-6	HF Flowback Water Storage	HF flowback water loss of containment from above ground tank impacting inland surface water.
	IW-7	Chemical Storage	Loss of containment of chemicals impact inland surface water.
	IW-8	Chemical Handling	Chemical spills impact inland surface water (localised).
	IW-9	Chemical Transport	Spills impact surface water.
	IW-10	Accommodation Camp	Sewage and greywater impact on inland surface water.
	TE-2	Land Clearing	Damage to important and critical habitat for fauna species.
	TE-4	Land Clearing	Land clearing operations introduce or spread weeds.
	TE-5	Land Clearing	Increased erosion impacts the land.

Soil and Water Quality Risk Sources			
	Risk ID	**Risk Source**	**Risk Description**
	TE-9	Low Point Drains (LPD) in Gas Flowline	Loss of containment of condensed LPD water.
	TE-10	Drilling of Petroleum Wells	Drilling fluid spills impacting the land (any volume).
	TE-13	Operation of Petroleum Wells	Fluid or chemical spill from process equipment.
	TE-14	Wastewater Flowlines	Wastewater flowline leaks impact soil.
	TE-16	HF Flowback Water Storage	HF flowback water loss of containment by overtopping impacting soil.
	TE-17	HF Flowback Water Storage	HF flowback water loss of containment from above ground tank impacting soil.
	TE-19	Chemical Storage	Loss of containment and chemicals impact soil.
	TE-20	Chemical Handling	Spills impact soil.
	TE-21	Chemical Transport	Spills impact soil.
	TE-24	Accommodation Camp	Sewage and greywater impact on soil.
	TE-26	Flood inundation	Extreme flood event across the Activity site.
Instrument Calibration	• Water Quality Monitoring: Instrument calibrated before use. pH probe calibrated with a two-point calibration using a pH buffer of 7 and 10. EC meter calibrated with a 1413 µs/cm (or similar) standard. • Quarterly manual calibration of level sensors and alarms tested.		

6.3.5 Groundwater Environmental Quality

Table 6.3—9 Environmental Outcomes, Performance Standards and Measurement Criteria – Groundwater Environmental Quality

Environmental Outcome	EPS Number	Environmental Performance Standard	Measurement Criteria	Records
No significant impact on groundwater quality or quantity.	**EPS-GE1**	No significant environmental harm to groundwater from the loss of circulation while drilling or hydraulic fracturing.	• Drilling reports include details of all additives utilised when drilling through freshwater aquifers and demonstrate that they were not considered ecologically toxic. • Hydraulic fracturing additives use records demonstrate that additives were risk assessed and deemed safe for use.	• Drilling fluid additive summary reports • Hydraulic Fracture additive summary reports • Ground water monitoring reports

Environmental Outcome	EPS Number	Environmental Performance Standard	Measurement Criteria	Records
			• Groundwater monitoring demonstrates no impact on groundwater at impact monitoring bores.	
	EPS-GE2	No significant environmental harm to groundwater from loss of well control while drilling.	• Training records demonstrate that well control training was carried out by those in control of drilling. • The Well Barrier Integrity Validation Report (WBIV) demonstrates compliance with DITT requirements. • Drilling and stimulation additives use reports demonstrate compliance with additives approved under this EMP. • Groundwater monitoring demonstrates no impact on groundwater at impact monitoring bores	• Training matrices • WBIV reports • Additive summary report • Ground water monitoring reports
	EPS-GE3	Groundwater extraction limited to licenced volume.	• Water extraction records available that demonstrate the volume extracted is less than the maximum permitted for the Activity.	• Groundwater monitoring report • Water meter readings

Table 6.3—10 Groundwater Environmental Quality Risk Sources

Groundwater Environmental Quality Risk Sources			
Risk Source	**Risk Number**	**Risk Source**	• **Risk Description**
	HP-1	Drilling of Petroleum Wells	• Loss of well control or drilling fluid chemicals impacting the aquifer.
	HP-2	Hydraulic Fracturing	• HF fluid chemicals impacting the aquifer.
	HP-4	Groundwater Extraction	• Reduced groundwater quantity.
Instrument Calibration	• Groundwater volume: Approved DEPWS bore meter used with no calibration required. • Quarterly manual calibration of level sensors and alarms tested.		

6.3.6 Terrestrial Environmental Quality

Table 6.3—11 Environmental Outcomes, Performance Standards & Measurement Criteria – Terrestrial Environmental Quality

Environmental Outcome	EPS Number	Environmental Performance Standard	Measurement Criteria	Records
No significant impact on threatened flora and fauna.	**EPS-TE1**	Where practicable, new disturbance occurs in the Infrastructure Movement Zone that has been adjusted to avoid sensitive receptors and their buffers (if any) and assessed by an ecologist prior to clearing.	• Field assessments and/or GPS logs demonstrate that on-ground scouting by an ecologist prior to any new clearing has occurred. • As-built infrastructure reports demonstrate that sensitive areas were avoided to ALARP.	• Spatial survey data • Environmental assessment report • GPS coordinates and shape files of as-built infrastructure
	EPS-TE2	No unmanaged biosecurity risk from declared and priority weeds within cleared footprint.	• Records demonstrating that vehicles have completed weed self-declarations upon entering the CPP Area. • Records of annual weed surveys demonstrate that the work area is free of declared weeds, or that identified declared and priority weeds are being managed/controlled.	• Induction records • Weed declaration register • Incident register • Weed survey reports • Annual rehabilitation inspection reports • Weed Identification material on site
	EPS-TE3	No bushfires from the conduct of the Activity in the CPP Area.	• Fire break inspection and maintenance records demonstrate that fire breaks in operational areas are checked and cleared of fire-risk material during the Dry Season until progressive rehabilitation commences. • Records of fire management measures demonstrate controls in place to reduce chance of fire. • Well pad and CGP flares constructed with relevant exclusion zones validated by modelling.	• Site inspection checklists • Fire break maintenance work orders • Hot Works Permits • Spatial survey data • Environmental assessment report • GPS coordinates and shape files of as-built infrastructure. • Flare exclusion zones modelling results.
Rehabilitation of the land meets ecological values.	**EPS-TE4**	Areas used for the Activity are rehabilitated consistent with surrounding land uses and ecological values as compared to analogue sites.	• Final assessment report demonstrates that perennial groundcover and canopy-cover vegetation, as assessed between analogue sites and adjacent cleared area, will be equivalent of 70% of the adjacent vegetation cover.	• Rehabilitation final assessment report
	EPS-TE5	No priority or declared weeds in areas being rehabilitated.	• Final assessment report demonstrates that no priority or declared weeds are present.	• Weed survey reports • Corrective action register • Rehabilitation final assessment report
	EPS-TE6	No ongoing erosion from cleared areas used during the Activity.	• Inspection reports demonstrate that identified erosion issues are being remediated and sediment control measures in place; and	• Site inspection reports • ESC maintenance work orders • Annual rehabilitation inspection reports

Environmental Outcome	EPS Number	Environmental Performance Standard	Measurement Criteria	Records
			• Final assessment report demonstrates no significant erosion attributable to the Activity.	• Final rehabilitation summary reports
	EPS-TE7	Rehabilitated areas are safe for continued land use.	• Inspection and final assessment reports demonstrate no subsidence associated with flowlines. • Well reports / files demonstrate that a well is suspended and decommissioned in accordance with *Code* requirements. • Monitoring records demonstrate that all above ground equipment removed and there is no visible contamination at final rehabilitation.	• Site inspection checklists • Well reports/files • Rehabilitation final assessment report • Groundwater monitoring reports • Drilling Waste Assessment reports

Table 6.3—12 Terrestrial Environment Risk Sources

Terrestrial Environment Risk Sources			
	Risk Code	**Risk Source**	**Risk Description**
Risk Source	**TE-1**	Land Clearing	Mobile plant starts a bushfire that impacts ecosystems.
	TE-2	Land Clearing	Damage to important and critical habitat for fauna species.
	TE-3	Land Clearing	Land clearing operations start a bushfire.
	TE-4	Land Clearing	Land clearing operations introduce or spread weeds.
	TE-5	Land Clearing	Increased erosion impacts the land
	TE-12	Operation of Petroleum Wells	Fires started by operation of flares impacts ecosystems.
	TE-15	Hydraulic Fracturing Sand	Weeds Introduced with HF Sand.
	TE-22	Carpentaria Gas Plant	Bushfire started by operation of flare impacting ecosystems.
	TE-25	Accommodation Camp	Bushfire started by camp operations impacting ecosystems.
Instrument Calibration	• Water Quality Monitoring: Instrument calibrated before use. pH probe calibrated with a two-point calibration using a pH buffer of 7 and 10. EC meter calibrated with a 1413 µs/cm (or similar) standard.		

7 Management Plans and Procedures

7.1 Overview

The following list of Management Plans for the Activity required in an EMP under *the Code,* are summarised in this section and cross-referenced to relevant Appendices where necessary.

Table 7.1—1 Summary of Management Plans

Plan/Assessment	Focus	Location
Rehabilitation Management Plan	Infrastructure related to the Activity – progressive.	**Appendix 03**
Weed Management Plan	Surveillance, mitigation, and control.	**Appendix 04**
Erosion and Sediment Control Plan	Surveillance, mitigation, and control.	**Appendix 05**
Waste and Wastewater Management Plan	HF flowback, water handling station, camp & gas processing plant.	**Appendix 06**
Spill Management Plan	Tiered spill response procedures.	**Appendix 07**
Emergency Response (Contingency) Plan	Tiered HSE response procedures.	**Appendix 09**
Bushfire Management Plan	Surveillance, mitigation, and control.	**Appendix 12**
Methane Emissions Management Plan	Comply with *the Code*.	**Appendix 13**

7.2 Rehabilitation Plan

In accordance with *the Code* (Section A.3.9), a project-specific Rehabilitation Management Plan has been developed as part of the EMP by suitably qualified persons using *Rehabilitation Plan Guide for Surface Disturbance: Onshore Petroleum Disturbance* [DEPWS, 2020]. A summary of the Rehabilitation Management Plan is provided below.

Table 7.2—1 Rehabilitation Management Plan Overview

#	Section Title	Summary
1 & 2	**Introduction and Scope**	The plan applies to the disturbance associated with the Activity under IMP 5-3 within the CPP Area.
3	**Environmental Description and Risks**	This section provides information on the site-specific environmental risks and associated controls to be implemented. Some key risks that have been considered are the management of removed topsoil, the presence of weeds of concern, cattle grazing, soil compaction, subsidence, erosion, contamination, and bushfire risk.
4	**Final Land Use**	Details Imperial's commitment to returning the land to as close as possible to its pre-disturbed condition. This is in line with future land use requirements, as determined through stakeholder engagement and the requirements of the regulations.
5	**Rehabilitation Works**	This section provides an overview of the works required to meet rehabilitation success measures. This includes the establishment of analogue sites, civils construction, monitoring, and maintenance, well suspension and decommissioning, and flow line abandonment.
6	**Rehabilitation Success Criteria**	Here the objectives for rehabilitation success are defined. Objectives include returning the landform to the pre-disturbance level requiring little or no ongoing management. Measurement criteria are presented to assess the rehabilitation success against the objectives.
7	**Monitoring and Maintenance Program**	A monitoring and measurement program is presented to assess the rehabilitation success of areas being progressively rehabilitated. The program sets out the survey methods;

#	Section Title	Summary
		measurable attributes; corrective actions; and ongoing maintenance and reporting; for each of the Activity phases.
8	**Relinquishment and Transfer of Liability to Landholders**	An outline of the transfer procedure of infrastructure and land to the Landholder is provided. This includes a protocol if a Landholder requests access tracks or groundwater bores to be remain.
9	**Annual Review**	This section details the annual updates that will be made to the plan post-site assessment.

7.3 Weed Management Plan

An Activity-specific Weed Management Plan has been developed as part of the EMP; refer to **Appendix 04** for the complete plan.

Table 7.3—1 Weed Management Plan Overview

#	Section Title	Summary
1	**Introduction** 1. Location 2. Scope & Field Assessment Zones 3. Legal Requirements 4. Recommendations from the Scientific Enquiry (& Weed Officers)	The key objective is to set out the weed management measures to be implemented to prevent the introduction and spread of weeds during the works associated with the Activity. These measures will follow applicable legislation, regulations, conditions, and regional weed management plans. Details of nominated weed officers are provided.
2	**Weed Introduction and Risks**	This section provides the risks, mitigation measures, and measurement criteria to prevent the introduction of new weed species and to prevent the spread of weeds.
3	**Weed Species** 1. Regional Priorities 2. October 2023 Survey Results	This section provides a desktop review of the NT Weed Branch dataset, and the results of a baseline weed survey (Oct 2023 and previous weed survey results) with the relevant introduced flora species (weeds) to the CPP Area.
4	**Annual Action Plan**	Details the weed management areas and plans within CPP.
5	**Mitigation Monitoring**	This sets out the requirements for weed mitigation and monitoring requirements within the CPP Area. Weed recording, reporting, and notification in accordance with the *NT Weed Data Collection Guidelines*.
6	**Notification Procedure**	Should a new weed species in the CPP Area be identified, this section outlines the method and time frame in which the DEPWS Weeds Officer will be notified.
7	**Recording**	Summarises the method in which weed surveys were conducted.

#	Section Title	Summary
8	**Reporting**	This section provides items to be included in the annual report submission to DEPWS.
9	**Works Cited and Relevant Reference List**	Reference list.
App. A	**Weed Data**	This is the data set (species, location, etc) for the weeds identified during the 2023 weed survey.
App. B	**Weed Figures**	This Appendix provides detailed maps of all weeds detected, both historically and currently within the CPP Area and surrounds.

7.4 Waste and Wastewater Management Plan

An Activity-specific Waste and Wastewater Management Plan (WWMP) has been developed as part of the EMP; refer to **Appendix 06** for the complete plan.

Table 7.4—1 Waste and Wastewater Management Plan Overview

#	Section Title	Summary
1 – 3	**Introduction** **Waste Hierarchy** **Waste & Wastewater Sources**	The objectives of the WWMP are to describe the relevant works, environmental risks and impacts involved in managing Activity wastewater streams; to define the management methods and approaches, estimate quantities; and monitor, manage and report wastewater volumes. The Waste Management Hierarchy (avoid, reduce, reuse, recycle, treat, and dispose), as outlined in the *National Waste Policy*, *2018 (Cth)* will be used to achieve optimal environmental outcomes. Wastewater types are categorised into the following key categories: domestic, civil construction, drilling, HF stimulation, appraisal testing, and ancillary works. The waste characteristics and volumes for each waste category are detailed. Please refer to **Section 3.8.3** of this EMP and **Appendix 06** for this detail.
4	**Wastewater Management**	This section outlines how wastewater will be managed during the Activity. It includes an overview of the proposed storage methods, as well as a waste hierarchy for the proposed waste streams. This section provides a table (**Table 6—1**, **Appendix 06**) listing the aspects of CPP activities and the respective wastewater streams; methods recycle, treat, and dispose of each type of waste from the Activity. Summaries are provided of how infrastructure has been designed and developed to ensure risks have been assessed, and appropriate controls in place effectively manage and handle wastewaters. The environmental impacts and risks associated with the management (treatment, handling, and reuse) of wastewater are deemed to be reduced to ALARP, and acceptable. This conclusion is based on the analysis of chemicals and HF flowback presented in **Appendix 06** of this EMP; identification and implementation of

#	Section Title	Summary
		multiple controls detailed in **EMP Section 6**, **Appendix 07** (Spill Management Plan), and the environmental performance standards (**Section 6** of this EMP).This conclusion is based on the analysis of chemicals and HF flowback presented in **Appendix 06** of this EMP; identification and implementation of multiple controls detailed in **EMP Section 6**, **Appendix 07** (Spill Management Plan), and the environmental performance standards (**Section 6** of this EMP).
5	**Freeboard Management**	This section analyses rainfall and evaporation data to determine freeboard requirements for a sump or open-top tanks to minimise the risk of overtopping. A 1:1,000 ARI rainfall event was used in the assessment to determine the freeboard.
6	**Monitoring**	Monitoring would be undertaken in accordance with NT requirements, with methodology in accordance with Australian Standards and Guidelines.
7 – 9	**Transport on Unsealed Access Tracks** **Waste and Wastewater Offsite Disposal** **Waste Movement Tracking**	The protocols for the transport of waste are described. Imperial will use NT licensed transport providers and wastewater storage and treatment facilities, and transport wastewater interstate to a licensed storage and treatment facility. Waste tracking will be carried out and documented as per NT requirements, using a chain of custody system.
10	**Wildlife, Stock and Human Interaction**	Management and control methods will be implemented to minimise the risk of wildlife, stock and human receptors interacting with stored waste. Measures will include fencing of the well pads; installation of signage at the main well pad access gates; treatment tanks with no clear fauna access points; and installation of fauna ladders in sump/s.

7.5 Spill Management Plan

An Activity-specific Spill Management Plan has been developed as part of the EMP; refer to **Appendix 07** for the complete plan.

Table 7.5—1 Spill Management Plan Overview

#	Section Title	Summary
1 - 2	**Purpose** **Objectives**	The Spill Management Plan has been developed to support the Activity covered in this EMP, in accordance with *the Code*. The objective of this plan is to assess the potential for any loss of containment and to minimise the potential and actual harm should a loss occur.
3	**Threats to the Receiving Environment**	This section outlines the threats to the receiving environment. These include migration of spills to offsite locations, the loss of primary containment, ineffective secondary containment, loss of containment during transportation, and the loss of well control.
4	**Potential Spill Materials**	Details of potential spill materials can be found here, including a summary of their tiered impacts as outlined by the Human Health and Environmental Risk Assessment (HHERA) (**Appendix 08**). Risks and controls associated with spills (HF flowback, uncontrolled methane emissions, fuels, and maintenance chemicals) are presented.
5	**Potential Spill Scenarios**	Potential worse case spill scenarios have been determined, including spill mechanism, estimated quantities, materials spills, location, and key management controls.
6	**Pooled Water Area and Infiltration in Soil**	Here an assessment of the soil type is provided, with an accompanying model of the potential area and depth of soil infiltration, if a spill were to occur.
7	**Control Measures**	The key management control measures in place to prevent and/or minimise the risk of spills is described. These measures include storage and containment (including secondary containment) in accordance with relevant codes; drilling sumps designed and operated to manage a 1:1,000 ARI rainfall event; monitoring; transport of chemicals and wastewater.

#	Section Title	Summary
8	**Spill Response and Management**	This section provides an overview of tiered spill response and management for spills during the Activity. Note that where the spill results from an emergency, the Emergency Response (Contingency) Plan (**Appendix 09**) takes precedence. An initial assessment guideline, spill response actions, and an overview of the clean-up of contaminated material are provided. Details of the spill register, and communications plans can be also found.
9	**Incident Reporting**	Incident and reporting requirements will comply with relevant legislation (EMP **Section 2** – Legislative Requirements and **Section 8** – Implementation Strategy). Reportable and recordable incidents are outlined an identified.
10	**Records and Record Keeping**	All records and record keeping will align with the requirements outlined in Regulation 36(1) and defined in Regulation 36(3) of the *PER*.
11	**Chemical Tables**	Here an indicative list of the drilling, completions, and cementing fluids can be found. Details of typical environmental / disposal considerations and recommenced handling and storage consideration for hazardous chemicals are presented.

7.6 Emergency Response/Contingency Plan

An Emergency Response (Contingency) Plan (ERP) has been developed as part of the EMP; refer to **Appendix 09**. Imperial will update its Emergency Response (Contingency) Plan and associated bridging documents with the contractor's Emergency Response Plans for the proposed activities.

Table 7.6—1 Emergency Response Plan Overview

#	Section Title	Summary
1	**Contents, Document Control, and Definitions**	Table of contents, the document control history, and the abbreviation and units used in the ERP.
2	**Introduction**	The purpose of the ERP is to set out the emergency response arrangements and requirements to ensure an effective and timely response and recovery to emergency and well-related events. • Outlines the additional plans to be used in conjunction. • Provides an estimate of the number of personnel on site during each phase of the Activity. • Summarises location of Activity and well pad coordinates.
3	**Emergency Response Team**	This is a comprehensive list of the personnel and their relevant accountabilities under the ERP.
4	**Emergency Response Team – Actions**	Time dependant action lists for: • First Responders • Site Supervisor • Incident Controller • ERT Leader • ERT Information Coordinator • All Personnel
5	**Response Scenario Guidelines**	A table outlining recommended actions for a range of emergency scenarios, including specific actions for First Responders, Site Supervisor(s), and Incident Controllers. An adaptable evacuation procedure is provided in the event a full site emergency evacuation is required.

6	**Emergency Response Communications**	A description is provided for:
		• Internal communication protocol and UHF Channels.
		• External communication protocols for:
		  ○ External emergency services communication
		  ○ Stakeholders

#	Section Title	Summary
		○ Regulatory notification ○ Media enquiries.
7	**Emergency Response Equipment & Guidelines**	This section provides a summary of the emergency response equipment available on site as well as the trained medical assistance and numbers to call in an emergency. Information regarding emergency response services available by road and air with their estimated locations and arrival times.
8	**Recovery Actions**	Sets out the actions to conduct post emergency as part of the review, investigate, recover, and clean-up of the emergency. Details the issues to consider during the aftermath of an emergency including: • Emergency conclusion – final information to be distributed and procedure to determine when the emergency is over. • Debriefing – topics to discuss with relevant parties. • Training – how training will be provided against this plan. • Review and Update – when the plan needs to be updated.
9	**Emergency Contact Details**	Lists the Emergency Contact details for: • Empire Energy • InGauge Energy • Government Agencies and Stakeholders • Other (medical services, police, well control services, fire, service stations etc
10	**Appendix 1: Incident Notification Guideline**	Lists the regulatory requirements, timeframes, and methods to report incidents to various government departments.
11	**Appendix 2: Site ERN Display Sheets**	General site Emergency Response Numbers (ERN) for Carpentaria well pads 1, 2/3, and 4.

7.7 Erosion and Sediment Control Plan

Imperial has engaged a Certified Professional consultancy in Erosion and Sediment Control (CPESC) accreditation to prepare an Erosion and Sediment Control Plan (ESCP) for the activities covered under this EMP. The ESCP is attached as **Appendix 05**.

Table 7.7—1 Erosion and Sediment Control Plan Overview

#	Section Title	Summary
1	**Introduction**	The ESCP has been prepared to provide a best-practice framework for the implementation of effective erosion and sediment control throughout the well construction works. The ESCP applies to all aspects of the Activity, including the land disturbance associated with access tracks.
2	**Site Characteristics**	This section provides an overview of site characteristics relevant to erosion and sediment control, including climate and rainfall; landform class and description; soil type and description; and a figure showing 1 m contours for the main Activity area.
3	**Erosion Hazard and Risk**	This section describes the inputs and equations used to assess erosion hazard and risk for the Activity. Erosion hazards within individual project sub-catchments was assessed using the Revised Universal Soil Loss Equation – RUSLE [IECA, 2008]. This is commonly used to predict the long-term, average, and annual soil loss from sheet and rill erosion under specified management conditions.
4	**Erosion and Sediment Control Measures**	This section details the ESC measures for the ground-disturbing works for the new CPP well pad access corridors, well pads, gas processing plant and HF flowback depot and gravel pits. CPP topsoil, which has crucial elevated cation exchange capacity for land restoration, will be stockpiled for use in rehabilitation. Rehabilitation will be undertaken progressively as roads, flowlines and well pads are constructed. The erosion and sediment control strategies will also be used for ancillary areas such as site compounds, turn-around points, lay-down areas, etc.
5	**Management and Implementation**	This section outlines responsibilities, training, installation of ESC measures, and implementation of updates and variations.

#	Section Title	Summary
		The installation and maintenance of all ESC measures would be overseen by a suitably qualified person. Installation would be consistent with the ESC Plan.

7.8 Bushfire Management Plan

An Activity-specific Bushfire Management Plan (BMP) has been prepared and attached as **Appendix 12**. An overview of this plan follows.

Table 7.8—1 Bushfire Management Plan Overview

#	Section Title	Summary
1	**Introduction**	The introduction sets out the purpose of the document: to ensure the EMP complies with Section A.3.7 of *the Code*.
2	**Background**	This section describes an overview of the biome of the CPP Area, fire management practices in the region, land use and the Activity itself. The CPP Area is in the tropical savannah zone. The CPP Area is burnt regularly to reduce fuel loads and the risk of significant fires. The CPP Area is largely used for cattle grazing. The Activity comprises the clearing of up to 226 ha, the construction of new wells, access tracks, gravel pits, gravel pits extensions, water bore pads, well pads, a flowline/pipeline and supporting infrastructure (including the CGP), and a water handling station.
3	**Analysis of Baseline Information**	Baseline fire information has been sources from the North Australia and Rangelands Fire Information (NAFI) website. Imperial will review this document annually for currency of this baseline information. This section presents two maps, including fire frequency in the CPP Area, and the time since last burn.
4	**Impacts of the Activity on Existing Fire Management**	The BMP has been developed in line with the *Savanna Regional Bushfire Management Plan 2022-23* (SRMP) and the *Bushfires Management Act, 2016 (NT)* to support fire management within the Savanna Fire Management Zone. THE SRBMP highlights three risks with a high-risk rating: • Detrimental impacts of Gamba Grass and Fire Weeds.

#	Section Title	Summary
		• Damaging fires crossing property boundaries through loss of cooperation between neighbours, land managers with an insufficient level of expertise in fire management. • Risk of recurring wildfires impacting multi-tenure fire and land management objectives. • Control measures are detailed for each risk, comprising management plans/appendices of this EMP.
5	**Infrastructure Design, Construction and Operation**	This section sets out the design of the ring-fire access trail/fire break of 8 m, above-ground enclosed tanks and the operation of all machinery in line with manufacturer's specifications to minimise the risk of fire. Flares may be installed at each well head. If so, these will be located within a dedicated exclusion zone validated by modelling. It is also stipulated that the welding temperatures for PE pipe used in construction will not be high enough to be considered a potential source of ignition.
6	**Fire Management Practices**	This section provides an overview of fire access and fire break infrastructure, seasonal conditions and fire load assessment, annual fire mapping, controlled burns, monitoring of bushfire alerts, coordination with landholder/s and other users, local bushfire brigades.
6.1	**Fire Access Trails and Fire Breaks**	Fire access trails and fire breaks of approximately 8 m wide will be established throughout the CPP Area.
6.2	**Seasonal Conditions and Fire Load Assessment**	Seasonal fire load assessments will be carried out in the CPP Area and maintained for the duration of the Activity as required. Access roads and tracks may also act as fire breaks.
6.3	**Annual Fire Mapping**	Annual mapping will be conducted in the CPP Area to monitor changes in fire frequency. If a fire occurs in the immediate area during the Activity, Imperial (in consultation with relevant land managers) will map the extent of the fire and report it to DEPWS.
6.4	**Controlled Burns**	There will be no controlled burns under this EMP. However, leaseholders and Traditional Owners frequently conduct controlled burns in the area.
6.5	**Monitoring of Bushfire Alerts**	The Site Supervisor will monitor the NAFI website and Secure NT website daily in the Dry Season and weekly in the Wet Season

#	Section Title	Summary
		and liase with relevant land holders/pastoralists about potential fire control measures if a fire threatens the CPP Area or infrastructure.
6.6	**Coordination with Leaseholder/s and other Land Users**	Imperial has ensured that the Activity will not affect leaseholder's potential fire management strategies through frequent engagement.
6.7	**Local Bushfire Brigade**	Imperial may support the local fire brigade if the need arises.
7	**Fire Control Measures**	This section sets out the controls Imperial will implement and maintain to ensure the risk of fire is as low as reasonably practicable.
8	**Emergency Contact Details**	Emergency contact details of relevant emergency services, NAFI, link to an incident map for fire, etc.
9	**Fire Management Plan 1-Pager**	The one-pager comprises the emergency response to a fire, including emergency contact details, roles and responsibilities and maps of fire management zones. The one pager will be posted at prominent locations at the well pads and campsites and will be referenced in conjunction with the Emergency Response Plan (**Appendix 09**).

7.9 Unexpected Finds Procedure

The following sections detail the procedures to be followed if there is a discovery of potential cultural heritage objects or human remains. All personnel must receive training on what to do when unexpected cultural finds are found. Responsibilities of personnel are detailed in **Section 7.9.3** below.

Aboriginal Cultural Finds

Aboriginal cultural finds may include;

- Stone artifacts – with sharp edges or flat sections (grind stones) that are evidence of human modification.
- Scar trees – bark removed for canoes or cultural reasons.
- Bone and shell – potential waste dump (midden).

- Land features – features of the land such as raised areas that are evidence of human modification (e.g. bora rings) or middens.

Historic Cultural Finds

Historic finds may include;

- Glass – fragments or complete (e.g. bottles).
- Ceramic – plates, cups, pipes, etc.
- Metal – manufactured metal objects such as buckles, machinery parts, tools, tins.
- Wood – manufactured wood items.
- Stone – manufactured stone items.
- Bone and shell – potential waste dump.

7.9.1 Discovery of Potential Cultural Heritage Places and Objects

Cultural heritage may be discovered even in areas that have been assessed as being free of cultural heritage places and objects.

If a suspected cultural heritage place or object is discovered:

1. Refer to Discovery of Potential Human Remains procedure below if the discovery is suspected of being human remains.
2. All work within a 50 m radius of the suspected cultural heritage find must cease immediately and the area must be flagged/fenced appropriately to ensure that no further work activities can be undertaken within it.
3. The discovery must be reported immediately to the Site Supervisor, who immediately communicates with the Project Manager.
4. The Project Manager must notify the Senior Heritage Officer at NT Heritage Branch on 08 8999 5039 or Heritage.Branch@nt.gov.au.
5. The Interest Holder must Report in writing as soon as practical, finds that are Aboriginal or Maccassan archaeological objects or places, as defined in the *Heritage Act, 2011 (NT)*, to the CEO of the Heritage Branch of the Department of Territory Families, Housing and Community. The report must include:
    a. a description of the place or object;
    b. its location;

c. the person's name and address; and

d. if known by the person – the name and address of the owner or occupier of the place or place where the object is located.

6. Work is not to recommence in the vicinity of the find until direction is provided by the Heritage Branch of the Northern Territory Government.

    a. If the investigation recognises an archaeological place or object, an Application to Carry Out Works on a Heritage Place or Object needs to be lodged with the Heritage Branch prior to recommencement of works.

7.9.2 Discovery of Potential Human Remains

While undertaking on-ground activities, potentially human material may be discovered. If suspected human remains are discovered during the Activity, they must be initially assumed to be a crime scene and treated accordingly.

If potential human material is identified:

1. All work within a 50 m radius of potentially human material must stop immediately.
2. Report the discovery immediately to the Site Supervisor. The Site Supervisor must immediately notify the Project Manager of the discovery. No temporary fencing should be erected unless directed by the police.
3. The Project Manager must immediately notify the Police.
4. The Police will take control of the site as a potential crime scene.
5. If there are reasonable grounds to believe that the remains are:

    a. A crime scene – the Police will provide direction on the management of the discovery.

    b. If remains are Aboriginal ancestral or historical remains rather than a crime scene, the Project Manager should immediately notify:

        i. the Senior Heritage Officer at NT Heritage Branch on 08 8999 5039 or **Heritage.Branch@nt.gov.au**., and;

        ii. Report in writing as soon as practical Aboriginal or Maccassan archaeological objects, as defined in the Heritage Act 2011 (NT), to the CEO of the Department of Territory Families, Housing and Community. The report must include a description of the place or object; its location; the person's name and address; and if known by the person – the name and address of the owner or occupier of the place or place where the object is located.

iii. Relevant Traditional Owners (Land Council) if finds are Aboriginal or Maccassan archaeological objects.

6. Work is not to recommence in the vicinity of the find until direction is provided by the relevant authorities (Police or Heritage Branch of the Northern Territory Government).

7.9.3 Responsibilities

Employee/Contractor

- Stop work and report all suspected cultural heritage and human remains finds to Site Supervisor.

Site Supervisor

- Report all suspected cultural heritage and human remains finds to Project Manager.
- Ensure all employees/contractors are aware of the exclusion area. Establish temporary fencing at exclusion boundary, unless find is suspected human remains.

Project Manager

- Suspected Human Remains:
    - Immediately contact Police of the discovery.
    - If find not a crime scene but rather Aboriginal ancestral or historical remains, notify:
        - Immediately - the Senior Heritage Officer at NT Heritage Branch on 08 8999 5039 or **Heritage.Branch@nt.gov.au**.
        - As soon as practical in writing – the CEO of the Department of Territory Families, Housing and Community and the relevant Land Council.
    - Advise employees/contractors to restart work if cleared by relevant authorities (Police or Heritage Branch of the Northern Territory Government).
- Cultural Heritage Find:
    - Immediately notify the Senior Heritage Officer at NT Heritage Branch on 08 8999 5039 or **Heritage.Branch@nt.gov.au**.
    - If find is Aboriginal or Maccassan archaeological place or objects, as soon as practical in writing notify the CEO of the Department of Territory Families, Housing and Community and the relevant Land Council.
- Advise employees/contractors restart work if cleared by the Heritage Branch of the Northern Territory Government.

7.10 Methane Emissions Management Plan (MEMP)

An Activity-specific Methane Emissions Management Plan has been prepared and attached as **Appendix 13**.

Table 7.10—1 Methane Emissions Management Plan

#	Section Title	Summary
1	**Introduction**	• The introduction sets out the document's background, aim, purpose and scope to ensure the EMP complies with Section D.5.1.2 of *the Code*.
2	**Activity Description**	• Refers to the detailed description of the Activity in **Section 3** of the EMP.
3	**Greenhouse Gas Emissions – Large Emitters**	• Details how Imperial will apply to recover gas on an appraisal basis under Section 57AAA of the *Petroleum Act, 1984 (NT)* and, therefore, not exceed the large emitters emissions threshold in the NT Greenhouse Gas Emissions Management for New and Expanding Large Emitters policy. • If the application under Section 57AAA is unsuccessful and the CPP proceeds on a basis different to the one described, this EMP will be revised or modified under the *PER* to account for any new or increased environmental impacts or risks. This revision would include a greenhouse gas abatement plan if Imperial's estimated scope 1 emissions exceed 100,000 tCO_2-e in any financial year over the life cycle of the project.
4	**Regional Methane Monitoring**	• Details how The Methane and Greenhouse Gas Studies for the Beetaloo Sub-basin Strategic Regional Environmental and Baseline Assessment (the Methane Study) satisfy the requirements of Sections D.4.1, D.4.2 and D.4.3 of *the Code*.
5	**Methane Sources, Controls and Standards**	• Certain aspects of the Activity may give rise to methane emissions. These aspects and the controls to limit methane emissions are described in this section. Industry standards and codes that relate to the minimisation of methane emissions are listed.
6	**Monitoring Methodology and Frequency**	• Details how the requirements of Sections D.5.2.2 (Inspection and Monitoring Frequency) and D.5.3.2 (Standard Leak Detection Instruments) of *the Code* will be met. This section

#	Section Title	Summary
		also details the methodology to be used during leak detection surveys.
7	**Leak Classification**	• Details how Section D.5.5.1 (Minor Leaks) and Section D.5.2.2 (Significant Leaks) of *the Code* are defined.
8	**Leak Remediation and Notification**	• Details how the requirements of Sections D.5.6.1 (Minor Leaks) and D.5.6.2 (Significant Leaks) of *the Code* are remedied and notified.
9	**Compressors and Pneumatic Devices**	• Details how the requirements of Section D.5.7.2 of *the Code* concerning the design, selection, and operation are met to minimise or eliminate fugitive emissions.
10	**Venting and Flaring**	• Imperial will apply to the Minister for approval to recover petroleum on an appraisal basis under Section 57AAA of the *Petroleum Act, 1984 (NT)*. If successful, this will enable Imperial to conduct production appraisal tests without significant flaring. • If the application under Section 57AAA is unsuccessful and the CPP proceeds on a basis different to the one described, this EMP will be revised or modified under the *PER* to account for any new or increased environmental impacts or risks. This revision would include a greenhouse gas abatement plan if Imperial's estimated scope 1 emissions exceed 100,000 tCO_2-e in any financial year over the life cycle of the project. • Section D.5.9 of *the Code* details the requirements to ensure that venting and flaring of natural gas is eliminated or minimised where practicable.
11	**Other Fugitive Emission Sources**	• D.5.9.4 of *the Code*. In addition to leaks, venting, and flaring, which are considered in the preceding section of this MEMP, methane may also be released in significant quantities during certain planned and unplanned operations. These include some maintenance operations where gas in pipelines, or other equipment is blown down, system upsets or accidental releases. Such emissions must be estimated using methods consistent with the *National Greenhouse and Energy Reporting (Measurement) Determination 2008*. Other methods may be used if approved in an EMP.

#	Section Title	Summary
12	**Annual Reporting**	• Details the requirements of NT Section D.6.2 of *the Code* and Commonwealth reporting to the Clean Energy Regulator under the *National Greenhouse Energy Reporting Act, 2007 (CTH)*.

8 Implementation Strategy

This section covers the EMP's implementation strategy and details the expected requirements for all environmental and operational aspects of the CPP Area. Consistent with its values, Imperial is committed to conducting its operations in an environmentally responsible and sustainable manner aligned with community/social expectations. Imperial believes that achieving and maintaining good environmental outcomes is critical to the success of our business. The Implementation Strategy for the Activity has been designed to ensure that construction, operations, and rehabilitation across the CPP Area are environmentally focused on Isolation-Containment-Integrity and Monitoring throughout the life cycle of the CPP Activity, including in the atmospheric and subsurface environments. In addition, it provides summary details on how ongoing Stakeholder Engagement will be implemented and the commitments to training and instrument calibration where relevant.

The Implementation Strategy has also been designed to provide the basis of a risk register for the Activity to track environmental performance and conformance and assist in audit processes.

Imperial's environmental performance standards are set to achieve positive environmental outcomes during the Activity, as detailed in **Section 6**.

8.1 Management System

Imperial operates under a Health, Safety, and Environment Management System (HSEMS), which outlines the policies, plans, and procedures that govern the Activity. In addition to meeting legal requirements, the Activity will be governed by additional risk-focused plans to ensure that the environmental outcomes and environmental performance standards in place are met. The systems, plans, and procedures that are key to managing environmental risk include the following aspects:

1. Roles and responsibilities
2. Training and awareness

3. Emergency and contingency preparedness
4. Contractor management
5. Monitoring
6. Performance and incident reporting
7. Records management
8. Change management
9. Auditing and assurance
10. Corrective action, review, and continuous improvement

8.1.1 Roles and Responsibilities

Imperial plans to operate the CPP Area utilising the following indicative management structure, with responsibilities aligned to specific roles detailed on the subsequent page as they relate to compliant delivery of the Activity. The management structure **Figure 8.1—1** reflects the governance in place to achieve the environmental outcomes and performance standards associated with the EMP. In addition to the roles described within the structure there will be a dedicated Site Supervisor who may also be a contractor representative.

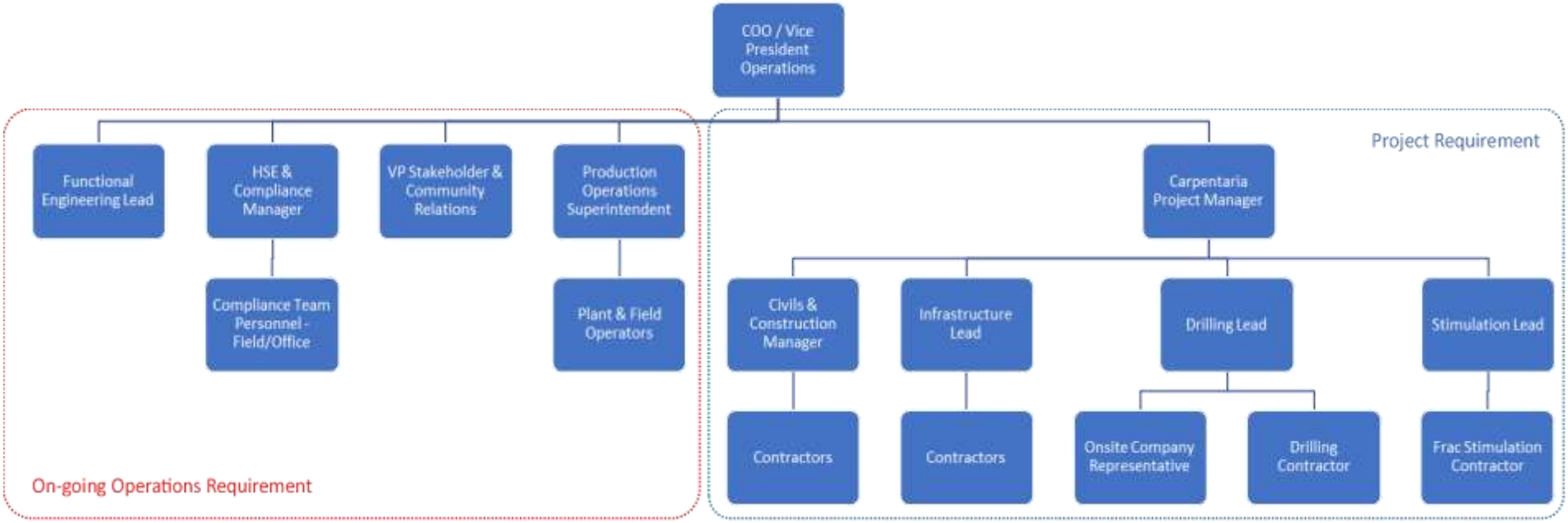


Figure 8.1—1 Management Structure

COO/Vice President Operations:

- Imperial Oil & Gas employee accountable for the safe, environmentally responsible, delivery of the Activity in accordance with the management systems and obligations outlined within this EMP.
- Is the primary point of contact for communications with the regulator, and in the event of an emergency.

Carpentaria Project Manager

- Imperial employee/contractor responsible for the delivery of the Activity in accordance with the management systems and obligations outlined within this EMP.
- Ensures those working on, or in connection with the Activity have appropriate (scope-specific) training and awareness of environmental risks and controls associated.
- Acts in the role of Emergency Response Team Leader in the event of an emergency.
- Responsible for the implementation of contractor management, monitoring, reporting, records management, change management, assurance, and continuous improvement systems.

Civils and Construction Manager

- Imperial employee/contractor responsible for ensuring all areas of civil construction, maintenance, and supporting operations are carried out in accordance with the EMP and HSEMS.
- Responsible for the environmentally compliant management of land clearing, earthworks, construction, and maintenance of facilities and infrastructure needed to conduct the Activity.
- Acts in the role of Incident Controller in the event of a civils-related emergency event.
- Responsible for the implementation of civils construction scope-specific training and awareness, contractor management, monitoring, reporting, records management, change management, assurance, and continuous improvement systems.
- Primary point of contact for civils contractor management and civils and construction Site Supervisors.

Infrastructure Lead

- Imperial employee/contractor responsible for engineering, planning, design, contracting, and supporting operations for access tracks, well pads, wells, Carpentaria Gas Plant, Water Handling Station, groundwater bore pads, camp, gravel pits, flowlines, pipelines are designed and maintained in accordance with the EMP and HSEMS.
- Primary point of contact for infrastructure-related design and maintenance-related works.

- Acts in the role of Incident Controller in the event of infrastructure-related emergency.
- Responsible for the implementation of infrastructure-specific training and awareness, contractor management, monitoring, reporting, records management, change management, assurance, and continuous improvement systems.

Drilling Lead

- Imperial employee/contractor responsible for the drilling, completions, workovers, and supporting operations of the Activity, including engineering, planning, design, contracting are in compliance with the EMP and HSEMS.
- Acts in the role of Incident Controller in the event of drilling, completion, or workovers-related emergency events.
- Responsible for ensuring that all drilling, completions and workovers are carried out as per the approved WOMP and that drilling, completions and cementing additives utilized are in line with those assessed in the EMP.
- Responsible for the implementation of drilling, completions, workovers training and awareness, contractor management, monitoring, reporting, records management, change management, assurance and continuous improvement systems.
- Primary point of contact for the Site Supervisor/onsite company representative (OCR).

Stimulation Lead

- Imperial employee/contractor responsible for the hydraulic fracturing and related Supporting Operations of the Activity, including engineering, planning, design, contracting are in compliance with the EMP and HSEMS.
- Acts in the role of Incident Controller in the event of a hydraulic fracturing emergency.
- Responsible for ensuring that all hydraulic fracturing-related works are carried out as per the approved WOMP and that additives utilized are in line with those assessed in the EMP.
- Responsible for the implementation of hydraulic fracturing related training and awareness, contractor management, monitoring, reporting, records management, change management, assurance and continuous improvement systems.
- Primary point of contact to stimulation contractor management and hydraulic fracture Stimulation Site Supervisor / OCR.

HSE and Compliance Manager

- Imperial employee/contractor responsible for providing guidance and leadership to site personnel on the day-to-day management of health, safety, environment, and regulatory compliance matters.

- In the event of an emergency, acts in the role of Emergency Response Team Information Coordinator.
- Ensures that third parties, or those completing monitoring under this EMP are suitably qualified where required.
- Responsible for environmental performance, routine and incident reporting, auditing and assurance, corrective actions, review, and continuous improvement.

Stakeholder, Government, and Community Relations

- Imperial employee/contractor responsible for stakeholder consultation, documentation, and follow-up on corporate commitments with relevant parties during planning and execution phases of the Activity.
- Responsible for ensuring all Imperial employees and contractors are kept abreast of stakeholder, government, and community relations requirements.
- Ensures that relevant stakeholders are advised and engaged where required prior to the execution of Activity.

Production Operations Superintendent / Site Supervisor

- Imperial employee/contractor responsible for well operations, gas plant, water handling station, flow lines and supporting operations, providing guidance and leadership to the Plant and Field Operators.
- Accountable for the safe, reliable, and environmentally responsible production from the assets, including maintenance activities necessary to maintain operational capability and regulatory compliance.
- Acts in the role of Incident Controller or Site Supervisor, in the event of well operations, gas plant, flow line, well or supporting operations emergency.
- Responsible for ensuring that all well operations, gas plant, water handling station flow lines and supporting operations are carried in compliance with operating plans, the EMP and HSEMS.
- Responsible for the implementation of well operations, gas plant, water handling station flow lines and supporting operations training and awareness, contractor management, monitoring, reporting, records management, change management, assurance and continuous improvement systems.
- Primary point of contact for the Site Supervisor / onsite company representative (OCR).

Contractors Including Operating Staff / Site Supervisor

- Specialist providers of Civil, Construction, Drilling, Completion, Workover, Hydraulic Fracturing, maintenance equipment, services and expertise.

- Third parties including among others, subject matter experts, cultural heritage representatives, and general sub-contractors, who are involved in the day-to-day delivery of the Activity.

8.1.2 Training and Awareness

Each employee or contractor working on, or in connection with the Activity described in the EMP will be made aware of their responsibilities in relation to the plan by:

- Making copies of the EMP and Appendices available to those working in connection with the Activity.
- Creating and implementing a compliance obligation register specific to each work scope that will be supplied to contractors and site supervisors.
- Creating an EMP and ERP overview/training sessions for those working in connection with the Activity.
- Providing work instructions/hold point lists that include environmental obligations for use during civils construction works.
- Conducting site-specific inductions that are scope specific covering at a minimum: go, no go zones, communication protocols and call up procedures, speed limits, incident reporting requirements, emergency response procedures, biosecurity hygiene requirements, cultural heritage, and stakeholder considerations.

Records of those that have completed the EMP, ERP and site inductions will be maintained.

For employees and contractors, training matrices will be reviewed to verify that those conducting sampling or monitoring have training or competencies suitable for the scope of work.

8.1.3 Emergency and Contingency Preparedness and Response

An Emergency Response (Contingency) Plan (ERP) is in place covering the Activity, see **Appendix 09**. The ERP provides a broad framework for managing potential emergency events to minimise the potential risk to human safety and the environment, and includes:

- Decision trees and escalation points.
- Emergency contacts.
- Emergency action guides.
- Details of emergency response personnel, equipment, and facilities.

Imperial will ensure all personnel, contractors and visitors are aware and trained in the emergency response protocol relevant to their role/position. This will be achieved via site inductions, and submitting the Emergency Response Plan to all contractors, and the site-specific Emergency Response Numbers to visitors.

8.1.4 Contractor Management

Some of the work undertaken under this EMP will be performed by Imperial personnel using standard work instructions. However, most of the proposed Activity will be undertaken by specialist contractors. Efforts are therefore focused on effective contractor management, to ensure third parties are compliant with the relevant EMP commitments and contractual requirements. Contractors will have their own specific HSEMS with associated work procedures and work instructions. The HSE bridging arrangements between the CPP EMP requirements and each Contractor, will be formalised at the time of each Contract appointment. The contract and scope of work are the key mechanisms Imperial uses to manage contractors and outline compliance requirements for the contracted activity. Contractors are also provided with:

- Key compliance and system documents.
- Relevant inspections, work procedures, work instructions and other tools required to implement the EMP.
- Monitoring and reporting requirements.
- Hold Points which require a deliverable to be completed prior to entry into a new activity phase (i.e., prior to mobilisation, operation, and demobilisation).

Assurance over contractor performance is undertaken during the Activity and in Audits discussed further below.

8.2 Monitoring

The Monitoring system for the Activity has been designed to ensure that construction and operations across the CPP Area are environmentally focused on Isolation-Containment-Integrity and Monitoring through the life cycle of the Activity, including in the atmospheric and subsurface environments. The elements of the monitoring system are implemented to ensure risk mitigation measures (controls) described in the environmental risk assessment (**Section 6.2**) are effective and that the CPP Environmental Outcome objectives (seven) and related codified Environmental Performance Standards (twenty nine) are being achieved.

Table 8.2—1 CPP Environmental Outcome, Objectives, and Performance Standards

Outcome Objectives	EPS #	Environmental Performance Standard
No unnecessary greenhouse gas emissions	**EPS-AQ1**	Flaring or venting of gas during appraisal phase occurs only when wells are being flowed to clean up or due to CGP process upset.

Outcome Objectives	EPS #	Environmental Performance Standard
generated from the Activity.	**EPS-AQ2**	No uncontrolled leaks (fugitive emissions) from the CGP and pipeline connection to the McArthur River Gas Pipeline.
	EPS-AQ3	No uncontrolled leaks (fugitive emissions) from the well heads.
	EPS-AQ4	No uncontrolled leaks (fugitive emissions) from gas gathering flowlines
	EPS-AQ5	Vehicle emissions do not exceed manufacturers' specifications.
No significant negative impact on community.	**EPS-CE1**	Site access and speed limits are reiterated to visitors and workers.
	EPS-CE2	No unmanaged biosecurity risk from declared and priority weeds within cleared footprint.
	EPS-CE3	No bushfires from conduct of the Activity in the CPP Area.
	EPS-CE4	No impacts to human health from use of hydraulic fracturing chemicals or hydraulic fracturing sand.
	EPS-CE5	No significant negative impact on community from light, noise, and traffic.
	EPS-CE13	No significant negative impact on resource availability to local community.
	EPS-CE14	No significant deterioration in local community cohesion.
No significant impact on indigenous and non-indigenous artefacts, sacred or heritage sites.	**EPS-CH1**	No unauthorised disturbance to Aboriginal or Macassan archaeological places or objects, sacred sites, cultural heritage sites or non-indigenous cultural heritage sites by the Activity.
No significant long-term impact on soil stability, quality, or surface water.	**EPS-SS1**	No uncontrolled or unremedied sediment releases from constructed infrastructure during operations.
	EPS-SS2	No over-topping of above-ground tanks.

Outcome Objectives	EPS #	Environmental Performance Standard
	EPS-SS3	No leaks, or loss of containment, of flowback water from above-ground tanks that cause serious environmental harm to the sub-soil.
	EPS-SS4	No leaks from the flowback flowlines that cause serious environmental harm to the sub-soil.
	EPS-SS5	No over-topping of drilling by-products from sump/s.
	EPS-SS6	No leaks of drilling by-products that cause serious environmental harm to sub-soils from use sump/s.
	EPS-SS7	No fluid additive, chemical, or fuel spills escape storage and handling areas during operations.
	EPS-SS8	Spills do not result in serious environmental harm.
	EPS-SS9	No runoff of grey water and treated sewage effluent out of designated irrigation area.
	EPS-SS10	Progressive rehabilitation of significantly disturbed areas commenced within 12 months of no longer being required for the Activity.
No significant impact on groundwater quality or quantity.	**EPS-GE1**	No significant environmental harm to groundwater from the loss of circulation while drilling or hydraulic fracturing.
	EPS-GE2	No significant environmental harm to groundwater from the loss of well control while drilling.
	EPS-GE3	Groundwater extraction limited to licenced volume.
No significant impact on threatened flora and fauna.	**EPS-TE1**	New disturbance assessed by an ecologist and sensitive areas avoided where practicable.
	EPS-TE2	No unmanaged biosecurity risk from declared and priority weeds within cleared footprint.
	EPS-TE3	No bushfires from the conduct of the Activity in the CPP Area.

Outcome Objectives	EPS #	Environmental Performance Standard
Rehabilitation of the land meets ecological values	**EPS-TE4**	Areas used for the Activity are rehabilitated consistent with surrounding land uses and ecological values as compared to analogue sites.
	EPS-TE5	No priority or declared weeds in areas being rehabilitated.
	EPS-TE6	No ongoing erosion from cleared areas used during the Activity.
	EPS-TE7	Rehabilitated areas are safe for continued land use.

The regulations require that the environmental monitoring is undertaken in a manner that is accurate and can be audited against the environmental performance standards and measurement criteria specified in the plan, and the intervals at which each type of monitoring will be carried out. The aspect-specific Management Plans in **Section 7** and the Appendices, detail the monitoring requirements, and instrument calibration where relevant, to ensure the CPP Environmental Outcome objectives and associated Environmental Performance Standards are being achieved. These Monitoring and Commitment requirements for the Activity are tabulated and summarised in **Table 8.2—2**. Where relevant, the corresponding Environmental Performance Standard(s) are listed for each element of the of the CPP monitoring system. This will assist in the establishment of a register for tracking environmental performance and conformance in the implementation of the Activity and assist in future audits of the Activity.

All sampling and analyses carried out to meet the requirements of the EMP and *the Code* will be conducted by suitably qualified persons (SQP). Instruments and measuring and metering devices will be maintained and calibrated in accordance with the manufacturer's specifications in readiness for use.

Table 8.2—2 Summary of the Monitoring and Commitments Outlined in this EMP and its Appendices

Monitoring Requirements	Frequency	Monitoring #	EPS #
General Requirements		**7**	
Monitoring local weather, climate information (BoM), and bushfire.	Daily, presented at daily safety toolbox meetings.	1	EPS-CE3 EPS-SS1 EPS-SS2 EPS-SS5 EPS-TE6
Monitoring of the 7-day weather forecast to determine the works program around the forecasts.	Daily, presented at daily safety toolbox meetings.	2	EPS-CE3 EPS-SS1 EPS-SS2 EPS-SS5 EPS-TE6
All new staff and visitors to complete site induction.	As required.	3	EPS-CE1 EPS-CE2 EPS-CE3 EPS-CE4 EPS-CH1 EPS-SS8
Job Hazard Analysis.	Introduction of any new approved tasks.	4	EPS-CE4
Non-conformances will be reported as soon as possible, but within 24 hours at a minimum.	Duration of works.	5	EPS-AQ2 EPS-AQ3 EPS-AQ4 EPS-SS8 EPS-CE1 EPS-CE2 EPS-CE3 EPS-CE4 EPS-CH1
Collect spatial data of all works areas, separately recording areas that required vegetation clearing/disturbance.	As required.	6	EPS-CH1 EPS-TE4
Groundwater monitoring at well pads conducted in accordance with *the Code*.	Quarterly	7	EPS-GE1-GE3
EMP – Description of Activity		**15**	
Before any flowline construction work is carried out in watercourses, Imperial will check the 7-day forecast to ensure an adequate window for the trenching, installation, backfill, and stabilisation works to be carried out. Clause A.3.4(f) of *the Code* mandates that directional drilling under a watercourse must be preferred over trenching for all buried infrastructure unless geomorphic and hydrological investigations confirm that trenching will not adversely affect water flow patterns and waterhole water retention timing. Imperial will use a decision tree (**Section 3.4.8.1**) for determination when crossing a watercourse. Pre- and post-trenching drone imagery and GPS photo monitoring to ensure backfilling restores trenched area to pre-construction condition.	Before and after trenching GPS photo points and drone acquisition of High-Resolution Ortho Photography with corresponding high precision DSM of the trench location must be taken. Before trenching the 7-day weather forecast must be checked to ensure an adequate window for the trenching, installation, backfill, and stabilisation works to be carried out. In addition to the rehabilitation work conducted as per the Rehabilitation Management Plan. The trenched location will be visited as soon as practical after the first run-off producing rainfall event and after the first Wet Season to ensure stable condition.	8	EPS-SS1

Monitoring Requirements	Frequency	Monitoring #	EPS #
Areas disturbed by the installation will be reinstated as soon as practicable, including pulling stockpiled timber back over the ROW. Appropriate measures from the ESCP will be implemented. Fences that have been removed be re-erected.	As required.	9	EPS-TE4
The precautions applied to aquifer protection for the petroleum wells include the following: • Aquifer isolation considered during the well design and program planning processes. • Demarcated stratigraphic definition to the base of the deepest recognised aquifer unit confirmed at each well pad during the installation of a groundwater control monitoring/production. • Bore prior to drilling the first petroleum well on that well pad. • Top of Cement (ToC) brought to surface for all casing annuli, where practicable. • All aquifer units not in communication isolated from each other at the wellbore. • Permeable hydrocarbon-bearing zones isolated from aquifers by two verified well barriers.	Drilling of petroleum well.	10	EPS-GE1-GE3
A completed and/or revised Well Barrier Integrity Validation Report (WBIV) submitted to the Mining and Energy Division of DITT for approval.	Drilling of petroleum well.	11	EPS-AQ3 EPS-GE2
Groundwater monitoring at each existing well pad has been conducted in accordance with relevant regulations.	Quarterly at each well pad.	12	EPS-GE1-GE3
The flowline networks will be subject to testing to validate mechanical strength and to detect leaks before commissioning. Safety precautions will be implemented during testing.	Prior to commissioning.	13	EPS-SS4
A survey will be carried out to locate the flowlines and related infrastructure relative to permanent marks and benchmarks that conform to the Mapping Grid of Australia (MGA 94).	During flowline construction.	14	EPS-SS4
All buried flowlines will have a detectable tracer wire installed.	Flowline construction.	15	EPS-SS4
Commissioning will ensure that the PE pipes and all associated facilities are checked and verified to ensure that they are fit for the nominated operating envelopes.	Flowline commissioning.	11	EPS-SS4
Both flowline networks will be fitted with manifolds and valves so they can be isolated into sections. These valves will be locked to prevent unauthorised operation unless they are within a fenced facility with restricted access.	Ongoing	12	EPS-SS4
The CGP will be controlled by a Programmable Logic Controller (PLC) system. The PLC can provide outputs to alarms, control the function of process equipment, and provide logging and trending data.	Ongoing	13	EPS-AQ2
The plant control system also includes the following components: • Burner management system for the TEG unit. • Ability to provide custody transfer calculations. • An uninterruptible power supply (UPS) for the control system and emergency lighting. • SCADA system. • A system to switch over to an emergency generator.	Ongoing	14	EPS-AQ2

Monitoring Requirements	Frequency	Monitoring #	EPS #
All water bores will be drilled, commissioned, and tested according to the issued Bore Work Permit conditions by appropriately licensed drillers.	As required.	15	EPS-GE3
Imperial is registered and reports all relevant emissions under the National Greenhouse and Energy Reporting Scheme (NGERS).	Annually	16	EPS-AQ1
Appraisal monitoring including reservoir pressures, gas flows and durations.	Ongoing during appraisal testing of each well.	17	EPS-AQ3
Environmental Assessment - Appendix 01		**4**	
Undertake pre-clearance surveys prior to clearing works to identify significant habitat trees that should be avoided.	Prior to new site clearing.	18	EPS-TE1
Undertake post-works weed and rehabilitation surveys.	Annually	19	EPS-TE2
Maintain buffer distances measured from the outer edge of riparian vegetation as outlined in the *Land Clearing Guidelines [DEPWS, 2021c]*.	Prior to new site clearing.	20	EPS-TE1
Gouldian Finch - The CPP Area layout is designed to minimise impacts to potential habitat (snappy gum woodland) in the landscape.	Prior to new site clearing.	21	EPS-TE1
Cultural and Heritage Assessment – Appendix 02		**3**	
New site disturbance – Cultural Monitors on site.	New ground disturbance works.	22	EPS-CH1
Chance finds during new disturbances – implement procedure.	Ongoing	23	EPS-CH1
Identified archaeological site to be avoided.	Ongoing	24	EPS-CH1
Rehabilitation Management Plan – Appendix 03		**5**	
Survey vegetation ground cover and canopy height at analogue sites for cleared areas.	No more than 12 months prior to construction.	25	EPS-TE4 EPS-TE7
Stabilisation and maintenance - Inspect / monitor cleared areas and/or areas being progressively rehabilitated.	Ongoing	26	EPS-TE7
Inspect areas being progressively rehabilitated annually at the end of the defined Wet Season.	Ongoing annual/post local Wet Season inspections until Success Criteria are met.	27	EPS-SS10 EPS-TE4
Assessments of fire frequency and intensity.	Annually following end of the Dry Season.	28	EPS-TE3
Annual Rehabilitation Inspections by a suitably qualified person (SQP).	Starting twelve months after rehabilitation commences until Minister satisfied with rehabilitation outcomes.	29	EPS-TE7
Weed Management Plan – Appendix 04		**6**	
Requirement that all equipment/machinery arrives on site clean of plant and soil matter. All vehicles to undertake and complete Weed Hygiene self-declaration prior to arriving onsite. Records will be retained.	Ongoing	30	EPS-TE2 EPS-TE5
Develop weed identification material to be made available to staff and contractors while working on the lot. Problem weeds can be defined during pre-work toolboxes.	Ongoing	31	EPS-TE2 EPS-CE2

Monitoring Requirements	Frequency	Monitoring #	EPS #
Compulsory site inductions will present information to staff and contractors working on site on problem weed species and protocols to minimise risk of introduction including wash down locations and procedures, certification of plant and machinery before entering site, weed hygiene measures, non-compliance, and reporting procedures.	Ongoing	32	EPS-TE2 EPS-CE2
Use existing and designated tracks where possible. Restrict access to areas outside of the cleared footprint to limit the disturbance area to within the approved footprint.	Ongoing	33	EPS-TE2
Conduct post-Wet Season weed surveys to determine whether any weed introductions have occurred and to monitor existing weed populations. Take the appropriate and government authority preferred corrective actions where necessary.	Annually	34	EPS-TE2
Monitoring data of weed populations and also weed free areas based on preconstruction data.	Annually	35	EPS-TE2
Erosion and Sediment Control Plan – Appendix 05		**10**	
Project Manager - Overall responsibility for environmental compliance (including ESC implementation).	Ongoing	36	EPS-TE6
Construction Superintendent - Notify the Environmental Manager immediately of any non-compliance with ESCP.	During civils work.	37	EPS-SS1
Site Supervisor/Foremen will ensure: • ESC measures are installed prior to commencing any disturbance operations. • Conduct site inspections as required to ensure ESC measures are operational and in good order. • Monitor daily rainfall. • Notify Environmental Advisor when runoff generating rainfall occurs in the previous 24 hours during clearing. • Treat, test and dispose of captured runoff as per operation procedures.	During civils work.	38	EPS-SS1
Environmental Manager/Advisor will: • Conduct site inspections and audits as required. • Prepare audit reports based on inspections. • Provide advice, as required regarding ESC site improvement. • Conduct in-situ monitoring as required. • Collect and submit samples to laboratory as required. • Collate results and prepare reports as required. • Maintain current records of rainfall, water quality, treatment, practices, discharge operations.	During civils work.	39	EPS-TE6
When a site inspection detects a notable failure in the adopted ESC measures, the source of this failure must be reported, investigated and appropriate amendments made to the site and the ESCP.	Ongoing	40	EPS-TE6
Report any damage to ESC devices and any potential or actual environmental harm in line with Duty to Notify under the requirements of the *Waste Management and Pollution Control Act*.	Ongoing	41	EPS-TE6
Daily site inspections (during rainfall) during construction activity: • All drainage, erosion, and sediment control measures.	During civils work.	42	EPS-TE6

Monitoring Requirements	Frequency	Monitoring #	EPS #
• Occurrences of excessive sediment deposition (whether on-site or off-site). • All site discharge points (including dewatering activities as appropriate).			
Monthly site inspections (even if work is not occurring on-site) • All drainage, erosion, and sediment control measures. • Occurrences of excessive sediment deposition (whether on-site or off-site). • Occurrences of construction materials, litter or sediment placed, deposited, washed, or blown. from the site, including deposition by vehicular movements.	Monthly	43	EPS-TE6
Following rainfall event during construction of 20 mm (or based on local rainfall/runoff assessment) – NOTE: May be impacted by access constraints following rainfall. • All drainage, erosion, and sediment control measures. • Occurrences of excessive sediment deposition (whether on-site or off-site). • Occurrences of construction materials, litter or sediment placed, deposited, washed, or blown from the site, including deposition by vehicular movement.	As required.	44	EPS-TE6
Waste and Wastewater Management Plan - Appendix 06		**16**	
Wastewater sumps will be equipped with a remote telemetry system. This will be either a water level sensor and/or a camera. If only a camera is setup, the sump must have water level markers that provide accurate water level estimates.	Ongoing	46	EPS-SS2
Sampling and analysis of the drilling waste assessed using analyte testing standards for drill cuttings and drilling mud. Total and leachability concentration testing, in accordance with Table 9 of *the Code*, performed to assess and classify the waste.	As required.	47	EPS-SS10
Remote telemetry systems will be installed to allow for remote monitoring and response to alarm activation on HF flowback tanks. These will include a water level sensor, a leak detection sensor and possibly a camera.	Ongoing	48	EPS-SS3
During the flowback period, fluid will be monitored in accordance with section C.5.4 (b) ii of *the Code* by field testing for EC.	During flowback, field test once every 24 hours during flowback activities until results stabilize.	49	EPS-SS8
Cumulative flowback fluid volume for each well.	At one month, 3 months, 6 months, and 12 months after flowback has commenced.	50	EPS-SS4
A sample from all produced water and flowback fluid storages must be taken and tested for the analytes listed in Section C.8. by SQP and NATA Laboratory.	Once every 6 months	51	EPS-SS3 EPS-SS4
Wastewater sump at well pads available freeboard visual inspection and/or remote telemetry.	Daily during drilling otherwise weekly while operational.	52	EPS-SS5 EPS-SS6
HF flowback water storage - water handling station and/or well pad - stored volume and available freeboard visual inspection and/or remote telemetry.	Weekly in Dry Season and daily in Wet Season while operational.	53	EPS-SS2 EPS-SS3
HF flowback water storage - water handling station and/or well pad – leak detection - remote telemetry with alarm and and/or visual inspection for permanently staffed sites.	Continuous, while operational.	54	EPS-SS2 EPS-SS3

Monitoring Requirements	Frequency	Monitoring #	EPS #
LPD Water - LPD IBC (multiple locations) – EC, pH, and volume.	Conditionally sampled monthly for 12 months.	55	EPS-SS8
Water accumulated on tank lids – EC, pH.	As required before release to erosion and sediment control.	56	EPS-SS1
Waste and wastewater disposal will be managed only by licensed contractors. The requirements for waste tracking include: • A controlled waste consignment authorisation (CA) must be completed for all controlled waste transported into, within or out of the Northern Territory (NT). • For controlled waste leaving the NT to another State or Territory, a CA must also be obtained from the destination jurisdiction. • For every movement of a controlled waste, within, into or out of the NT, a Waste Transfer Certificate (WTC) must be completed.	As required.	57	EPS-SS8
To meet compliance outcomes, flow meters, tank level indicators and weigh scales on waste transport vehicles will be installed or required by transport contractors to provide an accurate annual water balance report for regulatory review.	As required and annual reporting.	58	EPS-SS8
Signage will be installed at the entryway to each well pad and the WHS and will include contact information for the site supervisor.	Ongoing	59	EPS-CE1 EPS-CE2
Full access to the site will be restricted to those inducted, where hazards and risks will be identified, and controls established. All other persons will require an inducted host as escort to ensure exposure to waste and wastewater hazards are minimised.	Ongoing	60	EPS-CE1
The CPP Area will be routinely monitored during operations to ensure signage is legible, controls are maintained, remain effective, and are repaired as required.	Ongoing	61	EPS-CE1
Spill Management Plan – Appendix 07		**14**	
All personnel onsite must report all spills as soon as possible to their supervisor. Site induction must include this requirement.	Ongoing	62	EPS-SS8
Spill Incident - Site Supervisor will conduct an initial assessment of the nature of the spill to identify the potential hazards, and to determine if an emergency response is required: • Priority Level Spill Action Assessment undertaken in accordance with SMP. • Type, location and extent/volume of spill and weather conditions. • The material's hazardous characteristics and the associated control measures, including any potential risks associated with chemical mixing, such as oxidising and reducing agents, as outlined in the Safety Data Sheet. • Determine relevant personnel and parties to notify.	As required.	63	EPS-CE1 EPS-SS8
During the Wet Season, chemicals or wastewater are not to be transported on unsealed roads if significant rainfall (> 300 mm over 4 days) is forecast.	As required.	64	EPS-CE1 EPS-SS8
On-site unsealed tracks on the planned route have been visually inspected and are in good condition.	As required.	65	EPS-CE1 EPS-SS8

Monitoring Requirements	Frequency	Monitoring #	EPS #
Emergency response measures (e.g. spill kit, communication tools) are available and functional.	Ongoing	66	EPS-CE1 EPS-GE2 EPS-SS8
Chemicals and wastewater will not be transported via road across flowing creeks or watercourses on the route.	As required.	67	EPS-CE1 EPS-SS8
Wet Season transport of chemicals or wastewater will not be authorised until Site Supervisor has undertaken the checklist of the above key controls.	As required.	68	EPS-CE1 EPS-SS8
If a chemical or wastewater transport vehicle becomes bogged, the response scenario is outlined in ERP.	As required.	69	EPS-SS8
Secondary containment monitored weekly during the Dry Season and daily during the Wet Season in accordance with A.3.8.(i) of *the Code*.	Ongoing as required.	70	EPS-SS7
If secondary containment is compromised, it must be repaired as soon as practicable.	Ongoing as required.	71	EPS-SS7
Monitoring of secondary containment may be done remotely via camera.	Ongoing as required.	72	EPS-SS8
Above ground tanks will be double-lined and have leak detection sensors placed between liners that can be monitored remotely.	Ongoing as required.	73	EPS-SS3
Level sensors will be installed in the above-ground tanks and wastewater sumps to measure freeboard and will be calibrated to ensure accuracy.	Ongoing as required.	74	EPS-SS2
Off-site disposal must be undertaken following the *Waste Management and Pollution Control Act, 1998 (NT)*. • All listed waste transportation shall be undertaken by licenced contractors and be tracked and disposed of at approved waste management facilities. • Waste containers should be labelled in accordance with *Globally Harmonized System of Classification and Labelling of Chemicals (GHS)* based on type of hazard spill material [UNITED NATIONS, 2023]. • Materials that escape from primary containment or are otherwise spilled onto secondary containment will be removed as soon as possible and returned to containment if able to be reused or disposed in accordance with this subsection. • Quantities of contaminated material too large for sealed containers must be dealt with by engaging licensed contractors as soon as practicable**.**	Ongoing as required.	75	EPS-TE7
Emergency Response Plan – Appendix 09		**11**	
EP 187 is outside of the NTFRS emergency response area. Therefore, self-funded emergency response measures, including provision of an ambulance and paramedic, are to be assessed based on risk (including response to road crash, etc.).	Ongoing as required.	76	EPS-CE1 EPS-CE4 EPS-SS3 EPS-SS8 EPS-TE3
All personnel and contractors have the duty to report incidents that might require the activation of this ERP. The activation process involves reporting the incident to the Site Supervisor who will review the situation and initiate	Ongoing as required.	77	EPS-CE1 EPS-CE4 EPS-SS3

Monitoring Requirements	Frequency	Monitoring #	EPS #
communication with the Project Manager accountable for the Activity. The accountable Project Manager either assumes the role of the Emergency Response Team Leader or may delegate responsibility to a better qualified team member.			EPS-SS8 EPS-GE2 EPS-TE3
Activation triggers may include, but are not limited to the following: • Injury/loss of life. • Impact on the biological, physical environment or ecosystem functions. • Damage or threat to property/assets. • Impact on community, cultural heritage sites, or both. • Regulatory breach. • Loss or extended disruption to critical services and ability to continue operations.	Ongoing as required.	78	EPS-CE1 EPS-CE4 EPS-SS3 EPS-SS8 EPS-GE2 EPS-TE3
The incident will be managed by the Emergency Response Team: 1. Emergency Response Team Leader 2. Incident Controller and/or Site Supervisor 3. Emergency Response Team Information Coordinator 4. Imperial Management Team delegate	Ongoing as required.	79	EPS-CE1 EPS-CE4 EPS-SS3 EPS-SS8 EPS-GE1-2 EPS-TE3
The ERT is responsible for the overall response and local management of emergencies associated with EP 187.	Ongoing as required.	80	EPS-CE1 EPS-CE4 EPS-SS3 EPS-SS8 EPS-G2 EPS-TE3
The Emergency Response Team Leader (ERT-L) will identify and nominate individuals for the response team roles.	Ongoing as required.	81	EPS-CE1 EPS-CE4 EPS-SS3 EPS-SS8 EPS-GE2 EPS-TE3
Upon activation of the ERP, internal communication protocol will be implemented in accordance with ERP, remaining in effect until normal operations resume.	Ongoing as required.	82	EPS-CE1 EPS-CE4 EPS-SS3 EPS-SS8 EPS-GE2 EPS-TE3
Upon being made aware of an emergency, the ERT-L will: • Coordinate the collection of documentation and information to aid in emergency management. • Communicate with relevant stakeholder/s subject to the scale of the emergency. • Notify the regulator (if deemed required as per requirements outlined in **Appendix 01** of this document).	Ongoing as required.	83	EPS-CE1 EPS-CE4 EPS-SS3 EPS-SS8 EPS-GE2 EPS-TE3
A debriefing is to be conducted by the ERT-L (or external provider where appropriate) to discuss problems and necessary improvements for incorporation into the emergency preparedness and procedures.	Ongoing as required.	84	EPS-CE1 EPS-CE4 EPS-SS3

Monitoring Requirements	Frequency	Monitoring #	EPS #
			EPS-SS8 EPS-GE2 EPS-TE3
The Emergency Response Team will be trained against this plan. Training will be provided in the form of: • Emergency Response exercises or drills. • Toolbox talks.	Ongoing as required.	85	EPS-CE1 EPS-CE4 EPS-SS3 EPS-SS8 EPS-GE2 EPS-TE3
The ERP is to be reviewed and updated as necessary in response to one or more of the following: • Annually. • When major changes have occurred, which may affect the Emergency Response coordination or capabilities. • Following routine testing of the plan, or after an emergency. • Before installing and commissioning new plant and equipment. • A change of Emergency Contact information.	Ongoing as required.	86	EPS-CE1 EPS-CE4 EPS-SS3 EPS-SS8 EPS-GE2 EPS-TE3
Contact numbers, and the Emergency Response Number (ERN) Display sheets will change based on the activity being undertaken and should be checked and updated frequently.	Ongoing as required.	87	EPS-CE1 EPS-CE4 EPS-SS3 EPS-SS8 EPS-GE2 EPS-TE3
Traffic – Appendix 11		**4**	
Internal Activity-related communication protocol shall be established to assist drivers when accessing the Carpentaria Highway (including approaching from west of the southern access, or east of the northern access).	Ongoing as required.	88	EPS-CE1
Reduced speed limit between the northern and southern access points, considered (in conjunction with DIPL, along with appropriate warning signage (particularly 'Trucks Entering' signage).	Ongoing as required.	89	EPS-CE1
Advanced warning signage shall be considered on the Carpentaria Highway to forewarn approaching non-Activity related traffic of the potential increased presence of large commercial vehicles.	Ongoing as required.	90	EPS-CE1
On-going inspections and maintenance should be undertaken to ensure the integrity of both the sealed carriageway and unsealed shoulders is of an appropriate standard in the vicinity of the three access points.	Ongoing as required	91	EPS-CE1
Bushfire Management Plan – Appendix 12		**14**	
Fire access trails and fire breaks approximately 8 m wide will be established throughout the CPP around facilities as part of the civil construction works. These fire access trails and fire breaks will be maintained during operations as required. Access roads and tracks may also act as fire breaks.	Ongoing as required.	92	EPS-CE3 EPS-TE3

Monitoring Requirements	Frequency	Monitoring #	EPS #
Seasonal fire load assessment updates using NAFI information will be carried out at Activity sites throughout the duration of the Activity. These assessments will inform maintenance requirements to ensure that the fire breaks are effective.	Annually	93	EPS-CE3 EPS-TE3
There will be no controlled burns under this EMP. However, the land holders and Traditional Owners may conduct controlled burns in the area.	N/A	94	EPS-CE3 EPS-TE3
Annual mapping utilizing the available information from the NAFI database will be conducted for the CPP Area to monitor changes to fire frequency.	Annually	95	EPS-CE3 EPS-TE3
If a fire occurs in the CPP Area during the Activity, Imperial (in consultation with land managers) will map the extent of the fire effects within the immediate area and provide DEPWS with the information.	Ongoing as required.	96	EPS-CE3 EPS-TE3
The Site Supervisor will monitor the NAFI website and Secure NT website daily in the Dry Season and weekly in the Wet Season. The Site Supervisor will liaise with relevant land holders/pastoralists if a fire on adjacent properties threatens the CPP Area or infrastructure.	Ongoing as required.	97	EPS-CE3 EPS-TE3
Fire access trails will be monitored for grassy weeds and controlled where necessary.	Ongoing as required.	98	EPS-CE3 EPS-TE3
Fire breaks will be monitored, maintained and inspection records will demonstrate that fire breaks are routinely checked and cleared of fire-risk material for the duration of the Activity.	Ongoing as required.	99	EPS-CE3 EPS-TE3
Any reduced fuel load areas between fire breaks and the well pad and CGA area fence lines will be monitored and maintained, to ensure any regrow of large vegetation is removed.	Ongoing as required.	100	EPS-CE3 EPS-TE3
The Site Supervisor will monitor the NAFI website and Secure NT website daily in the Dry Season and weekly in the Wet Season and liase with relevant land holders/pastoralists about potential fire control measures if a fire threatens the CPP Area or infrastructure.	Ongoing as required.	101	EPS-CE3 EPS-TE3
During the operation of the Activity, the Site Supervisor will liaise with relevant land holders/pastoralists if it is considered any CPP activities may affect their fire management practices.	Ongoing as required.	102	EPS-CE3 EPS-TE3
All machinery and vehicles will be parked in areas of low fire risk where possible.	Ongoing as required.	103	EPS-CE3 EPS-TE3
Permits under Section 46 of the *Bushfires Management Act, 2016 (NT)* will be sought if flaring is required during NT declared fire danger periods.	Ongoing as required.	104	EPS-CE3 EPS-TE3
All personnel will be trained at site inductions and annually in: • Activity fire prevention and management measures. • Firefighting equipment location, and operation and communication requirements. • Use of hot work permits for any equipment that has the potential to create heat, sparks, or flames, and which could initiate a fire, such as welding, angle grinding, etc. • Restricted smoking areas and requirements.	CPP site inductions. Annually	105	EPS-CE3 EPS-TE3

Monitoring Requirements	Frequency	Monitoring #	EPS #
• The Bushfire Management Plan and Emergency Response (Contingency) Plan procedures. • Familiarity with the Bushfire Management Plan one pager.			
Methane Management Plan – Appendix 13		**8**	
Regular visits will be made to operational well sites, gathering systems and processing facilities in accordance with MEMP.	Ongoing	106	EPS-AQ2 EPS-AQ3 EPS-AQ4
PGD used on-site where signed or inductions require. Should a methane leak be identified by PGD monitoring, leak classification, remediation and notification requirements as described in the MEMP will be implemented.	Ongoing	107	EPS-AQ2 EPS-AQ3 EPS-AQ4
All persons completing emission detection activities will be properly trained and competency assured.	Ongoing	108	EPS-AQ2 EPS-AQ3 EPS-AQ4
Leak inspections will be conducted on the minimum frequencies: • Above ground facility – petroleum well pad equipment. • Low pressure pipeline and fittings. • Steel or high-pressure pipelines. • Compressor stations and pneumatic devices. • Processing plant. • All gas containing equipment following major maintenance (e.g., repacking, replacement of seals).	6 monthly Annually Quarterly Annually Within 48hrs of recommissioning.	109	EPS-AQ2 EPS-AQ3 EPS-AQ4
Leak inspections of individual operating plant will be undertaken at an increased frequency as determined by the risk assessment and in consideration of previous audit/inspection findings for those specific facilities.	Ongoing	110	EPS-AQ2 EPS-AQ3 EPS-AQ4
Where the operator uses optical gas imaging for leak detection, an annual inspection using US EPA Method 21 will also be performed on the facility.	Annually	111	EPS-AQ2 EPS-AQ3 EPS-AQ4
Comply with Section D.5.6 of *the Code* requirements for leak remediation and notifications.	As required.	112	EPS-AQ2 EPS-AQ3 EPS-AQ4
Any identified leak that reports above the threshold level for reporting significant leaks, or if the leak is too large or not safe to measure, will be recorded and reported as per Section D.5.6.2 of *the Code*.	As required.	113	EPS-AQ2 EPS-AQ3 EPS-AQ4
Stakeholder Engagement – Appendix 10		**7**	
Online consultation portal and contact mechanism to provide information to stakeholders and the community about proposed activities for the CPP and provided direct contact details as a mechanism to collate and respond to information requests and feedback.	Ongoing	114	EPS-CE13 EPS-CE14
Community drop-in sessions are to be scheduled annually to continue to build on transparent sharing of Activity information and activity updates.	Ongoing	115	EPS-CE13 EPS-CE14

Monitoring Requirements	Frequency	Monitoring #	EPS #
Consider further information to share with the community about workforce development and employment opportunities as appropriate to development activities.	Ongoing	116	EPS-CE13 EPS-CE14
Work with all contractors to encourage their engagement with the local workforce where practical.	Ongoing	117	EPS-CE13 EPS-CE14
Continue to ensure water and wastewater is discussed in further information forums and methodologies to build on stakeholder and community understanding.	Ongoing	118	-
Continue to ensure environmental monitoring is discussed in further information forums and methodologies to build on stakeholder and community understanding.	Ongoing	119	-
Ongoing consultation as appropriate to meet regulator and stakeholder expectations in relation to rehabilitation.	Ongoing	120	EPS-SS10 EPS-TE4 EPS-TE7

8.3 Environmental Performance Reporting

8.3.1 Incident Reporting

Details of all incidents identified will be recorded in an incident reporting system and spills of liquid contaminants or hazardous chemicals will be recorded in a register. Actions will be taken to rectify the incident and prevent its reoccurrence. If required, a more formal investigation will be undertaken. All personnel are required to report all incidents no matter how minor. Incident reporting and corrective actions will be used as learning opportunities and to assist continual improvement.

Part 3 of the *PER* regulates how the Imperial is to report Recordable and Reportable Incidents.

Table 8.3—1 details the external incident notification, reporting requirements and timeframes for environmental incidents associated with the Activity.

Table 8.3—1 Incident Reporting Requirements

Requirements	How and By When
Petroleum (Environment) Regulations 2016 (NT)	
Recordable Incident Reporting (Reg 35): A recordable incident is an incident arising from the Activity that has resulted in an environmental impact or environmental risk (not specified in this EMP) or has resulted in a contravention of a breach of an Environmental Objective or Environmental Performance Standard in the EMP or is inconsistent with an environmental outcome specified in the EMP that applies to the Activity and is not reportable.	
The recordable incident report must relate to each reporting period for the regulated Activity and contain the following: • A record of all recordable incidents that occurred during the reporting period. • All material facts and circumstances concerning the recordable incidents that the operator knows or is able, by reasonable search or enquiry, to find out. • Any action taken to avoid or mitigate any adverse environmental impacts of recordable incidents. • The corrective action that has been taken, or is proposed to be taken, to prevent similar recordable incidents.	Notify the Minister (via DEPWS email Onshoregas.depws@nt.gov.au) in writing no later than 15 days after the reporting period. Regulation 35(4)(b) of the *PER* requires a recordable incident report to be provided each 90 days after the day on which an EMP is approved (the reporting period), unless an agreement is made in writing between the Minister and Imperial about an alternative reporting period under Regulation 35(4)(a). Imperial agrees to the following reporting periods: • Quarter 1: 1 January to 31 March, report due 15 April. • Quarter 2: 1 April to 30 June, report due 15 July. • Quarter 3: 1 July to 30 September, report due 15 October. • Quarter 4: 1 October to 31 December, report due 15 January.
Reportable Incident Reporting (Reg 33 and 34): A reportable incident is an incident relating to the Activity that has caused or has the potential to cause material (Section 8) or serious (Section 9) environmental harm as defined under the *Environment Protection Act 2019 (NT)*.	
The initial written report will include: • The results of any assessment or investigation of the conditions or circumstances that caused or contributed to the occurrence of the reportable incident, including an evaluation of the effectiveness of the designs, equipment, procedures, and management protocols that were in place to prevent the occurrence of an incident of that nature. • The nature and extent of the material environmental harm or serious environmental harm that the incident caused or had the potential to cause. • Any actions taken, or proposed to be taken, to clean up or rehabilitate an area affected by the incident. • Any actions taken or proposed to be taken to prevent a recurrence of an incident of a similar nature.	• Notify the Minister orally or in writing as soon as practical but not later than 2 hours after the incident first occurred or, if the incident was not detected by the Incident Holder at the time it first occurred when the Interest Holder becomes aware of the reportable incident. • The notification must specify the contact details of the Interest Holder, all material facts, and circumstances about the reportable incident that the Interest Holder knows or is able to find out by reasonable search information about any action taken to avoid or mitigate material or significant environmental harm and information about the corrective action that has been taken or proposed to be taken to prevent similar reportable incidents. • DEPWS prefer reportable incidents to be notified to Onshoregas.depws@nt.gov.au. • If the Interest Holder gives notices of the reportable incident orally, the Interest Holder must give the Minister a written notice not later than 24 hours after giving oral notice which specifies the matters in Reg 33(3)(c). • An initial report will be provided to the Minster as soon as practicable but no later than three days after the incident first occurs. • During the period between giving the initial report and the final report, the interest holder must give the Minister interim reports that include further information about the matters mentioned in Sub-regulation (3)(b) and any other matters relevant to the reportable incident. • Notify the AAPA orally or in writing as soon as practical if the reportable incident impacts a sacred site.
The final reportable incident report must include a root cause analysis of the reportable incident.	The final report is to be provided to the Minister as soon as practicable but no later than 30 days after the clean-up or rehabilitation of the area affected by the reportable incident is completed.
Waste Management and Pollution Control Act 1998 (NT)	
Duty to notify of incidents causing or threatening to cause pollution. Where an incident occurs in the conduct of an activity and the incident causes or may threaten to cause pollution resulting in material environmental harm or serious environmental harm. A notification is required to specify: • The incident causing or threatening to cause pollution. • The place where the incident occurred. • The date and time of the incident.	• The Interest Holder must notify the NT EPA as soon as practicable after (and in any case within 24 hours) after first becoming aware of the incident or the time they should reasonably be expected to become aware of it. • The duty of the Interest Holder to notify the NT EPA of incidents causing or threatening to cause pollution resulting in material environmental harm or serious environmental harm only applies if that incident occurs outside of the CPP Area or if a spill or leak occurs that leaves the CPP Area or is not confined to land less than 1 km from the centre of a pipeline.

Requirements	How and By When
• How the pollution has occurred, is occurring or may occur. • The attempts made to prevent, reduce, control, rectify or clean up the pollution or resultant environmental harm caused or threatening to be caused by the incident; and the identity of the person notifying.	
Heritage Act 2011 (NT)	
When a proponent discovers a place or object that is known to be an Aboriginal or Macassan archaeological place or object, they must provide a written report to the CEO of the Heritage Council which includes: • A description of the place or object. • Its location. • The person's name and address. If known by the person – the name and address of the owner or occupier of the place or where the object is located.	• The proponent must advise the director of the Heritage Branch (**08 8999 5039**) of the discovery and its location as soon as practical after the discovery. • Also, the proponent must provide a written report to the CEO of the Northern Land Council (NLC) within seven days of the discovery.
Work Health and Safety (National Uniform Legislation) Act 2011 and Regulations 2011 (NT)	
A person who conducts a business or undertaking must ensure that the regulator is notified immediately after becoming aware that a notifiable incident arising from the conduct of the business or undertaking has occurred. A notifiable incident means: • The death of a person • A serious injury or illness of a person • A dangerous incident Requirement to notify NT WorkSafe if the volumes of chemicals held on-site exceed requirements. The person with management or control of a workspace (Interest Holder) has a duty to preserve incident sites at which a notifiable incident has occurred so far as reasonably practicable.	• The proponent must notify NT WorkSafe immediately after becoming aware that a notifiable incident has occurred. Notify by phone or in writing. • A person giving notice by telephone must give details of the incident and (if required) give written notice within 48 hours of being required to do so. • The Interest Holder will preserve any incident site so far as reasonably practicable.
Transport of Dangerous Goods by Road and Rail (National Uniform Legislation) (NT)	
If a driver of a road vehicle transporting dangerous goods and the vehicle is involved in an incident resulting in a dangerous situation, they must notify the prime contractor for the goods, the Competent Authority, and the police or fire service of the incident.	As soon as practicable after the incident occurred.

8.3.2 Routine Reporting

Imperial will create and submit reports as per the details provided in **Table 8.3—2**.

Table 8.3—2 Routine Reporting Requirements

Frequency	Report Detail	Recipient
Before the Commencement of the Activity	Notifying commencement of construction, drilling, or seismic survey.	• The Minister for Environment. • The occupier of the land in which the Activity is carried out. • The owner of the land on which the Activity is to be carried out.
Before the Commencement of the Activity	A Sewage Treatment System or series of systems, if installed, that will treat more than 2,000 L/day, a notice of intention to install the wastewater management system or series of wastewater management systems at least 7 days before the start of the installation in the prescribed form.	Chief Health Officer, Department of Health (DoH)
Within 6 Months of Flowback Occurring	Flowback fluid report as outlined in *PER* Regulation 37A.	DEPWS
Within 6 Months of Produced Water Being Extracted	Produced water report as outlined in *PER* Regulation 37B.	DEPWS
Quarterly	A quarterly recordable incident report summarising recordable incidents during operational and non-operational works (Regulation 35 of the *PER*).	DEPWS
Annually	An annual environmental performance report will be prepared and submitted to the Minister three months after the anniversary of the EMP acceptance date under Item 11 of Schedule 1 of the *PER*.	DEPWS

Frequency	Report Detail	Recipient
Annually	All greenhouse gas emissions provided Imperial's emissions exceed the reporting threshold specified by the *National Greenhouse and Energy Reporting Act, 2007 (Cth).*	Clean Energy Regulator
Annually	All greenhouse gas emissions even if they do not exceed the reporting threshold specified by the *National Greenhouse and Energy Reporting Act, 2007 (Cth*).	NT Government
Annually	Water and wastewater tracking and reporting requirements under Clause C.6.1(a) of *the Code.*	DEPWS
Annually	Clause D.6.2 of *the Code* requires an annual report that summarises the following • The records of the stages of flowback activities, Clause D.6.2(c). • The cumulative number of hours of operation for each reciprocating compressor, or the number of months since initial start-up or the previous reciprocating compressor rod packing replacement Clause D.6.2 (d). • The results of leak detection surveys (in the annual report under the *Petroleum Act, 1984 (NT)* Section 61H).	DEPWS
Annually	Post-Wet Season weed report in accordance with **Appendix 04**.	DEPWS – Weed Management Branch
At the End of the Field Campaign	In accordance with Clause D.6.2 (a) of *the Code*, baseline assessments will be submitted at the end of the field campaign.	DEWPS

Frequency	Report Detail	Recipient
After Rehabilitation	• Rehabilitation final assessment report.	The Minister for Environment

8.4 Records Management

Records associated with the EMP will be kept on file in Imperial's document management system for ease of retrieval.

For documents considered prescribed records (defined below), they will be kept for the longer of five years following the period during which the petroleum interest is in force or 15 years after the record comes into existence.

Prescribed records are defined in Regulation 36 (3) of the *PER* and include:

- The environment management plan and each revision of the plan, as approved by the Minister.
- Reports, including monitoring, audit, and review reports, about environmental performance or the implementation strategy under the plan.
- Records of emissions and discharges into the environment made in accordance with the plan.
- Records of calibration and maintenance of monitoring devices used in accordance with the plan.
- Records of, and copies of reports about, reportable incidents and recordable incidents.
- Certificates associated with the disposal of waste.
- Information or records relating to stakeholder engagement.
- All documents developed or received by Imperial in relation to matters to which these regulations apply.
- Records of any other documents that Imperial is required to keep by these regulations.

Reports mentioned in sub-regulation (3)(c) must include details of the methodology used and the results of all monitoring and sampling activities, including raw data.

8.5 Revision of the EMP

Revision of the EMP is required if new or increased risks are identified and/or prior to the 5-year anniversary of the EMP approval date as per the below regulations:

8.5.1 Regulation 17

Regulation 17 of the *PER* requires Imperial to submit to the Minister, for approval, a proposed revision of the current plan no later than 30 days after the following has occurred:

(a) A new environmental impact or risk not provided for in the current plan for the Activity.

(b) An increase, not provided for in the current plan for the Activity, in an existing environmental impact or risk.

8.5.2 Regulation 18

Regulation 18 of the *PER* requires Imperial to submit to the Minister, for approval, a proposed revision of the current plan at least 90 days before the end of each period of five years starting on the day defined in Regulation 18 (1).

8.6 Change Management - Modification to Regulated Activity

Regulation 22 of the *PER* provides that if Imperial proposes to modify the Regulated Activity to which this EMP relates in a manner that will not require a revision of the EMP before Imperial modifies the Regulated Activity, the Minister will be given a notice that specifies details of the proposed modification.

8.7 Auditing and Assurance

In addition to regular monitoring as set out in this document, audits assessing compliance with this EMP, and associated work instructions will be undertaken by Imperial during the execution of the activity as per the audit schedule (**Table 8.7—1**).

System deficiencies/non-compliances arising from audits and assurance will have corrective actions agreed upon and assigned to the relevant personnel and may be logged as non-conformance. The status of corrective actions will be tracked through to closure and reported in the annual environmental report.

Table 8.7—1 EMP Audit Schedule

Audit/Assurance Type	Scope of Audit/Assurance Type	Frequency	Responsibility
Operational Integrity	Operational compliance checks to ensure risk management controls are implemented.	Quarterly	HSE and Compliance Manager
Annual Assurance	Compliance against CCP EMP commitments and risk management controls.	Annually	HSE and Compliance Manager

8.7.1 Corrective Actions

Imperial's incident management procedures and systems are part of the HSE management systems and are designed to:

- Ensure all incidents and hazards are reported in a standard format so that the consistency and accuracy of the process is maintained.
- Identify the underlying and basic causes of all incidents and hazards.
- Implement corrective/improvement actions to prevent the recurrence of similar incidents and hazards.
- Provide information to prepare the incidents and hazard statistics and identify potential trends.
- Identify potential suitable corrective actions.
- All corrective/improvement associated with incident, hazards, audits, and assurance activities are recorded, tracked by the system. Any overdue actions are followed up and escalated as required.

8.7.2 Review and Continuous Improvement

Implementation of this EMP will be assessed and potentially revised as required based on monitoring and assurance results, feedback, change to the proposed work program or a material increase in risk level.

References

Victorian Environment Protection Agency. (2021). 1828.2: Waste Disposal Categories - Characteristics and Thresholds. (Report No. epa.vic.gov.au

A. Anderson, P. Ashworth, V. Beck, B. Hart, D. Jones, B. Pristely, D. Ritchie, & R. Smith. (2018). *Scientific Inquiry into Hydraulic Fracturing in the Northern Territory*. **https://frackinginquiry.nt.gov.au/inquiry-reports?a=494286**, **https://frackinginquiry.nt.gov.au/inquiry-reports?a=494327**

Commonwealth of Australia. (2018). National Waste Policy: less waste is more. (Report No.: Commonwealth of Australia. **https://www.environment.gov.au/system/files/resources/d523f4e9-d958-466b-9fd1-3b7d6283f006/files/national-waste-policy-2018.pdf**

J. M Bowler, G. A. T Duller, N Perret, J. R Prescott, & K-H Wyrwoll. (1998). *Hydrologic changes in monsoonal climates of the last glacial cycle: stratigraphy and lumenescence dating of Lake Woods, N.T., Australia*. *Palaeoclimates*, *3*(1-3), 179-207.

C. J. A Bradshaw. (2012). *Little left to lose: deforestation and forest degradation in Australia since European colonization*. *Journal of Plant Ecology*, *5*(1), 109-120. **https://doi.org/10.1093/jpe/rtr038**

R Browell, & J Potgierter. (2022). Environmental Health Interim Baseline Report: Air Quality Strategic Regional Environmental and Baseline Assessment for the Beetaloo Sub-basin. (Report No. Parks and Water Security. Flora and Fauna Division Northern Territory. Department of Environment: Northern teritory Government. **https://hdl.handle.net/10070/898283**

GM Byram. (1959). *Combustion of forest fuels*. *Forest fire: control and use*, 61-89.

S Capon, C James, & M Reid. (2016). *Vegetation of Australian Riverine Landscapes*. **https://doi.org/10.1071/9780643104525**

Samantha Capon, Cassandra James, & Michael Reid. (2016). *Vegetation of Australian riverine landscapes: biology, ecology and management*. CSIRO PUBLISHING.

C. S Christian, L. C Noakes, R. A Perry, R. O Slatyer, A Stewart, & D. M Traves. (1954). *Survey of the Barkly Region, Northern Territory and Queensland, 1947-48*.

C.S Christian, S.T Blake, L.N Noakes, & G.A Stewart. (1954). *No. 3 Survey of the Barkly Region, Northern Territory and Queensland 1947-48*. *CSIRO Land Research Surveys*, *1*(198).

C.S Christian, & Stewart. (1953). *General Report On Survey of the Katherne-Darwin Region*

R. A Clement, H Flores-Moreno, L. A Cernusak, & A. W Cheesman. (2021). *Assessing the Australian Termite Discovery Anomaly: How Habitat and Rainfall Affect Termite Assemblages*. **https://doi.org/10.3389/fevo.2021.657444**

Threatened Species Scientific Committee. (2016). *Conservation Advice Erythrura gouldiae Gouldian finch*. **https://www.environment.gov.au/biodiversity/threatened/species/pubs/413-conservation-advice-07122016.pdf**

Barkly Regional Council. *The Region. Demographics*. Retrieved July 2024 from **https://www.barkly.nt.gov.au/region/demographics**

CSIRO. (2024). Bushfire Best Practice Guide. (Report No. **https://research.csiro.au/bushfire/bushfire-basics/how-**

bushfires-behave/vegetation/,

J Davis, G Gillespie, N Cuff, E Garcia, A Andersen, L Young, I Leiper, R Ribot, M Kennard, & A Pintor. (2021). *Beetaloo GBA region baseline survey program. Research Institute for Environment & Livelihoods, Charles Darwin University, Darwin, Australia*.

DCCEEW. (2000). Revision of the Interim Biogeographic Regionalisation of Australia (IBRA) and the Development of Version 5.1 - Summary Report. (Report No. Energy Department of Climate Change, the Environment and Water: Australian Government. **https://www.dcceew.gov.au/sites/default/files/documents/revision-ibra-development-5-1-summary-report.pdf**

DCCEEW. (2008). *Gulf Fall and Uplands bioregion*. Australian Government. **https://www.dcceew.gov.au/sites/default/files/env/resources/a8015c25-4aa2-4833-ad9c-e98d09e2ab52/files/bioregion-gulf-fall-and-uplands.pdf#:~:text=The%20landscape%20of%20the%20Gulf%20Fall%20and%20Uplands,land%20uses%20include%20Aboriginal%20land%20and%20conservation%20reserves**.

DCCEEW. (2023). Conservation Advice for Tiliqua scincoides intermedia (northern blue-tongue skink). (Report No. Energy Department of Climate Change, the Environment and Water: Australian Government. **https://www.environment.gov.au/biodiversity/threatened/species/pubs/89838-conservation-advice-21122023.pdf**

B. De Vincentiis, S. Guthridge, J-Y. Su, & K. Johnston. (2021). *Story of Our Children and Young People, Barkly 2021*. **https://cmc.nt.gov.au/__data/assets/pdf_file/0005/1084811/Barkly-Story-2021.pdf**

Barkly Regional Deal. (2019). *Barkly Regional Deal*. Retrieved July 2024 from **https://barklyregionaldeal.com.au/about/**

DEPWS. (2018). Preliminary Guideline: Groundwater Monitoring Bores for Exploration Petroleum Wells in the Beetaloo Sub-basin. (Report No. Department of Environment and Natural Resources: Department of Environment and Natural Resources. **https://denr.nt.gov.au/__data/assets/pdf_file/0009/618957/Preliminary-Guideline-Petroleum-Well-Water-Quality-Monitoring.pdf**

DEPWS. (2020). Rehabilitation Plan Guide for Surface Disturbance: Onshore Petroleum Disturbance. (Report No. Water and the Environment Department of Agriculture **https://depws.nt.gov.au/__data/assets/pdf_file/0004/936823/Rehabilitation-Plan-Guide-v0.4.pdf**

DEPWS. (2021a). Katherine Regional Weeds Strategy 2021-2026. (Report No.: Department of Evnironments, Parks, and Water Security. **https://depws.nt.gov.au/__data/assets/pdf_file/0006/269286/Katherine-Regional-Weeds-Strategy-2021-2026.pdf**

DEPWS. (2021b). Land Clearing Guidelines - Northern Territory Planning Scheme. (Report No. LRM2021/0077~0002). Parks and Water Security Department of Environment **https://nt.gov.au/__data/assets/pdf_file/0007/236815/land-clearing-guidelines.pdf**

DEPWS. (2021c). Northern Territory Weed Management Handbook. (Report No. Parks and Water Security Department of Environment

https://nt.gov.au/__data/assets/pdf_file/0004/233833/nt-weed-management-handbook.pdf

DEPWS. (2022). Regional Report: Strategic Regional Environmental and Baseline Assessment for the Beetaloo Sub-basin. (Report No. Parks and Water Security. Flora and Fauna Division Northern Territory. Department of Environment **https://hdl.handle.net/10070/900467**

DEPWS. (2023). Georgina Wiso Water Allocation Plan 2023-2031. (Report No. 12/2023). Parks and Water Security Department of Environment: Northern Territory, Australia. **https://nt.gov.au/environment/water/management-security/water-control-districts/daly-roper-beetaloo/planning-for-the-georgina-basin**

DEWHA. (2013). *Matters of national environmental significance: significant impact guidelines 1.1 environment protection and biodiversity conservation act 1999*. *Canberra: Department of Environment*.

DIPL. (2023). *Carpentaria Highway major upgrade*. **https://dipl.nt.gov.au/projects/carpentaria-highway**

DPIR. (2021). *Ribbon Grass (Chrysopogon Fallax) in the Western Australian Rangelands*.

S Emery, G Cocks, & R Keeley. (2007). *Selection and Use of Locally Available Pavement Materials for Low-Volume Roads in Western Australia*. *Transportation Research Record: Journal of the Transportation Research Board*, *1989-2*(1), 194-200. **https://doi.org/10.3141/1989-64**

NT EPA. (2013). Guidelines on Conceptual Site Models. (Report No. Northern Territory Environment Protection Authority: Northern Territory Government. **https://ntepa.nt.gov.au/__data/assets/pdf_file/0007/904327/draft_guidelines_conceptual_site_models.pdf**

NT EPA. (2018). Northern Territory Noise Management Framework Guideline. (Report No. Northern Territory Environmental Protection Agency **https://ntepa.nt.gov.au/__data/assets/pdf_file/0004/566356/noise_management_framework_guideline.pdf**

NT EPA. (2022). NT EPA Environmental Factors and Objectives. (Report No. Parks and Water Security Department of Environment **https://ntepa.nt.gov.au/__data/assets/pdf_file/0020/804602/guide-ntepa-environmental-factors-objectives.pdf**

M Hill, & N Hanan. (2010). *Ecosystem function in savannas: Measurement and modeling at landscape to global scales*. CRC Press.

C. R. Huddlestone-Holmes, E. Frery, P. Wilkes, A. H. E. Bailey, G. Bernadel, C. Brandon, S. Buchanan, S. B. Cook, R. S. Crosbie, T. Evans, L. Golding, Dda. Gonzalez, M. E. Gunning, L. S. Hall, B. Henderson, A. Herr, K. Holland, A. Jarrett, J. Kear, J. Kirby, M. Lech, S. Lewis, C. Macfarlane, J. Martinez, S. Northover, J. Murray, A. O'Grady, M. L. Orr, R. Owens, C. Pavey, D. Post, B. Sundaram, P. Rachakonda, M. Raiber, T. Ransley, S. Tetreault-Campbell, & L. Wang. (2020). *Geological and Environmental Baseline Assessment for the Beetaloo GBA Region. Geological and Bioregional Assessment: Stage 2 Baseline Assessment*. **https://www.bioregionalassessments.gov.au/assessments/geological-and-bioregional-assessment-program/beetaloo-sub-basin/beetaloo-gba-region-stage-two-report**

IAP2. (2015). *Quality Assurance Standards*. Accessed: January 2024 **https://iap2.org.au/resources/quality-assurance-standard/**

IECA. (2008). *Best Practice Erosion and Sediment Control.* . International Erosion Control Association (Australasia). **https://www.austieca.com.au/documents/item/1021**, **https://www.austieca.com.au/documents/item/1022**, **https://www.austieca.com.au/documents/item/1023**

Imperial. (2021). *IMP4-3 Modification 1 Regulation 23 Anthony Lagoon*. **https://depws.nt.gov.au/__data/assets/pdf_file/0007/1277764/imp4-3-modification-1-regulation-23-anthony-lagoon.pdf**

Imperial. (2023). *Annual Environmental Performance Report* (2D Seismic Work Program EP187 (IMP1-3), Issue. **https://depws.nt.gov.au/__data/assets/pdf_file/0003/1304085/ep187-annual-report-2d-seismic-work-program2022-2023.pdf**

S Jung. (2019). *Imperial Energy seismic line and drill pad archaeological survey – Favenc Range, Northern Territory*.

S Jung. (2021). *Imperial Energy seismic line and drill pad archaeological survey – Favenc Range, Northern Territory Supplementary Report*.

S Jung. (2023). *Archaelogical survey report: EP187 Pilot - Referral and EMP - Baseline Surveys*.

J Ludwig, D Tongway, K Hodgkinson, D Freudenberger, & J Noble. (1996). *Landscape ecology, function and management: principles from Australia's rangelands*. Csiro Publishing.

N McKenzie, D Jacquier, R Isbell, & K Brown. (2004). *Australian Soils and Landscapes*. CSIRO Publishing. **https://www.publish.csiro.au/book/3821/**

S Morton. (2022). *Australian Deserts: Ecology and Landscapes*. CSIRO Publishing. **https://www.publish.csiro.au/book/7568/**

United Nations. (2016). *United Nations Declaration on the Rights of Indigenous Peoples Free, Prior and Informed Consent*. Accessed: 30th April 2023 **https://www.un.org/development/desa/indigenouspeoples/publications/2016/10/free-prior-and-informed-consent-an-indigenous-peoples-right-and-a-good-practice-for-local-communities-fao/**

United Nations. (2023). *Globally Harmonized System of Classification and Labelling of Chemicals (GHS)* (10 ed.). United Nations Publication.

NEPC. (2011). Assessment of Site Contamination Measures. Schedule B2. Guideline on Site Contamination. (Report No. **https://www.nepc.gov.au/sites/default/files/2022-09/schedule-b2-guideline-site-characterisation-sep10.pdf**

M. L Orr, G Bernardel, R Owens, L. S Hall, N Skeers, B Reese, & M Woods. (2020). Geology of the Beetaloo GBA region. Technical appendix for the Geological and Bioregional Assessment: Stage 2. (Report No. Bureau of Department of the Environment and Energy & CSIRO and Geoscience Australia Meteorology

M. A Randal. (1966). *Northern Territory Map sheet and explanatory notes. 1:250 000 geological series. Sheet SE53-15*. Bureau of Mineral Resources (Geoscience Australia). **https://geoscience.nt.gov.au/gemis/ntgsjspui/handle/1/87272**

C Richards, M Bond, & Northern Territory. (2023). Environmental Health Baseline Report: Soils. Strategic Regional Environmental and Baseline Assessment for the Beetaloo Sub-basin.

(Report No. Parks and Water Security. Flora and Fauna Division. Department of Environment

K. S Richards, R. R Arnett, & S. Ellis. (1985). *Geomorphology and Soils*. Routledge. **https://doi.org/10.4324/9780429320781**

J Russell-Smith, P Whitehead, & P Cooke. (2009). *Culture, ecology and economy of fire management in North Australian savannas: rekindling the Wurrk tradition*. Csiro Publishing.

C Shipton, T Cohen, M Forbes, F Boesl, Z Jacobs, R Dixon, Dimakarri, E Dixon, S Kingston, C Albert, & S O'Connor. (2021). *Diverse stone artefacts around Lake Woods, Central Northern Territory, Australia*. *Australian Archaeology*, *87*(2), 156-178.

H Smolinski, P Galloway, & J Laycock. (2019). Pindan soils in the La Grange area, West Kimberley: land capability assessment for irrigated agriculture. (Report No. Resource management technical report 412). Perth Department of Primary Industries and Regional Development **https://library.dpird.wa.gov.au/cgi/viewcontent.cgi?article=1395&context=rmtr**

Australian Bureau of Statistics. (2021a). *Barkly. 2021 Census Aboriginal and/or Torres Strait Islander people QuickStats*. **https://www.abs.gov.au/census/find-census-data/quickstats/2021/IARE707003**

Australian Bureau of Statistics. (2021b). *Barkly. 2021 Census All persons QuickStats*. **https://www.abs.gov.au/census/find-census-data/quickstats/2021/LGA70420**

S Tickell. (2022a). Beetaloo Sub-basin SREBA Water Studies: Aquifer mapping and summary report. Technical Report 19/2022. (Report No. Parks and Water Security. Palmerston Northern Territory Department of Environment, Northern Territory

S Tickell. (2022b). Beetaloo Sub-basin SREBA Water Studies: Gamma log & cross-sectional analysis for overlying primary aquifers. Northern Territory Government. (Report No. Northern Territory Government **https://hdl.handle.net/10070/900040**

W. G. Whitford, & B. D. Duval. (2019). *Ecology of Desert Systems* (Second ed.). **https://books.google.com/books?hl=en&lr=&id=4WCqDwAAQBAJ&oi=fnd&pg=PP1&dq=Whitford+W.G.+and+Duval+B.D.,+(2020).+Ecology+of+desert+ecosystem,+second+edition,+Elsevier&ots=7ElrEtBMd4&sig=OFFHbK98ft1hyBUkpfxSifQ-n34**

K. Witt, J. Keenan, G. Lewis, B. Fredericks, P. Jezierski, L. Jessup, & H. Zhang. (2023). *Social, Cultural and Economic (SCE) studies of the Strategic Regional Environment and Baseline Assessment (SREBA) for the Beetaloo Sub-basin* (The University of Queensland Centre Natural Gas Report, Issue.

L Young, J Patykowski, I Leiper, C Nano, A Fisher, G Gillespie, G Barnett, K Buckley, N Hanrahan, P McDonald, A Miller, R Ribot, L Ruykys, A Stewart, & A Zimny. (2022). Terrestrial Ecosystems Baseline Report: Chapter 3 Flora and vegetation communities. Strategic Regional Environmental and Baseline Assessment for the Beetaloo Sub-basin. (Report No. Technical Report No: 36/2022). **https://hdl.handle.net/10070/900109**

L Young, J Patykowski, I Leiper, C Nano, A Fisher, G Gillespie, G Barnett, K Buckley, N Hanrahan, P McDonald, A Miller, R Ribot, L Ruykys, A Stewart, & A Zimny. (2022). Terrestrial Ecosystems Baseline Report: Strategic Regional Environmental and Baseline Assessment for the Beetaloo Sub-basin. (Report No. -). Parks and Water Security Northern Territory Department of Environment

Environment Protection Act (2019). Northern Territory. Department of Environment, Parks and Water Security (DEPWS). Repe045. **https://legislation.nt.gov.au/en/Legislation/ENVIRONMENT-PROTECTION-ACT-2019**

Petroleum Act (1984). Northern Territory. REPP044. **https://legislation.nt.gov.au/en/Legislation/PETROLEUM-ACT-1984**

Victorian Environment Protection Agency. (2021). 1828.2: Waste Disposal Categories - Characteristics and Thresholds. (Report No. epa.vic.gov.au

A. Anderson, P. Ashworth, V. Beck, B. Hart, D. Jones, B. Pristely, D. Ritchie, & R. Smith. (2018). *Scientific Inquiry into Hydraulic Fracturing in the Northern Territory*. **https://frackinginquiry.nt.gov.au/inquiry-reports?a=494286**, **https://frackinginquiry.nt.gov.au/inquiry-reports?a=494327**

APGA. (2019). Code of Practice Upstream Polyethylene Gathering Networks – CSG Industry. (Report No.: APGA. **https://www.apga.org.au/resources/code-practice-upstream-pe-gathering-lines-csg-industry-and-companion-papers**

Commonwealth of Australia. (2018). National Waste Policy: less waste is more. (Report No.: Commonwealth of Australia. **https://www.environment.gov.au/system/files/resources/d523f4e9-d958-466b-9fd1-3b7d6283f006/files/national-waste-policy-2018.pdf**

Austroads. (2021). *Guide to Road Design* (5.1 ed.). **https://austroads.com.au/safety-and-design/road-design/guide-to-road-design**

J. M Bowler, G. A. T Duller, N Perret, J. R Prescott, & K-H Wyrwoll. (1998). *Hydrologic changes in monsoonal climates of the last glacial cycle: stratigraphy and lumenescence dating of Lake Woods, N.T., Australia*. *Palaeoclimates*, *3*(1-3), 179-207.

C. J. A Bradshaw. (2012). *Little left to lose: deforestation and forest degradation in Australia since European colonization*. *Journal of Plant Ecology*, *5*(1), 109-120. **https://doi.org/10.1093/jpe/rtr038**

R Browell, & J Potgierter. (2022). Environmental Health Interim Baseline Report: Air Quality Strategic Regional Environmental and Baseline Assessment for the Beetaloo Sub-basin. (Report No. Parks and Water Security. Flora and Fauna Division Northern Territory. Department of Environment: Northern teritory Government. **https://hdl.handle.net/10070/898283**

GM Byram. (1959). *Combustion of forest fuels*. *Forest fire: control and use*, 61-89.

S Capon, C James, & M Reid. (2016). *Vegetation of Australian Riverine Landscapes*. **https://doi.org/10.1071/9780643104525**

Samantha Capon, Cassandra James, & Michael Reid. (2016). *Vegetation of Australian riverine landscapes: biology, ecology and management*. CSIRO PUBLISHING.

C. S Christian, L. C Noakes, R. A Perry, R. O Slatyer, A Stewart, & D. M Traves. (1954). *Survey of the Barkly Region, Northern Territory and Queensland, 1947-48*.

C.S Christian, S.T Blake, L.N Noakes, & G.A Stewart. (1954). *No. 3 Survey of the Barkly Region, Northern Territory and Queensland 1947-48*. *CSIRO Land Research Surveys*, *1*(198).

C.S Christian, & Stewart. (1953). *General Report On Survey of the Katherne-Darwin Region*

R. A Clement, H Flores-Moreno, L. A Cernusak, & A. W Cheesman. (2021). *Assessing the Australian Termite Discovery Anomaly: How Habitat and Rainfall Affect Termite Assemblages*. **https://doi.org/10.3389/fevo.2021.657444**

Threatened Species Scientific Committee. (2016). *Conservation Advice Erythrura gouldiae Gouldian finch*. **https://www.environment.gov.au/biodiversity/threatened/species/pubs/413-conservation-advice-07122016.pdf**

Barkly Regional Council. *The Region. Demographics*. Retrieved July 2024 from **https://www.barkly.nt.gov.au/region/demographics**

CSIRO. (2024). Bushfire Best Practice Guide. (Report No. **https://research.csiro.au/bushfire/bushfire-basics/how-**

bushfires-behave/vegetation/,

J Davis, G Gillespie, N Cuff, E Garcia, A Andersen, L Young, I Leiper, R Ribot, M Kennard, & A Pintor. (2021). *Beetaloo GBA region baseline survey program. Research Institute for Environment & Livelihoods, Charles Darwin University, Darwin, Australia*.

DCCEEW. (2000). Revision of the Interim Biogeographic Regionalisation of Australia (IBRA) and the Development of Version 5.1 - Summary Report. (Report No. Energy Department of Climate Change, the Environment and Water: Australian Government. **https://www.dcceew.gov.au/sites/default/files/documents/revision-ibra-development-5-1-summary-report.pdf**

DCCEEW. (2008). *Gulf Fall and Uplands bioregion*. Australian Government. **https://www.dcceew.gov.au/sites/default/files/env/resources/a8015c25-4aa2-4833-ad9c-e98d09e2ab52/files/bioregion-gulf-fall-and-uplands.pdf#:~:text=The%20landscape%20of%20the%20Gulf%20Fall%20and%20Uplands,land%20uses%20include%20Aboriginal%20land%20and%20conservation%20reserves**.

DCCEEW. (2022). *Australian Protected Areas Dashboard*. Retrieved December 2023 from **https://www.dcceew.gov.au/environment/land/nrs/science/capad/dashboard**

DCCEEW. (2023). Conservation Advice for Tiliqua scincoides intermedia (northern blue-tongue skink). (Report No. Energy Department of Climate Change, the Environment and Water: Australian Government. **https://www.environment.gov.au/biodiversity/threatened/species/pubs/89838-conservation-advice-21122023.pdf**

B. De Vincentiis, S. Guthridge, J-Y. Su, & K. Johnston. (2021). *Story of Our Children and Young People, Barkly 2021*. **https://cmc.nt.gov.au/__data/assets/pdf_file/0005/1084811/Barkly-Story-2021.pdf**

Barkly Regional Deal. (2019). *Barkly Regional Deal*. Retrieved July 2024 from **https://barklyregionaldeal.com.au/about/**

DENR. (2018). Preliminary Guideline: Groundwater Monitoring Bores for Exploration Petroleum Wells in the Beetaloo Sub-basin. (Report No. Department of Environment and Natural Resources **https://denr.nt.gov.au/__data/assets/pdf_file/0009/618957/Preliminary-Guideline-Petroleum-Well-Water-Quality-Monitoring.pdf**

DENR. (2020). Bushfire Management Planning Guide: Onshore Petroleum Projects. (Report No. Department of Environment and Natural Resources

https://depws.nt.gov.au/__data/assets/pdf_file/0006/787488/bushfire-management-planning-guide.pdf

DEPWS. (2018). Preliminary Guideline: Groundwater Monitoring Bores for Exploration Petroleum Wells in the Beetaloo Sub-basin. (Report No. Department of Environment and Natural Resources: Department of Environment and Natural Resources. **https://denr.nt.gov.au/__data/assets/pdf_file/0009/618957/Preliminary-Guideline-Petroleum-Well-Water-Quality-Monitoring.pdf**

DEPWS. (2020). Rehabilitation Plan Guide for Surface Disturbance: Onshore Petroleum Disturbance. (Report No. Water and the Environment Department of Agriculture **https://depws.nt.gov.au/__data/assets/pdf_file/0004/936823/Rehabilitation-Plan-Guide-v0.4.pdf**

DEPWS. (2021a). Katherine Regional Weeds Strategy 2021-2026. (Report No.: Department of Evnironments, Parks, and Water Security. **https://depws.nt.gov.au/__data/assets/pdf_file/0006/269286/Katherine-Regional-Weeds-Strategy-2021-2026.pdf**

DEPWS. (2021b). Land Clearing Guidelines. (Report No. LRM2021/0077~0002). Parks and Water Security Department of Environment **https://nt.gov.au/__data/assets/pdf_file/0007/236815/land-clearing-guidelines.pdf**

DEPWS. (2021c). Land Clearing Guidelines - Northern Territory Planning Scheme. (Report No. LRM2021/0077~0002). Parks and Water Security Department of Environment **https://nt.gov.au/__data/assets/pdf_file/0007/236815/land-clearing-guidelines.pdf**

DEPWS. (2021d). Northern Territory Weed Management Handbook. (Report No. Parks and Water Security Department of Environment **https://nt.gov.au/__data/assets/pdf_file/0004/233833/nt-weed-management-handbook.pdf**

DEPWS. (2022). Regional Report: Strategic Regional Environmental and Baseline Assessment for the Beetaloo Sub-basin. (Report No. Parks and Water Security. Flora and Fauna Division Northern Territory. Department of Environment **https://hdl.handle.net/10070/900467**

DEPWS. (2023a). Georgina Wiso Water Allocation Plan. (Report No. **https://nt.gov.au/__data/assets/pdf_file/0007/1284829/georgina-wiso-water-allocation-plan-2023-2031.pdf**

DEPWS. (2023b). Georgina Wiso Water Allocation Plan 2023-2031. (Report No. 12/2023). Parks and Water Security Department of Environment: Northern Territory, Australia. **https://nt.gov.au/environment/water/management-security/water-control-districts/daly-roper-beetaloo/planning-for-the-georgina-basin**

Young L et al; DEPWS. (2023). *Terrestrial Ecosystems Baseline Report: Strategic Regional Environmental and Baseline Assessment for the Beetaloo Sub-basin*. 5/07/2023

DEWHA. (2013). *Matters of national environmental significance: significant impact guidelines 1.1 environment protection and biodiversity conservation act 1999. Canberra: Department of Environment*.

DIPL. (2023). *Carpentaria Highway major upgrade*. **https://dipl.nt.gov.au/projects/carpentaria-highway**

DPIR. (2021). *Ribbon Grass (Chrysopogon Fallax) in the Western Australian Rangelands*.

S Emery, G Cocks, & R Keeley. (2007). *Selection and Use of Locally Available Pavement Materials for Low-Volume Roads in Western Australia*. *Transportation Research Record: Journal of the Transportation Research Board*, *1989-2*(1), 194-200. **https://doi.org/10.3141/1989-64**

NT EPA. (2013). Guidelines on Conceptual Site Models. (Report No. Northern Territory Environment Protection Authority: Northern Territory Government. **https://ntepa.nt.gov.au/__data/assets/pdf_file/0007/904327/draft_guidelines_conceptual_site_models.pdf**

NT EPA. (2018). Northern Territory Noise Management Framework Guideline. (Report No. Northern Territory Environmental Protection Agency **https://ntepa.nt.gov.au/__data/assets/pdf_file/0004/566356/noise_management_framework_guideline.pdf**

NT EPA. (2022a). DRAFT Environmental factor guidance: Atmospheric processes. (Report No. Northern Territory Environment Protection Authority: Northern Territory Government. **https://ntepa.nt.gov.au/__data/assets/pdf_file/0020/1104482/draft-environmental-factor-guidance-atmospheric-processes.pdf**

NT EPA. (2022b). NT EPA Environmental Factors and Objectives. (Report No. Parks and Water Security Department of Environment **https://ntepa.nt.gov.au/__data/assets/pdf_file/0020/804602/guide-ntepa-environmental-factors-objectives.pdf**

Northern Territory Government. (2021). Greenhouse Gas Emissions Management for New and Expanding Large Emitters. (Report No. Office of Climate CHange **https://depws.nt.gov.au/__data/assets/pdf_file/0008/1041938/ntg-large-and-expanding-emitters-policy-2021-version-1.1.pdf**

M Hill, & N Hanan. (2010). *Ecosystem function in savannas: Measurement and modeling at landscape to global scales*. CRC Press.

C. R. Huddlestone-Holmes, E. Frery, P. Wilkes, A. H. E. Bailey, G. Bernadel, C. Brandon, S. Buchanan, S. B. Cook, R. S. Crosbie, T. Evans, L. Golding, Dda. Gonzalez, M. E. Gunning, L. S. Hall, B. Henderson, A. Herr, K. Holland, A. Jarrett, J. Kear, J. Kirby, M. Lech, S. Lewis, C. Macfarlane, J. Martinez, S. Northover, J. Murray, A. O'Grady, M. L. Orr, R. Owens, C. Pavey, D. Post, B. Sundaram, P. Rachakonda, M. Raiber, T. Ransley, S. Tetreault-Campbell, & L. Wang. (2020). *Geological and Environmental Baseline Assessment for the Beetaloo GBA Region. Geological and Bioregional Assessment: Stage 2 Baseline Assessment*. **https://www.bioregionalassessments.gov.au/assessments/geological-and-bioregional-assessment-program/beetaloo-sub-basin/beetaloo-gba-region-stage-two-report**

IAP2. (2015). *Quality Assurance Standards*. Accessed: January 2024 **https://iap2.org.au/resources/quality-assurance-standard/**

IECA. (2008). *Best Practice Erosion and Sediment Control.* . International Erosion Control Association (Australasia). **https://www.austieca.com.au/documents/item/1021**, **https://www.austieca.com.au/documents/item/1022**, **https://www.austieca.com.au/documents/item/1023**

Imperial. (2021). *IMP4-3 Modification 1 Regulation 23 Anthony Lagoon*. **https://depws.nt.gov.au/__data/assets/pdf_file/0007/1277764/imp4-3-modification-1-regulation-23-anthony-lagoon.pdf**

Imperial. (2023). *Annual Environmental Performance Report* (2D Seismic Work Program EP187 (IMP1-3), Issue. **https://depws.nt.gov.au/__data/assets/pdf_file/0003/1304085/ep187-annual-report-2d-seismic-work-program2022-2023.pdf**

S Jung. (2019). *Imperial Energy seismic line and drill pad archaeological survey – Favenc Range, Northern Territory*.

A Knapton. (2020). *Upgrade of the Coupled Model of the Cambrian Limestone Aquifer and Roper River Systems* **https://hdl.handle.net/10070/827500**.

J Ludwig, D Tongway, K Hodgkinson, D Freudenberger, & J Noble. (1996). *Landscape ecology, function and management: principles from Australia's rangelands*. Csiro Publishing.

N McKenzie, D Jacquier, R Isbell, & K Brown. (2004). *Australian Soils and Landscapes*. CSIRO Publishing. **https://www.publish.csiro.au/book/3821/**

S Morton. (2022). *Australian Deserts: Ecology and Landscapes*. CSIRO Publishing. **https://www.publish.csiro.au/book/7568/**

United Nations. (2016). *United Nations Declaration on the Rights of Indigenous Peoples Free, Prior and Informed Consent*. Accessed: 30th April 2023 **https://www.un.org/development/desa/indigenouspeoples/publications/2016/10/free-prior-and-informed-consent-an-indigenous-peoples-right-and-a-good-practice-for-local-communities-fao/**

United Nations. (2023). *Globally Harmonized System of Classification and Labelling of Chemicals (GHS)* (10 ed.). United Nations Publication.

NEPC. (2011). Assessment of Site Contamination Measures. Schedule B2. Guideline on Site Contamination. (Report No. **https://www.nepc.gov.au/sites/default/files/2022-09/schedule-b2-guideline-site-characterisation-sep10.pdf**

M. L Orr, G Bernardel, R Owens, L. S Hall, N Skeers, B Reese, & M Woods. (2020). Geology of the Beetaloo GBA region. Technical appendix for the Geological and Bioregional Assessment: Stage 2. (Report No. Bureau of Department of the Environment and Energy & CSIRO and Geoscience Australia Meteorology

J Paktinat, B O'Neil, C Aften, & M Hurd. (2011). *High Brine Tolerant Polymer Improves the Performance of Slickwater Frac in Shale Reservoirs* North American Unconventional Gas Conference and Exhibition, The Woodlands, Texas, USA. **https://onepetro.org/SPEGTS/proceedings-abstract/11UGC/All-11UGC/SPE-144210-MS/150002**

M. A Randal. (1966). *Northern Territory Map sheet and explanatory notes. 1:250 000 geological series. Sheet SE53-15*. Bureau of Mineral Resources (Geoscience Australia). **https://geoscience.nt.gov.au/gemis/ntgsjspui/handle/1/87272**

C Richards, M Bond, & Northern Territory. (2023). Environmental Health Baseline Report: Soils. Strategic Regional Environmental and Baseline Assessment for the Beetaloo Sub-basin. (Report No. Parks and Water Security. Flora and Fauna Division. Department of Environment

K. S Richards, R. R Arnett, & S. Ellis. (1985). *Geomorphology and Soils*. Routledge. **https://doi.org/10.4324/9780429320781**

J Russell-Smith, P Whitehead, & P Cooke. (2009). *Culture, ecology and economy of fire management in North Australian savannas: rekindling the Wurrk tradition*. Csiro Publishing.

Jung S. (2021). *Imperial Energy Seismic Line and Drill Pad Archaeological Survey - Favenc Range, Northern Territory*.

C Shipton, T Cohen, M Forbes, F Boesl, Z Jacobs, R Dixon, Dimakarri, E Dixon, S Kingston, C Albert, & S O'Connor. (2021). *Diverse stone artefacts around Lake Woods, Central Northern Territory, Australia*. *Australian Archaeology*, *87*(2), 156-178.

H Smolinski, P Galloway, & J Laycock. (2019). Pindan soils in the La Grange area, West Kimberley: land capability assessment for irrigated agriculture. (Report No. Resource management technical report 412). Perth Department of Primary Industries and Regional Development **https://library.dpird.wa.gov.au/cgi/viewcontent.cgi?article=1395&context=rmtr**

Australian Bureau of Statistics. (2021a). *Barkly. 2021 Census Aboriginal and/or Torres Strait Islander people QuickStats*. **https://www.abs.gov.au/census/find-census-data/quickstats/2021/IARE707003**

Australian Bureau of Statistics. (2021b). *Barkly. 2021 Census All persons QuickStats*. **https://www.abs.gov.au/census/find-census-data/quickstats/2021/LGA70420**

S Tickell. (2022a). Beetaloo Sub-basin SREBA Water Studies: Aquifer mapping and summary report. Technical Report 19/2022. (Report No. Parks and Water Security. Palmerston Northern Territory Department of Environment, Northern Territory

S Tickell. (2022b). Beetaloo Sub-basin SREBA Water Studies: Gamma log & cross-sectional analysis for overlying primary aquifers. Northern Territory Government. (Report No. Northern Territory Government **https://hdl.handle.net/10070/900040**

W. G. Whitford, & B. D. Duval. (2019). *Ecology of Desert Systems* (Second ed.). **https://books.google.com/books?hl=en&lr=&id=4WCqDwAAQBAJ&oi=fnd&pg=PP1&dq=Whitford+W.G.+and+Duval+B.D.,+(2020).+Ecology+of+desert+ecosystem,+second+edition,+Elsevier&ots=7ElrEtBMd4&sig=OFFHbK98ft1hyBUkpfxSifQ-n34**

K. Witt, J. Keenan, G. Lewis, B. Fredericks, P. Jezierski, L. Jessup, & H. Zhang. (2023). *Social, Cultural and Economic (SCE) studies of the Strategic Regional Environment and Baseline Assessment (SREBA) for the Beetaloo Sub-basin* (The University of Queensland Centre Natural Gas Report, Issue.

B Yang, J Zhao, J Mao, H Tan, Y Zhang, & Z Song. (2019). *Review of friction reducers used in slickwater fracturing fluids for shale gas reservoirs*. *Journal of Natural Gas Science and Engineering*, *62*, 302-313. **https://doi.org/10.1016/j.jngse.2018.12.016**

L Young, J Patykowski, I Leiper, C Nano, A Fisher, G Gillespie, G Barnett, K Buckley, N Hanrahan, P McDonald, A Miller, R Ribot, L Ruykys, A Stewart, & A Zimny. (2022). Terrestrial Ecosystems Baseline Report: Chapter 3 Flora and vegetation communities. Strategic Regional Environmental and Baseline Assessment for the Beetaloo Sub-basin. (Report No. Technical Report No: 36/2022). **https://hdl.handle.net/10070/900109**

L Young, J Patykowski, I Leiper, C Nano, A Fisher, G Gillespie, G Barnett, K Buckley, N Hanrahan, P McDonald, A Miller, R Ribot, L Ruykys, A Stewart, & A Zimny. (2022). Terrestrial Ecosystems Baseline Report: Strategic Regional Environmental and Baseline Assessment for the Beetaloo Sub-basin. (Report No. -). Parks and Water Security Northern Territory Department of Environment

Environment Protection Act (2019). Northern Territory. Department of Environment, Parks and Water Security (DEPWS). Repe045. **https://legislation.nt.gov.au/en/Legislation/ENVIRONMENT-PROTECTION-ACT-2019**

Petroleum Act (1984). Northern Territory. REPP044. **https://legislation.nt.gov.au/en/Legislation/PETROLEUM-ACT-1984**

Victorian Environment Protection Agency. (2021). 1828.2: Waste Disposal Categories - Characteristics and Thresholds. (Report No. epa.vic.gov.au

A. Anderson, P. Ashworth, V. Beck, B. Hart, D. Jones, B. Pristely, D. Ritchie, & R. Smith. (2018). *Scientific Inquiry into Hydraulic Fracturing in the Northern Territory*. **https://frackinginquiry.nt.gov.au/inquiry-reports?a=494286**, **https://frackinginquiry.nt.gov.au/inquiry-reports?a=494327**

APGA. (2019). Code of Practice Upstream Polyethylene Gathering Networks – CSG Industry. (Report No.: APGA. **https://www.apga.org.au/resources/code-practice-upstream-pe-gathering-lines-csg-industry-and-companion-papers**

Commonwealth of Australia. (2018). National Waste Policy: less waste is more. (Report No.: Commonwealth of Australia. **https://www.environment.gov.au/system/files/resources/d523f4e9-d958-466b-9fd1-3b7d6283f006/files/national-waste-policy-2018.pdf**

Austroads. (2021). *Guide to Road Design* (5.1 ed.). **https://austroads.com.au/safety-and-design/road-design/guide-to-road-design**

J. M Bowler, G. A. T Duller, N Perret, J. R Prescott, & K-H Wyrwoll. (1998). *Hydrologic changes in monsoonal climates of the last glacial cycle: stratigraphy and lumenescence dating of Lake Woods, N.T., Australia*. *Palaeoclimates*, *3*(1-3), 179-207.

C. J. A Bradshaw. (2012). *Little left to lose: deforestation and forest degradation in Australia since European colonization*. *Journal of Plant Ecology*, *5*(1), 109-120. **https://doi.org/10.1093/jpe/rtr038**

R Browell, & J Potgierter. (2022). Environmental Health Interim Baseline Report: Air Quality Strategic Regional Environmental and Baseline Assessment for the Beetaloo Sub-basin. (Report No. Parks and Water Security. Flora and Fauna Division Northern Territory. Department of Environment: Northern teritory Government. **https://hdl.handle.net/10070/898283**

GM Byram. (1959). *Combustion of forest fuels*. *Forest fire: control and use*, 61-89.

S Capon, C James, & M Reid. (2016). *Vegetation of Australian Riverine Landscapes*. **https://doi.org/10.1071/9780643104525**

Samantha Capon, Cassandra James, & Michael Reid. (2016). *Vegetation of Australian riverine landscapes: biology, ecology and management*. CSIRO PUBLISHING.

C. S Christian, L. C Noakes, R. A Perry, R. O Slatyer, A Stewart, & D. M Traves. (1954). *Survey of the Barkly Region, Northern Territory and Queensland, 1947-48*.

C.S Christian, S.T Blake, L.N Noakes, & G.A Stewart. (1954). *No. 3 Survey of the Barkly Region, Northern Territory and Queensland 1947-48*. *CSIRO Land Research Surveys*, *1*(198).

C.S Christian, & Stewart. (1953). *General Report On Survey of the Katherne-Darwin Region*

R. A Clement, H Flores-Moreno, L. A Cernusak, & A. W Cheesman. (2021). *Assessing the Australian Termite Discovery Anomaly: How Habitat and Rainfall Affect Termite Assemblages*. **https://doi.org/10.3389/fevo.2021.657444**

Threatened Species Scientific Committee. (2016). *Conservation Advice Erythrura gouldiae Gouldian finch*. **https://www.environment.gov.au/biodiversity/threatened/species/pubs/413-conservation-advice-07122016.pdf**

Barkly Regional Council. *The Region. Demographics*. Retrieved July 2024 from **https://www.barkly.nt.gov.au/region/demographics**

CSIRO. (2024). Bushfire Best Practice Guide. (Report No. **https://research.csiro.au/bushfire/bushfire-basics/how-**

bushfires-behave/vegetation/,

J Davis, G Gillespie, N Cuff, E Garcia, A Andersen, L Young, I Leiper, R Ribot, M Kennard, & A Pintor. (2021). *Beetaloo GBA region baseline survey program. Research Institute for Environment & Livelihoods, Charles Darwin University, Darwin, Australia*.

DCCEEW. (2000). Revision of the Interim Biogeographic Regionalisation of Australia (IBRA) and the Development of Version 5.1 - Summary Report. (Report No. Energy Department of Climate Change, the Environment and Water: Australian Government. **https://www.dcceew.gov.au/sites/default/files/documents/revision-ibra-development-5-1-summary-report.pdf**

DCCEEW. (2022). *Australian Protected Areas Dashboard*. Retrieved December 2023 from **https://www.dcceew.gov.au/environment/land/nrs/science/capad/dashboard**

DCCEEW. (2023). Conservation Advice for Tiliqua scincoides intermedia (northern blue-tongue skink). (Report No. Energy Department of Climate Change, the Environment and Water: Australian Government. **https://www.environment.gov.au/biodiversity/threatened/species/pubs/89838-conservation-advice-21122023.pdf**

B. De Vincentiis, S. Guthridge, J-Y. Su, & K. Johnston. (2021). *Story of Our Children and Young People, Barkly 2021*. **https://cmc.nt.gov.au/__data/assets/pdf_file/0005/1084811/Barkly-Story-2021.pdf**

Barkly Regional Deal. (2019). *Barkly Regional Deal*. Retrieved July 2024 from **https://barklyregionaldeal.com.au/about/**

DENR. (2018). Preliminary Guideline: Groundwater Monitoring Bores for Exploration Petroleum Wells in the Beetaloo Sub-basin. (Report No. Department of Environment and Natural Resources **https://denr.nt.gov.au/__data/assets/pdf_file/0009/618957/Preliminary-Guideline-Petroleum-Well-Water-Quality-Monitoring.pdf**

DENR. (2020). Bushfire Management Planning Guide: Onshore Petroleum Projects. (Report No. Department of Environment and Natural Resources **https://depws.nt.gov.au/__data/assets/pdf_file/0006/787488/bushfire-management-planning-guide.pdf**

DEPWS. (2018). Preliminary Guideline: Groundwater Monitoring Bores for Exploration Petroleum Wells in the Beetaloo Sub-basin. (Report No. Department of Environment and Natural Resources: Department of Environment and Natural Resources.

https://denr.nt.gov.au/__data/assets/pdf_file/0009/618957/Preliminary-Guideline-Petroleum-Well-Water-Quality-Monitoring.pdf

DEPWS. (2020). Rehabilitation Plan Guide for Surface Disturbance: Onshore Petroleum Disturbance. (Report No. Water and the Environment Department of Agriculture **https://depws.nt.gov.au/__data/assets/pdf_file/0004/936823/Rehabilitation-Plan-Guide-v0.4.pdf**

DEPWS. (2021a). Katherine Regional Weeds Strategy 2021-2026. (Report No.: Department of Evnironments, Parks, and Water Security. **https://depws.nt.gov.au/__data/assets/pdf_file/0006/269286/Katherine-Regional-Weeds-Strategy-2021-2026.pdf**

DEPWS. (2021b). Land Clearing Guidelines. (Report No. LRM2021/0077~0002). Parks and Water Security Department of Environment **https://nt.gov.au/__data/assets/pdf_file/0007/236815/land-clearing-guidelines.pdf**

DEPWS. (2021c). Land Clearing Guidelines - Northern Territory Planning Scheme. (Report No. LRM2021/0077~0002). Parks and Water Security Department of Environment **https://nt.gov.au/__data/assets/pdf_file/0007/236815/land-clearing-guidelines.pdf**

DEPWS. (2021d). Northern Territory Weed Management Handbook. (Report No. Parks and Water Security Department of Environment **https://nt.gov.au/__data/assets/pdf_file/0004/233833/nt-weed-management-handbook.pdf**

DEPWS. (2022). Regional Report: Strategic Regional Environmental and Baseline Assessment for the Beetaloo Sub-basin. (Report No. Parks and Water Security. Flora and Fauna Division Northern Territory. Department of Environment **https://hdl.handle.net/10070/900467**

DEPWS. (2023a). Georgina Wiso Water Allocation Plan. (Report No. **https://nt.gov.au/__data/assets/pdf_file/0007/1284829/georgina-wiso-water-allocation-plan-2023-2031.pdf**

DEPWS. (2023b). Georgina Wiso Water Allocation Plan 2023-2031. (Report No. 12/2023). Parks and Water Security Department of Environment: Northern Territory, Australia. **https://nt.gov.au/environment/water/management-security/water-control-districts/daly-roper-beetaloo/planning-for-the-georgina-basin**

Young L et al; DEPWS. (2023). *Terrestrial Ecosystems Baseline Report: Strategic Regional Environmental and Baseline Assessment for the Beetaloo Sub-basin*. 5/07/2023

DEWHA. (2013). *Matters of national environmental significance: significant impact guidelines 1.1 environment protection and biodiversity conservation act 1999. Canberra: Department of Environment*.

DIPL. (2023). *Carpentaria Highway major upgrade*. **https://dipl.nt.gov.au/projects/carpentaria-highway**

DPIR. (2021). *Ribbon Grass (Chrysopogon Fallax) in the Western Australian Rangelands*.

S Emery, G Cocks, & R Keeley. (2007). *Selection and Use of Locally Available Pavement Materials for Low-Volume Roads in Western Australia. Transportation Research Record: Journal of the Transportation Research Board, 1989-2*(1), 194-200. **https://doi.org/10.3141/1989-64**

NT EPA. (2013). Guidelines on Conceptual Site Models. (Report No. Northern Territory Environment Protection Authority: Northern Territory Government. **https://ntepa.nt.gov.au/__data/assets/pdf_file/0007/904327/draft_guidelines_conceptual_site_models.pdf**

NT EPA. (2018). Northern Territory Noise Management Framework Guideline. (Report No. Northern Territory Environmental Protection Agency **https://ntepa.nt.gov.au/__data/assets/pdf_file/0004/566356/noise_management_framework_guideline.pdf**

NT EPA. (2022a). DRAFT Environmental factor guidance: Atmospheric processes. (Report No. Northern Territory Environment Protection Authority: Northern Territory Government. **https://ntepa.nt.gov.au/__data/assets/pdf_file/0020/1104482/draft-environmental-factor-guidance-atmospheric-processes.pdf**

NT EPA. (2022b). NT EPA Environmental Factors and Objectives. (Report No. Parks and Water Security Department of Environment **https://ntepa.nt.gov.au/__data/assets/pdf_file/0020/804602/guide-ntepa-environmental-factors-objectives.pdf**

Australian Government. (2019). *Australian Rainfall and Runoff* **https://arr.ga.gov.au/**

Northern Territory Government. (2021). Greenhouse Gas Emissions Management for New and Expanding Large Emitters. (Report No. Office of Climate CHange **https://depws.nt.gov.au/__data/assets/pdf_file/0008/1041938/ntg-large-and-expanding-emitters-policy-2021-version-1.1.pdf**

M Hill, & N Hanan. (2010). *Ecosystem function in savannas: Measurement and modeling at landscape to global scales*. CRC Press.

C. R. Huddlestone-Holmes, E. Frery, P. Wilkes, A. H. E. Bailey, G. Bernadel, C. Brandon, S. Buchanan, S. B. Cook, R. S. Crosbie, T. Evans, L. Golding, Dda. Gonzalez, M. E. Gunning, L. S. Hall, B. Henderson, A. Herr, K. Holland, A. Jarrett, J. Kear, J. Kirby, M. Lech, S. Lewis, C. Macfarlane, J. Martinez, S. Northover, J. Murray, A. O'Grady, M. L. Orr, R. Owens, C. Pavey, D. Post, B. Sundaram, P. Rachakonda, M. Raiber, T. Ransley, S. Tetreault-Campbell, & L. Wang. (2020). *Geological and Environmental Baseline Assessment for the Beetaloo GBA Region. Geological and Bioregional Assessment: Stage 2 Baseline Assessment*. **https://www.bioregionalassessments.gov.au/assessments/geological-and-bioregional-assessment-program/beetaloo-sub-basin/beetaloo-gba-region-stage-two-report**

IAP2. (2015). *Quality Assurance Standards*. Accessed: January 2024 **https://iap2.org.au/resources/quality-assurance-standard/**

IECA. (2008). *Best Practice Erosion and Sediment Control.* . International Erosion Control Association (Australasia). **https://www.austieca.com.au/documents/item/1021**, **https://www.austieca.com.au/documents/item/1022**, **https://www.austieca.com.au/documents/item/1023**

Imperial. (2021). *IMP4-3 Modification 1 Regulation 23 Anthony Lagoon*. **https://depws.nt.gov.au/__data/assets/pdf_file/0007/1277764/imp4-3-modification-1-regulation-23-anthony-lagoon.pdf**

Imperial. (2023). *Annual Environmental Performance Report* (2D Seismic Work Program EP187 (IMP1-3), Issue.

https://depws.nt.gov.au/__data/assets/pdf_file/0003/1304085/ep187-annual-report-2d-seismic-work-program2022-2023.pdf

S Jung. (2019). *Imperial Energy seismic line and drill pad archaeological survey – Favenc Range, Northern Territory*.

A Knapton. (2020). *Upgrade of the Coupled Model of the Cambrian Limestone Aquifer and Roper River Systems* **https://hdl.handle.net/10070/827500**.

J Ludwig, D Tongway, K Hodgkinson, D Freudenberger, & J Noble. (1996). *Landscape ecology, function and management: principles from Australia's rangelands*. Csiro Publishing.

N McKenzie, D Jacquier, R Isbell, & K Brown. (2004). *Australian Soils and Landscapes*. CSIRO Publishing. **https://www.publish.csiro.au/book/3821/**

S Morton. (2022). *Australian Deserts: Ecology and Landscapes*. CSIRO Publishing. **https://www.publish.csiro.au/book/7568/**

United Nations. (2016). *United Nations Declaration on the Rights of Indigenous Peoples Free, Prior and Informed Consent*. Accessed: 30th April 2023 **https://www.un.org/development/desa/indigenouspeoples/publications/2016/10/free-prior-and-informed-consent-an-indigenous-peoples-right-and-a-good-practice-for-local-communities-fao/**

United Nations. (2023). *Globally Harmonized System of Classification and Labelling of Chemicals (GHS)* (10 ed.). United Nations Publication.

NEPC. (2011). Assessment of Site Contamination Measures. Schedule B2. Guideline on Site Contamination. (Report No. **https://www.nepc.gov.au/sites/default/files/2022-09/schedule-b2-guideline-site-characterisation-sep10.pdf**

M. L Orr, G Bernardel, R Owens, L. S Hall, N Skeers, B Reese, & M Woods. (2020). Geology of the Beetaloo GBA region. Technical appendix for the Geological and Bioregional Assessment: Stage 2. (Report No. Bureau of Department of the Environment and Energy & CSIRO and Geoscience Australia Meteorology

J Paktinat, B O'Neil, C Aften, & M Hurd. (2011). *High Brine Tolerant Polymer Improves the Performance of Slickwater Frac in Shale Reservoirs* North American Unconventional Gas Conference and Exhibition, The Woodlands, Texas, USA. **https://onepetro.org/SPEGTS/proceedings-abstract/11UGC/All-11UGC/SPE-144210-MS/150002**

M. A Randal. (1966). *Northern Territory Map sheet and explanatory notes. 1:250 000 geological series. Sheet SE53-15*. Bureau of Mineral Resources (Geoscience Australia). **https://geoscience.nt.gov.au/gemis/ntgsjspui/handle/1/87272**

C Richards, M Bond, & Northern Territory. (2023). Environmental Health Baseline Report: Soils. Strategic Regional Environmental and Baseline Assessment for the Beetaloo Sub-basin. (Report No. Parks and Water Security. Flora and Fauna Division. Department of Environment

K. S Richards, R. R Arnett, & S. Ellis. (1985). *Geomorphology and Soils*. Routledge. **https://doi.org/10.4324/9780429320781**

J Russell-Smith, P Whitehead, & P Cooke. (2009). *Culture, ecology and economy of fire management in North Australian savannas: rekindling the Wurrk tradition*. Csiro Publishing.

Jung S. (2021). *Imperial Energy Seismic Line and Drill Pad Archaeological Survey - Favenc Range, Northern Territory*.

C Shipton, T Cohen, M Forbes, F Boesl, Z Jacobs, R Dixon, Dimakarri, E Dixon, S Kingston, C Albert, & S O'Connor. (2021). *Diverse stone artefacts around Lake Woods, Central Northern Territory, Australia*. *Australian Archaeology*, *87*(2), 156-178.

H Smolinski, P Galloway, & J Laycock. (2019). Pindan soils in the La Grange area, West Kimberley: land capability assessment for irrigated agriculture. (Report No. Resource management technical report 412). Perth Department of Primary Industries and Regional Development **https://library.dpird.wa.gov.au/cgi/viewcontent.cgi?article=1395&context=rmtr**

Australian Bureau of Statistics. (2021a). *Barkly. 2021 Census Aboriginal and/or Torres Strait Islander people QuickStats*. **https://www.abs.gov.au/census/find-census-data/quickstats/2021/IARE707003**

Australian Bureau of Statistics. (2021b). *Barkly. 2021 Census All persons QuickStats*. **https://www.abs.gov.au/census/find-census-data/quickstats/2021/LGA70420**

S Tickell. (2022a). Beetaloo Sub-basin SREBA Water Studies: Aquifer mapping and summary report. Technical Report 19/2022. (Report No. Parks and Water Security. Palmerston Northern Territory Department of Environment, Northern Territory

S Tickell. (2022b). Beetaloo Sub-basin SREBA Water Studies: Gamma log & cross-sectional analysis for overlying primary aquifers. Northern Territory Government. (Report No. Northern Territory Government **https://hdl.handle.net/10070/900040**

W. G. Whitford, & B. D. Duval. (2019). *Ecology of Desert Systems* (Second ed.). **https://books.google.com/books?hl=en&lr=&id=4WCqDwAAQBAJ&oi=fnd&pg=PP1&dq=Whitford+W.G.+and+Duval+B.D.,+(2020).+Ecology+of+desert+ecosystem,+second+edition,+Elsevier&ots=7ElrEtBMd4&sig=OFFHbK98ft1hyBUkpfxSifQ-n34**

K. Witt, J. Keenan, G. Lewis, B. Fredericks, P. Jezierski, L. Jessup, & H. Zhang. (2023). *Social, Cultural and Economic (SCE) studies of the Strategic Regional Environment and Baseline Assessment (SREBA) for the Beetaloo Sub-basin* (The University of Queensland Centre Natural Gas Report, Issue.

B Yang, J Zhao, J Mao, H Tan, Y Zhang, & Z Song. (2019). *Review of friction reducers used in slickwater fracturing fluids for shale gas reservoirs*. *Journal of Natural Gas Science and Engineering*, *62*, 302-313. **https://doi.org/10.1016/j.jngse.2018.12.016**

L Young, J Patykowski, I Leiper, C Nano, A Fisher, G Gillespie, G Barnett, K Buckley, N Hanrahan, P McDonald, A Miller, R Ribot, L Ruykys, A Stewart, & A Zimny. (2022). Terrestrial Ecosystems Baseline Report: Chapter 3 Flora and vegetation communities. Strategic Regional Environmental and Baseline Assessment for the Beetaloo Sub-basin. (Report No. Technical Report No: 36/2022). **https://hdl.handle.net/10070/900109**

L Young, J Patykowski, I Leiper, C Nano, A Fisher, G Gillespie, G Barnett, K Buckley, N Hanrahan, P McDonald, A Miller, R Ribot, L Ruykys, A Stewart, & A Zimny. (2022). Terrestrial Ecosystems Baseline Report: Strategic Regional Environmental and Baseline Assessment for the Beetaloo Sub-basin. (Report No. -). Parks and Water Security Northern Territory Department of Environment