

6.3.4.3 Aquatic Ecosystems

Riparian vegetation at the CPP Area is primarily centred around Relief Creek, which is the closest >3rd order watercourse to the CPP Area. Significant alluvial groundwater dependent ecosystem (GDE) vegetation (riparian woodland and Melaleuca Forest) associated with sandstones ranges and escarpments where the Sturt Plateau and Gulf Fall and Uplands bioregions converge, was identified in the SREBA [DEPWS, 2022b]. However, most of this habitat is to the east and north of the CPP Area at lower ground elevations, with comparatively little in the CPP area (refer **Figure 6.3—30**).

Comparison of GDE with Ordered streams in the CPP Area (refer to **Figure 6.3—1** above) suggests that GDEs are primarily restricted to Stream Order 3 drainage lines or greater, which occur to the east and north of CPP and which are lower in elevation in the respective catchments. As noted previously, the CPP Area encompasses the crest of the Favenc Range, which forms the headwaters of the Limmen Bight River catchment to the north of the CPP Area and the McArthur River to the east of the CPP Area.

The water table at the existing well pads has consistently been measured to be > 60 m BGL, dependent on topography (**Table 6.3—3**). Generally, where groundwater is within 20 m of the land surface, some native plants may access and use this groundwater.

The most common dominant overstorey tree species in the woodland on rocky flat habitat at lower elevations near the CPP Area is the snappy gum species, *Eucalyptus leucophloia*, which is known to readily form hollows and to provide breeding habitat for the Gouldian Finch [J Davis et al., 2021; DEPWS, 2023b].

Mapping of this habitat in the CPP Area, together with perennial water holes, shows that the CPP Area does not intersect with or encroach significantly on the snappy gum open woodlands to the north and east of the CPP Area, in the Gulf Fall and Uplands bioregion, where waterholes are also more common due to lower elevation (**Figure 6.3—36**).

Baseline and ongoing seasonal surface water quality monitoring of selected perennial waterholes near CPP area will be conducted as part of monitoring overall isolation, containment, and integrity in the CPP Activity (**Section 6.2** of the EMP – Environmental Performance Standards).

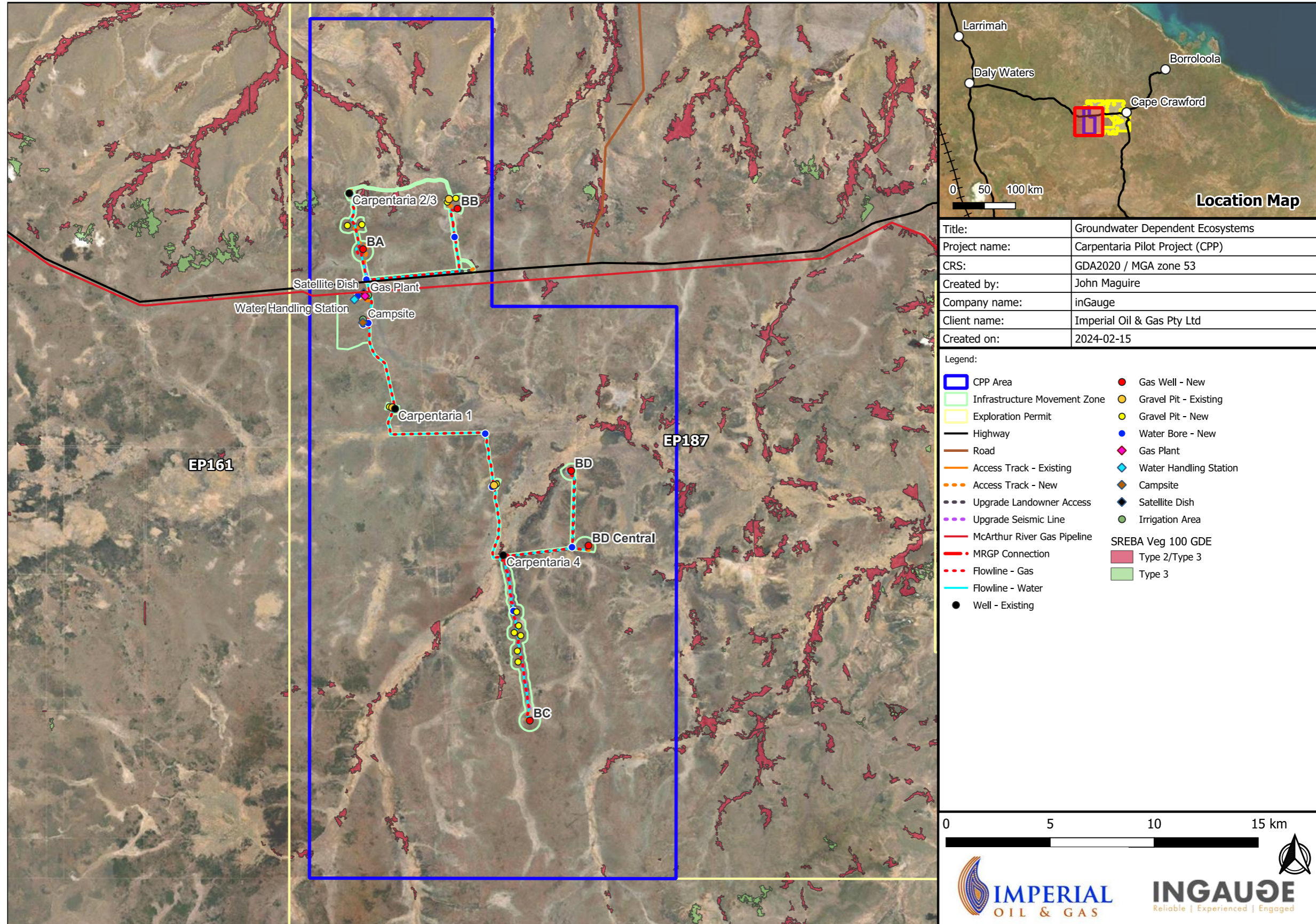


Figure 6.3—30 GDE in the Vicinity of the CPP Area on the Favenc Range Drainage Network (Overview)

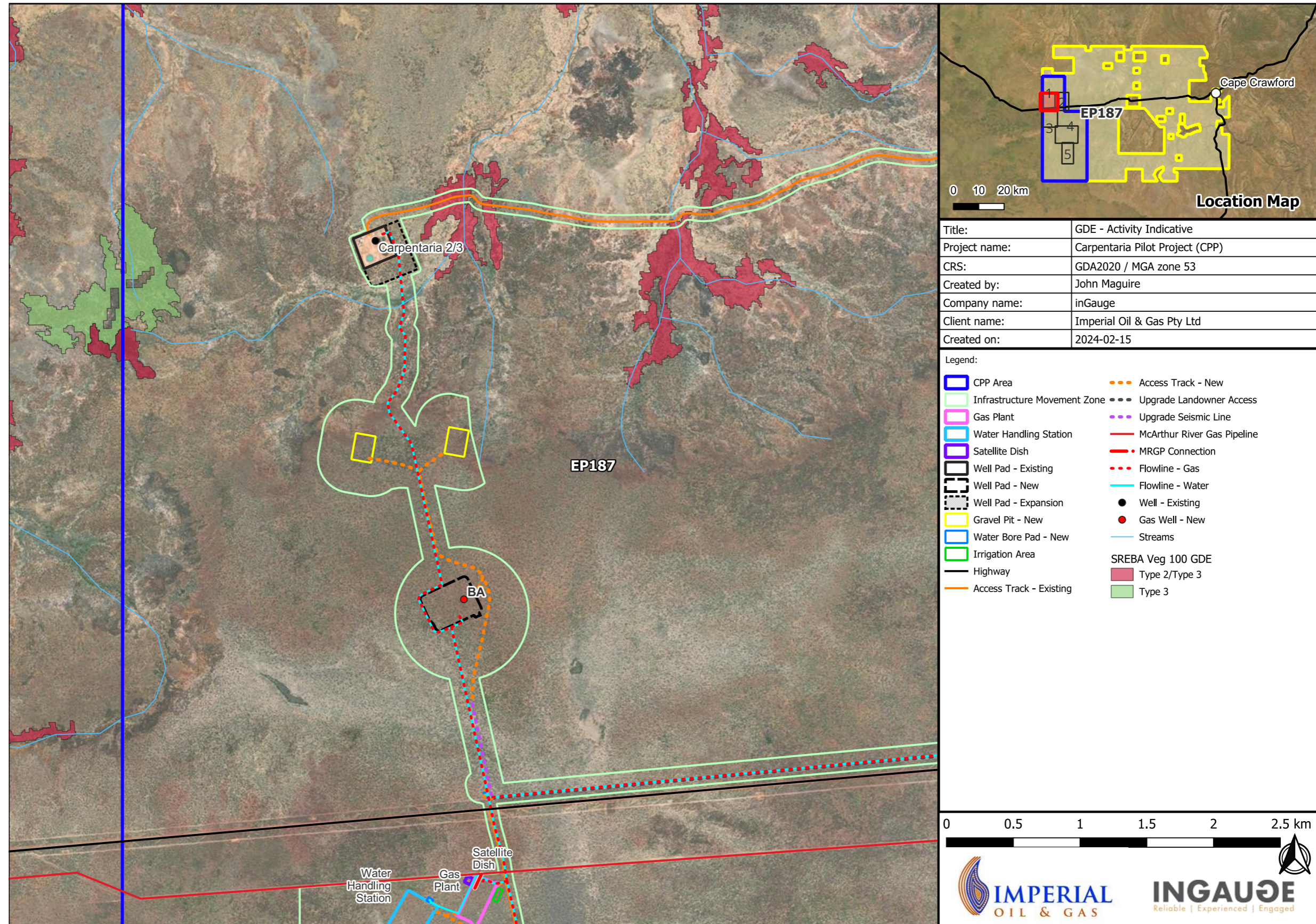


Figure 6.3—31 GDE in the Vicinity of the CPP Area on the Favenc Range Drainage Network – Map 1

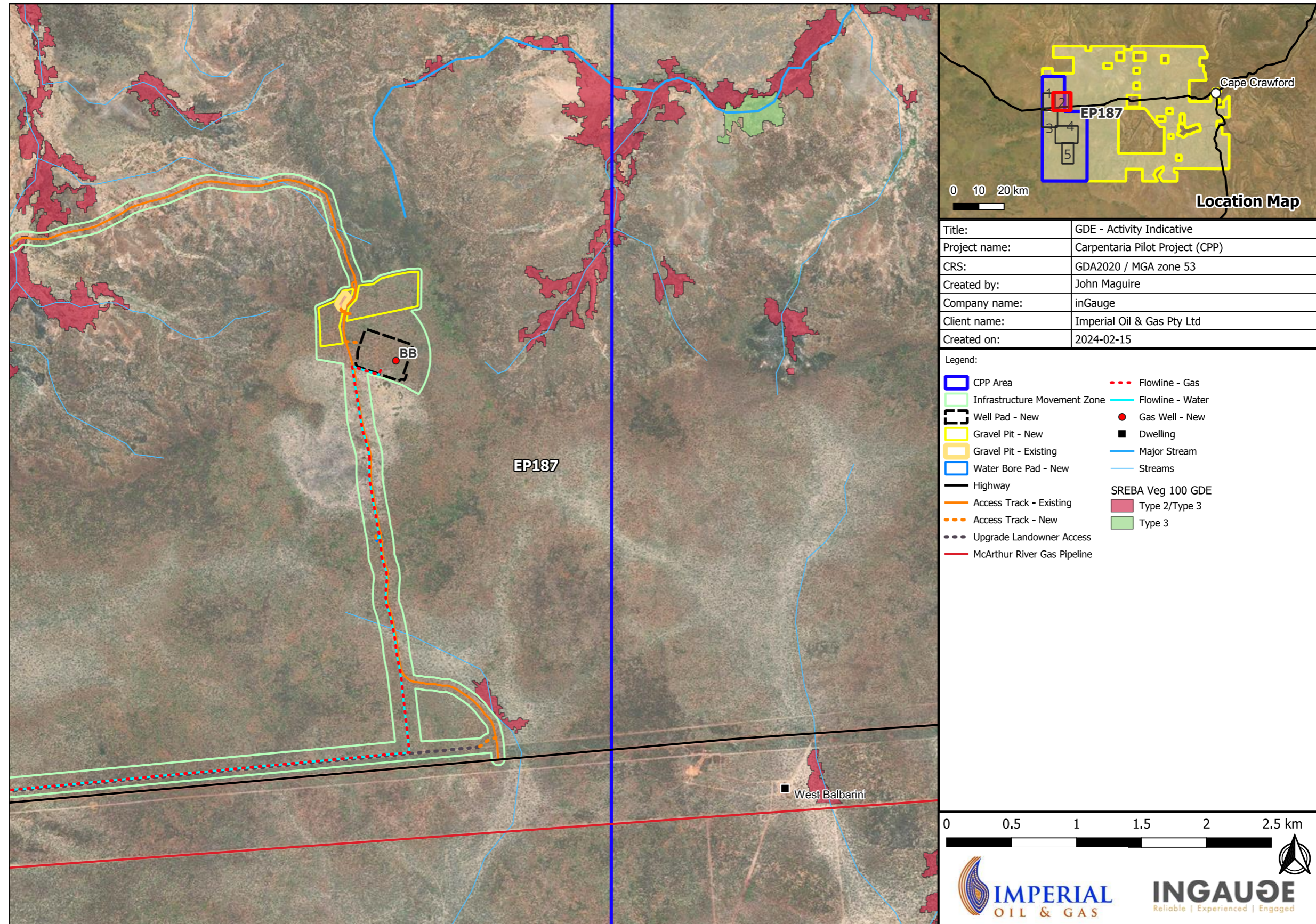


Figure 6.3—32 GDE in the Vicinity of the CPP Area on the Favenc Range Drainage Network – Map 2

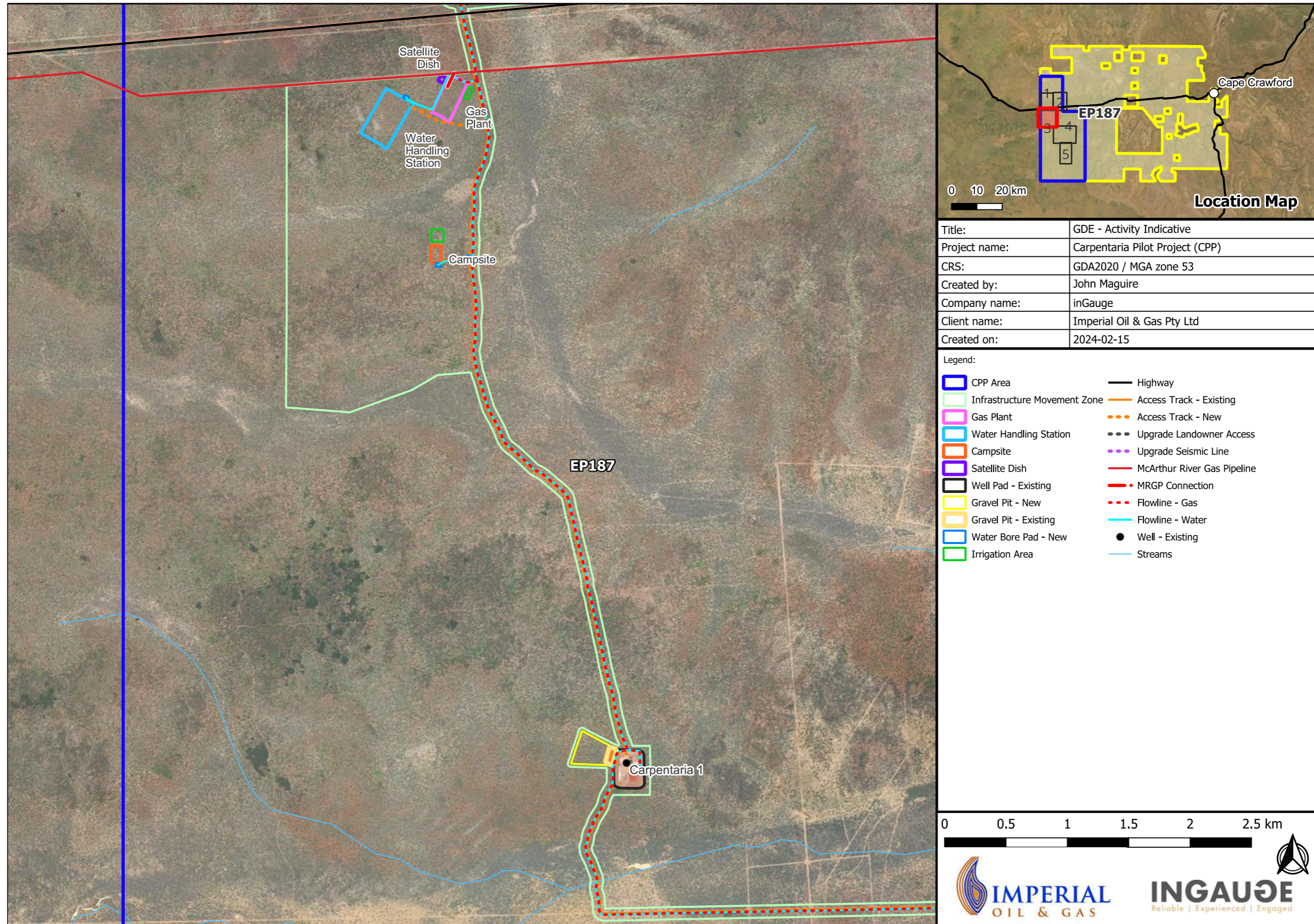


Figure 6.3—33 GDE in the Vicinity of the CPP Area on the Favenc Range Drainage Network – Map 3

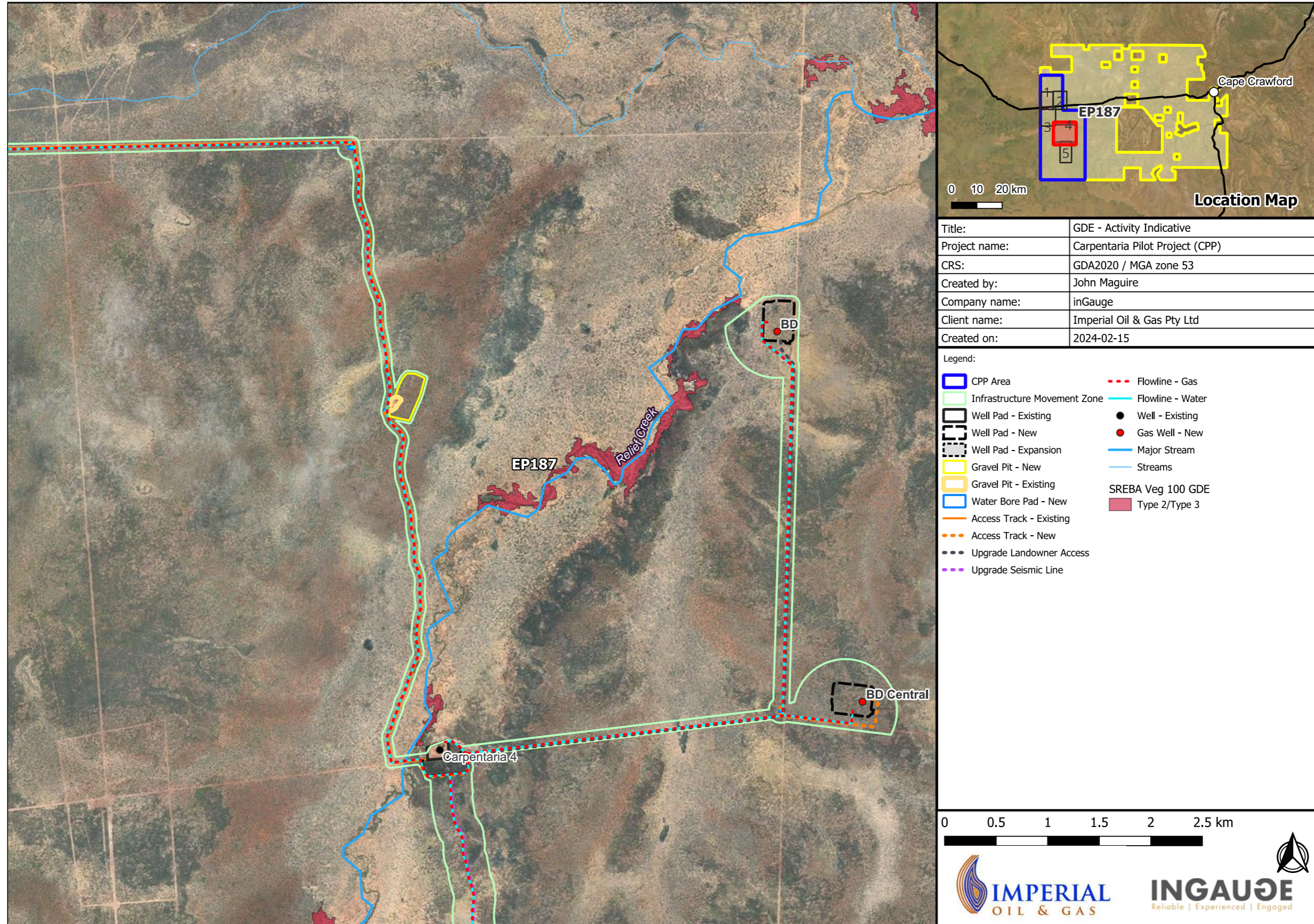


Figure 6.3—34 GDE in the Vicinity of the CPP Area on the Favenc Range Drainage Network – Map 4

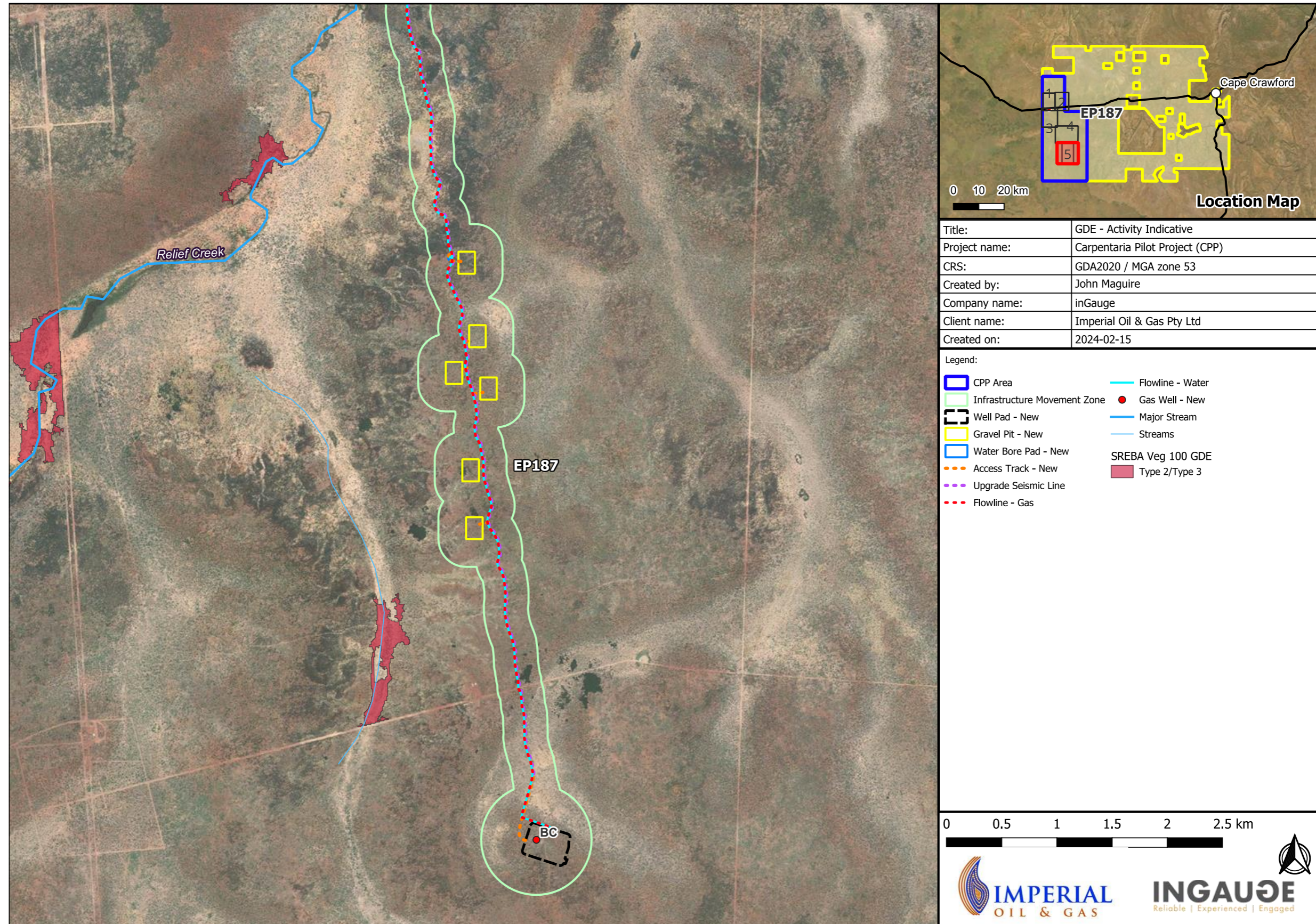


Figure 6.3—35 GDE in the Vicinity of the CPP Area on the Favenc Range Drainage Network – Map 5

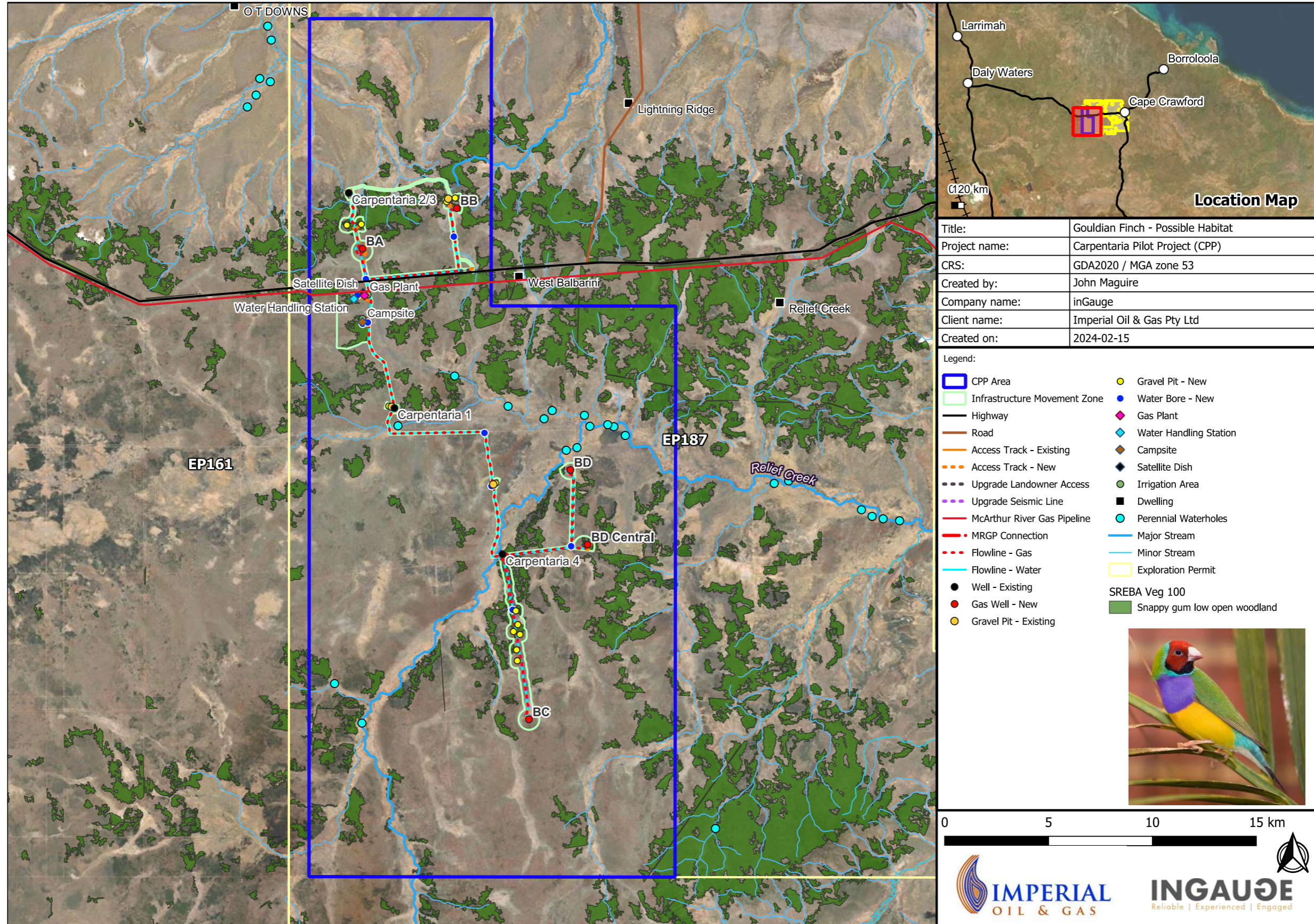


Figure 6.3—36 Potential Gouldian Finch Habitat and Perennial Waterholes in the CPP Area (Overview)

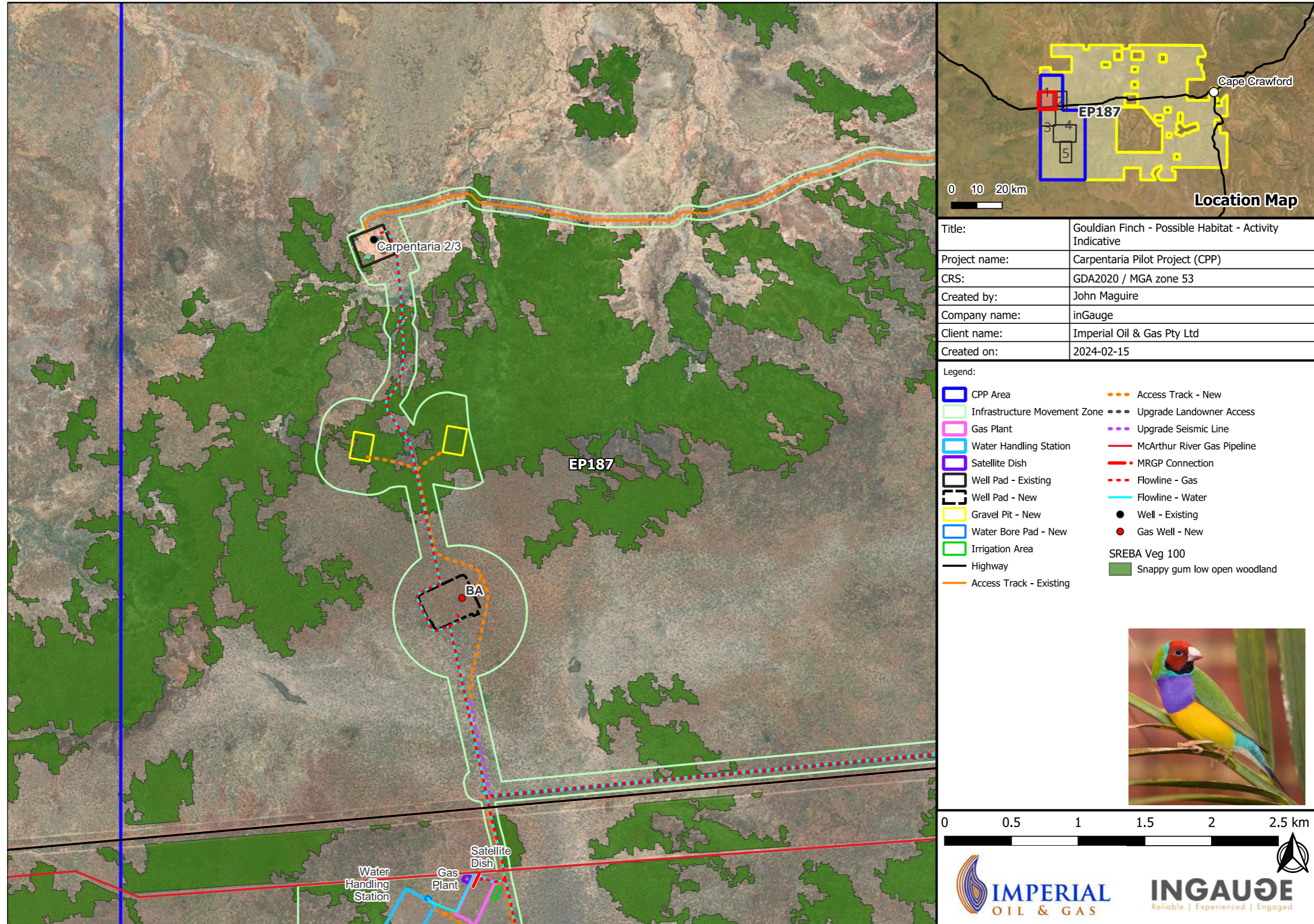


Figure 6.3—37 Potential Gouldian Finch Habitat and Perennial Waterholes in the CPP Area – Map 1

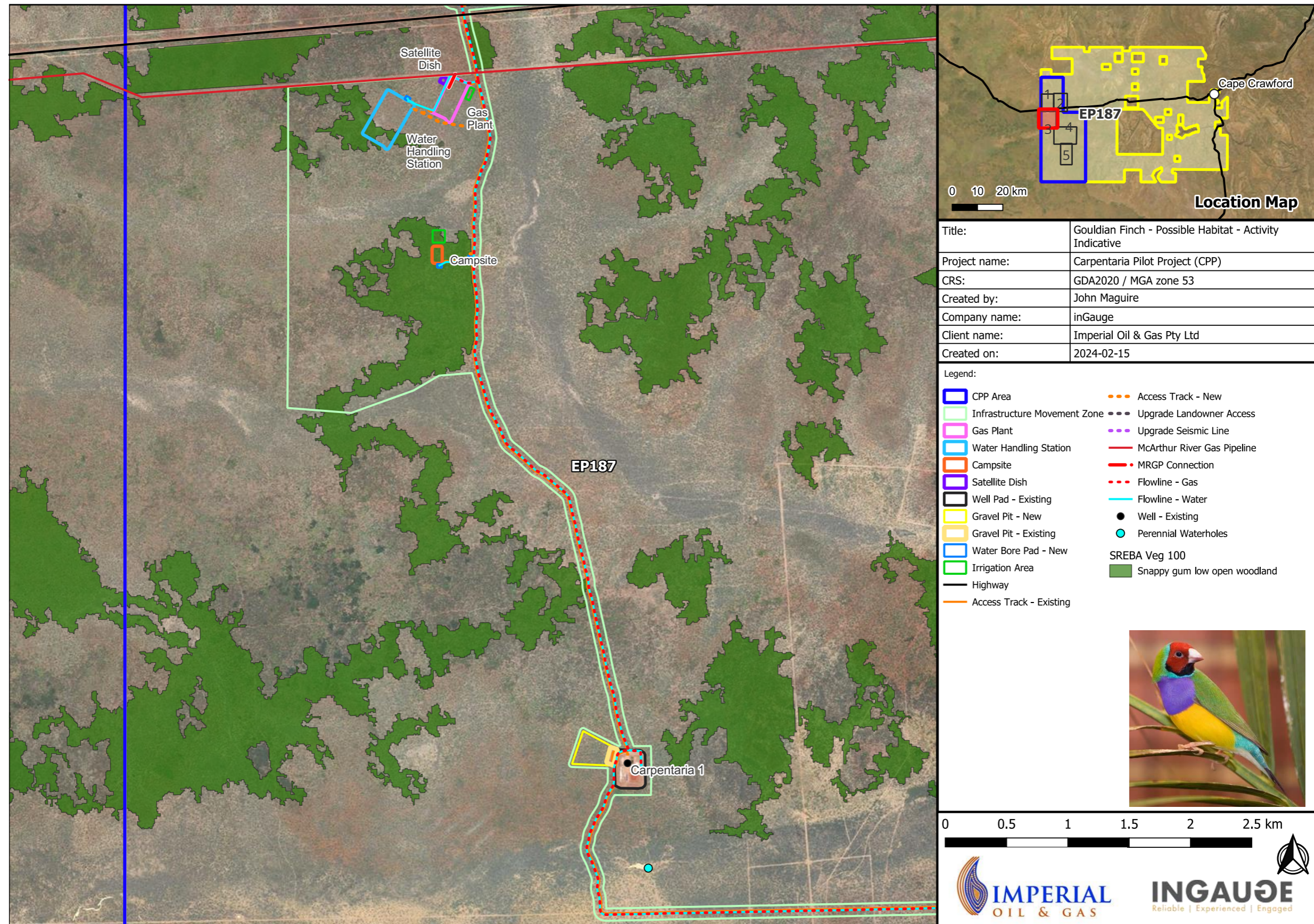


Figure 6.3—39 Potential Gouldian Finch Habitat and Perennial Waterholes in the CPP Area – Map 3

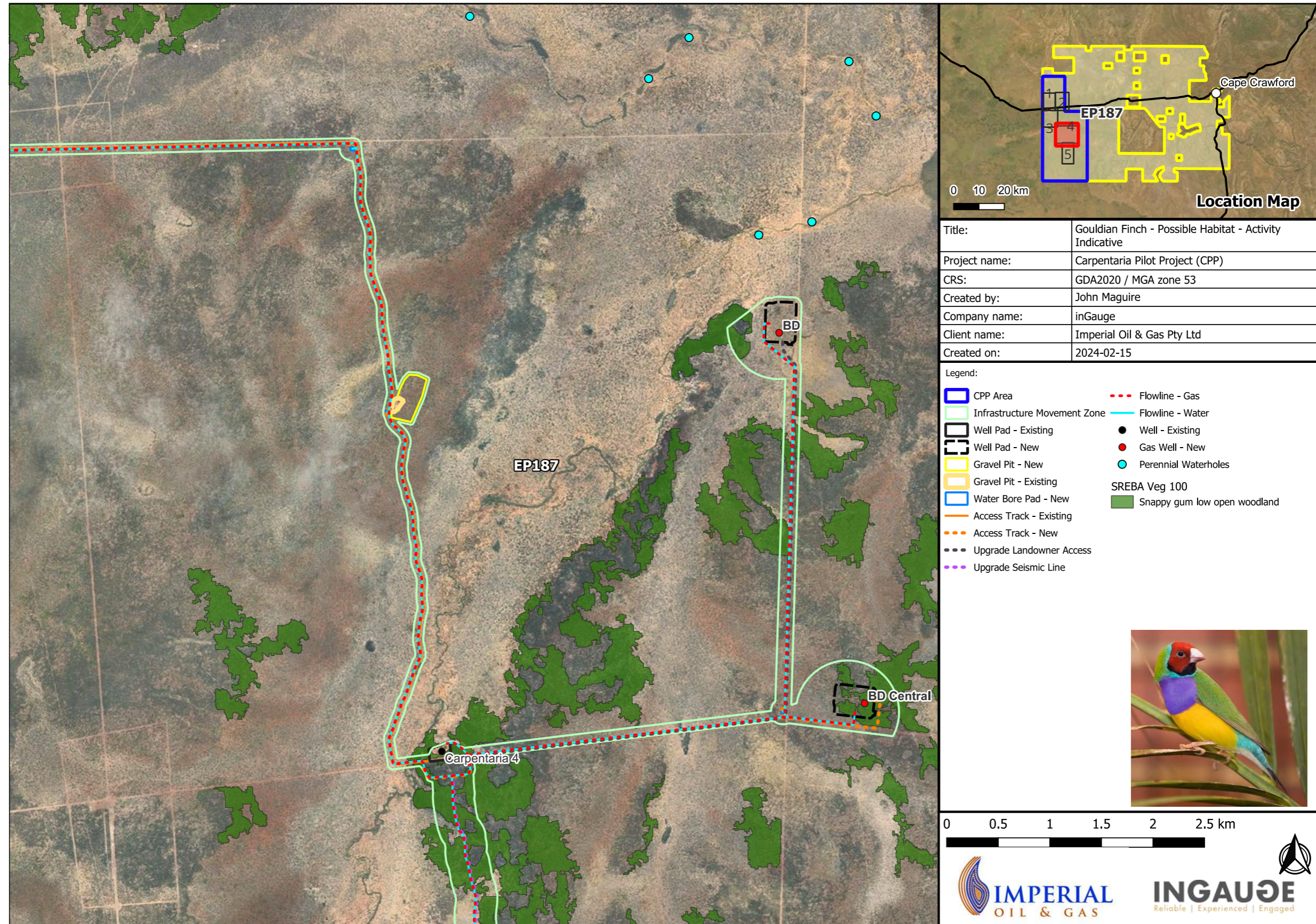


Figure 6.3—40 Potential Gouldian Finch Habitat and Perennial Waterholes in the CPP Area – Map 4

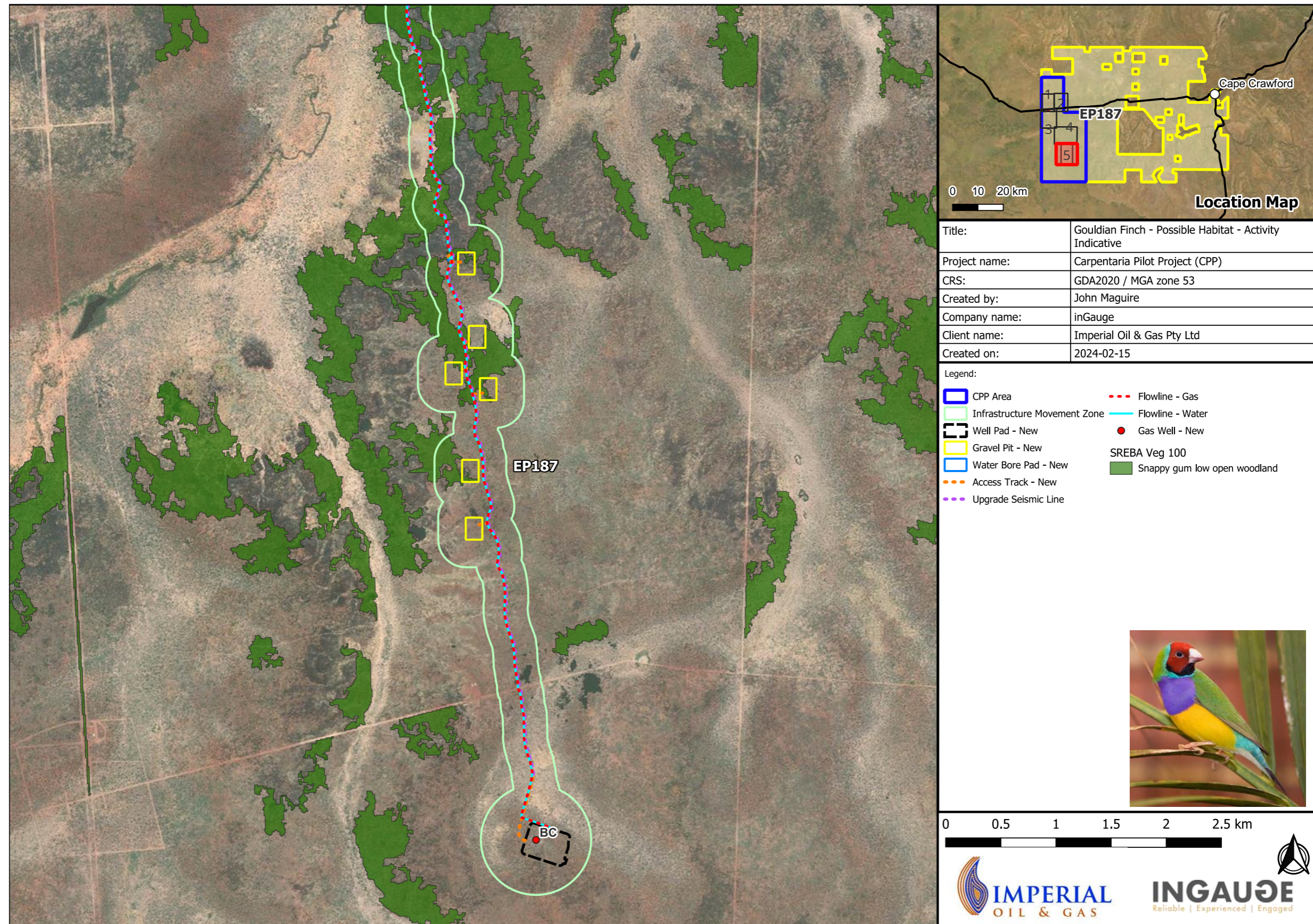


Figure 6.3—41 Potential Gouldian Finch Habitat and Perennial Waterholes in the CPP Area – Map 5

6.3.5 Potential Groundwater Extraction

Imperial will apply to increase its existing groundwater extraction licence from 85 ML/a up to 750 ML/a, which is less than 10% of the Georgina Basin petroleum cap of 8 GL/a under the WAP, and approximately 0.4% of the ESY.

Imperial does not consider the proposed volume of annual groundwater extraction to constitute a significant potential impact to available groundwater. In addition, Imperial proposes to reuse hydraulic fracturing flowback water, which would result in a groundwater extraction of up to 950 ML over a 5-year period.

The CPP Area is located on the Cambrian Limestone Aquifer (CLA). The CLA is vast and covers an area of approximately 570,000 km². Despite the large area of the CLA in the more arid south, which includes the Beetaloo, its regional contribution to the total throughflow to the rivers and springs located approximately 300 km north-west of the CPP Area, is minor compared to the CLA area north of the Beetaloo [S Tickell, 2022].

The volume of groundwater stored in the CLA is very significant: between 1,819,000 GL and 3,690,000 GL [A Knapton, 2020]. This volume is equivalent to more than 5,000 times the total volume of Sydney Harbour.

6.3.6 Aquifer Protection

The Cambrian Limestone Aquifer (CLA) is the recognised aquifer system at 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, 2022]. In the Beetaloo SREBA area, the CLA extends for up to approximately 700 km from Mataranka in the north to the Barkly Highway in the south.

In an east-west direction, the CLA 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 northern rivers and springs is minor compared to the areas north of the Beetaloo [S Tickell, 2022].

The volume of groundwater stored in the Gum Ridge Formation (GRF) aquifer is very significant; between 1,819,000 GL and 3,690,000 GL [A Knapton, 2020]. The GRF occurs as 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 GRF measured at five locations in the Beetaloo showed a variance of less than ± 0.1 m over a 3-year period, and no clear trends within or between hydrograph sites [S Tickell, 2022].

A key requirement of *the Code* in relation to groundwater monitoring in the Beetaloo is the requirement for a precautionary stratigraphic bore hole to be drilled at a new well pad (which potentially can be used as a water production bore), to the base of the deepest recognised aquifer.

Stratigraphic assessment is required in the Statement of Bore (Section 53 *Water Act 1992 (NT)*) to identify the aquifer(s) and respective interval depth(s). A gamma log should also be conducted on the open borehole to enable more accurate identification of aquifers in the CLA sequence [DENR, 2018].

The measured top and base of the Gum Ridge aquifer relative to ground level at different existing CPP well pads is shown in **Table 6.3—3**.

Table 6.3—3 Gum Ridge Aquifer Thickness at Existing CPP Well Pads

Bore Owner	RN	Top (mbgl)	Base (mbgl)	Thickness (m)
Imperial	RN041800	72	96	24
Imperial	RN042463	74	90	16
Imperial	RN042464	74	90	16
Imperial	RN041678	55	96	41

Each of the four petroleum wells that have been constructed on EP 187 has an independently validated and approved well barrier integrity verification (WBIV) program and monitoring report schedule as required under the relevant Well Operations Management Plan (WOMP) for each well. Further details on aquifer protection during well construction can be found in **Section 3** of the EMP.

Owing to the more than 60 m of low permeability, indurated, and weathered, kaolin clay soil that sits above the water table at CPP (**Section 6.2.3.2**), there is a low risk of the CLA aquifer being polluted from surface infiltration at the CPP Area. This soil layer acts as a surface aquifer protection zone. A conservative, worst-case, numerical modelling approach was used to assess both the potential area and depth of soil infiltration from spill scenarios at a CPP well pad.

This assessment is provided in EMP **Appendix 08** (Human Health and Environment Chemical Risk Assessment), which includes Appendix B (Potential Risk to Groundwater from Hypothetical Water Releases). The modelling results indicate that the HF chemicals that are organic CoPC (e.g., methanol and glutaraldehyde) would theoretically take approximately 100 years to infiltrate the soil to 20 m BGL. Both methanol and glutaraldehyde are also readily biodegradable, which makes this potential groundwater contamination scenario highly unlikely.

The potential for chloride contamination of well pad soil in the event of a spill is a key consideration in onshore gas developments. Chloride soil contamination due to 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 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 be likely to significantly impact future plant growth, without appropriate soil remediation (refer **Appendix 07** Spill Management Plan, **Section 4.2**).

Similarly, a sub-surface aquifer protection zone sits below the CLA aquifer basement of the CPP Area and the target Velkerri formation. This aquifer protection zone is approximately > 900 m of thick rock, which is 150% of *the Code* and international recognised minimum aquifer protection zone requirement of 600 m [The Royal Society et al., 2012]. This protection zone ensures that there is no potential connection between the much deeper shale HF operation and the base of the overlying CLA aquifer.

No PBT chemicals will be used during the Activity that pose a potential risk to human health and that could leave a lasting impact on groundwater if a significant spill were to occur, (**Appendix 08** Human Health and Environment Chemical Risk Assessment). In addition, CoPC in the HF fluid system is at such exceedingly low concentrations that the risk of potential toxicity effects to fauna in the area is extremely low.

Ongoing groundwater monitoring at each well pad and implementation of the ongoing well integrity management system required under the WOMP (EMP **Section 3**), will ensure long-term protection of the CLA aquifer from the Activity. *The Code* requirement for decommissioning wells is described in the EMP **Section 3.5.4**.

Ongoing groundwater monitoring in down-gradient production/monitoring bores (refer EMP **Section 4.10**) at all well pads will continue to be undertaken into the future until the petroleum wells and well pads are decommissioned to provide assurance that the Activity has not caused a detectable impact to groundwater quality.

6.4 Air Quality

6.4.1 Air Quality Monitoring

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, 2022a].

Owing to the remote nature of the location, measurement of particulate matter (PM) in accordance with the relevant Australian Standards was not practicable. The measurements were carried out using a light scattering particle sensor, which is portable, has a low power demand, does not require samples to be taken and does not have excessive maintenance requirements. To overcome these limitations, 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 results of the monitoring at Bullwaddy for October – November 2022 are shown in **Table 6.4—1** together with the NEPM standards. The measured average concentration for PM10 (Particulate Matter $\leq 10 \mu\text{m}$) for October – November 2022 was $14 \mu\text{g}/\text{m}^3$, well within the NEPM PM10 standard of $25 \mu\text{g}/\text{m}^3$. The measured maximum 24-hour PM10 concentration was $31 \mu\text{g}/\text{m}^3$, also well within the NEPM PM10 standard of $50 \mu\text{g}/\text{m}^3$.

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

Table 6.4—1 NEPM Limits and Bullwaddy Annual Average PM10 and PM2.5 concentrations

	Bullwaddy (average October – November)	Bullwaddy (24-hour maximum)	NEPM (annual average)	NEPM (daily limit)
PM10	$14 \mu\text{g}/\text{m}^3$	$31 \mu\text{g}/\text{m}^3$	$25 \mu\text{g}/\text{m}^3$	$50 \mu\text{g}/\text{m}^3$
PM2.5	$13 \mu\text{g}/\text{m}^3$	$30 \mu\text{g}/\text{m}^3$	$8 \mu\text{g}/\text{m}^3^*$	$25 \mu\text{g}/\text{m}^3^{**}$

* Reducing to $7 \mu\text{g}/\text{m}^3$ in 2025.

**Reducing to $20 \mu\text{g}/\text{m}^3$ in 2025.

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 high PM2.5 to PM10 ratio is unusually high compared with international figures, which likely reflects

the high smoke levels that arise during bushfires and burn-offs. Bushfire occurrence in the region is discussed further in **Section 6.4.2**.

Ongoing air quality monitoring at the Bullwaddy site, 89 km east of CPP, will provide a focused level of surveillance and air quality in the CPP Area and neighbouring Beetaloo petroleum operators [DEPWS, 2022a].

6.4.2 Atmospheric Processes

A key objective of NTEPA's Environmental Factor for Atmospheric Processes is to minimise greenhouse gas emissions so as to contribute to the NT Government's goal of achieving net zero greenhouse gas emissions by 2050 [NT EPA, 2022a].

This Policy applies to all new projects and expansion of existing projects likely to be 'large greenhouse gas emitters' with emissions that meet the emissions threshold of estimated scope 1 emissions of 100,000 tCO₂-e in any financial year over the life cycle of a project, not counting emissions generated from land clearing directly associated with the Activity.

6.4.2.1 GHG Emissions Baseline Assessment

The Methane and Greenhouse Gas Studies for the Beetaloo Sub-basin Strategic Regional Environmental and Baseline Assessment (the Methane Study) aimed to establish the greenhouse gas baseline for the Beetaloo Sub-basin [GISERA, 2019].

The Methane Study also establishes reference sites and a program for ongoing monitoring to address the requirements described in the final report of the Scientific Inquiry into Hydraulic Fracturing in the Northern Territory [A. Anderson et al., 2018] (the Inquiry) and therefore has been accepted as satisfying Section 4.1 of the Code [A. Anderson et al., 2018].

Australian tropical savannah bushfires annually burn approximately 200M tons of carbon, releasing an estimated 750 MtCO₂-e into the atmosphere, contributing approximately 5% of global emissions from bushfires [M Hill et al., 2010].

Consistent with this continental scale of savannah bushfires, a fire history report (2001-2023) was generated from the NAFI database linked area for the Activity, which encompasses the Sturt Plateau bioregion (~ 98,500 km²) to the west, and the Gulf Fall and Uplands bioregion (~112,500 km²) to the east and north of the CPP Area (see **Figure 6.4—1**).

On average, during the last decade, approximately 6,500-8,000 km² have been burned yearly in each of these bioregions, which is some 7% of the total area in each bioregion. Bushfires in both bioregions in 2023 were particularly widespread. Regional bushfires may have a seasonal impact on community health with an increased respiratory caseload [Jacobs, 2022].

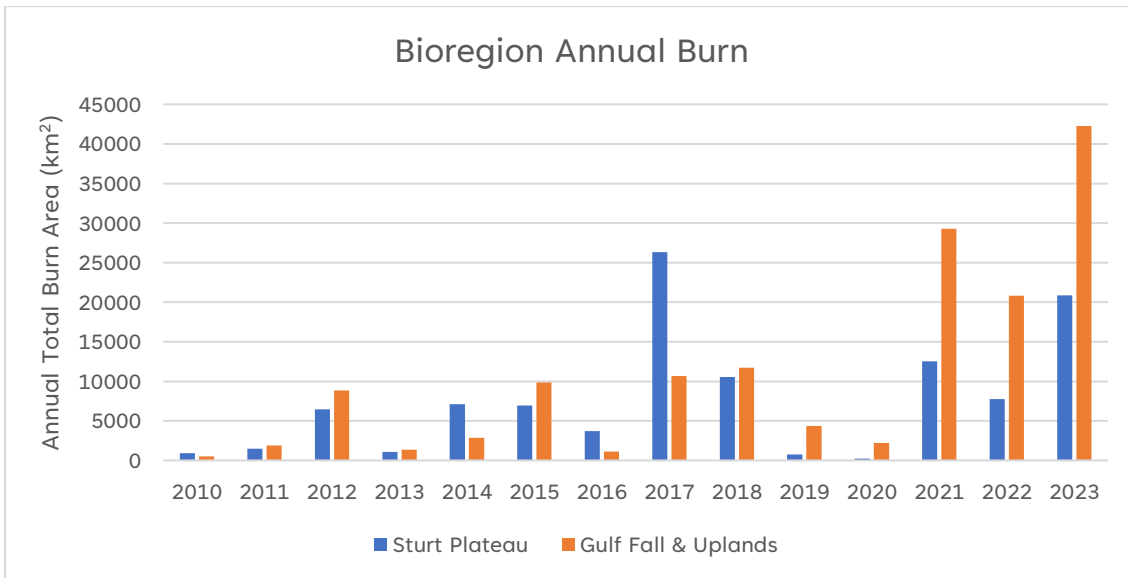


Figure 6.4—1 Bioregion Annual Burn History

6.4.2.2 CPP Greenhouse Gas Emissions

The *Greenhouse Gas Emissions Management for New and Expanding Large Emitters* [Northern Territory Government, 2021] policy details the minimum requirements for managing greenhouse gas emissions from new or expanding industrial and land use development projects

‘Large greenhouse gas emitters’ under this policy are industrial projects (e.g., petroleum, mining, extractive, refining or manufacturing projects) that exceed the emissions threshold of estimated scope 1 emissions of 100,000 tCO₂-e in any financial year over the life cycle of a project, excluding emissions generated from land clearing directly associated with the Activity.

Flaring the expected ~25 TJ/day during the appraisal phase would result in approximately 475,000 tCO₂-e of Scope 1 emissions annually. This rate of emission exceeds the threshold for large greenhouse gas emitters.

Before the Activity commences, Imperial will apply to the NT Minister for Mining and Industry for approval to recover petroleum on an appraisal basis under Section 57AAA of the *Petroleum Act 1984 (NT)*. If the Minister approves Imperial’s application the Activity will proceed without significant flaring with gas being exported to the McArthur River Gas Pipeline (MRGP).

Excluding flaring of gas to be exported to the MRGP, the average annual GHG estimated annual 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 tCO₂-e [NT EPA, 2022a]. (see **Figure 6.4—2**). A detailed breakdown of GHG emissions is provided in the EMP **Section 3**

(Table 3.9—4). The sourcing of proppant sand supply within the Beetaloo region will potentially further reduce GHG emissions.

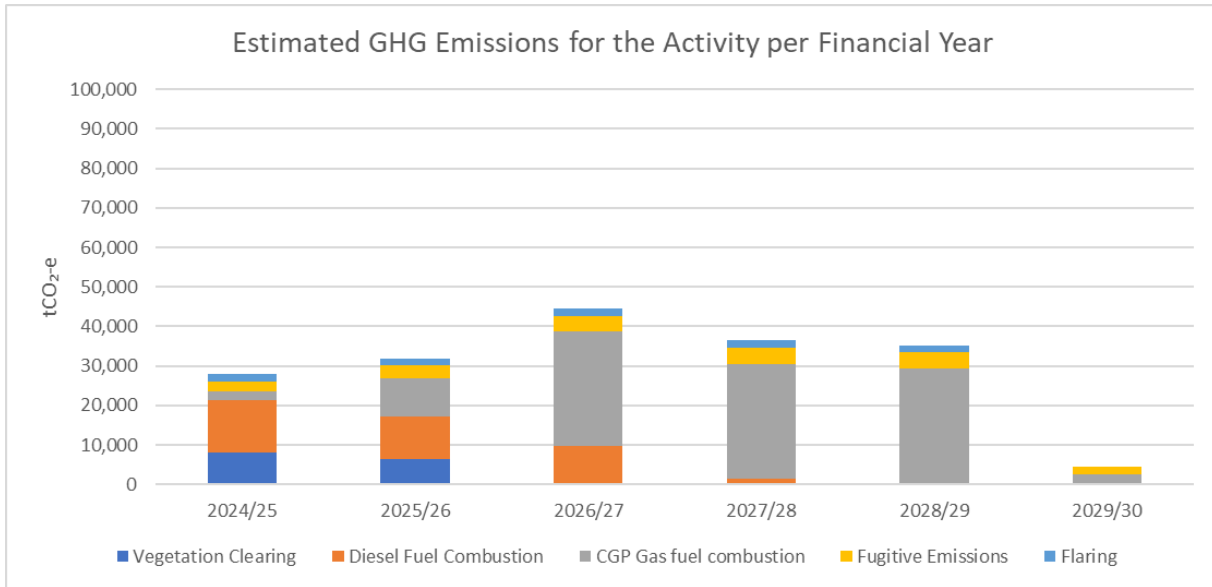


Figure 6.4—2 CPP Estimated Annual GHG Emissions

6.5 People

6.5.1 Community and Economy

A Stakeholder Engagement and Consultation Plan for the CPP Activity is contained in EMP **Section 5** – Stakeholder Engagement. The outcomes of the stakeholder engagement undertaken to date, for the proposed Activity including a Stakeholder Engagement Report and a Communications Log are contained in EMP **Appendix 10** (Stakeholder Engagement Report). An ongoing stakeholder engagement plan is also contained in EMP **Section 5**.

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 NT governments have allocated \$150 million to deliver upgrades on the Carpentaria Highway over four years [DIPL, 2023].

The upgrades involve sealing, reconstructing, widening, and lifting as well as other flood immunity improvements, commencing 2km east of the Carpentaria Highway intersection with the Stuart Highway at Birdum (Hi-Way Inn), approximately 202 km west of the Activity’s southern turnoff. The road will be sealed to a two-lane standard. The next stage of construction will take place between chainage 50 km and chainage 109 km east of Stuart Highway.

Construction commenced in early October 2023 and is expected to be completed in late 2024. 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 project. This work would leave approximately 93 km of the Carpentaria Highway with the single central seal to the turnoff to the southern part of the CPP Area.

The nearest homestead (West Balbarini) is approximately 1.3 km east of the CPP eastern boundary, and approximately 7.5 km east of the existing Carpentaria Highway turnoff to the campsite, WHS and CGP (refer to **Figure. ii** above in the **Executive Summary**). Most of the truck movements to the Activity will be from the west to this turnoff. Due to the distance from the main Activity, any nuisance to the homestead is unlikely.

The proposed CGP location is approximately 500 m south of the Carpentaria Highway, and the camp is approximately 2 km from the highway (**Figure 6.5—1**). These distances provide visual screening from the highway; however, a visual assessment has concluded that light glow from the Activity will be visible to any potential night-time highway traffic.



(Carpentaria Highway is to the left and the proposed CPP Area, is to the right.
McArthur River Gas Pipeline Corridor is to the right.)

Figure 6.5—1 500 m Buffer to Proposed CPP Area

A traffic impact assessment (TIA) was undertaken for the Activity (**Appendix 11**) for 2024-2025 inclusive. The predicted traffic volumes were compared against the Austroads (2021) Guide to Road Design – Part 3: Geometric Design, which identifies that on roads “... where traffic volumes

less than 150 vehicles per day and, particularly, where terrain is open, single carriageways may be used”.

The TIA determined that:

- Traffic volumes on the Carpentaria Highway presently 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 6.5—2**).
- 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-October. The baseline traffic is highest in June to August, which corresponds to the regional cattle muster season. CPP trucking would peak in August-September when the bulk of trucking sand to the CPP Area is scheduled to occur.

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.”

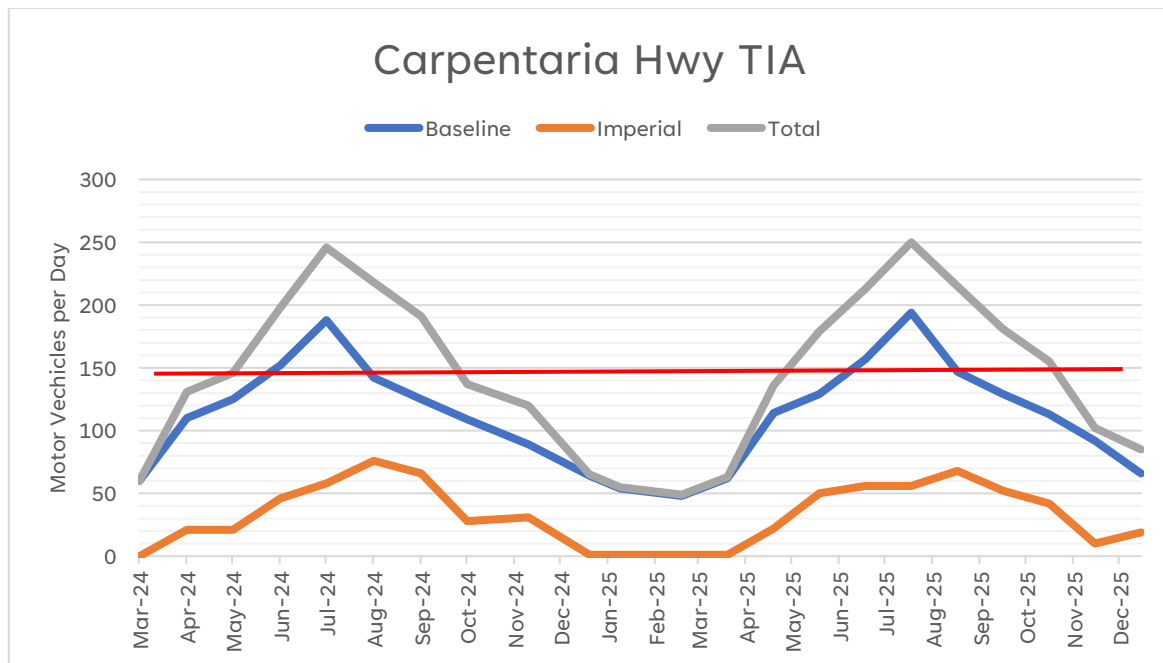


Figure 6.5—2 Traffic Impact Assessment Carpentaria Highway

6.5.2 Culture and Heritage

Imperial has facilitated ongoing field visits for Traditional Owners (TO) and the wider community to offer further opportunities to see the Activity being undertaken. Imperial has employed TO under the NLC Cultural Manager program to participate in previous EP 187 heritage clearances, seismic line and well pad clearing, drilling operations, hydraulic fracture operations, and HF flowback and flaring operations.

Feedback from stakeholders who have participated has been positive, providing an understanding of the scale and impact of current works. Field visits and employment of local businesses and cultural managers will continue to be an important part of ongoing engagement.

The CPP Area lies wholly within NT Portion 5706, which is an Indigenous estate for the Mambaliya Rrumburriya Wuyaliya Aboriginal Land Trust. The CPP Area encompasses several ALRA Section 19 lease holdings, which are run as extensive cattle grazing agistments, allowing livestock access to grassland, watercourses, and riparian areas within respective S-19 agistment leasehold areas.

In 2013, Imperial lodged an application for the 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 subsequently executed with Imperial in 5 February 2014, and approved by the Commonwealth Minister for ALRA. 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 under Part IV of ALRA.

The NLC Exploration Permit includes standard terms and conditions relating to:

- EP 187 work programs and consultation
- Annual reporting
- Sacred sites
- Employment and training opportunities
- Appraisal activities.

On 14 September 2016, the NT Government announced a moratorium on hydraulic fracturing of unconventional onshore reservoirs. The moratorium was subsequently removed on 17 April 2018 and published in *the Code* in 2019. Since that time, Imperial has conducted an active annual exploration program on EP 187 focused in the CPP Area, requiring annual stakeholder engagement meetings on-Country and has been proactively focusing on building respectful relationships with stakeholders, as the EP 187 shale exploration matures.

Imperial has a strong track record of engaging with Aboriginal people as custodians of the land and has attended more than 35 on-Country meetings across its permits since 2011. Materials for engagement include presentations, pictures, models, and videos to explain various stages of the current operations, facilitating open dialogue with company representatives present to listen to concerns and answer questions.

Imperial has conducted a series of archaeological surveys [S Jung, 2019, [Appendix 02]; 2021, 2023] in areas of petroleum exploration interest on EP 187, primarily within the CPP Area. These surveys, conducted with Senior Traditional Owners as Cultural Advisors, have significantly expanded understanding of the Area's ancestral resources, sacred sites, and other features.

The most recent survey was done in September and October 2023 to facilitate the location of the proposed four new well pads (to be selected from five sites to be investigated), and access corridors and related facilities, including WHS, CGP and the campsite.

The survey crew included three Traditional Owners and was conducted with an archaeologist and an environmental ecologist over a three-day period utilising an aviation resource. The results of the survey found no archaeological sites in the proposed disturbance areas. The report states that the proposed works are cleared and comply with the requirements of the *Heritage Act 2011* (NT), as no archaeological material was found (further information is available in **Appendix 02** Cultural and Heritage Assessment Report).

The report concludes that Relief Creek is identified as an area of high archaeological potential in the CPP Area. The remainder of the CPP Area has a low potential for archaeological sites, apart from some of the braided creeks north of the highway that are more likely to have a higher archaeological potential (Jung, 2023 [**Appendix 02**]).

All previous petroleum exploration activities by Imperial on EP 187 were undertaken with an Aboriginal Areas Protection Authority (AAPA) Authority Certificate. A new authority certificate from the AAPA for the Activity is required before the Minister for Environment Parks and Water Security can approve the EMP. The Activity is being assessed by the AAPA.

6.5.3 Human Health

Chemicals that may be used in wells for hydraulic fracturing are disclosed, in compliance with the DEPWS EMP Content guideline, in the EMP's **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.

An 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.

The large quantity of sand needed for HF, was identified as a potential health risk due to potential exposure of onsite workers to silica dust. This has been addressed in the well pad design and operational risk assessments and handling procedures. The purchase of damp sand for HF operations will reduce potential occupational silica exposure to also mitigate this risk.

The CoPC in the HF fluid system are at extremely low concentrations (mg/L or ppm), and any potential toxicity effects to fauna are negligible.

Laboratory analysis of drilling waste from 3 existing CPP petroleum wells has been conducted in accordance with regulatory requirements. The waste has been classified as suitable for unconfined disposal (burial and capping – in situ onsite landfill); the material does not contain elevated CoPC and is considered inert.

The HF flowback contains chemicals used in the HF, principally guar gum, friction reducers and residual biocide. It may also contain geogenic (earth origin) constituents of potential concern. Analysis of HF flowback from three previous CPP wells shows that the CPP HF flowback is of suitable quality for reuse in HF operations, reducing the volume disposed offsite and the total volume of groundwater extracted for HF operations.

Key environmental CoPC in CPP flowback water include Chloride, Lithium, Phenol, and Biocide (TTPC) because of their respective levels and associated potential toxicity. In addition, the high organic load in HF flowback will require strategies to optimize digestion. A breakdown of key CoPC is presented in **Table 6.5—1**.

Table 6.5—1 Key CoPC

Constituent	95% UCL Value	Notes
Chloride salts	34,000 mg/L	Chloride contamination of soil is the most frequently reported pollution problem occurring at shale well pads in North America due to spills of HF flowback. Elevated chlorides in HF flowback are primarily from geogenic sources in the target shale formation.
Lithium	20 mg/L	A naturally occurring metal that tends to accumulate in water systems due to its high-water solubility and mobility characteristics. The health-based screening level of lithium in drinking water is 10 µg/L. The lithium in HF flowback is primarily from geogenic sources in the target shale formation.

Constituent	95% UCL Value	Notes
Manganese	14 mg/L	A naturally occurring metal that has relatively low solubility in water. The health-based screening level of Mn in drinking water is 10 µg/L (ppb). The elevated Manganese in HF flowback is primarily from geogenic sources in the target shale formation.
Alpha	166 Bq/L	A naturally occurring radionuclide particle commonly found in soil, water, and rock. The health-based screening level of Alpha particles in drinking water is 0.5 Bq/L. The elevated Alpha in HF flowback is from geogenic sources in the target shale formation. Alpha particles are not soluble in water, but they may be suspended. Analyses of NORM from many different oil and gas fields show that produced water may contain 224 Ra, 226 Ra and 228 Ra in concentrations of up to a few hundred Bq/L (IAEA, 2003).
Phenol (hydroxy-benzene)	109 mg/L	Phenol is readily soluble and slightly persistent in water, with a half-life of between 2 to 20 days. Acute toxic effects may include the death of animals, birds, or fish, and death or low growth rate in plants. A freshwater moderate reliability trigger value of 320 µg/L was derived for phenol (ANZECC, 2000).
Tetrakis (hydroxy-methyl) phosphonium chloride (TTPC)	< 28mg/L	TTPC is a biocide that is particularly effective at low concentrations in managing gram-negative bacteria; a key biocide characteristic needed to manage bacterial communities in CPP water. It is stable over a wide pH range and is not susceptible to photodegradation and is of comparatively low toxicity to non-aquatic life. TTPC is biodegradable, but not readily biodegradable. It is strongly absorbed by soil and sediment. TTPC is not expected to bioaccumulate. TTPC concentration in CPP water is significantly lower (5-fold) than observable effects on drinking water for birds. The drinking water TTPC < 150 mg/L. This is much higher than the predicted maximum concentration in CPP water, indicating its presence does not present a threat to terrestrial fauna. However, TTPC is very toxic to aquatic life with potentially longer lasting effects.

6.6 Rainfall Analysis

Appraisal operations will occur 24 hours a day, 365 days per year, including during the Wet Season (November to March). Weather conditions will be monitored daily during the Wet Season in accordance with the EMP. A detailed rainfall design analysis is provided in EMP **Appendix 06** (Waste and Wastewater Management Plan). A summary is provided below.

The monthly average rainfall as a percentage of total annual rainfall during the Dry Season (April to October inclusive) is < 8% of the annual average total rainfall **Figure 6.6—1**. On average, there are 195 days with no-rain each year in the CPP Area. Rainfall in this arid period is highly variable, as described in the EMP – **Section 4** (Description of the Environment).

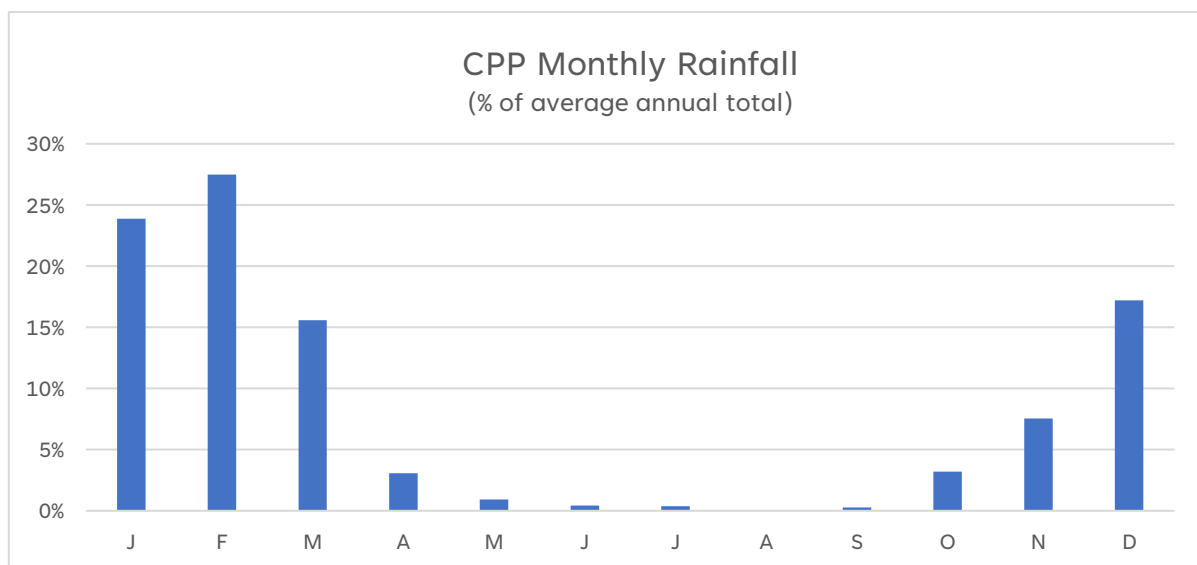


Figure 6.6—1 CPP Area Monthly Rainfall as % of Annual Average Total

Analysis of daily rainfall data from the McArthur River Mine shows that between about 70 and 190 annual cumulative rain events of greater than 100 mm in less than 7 days have occurred since 1965, as shown in **Figure 6.6—2**. Heavy vehicle access may be significantly affected during such events, which may impact the schedule set out in **Figure 5.2—2**.

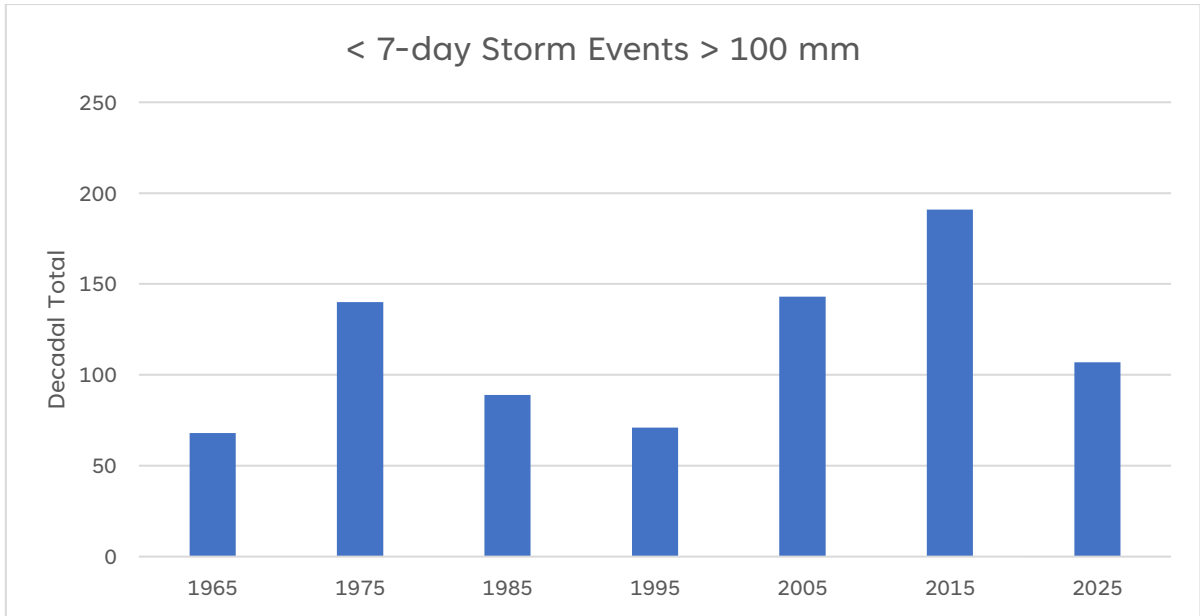


Figure 6.6—2 High Rainfall Events – McArthur River Mine

7 Risk Assessment

7.1 Methodology

Petroleum (Environment) Regulations 2016 (NT) (PER) Schedule 1 Clause 3 requires details of all environmental impacts and environmental risks of a 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 an Environmental Risk Assessment (ERA) for the Activity. 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. This model assesses 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.

Section 6 (Environmental Risks and Mitigation Measures) of the EMP presents a detailed ERA. The ERA 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 7.1—1**.

Table 7.1—1 Environmental Risk Assessment: Risk Matrix

Consequence		Negligible	Minor	Moderate	Major	Critical	
		I	II	III	IV	V	
Likelihood	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

The ERA identified sensitive environmental factors, and their initial and residual risk rankings. The results of the ERA for environmental factors with an initial risk ranking of 4 and 5 are summarised in **Table 7.1—2**.

The full risk assessment table is provided in **Table 6.1 – 6** of the **EMP**.

Table 7.1—2 Summary Environmental Factors - Higher Initial Risk Rankings

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	Wastewater flowline leak 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

7.2 Environmental Outcomes & Measurement Criteria

The EMP has been developed to comply with the *Petroleum (Environment) Regulations 2016* (NT) and *the Code*. This includes the Activity's Environmental Outcomes, also called Environmental Performance Standards (EPS), and SMART¹ Measurement Criteria, to be used in determining whether an environmental outcome or EPS has been met.

The approach used in developing the Activity's Environmental Outcomes (EO) includes a combination of the key Environmental Factors and Risk sources to align the corresponding Measurement Criteria and Activity monitoring for record-keeping purposes. The Activity's Environmental Outcomes, Residual Risk ranking are detailed in the EMP **Section 6** (Environmental Risks and Mitigation Measures).

The key residual risk of significance arises from the onsite storage of significant inventory volumes of HF Flowback, stored in above-ground covered tanks either at the well pads or the WHS. While catastrophic failure of one of these tanks is extremely unlikely, tank overflow or other scenarios could potentially lead to significant soil and surface water contamination with chloride salts and other CoPC. The Activity's design and associated statutory management plans underline the principles of the Activity:

- Isolation
- Integrity
- Containment
- Monitoring to manage Residual Risks.

7.3 Cumulative Impact

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 prior to 2013 have been excluded based on the assumption that the land has been fully rehabilitated and no additional monitoring is required.

¹ Specific, Measurable, Achievable, Relevant

Table 7.3—1 Estimated Cumulative Impacts for Approved Activities within Cumulative Study Area

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 ~	~ 65 LV and ~29 HV per week (average)	~51 average	Yet to commence.
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.

7.4 Significant Impact and Offset Assessment

Referring a proposal to the NT EPA; Environmental impact assessment; Guidance for proponents 2021 details the matters the NT EPA may have regard to in determining whether a proposal is capable of having a significant impact on the environment, including the following:

1. Objects of the Environment Protection Act 2019 or other NT environmental legislation.
2. Value (e.g., effects on environmental factors and objectives), sensitivity and quality of the environment which is likely to be impacted.
3. Extent (intensity, duration, magnitude, frequency, and geographic footprint) of likely impacts.
4. Consequence of likely impacts (or change).
5. Resilience of the environment to cope with the impacts or change.
6. Cumulative impact with other proposals.
7. Connections and interactions between parts of the environment to inform a holistic view of impacts to the environment.
8. Level of confidence in the prediction of impacts and the success of proposed mitigation.

The NT EPA may also consider:

- Its guidance on particular matters or standards endorsed by the NT EPA.
- Relevant definitions of significance under the Environment Protection and Biodiversity Conservation Act 1999 (Commonwealth; EPBC Act) and national standards, e.g., National Environment Protection Measures (NEPM), against which a proposal can be assessed.
- The presence of planning or policy frameworks and/or other statutory decision-making processes that can regulate the mitigation of the potential impacts of a proposal on the environment.
- Previous decisions of the NT EPA on the significance of impacts.

The results of the EMP Risk assessment (**Section 6** – Environmental Risks and Mitigation Measures) demonstrate that:

- The Activity can be suitably managed, and risks will be addressed.
- The Environmental Performance Standards and associated Measurement Criteria (EMP **Section 6**) monitor how the Outcomes are met.

- The statutory management plans in EMP Section 7 and appendices describe how this is achieved.
- The implementation strategy of the proposed Activity is described the EMP Section 8.
- A significant residual impact is not considered likely for the proposed Activity.

The proposed increase in cleared area is modest for the scale of potential energy production from the Activity. The Activity includes the expansion of the total Activity operational land disturbance footprint by up to ~226 ha (including 21 ha of contingency area for access tracks, flowlines and pipelines) which is ~0.05% of the 442,700 ha area of EP 187.

The estimated annual average GHG emissions over the term of the EMP are well below the large emitter threshold of 100,000 tCO₂-e/annum.

Carpentaria Highway is being upgraded in a \$150 million project. Stage 1 was completed in November 2023, with completion to chainage point 50km from the Stuart Highway. Stage 2 will complete the upgrade to chainage point 109 km and is expected to be complete in late 2024. Stage 2 will include construction of one passing section approximately 1.5 km long, midway along the 93 km length from chainage 109 km to the turn-off to southern part of the CPP, which is approximately 202 km east of the Stuart Highway.

Stakeholders have been engaged and land access agreements will be in place with affected parties, and the EMP will be submitted for public comment and input.

During the Activity, workers' health and safety will be protected by the implementation of the contractor's safety management system.

As such, no offset assessment and delivery are therefore considered to be required for State or Commonwealth matters.

8 Conclusions

The conclusions of the EMP referral assessment are as follows:

- The produced CPP gas from previous campaigns has low levels of CO₂ and hydrogen sulphide.
- The Activity is unlikely to have a significant impact on environmental values protected under the *Environment Protection Act 2019* (NT) if gas produced is recovered on an appraisal basis rather than flared. This appraisal gas production would be equivalent to approximately 475,000 tCO₂-e/annum, if flared rather than exported to the McArthur River Gas Pipeline.
- Imperial will apply to the Minister for Mining and Industry for approval to recover petroleum on an appraisal basis under Section 57AAA of the *Petroleum Act 1984* (NT). If successful, this will allow Imperial to export gas to the McArthur River Pipeline.
- Total GHG emissions from the Activity appraisal stage are reduced by more than 90% without flaring of gas. Annual average estimated GHG emissions are approximately 30,000 tCO₂-e from FY 2024 through FY 2029 (5-year term of 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 tCO₂-e
- Imperial will apply for an increased volume of allowable groundwater extraction under GWEL GRF10316 from 85 ML/a up to 750 ML/a. The increased volume is 7.5% of the proposed 10 GL GWEL cap on Beetaloo petroleum production in the Georgina Wiso WAP, and 0.36% of the WAP ESY of 210 GL/a. In terms of the Georgina Basin, in which the CPP is located, the volume of 750 ML/a is less than 10% of the Georgina petroleum cap of 8 GL/a, and approximately 0.4% of the Georgina ESY of 186 GL/a. The overall maximum ground water total to be extracted over the CPP EMP 5-year period is estimated to be approximately 950 ML.
- The Risk Assessment of chemicals to be used in hydraulic fracturing did not identify any PBT chemicals harmful to human health, in terms of measured Persistent, Bio-accumulative, and Toxic (PBT) criteria. In addition, the concentration of CoPC in the HF fluid system is extremely low and potential toxicity effects on local fauna are therefore very low (EMP **Appendix 08** Human Health and Environment Chemical Risk Assessment).
- Analysis of the HF flowback/water from three previous EP 187 wells indicates compatibility with complete reuse in subsequent HF operations. This reduces the volume of HF Flowback fluid disposed offsite. This significantly reduces potential cumulative transport impacts from the Activity, including GHG emissions.

- The key CoPC in HF flowback may be Chlorides, Lithium, Alpha, Phenol, and the Biocide Tributyl Tetradecyl Phosphonium Chloride (TTPC). The ability of these chemicals to cause environmental harm will depend upon their concentration and associated toxicity and the associated conditions of the spill event and spill response as outlined in EMP **Appendix 07** – Spill Management Plan. The concentration of CoPC in the HF flowback is considered most unlikely to present potential toxicity effects on local fauna (EMP **Appendix 08** – Human Health and Environment Chemical Risk Assessment). The HF flowback is also unlikely to be palatable due to elevated salinity, so risks are therefore very low.
- As outlined in HF flowback spill infiltration modelling (EMP **Appendix 07**), predicted soil chloride concentration rapidly attenuates with depth. However, predicted chloride concentration increase in the surface soil may exceed 25 mg/kg at a spill site. The resultant cumulative increase in potential chloride concentrations at a spill site is likely to significantly impact on future plant growth without appropriate soil remediation. The proposal to have a central WHS for reuse HF flowback provides a high level of confidence in containment and integrity in managing HF flowback at CPP.
- The use of a buried polyethylene flowlines, constructed in compliance with the Australian *Polyethylene Gathering Network (PEGN) Code* to transfer high volumes of HF flowback between well pads and WHS provides a high level of confidence in containment and integrity in managing HF flowback transfer.
- The site selection process takes into consideration environmental values and includes avoidance of adverse impacts to these values to as low as reasonably practicable and acceptable; it includes the Activity's principles of Isolation, Containment, Integrity.
- The additional land area to be cleared for the proposed CPP Activity is ~ 226 ha (including 21 ha of contingency area for access tracks, flowlines and pipelines) which is ~0.05% of the 442,700 ha area of EP 187. The area of vegetation to be cleared for infrastructure development is considered ALARP and acceptable.
- The first-year average site labour force is estimated to be 130 personnel; peak site labour force is estimated to be up to about 280 personnel.
- The proposed land disturbance area includes a dedicated campsite south of the Carpentaria Highway and accessed by a private access track. It will not be visible from the highway, other distant light glow visible to any potential night-time highway traffic.
- The present 4-year government program to deliver Carpentaria Highway upgrades [DIPL, 2023] will take place between chainage 50 km and chainage 109 km east of Stuart Highway 7 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 this program. Construction commenced in early October 2023 and be completed in late 2024.

- The Activity is an appraisal testing project for production of shale gas in the Beetaloo. There are no existing commercially producing shale gas analogues to draw from in Australia. If the Appraisal Phase is not successful, the residual environmental impacts from the Activity are unlikely to be significant.
- Overall land clearing and groundwater requirements are modest. There are no pits, waste rock or tailing dams that are to be left behind. Rehabilitation of the well pads, water handling station and other disturbance areas will be facilitated by site selection on deep sandy clay loam tussock grass country in the Sturt Plateau.
- The well pad includes a multi-well pad design, which significantly scales up potential energy production intensity at a well pad, and:
 - Maximises petroleum production so that the optimum value of the resource is returned to the NT (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]).
- 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 significantly enhance native savannah tussock grassland recovery in the rehabilitation of disturbed sites to baseline conditions.
- The EMP specifies arrangements for recording, monitoring, and reporting information in a manner that will enable the Minister for Environment, Parks and Water Security to determine whether the environmental outcomes and environmental performance standards in the EMP are being met.
- Stakeholder engagement has been ongoing since EP 187 exploration recommenced in 2019 and will continue throughout the life of the Activity. A Stakeholder Engagement and Consultation Plan for the CPP Activity is contained in the EMP **Section 5** – Stakeholder Engagement. The outcomes of the stakeholder engagement undertaken to date, for the proposed Activity, including a Stakeholder Engagement Report and a Communications Log, are contained in the EMP **Appendix 10** (Stakeholder Engagement Report).

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