









TOTALENERGIES EP PNG LIMITED

PAPUA LNG

PAPUALNG

Upstream Environmental Impact Statement
PRL-15 Addendum

Main Report and Appendices

PAPUA LNG is operated by a subsidiary of TOTALENERGIES S.A in joint venture with

TotalEnergies ExxonMobil Santos JX

Client Contact:	Christian Ille christian.ille@totalenergies.com

ERIAS Contact:	Luci David luci.david@eriasgroup.com
ERIAS Alternative Contact:	Andrew Todd-Weckmann Andrew.todd@eriasgroup.com

Document	Date	Compiled by	Checked by	Authorised by
01215E_81_v1	08/2024	A. Todd-Weckmann, A. Wright, C. Dixon, C. Monahan, I. Pym, I. Woxvold, L. David	A. Todd-Weckmann, A. Togolo, C. Monahan, L. David	L. David
01215E_81_v2	09/2024	A. Todd-Weckmann, A. Togolo, C. Monahan, I. Pym, I. Woxvold L. David	A. Todd-Weckmann, C. Monahan, L. David	L. David
01215E_81_v3	11/2024	A. Todd-Weckmann, I. Woxvold, C. Monahan, I. Pym, L. David	A. Todd-Weckmann, C. Monahan, A. Corr, L. David	L. David

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Appendices

Appendix 1 SLR Papua LNG CPF P3 Relocation. Air Quality Impact Assessment

Appendix 2 SLR Papua LNG CPF P3 Relocation. Noise Impact Assessment

Glossary

Term	Definition
dBA LAeq	the equivalent continuous sound level in decibels that has the same total sound energy as the fluctuating level being measured. dBA LAeq is particularly relevant for human exposure because it emphasizes frequencies that the human ear is most sensitive to.
dBA Leq	the sound level in decibels that has the same total sound energy as the fluctuating level being measured.
enhanced propagation	worst-case meteorological conditions
intangible cultural heritage	the practices, representations, expressions, knowledge and skills, and the instruments, objects, artifacts and cultural spaces associated therewith that communities, groups and, in some cases, individuals recognize as part of their cultural heritage (UNESCO, 2003).
neutral propagation	calm meteorological conditions
tangible cultural heritage	cultural heritage values that have a physical presence and can be seen or touched; they include archaeological sites where physical remains of past cultural activity are present (e.g., pieces of pottery or shell on the ground surface); landscape features, such as hills, caves and river mouths; and individual trees or stands of vegetation or other landscape or biogeographic manifestations of spiritual, sacred or ritual significance. In addition, tangible cultural heritage values include movable material cultural items (e.g., ancestral heirlooms and traditionally made items used in day-to-day subsistence or leisure activities).
Type I ecosystem service	provisioning, regulating, cultural and supporting ecosystem services, over which the client has direct management control or significant influence, and where impacts on such services may adversely affect communities.
Type II ecosystem service	provisioning, regulating, cultural and supporting ecosystem services, over which the client has direct management control or significant influence, and on which the project directly depends for its operations.

Abbreviations

Abbreviation	Definition
AASS	actual acid sulfate soil
AGRU	acid gas removal unit
amsl	above mean sea level
ANC	acid neutralizing capacity
ASS	acid sulfate soils
AusRivAS	Australian River Assessment System
bbld	barrels per day
BTEXN	benzene, toluene, ethylbenzene, xylene and naphthalene
CCRA	climate change risk assessment
CEPA	Conservation and Environment Protection Authority

Abbreviation	Definition
CESMP	construction environmental and social management plan
CHMP	cultural heritage management plan
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CO	carbon monoxide
CO_2	carbon dioxide
COF	construction offloading facility
CPF	central processing facility
CR	Critically Endangered
dBA	A-weighted decibel
DD	Data Deficient
DPE	Department of Petroleum and Energy
DSP	Delta Swamps and Plains
EIA	environmental impact assessment
EIR	environment inception report
EIS	environmental impact statement
EMPNGA	ExxonMobil PNG Antelope Limited
EMVAR	environmental monitoring verification audit and reporting
EN	Endangered
Environment Act	*Environment Act 2000*
EPR	export pipeline route
ESBS	environmental and social baseline studies
ESMP	environmental and social management plan
ESMS	environmental and social management system
FEED	front end engineering design
FIMS	Forest Inventory Mapping System
GHG	greenhouse gas
GIS	geographical information system
H_2S	hydrogen sulfide
HDD	horizontal directional drilling
HP	high pressure
HSE	health, safety and environment
HSSE	health, safety, security and environment
IAQM	Institute of Air Quality Management
IECA	International Erosion Control Association
IESC	independent environmental and social consultant
IFC	International Finance Corporation
IHM	Indigenous Heritage Management
IPR	independent peer reviewer
IUCN	International Union for Conservation of Nature
JPHL	Jerilai Pujari Holdings Limited

Abbreviation	Definition
LIDAR	light detection and ranging
LLG	local level government
LNG	liquefied natural gas
LoR	limit of reporting
MMscfd	million standard cubic feet per day
MOF	module offloading facility
MPH	Middle Purari Hills
MSL	mean sea level
Mtpa	million tons per annum
Mv	Mangroves
NEMP	national environment management plan
NGO	non-government organization
NLB	new logistic base
NMAG	National Museum and Art Gallery
NO_2	nitrous dioxide
NO_X	oxides of nitrogen
NT	Near Threatened
PAH	polycyclic aromatic hydrocarbons
PAOI	Project area of influence
PASS	potential acid sulfate soil
PCS	pre-clearance surveys
PFAS	perfluoroalkyl and polyfluoroalkyl substances
PFHxS	perfluorohexane sulfonate
PFOS	perfluorooctane sulfonate
PIIM	project induced in-migration
$PM_{2.5}$	particulate matter with an aerodynamic diameter of 2.5 μm or less
PM_{10}	particulate matter with an aerodynamic diameter of 10 μm or less
PNG	Papua New Guinea
PNGRIS	Papua New Guinea Resource Information System
ppm	parts per million
PRL	Petroleum Retention Licence
RAP	Resettlement Action Plan
ROW	right-of-way
RR	restricted-range
RSD	relative standard deviation
SC	Southeast Coast
SEMP	stakeholder engagement management plan
SEP	stakeholder engagement plan
SH	Southeast Hills
SO_2	sulfur dioxide
SPMT	self-propelled modular transporter

Abbreviation	Definition
SRI	Social Research Institute
TEP PNG	TotalEnergies EP PNG Limited
TPH	total petroleum hydrocarbons
TSP	total suspended particulate
TSS	total suspended solids
US EPA	United States Environmental Protection Agency
VCA	vegetation clearance area
VOC	volatile organic compound
VU	Vulnerable
WHO	World Health Organization

1. Introduction

1.1 Overview

TotalEnergies EP PNG Limited (TEP PNG), and its joint venture partners are planning the development of the Elk-Antelope gas fields of Petroleum Retention Licence 15 (PRL-15), in Kikori District, Baimuru Rural Local Level Government, Gulf Province, Papua New Guinea. TEP PNG is the operator of the Papua LNG Project (the 'Project') on behalf of the joint venture partners.

The Project will comprise two components (Figure 1.1):

- Upstream: production, well development and associated infrastructure at the Elk-Antelope gas fields, construction and operation of an upstream central processing facility (CPF), onshore and offshore gas and condensate export pipelines to the liquefied natural gas (LNG) plant in Caution Bay and offshore project infrastructure in Caution Bay.
- Downstream: expansion of the existing LNG plant in Caution Bay, 20 km northwest of Port Moresby.

TEP PNG will design, construct and operate the upstream aspects of the Project. ExxonMobil PNG Antelope Limited (EMPNGA) will design, construct and operate, and seek approval for, the Project's downstream facilities.

The following environmental impact statement (EIS) has been submitted to support the environment permit application process for the Upstream Project. The Upstream Environmental Impact Statement (2019 Upstream EIS) (ERIAS, 2019) was submitted to the CEPA on 13 December 2019 and is currently being assessed by the Independent Peer Reviewer (IPR).

This document provides an environmental and social assessment of substantial changes within PRL-15 since the 2019 Upstream EIS was submitted:

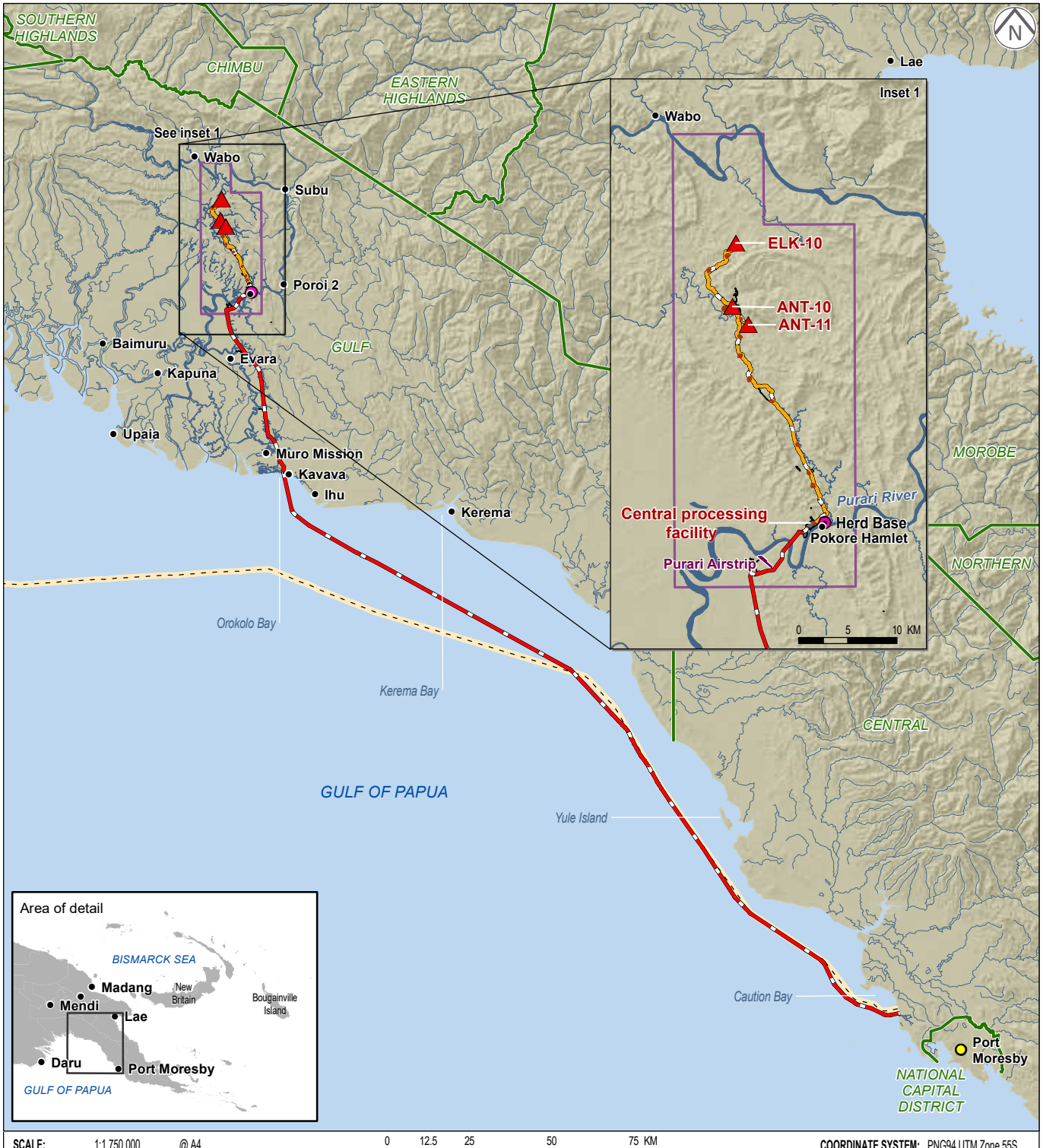
- Relocation of the CPF.
- Acid gas management strategy.

This PRL-15 EIS Addendum (EIS Addendum) will be provided to CEPA for assessment by the IPR and inclusion in the Level 3 environment permit to be issued for the Upstream Project.

Project Location

Papua LNG Project | PRL-15 EIS Addendum

FIGURE 1.1



1.2 Project Proponent

The Papua LNG Project Joint Venture participants are:

- TEP PNG (an affiliate of TotalEnergies SA).
- EMPNGA and ExxonMobil PNG Elk Limited (affiliates of Exxon Mobil Corporation (ExxonMobil)).
- JX Nippon Oil and Gas Exploration (Papua LNG) Pty Ltd.[1]
- Pac LNG Assets Limited, Pac LNG International Limited, Pac LNG Investments Limited, Pac LNG Overseas Limited and Pac LNG Holdings Limited (affiliates of Santos Limited).

The State of Papua New Guinea, through the government and the legally recognised landowners, have rights under the *Oil and Gas Act 1998* to acquire up to a 22.5% participating interest in the development license. Should this right be exercised, the current participating interests would be reduced accordingly.

1.3 Report Purpose, Scope and Structure

This EIS Addendum has been prepared in accordance with the *Environmental Act 2000*. The assessment, along with the 2019 Upstream EIS will inform the decision from the Papua New Guinea Environment Council and Minister for Environment and Conservation for the approval of the Upstream Project.

This EIS Addendum considers substantial changes within PRL-15 since the 2019 Upstream EIS was submitted.

The structure of this EIS Addendum follows the table of contents for the 2019 Upstream EIS with the exception of the marine existing environment and impact assessment chapters and the cumulative assessment chapter. These chapters have been removed as they are not relevant to the changes being assessed. Where there are no substantial changes, the descriptions of the Project (including impact assessments and proposed management measures) provided in the 2019 Upstream EIS remain relevant and will not be repeated in the EIS Addendum (see Chapter 3).

A convention further to those described in Section 1.5.5 of the 2019 Upstream EIS has been adopted for this EIS Addendum, whereby legacy wellpads are named using sentence case, e.g., Antelope-1 and Elk-4, and development wellpads are abbreviated in capitals, e.g., ELK-10 and ANT-11.

1.4 References

ERIAS. 2019. Papua LNG Project Upstream Environmental Impact Statement. 01215B_23_v5. December. Unpublished report to Total E&P PNG Limited.

1 JX Nippon Oil and Gas Exploration (Papua LNG) Pty Ltd became a Papua LNG Project Joint Venture participant on 6 July 2023.

2. Regulatory Framework

2.1 Overview

The description of the legal and other requirements relevant to the Upstream Project, provided in Chapter 2 of the 2019 Upstream EIS (ERIAS, 2019), identifies the main laws, regulations and policies applicable to the Project. The regulatory framework comprises the following:

- Papua New Guinea legislation, including the Conservation and Environment Protection Authority (CEPA's) operational procedures and codes of practice under the *Environment Act 2000* (*Environment Act)* and supporting *Environment (Prescribed Activities) Regulation 2002* (the regulation).[1]
- Relevant international conventions and agreements ratified by Papua New Guinea.
- International environmental and social guidelines and industry standards.
- TEP PNG environmental and social standards relevant to the Project.

To date, TEP PNG has submitted to CEPA the following documents to obtain approval for construction of the Upstream Project, in accordance with the requirements set out in the *Environment Act*:

- Notification of Intent to carry out preparatory works (s. 48) (submitted October 2015).
- Environment permit application (s. 60) (submitted October 2015). Subsequently, the Director advised the Project is classified as a Level 3 Activity Sub-Category 18: Petroleum and gas production and processing, and that an EIA would be required (s. 50).
- Environment Inception Report (EIR) (s. 52) (submitted October 2016). The Director approved the EIR in December 2016. The EIR was revised and resubmitted in June 2019.
- Upstream EIS (s. 53) (submitted December 2019). Currently being assessed.
- Upstream Project Construction Environment and Social Management Plan (CESMP) (submitted September 2021 (ERIAS, 2020)). Currently being assessed.

There is no clear mechanism under the *Environment Act* regarding changes to environment permit applications, i.e., changes to a project once the EIS has been submitted, is being assessed and prior to issue of the Level 3 environment permit. There is only a process for amendment to environment permits that have been granted (s. 71).

1 The *Environment (Amendment) Act 2014* documents amendments to the Environment Act, including some changes to the environmental impact assessment (EIA) process; however, as of 14 April 2022, noting that no further update is available, it is understood that only Part II of the Environment (Amendment) Act has commenced (PILIN, 2024). Therefore, the discussion in this section aligns with the Environment Act.

TEP PNG has consulted with CEPA and agreed to submit an addendum to the 2019 Upstream EIS, as an update to that document, capturing substantial changes to the Project description and the associated environmental and social impacts that require assessment under the *Environment Act*. The EIS Addendum and 2019 Upstream EIS will be the subject of the Independ Peer Review required by CEPA to evaluate the Project and assist with the drafting of the environment permit.

This EIS Addendum has been prepared considering the Guideline for Conduct of Environmental Impact Assessment and Preparation of Environmental Impact Statement (DEC, 2004).

2.2 References

DEC. 2004. Guideline for Conduct of Environmental Impact Assessment and Preparation of Environmental Impact Statement (GL-ENV/02/2004). PNG Department of Environment and Conservation, Port Moresby.

ERIAS. 2019. Papua LNG Project Upstream Environmental Impact Statement. 01215B_23_v5. December. Unpublished report to Total E&P PNG Limited.

ERIAS. 2020. Papua LNG Project Upstream Construction environmental and Social Management. 01215B_30_v3. May. Unpublished report to Total E&P PNG Limited.

PILIN. 2024. Papua New Guinea Legislation Indexes. Legislation Indexes. Index to the PNG Laws - compiled by the PNG Department of Justice and Attorney General. Index current as of 14th April 2022. Accessed on the www on 20 May 2024 at https://www.paclii.org/pg/indices/legis/pnglaws-april2022.pdf. Pacific Island Legal Information Institute.

3. Impact Assessment Process and Method

3.1 Assessment Approach

Characterisation of the existing environment within PRL-15 was undertaken in the Upstream environmental and social baseline studies (ESBS) (ERIAS, 2017) and assessment of environmental and social impacts of the Upstream Project was undertaken in the 2019 Upstream EIS (ERIAS, 2019). Chapter 3 of the 2019 Upstream EIS describes the five stages of the environmental and social impact assessment process, i.e., screening, scoping, characterisation of the environmental and social setting, impact assessment and reporting.

Since completion of the 2019 Upstream EIS, pre-clearance surveys (PCS) have been undertaken within much of PRL-15. This EIS Addendum draws on the characterisation of the existing environment undertaken for the 2019 Upstream EIS, updated to include information provided from PCSs (described in Chapters 7 to 9).

Embedded design controls and mitigation and management measures to avoid and minimize potential environmental and social impacts are described in the 2019 Upstream EIS and further developed in the Project environmental and social management system (ESMS) documentation including the Upstream Construction and Environment and Social Management Plan (CESMP) which comprises a number of discipline-specific environmental and social management plans and procedures that describe how the impacts associated with the Project will be managed, consistent with the embedded design controls and mitigation and management commitments made in the 2019 Upstream EIS. Since completion of the 2019 Upstream EIS, TEP PNG has also developed various plans and procedures to guide environmental management for the Project. The additional management plans and procedures to avoid and minimize potential impacts identified for construction of the Upstream Project are described within the relevant impact assessment chapter (Chapters 10 to 15) in the 2019 Upstream EIS, and Chapter 16 of this EIS Addendum.

The impact assessment undertaken in Chapters 10 to 14 is based upon the detailed assessments for the 2019 Upstream EIS using one of three assessment methods (Section 3.1.4.2 of the 2019 Upstream EIS):

- Compliance standard assessment.
- Significance assessment.
- Assessment of unplanned, accidental or abnormal impacts.

The residual impact assessment tables from the 2019 Upstream EIS have been revised to only present potential impacts relevant to the two substantial changes being assessed (see Chapters 1 and 4). Where there is no change to the information described in the 2019 Upstream EIS, e.g., geological characterisation, economic infrastructure, business activity, employment opportunities and workforce skills and training, reference is provided to the relevant sections of the 2019 Upstream EIS, rather than repeat information in this document. Supporting text to the

assessments in Chapters 10 to 14 is only provided to justify any changes to the 2019 Upstream EIS assessment; otherwise, the reader is referred to that document for further details on assessments. Details on the approach undertaken for impact assessment, including the categories for magnitude of impact, sensitivity of receptor and matrix for significance of impact, are also as described in the 2019 Upstream EIS (Chapter 3, Volume 1).

3.2 Additional Studies

Further to the PCS data that has been collected to date, this EIS Addendum draws on the following studies that have been completed since the 2019 Upstream EIS was completed or prepared to assess the substantial changes within PRL-15 (Table 3.1).

Table 3.1 – Studies used to Inform the EIS Addendum

Topic	Report Name	Report Author	Reference
All	Upstream Papua LNG Project Alternatives Assessment Report	ERIAS	ERIAS (2023)
Terrestrial biodiversity	Biodiversity Comparison Site Survey	ERIAS	ERIAS (2024)
Community and demographics	Community Directory Update - Upstream	IDP	IDP (2024)
Ecosystem services	Ecosystem Services Walk-Through for PRL-15 FPIC Inventory: Peiho, Jaoho, Nemina and Sopusa Clans	IDP	IDP (2023)
Air quality	Papua LNG CPF Relocation – Air Quality Impact Assessment	SLR Consulting	Appendix 1
Noise	Papua LNG CPF Relocation – Noise Quality Impact Assessment	SLR Consulting	Appendix 2
River dredging and barging	Dredging Impact Assessment. Papua LNG Purari River Dredging	BMT	BMT (2024, draft in progress)

3.3 References

BMT. 2024. Dredging Impact Assessment. Papua LNG Purari River Dredging. 002820. Draft. January.

ERIAS. 2017. Papua LNG Project Upstream Environmental and Social Baseline Studies Report. 01215B_22_v7. December. Unpublished report to Total E&P PNG Limited.

ERIAS. 2019. Papua LNG Project Upstream Environmental Impact Statement. 01215B_23_v5. December. Unpublished report to Total E&P PNG Limited.

ERIAS. 2023. Upstream Papua LNG Project. Alternatives Assessment Report. Draft. 01215E_72_v3. November. Prepared for TotalEnergies EP PNG.

ERIAS. 2024. Papua LNG Project. Biodiversity Comparison Site Survey. 01215E_73_v3. February. Prepared for TotalEnergies EP PNG.

IDP. 2023. Ecosystem Services Walk-Through for PRL-15 FPIC Inventory: Peiho, Jaoho, Nemina and Sopusa Clans. Papua LNG Project. November. Revision 1. Prepared by IDP Consulting for TotalEnergies EP PNG Limited.

IDP. 2024. Community Directory Update - Upstream. Papua LNG Project. May. Revision 1. Prepared by IDP Consulting for TotalEnergies EP PNG Limited. Confidential and unpublished.

4. Project Description

4.1 Overview

Significant design reviews have been completed since 2019 to reduce capital expenditure and the Project footprint to reduce costs and improve the environmental and social acceptability of the Project. This iterative approach has resulted in design changes from the pre-FEED design in 2019. The two substantial changes resulting are:

- Relocation of the central processing facility (CPF).
- Changes to the acid gas management strategy.

Only these, and related, changes are described in this chapter. Details regarding elements of the Project that have not changed can be found in Chapter 4 of the 2019 Upstream EIS (ERIAS, 2019).

4.2 Relocation of the CPF

Section 4.5.2 (Proposed Site) of the 2019 Upstream EIS presented a description of the CPF site. Initially, location CPF P2C was preferred as the site of the CPF as it:

- Enables a large CPF platform high above the maximum flooding level.
- Has a reasonable expectation of soil quality.
- Has gentle slope access to a meander of the river where ramps and offloading facilities were initially planned to be installed to unload large CPF modules during construction (up to 2,300 t) and support operations.
- Is distanced from faults identified on previous seismic maps (Kuku faults and Herd faults).

This location required the construction of a new Logistics Base (NLB) serviced by river ramps and offloading facilities to support construction and operations, heavy haul Road R02 from the NLB to the CPF, and Road R04 from the CPF to Herd Base. A focus of FEED design was to reduce the Project footprint and it has become possible to:

- Improve accommodation and support facilities at Herd Base so it has become a long-term asset.
- Locate the operations camp at Herd Base increasing the value of Herd Base improvements.
- Move warehouse and logistics facilities originally planned at NLB to Herd Base, reducing costs and footprint.
- Optimize the CPF design to reduce the footprint, especially during the operations phase.

- Understand more about the Herd faults and reclassify them as no longer active in recent geological time, hence removing this as a constraint on the CPF location.
- Change from a complex ramp system for module offloading at the NLB to a lifting system located close to the CPF location (site P3).
- Determine that the pre-existing gravel pit west of Herd Base is suitable for borrow material and incorporation into the CPF platform.

The proposed location of the CPF has therefore been moved from site P2C to P3. This allows the Project's operating facilities to be concentrated in a smaller area closer to Herd Base and the removal of the NLB and Roads R02 and R04, resulting in an overall reduction in footprint. Several efforts were made to reduce the impacts of the CPF 2PC location, including a footprint reduction during FEED. The CPF P3 location represents a 40-ha decrease from the 2019 Upstream EIS and a 25-ha decrease from CPF 2PC FEED design (Figure 4.1).

A summary of the changes associated with the CPF P3 site location is provided in Table 4.1.

Table 4.1 – CPF Location Change Summary

Project Infrastructure	Upstream EIS	EIS Addendum
CPF location	P2C	P3
NLB	West of Herd Base and south of CPF P2C to be used for construction and operations	Not required. Logistics to operate from Herd Base expansion. Construction offloading to occur at the module offloading facility (MOF) and the construction offloading facility (COF) at CPF P3
Roads	Road R01 Road R02 Road R04	Not required Not required Halved in length and name changed to Road R03
Operations camp	Part of CPF P2C	Existing Herd Base expansion
Trunkline/export pipeline	Export pipeline trenchless crossing east of NLB	Realignment of pipeline to/from CPF P3 Export pipeline trenchless crossing approximately 1 km upstream of the original crossing location

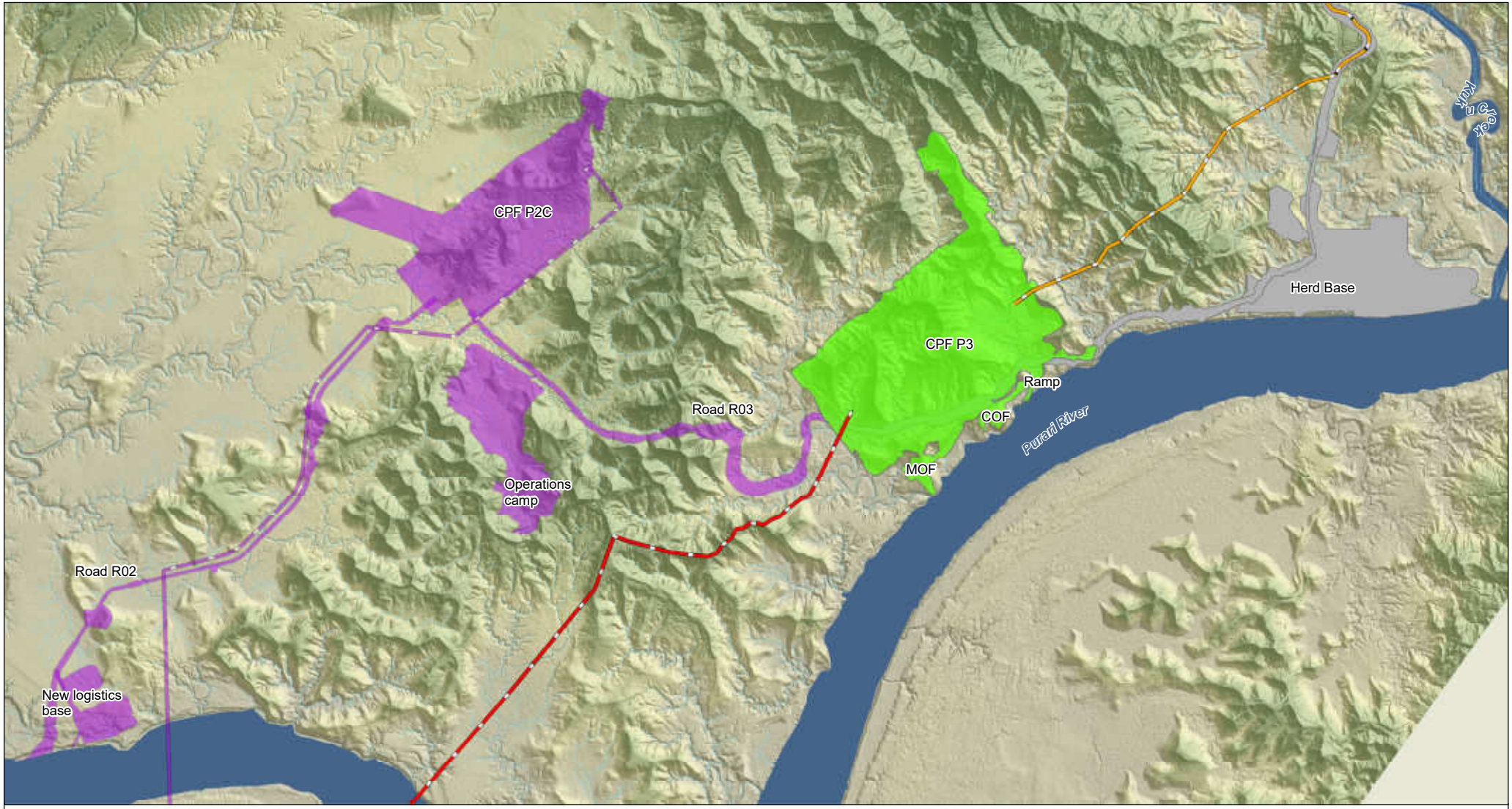
4.3 Acid Gas Management Strategy

Section 4.11.1.1 (Acid Gas Management) of the 2019 Upstream EIS presented an acid gas management strategy that involved partial reinjection into the Elk reservoir. This concept comprised incineration of acid gas via a thermal oxidizer followed by sulfur recovery (desulfurization) prior to release of the gas via a conventional stack. Once the Elk reservoir was depleted, after approximately 4 years of production, acid gas would be reinjected into the reservoir. The thermal oxidizer and flue gas desulfurization processes would remain on standby, ready to operate at short notice so that acid gas could be treated if acid gas reinjection was not possible.

CPF Locations P2C and P3

Papua LNG Project | PRL-15 EIS Addendum

FIGURE 4.1



SCALE: 1:21,000 @ A4

0 2.5 5 10 15 KM

COORDINATE SYSTEM: PNG94 PNGMG94 Zone 55

01215E_81_GIS027

This acid gas management strategy has been changed to full reinjection into the Antelope reservoir from the start of production. Once the Elk reservoir is depleted, Elk will receive the acid gas as planned in the partial reinjection concept. In the event that acid gas reinjection is not available, acid gas will be processed via a gas-assisted acid gas flare rather than the thermal oxidizer and flue gas desulfurization process. The gas-assisted flare is preferred as:

- It is simpler, e.g., there is less chance of it failing and requiring repairs/maintenance.
- Modelling has demonstrated that sulfur emissions will be compliant with Project criteria.
- There are greater process efficiencies and hence a lower cost.
- Elimination of the need for continuous fuel gas burning by standby thermal oxidizer.

The benefit of the revised strategy is a significant reduction in the amount of acid gas released to the atmosphere during the first four years of production, i.e., the 5 to 20% of the acid gas that would not be burnt in the incineration process released to the atmosphere.

The following modifications are required for the full reinjection concept:

- During the initial Elk reservoir depletion, acid gas will be returned to Antelope field via a dedicated new 10-inch line to the Antelope injection wellpad.
- Acid gas reinjection into Antelope has been moved from Antelope-1 to Antelope-4 (renamed ANT-11) for more efficient acid gas injection.
- Two development wells will be installed at ELK-10. These wells will be converted into acid gas injection wells once the field is depleted.
- Gas produced from ELK-10 will be sent to the ANT-10 manifold through two 14” flowlines to accommodate the increased Elk production rate due to the second well. The gas will be sent to the CPF via two 22” trunklines.
- Two injection wells at ANT-11: one for water disposal as originally planned and one for acid gas injection (until Elk reservoir is depleted).
- Elk fluid will be recompressed using an ejector installed at ANT-10 pad and a compressor installed at the CPF to further accelerate, and ensure sufficient depletion of, the Elk reservoir prior to its conversion into acid gas storage.
- The capacity of the acid gas removal and compression systems at the CPF has been increased to accommodate the likely acid cycling within the Antelope reservoir.

A summary of the changes associated with the new acid gas management strategy is provided in Table 4.2. The footprint associated with the revised acid gas management strategy is within the existing Project footprint for the gas gathering systems and wellpads, shared pipeline/road platform, e.g., along Road R05, and the CPF P3 site location.

Table 4.2 – Acid Gas Management Change Summary

Project Infrastructure	Upstream EIS	EIS Addendum
Elk wells	1 gas producing well ELK-10	2 gas producing wells ELK-10
Elk flowline	1 x 14” diameter pipeline to the CPF	2 x 14” pipelines to ANT-10
Acid gas injection line	Converted Elk flowline	Start of production: • 1 x 10” pipeline from CPF to ANT-11 Post Elk depletion: • 1 x 10” pipeline from CPF to ANT-10 via ANT-11 • 1 x Elk 14” converted flowline from ANT-10 to ELK-10 (the other Elk flowline will be backup)
Acid gas injection	Elk gas producing well converted to acid gas disposal once Elk reservoir depleted	1 well at ANT-11* Elk gas producing wells converted to acid gas disposal once Elk reservoir depleted
Acid gas treatment (at CPF)	Acid gas removal unit (AGRU) sized for 6% acid gas Thermal oxidizer and sulfur recovery unit (flue gas desulfurization)	Acid gas removal unit (AGRU) sized for 8% acid gas# Gas-assisted acid gas flare
Acid gas liquid effluent disposal	1 well at ANT-11* and only required until Elk reservoir depleted	Not required
Produced water wells	1 well at ANT-11*	1 well at ANT-11*

* ANT-11 pad location has moved from existing Antelope-1 to existing Antelope-4 which is refurbished. See Figure 1.3 in the 2019 Upstream EIS # There is a different acid gas content due to reinjection of acid gas into the Antelope reservoir from start up thereby increasing acid gas content of the Antelope reservoir over time.

4.4 Revisions to 2019 Upstream EIS Project Description

4.4.1 Summary

A number of revisions are required to the project description presented in the 2019 Upstream EIS to reflect the substantial changes, described in the preceding sections, that are the subject of this EIS Addendum. Table 4.3 identifies the sections of the project description that require a revision.

Table 4.3 – Summary of Project Description Revisions

2019 Upstream EIS Chapter Number	Upstream EIS Heading	Reasons Revisions Required in EIS Addendum
4.1	Introduction	No change required
4.2	Gasfield and the Resources	Additional Elk gas producer well therefore increased gas production from Elk
4.3	Wells and Wellpads	Additional Elk gas producer well Change in location for acid gas and produced water injection
4.4	Flowlines and Trunklines	Additional Elk flowline Change in acid gas injection line Rerouting to the CPF P3 site Shared road and pipeline platform

2019 Upstream EIS Chapter Number	Upstream EIS Heading	Reasons Revisions Required in EIS Addendum
4.5	Gas Processing Facilities	CPF relocation and revised layout
4.6	Transporting the Gas	Rerouting from the CPF P3 site location
4.7	Personnel and Accommodation	New location operations camp
4.8	Infrastructure	Additional logistical function at Herd Base Water extraction and discharge locations Road changes
4.9	Logistics and Transport	No change required
4.10	Construction	Revised cut and fill profile associated with the CPF P3 site location
4.11	Operations	Revised acid gas management strategy
4.12	Decommissioning	No change required
4.13	Project Summary	Revised disturbance footprint
4.14	References	References provided in Section 4.5

Only sections that require an update to reflect the substantial changes are addressed in the following sections. Information that has not changed has not been reproduced and can be found in the 2019 Upstream EIS.

4.4.2 2019 Upstream EIS Section 4.2 Gasfield and the Resources

Production profiles for gas and condensate have been revised to meet the Caution Bay LNG plant feed gas demand (guaranteed 5.6 million tons per annum (Mtpa) at 94% availability), and the Papua New Guinea domestic market obligation (up to 5% of gas sales under the 2019 Gas Agreement[1]). These revised average production revised profiles are shown in Figure 4.2.

At peak, the CPF has now been designed to treat about 960 million standard cubic feet per day (MMscfd), and to export 875 MMscfd of treated gas along with 16,500 barrels per day (bbld) of condensate. Assuming 94% availability of the facilities, this results in an average gas production of circa 900 MMscfd, an average gas export of circa 820 MMscfd (Years 2 to 17 when there is little change in production), and an average condensate export of approximately 10,000 bbld.

4.4.3 2019 Upstream EIS Section 4.3 Well and Wellpads

The Elk-Antelope fields will be developed with up to 11 wells and 3 wellpads as summarized in Table 4.4.

1 Total, and partners ExxonMobil and Oil Search (now Santos), signed a gas agreement with the Independent State of Papua New Guinea for the Papua LNG Project.

FIGURE 4.2

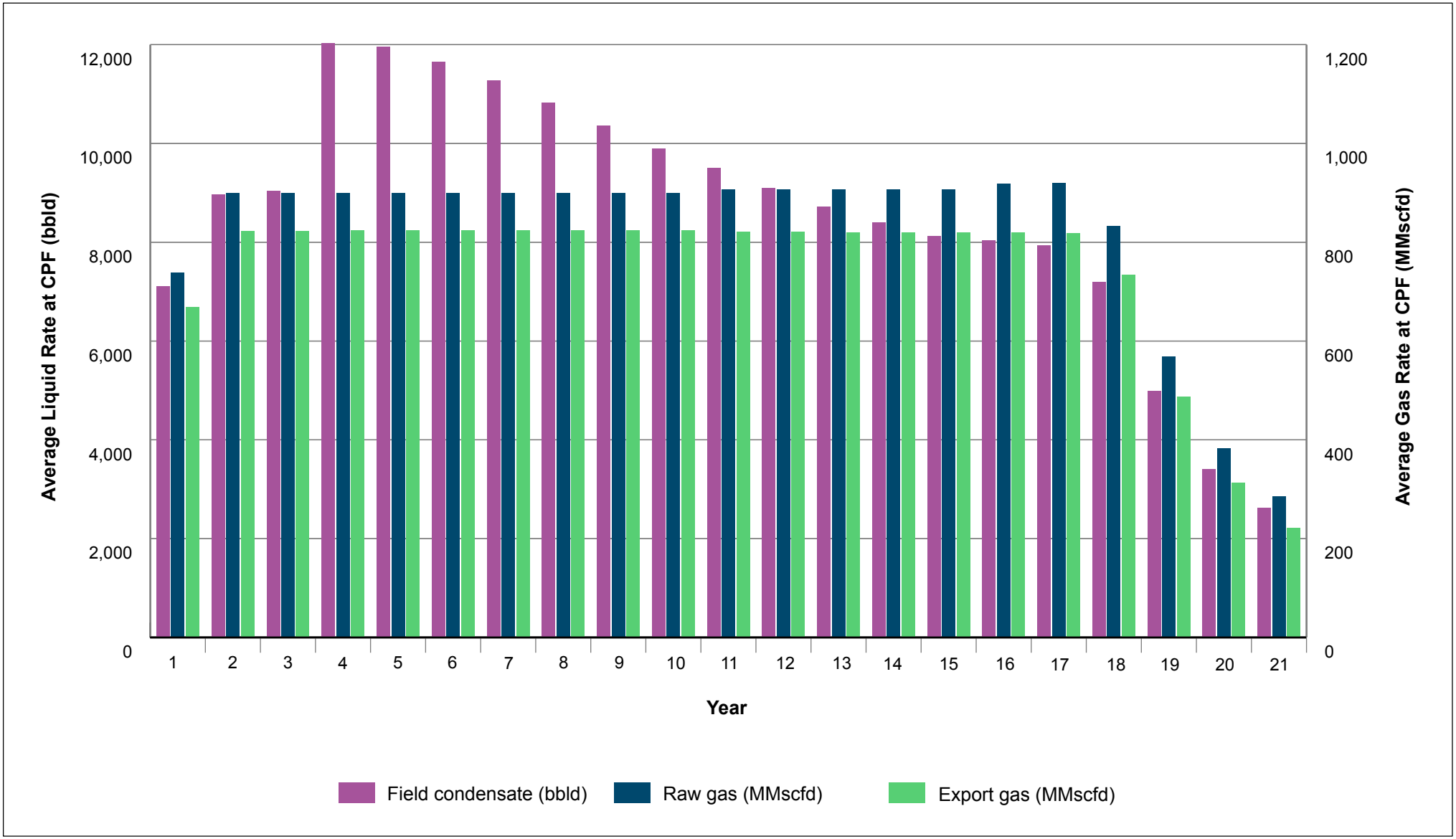

12,000
10,000
8,000
6,000
4,000
2,000
0
Average Liquid Rate at CPF (bbld)
1,200
1,000
800
600
400
200
0
Average Gas Rate at CPF (MMscfd)
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
Year
Field condensate (bbld)
Raw gas (MMscfd)
Export gas (MMscfd)

Table 4.4 – Summary of Wells and Wellpads

Field	Elk	Antelope	
Wellpad	ELK-10*	ANT-10	ANT-11#
Area† (ha)	1.9	3.1	2.8
Number of gas producer wells	2	7	–
Number of acid gas injection wells	2**	–	1##
Number of produced water wells	–	–	1
Total number of wells	2	7	2

* Existing Elk-1 pad modified and refurbished. # Existing Antelope-4 pad modified and refurbished. † Footprint including vegetation clearing area. ** Converted producer well. One injector well and one back up injector well. ## Only while Elk is being depleted.

The Elk field will be developed with two production wells drilled from the existing Elk-1 wellpad, which will be upgraded and renamed ELK-10. No water injection is planned for the Elk field; however, once the Elk reservoir is depleted, the ELK-10 wells will be converted to gas injection wells.

The Antelope field will be developed with a new wellpad, named ANT-10, located near the existing Antelope-5 wellpad. Seven producer wells will be drilled from this wellpad. The ANT-10 wells have been regrouped in one platform thus reducing the footprint from that presented in the 2019 Upstream EIS (Figure 4.3 and Table 4.8). An acid gas injection well and a produced water injection well will be drilled from the existing Antelope-4 wellpad which will be renamed ANT-11 (Figure 4.4). The ELK-10 wellpad will have a similar layout to ANT-10, but for only two producer wells.

The location of the wellpads in relation to the field, the gathering system and the CPF is provided in Figure 4.5.

4.4.4 2019 Upstream EIS Section 4.4 Flowlines and Trunklines

4.4.4.1 Characteristics of the Flowlines and Trunklines

The key characteristics of the flowlines and trunklines presented in the Upstream EIS have been revised to reflect the changes described in Table 4.2 and other updates and are summarized in Table 4.5. The pipelines will have a design life of 25 years.

The Elk flowlines will be suitable for both the transport of reservoir fluids and acid gas. Once the Elk reservoir is depleted, the Elk flowlines will be converted to acid gas injection flowlines and one will be used to transport acid gas from ANT-10 to ELK-10 for reinjection with the other remaining on standby. The acid gas injection flowline from the CPF to ANT-11 will continue to transport acid gas, and the new acid gas pipeline from ANT-11 to ANT-10 will be become operational so acid gas will ultimately be transported from the CPF to ELK-10 for reinjection via ANT-11 and ANT-10.

ANT-10 Layout

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FIGURE 4.3



ANT-11 Layout

Papua LNG Project | PRL-15 EIS Addendum

FIGURE 4.4



Overall Layout in PRL-15

Papua LNG Project | PRL-15 EIS Addendum

FIGURE 4.5

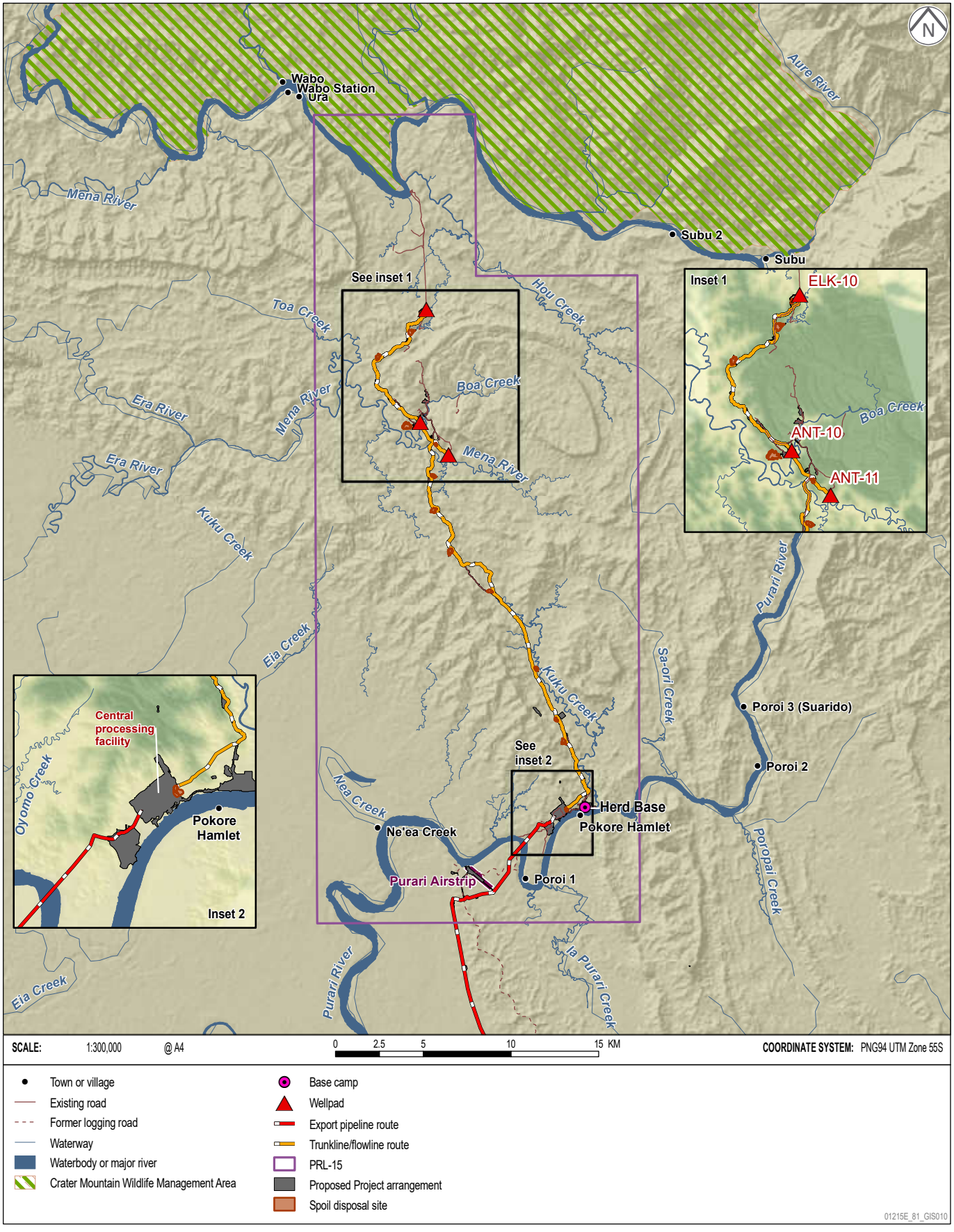


Table 4.5 – Key Characteristics of Flowlines and Trunklines

Pipeline	Fluid	Design Capacity	Length (km)†	Diameter (inches)	Design Pressure (bar)	Design Temp. (°C)
Elk flowline #1*	Reservoir fluids	320 MMscfd	10.0	14	220	104
Elk flowline #2 (new)*	Reservoir fluids	320 MMscfd				
Antelope trunkline #1	Reservoir fluids	490 MMscfd	28.0	22		
Antelope trunkline #2	Reservoir fluids	490 MMscfd				
Water injection flowline (CPF to ANT-11)	Produced water	2,900 bbld	28.0	4	57	70
Acid gas injection flowline (CPF to ANT-11) (new)	Acid gas	85 MMscfd	28.0	10	220	73
Acid gas injection flowline (ANT-11 to ANT-10) (new)	Acid gas	85 MMscfd	2.5	10	220	73

* Will be known as acid gas injection flowline when the Elk reservoir is depleted and the flowline is used to transport acid gas. † Length may vary slightly due to minor changes in design.

4.4.4.2 Routing of the Flowlines and Trunklines

The route of each gathering system pipeline is shown in Figure 4.5 and subject to optimization. The key features of the routes are summarized in Table 4.6, noting that the:

- Project has moved to a shared pipeline/road platform where possible to reduce the Project footprint.
- Alignment of the trunkline from ANT-10 to the CPF has been modified at its southern end to account for the CPF P3 site location.

Table 4.6 – Key Features of the Flowline and Trunkline Routes

Route	Length* (km)	Length* of Existing Tracks Followed (km)	Number of Waterway Crossings	Number of Major/ Secondary Fault Lines Crossed
Elk flowlines/acid gas injection flowlines (ELK-10 to ANT-10)	10.0	2.8	12	0/0
Antelope trunklines (ANT-10 to CPF)	28.0	21.5	94	0/5
Water and acid gas liquid injection flowlines (CPF to ANT-11)	28.0	0.0	14	0/0

* Length may vary due to minor changes in design.

4.4.5 2019 Upstream EIS Section 4.5 Gas Processing Facilities

4.4.5.1 Proposed Site

The location of the CPF has been moved approximately 1.6 km east-southeast from the location in the Upstream EIS. The CPF will be located adjacent to the Purari River, and approximately 29 km south of the ANT-10 wellpad and 40 km from the ELK-10 wellpad (see Figure 4.5). It will be approximately 1 km southwest of Herd Base.

The site is in an undulating area adjacent to the Purari River (approximately 120 m from the river bank) with elevations from 20 to 90 m above sea level. There are already some areas of disturbance associated with a pre-existing gravel pit and access tracks. The land is otherwise covered with dense tropical forest.

The Project will require land to site the CPF pad, and the temporary construction areas (including the laydown and the construction camp) and restricted zones. The land to be cleared of vegetation for the construction of the CPF facilities will be approximately 58 ha. Restricted/exclusion zones around the CPF are yet to be defined, but would not be cleared.

4.4.5.2 General Description

The CPF will still comprise services, processing and utilities areas, condensate storage facilities and flares and vents as described in Section 4.5.3 (General Description of the CPF) of the 2019 Upstream EIS; only the layout at the CPF P3 location has changed. The layout of the CPF is illustrated in Figure 4.6. The processing facilities have been placed at the back of the CPF pad so they are distanced furthest from the river, e.g., approximately 280 m.

The MOF, COF and ramp are required at the CPF location as, due to the construction schedule, the similar facilities at Herd Base will be in use at the same time and at capacity. Further, CPF modules will be transported from the MOF to the CPF site via a self-propelled modular transporter (SPMT) as they are too heavy for conventional trucks (Plate 4.1). The SPMT travels at very low speeds, e.g., 4 km/hr, and requires a low inclination, hence shorter roads with minimal slope are required (this results in a less direct route from the MOF to the CPF, but is shorter than Road R02 that was going to connect the NLB to the CPF (i.e., approximately 2.6 km vs 400 m). The MOF, COF and ramp on the river are temporary facilities that are only required for construction. Once construction is complete these facilities will be removed and the area rehabilitated.

The flare has been sited at the rear of the CPF maximizing the distance to communities and the Purari River, while respecting safety exclusion zones. Further, construction of the flare requires competent ground and for this reason the flare has been sited on a ridge which also provides elevation and reduces the flare stack length.

CPF P3 Site Layout

Papua LNG Project | PRL-15 EIS Addendum

FIGURE 4.6

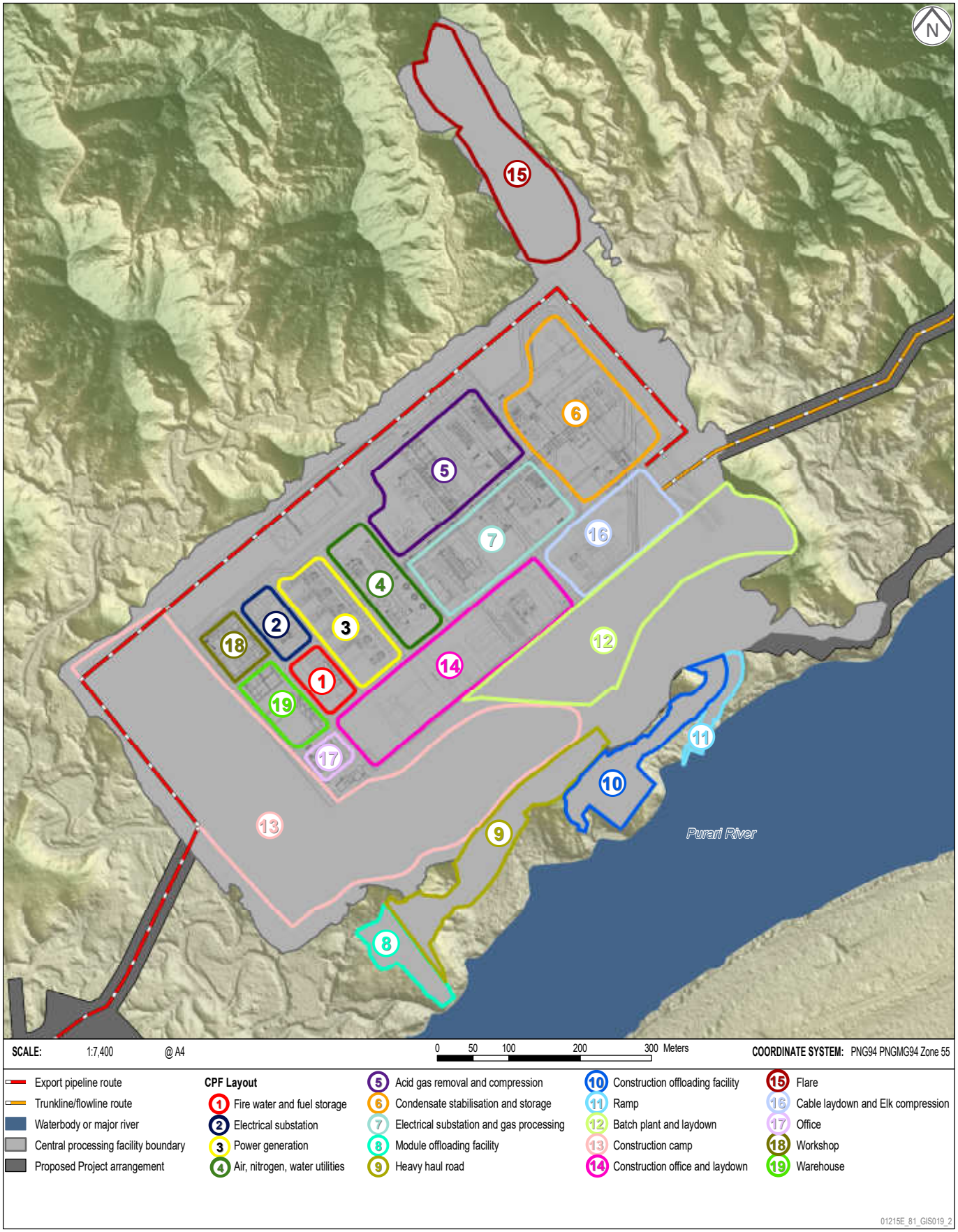


Plate 4.1 – Example of a SPMT



Source: YouTube (2024).

4.4.6 2019 Upstream EIS Section 4.6 Transporting the Gas

Section 4.6 of the Upstream EIS remains relevant with the exception of the export gas and condensate pipelines' route. A 2.4-km section has been realigned from the CPF P3 site location to the new Purari River crossing, and then for 1.0-km to the alignment shown in the Upstream EIS (see Figure 4.5). The remainder of the route remains the same as described and assessed in the Upstream EIS.

4.4.7 2019 Upstream EIS Section 4.7 Personnel and Accommodation

Section 4.7 of the Upstream EIS remains relevant with the exception of the accommodation facilities at the CPF. The permanent operations camp will now be located at Herd Base rather than at the CPF P3 site.

4.4.8 2019 Upstream EIS Section 4.8 Infrastructure

4.4.8.1 Herd Base

Herd Base will have a greater role than that described in the Upstream EIS. An expansion and upgrade to Herd Base has been approved under a Level 2 environment permit (EP-L2 (532) issued April 2023). Warehousing and logistics previously planned at the NLB will be accommodated at Herd Base in addition to the operations camp. Personnel will be transferred by small buses between Herd Base and CPF, an approximate 1-km distance along Road R03.

4.4.8.2 Roads

There has been a change to the roads required for the Project with Roads R01 and R02 being removed and the shortening of Road R04 which has been renamed Road R03. The roads that will be constructed by the Project are listed in Table 4.7 and shown in Figure 4.7. The roads will be paved with gravel and have a 25-year design life. Roads, including bridges and culverts, will be designed and built in accordance with the 2017 PNG road design manual for the category of rural roads in a hilly area.

Table 4.7 – Summary of Project Roads

Road No.	Road Description	Road Type	Length (km)	Width (m)	Maximum Gradient (%)	Design Speed (km/h)
R03*	Herd Base to CPF	Standard	2.0	10	15	30
R05*	Herd Base to ANT-10	Standard	28.0	10	15	30
R06	R05 (approximately 1.2 km southeast of ANT-10) to ANT-11	Standard	2.6	10	15	30
R07	ANT-10 to ELK-10	Standard	10.0	10	15	30

* An existing road that will be upgraded.

The majority of Roads 05, R06 and R07 is intended to be a shared road and pipeline platform within a right-of-way (ROW) nominally 30 m wide.

4.4.8.3 Waste Management

The waste management philosophy remains as described in Section 4.8.5 of the 2019 Upstream EIS. It is complemented by the TEP Waste Management Policy (L0-CHT-MAN-04). There are two changes to waste management associated with the CPF P3 site location:

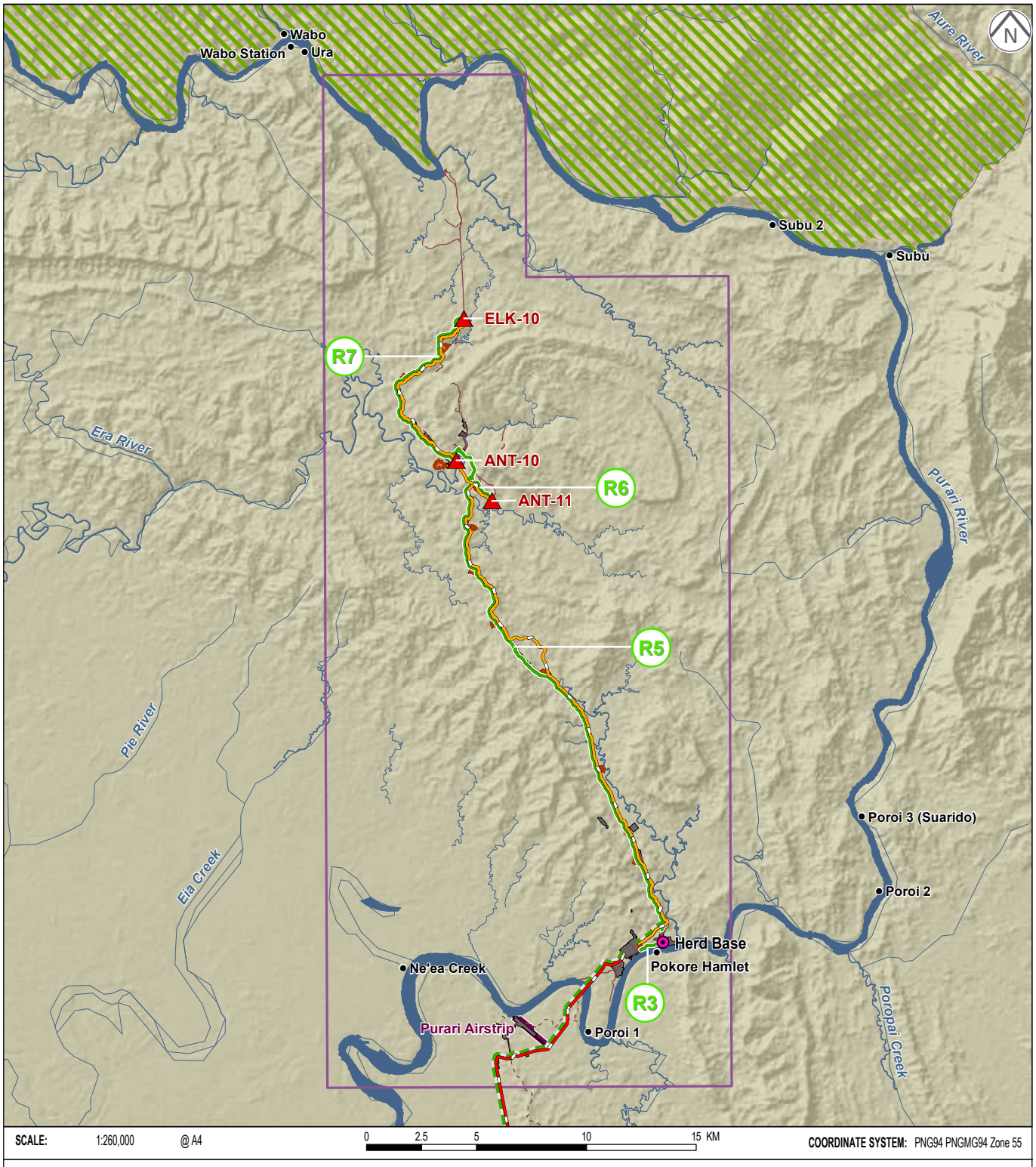
- The location of the landfill site will now be along Road R05. The landfill will contain one cell for construction and one cell for operations. The specific location will be determined during FEED as Project design progresses. The landfill will be designed to comply with TEP PNG's general specification for landfills and will be designed, located, constructed and operated in general accordance with the intent of the PNG Code of Practice for Sanitary Landfill Sites (DEC, 2001).

- During construction, the CPF contractor will be required to bring their own containerized incinerator to site to manage waste. This incinerator will be located within the construction contractor area at the CPF site and designed to internationally recognized standards such as IFC Environmental, Health and Safety Guidelines for Waste Management Facilities (IFC, 2007). During operations, waste will be managed at Herd Base according to existing environment permit conditions (EP-L2 (532)) and TEP's waste management plan (L2-PLN-HSE-07).

Project Layout and Road Network

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FIGURE 4.7



4.4.8.4 Water

A pumping station at the NLB was planned to extract water from the Purari River for use at the CPF P2C site. While water extraction volumes for the CPF P3 site will be the same as described in Section 4.11.1.2 of the 2019 Upstream EIS (Water Systems), water will be extracted from the Purari River at a pumping station that will be constructed at Herd Base and piped to the CPF P3 site via a buried pipeline within the Road R03 corridor. The open drain networks to manage and control surface water remain as described in Section 4.11.1.2 of the 2019 Upstream EIS (Open Drain Systems). Water that complies with the Project's environmental permit discharge values, will be discharged to the Purari River via a tributary, adjacent to the CPF. Extraction and discharge locations will be confirmed during detailed design.

4.4.9 2019 Upstream EIS Section 4.10 Construction

The CPF P3 site has a different cut and fill profile associated with earthworks and grading. Preliminary studies indicate that there will be approximately 3.3 million m^3 of cut material and approximately 3.9 million m^3 of fill material (Figure 4.8). Modules will be fabricated off site and transported to the CPF via barges for construction. Subject to optimization, the modules are not expected to exceed 52 m (length) x 18.5m (width) x 24 m (height) and 1,800 tons.

The number of wells has changed, with two producers to be drilled on ELK-10, and one produced water injector as well as one acid gas injector on ANT-11 and will be constructed as described in Section 4.10.3.1 of the 2019 Upstream EIS.

4.4.10 2019 Upstream EIS Section 4.11 Operations

The description of operations in Section 4.11 of the 2019 Upstream EIS remains relevant, noting that the layout for CPF P3 site is different to the layout for CPF P2C site and may continue to evolve as various components are studied. The exception is acid gas management and produced water storage.

Acid gas removal is described in Section 4.11.1.1 (Acid Gas Management); however, acid gas is now proposed to be reinjected at ANT-11 from the start of production. Once the Elk reservoir is depleted, acid gas will be reinjected at ELK-10. Mixing of the injected acid gas between the Elk and Antelope reservoirs is unlikely to occur given the two reservoirs are geologically segregated (see Section 4.2.2 (Gas) of the 2019 Upstream EIS); however acid gas injected into the Antelope reservoir will recycle back in the ANT-10 wells produced fluids (Figure 4.9). The acid gas management system therefore has been designed to manage acid gas up to a maximum of 8%. Approximately 83 MMscfd treated acid gas will be reinjected at peak.

In the event that acid gas reinjection is not possible, e.g., acid gas content greater than 8%, injector well not available, or acid gas management system failure (e.g., acid gas compressor), acid gas will be vented and burnt via a gas-assisted acid gas flare. The gas-assisted acid gas flare is a simpler process that replaces the thermal oxidizer and flue gas desulfurization process detailed in the 2019 Upstream EIS. Acid gas will be sent to the flare located along the northern boundary of the CPF, adjacent to the acid gas removal unit, where assist gas will be provided to help flare burning given the acid gas has a low heating value. The emissions from the gas-assisted flare will mainly comprise nitrous oxides (NOx), sulfur dioxide (SO_2) and carbon monoxide (CO).

CPF P3 Cut and Fill Profile

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FIGURE 4.8

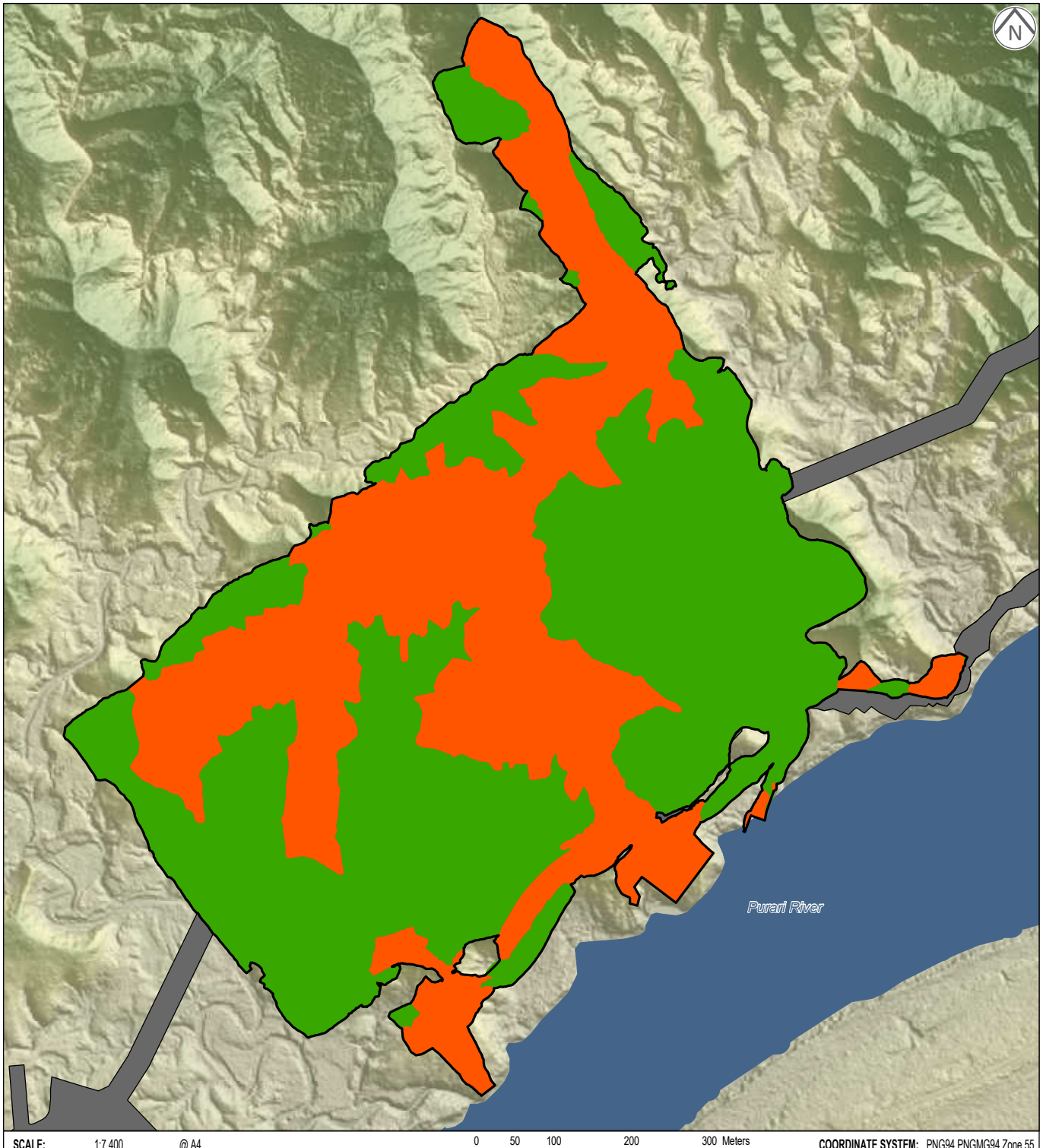
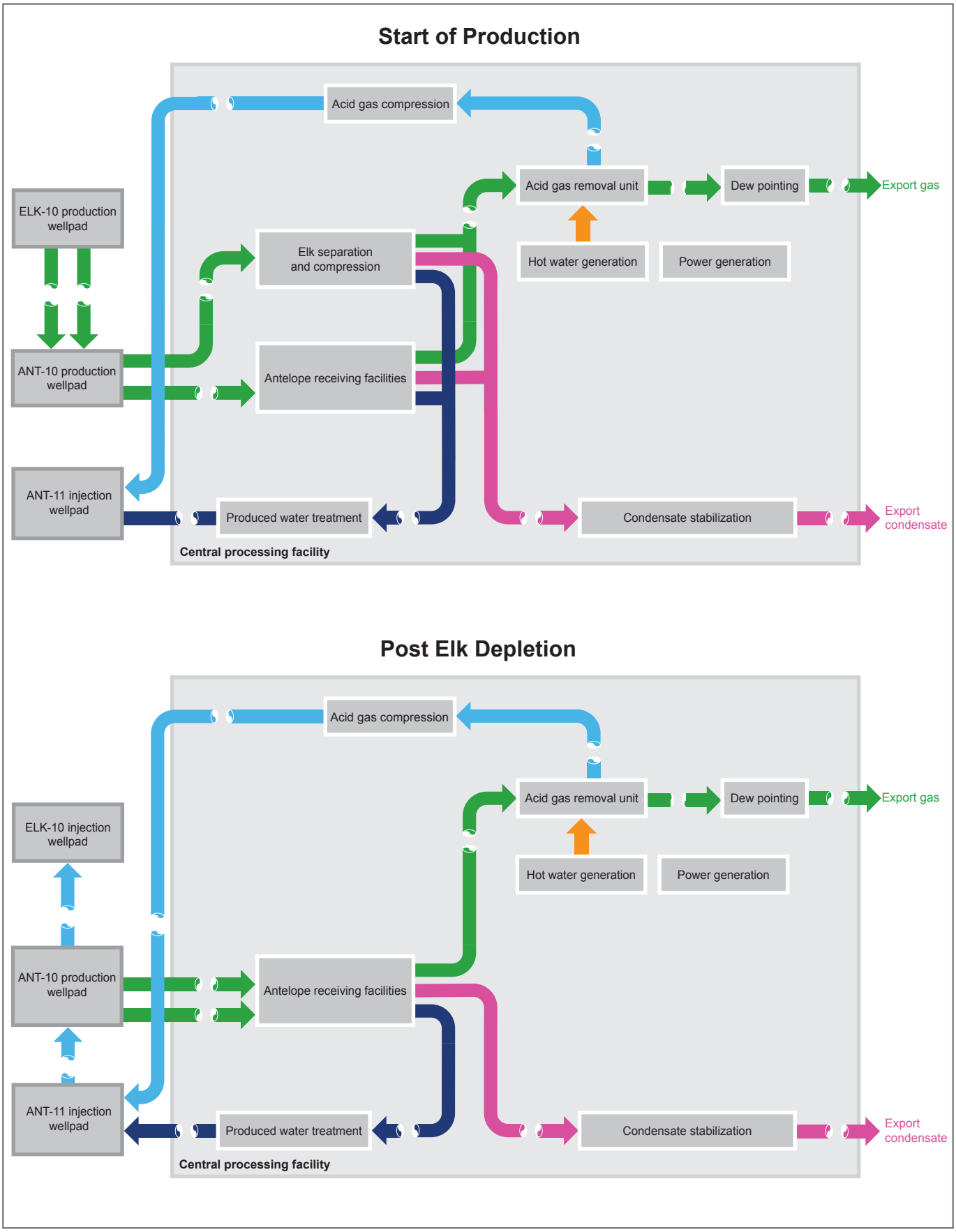


FIGURE 4.9


Start of Production
Acid gas compression
Acid gas removal unit
Dew pointing
Export gas
ELK-10 production wellpad
Elk separation and compression
Hot water generation
Power generation
ANT-10 production wellpad
Antelope receiving facilities
ANT-11 injection wellpad
Produced water treatment
Condensate stabilization
Export condensate
Central processing facility
Post Elk Depletion
Acid gas compression
Acid gas removal unit
Dew pointing
Export gas
ELK-10 injection wellpad
Hot water generation
Power generation
ANT-10 production wellpad
Antelope receiving facilities
ANT-11 injection wellpad
Produced water treatment
Condensate stabilization
Export condensate
Central processing facility

The water previously required for caustic soda dilution as part of the flue gas desulfurization process described in Section 4.11.1.1 (Thermal Oxidizer and Flue Gas Desulfurization) of the 2019 Upstream EIS is no longer required given the change to the gas-assisted acid gas flare.

The produced water holding tank capacity has been doubled from five to ten days to cater in case of a temporary upset in the produced water system.

4.4.11 2019 Upstream EIS Section 4.13 Project Summary

The 2019 Upstream EIS summarizes the direct disturbance footprint for the Project. The current direct footprint is provided in Table 4.8 noting that it does not include the Herd Base expansion, safety/security exclusion areas or buffer areas around Project infrastructure. The current footprint reflects TEP PNG's philosophy to reduce the Project footprint which has resulted in a decision to co-locate pipelines within the road footprint where practicable. A shared road/pipeline platform will could accommodate up to 70% of the flowline/gathering line and road network, hence the area of the pipeline and roads has been combined.

Of the estimated direct disturbance area, approximately 190 ha (23%) uses existing disturbed areas (anthropogenic, including areas disturbed by the PRL-15 operator) and the onshore export pipeline route traverses 217 ha of degraded vegetation. There has been a 102-ha reduction in the direct disturbance footprint since the 2019 Upstream EIS was prepared, noting that the direct disturbance area is subject to change pending finalization of the detailed design.

Table 4.8 – Project Facilities and Associated Direct Disturbance Areas

Project Facility	Estimated Total Area of Direct Disturbance (ha)		Does Project Facility Coincide with Existing Disturbance?
	2019 Upstream EIS	EIS Addendum*	
Wellpads			
ELK-10	2	2	Yes
ANT-10	5	3	No
ANT-11	2	3	Yes
Flowlines and Trunklines Construction ROW			
Elk flowline to ANT-10	24	Included in roads below	Yes (for approximately 1.6 km)
Flowlines and trunklines ROW from ANT-10 to CPF, includes water injection/acid gas flowline	146		Yes, shared road/pipeline platform utilizes existing roads (Roads R03, R05, R06)
Dam for water supply ELK-10, ANT-10	2	2	No
CPF			
CPF, including accommodation camps	100	60	Yes, existing road and borrow pit
Export Pipeline Construction ROW			
Export onshore pipeline including HDD sites and valve stations	217	217	Yes

Project Facility	Estimated Total Area of Direct Disturbance (ha)		Does Project Facility Coincide with Existing Disturbance?
	2019 Upstream EIS	EIS Addendum*	
Infrastructure			
Quarries and associated access†	52	50	No
Roads and associated laydown/camp areas (R01, R02, R04, R05, R06, R07)# (the EIS Addendum direct disturbance reflects the combined pipeline/road platform)	132	244	R03 (Herd Base to CPF P3), R05, R06, R07 (for approximately 1.6 km) – yes
Pipe yards along export pipeline route	19	58	Yes
Logistics Base	7	0	Herd Base
Purari Airstrip extension and vegetation clearing for visual approach	103	103	Yes
Spoil disposal areas (25 in 2019 Upstream EIS, 16 in EIS Addendum) and associated access	120	87	No
General landfills	5	5	TBD
TOTAL	**936**	**834**	

* Based on FEED design and subject to further changes. # Roads R01 and R02 no longer required and Road R04 shortened and renamed Road R03 in the EIS Addendum. † Quarry A is located within the CPF area. TBD = to be determined.

4.5 References

DEC. 2001. Environmental Code of Practice for Sanitary Landfill Sites. Department of Environment and Conservation, Port Moresby, Papua New Guinea.

ERIAS. 2019. Papua LNG Project Upstream Environmental Impact Statement. 01215B_23_v5. December. Unpublished report to Total E&P PNG Limited.

IFC. 2007. Environmental, Health and Safety Guidelines for Waste Management Facilities. International Finance Corporation, World Bank Group, Washington, D.C.

YouTube. 2024. Transport Module 1500Ton by MAMMOET (SPMT). A www publication accessed at https://www.youtube.com/watch?v=7wjEgg_yS3Q on 18 November 2024.

5. Project Options and Analysis

5.1 Overview

Chapter 5 of the 2019 Upstream EIS (ERIAS, 2019) describes the commercial, facility siting, design, technology, construction and transportation alternatives considered during the Project's conceptual and pre-Project design phases.

As described in Chapter 4 of this addendum, further optimization of the Project 'base case' design has continued through the Project's FEED resulting in changes to the:

- Location of the CPF.
- Acid gas management strategy.

Changes associated with the relocation of the CPF also include:

- Locating the logistics facilities at Herd Base rather than development of the NLB.
- Minor rerouting of the export pipeline in the vicinity of the CPF's new location.

This chapter describes the options assessed and the analysis of alternatives which has resulted in these changes, which are summarized in Table 5.1. Information that has not changed has not been reproduced and can be found in the 2019 Upstream EIS.

Table 5.1 – Summary of Project Options and Analysis Revisions

2019 Upstream EIS Chapter Number	2019 Upstream EIS Heading	Reasons Revisions Required in EIS Addendum
5.1	Introduction	No change required, but noting that modifications have been made to the criterion and rankings used to assess suitability of alternate CPF locations, which are described in Section 5.2.2 below.*
5.2	Commercialization and Export Options	No change required
5.3	Location and Layout Alternatives	Relocation of CPF from site P2C to P3. Logistics function and accommodation at Herd Base, rather than NLB.
5.4	Routing Alternatives	No change required#
5.5	Process and Technology Alternatives	Change in acid gas management
5.6	Construction Alternatives	Change in location of Purari River export pipeline crossing
5.7	Transportation and Logistics Options	No change required
5.8	No-Project Option	No change required

Note: * Also noting that further optimisation of the Project during FEED has resulted in the changes described above, consistent with Section 5.1.3 of the 2019 Upstream EIS. # There is no change in the overall routing considered in the 2019 Upstream EIS; however, there is a need for minor re-routing of the flowline to, and export pipeline from, the new CPF location along the selected route. These minor changes are not regarded to materially alter the impact assessments described in the 2019 Upstream EIS.

5.2 Revisions to 2019 Upstream EIS Project Options and Analysis

5.2.1 2019 Upstream EIS Section 5.3 Location and Layout Alternatives

5.2.1.1 Central Processing Facility

Assessment of Alternative Locations

As described in Section 5.3.1 of the 2019 Upstream EIS, several locations north of the Purari River within PRL-15 were considered for the CPF during the conceptual phase of Project development, including sites near the well pads, near Herd Base and near the Purari River. Assessment of the alternative locations considered environmental and social sensitivities, in addition to physical constraints and construction requirements, with site P2C selected as the proposed CPF location that was assessed in the 2019 Upstream EIS.

Since completion of the EIS, TEP PNG has investigated alternative locations for the CPF to avoid siting in primary (unlogged) alluvial and hill forest. Logged forest was identified as a preferred location for the CPF as the logged areas have lower biodiversity value and therefore disturbance in this forest would reduce the net requirement for biodiversity offsets associated with the Project. Investigations were therefore undertaken to identify whether there are alternative locations to the proposed CPF location (site P2C) that present a lower environmental and/or social risk, while still being technically and commercially viable.

Nine potential CPF locations (sites SP1 to SP9) were identified south of the Purari River based on elevation and vegetation condition (preferencing sites that were identified through remote sensing data as likely to contain degraded/logged forest) (TEP PNG, 2023a). A potential alternate location north of the Purari River (site P3), being the area of the current gravel pit to the west of Herd Base, was also identified. While reviewing aggregate sources for the Project, the infrastructure engineering contractor identified this site as not only a suitable borrow pit for construction but also as potentially an area for an alternate CPF platform (TEP PNG, 2023b). All sites are within PRL-15 and are shown in Figure 5.1.

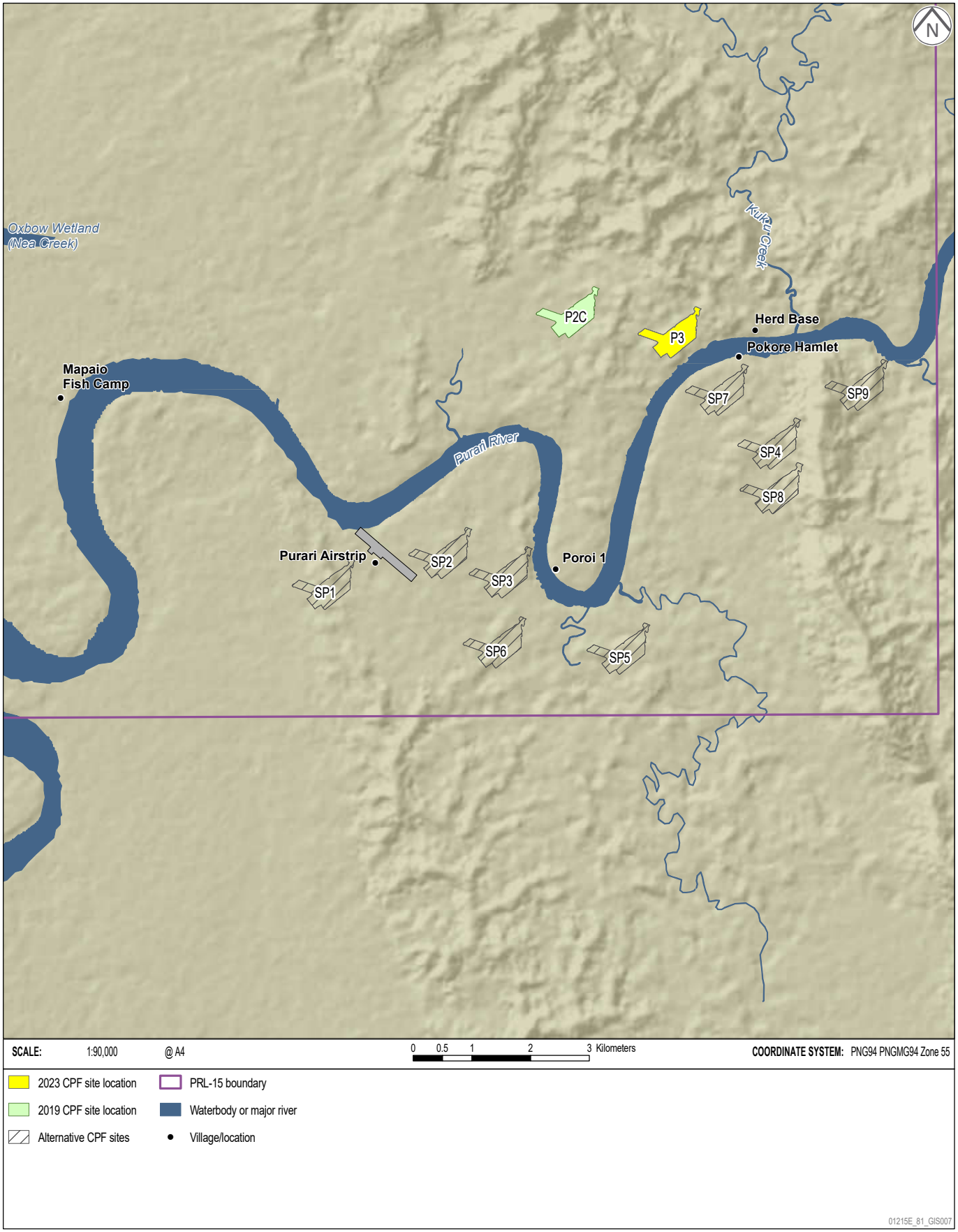
ERIAS was engaged by TEP PNG during 2023 to assist in assessing the suitability of these alternative locations, and the base case site P2C. The criteria used in this assessment expanded upon those described in Section 5.1.1 of the 2019 Upstream EIS and were developed based on a review of Project documents that describe the Project alternatives assessed (i.e., they tried to encapsulate criteria that were used in Project location-based decisions), a review of criteria used for similar publicly available reports and input from the TEP PNG Project team to confirm their applicability across the various Project components. They also considered feedback provided by the independent environmental and social consultant (IESC). The criteria considered:

- Physical constraints (soil type, terrain/slope stability, geohazards, flooding/drainage).
- Executability/technical feasibility (constructability, cost and commercial viability, regulation, company reputation, operability/complexity of operations, development flexibility, logistics/spread of operation).

CPF Locations Assessed

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FIGURE 5.1



- Health safety and security (security, workforce health and safety, community health and safety).
- Environmental sensitivity (protected areas, sensitive ecosystems of habitats, vegetation condition, priority species, acid sulfate soils, water resources, greenhouse gas emissions, cumulative impacts)
- Social sensitivity (land ownership, risk of in-migration, land and water use, physical displacement, economic displacement, amenity, cultural heritage, stakeholder acceptability).

The specific objective of the assessment was to identify whether there are locations additional to the currently proposed CPF location (site P2C) that present a lower environmental and/or social risk, while still being technically and commercially viable.

A qualitative assessment of the 'suitability' of each option was made across each criterion. Rankings for suitability were also further developed from the 'low, medium and high suitability' classifications used in the 2019 Upstream EIS. Rankings for suitability were assigned based on the colour system and descriptors shown in Table 5.2.

Table 5.2 – Suitability Rankings

Colour Coding	Suitability
	No go. Unacceptable environmental or social impacts that cannot be satisfactorily mitigated. Technically infeasible, economically unviable, substantial reputational damage.
	To be avoided wherever possible. If not possible, significant mitigation will be required, e.g., biodiversity offsets, compensation programs, substantial engineering features, and/or substantial costs and risks involved.
	Not without environmental/social impacts or engineering/economic/regulatory risks, but these can be readily managed to an acceptable level.
	Minimal environmental/social impacts and/or low engineering/economic/regulatory risks.
	Further studies/information are required to address major uncertainties in the assessment.
	Criterion is not applicable to the option being assessed.
X	Information is not available to complete the assessment.

Many technical and geophysical constraints were encountered when reviewing these alternative sites which made 7 of the 10 alternative locations 'No-go' due to proximity to faults, influence from flooding and safety distance to airstrip (ERIAS, 2023a). Three alternate locations were deemed as potential sites, being sites SP5 and SP9, both south of the Purari River, and site P3, north of the Purari River.

These sites were further assessed for viability which resulted in site SP9 being deemed 'No-go' due to geophysical and execution risks (ERIAS, 2023a). Of the remaining two viable sites, SP5 and P3, the assessment indicated there was no clear preference when considering all screening criteria. The 'suitability' rankings for these three sites and base case site P2C are shown in Table 5.3. Any relevant changes based on information obtained following completion of this assessment of alternative CPF locations, e.g., PCS terrestrial biodiversity and cultural heritage survey findings, ASS sampling and additional air quality and noise modelling at the CPF P3 site, are considered in this addendum.

Table 5.3 – CPF Site Suitability Rankings

Criteria	P2C	SP5	P3	SP9
Physical Constraints				
Soil type				
Terrain/slope stability				
Geohazards				
Flooding/drainage				
Executability/ Technical Feasibility				
Constructability				
Cost and commercial viability				
Regulation				
Company reputation				
Operability/complexity of operations				
Development flexibility				
Logistics/spread of operations				
Health, Safety and Security				
Security				
Workforce health and safety				
Community health and safety				
Environmental Sensitivity				
Protected areas				
Sensitive ecosystems or habitat				
Vegetation condition				
Priority species				
Acid sulfate soils (ASS)				
Water resources				
Greenhouse gas emissions				
Cumulative impacts	X	X	X	X
Social Sensitivity				
Land ownership				
Risk of in-migration				

Criteria	P2C	SP5	P3	SP9
Land and water use				
Physical displacement				
Economic displacement				
Amenity				
Cultural heritage				
Stakeholder acceptability	X	X	X	X

The assessment described in ERIAS (2023a) considered the CPF siting in isolation of other impacts associated with this design change, e.g., the need for additional infrastructure, additional pipeline crossings of the Purari River, accommodation south of the Purari River. When these elements were considered by TEP PNG, the clear preference was to locate the CPF at site P3 site rather than site SP5. This avoids multiplication of Project infrastructure, reduces the length of roads and pipelines and removes the need for personnel river crossings between the accommodation camp and CPF during operations.

Decision to Relocate CPF from Site P2C to Site P3

The CPF P2C location was selected in pre-FEED location based on conceptual and technical studies which have been progressively reviewed during the progress of the FEED. At pre-FEED, the CPF P2C site was preferred as it (TEP PNG, 2023c):

- Enables construction of a large CPF platform above the maximum flooding level.
- Has a reasonable expectation of soil quality.
- Has gentle slope access to a meander of the river where a large series of ramps were initially planned to be installed to unload larger CPF modules (up to 2,300 tons).
- Is located distant from faults identified on previous seismic maps (Kuku faults and Herd faults).

This location required the construction of a new logistic base (NLB) including a large offloading ramp system, a heavy haul road (Road R02) from the NLB to the CPF, and Road R04 from the CPF to Herd Base, that was required for construction and operations.

A large effort has been made during FEED to reduce capital expenditure and minimize the Project footprint and associated impacts in primary forest and it has become possible to:

- Improve accommodation and support facilities at Herd Base so it has become a long-term asset.
- Locate the operations camp at Herd Base increasing the value of Herd Base improvements.
- Move warehouse and logistics facilities originally planned at NLB to Herd Base, reducing costs and footprint.

- Optimize the CPF design to reduce the footprint, especially during the operations phase.
- Understand more about the Herd faults and reclassify them as no longer reactive in recent geological time, hence removing this as a constraint on the CPF location.
- Change from a complex ramp system for module offloading at the NLB to a lifting system located close to the CPF P3 site.
- Contain river access during operations to Herd Base, i.e., the module offloading facility (MOF), construction offloading facility (COF) and ramp at the CPF are not required post construction.
- Determine that the existing gravel pit west of Herd Base is suitable for borrow material and incorporation into the CPF platform.

A summary of these changes associated with relocating the CPF at site P3 rather than site P2C is provided in Table 4.1 (Chapter 4).

The adoption of the CPF P3 site, together with the operation camp relocation, cancellation of NLB and cancellation of Road R02 avoids multiplication of Project infrastructures. It also concentrates the impact of the Project's operating assets within a reduced perimeter and reduces the length of roads and pipelines. While the CPF P3 site is still in primary forest, a reduction in overall footprint of 40 hectares (compared with the footprint in the 2019 Upstream EIS) can be realized by this change through the shortening of Road R03 and associated construction footprints. As this site is closer to existing disturbances in the vicinity of Herd Base, it also reduces the spatial impact of the Project disturbance on the surrounding forest and neighbouring communities. This will deliver a reduction in Project footprint and therefore biodiversity offsets.

In addition, the selection of the P3 site enables the current project schedule to be maintained by minimizing technical changes to ongoing Project FEED studies and surveys. This will limit the impact on the planned Project start-up date and Project costs.

Pre-clearance surveys have been undertaken at both the P2C site (ERIAS, 2023b) and the P3 site (ERIAS, 2024a) to assess the environmental sensitivities of both locations. The two sites considered for the CPF have many similarities, including (ERIAS, 2024b):

- The flora and fauna found at each site are comparable; both sites contain IUCN, restricted range species, large trees and fauna observations.
- Sensitive habitats have been found at both sites, although they are different with the CPF P2C site containing alluvial forest, hill forest and forest pools and the CPF P3 site containing a small pandanus swamp and riparian zone. It is not possible to draw any conclusion on which site would be the preferred site from a PCS data perspective (ERIAS, 2024b). Notwithstanding difficulties differentiating which habitats are more important than others, primary alluvial forest and forest pools are challenging to replace/offset, hence the CPF P2C site is considered slightly more sensitive than the CPF P3 site.

5.2.1.2 Logistics and Offloading Facility

The following three options for the logistics and offloading facility were assessed pre-FEED:

- Option 1 – develop a NLB of approximately 20 ha on the northern bank of the Purari River, approximately 5 km downstream from Herd Base, and construct an approximate 2.6-km, flat, heavy transport road to the CPF.
- Option 2 – upgrade and expand the existing facilities at Herd Base (to be used as a logistics base for the duration of the Project) and construct an approximate 5-km, steeper, heavy transport road to the CPF.
- Option 3 – upgrade and use Herd Base for early works with the construction of a 'light-duty' road, using the existing track, to support initial mobilization and the development drilling campaign, then develop a smaller, approximate 7-ha, NLB and a 2.6-km heavy haul road to the CPF at a later stage.

Options 1 and 3 required the construction of a 2.6-km heavy transport road (Road R02) from the NLB to the CPF at site P2C. Option 2 required the construction of an approximate 5-km, steeper, heavy transport road (Road R04) over Kuku Ridge to the CPF P2C site from logistics facilities located at Herd Base.

Option 3 was the preferred pre-FEED option considered in the 2019 Upstream EIS because it enabled early mobilization of personnel and equipment to begin the construction of Project infrastructure, which better meet the Project timeline.

Since the completion of pre-FEED, the proposed location of the CPF has been moved to site P3, approximately 1 km southwest of Herd Base. This has reduced the length of haul road required between the CPF and Herd Base (Road R03) and removed the requirement to cross Kuku Ridge thereby making Option 2 a preferable option for the logistics facility. Placing the logistics facility at the expanded Herd Base also reduces the Project footprint and costs and logistics requirements by cancelling the need for establishment of a new site. Herd Base will now have a greater role than that described in the 2019 Upstream EIS. An expansion and upgrade to Herd Base has been approved under a Level 2 environment permit (EP-L2 (532) issued April 2023). Warehousing and logistics previously planned at the NLB will be accommodated at Herd Base, in addition to the operations camp.

With the cancellation of the NLB, offloading facilities (MOF and COF) for CPF construction will be relocated adjacent to the CPF (at site P3). A low-gradient heavy transport road of approximately 400 m length will be required between the MOF and the CPF site to allow transport of modular components for the CPF (see Section 4.4.5.2).

The total disturbance footprint of these construction offloading facilities is 4 ha, compared to the footprint of approximately 7 ha for the previously proposed NLB (excluding the 2.6-km heavy haul road to the CPF at site 2PC, which is now not required).

5.2.2 2019 Upstream EIS Section 5.5 Process and Technology Alternatives

Acid Gas Management

The raw gas produced from the Elk-Antelope reservoirs contains native carbon dioxide (CO_2) and hydrogen sulfide (H_2S) and is referred to as acid gas. It must be removed prior to liquefaction to achieve the technical and commercial specification of less than 45 ppm for CO_2 and less than 3 ppm for H_2S at the acid gas removal unit (AGRU) outlet where H_2S and CO_2 gases in the raw gas are absorbed in an amine solution. This amine solution is routed to a regeneration unit where the solution is heated using boiler-generated steam. This process requires 72 m^3/day of demineralized water that will be sourced from the Purari River. The acid gas is released from the amine solution in the form of vapor, which is routed to the acid gas injection system.

At the time of the preparation of the 2019 Upstream EIS, several acid gas management concepts were being assessed and the 'partial reinjection' concept was presented in the EIS. This concept involved, in the first four years of production, the incineration of the acid gas from the AGRU via a thermal oxidizer with between 80 and 95% sulfur recovery from the flue gas (desulfurization) before venting from a conventional stack. Sulfur recovered from the flue gas, in the form of sulfur dioxide (SO_2), was planned to be converted to a liquid effluent and reinjected with produced water into the Antelope reservoir. The efficiency of acid gas incineration of between 80 to 90% would result in 5 to 20% of the acid gas not being burnt and therefore would be released to the atmosphere. Once the Elk reservoir is depleted, after approximately four years, acid gas removed by the AGRU is directly reinjected into the Elk reservoir rather than going through the thermal oxidizer and flue gas desulfurization process.

At the completion of FEED, the selected acid gas management strategy has been changed to full reinjection of the acid gas into the Antelope reservoir from the start of production. The main driver of this change is the reduction in greenhouse emissions that will be achieved, notwithstanding that the system designed to accommodate higher acid gas levels in raw gas in the Antelope reservoir due to reinjection will increase power requirements for gas production and reinjection. Once the Elk reservoir is depleted, Elk will act as the main acid gas storage as planned in the partial reinjection concept. Modifications to infrastructure that are required to support this change are described in Chapter 4 and summarized in Table 4.2.

If acid gas reinjection is not available, acid gas will be processed via a gas-assisted acid gas flare rather than the thermal oxidizer and flue gas desulfurization process. The gas-assisted flare is preferred as:

- It is simpler from an operation standpoint, e.g., there is less chance of it failing and requiring repairs/maintenance.
- Modelling has demonstrated that sulfur emissions will be compliant with Project ambient air criteria.
- There are greater process efficiencies and hence a lower cost.
- Elimination of the need for continuous fuel gas burning by standby thermal oxidizer.

The changes resulting from the adoption of this full reinjection strategy do not increase the Project footprint requirements, thereby minimizing vegetation clearing and ground disturbance. The change needed for the associated infrastructure (additional pipelines and wells) are located within the existing Project footprint for the upstream gathering network and well pads. The changes to the acid gas processing also occur within the designed CPF footprint.

From an environmental perspective, the benefit of the full injection strategy is a reduction in the amount of acid gas released to the atmosphere during the first four years of production, i.e., the 5 to 20% of the acid gas that would not be burned in the incineration process released to the atmosphere.

5.2.3 2019 Upstream EIS Section 5.6 Construction Alternatives

River Crossings

Three export pipeline routes across the Purari River were evaluated during pre-FEED for their suitability for horizontal directional drilling (HDD) based on ground conditions for drilling platforms. The location of the CPF has been moved approximately 1.6 km east-southeast from the location in the 2019 Upstream EIS. The proposed location for the river crossing has therefore been moved further upstream given this change in CPF location and minor re-routing of the export pipeline that is consequentially required. Further design and geophysical investigations are being undertaken by TEP PNG to confirm the suitability of the new proposed river crossing location and engineering requirements to allow HDD, e.g., construction of stable platform for drilling.

5.3 References

ERIAS. 2019. Papua LNG Project Upstream Environmental Impact Statement. 01215B_23_v5. December. Unpublished report to Total E&P PNG Limited.

ERIAS. 2023a. Upstream Papua LNG Project alternatives assessment report. Report prepared by ERIAS for TotalEnergies EP PNG Limited.

ERIAS. 2023b. Pre-clearance Survey Findings – Central Processing Facility. Report prepared by ERIAS for TotalEnergies EP PNG Limited. Draft.

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ERIAS. 2024b. Papua LNG Upstream Project pre-clearance survey findings comparison - CPF P2 and CPF P3. Report prepared by ERIAS for TotalEnergies EP PNG Limited.

TEP PNG. 2023a. Multicriteria assessment of alternative CPF locations south of Purari River. TotalEnergies EP PNG Limited. Port Moresby.

TEP PNG. 2023b. Papua LNG Project - Upstream CPF site relocation. TotalEnergies EP PNG Limited. Port Moresby.

6. Stakeholder Engagement

6.1 Overview

Stakeholder engagement is an important aspect of any project development and an internal requirement of TEP PNG Societal Policy.

Chapter 6 of the 2019 Upstream EIS (ERIAS, 2019) describes TEP PNG's stakeholder engagement process and activities, specifically:

- The objectives, principles and methods used to design stakeholder engagement for the Project.
- The stakeholder engagement activities undertaken by TEP PNG to date, including resourcing arrangements.
- The key issues raised by stakeholders and how stakeholder input has been addressed in the EIS.
- How stakeholders will continue to be engaged through the Project phases, and how engagement activities will be verified, monitored and reported.

A Project Stakeholder Engagement Plan (SEP) was developed in October 2016 and formed the basis of the current Stakeholder Engagement Management Plan (SEMP) (L2-PLN-SDV-24) which guides the ongoing stakeholder engagement process.

This chapter describes the stakeholder engagement activities that have been completed since the submission of the Upstream EIS (2019) and stakeholder engagement related to the substantial changes which are being assessed in this EIS Addendum:

- Relocation of the central processing facility (CPF).
- Changes to the acid gas management strategy.

6.2 Post-EIS Stakeholder Engagement

6.2.1 Key Engagement Activities

Routine stakeholder engagement has been undertaken with Project-affected communities by TEP PNG community liaison officers since submission of the EIS and will continue to be undertaken. Engagement has been systematically recorded into TEP PNG's internal database (Borealis). Documented information includes the stakeholder engagement date, location, attendees and discussion topics. Table 6.1 summarizes the key stakeholder engagement activities that have occurred since the submission of the 2019 Upstream EIS.

Table 6.1 – Summary of Key Stakeholder Engagement Activities

Date	Topic	Stakeholder Groups	Activity
April 2022	EIS roadshow and disclosure	Project-affected communities (Wabo, Poroi 2, Poroi 1, Mapaio, Kaevaria, Evara, Aivai, Aumu, Apiope, Akoma, Muro Mission, Kaivakovu and Kavava)	Disclosure information presented to communities within the Project area of influence (PAOI) for the EIS included an overview of the Project description including key facilities and processes, an outline of the structure and findings of the EIS (including environmental and social sensitivities and impacts) and an overview of the environmental and social management plan (ESMP). English and Pidgin versions of the EIS Executive Summary were distributed to all villages.
May 2023	EIS disclosure	Provincial government	EIS was presented.
June 2023	EIS disclosure	National government agencies	EIS was presented.
Ongoing	Project updates	All	Quarterly Project (Tok Save) newsletters have been published to provide updates on key Project activities.
Ongoing	Project updates	Project-affected communities (Wabo, Poroi 2, Poroi 1, Mapaio, Kaevaria, Evara, Aivai, Aumu, Apiope, Akoma, Muro Mission, Kaivakovu and Kavava)	Lida Kibung meetings are open forum and occur biannually to discuss Project updates, national content, community development and environmental impacts. Refer to Table 6.2 for dates of completed meetings and their locations.
Ongoing	Project updates	Provincial government	Gulf provincial working group meetings are open forum and discuss Project updates, national content, community development and environmental impacts. Refer to Table 6.2 for dates of completed meetings.

Table 6.2 – Lida Kibung and Gulf Provincial Working Group Meetings Held to Date

Lida Kibung Meetings				Gulf Provincial Working Group Meetings		
No.	Date	Location	Segment	No.	Date	Location
1	31 May 2018	Wabo Camp	North	1	28 March 2018	Kerema
2	1 February 2019	Purari Airstrip	North	2	25 July 2018	Kerema
3	1 May 2019	Wabo	North	3	7 November 2018	Kerema
4	18 May 2019	Poroi 2	North	4	30 January 2019	Kerema
5	15 November 2019	Purari Airstrip	North	5	12 November 2019	Kerema
6	26 April 2023	Evara	North	6	16 November 2022	Kerema
7	10 April 2024	Wabo	North	7	19 July 2023	Kerema
8	10 April 2024	Kaeveria	North	8	7 February 2024	Kerema
9	4 September 2024	Kavava	South	9	8 May 2024	Kerema

Plates 6.1 to 6.2 depict the various stakeholder engagement materials used by TEP PNG to support the stakeholder engagement process, including the EIS roadshow flyer and the Project newsletter.

6.2.2 Outcomes of Engagement Undertaken

Further to feedback obtained during the EIS roadshow, comments boxes for feedback/concerns/queries were left at all villages for a period of 28 days. TEP PNG will continue to engage with stakeholders as the detailed design advances.

6.3 Stakeholder Engagement Related to Substantial Changes to the Project

Intensive stakeholder engagement has been conducted with the landholder clan (Nemina clan) who have been notified regarding CPF P3. Land access documentation has also been provided.

Broader engagement regarding CPF P3, and notification of the acid gas management strategy change, has also been undertaken. This was undertaken in all PRL 15 villages covering all landowning clans as well as land or resource users and other residents of each village. Engagement is ongoing with the Baimuru Local Level Government; the Ihu Local Level Government and the Gulf Provincial Government. The Project will continue to revisit the relevant villages and clans to discuss the proposed changes to the Project design in detail. Table 6.3 summarizes the engagement completed with PRL 15 villages.

Plate 6.1a – EIS Roadshow Flyer (April 2023) Page 1

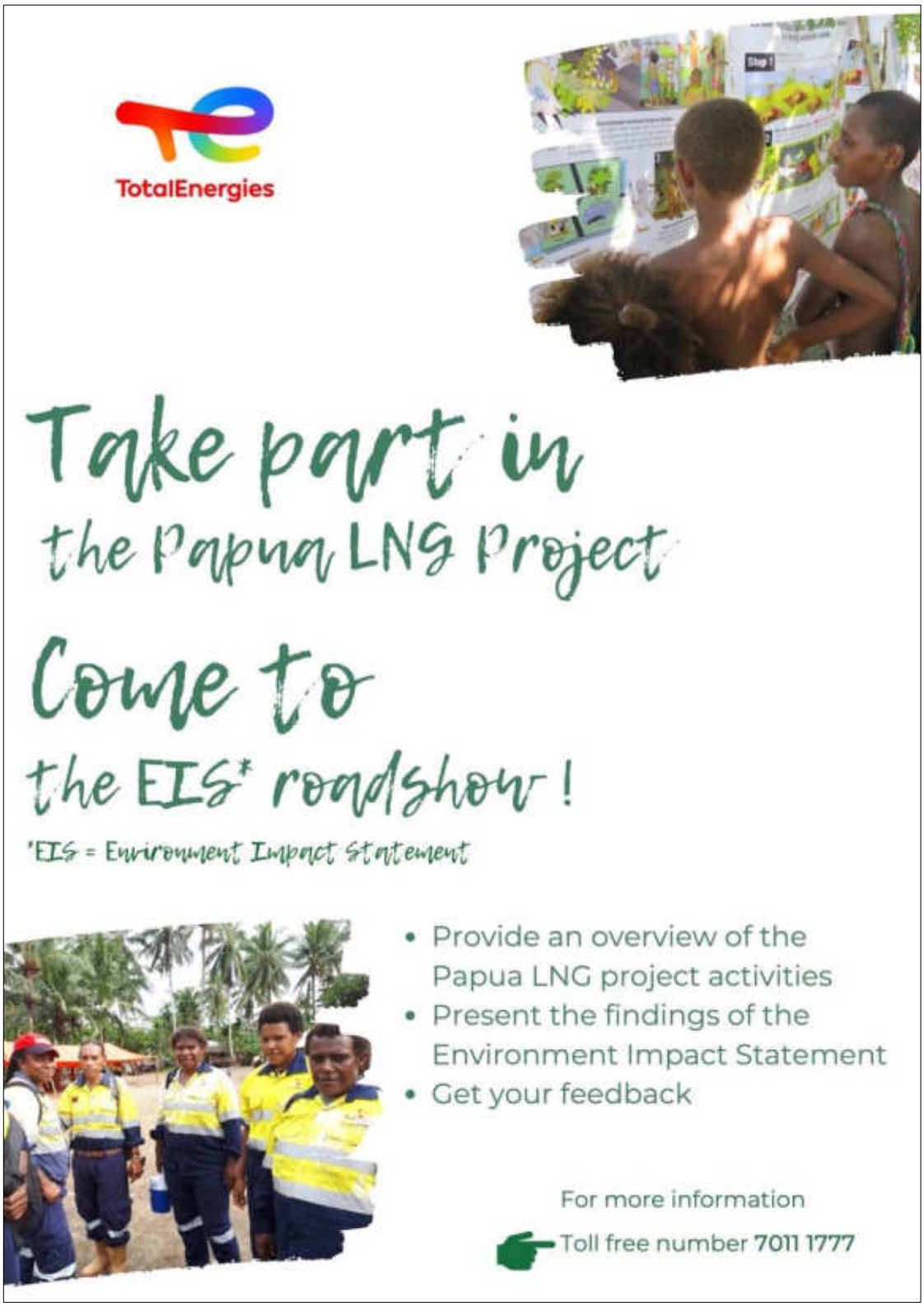


Plate 6.1b – EIS Roadshow Flyer (April 2023) Page 2



Plate 6.2 – Project Newsletter (May 2023)



PAPUALNG

KOMUNITI TOKSAVE

Quarterly Papua LNG Newsletter | May 10th, 2023 | ISSUE No. 7

The Independent Advisory Panel's visit to Elvaro community in Gulf province on January 18th, 2023

Papua LNG project status update

The Papua LNG logo revealed to members of the Government and executive members of the Papua LNG project partners TotalEnergies, ExxonMobil and Santos in Port Moresby on March 6, 2023

On March 6 2023, Papua LNG partners TotalEnergies, Santos and Exxon Mobil hosted an important event with government and business community leaders to announce the fully integrated Front-End Engineering Design (FEED) phase of the Project, and the unveiling of the Papua LNG logo.

The logo reflects the rich cultural heritage of the two provinces hosting the Project.

It depicts a crocodile to represent the Gulf province, and the two sails of the Lakatoi to represent the ancient tradition of the Hiri trade between Gulf and Central provinces.

We chose this logo as a reflection of our commitment to the regions that host Papua LNG.

Timeline

*FEED - [Front-End Engineering Design]
**FID - [Final Investment Decision]

Happening Soon

Barge trial on the Purari River in May 2023 Page 3

INSIDE

Latest on Lida Kibungs Pg. 4
Update on SMLIs Pg. 5
Donation of Computers Pg. 6

Table 6.3 – Summary of Stakeholder Engagement Related to the Substantial Project Changes

Date	Topic	Stakeholder Groups	Activity
9 November 2024	EIS Addendum changes in detail	Poroi 2 village	Three components: • Communication pack to guide discussion on the CPF location change and the altered acid gas management strategy. • Two A0 laminated posters with pictorial descriptions of the substantial Project changes (Plates 6.3 and 6.4). • Detailed one to two hour question and answer sessions following the presentation.
11 November 2024		Subu 2 village	
12 November 2024		Evara village	
13 November 2024		Wabo Station and village	
14 November 2024		Poroi 1 village	
December 2024		Baimuru Local Level Government (LLG). Including LLG President, area manager and staff	
December 2024		Ihu Local Level Government (LLG). Including LLG President, area manager and staff	
27 November 2024		Gulf Provincial Government; main heads of departments; part of the Gulf Provincial Working Group meeting	

6.4 Ongoing Engagement

TEP PNG is committed to continuing to build long-term relationships with stakeholders, fostering economic development and contributing to local talent and skills development throughout the life of the Project. Ongoing, meaningful and gender-appropriate engagement will continue through preconstruction, construction, operations and decommissioning phases in accordance with the SEMP.

Plate 6.3 – Community Engagement Poster for the Change of CPF Location

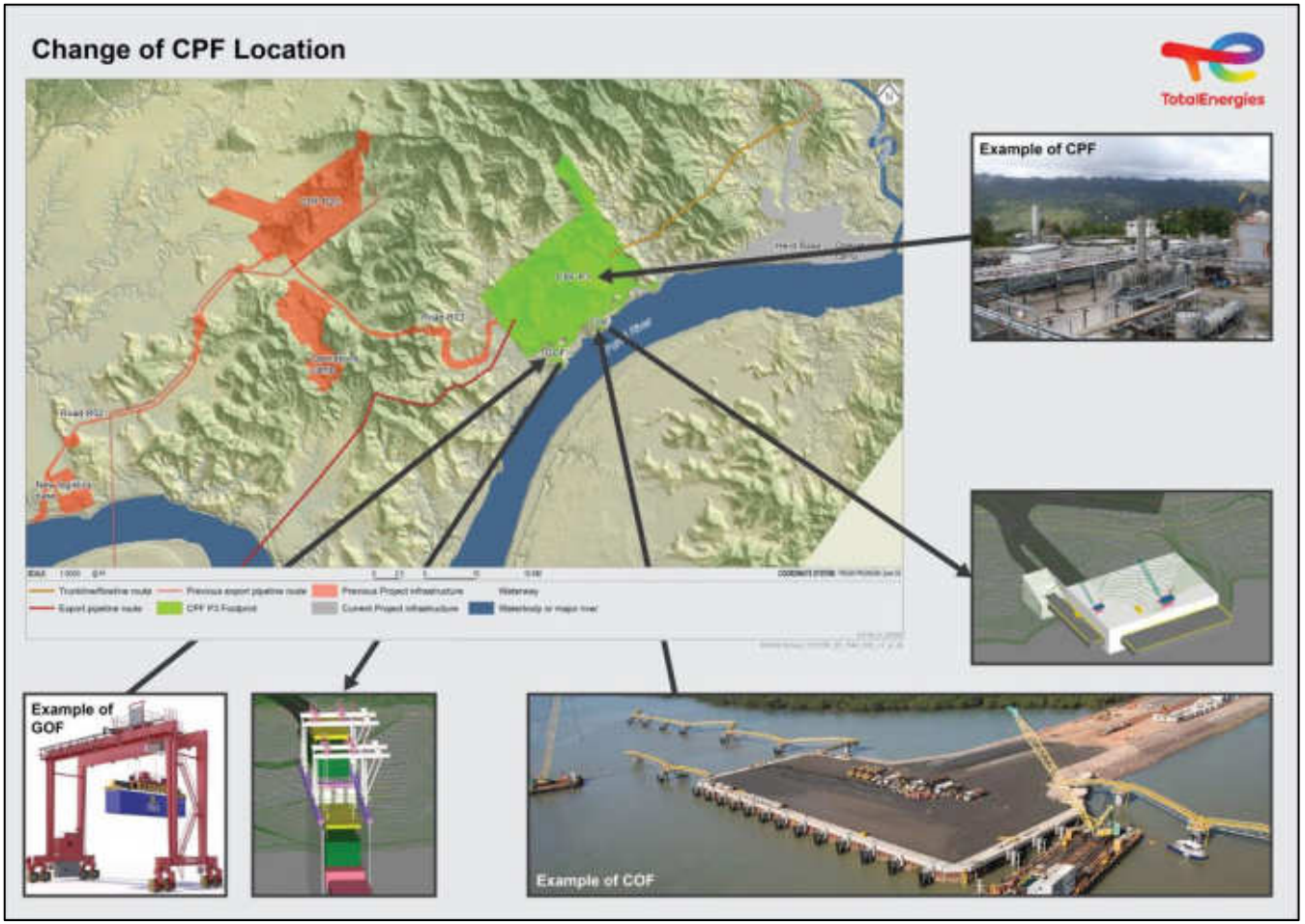
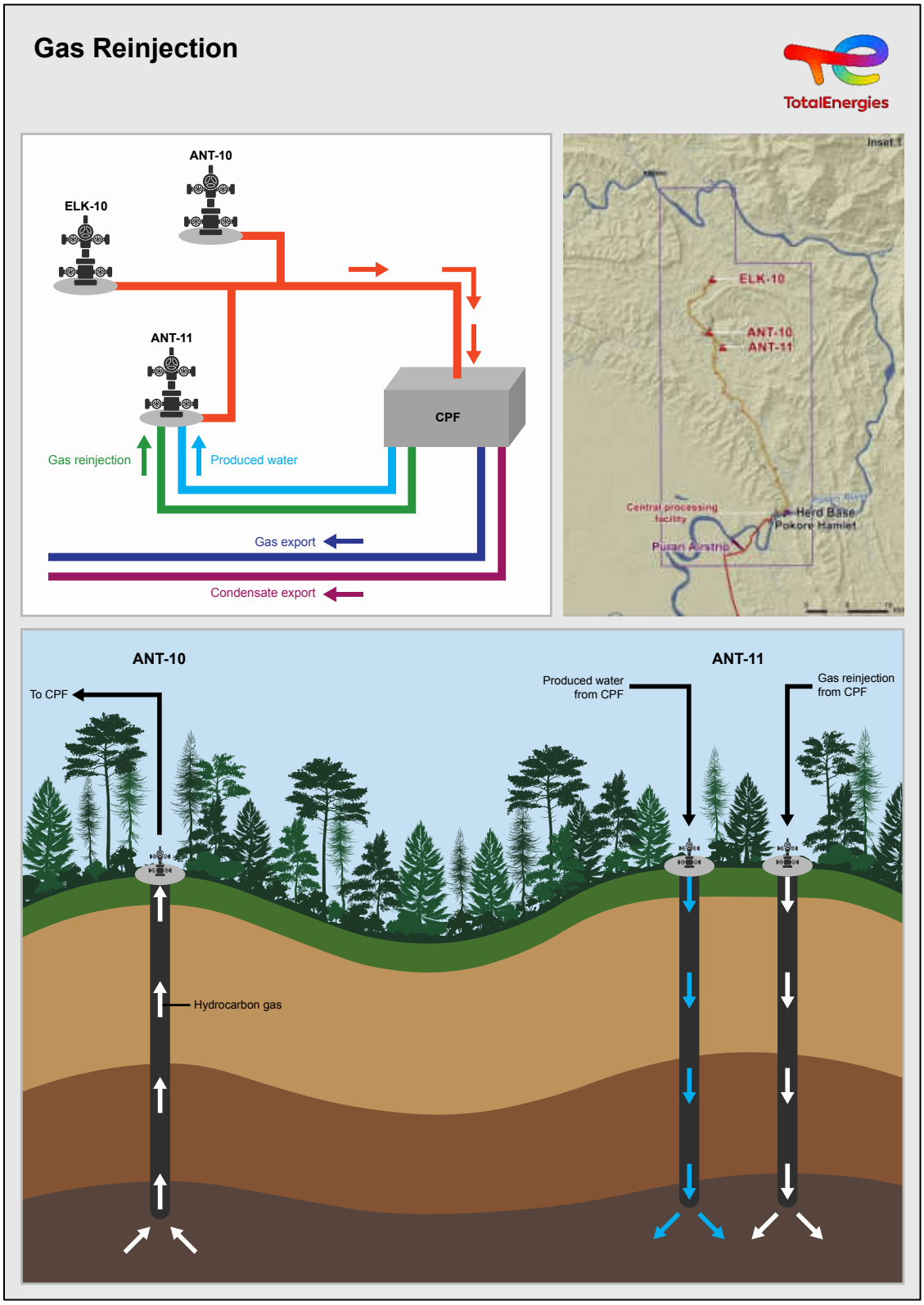


Plate 6.4 – Community Engagement Poster for Gas Reinjection



7. Terrestrial

7.1 Overview

A number of revisions are required to the description of the existing terrestrial environment in the 2019 Upstream EIS (ERIAS, 2019) to present more recent information that has been obtained.

Table 7.1 identifies the sections of the existing terrestrial environment that require a revision.

Table 7.1 – Summary of Existing Environment Terrestrial Revisions

2019 Upstream EIS Chapter Number	Upstream EIS Heading	Reasons Revisions Required in EIS Addendum
7.1	General Setting	No change required
7.2	Geology, Terrain and Soils	Revisions to description of acid sulfate soils (ASS), considering additional sampling undertaken for PCS
7.3	Hydrology and Meteorology	Information on flooding from additional hydrological modelling
7.4	Surface Water and Sediment Quality	Information from additional sampling undertaken for PCS, and Purari River dredging impact assessment
7.5	Groundwater	Information from additional bore sampling undertaken at Herd Base
7.6	Freshwater and Estuarine Biodiversity	Information from additional surveys undertaken for PCS, and Purari River dredging impact assessment
7.7	Terrestrial Biodiversity	Information from additional surveys undertaken for PCS
7.8	Vegetation Regeneration	No change required
7.9	References	References provided in Section 7.8

7.2 2019 Upstream EIS Section 7.2 Geology, Terrain and Soils

The limited soil sampling undertaken for the 2019 Upstream EIS identified the occurrence of acid sulfate soil (ASS) along a saturated drainage line associated with Kuku Creek, which is located in Sulfaquents of Soil Complex 1. Psammaquents and Sulfaquents of Soil Complexes 2 and 3 were also identified as soil units typically at risk of containing ASS.

Investigations for the occurrence of ASS are being undertaken as a component of the pre-clearance surveys (PCSs) for the Project. This includes visual/olfactory observations and field tests to identify potential ASS and collection of samples for laboratory analyses to confirm and quantify occurrence. No obvious correlation has been observed in results from ASS analyses and information from the Papua New Guinea Resource Information System (PNGRIS) on elevation, soil type, landform, vegetation type or geology to identify areas of low or high ASS risk (ERIAS, 2023a).

Sampling and analysis for ASS has been undertaken to a depth of 1 m in the area of the CPF P3 site (ERIAS, 2024a), and Road R03 (ERIAS, 2024b) which falls within the proposed CPF P3 site footprint. The locations of these sampling sites are shown in Figure 7.1, distinguishing sites where net acidity exceeded the action criterion of 18 mol H^+/tonne[1], which indicates the requirement for further ASS investigation and management[2]. Net acidity exceeded the action criterion at most locations, indicating that ASS management is required if soil is to be excavated. The acidity is attributable to actual acidity rather than potential acidity, and there is no effective acid neutralising capacity (ANC) in the soils.

Sampling has shown the area of Herd Base to be a lower risk area for the occurrence of ASS, with three of the seven sampling sites sampled having potential acidity above the action criterion (Figure 7.1) but with soil at these locations containing a large amount of ANC (ERIAS, 2023b; 2023c).

7.3 2019 Upstream EIS Section 7.3 Hydrology and Meteorology

The PCS of the CPF P3 site (ERIAS, 2024a) identified 7 defined[3] waterways and 68 undefined waterways within the surveyed area, which included areas outside the CPF P3 site footprint. These unnamed waterways are shown in Figure 7.2 and comprise short reaches between surrounding ridge lines that flow into the Purari River.

The defined waterway along the northern perimeter of the CPF P3 site is shown in Plate 7.1, and an example of an undefined waterway is shown in Plate 7.2.

Flood modelling has been undertaken to define the flood hazard from the Purari River and catchment streams as part of a navigation and hydrological study (HR Wallington, 2018). This modelling was undertaken for flood events of the Purari River and localized rainfall events within its catchments for return periods of 10 years, 100 years, 1,000 years and 10,000 years. Modelling results for the 1 in 100-year Purari River flooding event are shown in Figure 7.3, along with the footprint of the CPF P3 site.

Further discussion on flooding risk and design considerations is provided in Chapter 15.

1 Result shown is the highest acidity measurement from samples collected at 0-0.5 m and 0.5-1 m depth.
2 This action criterion is provided in the Australian National Acid Sulfate Soil Guidance (Sullivan et al., 2018).
3 A 'defined' waterway is one that has sufficient flow to create a riverine environment. This may include a feature in which water only intermittently flows. The key features in identifying a defined waterway are defined bed and banks and evidence of aquatic ecosystem features (e.g., aquatic macrophytes) that would likely be supported even when the watercourse temporarily dries out. A defined waterway contrasts to a drainage feature which is formed by overland flow during and immediately after rain but does not have aquatic ecosystem features, which are referred to as undefined waterways.

Acid Sulfate Soil Sampling Results

Papua LNG Project | PRL-15 EIS Addendum

FIGURE 7.1

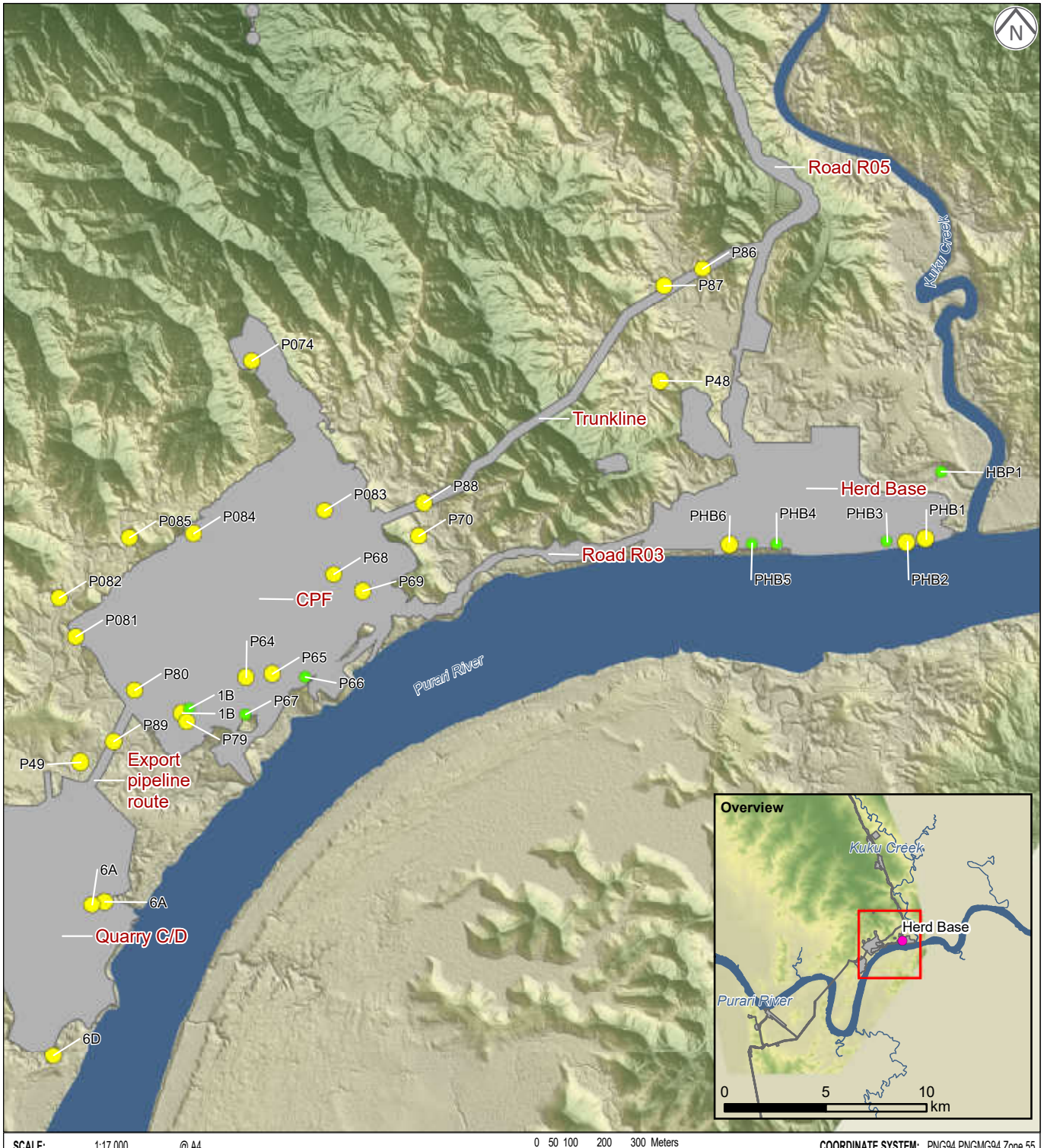


Plate 7.1 – Defined Waterway on Northern Perimeter of the CPF P3 Site (Site AQ088)



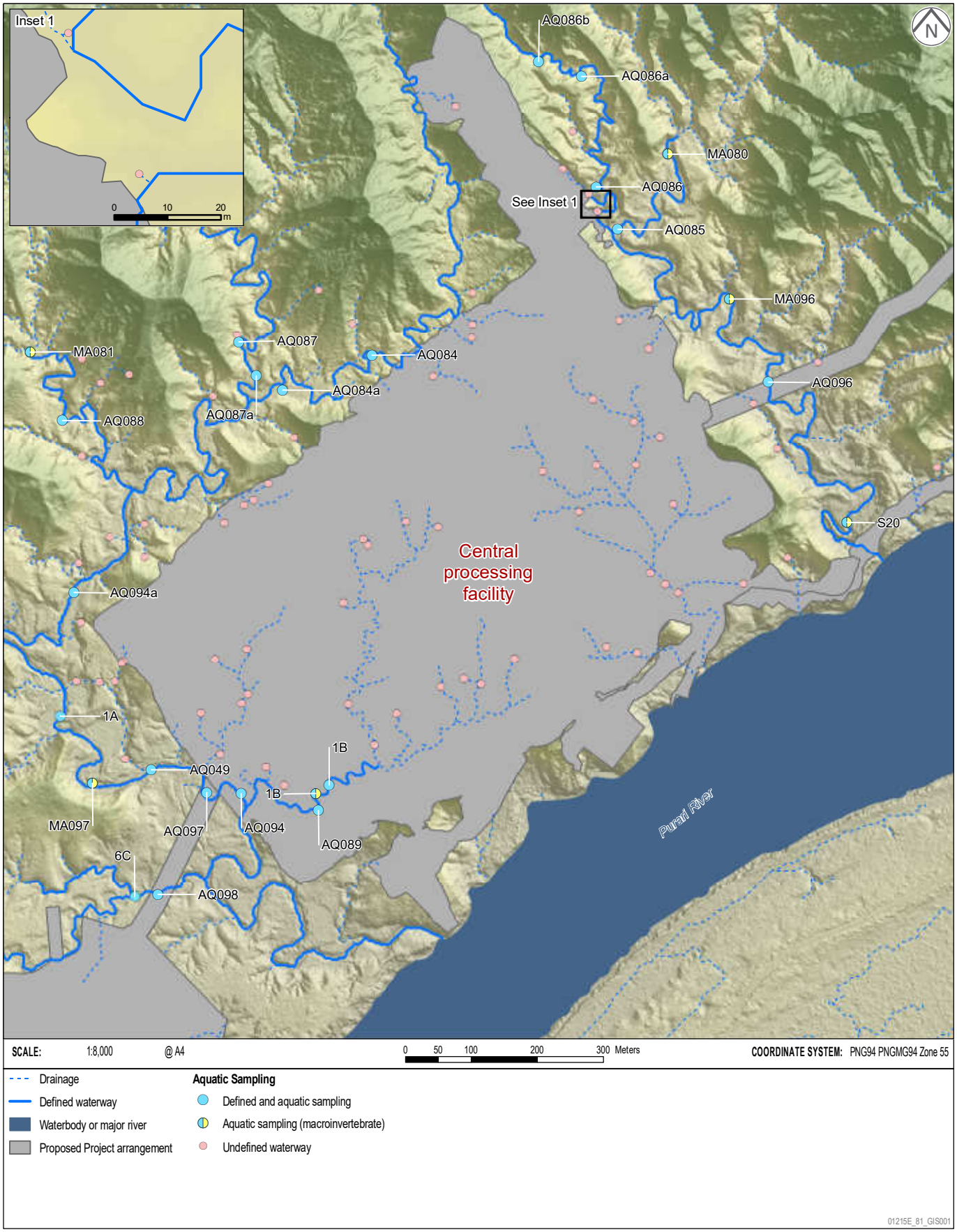
Plate 7.2 – Example of Undefined Waterway (302175E; 9186456N)



Location of Aquatic Environmental Features

Papua LNG Project | PRL-15 EIS Addendum

FIGURE 7.2



1 in 100-Year Purari River Flooding Event

Papua LNG Project | PRL-15 EIS Addendum

FIGURE 7.3



7.4 2019 Upstream EIS Section 7.4 Surface Water and Sediment Quality

7.4.1 Tributary Streams

Water quality surveys undertaken for the PCS in the areas of the CPF P3 site have included measurements of physicochemical parameters in defined waterways, at locations shown in Figure 7.2 (ERIAS, 2024a).

Results from these surveys were generally consistent with background conditions for tributary streams of the Purari River within PRL-15 reported in the 2019 Upstream EIS. Water is characterized as having low electrical conductivity (less than 150 µS/cm), circumneutral to moderately alkaline pH (pH 6.8 to 8.6) and are generally well-oxygenated (>80% saturation).

Concentrations of total suspended solids (TSS) were low (mostly <5 mg/L). Notwithstanding that slightly turbid waters were observed at some locations, the tributary streams were generally observed to be small, clear-flowing waterways.

7.4.2 Purari River

Characterisation of water and sediment quality was undertaken of various zones of the Purari River, including the Purari River mouth, lower Purari, mid-Purari and upper Purari, during 2023 as part of studies for a dredging impact assessment (BMT, 2024). Sampling of the mid Purari included sites along the reach between Ne'ea[4] Creek and Kuku Creek, which is the area in the vicinity of the CPF P3 site and Herd Base. These results are described in the following sections.

7.4.2.1 Water Quality

Water quality sampling was undertaken of the surface, middle and bottom of the water column at all sites.

Concentrations of inorganic and organic toxicants were generally lower than PNG regulatory limits[5] and international, i.e., Australian and New Zealand, water quality guidelines (ANZG, 2018). Concentrations of organic contaminants (including polycyclic aromatic hydrocarbons (PAH), total petroleum hydrocarbons (TPH) and benzene, toluene, ethylbenzene, xylene and naphthalene (BTEXN)) were less than limits of reporting (LoR), except for one outlier result for TPH.

Concentrations of dissolved metal/metalloids were mostly less than LoR and well below PNG regulatory limits. Levels were also lower than ANZG (2018) guidelines except for minor exceedances for zinc in three of four samples and copper in one of four samples collected near Herd Base.

Nutrient concentrations (nitrate, nitrite, ammonia, total kjeldahl nitrogen, total nitrogen, total phosphorus and soluble reactive phosphorus) were consistently low at all sites, with nitrite levels

4 Ne'ea is the new spelling for the formerly used Nea, any references in the 2019 EIS Addendum to Nea therefore also refer to Ne'ea.
5 Schedule 1 of the *Environment (Water Quality Criteria) Regulation 2002,* which provides legally enforceable freshwater water quality criteria in Papua New Guinea.

less than the LoR. Chlorophyll-a levels were also consistently below the LoR at all sites, indicating limited phytoplankton (algal) biomass.

TSS concentrations measured in the river reach near the airstrip ranged from 46 to 134 mg/L, with a mean of 80 mg/L and relative standard deviation (RSD) of 35%. Higher concentrations were measured near Herd Base ranging from 138 mg/L to 672 mg/L, with a mean of 406 mg/L and moderate variability (RSD 55%). Levels of TSS at all locations showed a consistent trend of increasing concentration with water depth. This overall large range in TSS concentrations in the Purari River is consistent with observations in the 2019 Upstream EIS, which reported concentrations ranging between 21 to 778 mg/L for this turbid major river system.

7.4.2.2 Sediment Quality

Sand was by far the dominant particle size in sediment samples collected at all sites, with average amounts of 82% at Herd Base and 96% near Purari airstrip.

Concentrations of volatile organic compounds, organotins, synthetic pyrethroids, organochloride pesticides, organophosphorus pesticides and herbicides, polychlorinated biphenyls, and carbamate pesticides were all below the LoR at all sample sites. Low levels of polyaromatic hydrocarbons (PAHs) were detected in all samples analysed across all sites, at levels below international sediment quality guidelines. Similar results were reported in the 2019 Upstream EIS.

Nutrient concentrations were broadly comparable across all sites and present in negligible amounts. Inorganic and organic carbon content was also low.

Concentrations of metals and metalloids were below international sediment quality guidelines levels, except nickel, consistent with results reported in the 2019 Upstream EIS. This exceedance is attributed to naturally elevated levels of nickel occurring in sediment associated with regional geology.

7.5 2019 Upstream EIS Section 7.5 Groundwater

The groundwater quality characterisation described in the 2019 Upstream EIS included information from sampling of groundwater supply bores at Herd Base. More recent sampling of these water supply bores (BH-01, BH-02, BH-03 and BH-04) has been undertaken (in August, October and December 2023, and February 2024), with results described below.

The depth from surface to groundwater in the four bores was recorded in August and October 2023 and ranged from 2.8 to 7.5 m.

Measurements of pH showed groundwater to be slightly acidic to circumneutral at BH-01 to BH-03; and moderately alkaline at BH-04. This higher pH for BH-04 is consistent with higher levels of bicarbonate measured in water samples from this bore. In comparison, the 2019 Upstream EIS reported groundwater to be moderately alkaline in all bore water samples.

There was also more variability in electrical conductivity measurements during the recent sampling, ranging from 30 to 1,000 μS/cm in August and October 2023, and 429 to 991 μS/cm in December 2023 and February 2024. In comparison, the 2019 Upstream EIS reported conductivity ranging from 765 to 992 μS/cm. The water remains classified according to WHO (2022) drinking water guidelines as representing fair drinking water based on aesthetic considerations, i.e., taste.

It is to be noted; however, that appreciable levels of coliforms were measured in many of the samples collected.

Concentrations of dissolved metals were low with most being less than the LoRs, and lower than WHO (2022) drinking water guidelines and Schedule 2 of the PNG *Public Health (Drinking Water) Regulation 1984*. Levels of PAHs, BTEX and TPHs were less than LoRs in all samples, except for total TPHs in BH-03 in December 2023 (290 µg/L) and February 2024 (690 µg/L). No health-based limit for total TPHs is provided in drinking water guidelines.

Perfluoroalkyl and polyfluoroalkyl substances (PFAS) were also measured in samples collected in August and October 2023, and February 2024. PFAS was detected in BH-03 during August 2023 (sum of PFAS being 0.11 µg/L) and October (0.15 µg/L), but was less than LoRs in February 2024. PFAS concentrations (all individual compounds and sum amounts) in all samples from other bores were less than the LoRs. The Australian PFAS National Environment Management Plan (NEMP) (HEPA, 2020) provides guidance on the management of PFAS contamination in the environment, with a drinking water guideline of 0.07 µg/L derived for the sum of perfluorooctane sulfonate (PFOS) and perfluorohexane sulfonate (PFHxS). Notwithstanding the detection of PFAS in water from BH-03 on two sampling occasions, sum concentrations of PFOS and PFHxS were less than the LoR of 0.01 µg/L, and hence less than the drinking water guideline.

7.6 2019 Upstream EIS Section 7.6 Freshwater and Estuarine Biodiversity

Section 7.6 of the 2019 Upstream EIS (ERIAS, 2019) describes the aquatic ecosystem and freshwater biodiversity of PRL-15. Further description is provided below of the aquatic habitat and fauna based on results of PCS undertaken in the area of the CPF P3 site (ERIAS, 2024a) and Road R03 (ERIAS, 2024b).

7.6.1 Aquatic Habitat

Low-gradient slow- to moderate-flowing tributary streams occur in the southern region of PRL-15. There is a transitional zone between the swift-flowing, clear-water environments that characterize the high- to moderate-gradient tributary streams and the slow-flowing, unconfined turbid major river systems of the Purari River. They have substrates dominated by gravel, pebbles and sand; the common occurrence of gravel and sand bars; and hydraulic habitats including riffles, glides and runs with occasional pools. They usually have low turbidity, although this is temporally variable and turbidity is higher in lower reaches. Woody debris, leaf litter, trailing vegetation and trailing roots are abundant, providing a high level of microhabitat complexity. Riparian vegetation is continuous lowland or alluvial forest, while aquatic macrophytes are absent, which is likely due to channel scour and shading by riparian vegetation (ERIAS, 2019).

The PCS of the CPF P3 site (ERIAS, 2024a) identified 7 defined waterways and 68 undefined waterways, i.e., ephemeral drainage lines and depressions, occurring within the surveyed area (see Section 7.3). These unnamed defined waterways comprise short reaches between surrounding ridge lines that flow into the Purari River. Stream condition was assessed using the Australian River Assessment System (AusRivAS) methodology at each of the defined waterways at water quality sampling sites, with sampling locations shown in Figure 7.2. Stream conditions

were consistent with observations for low-gradient slow- to moderate-flowing clear water tributary streams described above.

7.6.2 Aquatic Fauna

7.6.2.1 Aquatic Macroinvertebrates

Sampling in the upper Purari River and tributaries within PRL-15 undertaken for the 2019 Upstream EIS and PCS has found that macroinvertebrates are dominated by mayfly (*Ephemeroptera*) families (*Baetidae*, *Caenidae* and *Leptophlebiidae*). Other abundant taxa include copepods, *Hemiptera* (true bugs), and non-biting midges from the sub-family *Chironominae*. Other fauna occurring in lower abundance include decapods (freshwater shrimp and prawns), *Oligochaeta* (worms) and *Plecoptera* (stoneflies).

The following two endemic aquatic insect species, which Polhemus et al. (2004) found are restricted to the Papuan Gulf Coastal Lowlands ecoregion, are also expected to occur in the area of PRL-15:

- Waterstrider *Ciliometra setosa* (family Gerridae).
- Waterstrider *Lobates ivimka* (family Gerridae).

At the CPF P3 site macroinvertebrates sampling was undertaken at four locations, sites AQ085, AQ088, S20 and 1B (Figure 7.2). AQ085 recorded 74 species, AQ088 recorded 56 species, S20 recorded seven and 1B recorded six species. No threatened or protected species were recorded at the CPF P3 site.

7.6.2.2 Fish and Macrocrustaceans

Ariidae (forktail catfish) is the most specious fish family found in the upper Purari River and PRL-15, with 12 species identified during surveys undertaken for the 2019 Upstream EIS. *Eleotridae* and *Gobiidae* are also present and represented by six and five species respectively. Goldie River rainbowfish (*Melanotaenia goldiei*), estuarine glass perchlet (*Ambassis macracanthus*), greenback mullet (*Liza subviridis*), spoonsnouted catfish (*Doiichthyes novaeguineae*), nursery fish (*Kurtus gulliveri*) and freshwater anchovy (*Thryssa scratchleyi*) are found in relative abundance in the upper Purari River and PRL-15. The most abundant fish species in the clear-water tributaries are from the families *Eleotridae* (gudgeons), *Gobiidae* (gobies) *Terapontidae* (grunters) and *Melanotaeniidae* (rainbowfishes). Species of *Macrobrachium* prawns are the most abundant fauna in the clear-water tributaries. None of the species recorded are listed as threatened or protected.

Fish sampling was also undertaken during the PCS undertaken along Road 03 in 2019 (ERIAS, 2024b). Species recorded were similar to the findings of the 2019 Upstream EIS surveys, with no recorded species listed as threatened or protected.

A freshwater, potentially undescribed, crayfish reported in the 2019 surveys at site 0C appears to belong to the *Cherax cf. albertisii* species complex from Papua New Guinea and Northern Australia. The complex comprises at least four cryptic species based on recent molecular data and it is possible that this specimen is undescribed. Additional DNA sequencing is required to confirm whether this *Cherax cf. albertisii* is a new species or not. A single walking catfish (*Clarias*

batrachus), which is considered exotic, was found at site 0B (see Section 7.6.2.4). It is to be noted that sites 0C and 0B are on the perimeter of the previously proposed CPF P2C site and will no longer be subject to disturbance and development if the CPF is developed at the CPF P3 site location.

7.6.2.3 Sensitive Species, Ecosystems and Habitat Features

Sensitive Ecosystems and Habitat Features

Pandanus Swamps

The CPF P3 site and Road R03 surveys recorded one small area of pandanus swamp, which is considered sensitive in Papua New Guinea. Although common and widespread in the Upstream area, this vegetation type is associated with heavily waterlogged soils and disturbance can damage soils and interfere with water flows.

Riparian Zone

The riparian zone along the top of bank of the Purari River is also identified as potentially sensitive habitat. Such zones can provide specialist habitat for a variety of flora and fauna, including pig-nosed turtle nesting areas, and serve to limit erosion in flood-prone environments.

Sensitive Species

Sensitive species are those that meet one or more of the following criteria:

- Species listed under the *Fauna (Protection and Control) Act 1966*.
- Trade-restricted species under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and/or *International Trade (Fauna and Flora) Act 1979*.
- Species with a 'Threatened' status (i.e., Critically Endangered, Endangered, Vulnerable, Near Threatened) under the Red List published by the International Union for the Conservation of Nature (IUCN).
- Endemic and/or restricted-range species.
- Migratory and congregatory species.

The pig-nosed turtle (*Carretochelys insculpta*) and striped New Guinea softshelled turtle (*Pelochelys bibroni*) are known to nest in riparian zones of the Purari River and its tributaries. Both species are IUCN Red listed (IUCN, 2023), with *Carretochelys insculpta* listed as Endangered (EN) and *Pelochelys bibroni* as Vulnerable (VU). Nesting sites are used year after year and each is visited by multiple laying females. Turtle nesting site locations known to occur in the southern PRL-15 area are described in Section 7.7.7.3 of the 2019 Upstream EIS, with the closest nesting sites to the CPF P3 site located approximately 1 km upstream of Herd Base. A nesting site occurs near the confluence of Oyomo Creek with the Purari River and this site is now less likely to be subject to disturbance with the relocation of the CPF and MOF to the P3 site. The local community reports that the riparian zone at the confluence with tributary streams provides

suitable nesting locations when Purari River water levels are low. No turtle nesting sites have been observed in the riparian zone adjacent to the CPF P3 site during PCS.

Three Critically Endangered species, consisting of two sawfish species (*Pristis pristis* and *P. zijsron*) and one river shark (*Glyphis garricki*) have previously been identified as potentially occurring in the turbid main river channel of the Purari River and floodplain wetlands (ERIAS, 2019). A number of endemic damselfly, dragonfly and frog species, which rely on aquatic habitats, are also known to occur in PRL-15 (ERIAS, 2019), along with the endemic waterstriders described in Section 7.6.2.1.

Biological sampling was undertaken of various zones of the Purari River, including the Purari River mouth, lower Purari, mid-Purari and upper Purari, during 2023 as part of studies for a dredging impact assessment (BMT, 2024). This sampling program included water sampling for eDNA analysis to characterize and describe spatial patterns in the aquatic fauna that are otherwise difficult to detect using traditional sampling techniques. The targeted species for eDNA analysis included sawfish and river sharks (e.g., green sawfish, freshwater sawfish, speartooth shark), based on historical sightings. Additionally, a general vertebrate fauna species assay was used, encompassing other fish and vertebrate species, such as reptiles, birds, mammals, fish, and amphibians.

None of the target species, including sawfish, river sharks, and various river dolphin species, were detected by eDNA analysis. Most species identified via eDNA were not of conservation concern; however, the analysis revealed the presence of Endangered and Vulnerable species, including the pig-nosed turtle, Boeseman's rainbowfish, Lake Kutubu rainbowfish, and the cowtail stingray. The Vulnerable and Endangered species identified during the survey were also recorded during the 2017 baseline survey undertaken for the 2019 Upstream EIS; however, the cowtail stingray was cited as having a possible occurrence and was yet to be evaluated as Vulnerable at that time. Furthermore, the most prominent fish species recorded during the 2017 survey (greenback mullet (*Liza subviridis*), spoon-snouted catfish (*Doiichthyes novaeguineae*), nurseryfish (*Kurtus gulliveri*) and the freshwater anchovy (*Thryssa scratchleyi*)) were also recorded during the 2023 surveys.

7.6.2.4 Pest Species

Two pest aquatic species were recorded during the PCS of Road R03 (which falls within the proposed CPF P3 site footprint):

- A pond with cane toads (*Rhinella marina*) was recorded around chainage 1+500.
- A single walking catfish (*Clarias batrachus*) was recorded at site 0B.

While this catfish species is native to Asia it is considered exotic to PNG. The walking catfish is found in muddy substrates, fresh and brackish waters and terrestrial environments. It can survive outside of the water and travel on land as long as its gills are wet. It is considered an invasive threat as it is hard to contain and control due to its mass spawning that produces several thousands of eggs, voracious diet and ability to survive in muddy and low-oxygenated environment.

7.7 2019 Upstream EIS Section 7.7 Terrestrial Biodiversity

Changes made to the Project layout since completion of the 2019 Upstream EIS, notably including (but not limited to) a shift in the location of the CPF in southern PRL-15, necessitate a revision to the characterization of baseline terrestrial biodiversity values that may be impacted by Project development. Potential impacts to terrestrial biodiversity values are assessed in Chapter 10 in terms of predicted changes to the ongoing viability of ecosystem function and species' populations across the broader upstream terrestrial biodiversity study area (hereafter 'study area'). Because these features are not restricted to particular Project sites or areas (e.g., PRL-15), impact assessment requires consideration of (1) the distribution and status of each potentially affected biodiversity value across the study area, and (2) Project activities across the entire upstream Project Area of Influence (PAOI), which is contained within the study area. Accordingly, this addendum updates our understanding of the status and distribution of potentially affected biodiversity values, incorporating additional data collected during the pre-clearance survey (PCS) program undertaken since completion of the 2019 Upstream EIS both in PRL-15, including at the CPF P3 site (ERIAS, 2024a), and along the export pipeline route. It is important to note that the PCS program is not equivalent in scope to the 2016 environmental and social baseline studies (ESBS; ERIAS, 2017); the PCS program places particular focus on identifying sensitive habitats, focal ecological sites and plant populations that may be avoided by the Project; by contrast, mobile fauna are recorded on an opportunistic basis.

This addendum follows the terrestrial biodiversity baseline method outlined in the 2017 ESBS. Biodiversity values are evaluated at the species, ecosystem and focal site scales. Focus is placed on those values confirmed or likely to be present in the PAOI. The sensitivity of each biodiversity value is based on its inherent value and sensitivity to change, with each biodiversity value assigned one of the following five sensitivity rankings[6]:

- Not Sensitive.
- Low Sensitivity.
- Moderately Sensitive.
- Very Sensitive.
- Extremely Sensitive.

A detailed method of assigning sensitivity is outlined in the ESBS report (ERIAS, 2017).

7.7.1 Vegetation

The diversity and distribution of natural vegetation types across the PAOI and broader study area, and their overall condition, are similar to those reported in the ESBS. The following sections describe changes observed in the PAOI vegetation since the ESBS, and the vegetation affected by the CPF P3 site location.

6 These equate to sensitivity rankings of minimal, low, medium, high and very high, respectively, in Chapter 10.

7.7.1.1 Changes to Vegetation Typing

PCS ground-truthing has led to several small-scale changes in natural vegetation typing in the vicinity of proposed footprint areas.

The following changes were recorded in PRL-15:

- Two areas of Open alluvial forest (FIMS code Po) totaling 3.50 ha, formerly mapped as Hill forest (Hm), were identified on the Kuku Creek riverine plains along the Road R05 route in central PRL-15.
- A 0.31 ha area of Swamp woodland (FISM code Wsw), formerly mapped as Hill forest (Hm), was identified near Kuku Creek along the Road R05 route in central PRL-15.
- A 0.60 ha area of Large crowned alluvial forest (FIMS code Pl) near the Purari Airstrip in southern PRL-15 was reclassified as Hill forest (Hm).

The following change was recorded in the Aivai area in the central section of the export pipeline route:

- A 0.67 ha area of the vegetation complex Swamp woodland/Swamp grassland (FIMS code Wsw/Gsw) was reclassified as Mixed swamp forest (Fsw).

7.7.1.2 Changes in Vegetation Condition

The most notable change recorded in the PAOI vegetation since the ESBS is the commercial logging of approximately 3,602 ha of primary Hill forest (FIMS code Hm) in the Baimuru Block 3 logging concession, in the northern PAOI approximately 3 to 12 km east and northeast of Herd Base. The approximate area of recently logged forest, as interpreted from a recent remote sensing study (RSS, 2023), is shown in Figure 7.4.

7.7.1.3 Vegetation in the CPF P3 Site Option

The CPF P3 site is located in Hill forest (FIMS code Hm) in the Middle Purari Hills ecological zone. Most of the forest within the CPF P3 site is primary Hill forest, some areas of forest have previously been disturbed by road and quarry development associated with the Project.

7.7.2 Native Flora and Fauna

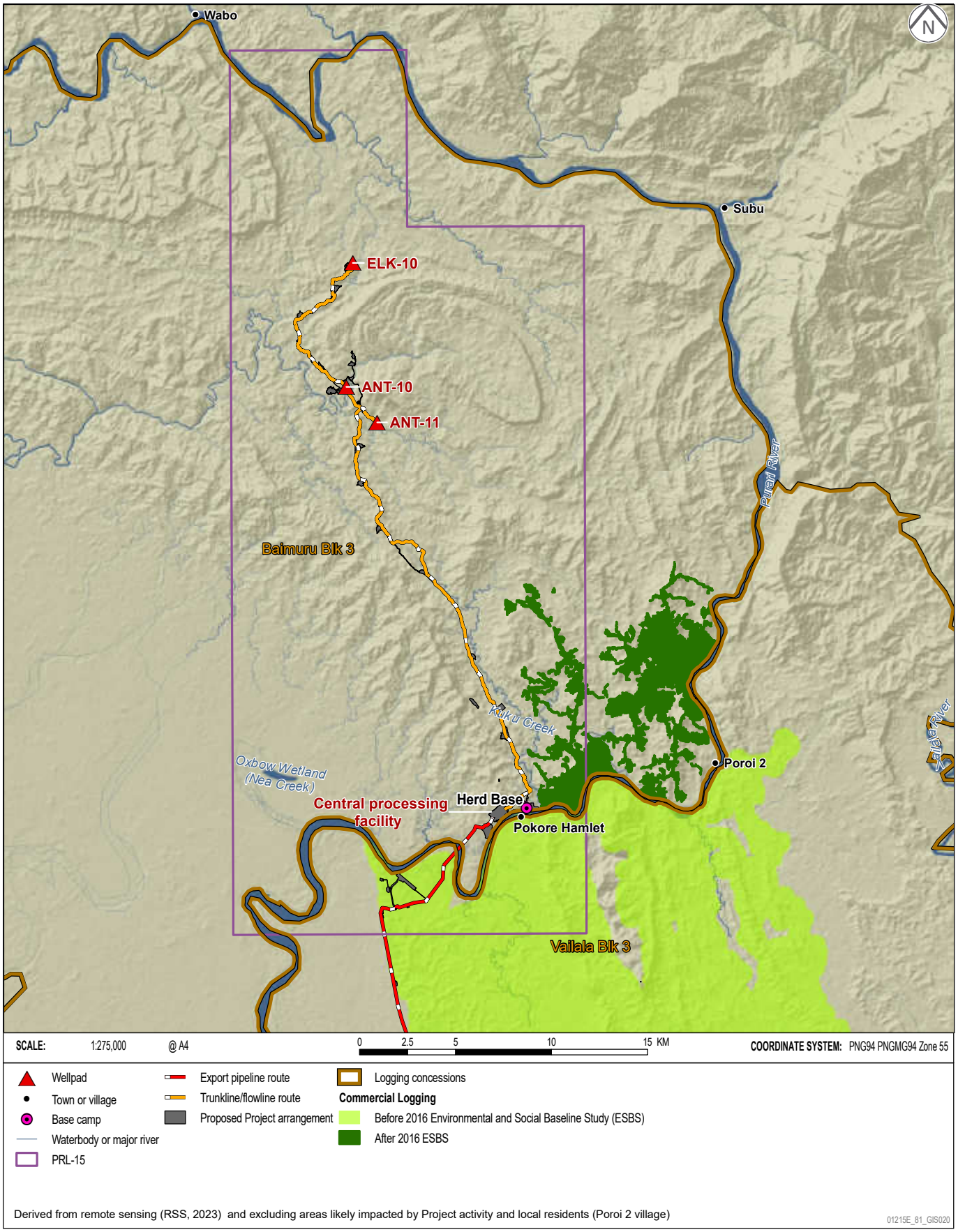
The PAOI is located in one of the world's most biologically diverse and endemically rich regions. More than 1,300 terrestrial plant and animal species have been recorded during Project-commissioned biodiversity baseline and pre-clearance surveys. A complete summary of all species recorded in the PAOI is beyond the scope of this addendum.

In accordance with the 2019 Upstream EIS method, only those species deemed to have Medium Sensitivity or higher are included in the impact assessment process. The following sections summarize the sensitive native flora and fauna species confirmed present or that may occur in the PAOI based on known distribution and habitat preferences.

Recent Commercial Logging in the Northern PAOI

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FIGURE 7.4



A total of 198 native species are assessed in this EIS Addendum. They include:

- Six (6) Extremely Sensitive species, all of them plants, four of which are confirmed present in the PAOI and two of which are precautionarily considered potentially present:
  - The International Union for Conservation of Nature (IUCN) Critically Endangered (CR) palm *Orania longistaminodia*. This large palm is a rare Papua New Guinean endemic previously known from just two collections, one in East Sepik Province and another from the Vailala River in Gulf Province. One found along Road R05 in central PRL-15 represents only the third known occurrence.
  - The IUCN CR tree *Dolicholobium rufiflorum*. This species is fairly common in the PAOI in PRL-15 and the export pipeline route (EPR, and on Mt Peroro, where hundreds have been counted during PCSs. It is otherwise known only from the type locality in the neighboring Vailala River catchment.
  - Two recently discovered (new-to-science) understory plants – *Begonia* sp. 5 and *Begonia* sp. 14 – both of which are rare (respectively known from 15 plants and one plant) and presently known only from PRL-15.
  - The IUCN CR small tree *Psychotria heterophylla*, known from a single locality near Ihu township on the Vailala River immediately east of the PAOI.
  - The IUCN CR tree *Myristica brachypoda*, known only from lowland forest in the neighboring Kikori River basin and potentially present in the PAOI.
- Seventy-three (73) Very Sensitive species:
  - Twenty-seven (27) IUCN threatened species, including:
    - Ten Endangered (EN) species:
      - Seven plants – four confirmed present in the PAOI (*Mammea grandifolia*, *Diospyros lolinopsis*, *Archidendron forbesii*, *Glochidion delticola*) and three likely or potentially present (*Endiandra cyphellophora*, *Eleutherostylis renistipulata*, *Ixora whitei*).
      - Two migratory shorebird species that visit the Purari delta shorefront habitats – far eastern curlew (*Numenius madagascariensis*) and great knot (*Calidris tenuirostris*).
      - And the pig-nosed turtle (*Carettochelys insculpta*).
    - Seventeen (17) Vulnerable (VU) species:
      - Ten plants, six of which are confirmed present (*Dracontomelon lenticulatum*, *Calophyllum suberosum*, *Anisoptera thurifera*, *Endospermum medullosum*, *Litsea globosa*, *Pterocymbium beccarii*) and 4 likely or potentially present (*Avicennia rumphiana*, *Koompassia grandiflora*, *Gmelina sessilis*, *Endiandra latifolia*).
      - Three mammals, two of which are confirmed present – lowland tree kangaroo (*Dendrolagus spadix*) and grey dorcopsis (*Dorcopsis luctuosa*) – and one potentially present – the water mouse (*Xeromys myoides*).

        - Three birds confirmed present – Papuan eagle (*Harpyopsis novaeguineae*), Scheepmaker's crowned pigeon (*Goura scheepmakeri*) and Pesquet's parrot (*Psittrichas fulgidus*).
        - The southern New Guinea giant softshell turtle (*Pelochelys bibroni*).
    - Plus 46 additional restricted-range (RR) species (seven of the Very Sensitive IUCN threatened species are also RR) that are deemed to be Very Sensitive due to their local rarity, very limited geographic range and/or specific habitat requirements. They include 36 plants, 1 snake, 2 frogs and 7 odonates. Thirty-two (32) of these species are new-to-science and were recently discovered during Project surveys and are known only from the PAOI, and a further nine species are known only from the wider Upstream Area.
- One-hundred and nineteen (119) Medium Sensitivity species:
    - Fifty-six (56) plants – 14 IUCN Near Threatened (NT) and 42 RR species. Nineteen (19) of the RR species are known only from the PAOI, and a further 14 are known only from the Upstream Area.
    - Four mammals – two NT and two RR species.
    - Twenty-seven (27) birds – 12 NT species, 13 nationally Protected species, plus the culturally significant southern cassowary (*Casuarius casurius*) and the rare southern New Guinea endemic species starry owlet-nightjar (*Aegotheles tatei*).
    - Five reptiles – Three RR species plus two culturally significant crocodile species – estuarine crocodile (*Crocodylus porosus*) and Hall's New Guinea crocodile (*Crocodylus halli*).
    - Eleven (11) RR frogs, eight of which are known only from the Kikori-Purari biogeographic zone.
    - Thirteen (13) RR odonates, two of which are known only from the PAOI, and a further six of which are known only from the Kikori-Purari biogeographic zone.
    - Three nationally Protected birdwing butterflies (*Ornithoptera* spp.), two of which are also IUCN NT.

Of the species listed above, 72 are being assessed in this addendum for the first time as they were not included in the 2019 Upstream EIS impact assessment. They include:

- Thirty-six (36) plants and one odonate (damselfly) are new-to-science and recently discovered on Project surveys conducted after the ESBS surveys. Most of these were discovered during PCS mobilizations.
- Eight other scientifically undescribed plants that were discovered on other lower Purari River basin industry project surveys and that were not known from the PAOI prior to the PCS mobilizations.
- One RR skink (*Sphenomorphus brunneus*) for which a recent PAOI record represents a geographic range extension.

- Twenty-six (26) IUCN listed plant species (2 CR, 2 EN, 8 VU, 13 NT and 1 Data Deficient (DD)) that were previously assessed due to a different earlier IUCN ranking or for which recent PAOI records represent a geographic range extension.

Thirty-nine (39) species that were previously assessed in the 2019 Upstream EIS (species with Medium Sensitivity or higher) are not assessed in this addendum. They include:

- Fifteen (15) species whose formal conservation status has changed – 10 plants and five birds whose IUCN *Red List* status has been downgraded to Least Concern.
- Fourteen (14) species excluded based on knowledge about their distribution, including:
  - Six species (five mammals, one plant) potentially present in the broader Upstream Area but considered absent from or unlikely to be present in the PAOI.
  - Six species (two plants, four odonates) no longer considered to be RR based on recent data and research.
  - Two RR species (one frog, one plant) whose sensitivity has been downgraded due to abundant PCS data or knowledge about its wider distribution beyond the Upstream Area.
- Nine species excluded for taxonomic or other identity reasons, including:
  - Four species (two plants, two mammals) previously considered to be undescribed local endemics but since identified as widespread named species.
  - Three RR subspecies or variants (two mammals, one plant) that are not recognized as distinct at the required taxonomic (species) level.
  - One timber tree previously misidentified as a threatened species (*Diospyros insularis*).
  - One CR mangrove tree - *Bruguiera hainesii* – recently recognized as a hybrid taxon but yet to have its IUCN status updated (hybrid taxa are not assessed in the IUCN *Red List*).
- One timber tree (*Pterocarpus indicus*) that, although globally threatened on the IUCN Red List, is common and widespread throughout New Guinea, including in a variety of habitats throughout the PAOI and surrounding major catchments (Kikori, Lakekamu).

7.7.3 Invasive Alien Species

7.7.3.1 Weeds

During PCSs and TEP PNG invasive species monitoring, 48 weed species have been recorded which were not listed in the ESBS (ERIAS, 2017). Of these, 14 are Priority 1 species and 5 are Priority 2. The Priority 1 species are:

- *Allamanda cathartica*.
- *Arundo donax*.

- *Calopogonium mucunoides*.
- *Centrosema molle*.
- *Leucaena leucocephala*.
- *Megathyrsus maximus* var. *maximus*.
- *Miconia crenata* (prev. *Clidemia hirta*).
- *Mimosa pigra*.
- *Pennisetum purpureum* (syn. *Cenchrus pupureus*).
- *Pueraria montana* var. *lobata*.
- *Pueraria phaseoloides* (syn. *Neustanthus phaeoloides*).
- *Sphagneticola trilobata*.
- *Tithonia diversifolia*.
- *Urochloa mutica*.

Since the 2019 Upstream EIS, *Angelonia angustifolia* has been downgraded from Priority 1 to Priority 2. In addition, *Macroptilium atropurpureum*, *Mimosa diplotricha* var. *diplotricha* and *Psidium guajava* have been upgraded from Priority 3 to Priority 2.

7.7.3.2 Alien Fauna

During PCSs and TEP PNG invasive species monitoring, two invasive animal species have been recorded or are likely to occur in the PAOI which were not listed in the ESBS (ERIAS, 2017). These are the coconut rhinoceros beetle (Priority 2; *Oryctes rhinoceros*) and Asian house gecko (Priority 3; *Hemidactylus frenatus*).

7.7.4 Migratory and Congregatory Species

No new migratory and/or congregatory species have been detected in the PAOI since the 2017 ESBS, no previously unreported caves (potentially harboring congregatory bird or bat colonies) have been reported during PCS.

7.8 References

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8. Existing Environment – Social and Cultural

8.1 Overview

A number of revisions are required to the description of the existing social and cultural environment in the 2019 Upstream EIS (ERIAS, 2019) to present more recent information that has been obtained. Where there is no additional information, the description in the 2019 Upstream EIS remains relevant and applicable.

Table 8.1 identifies the sections of the existing social and cultural environment that require a revision.

Table 8.1 – Summary of Existing Environment Social and Cultural Revisions

2019 Upstream EIS Chapter Number	Upstream EIS Heading	Reasons Revisions Required in EIS Addendum
9.1	Study Overview	No change required
9.2	General Setting	Updated to include Pokore Hamlet Updated community profile information related to PRL-15 villages
9.3	Governance	No change required
9.4	Economy and Employment	Information on economy and employment for Pokore Hamlet
9.5	Community Demographics	Information on community demographics for Pokore Hamlet
9.6	Education	Information on education for Pokore Hamlet
9.7	Community Health and Safety	Information on health facilities used by members of Pokore Hamlet
9.8	Livelihood and Natural Resource Use	No change required
9.9	Community Security (law and Order)	No change required
9.10	Community Transport and Access	No change required
9.11	Cultural Heritage and Archaeology	Results from Purari River cultural heritage mapping Information on cultural heritage and archaeology from additional surveys undertaken for pre-clearance surveys (PCS)
9.12	Ethnic Groups	No change required
9.13	Gender	No change required
9.14	Pre-existing Vulnerability	No change required
9.15	References	References provided in Section 8.8

8.2 2019 Upstream EIS Section 9.2 General Setting

The general setting remains as described in the 2019 Upstream EIS; however, since completion of the 2019 Upstream EIS, a new settlement referred to as 'Pokore Hamlet' has been established within PRL-15 on the south bank of the Purari River opposite Herd Base (see Figure 8.1; Plate 8.1).

A preliminary survey of this new settlement was completed by TEP PNG during June 2024 as a part of a Project-induced in-migration (PIIM) monitoring program. This survey has informed the high-level description of this community that follows and further information is to be collected to augment the data and fill data gaps where necessary.

In the 2019 Upstream EIS, it was reported that people living within PRL-15 speak Pawaian, and that this language group, along with the ecological zone, significantly impacts the history, cultural beliefs and traditional practices of villages within this area. Although residing within PRL-15, the residents of Pokore Hamlet speak the Ahia and Tok Pisin languages. The majority of the first migrants to this hamlet are from Evara, a village in the northern river transport route where Ahia is primarily spoken. Most of these migrants from Evara are members of the Ihopue clan.

The residents of Pokore Hamlet depend on natural resources to sustain subsistence lifestyles. Gardens are used to grow food source plants such as sweet potato, banana, aibika, cassava and beans. Residents fish every day in the Purari River and catch prawns in nearby creeks. Hunting and resource collection occurs in nearby forests, as well as deeper in the forest, targeting pigs, cassowary, wallaby, crocodile and cuscus. Hunting occurs to eat meat or to sell at the market in exchange for other materials or goods.

The main form of transport for residents of Pokore Hamlet is on the Purari River with dugout canoes or motorized dugout canoes. Hunting is undertaken on foot.

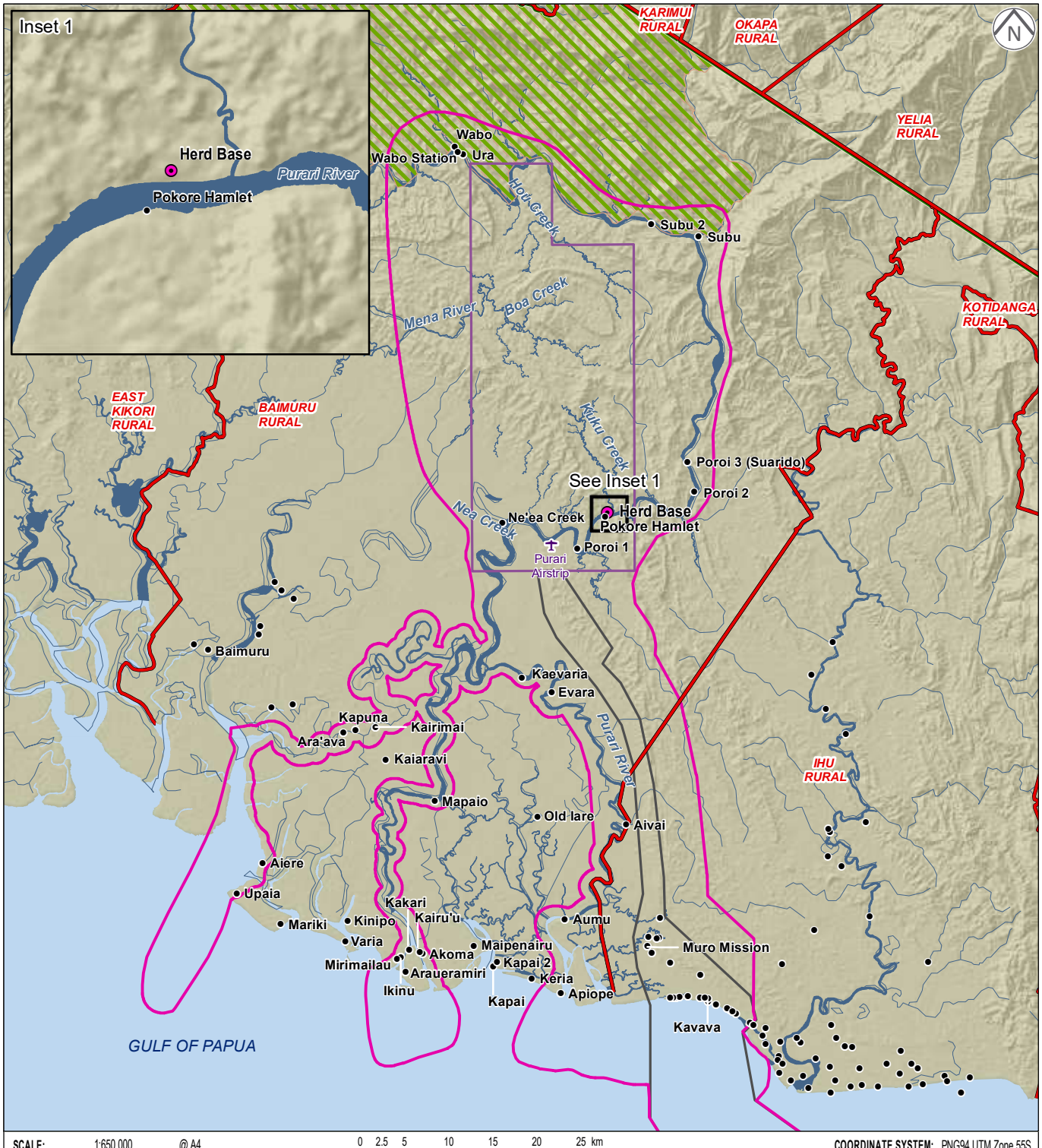
Plate 8.1 – View of Pokore Hamlet from Herd Base



Upstream Villages and Settlements

Papua LNG Project | PRL-15 EIS Addendum

FIGURE 8.1



8.3 2019 Upstream EIS Section 9.4 Economy and Employment

The 2019 Upstream EIS reported that most people in the PAOI are involved in subsistence activities and are not formally employed (ERIAS, 2019). Similar to other villages in the PAOI, residents of Pokore Hamlet depend on natural resources to sustain subsistence lifestyles. Of the 23 adults represented in the survey, 19 (83%) rely on subsistence living.

As reported in the 2019 EIS, the Papua LNG Project has provided a source of local employment. Two members of the hamlet (9%) worked as laborers at the time of the survey: one employed at Jerilai Pujari Holdings Limited (JPHL) a PRL-15 landholder company, and the other at the Papua LNG Project at Herd Base. Two respondents reported that they continue to rely on support from their parents.

8.4 2019 Upstream EIS Section 9.5 Community Demographics

8.4.1 Population and Household Characteristics

Since the 2019 Upstream EIS was prepared, the population of Pawaian and PRL-15 villages has increased by 31.0%, indicating that in-migration is likely occurring in the PAOI (Table 8.2).

The total population of Pokore Hamlet is 42, comprising 10 households, making Pokore Hamlet the third smallest community within the PAOI (see Table 9.3 of the 2019 Upstream EIS). This is consistent with findings that population and population density is lower in inland villages, compared with coastal villages. The average size of the 10 households is 4.5 people per household, which is less than that reported in the 2019 Upstream EIS for the Ahia language group and the PAOI. However, four households include the same household head. Without the repetition of this household head, the average size of households is 4.2 people per household.

Pokore Hamlet comprises 23 adults (15 females, 8 males) and 19 children aged 18 and under (7 females, 12 males). The survey indicated a sex ratio[1] of 91, which is lower than both the 2016 household survey (105) and the national ratio (108) (ERIAS Group, 2019).

The average age of residents of Pokore Hamlet is 21.7 years. This is slightly older than the average of 19 reported in the 2019 Upstream EIS (ERIAS, 2019). Forty-one percent (17) of the hamlet are less than 15 years of age, consistent with 2019 Upstream EIS (ERIAS, 2019). The number of residents aged 55 and above (5%, 2 respondents) is slightly lower than reported in the 2019 Upstream EIS (7%). The dependency ratio[2] is 100, which is greater than both the PAOI and Papua New Guinean ratios (89 and 75, respectively), but less than that reported for the Ahia language group (133) in the 2019 Upstream EIS. This dependency ratio indicates that there are equal numbers of people less than 15 years of age and older than 55 compared with the number of people aged 16 to 55.

1 The number of males per females, i.e., there are 100 males for every 110 females.
2 The number of people aged less than 15 and those aged more than 55 years, as a proportion of the number aged between 15 and 55.

Table 8.2 – Population of Pawaian and PRL-15 Villages

Village/ Settlement	2019 Upstream EIS*			EIS Addendum#		
	Population	Households	Average Household Size	Population	Households	Average Household Size
Pawaian						
Wabo	542	73	7.4	626	82	7.6
Wabo Station	108	22	4.9	191	38	5.0
Ura	229	42	5.5	295	41	7.2
Subu	62	11	5.6	50	8	6.2
Subu 2	97	13	7.5	186	26	7.2
Poroi 1 (Rainbow)	34	10	3.4	48	9	5.3
Poroi 2	301	44	6.8	412	61	6.8
Poroi 3 (Suarido)	45	8	5.6	24	3	8
Non-Pawaian						
Ne'ea Creek (formerly Mapaio Fish Camp)	32	5	6.4	25	3	8.3
Pokore Hamlet	-	-	-	42	10	4.5
Total	**1,450**	**228**	**6.4**	**1,899**	**281**	**6.8**

* Survey data collected during the environmental and social baseline studies (ERIAS, 2017).
#Survey data collected by IDP Consulting for the community directory update (IDP, 2024), except for Pokore Hamlet data collected by TEP PNG during the PIIM monitoring.

Table 8.3 indicates differences in demographic indicators between data collected in Pokore Hamlet in 2024, those reported for the Ahia language group in the 2019 Upstream EIS and the average across all PAOI language groups in the 2019 Upstream EIS.

Table 8.3 – Population and Demographic Indicators by Language Group

Language Group	Sex Ratio	Average Household Size	Population Less Than 15 Years of Age	Population 55 Years of Age and Above	Dependency Ratio
Pokore Hamlet (Ahia/Tok Pisin)	110	4.5	41%	5%	100
Ahia	106	7.0	55%	2%	133
Average (2019)	**105**	**6.7**	**40%**	**7%**	**89**

8.4.2 Marriage and Divorce

The Pokore Hamlet survey indicates that 40% of households in Pokore Hamlet contain polygamous marriages. This is much higher than that reported in the 2019 Upstream EIS. The youngest female spouse recorded is 19 years of age. There is insufficient data to compare this with the 2019 Upstream EIS, which reports 10% of females under 20 years of age being married. There is no data for the age of married males. One female participant aged 20 and currently married, had two children from a previous marriage, the oldest of which she gave birth to when she was 10 years old. There was no information available regarding divorce.

8.4.3 Religion

Religious dominations within Pokore Hamlet were similar to those reported in the 2019 Upstream EIS. The dominant religion of the hamlet is Seventh Day Adventist (six respondents) followed by Catholic (one respondent).

8.4.4 Migration

Pokore Hamlet was established in approximately 2020 by people migrating from Gulf Province. Following on from this initial establishment, in-migration to Pokore Hamlet has since been largely driven by marriage. The clan and village of origin for members of Pokore Hamlet is provided in Table 8.4. No issues or negative impacts resulting from in-migration were reported.

Table 8.4 – Clan and Village of Origin

Clan*	Original Village	Number of People
Beitori	Subu	9
Ihopue	Evara	15
Ihopue	TFI Logging Camp	1
Ihopue	Port Moresby	1
Peru'ava	Evara	1
Peru'ava	Pokore Hamlet*	1
Hove	Ke'eru, Kerema	1
Ehedahai	Evara	1
Mairitu	Evara	1
Mairo	Evara	1
Mairo	Keakea	1
Maipi	Orokolo	1
Ope	Orokolo	2
Ope	Pokore Hamlet#	1
Opu	Depokero	1
Ope	Opoloria	1
Unknown	Karati Village	1
Unknown	Ihu, Kerema	1
Unknown	Evara	1

Notes: * Clan names are yet to be confirmed. # Pokore Hamlet is marked as the original village for individuals born at this settlement.

8.4.5 Housing and Community Infrastructure

8.4.5.1 Housing

Ninety percent (90%) of houses (10 in total) are semi-improved, incorporating bush materials, sawn timber and sheets of roofing iron. The only other house in Pokore Hamlet is made of traditional materials, i.e., hardwood poles, split black palm floors, woven sago panels on the walls and a roof made of sago, nipa palm or grass. This trend in Pokore Hamlet varies from the 2019 Upstream EIS, which reported that 25% of houses were semi-improved, while 73% of houses were made from traditional materials.

8.4.5.2 Energy Sources

All respondents reported that solar power is used as the primary energy source for the household. This unanimous response from all households in Pokore Hamlet is in contrast to 53% of PAOI households that reported access to solar panels in the 2019 Upstream EIS.

8.4.5.3 Water and Sanitation

All respondents indicated that rainwater is collected and used (untreated) for drinking and cooking. The Purari River is used for bathing and laundry. The 2019 Upstream EIS reported a more diverse range of sources of drinking water, although households that speak the Ahia language similarly sourced their drinking water from a river/creek, tank or rainwater.

No information was collected on sanitation or domestic waste management.

8.5 2019 Upstream EIS Section 9.6 Education

Fifty percent (50%) of respondents reported that they attend or have attended school. While the results from the 2019 Upstream EIS indicate that 31% of boys and girls aged from 6 to 15 years attend school in the PAOI, school attendance in Pokore Hamlet is much higher at 56% for the same age range. However, in Pokore Hamlet no children below the age of 10 attend school. A breakdown of the highest education level attained is provided in Table 8.5.

Table 8.5 – Education Level of Pokore Hamlet Residents

Education Level	Male Children	Female Children	Male Adults	Female Adults
None	6	5	0	5
Grades 3 to 8	6	2	8	5
Grades 9 to 12	0	0	0	1

Note: Four residents of Pokore Hamlet did not respond to this question.

One survey respondent reported that household members attend Evara Primary School. Evara Primary School was not identified in the 2019 Upstream EIS and no details regarding the school are available.

8.6 2019 Upstream EIS Section 9.7 Community Health and Safety

Pokore Hamlet residents reported that they access health services at facilities in Poroi 2, Kapuna, and Herd Base, with the latter being a health facility not reported in the 2019 Upstream EIS.

The health facilities at Herd Base or Poroi 2 are reached by canoe (unmotorized). If a resident requires services at the Kapuna clinic, Kapuna is reached by motorized canoe and TEP PNG often provides fuel to reach this location.

8.7 2019 Upstream EIS Section 9.11 Cultural Heritage and Archaeology

The historical context of the Project area of influence (PAOI) is described in Section 9.2.2 of the 2019 Upstream EIS.

Characterization of the cultural heritage within PRL-15 was undertaken in the environmental and social baseline study (ESBS) (ERIAS, 2017), carried out for the 2019 Upstream EIS (ERIAS, 2019).

Following completion of the 2019 Upstream EIS, cultural heritage surveys are being undertaken as a component of the pre-clearance surveys (PCS) for the Project. Available data from these PCS have been used to describe the existing cultural heritage within the CPF P3 site, Road R03, trunkline and the export pipeline route vegetation clearance areas (VCA).

A number of sites that have been identified within PRL-15 during the PCS are not related to this EIS Addendum and therefore have not been assessed or mapped. These sites will be assessed, as necessary, in other approvals processes and will be managed according to the cultural heritage management plan (CHMP).

8.7.1 Tangible Cultural Heritage

Tangible cultural heritage is defined as cultural heritage values that have a physical presence and can be seen or touched; they include archaeological sites where physical remains of past cultural activity are present (e.g., pieces of pottery or shell on the ground surface); landscape features, such as hills, caves and river mouths; and individual trees or stands of vegetation or other landscape or biogeographic manifestations of spiritual, sacred or ritual significance. In addition, tangible cultural heritage values include movable material cultural items (e.g., ancestral heirlooms and traditionally made items used in day-to-day subsistence or leisure activities). Tangible cultural heritage is described in Section 9.11.1 of the 2019 Upstream EIS.

Three tangible cultural heritage archaeological sites have been recorded, on Nemina clan land, relevant to this assessment (Figure 8.2):

- No sites were recorded within the CPF P3 site.
- Site PUR_059 (registered with National Museum and Art Gallery (NMAG) as site OLR) lies within the proposed Road R03 VCA and was initially recorded in 2019 by Social Research Institute (SRI), now Indigenous Heritage Management (IHM) Consulting, and revisited during PCS in 2022 (ERIAS, 2022a). This site has subsequently been salvaged under a NMAG permit and with consent from the local communities (ERIAS, 2022b). This site is considered to be of high significance, evidenced by the presence of cordilyne plants surrounding the area which are important for ritual and human habitation; edible tree pants, such as galip nut tree; and a number of scattered and clustered stone artefacts which were removed as part of the salvage (Plate 8.2).

Location of Tangible Cultural Heritage Sites

Papua LNG Project | PRL-15 EIS Addendum

FIGURE 8.2

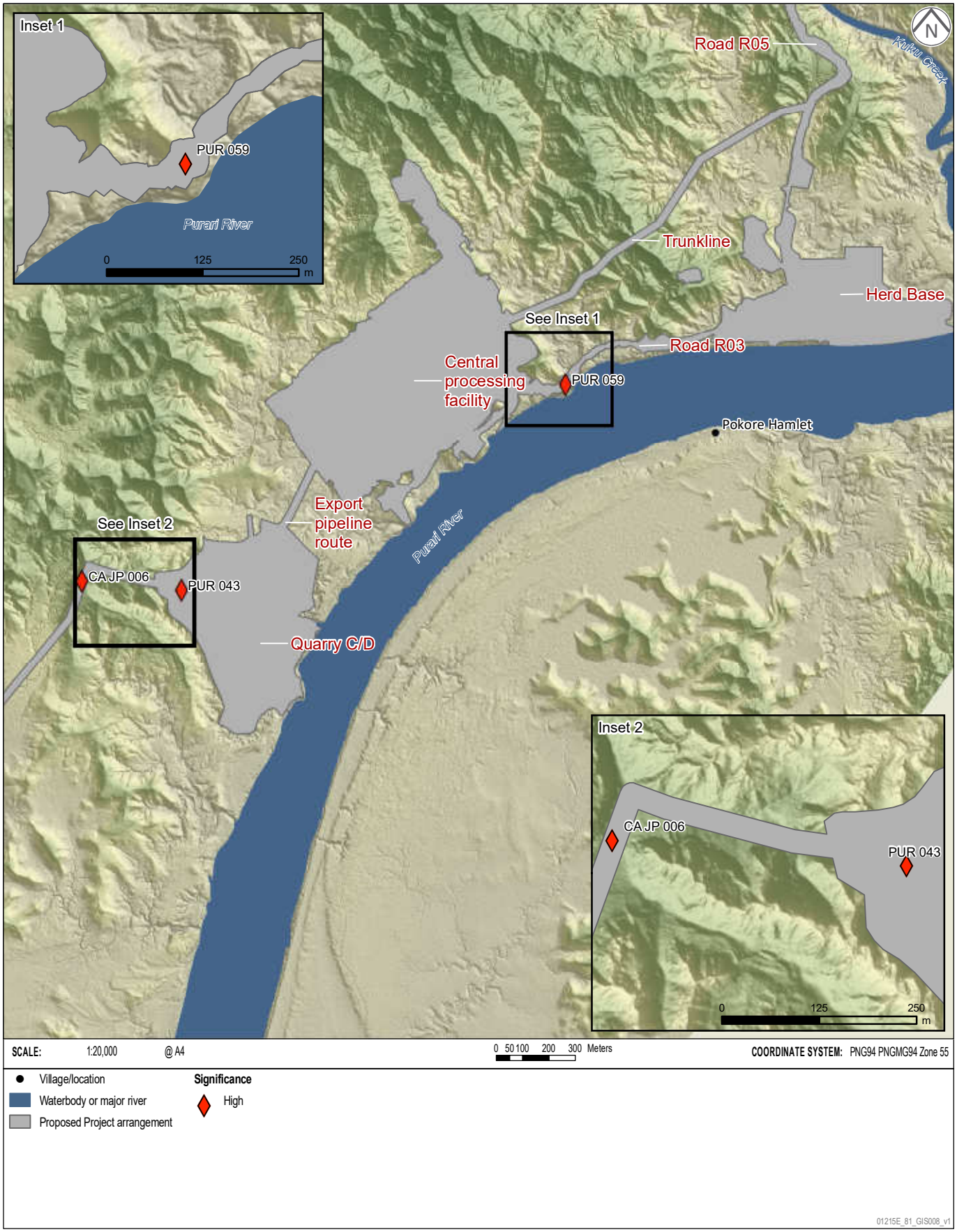


Plate 8.2 – Site PUR_059 Artifacts Recovered from Salvage



- Two sites, CA_JP_006 and PUR_043, have been identified within the proposed export pipeline route VCA:
  - CA_JP_006 was identified along the proposed export route VCA during cultural heritage surveys completed in 2023 (de Saint-Aubert, 2024). This is an archaeological site where a sago pestle, or 'omu' in Pawaian, was identified (Plate 8.3). Incisions were observed on the upper quarter, suggesting that it may have been attached to a handle. This site is yet to be verified by NMAG.
  - PUR_043 is an archaeological site located on a ridge top, which is part of the ridge complex with a settlement and occupation site. The site was first identified in 2018 along the proposed export route VCA where stone artifacts were observed (Plate 8.4). The site was subsequently salvaged under a NMAG permit in 2020, collecting surface scatters of cherts and few stone tools.

Plate 8.3 – Sago Pestle Observed at Site CA_JP_006



Plate 8.4 – Artifacts Identified at Site PUR_043 (Surface Scatter of Stone Flakes and Cores)



Source: SRI (2018).

Cultural heritage and spiritual sites were also confirmed to exist along the Purari River; however, the Nemina clan did not want these sites documented. These sites will be managed according to the CHMP.

Table 8.6 details the tangible cultural heritage sites, their significance and location.

Table 8.6 – Tangible Cultural Heritage Sites

Site Code	Site Category (Type)	Local Significance Rating*	Location
PUR_059 (OLR)	Archaeological (surface or subsurface scatters)	High	Within the Road R03 VCA
CA_JP_006	Archaeological (isolated surface artefact)	High#	Within the export pipeline route VCA
PUR_043	Archaeological (isolated surface artefact)	High†	Within the export pipeline route VCA

Notes: Grey shading represents sites that have subsequently been salvaged under NMAG permit. * Local significance ratings as defined in the TEP PNG Cultural Heritage Survey and Salvage Procedure (L2-PRO-SDV-15). # The significance of this site requires confirmation following consultation with communities and NMAG site inspections. † This site was initially given a Low local significance rating, but the significance rating was amended to high in 2022 due to considerations based on its functionality and the proximity of the site to the cultural landscape of the old ancestral settlement site of Poroi (the old Poroi village) (ERIAS, 2022c).

8.7.2 Intangible Cultural Heritage

Intangible cultural heritage is defined as the practices, representations, expressions, knowledge and skills, and the instruments, objects, artifacts and cultural spaces associated therewith that communities, groups and, in some cases, individuals recognize as part of their cultural heritage (UNESCO, 2003). Intangible cultural heritage is described in Section 9.11.2 of the 2019 Upstream EIS.

Three oral tradition (ceremonial/spirit tree), and one lookout (settlement), intangible cultural heritage sites have been recorded, on Nemina clan land, relevant to this assessment (Figure 8.3):

- Recorded site PUR_SAB_005, identified via consultation with the Nemina clan and visited during surveys (ERIAS, 2022c), is located within the CPF P3 site VCA. The site is believed to have been a lookout with views beyond the Purari River and surrounding areas, and there is a presence of cordyline plants indicating human presence (Plate 8.5). This does not necessarily represent an archaeological site. This site subsequently underwent salvage procedures under NMAG permit and with consent from the local communities. No archaeological evidence was observed on the surface and therefore the site did not warrant further archaeological salvage or shovel test pits (ERIAS, 2024a).

- Site PUR_SAB_003 was identified within the trunkline VCA (ERIAS, 2022c) (Plate 8.6). The site was an initiation site where teenage members (both male and female) from the Nemina clan would undergo certain stringent trainings taught by the initiators before the novices would be pronounced as man and woman, a rite of passage from teenagers to adults took place there. The practice and the site were abandoned long ago, however, the elderly members of the Nemina Clan have remembered the site landscape description and the actual practices up to present. This site underwent salvage procedures under NMAG permit and with consent from the local communities. No cultural material was recovered during salvage and the site is now cleared from any further salvage archaeology operations (ERIAS, 2024b).

- Site JP_007 was identified during recent cultural heritage surveys completed in 2023 (De Saint-Aubert, 2024). JP_007 is within the export pipeline route VCA and is an ancient spirit site marked by the presence of a *Ficus Benjamina* tree (Plate 8.7). The tree spirit is called *Teijupe* in Tehin. This site is yet to be verified by NMAG.

- An additional site (JP_001) that is located outside the trunkline VCA, but within the survey buffer, was identified during cultural heritage surveys in 2023 (De Saint-Aubert, 2024). According to information gathered during an interview in the village of Poroi 1 with the Nemina clan, this is a former initiation site that is still remembered by clan members. The presence of cordyline plants indicates human occupation (Plate 8.8). This site has been included in this EIS Addendum due to its high local significance rating, but is yet to be verified by NMAG.

Table 8.7 details the intangible cultural heritage sites, their significance and location.

Location of Intangible Cultural Heritage Sites

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FIGURE 8.3

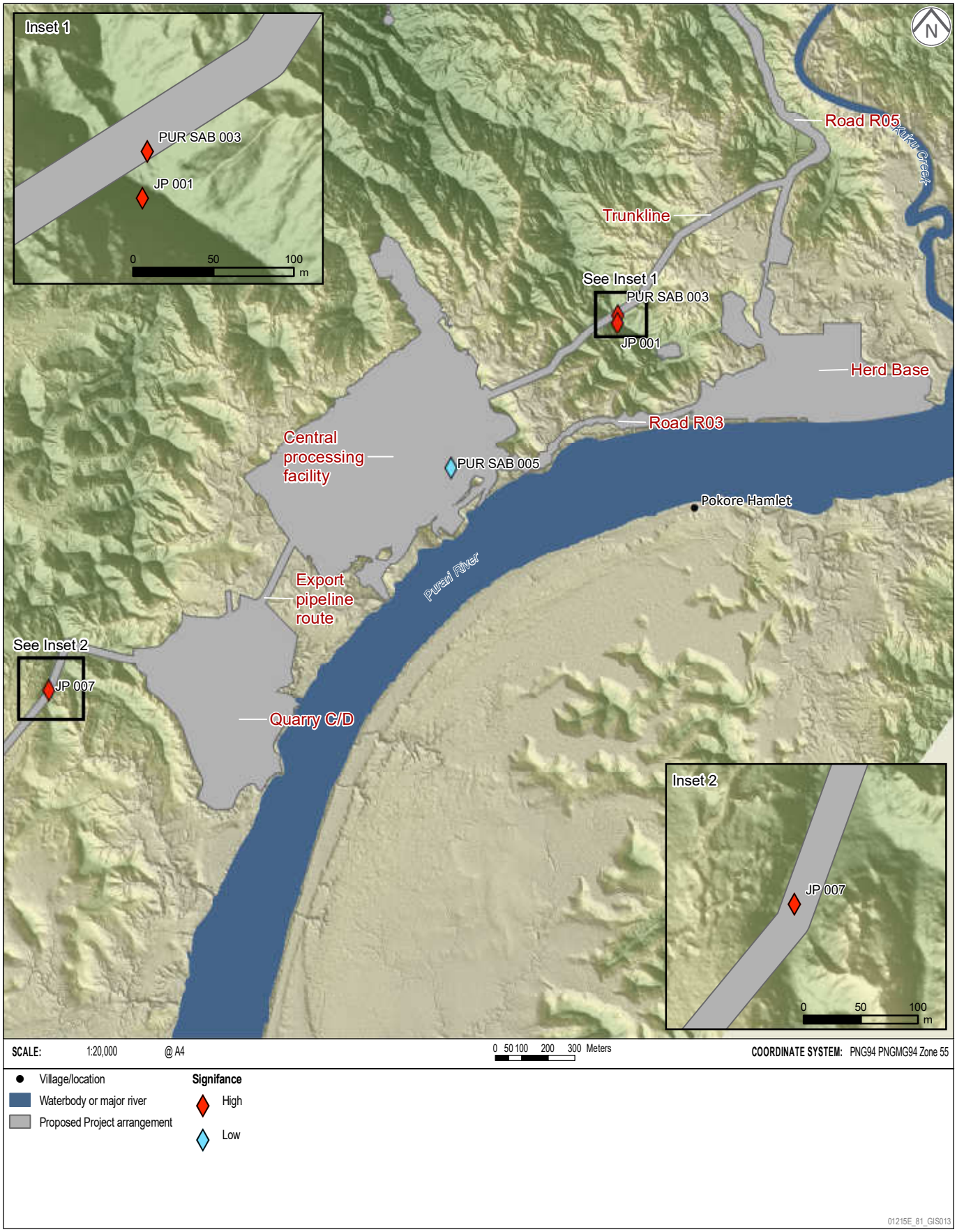


Plate 8.5 – Settlement Site PUR_SAB_005 with Presence of Cordyline Plants



Plate 8.6 – Oral Tradition (Ceremonial) Site PUR_SAB_003



Plate 8.7 – Oral Tradition (Ceremonial and Spirit Tree) Site JP_007



Plate 8.8 – Oral Tradition (Ceremonial) Site CA_JP_001 with Presence of Cordyline Plants

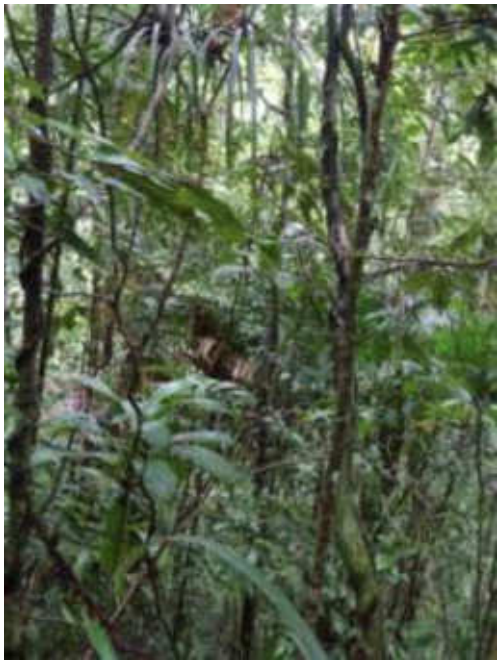


Table 8.7 – Intangible Cultural Heritage Sites

Site Code	Site Category (Type)	Local Significance Rating*	Location
PUR_SAB_005	Settlement (lookout)	Low	Within the CPF P3 site VCA
JP_007	Oral tradition (ceremonial site + spirit tree)	High#	Within the export pipeline route VCA
PUR_SAB_003	Oral tradition (ceremonial site)	High	Within the trunkline VCA
JP_001	Oral tradition (ceremonial site)	High#	Outside the trunkline VCA but within the survey buffer

Notes: Grey shading represents sites that have subsequently been salvaged under NMAG permit. * Local significance ratings as defined in the TEP PNG Cultural Heritage Survey and Salvage Procedure (L2-PRO-SDV-15). # The significance of this site requires confirmation following consultation with communities and NMAG site inspections.

8.8 References

de Saint-Aubert, J.P., 2024. Cultural Heritage Pre-Clearance Survey Final Report: Mobilisation #8, 9 and 10. Report prepared for Papua New Guinea National Museum and Art Gallery.

ERIAS. 2017. Upstream Environmental and Social Baseline Studies Report. Report prepared by ERIAS Group Pty Ltd for Total E&P Limited. Report No. 01215B_22_v7.

ERIAS. 2019. Papua LNG Project Upstream Environmental Impact Statement. 01215B_23_v5. December. Unpublished report to Total E&P PNG Limited.

ERIAS. 2022a. Cultural Heritage Pre-Clearance Survey Report: Preparatory Works Areas. Report No. 01215E_16_v3.

ERIAS. 2022b. Archaeological Salvage Excavation Report Site – PUR059: Preparatory Works Areas. Report prepared for Papua New Guinea National Museum and Art Gallery. Report No. 01215E_22_v3.

ERIAS. 2022c. Cultural Heritage Pre-Clearance Survey Report: Central Processing Facility and Associated Areas, Herd Base Expansion. Report No. 01215E_18_v3.

ERIAS. 2024a. Cultural Heritage Salvage Mission 1 Report. Report prepared for Papua New Guinea National Museum and Art Gallery. Report No. 01215E_71_v2.

ERIAS. 2024b. Cultural Heritage Salvage Mission 2 and 3 Report. Report prepared for Papua New Guinea National Museum and Art Gallery. Report No. 01215E_82_v1.

IDP. 2024. Community directory update - upstream. Report prepared by IDP Consulting for TotalEnergies EP PNG Limited. Confidential and unpublished.

9. Existing Environment – Amenity

9.1 Overview

With the exception of air quality, no new information has been collected since the 2019 Upstream EIS was prepared that would change the description of the existing environment – amenity – in Chapter 10 of the 2019 Upstream EIS (Table 9.1).

SLR (2024; Appendix 1: SLR Papua LNG CPF P3 Relocation. Air Quality Impact Assessment) updated the meteorological modelling and the revised meteorological dataset is provided in Section 9.2. This information on existing conditions has been used in the dispersion model to predict potential air quality impacts associated with the P3 location. Information that has not changed has not been reproduced and can be found in the 2019 Upstream EIS.

Table 9.1 – Summary of Existing Environment Revisions

2019 Upstream EIS Chapter Number	2019 Upstream EIS Heading	Reasons Revisions Required in EIS Addendum
10.1	General Setting	No change required
10.2	Air Quality	Updated meteorological modelling
10.3	Noise	No change required
10.4	Landscape and Visual Amenity	No change required
10.5	Commercial Marine and River Transport	No change required
10.6	Waste Characterisation	No change required
10.7	References	References provided in Chapter 18

9.2 2019 Upstream EIS Section 10.2 Air Quality

The air quality impact assessment that supported the 2019 Upstream EIS used wind data predicted by modelling at the central processing facility (CPF) site for 2014 and 2015. This modelled dataset was validated by comparison with observed records at the Wabo weather station (see Section 10.2 of the 2019 Upstream EIS). For the EIS Addendum, the model data inputs were updated with regional meteorological records for the most recent calendar year available, being 2022, to generate a meteorological dataset at the CPF P3 site. The same method and model configurations were used in the updated meteorological modelling study as used for the 2019 Upstream EIS; however, surface observational data from Wabo were not available to perform an updated validation.

9.2.1 Wind Speed and Direction

The predicted wind speeds at the CPF P3 site are different to those predicted at the CPF P2C site in the Upstream EIS air quality assessment given the change in location.

Figure 9.1 presents wind roses showing the wind data predicted by the modeling at the CPF P3 site. The site generally experiences low to moderate wind speeds (i.e., less than 5.0 m/s) predominately from the north-northeast and south, with a very low frequency of wind speeds

above 5 m/s predicted (Figure 9.2). Calm conditions (i.e., wind speeds less than 0.5 m/s) are predicted to occur approximately 8% of the time during the day, increasing to 16 to 17% of the time during the night.

Winds from the southwest dominate during the day across the year, and the strongest winds tend to blow from the south during the day. Winds from the northeast dominate during the night becoming more northerly during the wet season.

9.2.2 Atmospheric Stability

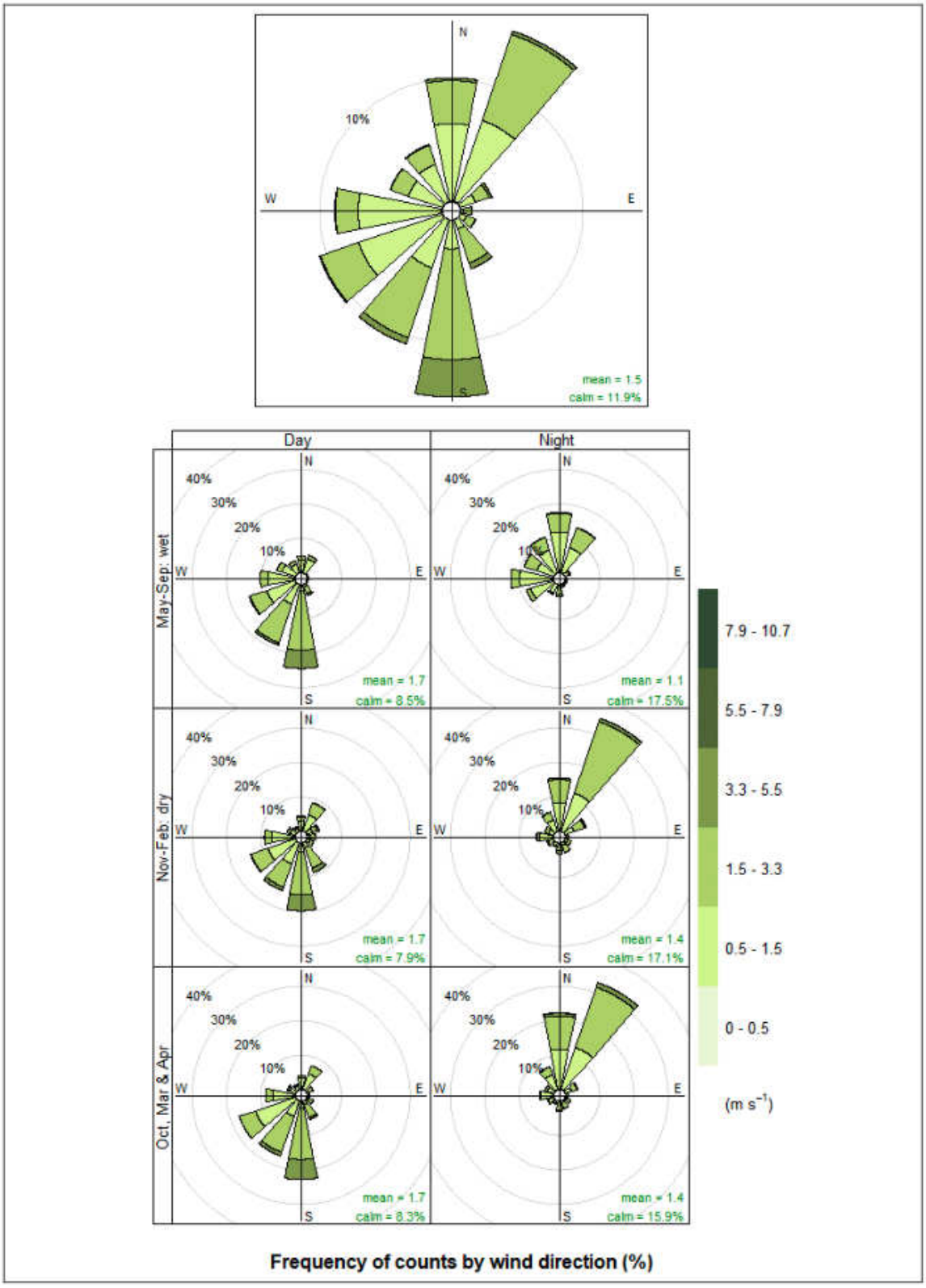
Atmospheric stability refers to the atmospheric tendency to resist or enhance vertical motion. Figure 9.3 presents the frequency of each atmospheric stability class predicted by the model for the CPF P3 site. Stability class F (i.e., moderately stable conditions) is predicted to occur approximately 40% of the modeled year at this location. This is indicative of very stable nighttime conditions (i.e., low winds), leading to a low level of mechanical mixing and poor dispersion.

9.2.3 Mixing Heights

The height of the turbulent layer of air near the earth's surface is referred to as the mixing height. The height of this layer is controlled mainly by convection (i.e., resulting from solar heating of the ground) and by mechanically generated turbulence, as the wind blows over the rough ground. Ground-level emissions from the CPF P3 site will be rapidly mixed in this layer.

Figure 9.4 shows the diurnal variation in mixing height at the CPF P3 site predicted by the meteorological modelling using the revised meteorological dataset, and used as an input in the dispersion model to predict potential air quality impacts. After the onset of vertical mixing at sunrise, the mixing height at the CPF P3 site increases over the morning. It reaches the maximum mixing height around the mid to late afternoon, i.e., approximately 4.00 p.m., at a height of around 1,250 m. This peak is due to the dissipation of ground-based temperature inversions and the growth of the convective mixing layer. In the early evening, the mixing height rapidly drops back to night-time levels.

Figure 9.1 – Wind Roses for the CPF P3 Site (CALMET)

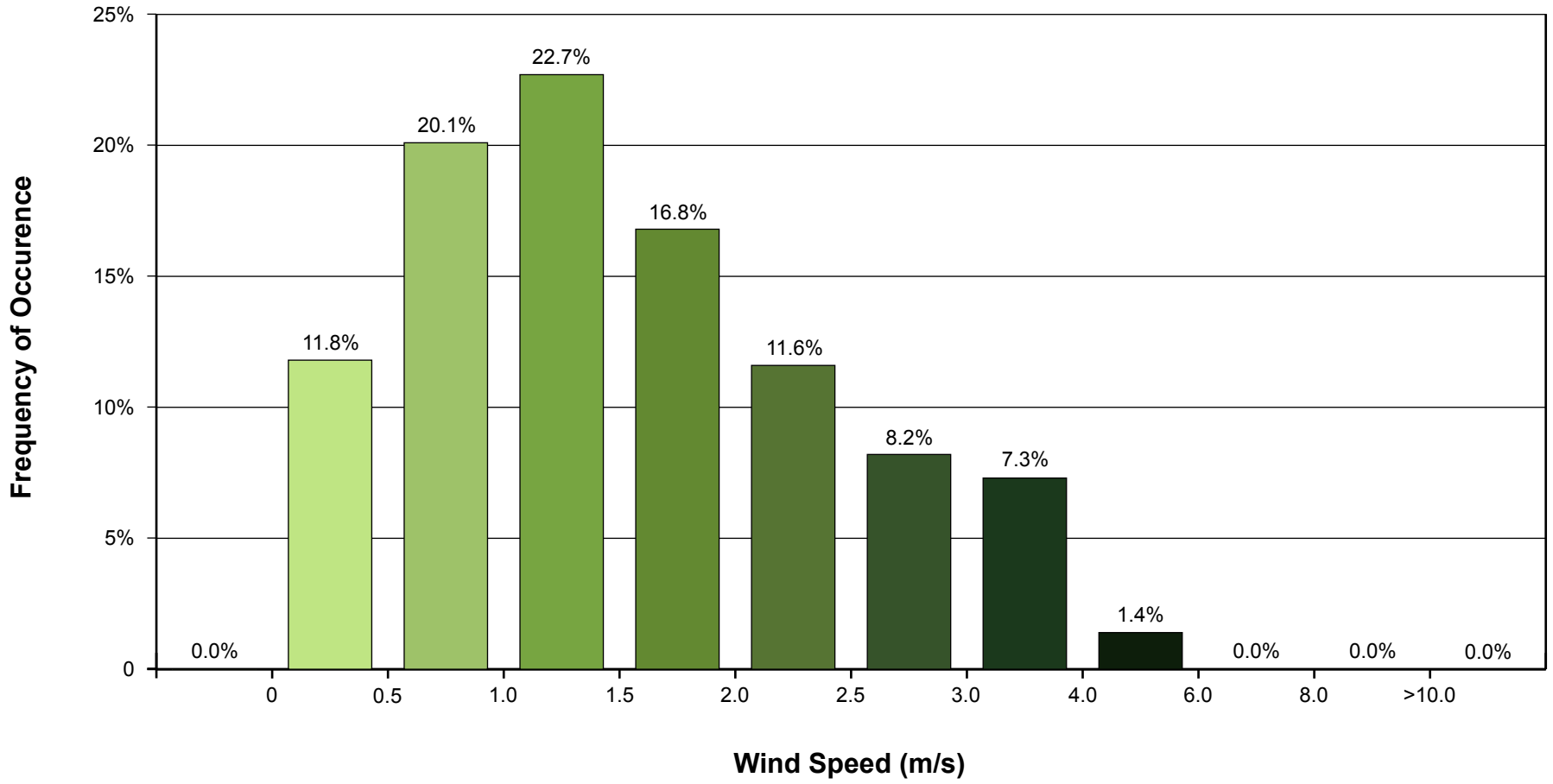


Source: Appendix 1.

Wind Speed Frequency Distributions for the CPF P3 Site (CALMET)

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FIGURE 9.2

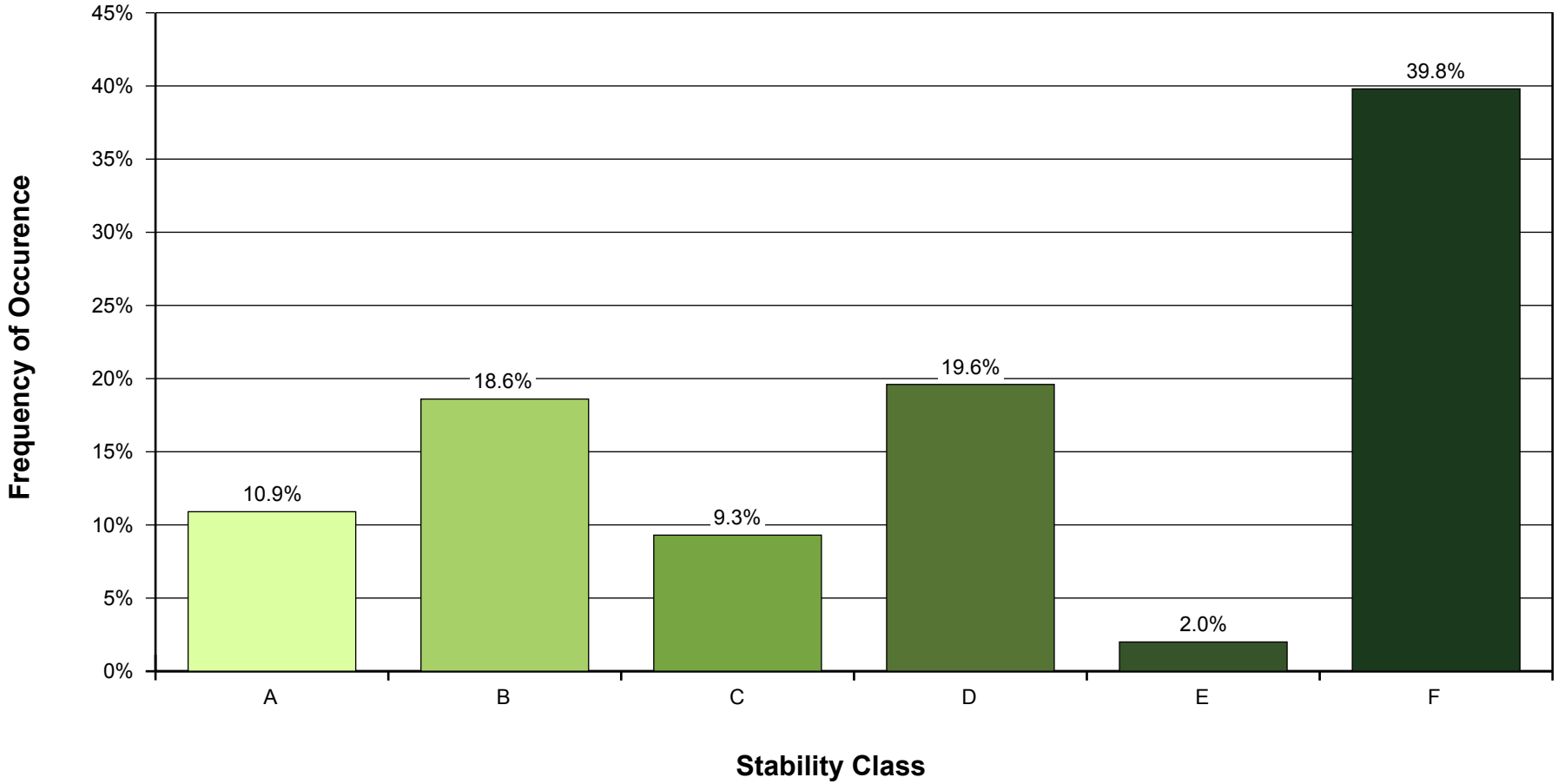


Source: Appendix 1

Stability Class Frequency Distributions for the CPF P3 Site (CALMET)

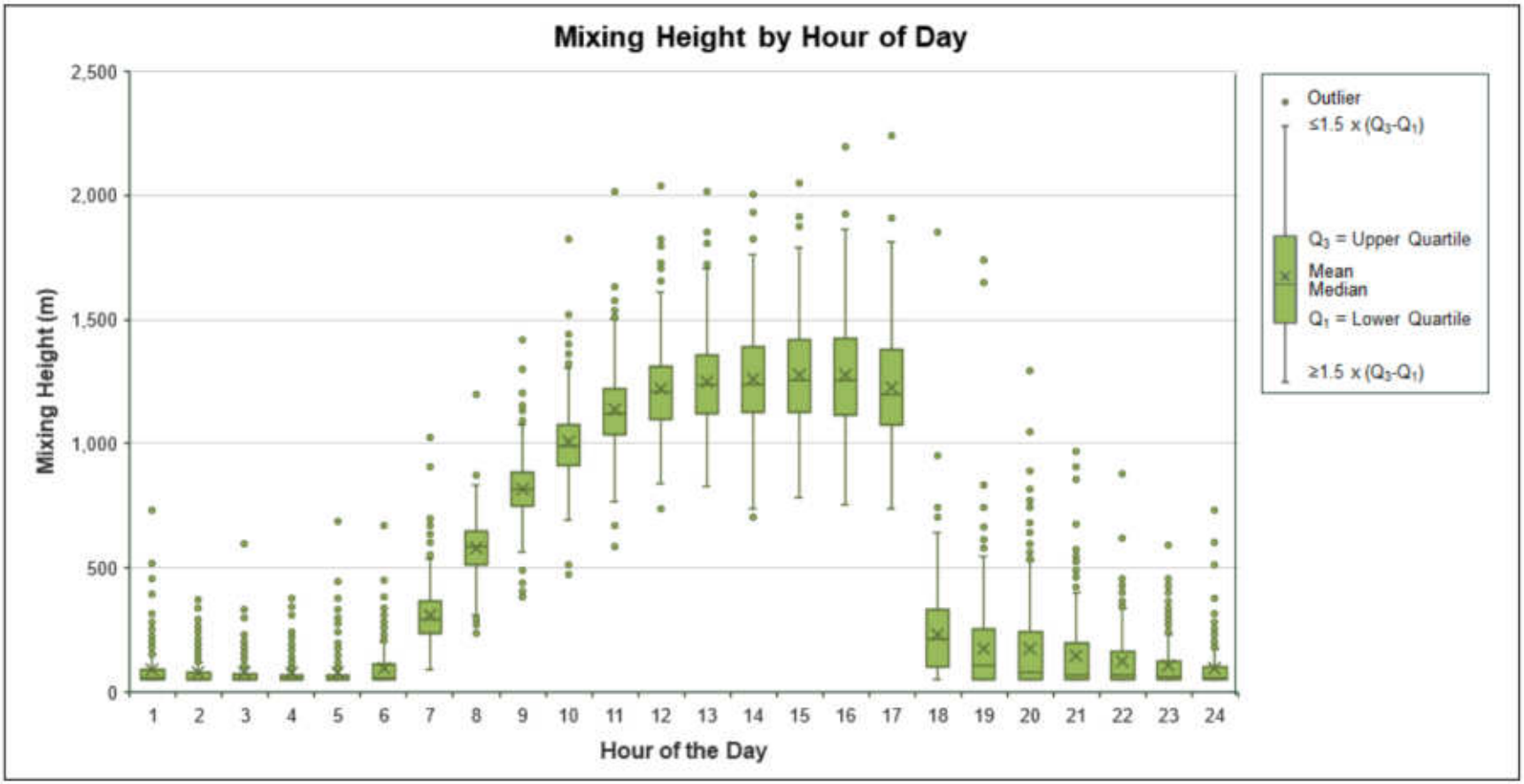
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FIGURE 9.3



Source: Appendix 1

Figure 9.4 – Diurnal Variation in Mixing Height for the CPF P3 Site (CALMET)



Source: Appendix 1.

10. Impacts: Terrestrial

10.1 Overview

A number of revisions are required to the assessment of impacts on the terrestrial environment in the 2019 Upstream EIS (ERIAS, 2019) to consider the changes to the Project described in Chapter 4 of this addendum, which have occurred since submission of the 2019 Upstream EIS.

Table 10.1 identifies the sections of the terrestrial environment impact assessment that require a revision. Impact assessments undertaken in this addendum are undertaken using assessment methods described in the 2019 Upstream EIS.

Mitigation measures considered in the assessments are as described in the 2019 Upstream EIS. Specific management measures are identified by the unique identification codes provided in summary assessment tables included in the following sections, with complete descriptions of these measures provided in Chapter 20 of the 2019 Upstream EIS.

Table 10.1 – Summary of Existing Environment Terrestrial Revisions

2019 Upstream EIS Chapter Number	Upstream EIS Heading	Reasons Revisions Required in EIS Addendum
11.1	Landform and Soils	Relocation of CPF from site P2C to P3
11.2	Groundwater	Relocation of CPF from site P2C to P3 Change in acid gas management
11.3	Hydrology, Fluvial Geomorphology and Sediment Processes	Relocation of CPF from site P2C to P3
11.4	Surface Water Quality	Relocation of CPF from site P2C to P3
11.5	Freshwater and Estuarine Biodiversity	Relocation of CPF from site P2C to P3
11.6	Terrestrial Biodiversity	Relocation of CPF from site P2C to P3 Change in acid gas management
11.7	References	References provided in Section 10.8

10.2 2019 Upstream EIS Section 11.1 Landform and Soils

The following potential impacts to landform and soils required reassessment considering the relocation of the CPF to site P3:

- Landform destabilization causing landslides or mass movement.
- Degradation of soil capacity.

10.2.1 Landform Destabilization

Like the previously proposed site P2C location for the CPF, site P3 is located on the alluvial plain of the Purari River at the foot of the ridge and ravine landform in PRL-15. This river plain landform is quite stable in regard to large landslides or mass movements due to its gently undulating to flat

topography. However, localized excavation, filling, or cut and fill of the ground surface associated with construction, operations and decommissioning may potentially cause some destabilization. Limited landslide zones have been encountered in the area of the CPF P3 site due to the presence of competent subsoils such as gravel, pebble, and mudstone on slopes. The site is considered to have favorable conditions regarding landslide hazards (TEP PNG, 2023), and any areas identified as prone to potential landslide will be removed during the cut activities of the site preparation. The sensitivity of the landform to destabilization was categorized to be ***Medium*** in the 2019 Upstream EIS, and this sensitivity ranking also applies to the CPF P3 site.

Impacts on landform stability during construction and operations of the CPF at site P3 are expected to be ***Minimal***, considering mitigation measures to be implemented (as described in Section 11.1.4 of the 2019 Upstream EIS). This provides an overall impact significance rating of ***Negligible***, like the assessment in the 2019 Upstream EIS. Impacts during decommissioning are expected to be similar, or lesser, to the construction and operations phases.

10.2.2 Degradation of Soil Capacity

Potential impacts to soil capacity that were considered in 2019 Upstream Project EIS were:

- Impacts on soil structure and developmental status, fertility or disturbance of soil profiles.
- Development of adverse chemical properties due to disturbance of acid sulfate soils (ASS) or accidental soil contamination.

Soil units in the Project area are poorly formed soils with limited soil pedological development and fertility and are susceptible to erosion. They are expected to recover slowly from any disturbance if topsoil is not appropriately managed. The sensitivity of soils to change in soil capacity in the area of all Project activities was therefore categorized to be ***Medium*** in the 2019 Upstream EIS. This sensitivity ranking also applies to soils at the CPF P3 site. The magnitude of impact is also the same as for previously proposed site P2C (i.e., ***Minimal***), resulting in an overall impact significance rating of ***Negligible***.

Investigations during pre-clearance surveys for the occurrence of ASS in the area of the CPF P3 site and Road R03 have shown the occurrence of soils with net acidity exceeding the action criterion of 18 mol H^+/ton (see Section 7.2 of this addendum). The acidity is attributable to actual acidity rather than potential acidity, and there is no effective acid neutralizing capacity in the soils. This indicates that ASS management is required if these soils are disturbed. The sensitivity of the soils with regard to ASS is therefore categorized to be ***Medium***, consistent with the ranking in the 2019 Upstream EIS given to soil units with ASS potentially present. With mitigation in accordance with the Project Acid Sulfate Soil Management Plan (L2-PLN-SDV-03), minimal soil degradation is expected to occur due to acid generation and mobilization of metals. Any impacts from earthworks during the construction phase and site decommissioning would be localized (within 50 m of the Project activity or component), and impacts would be short term with appropriate treatment of identified ASS. The magnitude of impact to soil capacity in the area of the CPF P3 site is therefore categorized to be ***Minimal***. This provides an overall significance rating of ***Negligible***.

Potential impacts on soil due to contamination from accidental hydrocarbon or chemical spills or leaks at the CPF P3 site during construction and operations are the same as previously assessed

in the 2019 Upstream EIS, i.e., ***Medium*** sensitivity of soil and ***Low*** magnitude of impact, resulting in a significance rating of ***Minor***.

Potential impacts during site decommissioning activities will be of similar rating, i.e., ***Minor*** decreasing to ***Negligible*** following closure.

10.2.3 Summary of Assessment of Residual Impact Significance

Table 10.2 provides a summary of the assessment of residual impacts to landform and soils. The table should be read in conjunction with the mitigation measures described in Chapter 20 of the 2019 Upstream EIS.

10.3 2019 Upstream EIS Section 11.2 Groundwater

10.3.1 Change in Acid Gas Management Strategy

The following impacts to groundwater required reassessment considering the change in acid gas management:

- Groundwater contamination due to:
  - Introduction of drilling muds and cuttings during the drilling of wells.
  - Injection of produced water and liquid effluent from the flue gas desulfurization process into Antelope reservoir.
  - Acid gas injection into Elk and Antelope reservoirs.

Small quantities of groundwater may occur in the geology of the gas resource target, the Kapau Limestone; however, exploration drilling to date has shown very little water is associated with gas and condensate. This geology is over 1,600 m deep, and the thickness of the low-permeability material overlying the hydrocarbon resource will effectively confine any water occurring in this unit.

With the change in acid gas management strategy, an additional gas producing well will be drilled at ELK-10 and an acid gas injection well at ANT-11. The risk of groundwater contamination from the introduction of drilling muds and cuttings during the drilling of wells, considering these additional wells, remains as described in the 2019 Upstream EIS, with an overall significance rating of ***Negligible***.

Liquid effluent containing sulfur recovered from the flue gas desulfurization process will no longer be reinjected with produced water into the Antelope reservoir during the first four years of operation. The overall significance rating for this potential impact to groundwater was previously assessed to be ***Negligible*** and remains so considering reinjection of production water alone.

Table 10.2 – Summary of Assessment of Impacts to Landforms and Soils

Key Sensitivity	Main Activity	Potential Impact	Location of Activity	Project Phase	Mitigation and Management*	Residual Assessment	
						Sensitivity/ Magnitude	Significance
Land stability	Earthworks	Destabilization causing landslide/mass movement	CPF P3 site	C, O, D	• EM002 • EM003 • EM004 • EM006 • EM029	Medium/Minimal	Negligible
Soil capacity	Earthworks	Adverse impacts on soil structure and developmental status, fertility or disturbance of soil profiles	CPF P3 site	C, O, D	• EM001 • EM002 • EM005 • EM006 • EM036	Medium/Low	Minor
	Earthworks	Adverse effects on chemical properties, due to oxidation of PASS	CPF P3 site	C, D	• EM007	Medium/Minimal	Negligible

C = Construction, O = Operations, D = Decommissioning and closure.
*Mitigation measure identifier, described in Chapter 20 of the 2019 Upstream EIS and Chapter 17 of this addendum.

The acid gas management strategy has been changed to full reinjection of the acid gas into the Antelope reservoir from the start of production, then reinjection into the Elk reservoir once depleted. The assessment of potential impacts on groundwater from reinjection of acid gas into Ek reservoir, which was assessed in the 2019 Upstream EIS, is also applicable to reinjection of acid gas into Antelope reservoir prior to deletion of the Elk reservoir.

Deeper formations consist of siltstones and mudstones that are unlikely to support aquifers being present in the area, hence the sensitivity of groundwater in the area of the acid gas injection is assessed to be ***Minimal***. The acid gas will be injected into the reservoirs at a depth of over 1,200 m below ground level and therefore will be contained well below the depth of any usable groundwater resource. The proposed embedded design controls will maintain wellbore integrity and contain acid gas within the reservoir such that migration to any shallow groundwater aquifers is not expected to occur. Low permeability mudstones, marls and shales of the Orubadi Formation overlie the hydrocarbon resource, also limiting any upward migration. The magnitude of impacts due to acid gas contaminating groundwater and effecting environmental values is therefore assessed to be ***Low***, giving an overall significance rating of ***Negligible***.

10.3.2 Relocation of CPF Site

The following impacts to groundwater required reassessment considering the relocation of the CPF to site P3:

- Groundwater contamination due to accidental hydrocarbon or chemical spills or leaks at Project facilities and various areas of activities.

Permanent shallow groundwater occurs in alluvial sediments close to the confluence of Kuku Creek and the Purari River, where abstraction bores target groundwater from the alluvial material to supply water for use at Herd Base. This alluvial material is thought to be connected to the surface waters of the Purari River. Overlying low-permeability fine silts and clay materials helps protect this resource from potentially contaminating surface activities.

The 2019 Upstream EIS categorized the sensitivity of groundwater to be ***Medium*** in areas adjacent to creeks and rivers in PRL-15, such as the CPF site. Accidental hydrocarbon or chemical spills or leaks may potentially occur at any area and phase of Project activity in the project area of influence (PAOI), including the CPF. Standard good industry practices will be adopted to prevent and protect against pollution due to accidental hydrocarbon and chemical spills or leaks during preparatory works, construction, operation and decommissioning activities, and to remediate where it occurs. These measures will limit the potential for contaminants to enter and contaminate groundwater. Impacts on groundwater quality are unlikely to be detectable, and the magnitude of impact is assessed to be ***Minimal***, giving an overall significance rating of ***Negligible***. This assessment remains applicable to the CPF P3 site.

10.3.3 Summary of Assessment of Residual Impact Significance

Table 10.3 provides a summary of the assessment of residual impacts to groundwater.

Table 10.3 – Summary of Assessment of Impacts on Groundwater

Key Sensitivity	Main Activity	Potential Impact	Location of Activity	Project Phase	Mitigation and Management*	Residual Assessment	
						Sensitivity/ Magnitude	Significance
Groundwater quality	Produced water reinjection	Groundwater contamination due to reinjection of produced water	Antelope gasfield	O	None	Minimal/Low	Negligible
	Acid gas reinjection	Groundwater contamination due to reinjection of acid gas	Antelope gasfield Elk gasfield	O	None	Minimal/Low	Negligible
	Use of hazardous materials	Groundwater contamination from accidental hydrocarbon or chemical spills or leaks	CPF P3 site	C, O, D	None	Minimal/Minimal	Negligible

C = Construction, O = Operations, D = Decommissioning and closure.
*Mitigation measure identifier, described in Chapter 20 of the 2019 Upstream EIS and Chapter 17 of this addendum.

10.4 2019 Upstream EIS Section 11.3 Hydrology, Fluvial Geomorphology and Sediment Processes

The following potential impacts to hydraulic processes and sediment transport required reassessment considering the relocation of the CPF to site P3:

- Alteration of hydrology or flow characteristics due to diversion or filling of defined waterways in the CPF footprint.
- Soil erosion due to ground disturbance causing increased total suspended solids (TSS), turbidity and sedimentation of defined waterways in the CPF footprint.

The assessment undertaken in the 2019 Upstream EIS considered the potential impacts that the CPF located at site P2C would have on the catchment of Oyomo Creek. Construction in Oyomo Creek catchment was to occur over 92 ha and cause the loss and diversion of approximately 5,600 m of waterway, comprising 3,100 m of moderate gradient streams and 2,500 m of low gradient streams. With the relocation of the CPF to site P3, these impacts on Oyomo Creek catchment will not occur.

There is a need for minor re-routing of the flowline to, and export pipeline from, the CPF P3 site location along the selected route. These minor changes are not regarded to materially alter the impact assessments described in the 2019 Upstream EIS.

10.4.1 Alteration of Hydraulic Processes

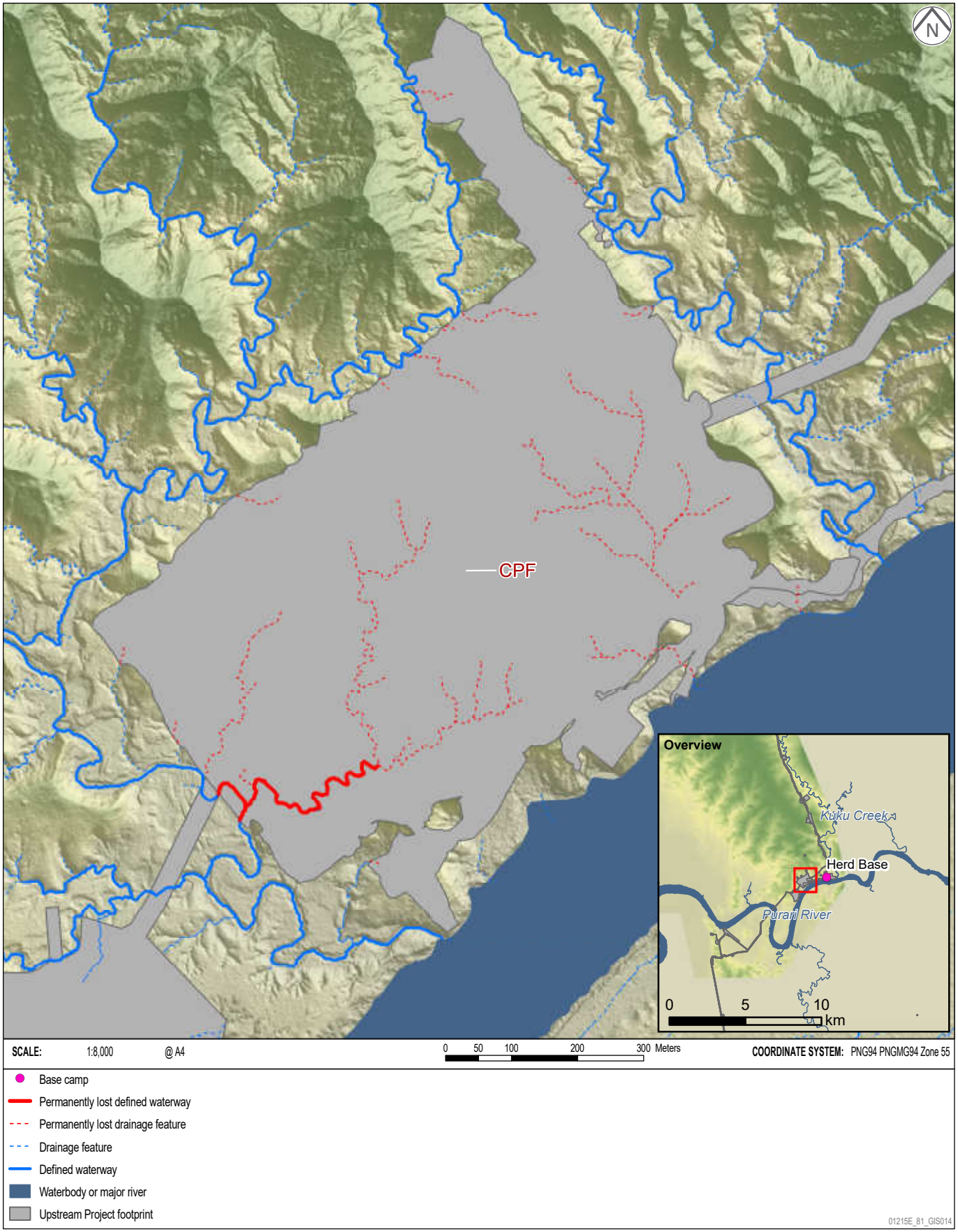
As described in Section 7.3 of this addendum, the PCS of the CPF P3 site identified seven (unnamed) defined waterways within the surveyed area. Most of these identified defined waterways within the surveyed area occur to the north of the CPF P3 site (see Figure 7.2), and hydraulic processes are not expected to be impacted. Within the CPF P3 site, the only defined waterway is within the western portion of the site, with approximately 600 m of waterway that will be permanently lost (Figure 10.1) in the creation of the platform for the CPF (see Figure 4.8).

Drainage features which are formed by overland flow during and immediately after rain but do not have aquatic ecosystem features, i.e., undefined waterways, also occur in the area. Based on the undefined waterways identified during PCS investigations, and geographical information system (GIS) topographical information, the total length of undefined waterways that will be lost within the footprint of the CPF P3 site (shown in Figure 10.1) is estimated to be approximately 4,600 m. Many of these drainage features are in the eastern area of the CPF P3 site within the 1 in 100-year flooding zone of the Purari River (see Figure 7.3). The CPF P3 site will have an elevation of approximately 37 m above mean sea level (amsl) after completion of site preparation, which is 18 m above the 1 in 100-year flooding level of the Purari River (TEP PNG, 2023). This will require backfilling this area of the site within the 1 in 100-year flood zone.

Waterways in the Vicinity of the CPF P3 Site

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FIGURE 10.1



The loss of the defined waterway in the western portion of the CPF P3 site during site construction is expected to have very minor impact on overall drainage patterns and hydraulic processes. A diversion channel (likely to be of less than 100 m length) will be constructed to divert flow from the upstream reach of this waterway to the lower reach below the CPF P3 site (Figure 10.1). Depending on the final design of the CPF, short diversion channels may also be required to divert flows from the northern perimeter of the CPF and from the western perimeter near the flare. Impacts on hydrology and fluvial geomorphology will be localized around the area of the stream diversions and earthworks at the CPF; hence, the magnitude of impacts will be ***Low***. The sensitivity of defined waterways in the PAOI is ***Medium*** since they are in near-natural condition and well-represented. This provides an overall impact significance rating of ***Minor***.

10.4.2 Increased TSS, Turbidity and Sedimentation

As shown in Figure 10.1, defined waterways are present near the western, northern and eastern perimeters of the CPF P3 site, flowing to the Purari River south of the CPF P3 site.

The Project Soil Management Plan (L2-PLN-SDV-22) and Site Restoration and Rehabilitation Management Plan (L2-PLN-SDV-21) describe measures that will be undertaken to restrict soils reporting to waterways. Contractors will develop site-specific Erosion and Sediment Control Implementation Plan in accordance with good international industry practice (i.e., International Erosion Control Association (IECA), 2008).

Notwithstanding implementation of sediment control measures, increases in suspended sediment and sedimentation are expected to occur in waterways in the area of the CPF P3 site during site construction. These impacts will be limited to the reaches of the streams immediately surrounding the CPF P3 site with the severest impacts occurring on the reach between the CPF P3 site and the Purari River, which is a distance of approximately 1 km. The magnitude of impact is expected to be ***Medium***. These impacts will ameliorate following construction when soils on embankments of the CPF platform have stabilized and revegetated. Given the sensitivity of the defined waterways is ***Medium***, this provides an overall impact significance rating for sediment impacts of ***Moderate*** during construction. Decommissioning activities at the CPF P3 site will also involve some minor earthworks, with the magnitude of impact expected to be ***Low***, providing an overall impact significance rating of ***Minor***.

Impacts of TSS, turbidity and sedimentation on the Purari River from earthworks at the CPF P3 site will be lesser given the naturally high sediment loads transported by this major river system. The sensitivity of the Purari River to increased suspended sediment and sedimentation is categorized as ***Low***, with a ***Low*** magnitude of impact predicted during construction and decommissioning. This provides an overall impact significance rating of ***Minor***.

10.4.3 Summary of Assessment of Residual Impact Significance

Table 10.4 provides a summary of the assessment of residual impacts to hydraulic processes and sediment transport.

Table 10.4 – Summary of Assessment of Impacts on Hydraulic Processes and Sediment Transport

Key Sensitivity	Main Activity	Potential Impact	Location of Activity	Project Phase	Mitigation and Management*	Residual Assessment	
						Sensitivity/ Magnitude	Significance
Hydraulic processes	Earthworks	Alteration of hydrology or flow characteristics due to filling and diversion of defined waterways	Vicinity of the CPF P3 site	C	• EM004	Medium/Low	Minor
Sediment transport	Earthworks	Soil erosion due to ground disturbance causing increased TSS, turbidity and sedimentation of defined waterways	CPF P3 site	C	• EM002 • EM003 • EM004 • EM005 • EM006 • EM010 • EM011 • EM012 • EM013	Medium/Medium	Moderate
				D		Medium/Low	Minor
		Soil erosion due to ground disturbance causing increased TSS, turbidity and sedimentation of Purari River	CPF P3 site	C, D		Low/Low	Minor

C = Construction, O = Operations, D = Decommissioning and closure
*Mitigation measure identifier, described in Chapter 20 of the 2019 Upstream EIS and Chapter 17 of this addendum.

10.5 2019 Upstream EIS Section 11.4 Surface Water Quality

As described in the 2019 Upstream EIS, stormwater from potentially contaminated areas of the CPF will be captured and treated by the OD1 and OD2 open drain system water collection and hydrocarbon-water separator system treatment system at the CPF. This planned discharge to the Purari River will take place according to applicable limits. The only difference with the relocation of the CPF to site P3 is that the discharge point will be located further upstream nearer to Herd Base. Potential impacts to surface water quality from these planned discharges from the CPF are therefore as described in the 2019 Upstream EIS. Potential impacts on the water quality of the Purari River due to treated sewage discharges, and discharges of accidental hydrocarbons and chemical releases on the CPF site are also as described in the 2019 Upstream EIS.

The results of these assessments are summarized in Table 10.5, with all residual impacts being either ***Negligible*** or ***Minor***.

10.6 2019 Upstream EIS Section 11.5 Freshwater Biodiversity

The following potential impacts to freshwater biodiversity required reassessment considering the relocation of the CPF to site P3:

- Direct disturbance and habitat fragmentation.
- Increased suspended sediment and sedimentation levels.
- Contamination of waterways.

10.6.1 Direct Disturbance and Habitat Fragmentation

Construction of the CPF at site P2C in the Oyomo Creek catchment would have resulted in the loss or diversion of approximately 5.5 km of waterways due to vegetation clearing and earthworks. As described in Section 10.4.1 of this addendum, the only defined waterway within the footprint of the CPF P3 site is within the western portion of the site, where approximately 600 m of waterway will be permanently lost (Figure 10.1). Approximately 100 m of this waterway will also require diversion outside the footprint of the CPF P3 site. Depending on the design, the diversion channel could create habitat for aquatic biota, albeit of a lower quality and modified nature to the habitat of the defined waterway that it replaces. As described in Section 10.4.1 of this addendum, the undefined waterways that will be lost within the footprint of the CPF do not have aquatic ecosystem features; hence, are not considered in the freshwater biodiversity assessment.

Like Oyomo Creek, the habitat of the defined waterway that will be lost has a ***Medium*** sensitivity since the stream:

- Is in an unmodified condition, like most other streams in the PAOI.
- Provides good-quality habitat for invertebrate and fish species but is not habitat for threatened aquatic species recorded in the Purari River.
- Is not unique but rather is representative of tributary stream habitat found throughout the PAOI and broader region.

The impact to habitat is irreversible but is not expected to extend beyond the CPF P3 site footprint, i.e., will only affect approximately 600 m of waterway, or to threaten the viability of a subregional population. This results in a ***Medium*** magnitude of impact rating, and an overall significance rating of ***Moderate.***

10.6.2 Increased Suspended Sediment and Sedimentation Levels

Increases in suspended sediment levels and in-stream sedimentation from earthworks and spoil stockpiling will occur in waterways located directly adjacent to construction sites subject to ground disturbance.

The PRL-15 waterways and the Purari River provide good-quality habitat for a wide range of species. This includes the threatened and endemic aquatic species identified as occurring or possibly present (see Section 7.6 of this addendum). These waterways; therefore, have a ***Medium*** sensitivity.

As described in Section 10.4.2, during construction of the CPF P3 site increases in suspended sediment and sedimentation are expected to occur in waterways around the CPF, in lower reaches near the highly turbid Purari River.

Localized declines in microalgae, invertebrate and fish communities are expected to occur due to this mobilization of sediment, particularly in the reach of the defined waterway from the CPF boundary to its confluence with the Purari River, which is a distance of approximately 1 km. Ecosystem viability is expected to be reduced in this area with impacts potentially occurring for longer than five years. The magnitude of impact during construction is therefore assessed to be ***Medium***, giving an overall significance rating of ***Moderate***. Decommissioning activities at the CPF P3 site will also involve some minor earthworks, with the magnitude of impact on aquatic species expected to be ***Low***, providing an overall impact significance rating of ***Minor***.

Impacts to biological communities will be lesser in the Purari River due to their adaptation and tolerance to its naturally high sediment loads, with the magnitude of impacts categorized to be ***Low*** during construction and decommissioning, providing an overall significance rating of ***Minor.***

10.6.3 Contamination of Waterways

Like the assessment of impacts on water quality, toxicity effects on aquatic biota due to contamination of waterways are as assessed in the 2019 Upstream EIS, i.e., ***Negligible*** or ***Minor***, with a summary of impact assessments provided in Table 10.6.

10.6.4 Summary of Assessment of Residual Impact Significance

Table 10.6 provides a summary of the assessment of residual impacts to freshwater biodiversity.

Table 10.5 – Summary of Assessment of Impacts on Surface Water Quality

Key Sensitivity	Main Activity	Potential Impact	Location of Activity	Project Phase	Mitigation and Management*	Residual Assessment	
						Sensitivity/ Magnitude	Significance
Surface water quality	Planned wastewater discharges	Deterioration in Purari River water quality due to treated stormwater and produced water discharges	CPF P3 site	O	• EM008 • EM016	Medium/Minimal	Negligible
		Deterioration in Purari River water quality due to sewage effluent discharge	CPF P3 site	C, O, D		Medium/Minimal	Negligible
		Deterioration in Purari River water quality due to discharge of firefighting foams	CPF P3 site	O		Medium/Low	Minor
	Use of hazardous materials	Deterioration in stream water quality due to accidental hydrocarbon or chemical releases	CPF P3 site	C, O, D	• EM017 • EM018	Medium/Low	Minor

C = Construction, O = Operations, D = Decommissioning and closure.
*Mitigation measure identifier, described in Chapter 20 of the 2019 Upstream EIS and Chapter 17 of this addendum.

Table 10.6 – Summary of Assessment of Impacts on Freshwater Biodiversity

Key Sensitivity	Main Activity	Potential Impact	Location of Activity	Project Phase	Mitigation and Management*	Residual Assessment	
						Sensitivity/ Magnitude	Significance
Habitat disturbance and fragmentation	Earthworks and physical infrastructure	Direct loss of aquatic habitat within CPF footprint	CPF P3 site	C	• EM001 • EM024	Medium/Medium	Moderate
Increased suspended sediment and sedimentation levels	Earthworks	Smothering of fauna and habitat in tributary streams from sediment generated by ground disturbance within CPF footprint	CPF P3 site	C	• EM002 • EM003 • EM004 • EM005 • EM006 • EM010 • EM012 • EM013	Medium/Medium	Moderate
			CPF P3 site	D		Medium/Low	Minor
		Smothering of fauna and habitat in Purari River from sediment generated by ground disturbance within CPF footprint	CPF P3 site	C, D		Medium/Low	Minor
Contamination of waterways	Planned wastewater discharges	Impacts on aquatic ecosystems and biota from discharge of treated sewage effluent – Purari River	CPF P3 site	C, O, D	• EM008 • EM016	Medium/Minimal	Negligible
		Impacts on aquatic ecosystems and biota from discharge of contaminated stormwater and produced water – Purari River	CPF P3 site	O		Medium/Low	Minor
		Impacts on aquatic ecosystems and biota from firefighting foams discharges during fire response training and equipment testing – Purari River	CPF P3 site	O		Medium/Low	Minor

Key Sensitivity	Main Activity	Potential Impact	Location of Activity	Project Phase	Mitigation and Management*	Residual Assessment	
						Sensitivity/ Magnitude	Significance
Contamination of waterways	Accidental hydrocarbon or chemical releases; use of hazardous materials	Impacts on aquatic ecosystems and biota from hydrocarbon or chemical spill or leaks – waterways adjacent CPF and Purari River	CPF P3 site	C, O, D	• EM017 • EM018	Medium/Low	Minor

C = Construction, O = Operations, D = Decommissioning and closure.
*Mitigation measure identifier, described in Chapter 20 of the 2019 Upstream EIS and Chapter 17 of this addendum.

10.7 2019 Upstream EIS Section 11.6 Terrestrial Biodiversity

10.7.1 Approach and Methodology

This addendum follows the impact assessment method outlined in the 2019 Upstream EIS. A detailed method of assigning sensitivity to receptor biodiversity values is outlined in the 2017 ESBS (ERIAS, 2017). Details on the approach undertaken for measuring the magnitude of impact, and the matrix for determining the significance of impact, are described in the 2019 Upstream EIS (Chapter 3, Volume 1).

This addendum updates the findings of the 2019 Upstream EIS based on the following recent additional information:

- Change in Project design, notably including (but not limited to) a shift in the location of the CPF in southern PRL-15.
- Changes to the list of sensitive species, including the addition of several new-to-science and IUCN threatened plant species recorded only after the ESBS surveys (see Section 7.7 for a detailed summary of changes to species-level sensitivities).
- Change in habitat condition due to commercial logging in some parts of PRL-15 (see Section 7.7).
- Changes in the understanding of some impact processes (see Section 10.7.2.2).

Much of this information pertains to species and ecosystems that occur outside of areas subject to the substantial changes in Project design. However, these changes in Project design cannot be assessed in isolation, since potential impacts to terrestrial biodiversity values are assessed at the scale of the entire upstream terrestrial biodiversity study area (hereafter 'study area') – for each biodiversity value, the magnitude of impact is based on the predicted change to the ongoing viability of the ecosystem or species population across the study area. Given that biodiversity values are not restricted to Project sites (e.g., the CPF footprint) or areas (e.g., PRL-15), impact assessment requires consideration of the following interacting features:

- The overall impact of combined Project activities across the study area (assumed to be contained within the upstream Project Area of Influence (PAOI)).
- The distribution and status of each biodiversity value across the whole study area. Following the 2019 Upstream EIS and basic ecological principles, where a species is not recorded at a particular site, development of that site is still considered to contribute to the overall impact to that biodiversity value if the site includes suitable habitat within the species' predicted range; for example, if the species was not recorded in the CPF P3 site, but is known to occur in similar habitat elsewhere in PRL-15, then the CPF P3 development is considered to impact that species through loss of suitable habitat, as it is possible the species may occur there but have gone undetected, or it may occur there in the future via natural dispersal mechanisms.

Accordingly, this addendum considers the combined impacts of all upstream Project activities on all sensitive biodiversity values present within the PAOI.

10.7.2 Potential Impacts

10.7.2.1 Overview

The impact processes that may affect terrestrial biodiversity values due to Project development are grouped into the following categories:

- Habitat loss and fragmentation, including loss of important features and impacts from barrier effects.
- Habitat degradation, including impacts from edge effects, erosion and movement of soil and spoil, sedimentation and contamination of waterways, reduction in air quality, fire, deforestation and acid rain.
- Natural regeneration failure following vegetation clearing.
- Loss of individuals and populations.
- Mortality or injury to fauna, including from vehicle strike and impacts from trenching.
- Disturbance to fauna and focal breeding and roosting sites; for example, through noise and light emissions.
- Introduction and spread of invasive alien species, including weeds, pests and pathogens.
- Indirect impacts from social and commercial aspects, including increased hunting, exploitation of forest resources and clearing of land for housing and gardens.

The various processes may impact biodiversity values directly or indirectly, where:

- Direct impacts occur due to planned Project activities, e.g., removing forest habitat to develop infrastructure during the Project construction phase associated with the CPF P3 site.
- Indirect impacts would not have occurred without Project development but do not directly result from planned Project activities.

This assessment adopts a high-level approach to determine the overall level of Project-related impacts to each biodiversity value. Although the various impact processes can be separately identified, the mechanisms of change are inter-related and their effects are accumulative such that examining each factor in isolation can lead to a misleading assessment. Thus, following the 2019 Upstream EIS approach, the overall impact magnitude to each biodiversity value is calculated as a combined function of all impact processes, both direct and indirect.

10.7.2.2 Updates to Potential Impact Considerations

A detailed analysis of the above impact processes is presented in the 2019 Upstream EIS. The following section outlines recent changes to how impact processes are considered to impact local biodiversity values, based on information that has become available since the 2019 assessment, including the substantial changes being assessed in this EIS Addendum.

Barrier Effects

It has been proposed that the new CPF P3 location may pose an increased risk of barrier effects for the flora, fauna and ecosystems of the Purari River's hinterland. However, it is anticipated that these effects will be local in scale and will not seriously impact access to riparian habitats for local flora and fauna populations, nor measurably impact the viability of any local flora and fauna populations, for the following reasons.

(1) Most or all forest fauna probably do not rely on access to the deep and fast-flowing Purari River. Rather, those species that do require access to water are more likely to utilize smaller watercourses that have high local availability.

(2) Many adjacent hill forest species do not occupy true riparian forest that is structurally more complex due to regular flooding disturbance (e.g., Korejs et al., 2023), and most forest species that do use local riparian forests, such as the southern cassowary (*Casuarius casuarius*), also utilize adjacent hill forest habitat.

(3) The bank along this section of the Purari River is quite high in most places (though still subject to occasional flooding) and there are no off-river swamp habitats that provide potential breeding habitat for fauna relying on permanently wet riverside vegetation, such as crocodiles or turtles.

(4) More importantly, there are extensive areas upstream and downstream from the CPF P3 site and Herd Base, and between them (interrupted by a road only), where foothill forest extends unbroken to the Purari riverbank.

For those species that do rely on riverside vegetation, connectivity along the riverbank habitat will be further interrupted, over and above the existing barrier provided by Herd Base. However, most of these species can also utilize adjacent foothill forest to a greater or lesser degree. Moreover, a narrow strip of riverside vegetation persists along most of the existing Herd Base riverfront, and most bird species that utilize this habitat (e.g., azure kingfisher (*Ceyx azureus*), shining flycatcher (*Myiagra alecto*)) have been observed to move freely through this narrow strip. A similar narrow strip of riverside vegetation will be maintained along most of the area between the CPF and Purari River. Secondary regrowth is also suitable for movement through these areas as true riparian vegetation often comprises similarly dense regrowth due to frequent flooding disturbance. There is potentially one species of conservation significance that, in this local topographic setting, may have its movement impeded, the IUCN VU Scheepmaker's Crowned Pigeon (*Goura scheepmakeri*). This bird is a rather ponderous mover, tends to avoid forest on steep slopes and preferentially utilizes gentle terrain along riverine floodplains in hill forest settings. However, this species is well represented in extensive areas of forest both upstream and downstream of the existing Herd Base – their local range reaches downstream to the mangrove/freshwater swamp forest interface, west along the alluvial forest delta rim to Mount Favenc and the Kikori River, and upstream past Wabo to Hathor Gorge. These populations are assumed to be independently viable and, moreover, they are still connected via continuous forest habitats on the other side of the Purari River and probably also across the foothills inland from the north bank of the Purari River. Thus, while barrier effects along this axis may be increased at the very local scale beyond the current level of interruption, it is not expected to result in the actual fragmentation of any local populations.

Edge Effects

In 2019, 100 m and 150 m buffers were used to define the area degraded by edge effects from facility/infrastructure clearings that were less than 150 m wide and greater than 150 m wide, respectively. In this 2024 assessment, the buffer has been precautionarily increased to 200 m for all Project clearings, irrespective of width. This is a more conservative assessment than the 100 m buffer proposed by the CEPA.

Loss of Sensitive Flora Individuals or Populations

For most plant taxa, local Project-related population decline is predicted to be proportional to the loss of suitable habitat (Hardner et al., 2015). Exceptions include:

- Rare plants known in the study area from only a few individuals recorded at one or two locations within or near planned footprints.
- Species that may be restricted to specific habitats in a limited area (for example, in primary forest near the boundary between foothill and alluvial landforms).

PCS data have provided additional information on several species that were previously thought to be much rarer. In addition, the development of a nursery at Herd Base, where many sensitive plant species are now under propagation, has for several species effectively limited the magnitude of impact arising from the loss of individuals or small populations.

Disturbance to Fauna from Noise

Based on recent studies on the responses of wildlife to anthropogenic noise pollution, and recent Project noise contour modelling (Appendix 2), a revision of noise impacts on fauna is warranted.

Table 10.7 outlines noise contour modelling predictions for habitats surrounding the CPF P3 site under various stages and conditions (Appendix 2). The surrounding terrain is a key determinant of the projected noise contours, with noise under construction and normal operational conditions reaching further into the forest on flatter terrain south of the Purari River. Noise levels much higher and far-reaching than those described in Table 10.7 will occur infrequently during downgraded cases (i.e., when the plant is not in normal operational mode) (during facility ‘turndown’, 2–4 times per year, <24 h duration) (Appendix 2).

Compared with average baseline levels (SLR, 2017), noise during construction and normal operational conditions will exceed pre-existing (1) daytime levels (pre-existing: c.50 dBA Leq) only within approximately 500 m of the site, and (2) night-time conditions (pre-existing: above 61 dbA Leq) only in limited areas immediately adjacent to the CPF P3 site. However, when considering potential impacts to fauna, it is important to note that pre-existing noise is dominated by insect sound between 4 kHz and 8 kHz (SLR, 2017). By contrast, most of the industrial noise from the CPF P3 site will be at lower frequencies – below 2 kHz with substantial noise generated at registers below 1 kHz (Appendix 2). This amounts to a large increase in pre-existing levels at these lower frequencies, compared to those in the 4–8 kHz range.

Table 10.7 – Noise Contour Modelling Predictions for Areas Surrounding the CPF P3 Site

Project Stage	Neutral (Low Wind) Conditions	Enhanced (High Wind) Conditions
Construction	Noise levels of 45 dBA Leq will reach up to several hundred meters into surrounding forest areas; maximum levels of more than 60 dBA Leq will reach 100–200 m into some immediately adjacent forest sites.	Noise levels of 45 dBA Leq will reach up to >1 km into some surrounding forest areas; maximum levels of more than 65 dBA Leq will reach 100–200 m into some immediately adjacent forest sites.
Operation	Noise levels of 45 dBA Leq will reach up to >1 km into surrounding forest areas; maximum levels of >65 dBA Leq will reach 100–200 m into some immediately adjacent forest sites.	Noise levels of 45 dBA Leq will reach up to approximately 2.5 km into surrounding forest areas; maximum levels of >65 dBA Leq will reach 100–200 m into some immediately adjacent forest sites.

The impact of noise on wildlife is a growing field of study, and many knowledge gaps remain. Research is most lacking for non-avian terrestrial species, nocturnal species, long-term exposure effects and impacts to fauna in tropical environments (Shannon et al., 2016; Jerem and Mathews, 2021). Nevertheless, many studies have shown a variety of adverse responses to noise pollution, including reduced diversity and abundance of birds and other animals, changes in faunal community structure (species composition), behavioral changes (e.g., avoidance, vocal, foraging, vigilance, reproduction), lower reproductive success, and adverse physiological changes (Shannon et al., 2016; Kok et al., 2023). In a recent review, almost half of studies reported a biological response at noise levels above 60 dBA, and >60% of studies reported a response above 65 dBA (Shannon et al., 2016). Several studies have documented adverse responses at levels above 45 dBA for birds and 52 dBA for terrestrial mammals (Shannon et al., 2016; Senzaki et al., 2020).

Responses are taxa specific, with some species more susceptible to noise than others. Larger birds with lower song frequencies and narrower vocal repertoires may be most susceptible to chronic industrial noise pollution (Rheindt, 2003; Francis et al., 2011). Relevant species occupying habitat near the CPF P3 site include southern cassowary (*Casuarius casuarius*), large pigeons including the IUCN threatened Scheepmaker's crowned pigeon (*Goura scheepmakeri*) and large owls. These species may be particularly susceptible to the increase in low frequency volumes predicted to arise from CPF construction, operation and decommissioning (Appendix 2).

Any adverse responses by these or other species are expected to be localized to the immediate vicinity of the CPF P3 site, predominantly within the 200-m degradation buffer defined above for edge effects. A low but additive impact magnitude is precautionarily predicted for the broader study area population of susceptible species. Given the uncertainty regarding noise impacts on fauna and species variation, only biodiversity monitoring through camera trapping and automated sound recording, coupled with noise monitoring, will determine their ultimate response.

Indirect Impacts to IUCN Threatened Freshwater Turtles via Local Population Growth

The 2019 Upstream EIS acknowledged that a Project-related increase in the local human population may result in a concomitant increase in the harvesting and exploitation of local biodiversity values. The highest levels of in-migration were predicted around the local Pawaian villages. During 2017 to 2023, the combined population of Pawaian communities monitored by the

Project (Ura, Wabo, Wabo Station, Subu, Subu 2, Poroi 1, Poroi 2 and Poroi 3) increased in size by 29.2% (from 1,418 to 1,832: IDP, 2024; ERIAS, 2019).

Since the ESBS, patterns of settlement observed along the Purari River upstream from the Purari Airstrip suggest that IUCN threatened river turtles may be disproportionately affected by population growth. Notably, households settling outside of the main Pawaian villages (for permanent or occasional occupation) show a marked preference for riverbank sites with sandy beaches, as these provide suitable places to wash, process sago, fish, build and maintain canoes, and for children to play. Many of these beaches also serve as nesting sites for the IUCN Endangered pig-nosed turtle (*Carettochelys insculpta*) and, to a lesser extent, the IUCN Vulnerable southern New Guinea giant softshell turtle (*Pelochelys bibroni*). Evidence from local residents indicates that these turtle species will abandon breeding sites that are frequently visited or otherwise disturbed. This heightened susceptibility to population growth has been factored into the current assessment.

10.7.3 Proposed Mitigation and Management Measures

Proposed mitigation and management measures are as outlined in the 2019 Upstream. The various PCS reports provide additional specific context for some of the recommendations made more broadly in the 2019 Upstream EIS, including:

- Plant species to be used for rehabilitation at each site.
- Individual priority plants, large trees, large fig trees, trees with large hollows, megapode nest mounds, hill forest pools, pandanus swamps and other sensitive species or focal sites to be retained in position where practical.

An additional recommendation was developed under the PCS program to maintain population viability of sensitive plants:

- If losses are unavoidable, prior to removing any plants: (1) collect suitable propagation material, and (2) demonstrate successful propagation of numbers to over-compensate losses, or (3) survey beyond proposed footprints to locate additional populations that, according to expert opinion, would provide sufficient propagation material to overcompensate for projected losses.

Several local endemic and IUCN threatened plant species are currently successfully under propagation in the Project nursery at Herd Base.

Two new commitments are proposed in this addendum:

- Develop and implement a comprehensive IUCN Threatened Freshwater Turtle Species Management Program; engage Piku Biodiversity Network (PNG NGO) and/or other ecologists as required; educate/train and engage local resident landowners in an effort to curb currently unsustainable hunting levels; initiate studies into the location and timing of nesting and to document harvesting rates; monitor local populations (EM049).
- Targeted baseline studies will be undertaken to better understand the ecology and population status of the study area's IUCN threatened freshwater turtles and the

harvesting practices of local residents. These studies will be undertaken prior to construction and will be followed by long-term monitoring of breeding and harvesting activity. The results of these studies may lead to amendment of or addition to existing mitigation measures (EM050).

10.7.4 Residual Impact Assessment

This section provides a residual impact assessment to terrestrial biodiversity for each of the potential impacts identified in Section 10.7.2 assuming successful implementation of the proposed mitigation measures. Although Section 10.7.2 distinguishes individual impact processes, the mechanisms of change are inter-related and their effects are accumulative. Thus, following the method outlined in the 2019 Upstream EIS, the significance of residual impacts is considered as the overall combined function of all impact processes on each biodiversity value.

Only those values judged to have Medium Sensitivity or higher are considered in this assessment. Values deemed Not Sensitive or to have Low Sensitivity are not here assessed; the impact magnitude for each of these values is deemed to be Medium or lower, and the impact significance is therefore Negligible or Minor.

A summary of the residual impact assessments is provided at the end of this section and in Table 10.9 (Section 10.7.4.3). A biodiversity offset program will be implemented to address residual impacts from the Project with International Finance Corporation (IFC) performance standards guiding its design.

10.7.4.1 Sensitivity of Terrestrial Biodiversity

This section summarizes the sensitivity of terrestrial biodiversity values present in the PAOI, focusing on those values ranked ***Medium*** sensitivity (or as ***Moderately Sensitive*** as in Chapter 7) or higher (see Section 10.7.1).

The sensitivity of terrestrial ecosystems, protected areas and focal sites is the same as described in the 2019 Upstream EIS.

Several changes have been made to the list of sensitive species since the 2019 Upstream EIS; based on, for example, reappraisal of original records, results of more recent surveys, taxonomic changes, or changes to the species' formal conservation status (summarized in Section 7.7.2). A total of 198 species recorded or potentially occurring in the PAOI are ranked as ***Medium*** sensitivity or higher. The most sensitive species newly considered in this addendum include:

- Five ***Very High*** sensitivity plants:
  - The International Union for Conservation of Nature (IUCN) Critically Endangered (CR) palm *Orania longistaminodia*. One found along Road R05 in central PRL-15 represents only the third known occurrence of this Papua New Guinean endemic palm.
  - The recently discovered (new-to-science) understory plant *Begonia* sp. 14 – known from a single plant along Road R07 in the upper Era River catchment in PRL-15.
  - The tree *Myristica brachypoda*, whose IUCN status was recently upgraded from Vulnerable (VU) to CR.

  - The IUCN CR tree *Dolicholobium rufiflorum* – otherwise known only from the type locality in the neighboring Vailala River catchment, it was located in the PAOI during recent PCSs and found to be locally fairly common.
  - The IUCN CR small tree *Psychotria heterophylla*, recently assessed for the first time by the IUCN and known from a single locality near Ihu township on the Vailala River immediately east of the PAOI.

- Thirty (30) ***High*** sensitivity species:
  - Ten IUCN threatened plants – *Dracontomelon lenticulatum* (VU), *Calophyllum suberosum* (VU), *Anisoptera thurifera* (VU), *Endospermum medullosum* (VU), *Gmelina sessilis* (VU), *Endiandra cyphellophora* (Endangered (EN)), *Endiandra latifolia* (VU), *Litsea globosa* (VU), *Eleutherostylis renistipulata* (EN) and *Pterocymbium beccarii* (VU).
  - Eighteen (18) recently discovered (new-to-science) plants, most of which are only known from the PAOI – *Pseuduvaria* sp. 2, *Dischidia* sp. 1, *Calamus* sp. 1, *Licuala* sp. 1, *Begonia* sp. 11, *Begonia* sp. 13, *Begonia* sp. 16, *Begonia* sp. 17, *Mammea* sp. 1, *Barringtonia* sp. 3, *Medinilla* sp. 2, *Syzygium* sp. 7, bamboo sp. 2, *Fittingia* sp. 1, *Rhadinopus* sp. 1, *Phaleria* sp. 1, *Etlingera* sp. 6 and *Etlingera* sp. 6.
  - Two IUCN Data Deficient (DD) restricted-range species previously known only from the type locality along the nearby lower Vailala River – *Pandanus pendulinus* and *Pandanus rex*.

Thirty-nine (39) species that were previously assessed in the 2019 Upstream EIS (species with ***Medium*** sensitivity or higher) are not assessed in this addendum. The most sensitive recent exclusions are:

- Three formerly ***Very High*** sensitivity species:
  - The IUCN CR mangrove tree *Bruguiera hainesii* – excluded on taxonomic grounds as it now considered to be a hybrid taxon (hybrid taxa are not assessed in the IUCN *Red List*).
  - The IUCN EN timber tree *Diospyros insularis*, whose presence was based on a misidentification.
  - The IUCN CR Bulmer's fruit bat (*Aproteles bulmerae*) whose presence in the PAOI is now considered unlikely.
- 13 formerly ***High*** Sensitivity species:
  - Four species whose IUCN *Red List* status has been downgraded to Least Concern – *Gluta papuana*, *Ceratopetalum succirubrum*, *Flindersia pimenteliana* and Salvadori's Teal (*Salvadorina waigiuensis*).
  - Five species now considered absent from or unlikely to be present in the PAOI – the plant *Cyrtandra externata* and four mammals – eastern long-beaked echidna (*Zaglossus bartoni*), Goodfellow's tree kangaroo (*Dendrolagus goodfellowi*), dusky pademelon (*Thylogale brunii*) and giant bandicoot (*Peroryctes broadbenti*).

- Two mammals previously considered to be undescribed local endemics but since identified as widespread named species (based on re-examination of skeletal material) – *Hydromys* sp. 1 now identified as Shaw Mayer's water rat (*Baiyankamys shawmayeri*), and *Pseudohydromys* sp. 1 now provisionally identified as white-bellied moss mouse (*Pseudohydromys* cf. *sandrae*).
- One species no longer considered to be restricted-range (RR) based on recent data and research – *Drepananthus (Cyathocalyx) lucidus.*
- The IUCN EN timber tree Burmese rosewood (*Pterocarpus indicus*) – although globally threatened, it is common and widespread throughout New Guinea in a variety of intact and disturbed habitats.

The full list of sensitive species, and their sensitivity rankings, is presented in Table 10.9 (Section 10.7.4.3).

10.7.4.2 Terrestrial Ecosystems, Protected Areas and Focal Sites

Table 10.8 summarizes the areal extent of natural vegetation that will be lost or degraded within affected ecosystems through clearing for the Project.

Due to the shift in CPF location, the area of ***High*** sensitivity primary alluvial forest that is proposed to be cleared has been reduced to nearly half of that considered in the 2019 Upstream EIS, from 0.13 to 0.07% of this ecosystem's extent across the study area. Proposed clearance areas in other ecosystems with Moderate sensitivity or higher are the same as or similar to those reported in the 2019 Upstream EIS.

Edge effect buffers have increased, resulting in a 50 to 100% increase in the area considered to be affected for all ecosystems here assessed. However, the magnitude of impact from edge effects remains unchanged, since the extended area is furthest from Project footprints and thereby subject to fewer effects. Edge effects in logged forest environments are expected to be negligible compared to past disturbance.

The magnitude of residual impacts to terrestrial ecosystems remains ***Low*** or ***Minimal*** in all cases – impacts will be localized and predominantly restricted to the vicinity of Project footprints, most of which comprise narrow linear clearings, and ecosystem function and viability are unlikely to be affected. The resulting impact significance will be ***Negligible*** or ***Minor*** for most ecosystems, though with a ***Moderate*** residual impact significance to ***High*** sensitivity primary alluvial forest.

There is no change in the magnitude of predicted impact to the Crater Mountain Wildlife Management Area or to focal sites. A ***Minor*** or ***Negligible*** residual impact significance is predicted in all cases.

Table 10.8 – Area (ha) and Percent (%) of Terrestrial Ecosystems Cleared and Degraded by Project Construction, Compared Against Study Area Availability*

Ecosystem†	Ecosystem Area 2016	Ecosystem Area 2024	Footprint				Degradation Buffer			
			Total Area#	Existing Clearance **	Project Clearance	% Cleared by Project 2024	Total Area	Existing Clearance **	Project Degradation	% Degraded by Project 2024
Primary hill forest (H)	250,982.73	247,377.01	461.08	1.76	459.32	0.19	2,225.06	1.05	2,224.01	0.90
Logged hill forest (H)	89,996.05	93,598.56	24.72	4.25	20.47	0.02	225.02	10.25	214.77	0.23
Primary alluvial forest (P)	85,000.94	85,004.44	60.75	0.15	60.60	0.07	497.61	3.83	493.78	0.58
Logged alluvial forest (P)	30,339.91	30,339.31	168.00	18.40	149.60	0.49	1,173.76	36.16	1,137.60	3.75
Primary swamp forest (Fsw)	111,460.01	103,479.86	51.08	0.00	51.08	0.05	395.71	0.00	395.71	0.38
Logged swamp forest (Fsw)	7,980.15	7,980.82	73.08	6.01	67.07	0.84	380.67	8.14	372.53	4.67
Swamp woodland (Wsw)	60,285.82	60,285.46	6.36	0.00	6.36	0.01	86.62	0.00	86.62	0.14
Low freshwater swamp vegetation (Hsw, Gsw, Gri)	7,496.87	7,496.87	0.76	0.00	0.76	0.01	11.58	0.27	11.31	0.15
Mangrove (M)	60,362.90	60,362.90	0.21	0.00	0.21	0.00	3.15	0.00	3.15	0.01
Riverine seral forest (Fri)	853.49	853.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Littoral forest (B)	178.00	178.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

* The areas calculated do not consider regeneration of some areas.
† The descriptive terms presented here are accompanied by their PNG Forest Inventory Mapping System (FIMS) code. They appear without the FIMS code in the text.
The total footprint varies from the Project disturbance footprint presented in Table 4.8 because the latter excludes the existing Herd Base facility area; it is included here to accurately describe the Project-related residual impact arising from development of the Elk-Antelope gas field.
** All existing clearance/disturbance areas are taken from south of the Purari River only; all disturbed areas overlapping proposed footprints north of the Purari River were impacted by exploration and development of the Elk-Antelope gas field and are included in the total Project footprint area.

10.7.4.3 Species

The approach taken to assessing species in this addendum is the same as that applied in the 2019 Upstream EIS. Most terrestrial species assessed here occur widely in ecosystems with suitable forest habitat and are not targeted by hunters. For these species, proportional losses of the ecosystems that species occupy provide a suitable surrogate measure for local population decline (Hardner et al., 2015).

Separate assessments are made for species that depend on microhabitats or other local landscape features that are not uniformly distributed in forest ecosystems, locally rare species that occur at very few sites, and hunting-sensitive fauna.

Widespread Forest Flora and Fauna

The magnitude of impact to most species occupying forest environments will be ***Low*** or ***Minimal***, involving either no measurable population decline or a minor decline that does not threaten the viability of the study area population. The residual impact significance for most taxa is ***Minor*** or ***Negligible***. A ***Moderate*** residual impact significance is predicted to those ***Very High*** or ***High*** sensitivity species that will incur an impact magnitude of ***Low***, including:

- Primary forest plants present only in the Middle Purari Hills ecological zone, or predominantly in the Middle Purari Hills with lesser occurrences in adjacent well-drained alluvial terrain at the northern rim of the Delta Swamps and Plains or in foothills of the northern export pipeline route. Relevant species include the ***Very High*** sensitivity IUCN CR tree *Dolicholobium rufiflorum*, the IUCN EN plant *Mammea grandifolia*, the IUCN VU plant *Litsea globosa*, plus 20 scientifically undescribed plants, most of which were discovered during Project surveys and are known only from the PAOI.

- The recently discovered snake *Stegonotus aplini*, which is so far known only from well-drained alluvial and adjacent foothill forest.

Rare Plants with One of Few Known Populations Near Project Footprints

Among the most at-risk species are those rare flora with one of few known individuals or populations recorded in or near proposed Project footprints. Fourteen species are assessed in this category, nine of which were recorded in the PAOI after the ESBS surveys.

The terrestrial herb *Begonia* sp. 14 was discovered during PCS in 2023 and is known from a single plant growing in damp conditions along a watercourse in primary forest in the upper Era River catchment in PRL-15. The site is located within the edge of the Road R07 footprint. The only known individual of this ***Very High*** sensitivity species will be lost without translocation or a shift in the edge of the Road R07 footprint with a significant buffer. Relocation may be viable, and begonias are relatively easy to propagate, but the species is yet to be grown in the nursery. Assuming successful propagation and the species' likely occurrence in similar habitat, the impact magnitude will remain ***Medium*** given the extensive developments planned for the only known site of occurrence. This will result in a ***Major*** residual impact significance. CPF development is relevant to this species as similar potentially suitable habitat (same vegetation, soil type, elevation, climate and ecological zone) occurs nearby at the CPF P3 site, and there are no substantial ecological barriers separating these areas.

Similar ***Medium*** level impact magnitudes are predicted for:

- *Phaleria* sp. 1 – Discovered during PCS in 2023 and known from a single plant growing in swamp forest within the proposed export pipeline route footprint near Aivai.
- *Pandanus pendulinus* – Previously known only from the type material collected from forest at Ihu near the Vailala River in 1926, it was rediscovered during PCS in alluvial forest near the proposed Road R05 footprint in PRL-15 (Kuku Creek oxbow area) and along the northern export pipeline route (Sawmill area). Fewer than 10 local examples are known. They are closely associated with poorly-drained sites that are difficult to rehabilitate, and some suitable habitat at the Kuku Creek site has already been impacted by gas exploration activities.

A ***Moderate*** impact significance is predicted for these ***High*** sensitivity species.

A lower impact magnitude is predicted for all other rare plant species located near Project footprints (Table 10.9), due to wider occurrences and, in most cases, the discovery of one or more sites well away from proposed footprints. Of these species, a ***Moderate*** impact significance is predicted for:

- The ***Very High*** sensitivity plants *Begonia* sp. 5 and *Orania longistaminodia*. The impact significance to *Begonia* sp. 5 has been downgraded from that applied in the 2019 Upstream EIS due to the discovery of additional populations during PCSs.
- The ***High*** sensitivity new-to-science plants *Etlingera* sp. 6, *Begonia* sp. 2, *Begonia* sp. 11, *Syzygium* sp. 1, *Medinilla* sp. 2, *Pseuduvaria* sp. 2 and *Mammea* sp. 1.

Other Fauna

Impact magnitudes to most fauna remain the same as those assigned in the 2019 Upstream EIS and are ***Low*** or ***Minimal***. The resulting impact significance to most species is ***Minor*** or ***Negligible***. A ***Moderate*** impact significance is predicted for:

- Nine ***High*** sensitivity species (two frogs and seven odonates) dependent on forest streams, forest pools and/or adjacent riparian vegetation.
- Two ***High*** sensitivity terrestrial IUCN threatened hunting-sensitive species – the lowland tree kangaroo (*Dendrolagus spadix*) and Scheepmaker's crowned pigeon (*Goura scheepmakeri*).

Compared to the Project design considered in the 2019 Upstream EIS, proposed riverbank facilities downstream from Herd Base are now positioned further from recorded nesting sites of the ***High*** sensitivity pig-nosed turtle and striped New Guinea soft-shelled turtle. However, only two known nest banks were within 200 m of proposed developments under the previous design, and direct impacts to those features were considered to be low. The higher impact predicted to occur from changes in our understanding of local settlement patterns overrides any benefits to these species achieved under the new design. The magnitude of impact to the ***High*** sensitivity pig-nosed turtle and striped New Guinea soft-shelled turtle is increased from ***Low*** to ***Medium***, due to a better understanding of the impact processes affecting these species (see

Section 10.7.2.2). The residual impact to these species remains ***Moderate***. However, it should be noted that the Pawaian land that is predicted to be most affected by in-migration includes more than 150 km of the Purari River between the Purari Airstrip and Hathor Gorge (upstream of Uraru village). Although the study area is large, this section of the Purari River is likely to support a high proportion of the area's nest banks that are used by IUCN threatened freshwater turtles. The level of impact on nesting turtles in this area is difficult to predict, but given that hunting and egg harvesting may already be at an unsustainable level, any additional harvesting, or damage or disturbance leading to abandonment of nest sites, could result in a significant long-term decline in breeding success and recruitment into the local study area population. Accordingly, targeted baseline studies will be undertaken to better understand the ecology and population status of the study area's IUCN threatened freshwater turtles and the harvesting practices of local residents. These studies will be undertaken prior to construction and will be followed by long-term monitoring of breeding and harvesting activity. The results of these studies may lead to amendment of or addition to existing mitigation measures.

Table 10.9 – Summary of Assessment of Residual Impact Significance to Terrestrial Biodiversity

Key Sensitivity	Main Activity	Potential Impact	Location of Activity	Project Phase	Mitigation and Management*	Residual Assessment	
						Sensitivity/ Magnitude	Significance
Ecosystems							
Primary hill forest	Vegetation clearing for construction of facilities and infrastructure; operation and decommissioning activities	Habitat loss and fragmentation; habitat degradation; fire; introduction and spread of invasive alien species	PRL-15; export pipeline route	C, O,D	• EM001 • EM002 • EM003 • EM004 • EM005 • EM011 • EM012 • EM018 • EM041 • EM078 • EM018 • EM023 • EM024 • EM025 • EM026 • EM027 • EM028 • EM029 • EM030 • EM036 • SM028 • SM029	Medium/Low	Minor
Primary alluvial forest						High/Low	Moderate
Logged alluvial forest						Medium/Low	Minor
Primary swamp forest			Export pipeline route			Medium/Low	Minor
Swamp woodland; low freshwater swamp vegetation						Medium/Low	Minor
Mangrove						High/Minimal	Minor
Riverine seral forest	Transfer of equipment and personnel by boat; forest resource use	Habitat degradation	River transport corridor			Medium/Minimal	Negligible

Key Sensitivity	Main Activity	Potential Impact	Location of Activity	Project Phase	Mitigation and Management*	Residual Assessment	
						Sensitivity/ Magnitude	Significance
					• SM030		
Protected Areas							
Crater Mountain Wildlife Management Area	In-migration	Habitat loss and fragmentation; habitat degradation; loss of individuals and populations; introduction and spread of invasive alien species; hunting	Pawaian villages (outside of Project areas)	C, O, D	See above	High/Minimal	Minor
Focal Sites							
Caves - general	Quarrying; disturbance of breeding and roosting colonies	Habitat loss and fragmentation; loss of individuals and populations; damage or destruction of feeding breeding nesting and roosting sites	PRL-15	C, O, D	• EM001 • EM027 • EM028 • SM028 • SM029 • SM030	High/Minimal	Minor
Caves - Wi'i Creek site						Very High/Minimal	Minor
Other rock shelters						Medium/Minimal	Negligible
Large trees	Vegetation clearing for construction of facilities and infrastructure	Habitat loss and fragmentation; loss of individuals and populations; loss of focal features	PRL-15, export pipeline route	C, O, D	• EM001 • EM018 • EM024 • EM025 • EM026 • EM027 • EM028	Medium/Low	Minor
Large fig trees							
Hill forest pools							

Key Sensitivity	Main Activity	Potential Impact	Location of Activity	Project Phase	Mitigation and Management*	Residual Assessment	
						Sensitivity/ Magnitude	Significance
					• EM041		
Forest Species: Primary Hill Forest (and Alluvial and/or Swamp Forest in Some Cases) Plants							
Very High sensitivity species, MPH, DSP and northern SH *Dolicholobium rufiflorum*	Vegetation clearing for construction of facilities/ infrastructure; operation and decommissioning activities.	Loss of individuals and habitat; degradation of remaining habitat; weed infestation; fire; reduction in population viability	PRL-15 and/or proposed export pipeline route	C, O, D	• EM001 • EM002 • EM004 • EM013 • EM018 • EM023 • EM024 • EM025 • EM026 • EM027 • EM028 • EM030 • EM031 • EM032† • EM033 • EM041	Very High/Low	Moderate
High sensitivity species MPH only, or predominantly MPH and DSP rim or northern SH *Dischidia* sp. 1; *Calamus* sp. 1; *Licuala* sp. 1; *Begonia* sp. 4; *Begonia* sp. 13; *Begonia* sp. 16; *Begonia* sp. 17; *Mammea grandifolia*; *Archidendron* sp. 1; *Litsea globosa*; *Medinilla* sp. 1; *Syzygium* sp. 3; *Syzygium* sp. 5; *Syzygium* sp. 7; *Bulbophyllum* sp. 1; Bamboo sp. 2; *Fittingia* sp. 1; *Maschalodesme* sp. 3; *Rhadinopus* sp. 1; *Etlingera* sp. 8						High/Low	Moderate

Key Sensitivity	Main Activity	Potential Impact	Location of Activity	Project Phase	Mitigation and Management*	Residual Assessment	
						Sensitivity/ Magnitude	Significance
High sensitivity species MPH only, found only at Aure Scarp, east of the Purari River and PRL-15 *Dracontomelon lenticulatum*						High/Minimal	Minor
Medium sensitivity species MPH only, or predominantly MPH and DSP rim or northern SH *Semecarpus* sp. 1; Annonaceae sp. 1; *Orophaea* sp. 1; *Calyptrocalyx* sp. 1; *Calyptrocalyx* sp. 2; *Ptychosperma* sp. 1; *Saribus pendulinus;* *Begonia* sp. 1; *Begonia* sp. 3; *Begonia* sp. 9; *Begonia* sp. 10; *Begonia* sp. 12; *Mammea novoguineensis*; *Hopea iriana*; *Vaccinium* sp. 1; *Cyrtandra* sp. 1; *Cyrtandra* sp. 2 ; *Barringtonia* sp. 1; *Syzygium* sp. 8; *Glochidion beehleri*; Bamboo sp. 3; *Maschalodesme* sp. 1;						Medium/Low	Minor

Key Sensitivity	Main Activity	Potential Impact	Location of Activity	Project Phase	Mitigation and Management*	Residual Assessment	
						Sensitivity/ Magnitude	Significance
Sapindaceae sp. 1; *Alpinia* sp. 1; *Alpnia* sp. 2; *Etlingera* sp. 1; *Etlingera* sp. 3; *Etlingera* sp. 4; *Riedelia* sp. 1; *Riedelia* sp. 2							
Medium sensitivity species MPH only found only at Aure Scarp east of the Purari River and PRL-15 *Saurauia* sp. 3; *Elaeocarpus amplifolius;* *Elaeocarpus miegei;* *Dysoxylum alatum;* *Palaquium warburgianum*						Medium/Minimal	Negligible
High sensitivity species SH and MPH (and DSP in some cases) *Anisoptera thurifera*; *Diospyros lolinopsis*; *Endospermum medullosum*; *Barringtonia* sp. 3; *Pterocymbium beccarii*; *Syzygium* sp. 2; *Ixora* sp. 3;						High/Minimal	Minor
Medium sensitivity species SH and MPH (and DSP and SC in some cases)						Medium/Minimal	Negligible

Key Sensitivity	Main Activity	Potential Impact	Location of Activity	Project Phase	Mitigation and Management*	Residual Assessment	
						Sensitivity/ Magnitude	Significance
Codiaeum tenerifolium; *Barringtonia* sp. 2; *Syzygium* sp. 4; *Eumachia purariensis*; *Ixora* sp. 1; *Ixora* sp. 4; *Ixora* sp. 5; *Maschalodesme* sp. 4; *Etlingera* sp. 2; *Etlingera* sp. 5							
Very High sensitivity species not recorded during Project surveys *Myristica brachypoda*						Very High/Minimal	Minor
High sensitivity species not recorded during Project surveys *Marsdenia venusta; Koompassia grandiflora; Gmelina sessilis*; *Endiandra cyphellophora*; *Endiandra latifolia*						High/Minimal	Minor
Medium sensitivity species not recorded during Project surveys *Goniothalamus aruensis*; *Cryptocarya massoy*						Medium/Minimal	Negligible
Forest Species: Disturbance Tolerant Hill Forest (and Alluvial and/or Swamp Forest in Some Cases) Plants							
High sensitivity species SH (and MPH/DSP in most	Vegetation clearing for construction of	Loss of individuals and habitat;	PRL-15 and/or	C, O, D	See above	High/Minimal	Minor

Key Sensitivity	Main Activity	Potential Impact	Location of Activity	Project Phase	Mitigation and Management*	Residual Assessment	
						Sensitivity/ Magnitude	Significance
cases) *Archidendron forbesii*; *Ficus* sp. 1	facilities/ infrastructure; operation and decommissioning activities.	degradation of remaining habitat; weed infestation; fire; reduction in population viability	proposed export pipeline route				
Medium sensitivity species SH and MPH (and DSP in some cases) *Miliusa* sp. 1; *Intsia bijuga*; *Adinandra forbesii*; *Bridelia macrocarpa*; Bamboo sp. 1; *Helicia latifolia*						Medium/Minimal	Negligible
Forest Species: Primary Alluvial and Swamp Forest Plants							
High sensitivity species *Pseuduvaria* sp. 1 *Oberonia* sp. 1	Vegetation clearing for construction of facilities/ infrastructure; operation and decommissioning activities.	Loss of individuals and habitat; degradation of remaining habitat; weed infestation; fire; reduction in population viability	PRL-15 and/or proposed export pipeline route	C, O, D	See above	High/Low	Moderate
Very High sensitivity species not recorded during Project surveys *Psychotria heterophylla*						Very High/Minimal	Minor
High sensitivity species not recorded during Project surveys *Calophyllum suberosum*; *Eleutherostylis renistipulata*; *Pandanus rex*; *Ixora whitei*						High/Minimal	Minor
Forest Species: Plants – Mangrove (and/or Freshwater) Swamp Forest							

Key Sensitivity	Main Activity	Potential Impact	Location of Activity	Project Phase	Mitigation and Management*	Residual Assessment	
						Sensitivity/ Magnitude	Significance
Bulbophyllum sp. 2	Transfer of equipment and personnel by boat; forest resource use	Loss of individuals; contamination of wetland habitat; habitat degradation	River transport corridor; coastal shorefront	C, O, D	See above	High/Minimal	Minor
High sensitivity species not recorded during Project surveys *Avicennia rumphiana*; *Glochidion delticola*						High/Minimal	Minor
Medium sensitivity species not recorded during Project surveys *Sonneratia ovata*						Medium/Minimal	Negligible
New-to-science and Other Very Rare Plants with One of Few Known Populations in or Near the Project Footprint							
Begonia sp. 14	Vegetation clearing for construction/upgrade of facilities/ infrastructure; dumping of spoil; operation and decommissioning activities;	Loss of only known individual; degradation of remaining habitat; weed infestation; fire; threat to population viability	Gas field (Road R07)	C, O, D	• EM001 • EM013 • EM018 • EM024 • EM025 • EM026 • EM027 • EM028 • EM032† • EM041	Very High/Medium	Major
Phaleria sp. 1			Export pipeline route			High/Medium	Moderate
Pandanus pendulinus		One of only two known sites already partly developed with some habitat lost; possible loss of additional individuals; degradation of remaining habitat; weed infestation; fire; threat to population viability	Road R05/trunkline			High/Medium	Moderate

Key Sensitivity	Main Activity	Potential Impact	Location of Activity	Project Phase	Mitigation and Management*	Residual Assessment	
						Sensitivity/ Magnitude	Significance
Begonia sp. 5		Loss of most of <5 known sites/populations (via vegetation clearance, edge effects, loss or contamination of watercourses and associated riparian habitat, or erosion/sedimentation of stream-side habitat); degradation of remaining habitat; weed infestation; fire; threat to population viability	CPF P3 site, Road R05/trunkline			Very High/Low	Moderate
Etlingera sp. 6						High/Low	Moderate
Orania longistaminodia		Loss of individuals from single known regional population (one of only three known globally); degradation of remaining habitat; weed infestation; fire; reduction in population viability				Very High/Low	Moderate
Begonia sp. 2; *Begonia* sp. 11; *Syzygium* sp. 1		Loss of one or more of few known individuals/populatio	Gas field, Road R05, Road R07			High/Low	Moderate

Key Sensitivity	Main Activity	Potential Impact	Location of Activity	Project Phase	Mitigation and Management*	Residual Assessment	
						Sensitivity/ Magnitude	Significance
Discocalyx sp. 1		ns; degradation of remaining habitat; weed infestation; fire; reduction in population viability	Road R05, Road R07, export pipeline route			Medium/Low	Minor
Medinilla sp. 2		Loss/degradation of suitable habitat near the only known site (600 m from the CPF P3 site and associated infrastructure)	CPF P3 site			High/Low	Moderate
Pseuduvaria sp. 2		Loss of one or more of few known individuals/populatio ns; degradation of remaining habitat; weed infestation; fire; reduction in population viability	Export pipeline route			High/Low	Moderate
Mammea sp. 1			Road R05. export pipeline route			High/Low	Moderate
Lasianthus sp. 1			Gas field (Road R07), CPF–Herd Base area			High/Minimal	Minor
Forest Species: Fauna - Hill Forest (and Alluvial and/or Swamp Forest in Some Cases)							
Birdwing butterflies MPH only: goliath birdwing (*Ornithoptera goliath*);	Vegetation clearing for construction of facilities/ infrastructure;	Loss of habitat; loss of specialist feeding	PRL-15	C, O, D	• EM001 • EM002 • EM023	Medium/Low	Minor

Key Sensitivity	Main Activity	Potential Impact	Location of Activity	Project Phase	Mitigation and Management*	Residual Assessment	
						Sensitivity/ Magnitude	Significance
paradise birdwing (*O. paradisea*)	operation and decommissioning activities.	plants; invasive alien species; fire			• EM024 • EM027 • EM028 • EM041		
Birdwing butterflies all ecological zones other than Mv: Southern tailed birdwing (*Ornothoptera meridionalis*)			All Project areas except mangroves and coastal			Medium/Minimal	Negligible
Tree hollow/cave roosting bats (all ecological zones): Papuan free-tailed bat (*Otomops papuensis*); Papuan sheath-tailed bat (*Saccolaimus mixtus*)	Vegetation clearing for construction of facilities/ infrastructure; operation and decommissioning activities; quarrying; hunting	Loss of individuals and/or breeding/roosting sites; fire; loss of foraging habitat; reduction in population viability	PRL-15, proposed export pipeline route		• EM001 • EM002 • EM027 • EM028 • EM031 • EM046 • EM047 • SM028 • SM029 • SM030	Medium/Minimal	Negligible
Medium sensitivity mammal species MPH only (and DSP rim in some cases): New Guinea quoll (*Dasyurus albopunctatus*); Woolley's three-striped dasyure (*Myoictis leucura*)	Vegetation clearing for construction of facilities/ infrastructure; operation and decommissioning activities; hunting	Loss of individuals and habitat; degradation of remaining habitat; weed infestation; fire; reduction in population viability	PRL-15		• EM001 • EM002 • EM009 • EM027 • EM028 • EM031 • EM033 • EM034	Medium/Low	Minor
Medium sensitivity bird species MPH and SH (and			PRL-15 and proposed			Medium/Minimal	Negligible

Key Sensitivity	Main Activity	Potential Impact	Location of Activity	Project Phase	Mitigation and Management*	Residual Assessment	
						Sensitivity/ Magnitude	Significance
DSP rim in several cases): Gurney's eagle (*Aquila gurneyi*); Blyth's hornbill (*Rhyticeros plicatus*); palm cockatoo (*Probosciger aterrimus*); glossy-mantled manucode (*Manucodia ater*); crinkle-collared manucode (*M. chalybatus*); trumpet manucode (*Phonygammus keraudrenii*); magnificent riflebird (*Ptiloris magnificus*); magnificent bird-of-paradise (*Diphyllodes magnificus*); king bird-of-paradise (*Cicinnurus regius*); Raggiana bird-of-paradise (*Paradisaea raggiana*)			export pipeline route		• EM035 • EM046 • EM047 • SM028 • SM029 • SM030		
Medium sensitivity reptiles MPH only: *Sphenomorphus brunneus*			PRL-15			Medium/Low	Minor
Medium sensitivity reptiles MPH and SH: *Gehyra* sp. 1; *Nactus papuana*			PRL-15, proposed export pipeline route			Medium/Minimal	Negligible

Key Sensitivity	Main Activity	Potential Impact	Location of Activity	Project Phase	Mitigation and Management*	Residual Assessment	
						Sensitivity/ Magnitude	Significance
Medium sensitivity microhylid frogs MPH only: *Austrochaperina* sp. 2; *Choerophryne crucifer*			PRL-15			Medium/Low	Minor
Medium sensitivity microhylid frogs MPH and SH (and DSP and other zones in some cases): *Callulops marmoratus*; *Cophixalus hannahae*; *Copiula mosbyae*; *Oreophryne* sp. 1;			PRL-15 and proposed export pipeline route			Medium/Minimal	Negligible
Forest Species: Fauna - Alluvial and/or Foothill Forest							
High sensitivity species DSP and limited MPH and/or SH: *Stegonotus aplini*	Vegetation clearing for construction of facilities/ infrastructure; operation and decommissioning activities; hunting	Loss of individuals and habitat; degradation of remaining habitat; weed infestation; fire; reduction in population viability	PRL-15 and proposed export pipeline route	C, O, D	See above	High/Low	Moderate
Medium sensitivity species DSP and limited MPH and/or SH: starry owlet-nightjar (*Aegotheles tatei*)						Medium/Low	Minor
Forest Species: Fauna Dependent on Forest Streams, Forest Pools and/or Adjacent Riparian Habitats							
High sensitivity species: *Cophixalus* sp. 3; *Oreophryne* sp. 2; *Argiolestes tuberculiferus*; *Pyrrhargiolestes angulatus*; *Teinobasis caelestis*;	Vegetation clearing for construction of facilities/ infrastructure; operation and	Loss of individuals/populations (via vegetation clearance, edge effects, loss or contamination of	PRL-15 and/or proposed export	C, O, D	• EM001 • EM002 • EM004 • EM009	High/Low	Moderate

Key Sensitivity	Main Activity	Potential Impact	Location of Activity	Project Phase	Mitigation and Management*	Residual Assessment	
						Sensitivity/ Magnitude	Significance
Teinobasis fragillima; *Nososticta purari*; *Rhyacocnemis gassmanni*; *Palaeosynthemis papilio*	decommissioning activities.	watercourses and associated riparian habitat, or erosion/sedimentation of stream-side habitat); degradation of remaining habitat; weed infestation; fire; reduction in population viability	pipeline route		• EM018 • EM023 • EM027 • EM028 • EM031 • EM033 • EM034 • EM035 • EM046 • EM047		
Medium sensitivity species: forest bittern (*Zonerodius heliosylus*); *Litoria exophthalmia*; *Litoria sauroni*; *Litoria* sp. 1; *Papurana arfaki*; *Papurana* sp. 2; *Metagrion trigonale*; *Teinobasis aurantiaca*; *Teinobasis debeauxi*; *Bironides ypsilon*; *Diplacina cyrene*; *Idiocnemis milou*; *Idiocnemis patriciae*; *Nososticta boonei*; *Nososticta paraconifera*; *Nososticta smilodon*; *Nososticta truncata*; *Drepanosticta taurulus*						Medium/Low	Minor
Odonates present in open and disturbed habitats: *Agyrtacantha* sp. 1; *Papuagrion forceps*						Medium/Minimal	Negligible
Forest Species: Fauna - Mangrove, Freshwater Swamp Forest and/or Alluvial Forest							

Key Sensitivity	Main Activity	Potential Impact	Location of Activity	Project Phase	Mitigation and Management*	Residual Assessment	
						Sensitivity/ Magnitude	Significance
High sensitivity species: false water rat (*Xeromys myoides*) (id. uncertain)	Vegetation clearing for construction of facilities/ infrastructure; transfer of equipment and personnel by boat; other operation and decommissioning activities; forest resource use	Loss of individuals/habitat; contamination of wetland forest habitat; habitat degradation	All Project areas	C, O, D	See above	High/Minimal	Minor
Medium sensitivity species: blue-black kingfisher (*Todirhamphus nigrocyaneus*); twelve-wired bird-of-paradise (*Seleucidis melanoleucus*)						Medium/Minimal	Negligible
Hunting-sensitive Fauna							
High sensitivity species: lowland tree kangaroo (*Dendrolagus spadix*); Scheepmaker's crowned pigeon (*Goura scheepmakeri*)	Hunting (indirect impacts); vegetation clearing for construction of facilities/ infrastructure; operation and decommissioning activities	Loss of individuals and habitat; degradation of remaining habitat; weed infestation; fire; reduction in population viability	PRL-15 and/or proposed export pipeline route	C, O, D	• EM002 • EM004 • EM009 • EM024 • EM027 • EM028 • EM031 • EM033 • EM034 • EM035 • EM046 • EM047 • SM028 • SM029 • SM030	High/Low	Moderate
Medium sensitivity species: southern cassowary (*Casuarius casuarius*)						Medium/Low	Minor
grey dorcopsis (*Dorcopsis luctuosa*); Papuan eagle (*Harpyopsis novaeguineae*); Pesquet's parrot (*Psittrichas fulgidus*)						High/Minimal	Minor

Key Sensitivity	Main Activity	Potential Impact	Location of Activity	Project Phase	Mitigation and Management*	Residual Assessment	
						Sensitivity/ Magnitude	Significance
IUCN Threatened freshwater turtles: pig-nosed turtle (*Carettochelys insculpta*); striped New Guinea soft-shelled turtle (*Pelochelys bibroni*)	In-migration; hunting and harvesting of eggs by local population and/or Project workforce; dredging (especially at logistics base); transfer of equipment and personnel by boat	Adult population reduction; nest failure; damage to/loss of river bank nest sites (especially Oyomo Creek mouth); loss of population viability	PRL-15; river transport corridor		• EM001 • EM004 • EM013 • EM014 • EM022 • EM024 • EM027 • EM028 • EM031 • SM028 • SM029 • SM030 • EM049 • EM050	High/Medium	Moderate
Hall's New Guinea crocodile (*Crocodylus halli*); estuarine crocodile (*C. porosus*)	Hunting and harvesting of eggs by local population and/or Project workforce; transfer of equipment and personnel by boat	Adult population reduction; nest failure; damage to/loss of nest sites; weed infestation			• EM014 • EM022 • EM023 • EM024 • EM027 • EM028	Medium/Low	Minor
Migratory/congregatory Shorebirds							
High sensitivity species: far eastern curlew (*Numenius madagascariensis*);	Dredging near the coast; transfer of equipment and	Loss of individuals; disturbance to feeding or roosting congregations	River transport corridor;	C, O, D	• EM019 • EM027 • EM028	High/Minimal	Minor

Key Sensitivity	Main Activity	Potential Impact	Location of Activity	Project Phase	Mitigation and Management*	Residual Assessment	
						Sensitivity/ Magnitude	Significance
great knot (*Calidris tenuirostris*)	personnel by boat; hunting	impacting on energy reserves required for migration	coastal shorefront		• EM046 • EM047		
Medium sensitivity species: Asian dowitcher (*Limnodromus semipalmatus*); black-tailed godwit (*Limosa limosa*); bar-tailed godwit (*L. lapponica*); grey-tailed tattler (*Tringa brevipes*); red knot (*Calidris canutus*); red-necked stint (*C. ruficollis*); curlew sandpiper (*C. ferruginea*)						Medium/Minimal	Negligible
Resident marine coastal birds							
Eastern osprey (*Pandion cristatus*); beach stone-curlew (*Esacus magnirostris*)	Transfer of equipment and personnel by boat; hunting	Loss of individuals; disturbance at breeding sites	River transport corridor; coastal shorefront	C, O, D	See above	Medium/Minimal	Negligible
Freshwater Wetland Birds							
Great egret (*Ardea alba*); intermediate egret (*Egretta intermedia*); little egret (*E. garzetta*)	Transfer of equipment and personnel by boat; construction, operation and decommissioning of	Disturbance at feeding/roosting sites; contamination of watercourses and associated riparian habitat	River transport corridor; coastal shorefront; PRL-15	C, O, D	See above	Medium/Minimal	Negligible

Key Sensitivity	Main Activity	Potential Impact	Location of Activity	Project Phase	Mitigation and Management*	Residual Assessment	
						Sensitivity/ Magnitude	Significance
	facilities and infrastructure; hunting						

*Mitigation measure identifier, described in Chapter 20 of the 2019 Upstream EIS and Chapter 17 of this addendum.
† More specific mitigation measures at the species level are provided in PCS reports.
Ecological zone abbreviations are as follows: Middle Purari Hills (MPH), Delta Swamps and Plains (DSP), Southeast Hills (SH), Southeast Coast (SC) and Mangroves (Mv).

10.8 References

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11. Impacts: Social

11.1 Overview

A number of revisions are required to the assessment of impacts on the social environment in the 2019 Upstream EIS (ERIAS, 2019) to consider the changes to the Project described in Chapter 4 of this addendum, which have occurred since submission of the 2019 Upstream EIS.

Table 11.1 identifies the sections of the social impact assessment that require a revision. Impact assessments in this addendum are undertaken using the assessment methods described in the 2019 Upstream EIS. Information that has not changed has not been reproduced and can be found in the 2019 Upstream EIS (noting the expansion of the social receptors to include Pokore Hamlet, see Section 11.3.1).

Mitigation measures considered in the assessments are as described in the 2019 Upstream EIS, only new mitigation and management measures will be discussed. Specific management measures are identified by the unique identification codes provided in summary assessment tables included in the following sections.

Table 11.1 – Summary of Existing Environment Social Revisions

2019 Upstream EIS Chapter Number	Upstream EIS Heading	Reasons Revisions Required in EIS Addendum
13.2	Social Impact Assessment Method	No change required
13.3	Economic Displacement and Livelihoods	Relocation of CPF from site P2C to P3
13.4	Economic Development and Employment	No change required
13.5	Education and Workforce Training	No change required
13.6	Community Health and Safety	Relocation of CPF from site P2C to P3
13.7	Governance and Leadership	No change required
13.8	Law and Order	No change required
13.9	Transport and Access	Relocation of CPF from site P2C to P3
13.10	References	References provided in Section 11.4

11.2 Pokore Hamlet Resettlement

Since completion of the 2019 Upstream EIS, a new settlement referred to as ‘Pokore Hamlet’ has been established within PRL-15 on the south bank of the Purari River opposite Herd Base and approximately 0.7 km southeast of the CPF P3 location (see Section 8.2). The people from Pokore Hamlet depend on natural resources for survival and wellbeing; hence, their environmental setting significantly influences their day-to-day activities, as described in the 2019 Upstream EIS.

Amenity impacts have been assessed and are discussed in Chapter 13. The impact assessment concludes that there will be noise exceedances at Pokore Hamlet at times during construction and operations, but especially at nighttime. Further, visual amenity will be impacted during construction and operation of the CPF P3 site due to direct views across the Purari River resulting in a major visual residual impact significance. Therefore, for the purpose of this EIS addendum, the assessment considers resettling Pokore Hamlet [SM031]. However, resettlement is not TEP PNG's preference. Therefore, TEP PNG will continue to investigate mitigation and management measures (including embedded designs controls) that can be applied to reduce impacts to Pokore Hamlet and avoid resettlement.

If required, resettlement of Pokore Hamlet would be undertaken according to TEP PNG's Resettlement Action Plan (RAP) (to be developed). Key components of the RAP would be:

- Identification of project impacts and affected populations.
- A legal framework for land acquisition and compensation.
- A compensation framework.
- A description of resettlement assistance and restoration of livelihood activities. This will involve:
  - Site selection and preparation.
  - Influx management.
  - Relocation schedule and assistance.
  - Replacement of services and enterprises.
  - Restoration of livelihood.
  - Treatment of cultural property.
  - Special assistance for women and vulnerable groups.
- A detailed budget.
- An implementation schedule.
- A description of organizational responsibilities.
- A framework for public consultation, participation, and development planning.
- A description of provisions for redress of grievances.
- A framework for monitoring, evaluation, and reporting.

Effective community engagement will be integral to the process and will include disclosure of relevant information on matters that directly affect them. Engagement and decision-making processes related to resettlement and livelihood restoration will include options and alternatives, where applicable. Engagement and participation of the Pokore Hamlet community through development of further mitigation and management measures, and if required, resettlement and

livelihood restoration planning activities will underpin the process that should result in living conditions that are equivalent to, or better than, existing conditions.

Given that a relocation site has not yet been identified for Pokore Hamlet, it is not possible to assess social impacts associated with the new location of the community. This will be the subject of a separate assessment at a later date [SM031].

11.3 Revisions to 2019 Upstream EIS Social

11.3.1 Social Receptors

Table 13.4 in Section 13.2.2.3 of the 2019 Upstream EIS defines the social receptors in and around PRL-15. Changes to the description of the receptors has been revised, where relevant, to include Pokore Hamlet (Table 11.2).

Table 11.2 – Revised Social Receptors

Receptor	Description
In and around PRL-15	
Project-affected communities	Communities and settlements in PRL-15 that could be directly affected by Project activities: Poroi 1, Purari Airstrip House and Pokore Hamlet.
River Transport Corridor	
Project-affected communities	Communities along the Purari and Urika-Ivo rivers (the primary and secondary transport corridors) that could be directly affected by Project river transport activities, including: Apiope, Aumu, Aivai, Evara, Kaevaria along the Purari River; and Mapaio, Kairu'u, Akoma, Ikinu, along the Urika-Ivo River. Ne'ea Creek (formerly Mapaio Fish Camp) settlement, Poroi 1 and Pokore Hamlet are common to both distributaries on the river transport corridor.

11.3.2 2019 Upstream EIS Section 13.3 Economic Displacement and Livelihoods

Project-related land access and restrictions on land use, the use of communal property or access to natural resources can adversely impact communities and persons that use this land or communal property. Involuntary resettlement refers both to physical displacement (e.g., relocation or loss of shelter) and to economic displacement, i.e., loss of assets or access to assets that leads to loss of income sources or other means of livelihood due to project-related land access and/or restrictions on land use (IFC, 2012).

11.3.2.1 Identification and Initial Assessment of Potential Impacts

The following impacts to economic displacement and livelihoods required reassessment considering the change in CPF location:

- Reduced livelihood of Project-affected persons living in and around PRL-15 due to land access.
- Reduced livelihood of Project-affected persons due to loss of Income from forest logging resources.

- Reduced access for Project-affected communities along the river transport corridor.

Reduced Livelihood of Project-affected Persons Living in and Around PRL-15 due to Land Access

There is a reduction of 102 ha in the Project direct disturbance since the 2019 Upstream EIS was prepared (see Section 4.4.11). Of this, the land required for the CPF has reduced from 100 ha to 60 ha, noting that final land requirements and potential exclusion zones will be further refined during the front-end engineering design (FEED) and as detailed design progresses. The P3 site will be situated on state leased land and the security and community safety buffer is expected to extend beyond the Project footprint and extend into the Purari River. These areas cannot be used by the community.

Like the previously proposed site P2C location for the CPF, site P3 is located in the largely unpopulated PRL-15. Project-affected persons use the land for subsistence, hunting and collecting resources, as they are dependent on these resources for their subsistence-based livelihoods.

The loss of natural resources (e.g., timber and wood products, wild and medicinal plants) due to land access is largely replaceable for Project-affected persons living in and around PRL-15 and the sensitivity was categorized to be ***Medium*** in the 2019 Upstream EIS. This sensitivity ranking also applies to the CPF P3 site. As described in Section 13.3.2.1 of the 2019 Upstream EIS, Project-affected persons living in and around PRL-15 are considered to have some resilience to change having already had exposure to land access impacts, thus a ***Medium*** impact magnitude rating is applied to land access for these communities. The initial social impact significance is therefore assessed, and remains, as ***Moderate***.

While the CPF P3 site does not directly impact residents from Pokore Hamlet accessing land surrounding the hamlet, there are times during the day when noise exceedances are predicted and this may deter residents from accessing land in these areas or require them to travel further distances to access resources. During operations, this 1 dBA exceedance is only under enhanced propagation and would not be considered perceptible. Day time noise exceedances during abnormal conditions, i.e., flaring, are also predicted a couple of times a year (for up to 24 hrs) under neutral and enhanced propagation. It is unlikely that these noise exceedances will deter residents from accessing the land to collect resources, but in the event they do, given the frequency and duration of these noise events, a ***Low*** impact magnitude rating is applied to land access for Pokore Hamlet. The initial social impact significance is therefore assessed as ***Minor***.

Reduced Livelihood of Project-affected Persons due to Loss of Income from Forest Logging Resources

Most of the land in commercial logging concession Vailala Block 3 to the south of the Purari River has already been logged. PRL-15 is in commercial logging concession Baimuru Block 3 (see Figure 7.4). Construction-related clearing associated with the CPF P3 site will reduce the loss of potentially commercial production forest in PRL-15 by 40 ha compared with the CPF P2C site. Chapter 16 of the 2019 Upstream EIS (ERIAS, 2019) assesses the potential loss of commercial forestry resources in terms of ecosystem services for commercial asset owners and royalty payments to landowners; therefore, these impacts are not assessed further in this section.

Reduced Access for Project-affected Communities along the River Transport Corridor

Rivers are the main transport routes for communities to access schools, hospitals, markets, food gardens, sago processing sites and fishing areas. Section 13.3.2.4 of the 2019 Upstream EIS stated that the predicted increase in barge traffic associated with Project construction activities is unlikely to restrict access and community use of the primary and secondary river transport corridors, respectively Purari River and Uriko-Ivo River. Exclusion zones near the construction offloading facility (COF)/module offloading facility (MOF) and ramp, and the existing Herd Base, will constrain river traffic to a narrower section of the Purari River near Pokore Hamlet; however, continuous river access along the river transport corridor will still be possible.

Section 11.3.3 discusses the potential impacts associated with transport and access, specifically for Pokore Hamlet, to the Purari River; therefore, transport route impacts are not assessed further in this section.

11.3.2.2 Proposed Mitigation, Management and Optimization Measures

Chapter 13, Section 13.3.3, of the 2019 Upstream EIS (ERIAS, 2019) describes proposed mitigation, management and optimization measures that will be implemented. The assessment further considers the resettlement of Pokore Hamlet (see Section 11.2).

11.3.2.3 Residual Impact Assessment

Reduced Livelihood of Project-affected Persons Living in and Around PRL-15 due to Land Access

Based on the implementation of mitigation and management measures, the magnitude of impact and residual significance ratings are the same as previously described in the 2019 Upstream EIS for Project-affected persons that use the land for subsistence, hunting and collecting resources, i.e., a reduction of the impact magnitude to ***Low*** resulting in the residual significance of impact to ***Minor***.

Eligible groups will be compensated in cash (at full replacement cost) and/or in-kind compensation and will participate in livelihood development programs for loss of access to natural resources. In addition, the selected location for the resettlement of Pokore Hamlet will consider the community's existing need to access the land for subsistence resources. Thus, a ***Negligible*** residual impact magnitude is attributed to a reduction in livelihood as a result of land access. As outlined in Section 11.3.2.1, potential loss of livelihood from land access is attributed ***Medium*** sensitivity Project-affected persons. Based on these ratings, the impact significance to livelihoods of Pokore Hamlet is reduced from ***Minor*** for the initial assessment to ***Negligible*** for the residual assessment.

11.3.2.5 Summary of Residual Economic Displacement and Livelihoods Impacts

A summary of the assessment of residual impacts to economic displacement and livelihoods is provided in Table 11.3.

11.3.3 2019 Upstream EIS Section 13.8 Transport and Access

Due to the lack of transportation and communication infrastructure in the PRL-15 Project area most people living along the Purari River rely predominantly on river transport by use of dugout

canoes, motorized dugout canoes or dinghies. As there are no public roads the Project will not impact public road traffic. However, increased river traffic and restrictions to river access can adversely impact Project-affected communities and people.

11.3.3.1 Identification and Initial Assessment of Potential Impacts

The following impacts to transport and access required reassessment considering the change in CPF location:

- Short-term disturbance of access to community services or natural resources.
- Loss or damage of assets due to increased river traffic.

Short-term Disturbance of Access to Community Services or Natural Resources

The main river transport route for Project logistics and transport is expected to be the Purari River. Herd Base and the COF/MOF and ramp at the CPF P3 site will be central to Project logistics resulting in a concentration of both Project, and community, river traffic at this location. The river is the only form of transport to and from services and resources for local communities and is central to maintaining livelihoods to communities along the river transport corridor.

The sensitivity of river transport corridor Project-affected communities to a disturbance of access due to an increase in barge traffic, particularly during the construction period, was categorized as ***High*** in the 2019 Upstream EIS, and this sensitivity rating remains unchanged.

As described in Section 13.9.2.1 of the 2019 Upstream EIS, the majority of the river traffic will occur during the construction period (approximately five years), with fewer barges using the river during the operations phase. Use of the Purari River, as the main river transport corridor, for barge traffic will be daily over this five-year timeframe. However, given the length of the river, at any given point in time, during the day it is estimated that there will be no more than 1 barge every 50 km, and at any point on the river the disturbance to Project-affected and local communities associated with a barge will last only a few minutes. Thus, a magnitude rating of ***Low*** is assigned. This results in an initial social impact significance of ***Minor.***

Unlike other sections of the Purari River, access to the river near Herd Base and the COF/MOF and ramp will be constrained by exclusion zones (safety buffers) which will concentrate non-Project river traffic close to Pokore Hamlet on the opposite bank of the river. This may make river access and travel for Pokore Hamlet difficult resulting in travel delays. As exclusion zones are expected to be in place throughout operations, a ***High*** magnitude ranking is applied, even though the impact is localized. This results in an initial social impact significance of ***Major.***

Table 11.3 – Summary of Assessment for Residual Impact Significance for Economic Displacement and Livelihoods

Activity	Potential Impact	Direct/ Indirect/ Induced	Location of Impact/ Receptor	Project Phase	Mitigation and Management*	Residual Assessment	
						Sensitivity/ Magnitude	Significance
Land access	Reduction of livelihood of Project-affected persons living in and around PRL-15 due to land access	Direct	Project-affected persons, living in and around PRL-15	C, O	• EM001 • SM001 • SM002 • SEM003	Medium/Low	Minor
	Reduction of livelihood of Pokore Hamlet due to land access	Indirect	Project-affected persons, living at Pokore Hamlet	C, O	• SM001 • SM002 • SEM003 • SM031	Medium/Negligible	Negligible

C = Construction, O = Operations.
*Mitigation measure identifier, described in Chapter 20 of the 2019 Upstream EIS and Chapter 17 of this addendum.

Loss or Damage of Assets due to Increased River Traffic

The 2019 Upstream EIS (ERIAS, 2019) describes how the villages along the Purari River often store their personal belongings close to or along the riverbanks, making them susceptible to disturbance by waves caused by large vessels. Village leaders from communities along the Purari River identified that waves from the barges currently using the Purari River for exploration and logging activities caused loss or damage to canoes through capsizing them or breaking their moorings, and loss of cooking and eating utensils that may have been left on the riverbank to dry. Assets, such as canoes, are highly valued and central to livelihood maintenance for most people in the PRL-15 Project area; therefore, loss or damage of these assets or the cooking utensils or tools stored in them can be significant for the individuals involved. This is especially the case for vulnerable groups and individuals such as families with no or poor food security and households that do not receive any income.

The assessment of impact for Project-affected and local communities remains the same as in the 2019 Upstream EIS, i.e., a sensitivity rating of ***Medium*** and an initial magnitude rating of ***Medium*** is assigned, as loss or damage caused by Project barges would be localized, temporary and largely reversible. This results in an initial social impact significance of ***Moderate***.

Pokore Hamlet does not have a beach and the banks are quite steep. River access is therefore not easy, and does depend on river levels. The CPF P3 site, and associated COF/MOF and ramp infrastructure, is located close to Pokore Hamlet. Together with Herd Base, this area will be a 'hub' where barge movements will be concentrated. Vessel wake from the barges, combined with any wake from community and other commercial barges (e.g., logging) that will be constrained to the section of the river closest to Pokore Hamlet, may cause canoes to break their moorings, or damage canoes and other equipment that may be left on the riverbank. Further, combined vessel wake from all river users in a constrained area may cause canoes to capsize. As for other Project-affected and local communities, a ***Medium*** sensitivity is assigned as these Pokore Hamlet has some level of exposure to barge movements and the impacts associated with wash. An initial magnitude rating of ***High*** is applied to loss or damage of assets as while Project barge wake impacts will be less frequent during operations, the exclusion zones will remain, resulting in non-Project river traffic traveling closer to Pokore Hamlet. The initial social impact significance is therefore assessed as ***Moderate***.

11.3.3.2 Proposed Mitigation, Management and Optimization Measures

Chapter 13, Section 13.9.3, of the 2019 Upstream EIS (ERIAS, 2019) describes proposed mitigation, management and optimization measures that will be implemented. The assessment further considers the resettlement of Pokore Hamlet (see Section 11.2).

11.3.3.3 Residual Impact Assessment

Short-term Disturbance of Access to Community Services or Natural Resources

Based on the implementation of mitigation and management measures, the magnitude of impact and residual significance ratings are the same as previously described in the 2019 Upstream EIS for Project-affected and local communities that use the river system as their main source of transport, i.e., a reduction of the impact magnitude to ***Negligible*** resulting in the residual

significance of impact of ***Negligible***. This also applies to Pokore Hamlet as they will be resettled and no longer residing opposite Herd Base and the CPF P3 site.

Loss or Damage of Assets due to Increased River Traffic

Based on the implementation of mitigation and management measures, the magnitude of impact and residual significance ratings are the same as previously described in the 2019 Upstream EIS for Project-affected and local communities that the reside close to and utilize the river transport system as their main source of transport, i.e., a reduction of the impact magnitude to ***Low*** resulting in the residual significance of impact of ***Minor***. This also applies to Pokore Hamlet as they will be resettled and no longer residing opposite Herd Base and the CPF P3 site.

11.3.3.4 Summary of Residual Transport and Access Impacts

A summary of the assessment of residual impacts to transport and access impacts is provided in Table 11.4.

11.4 References

ERIAS. 2019. Papua LNG Project Upstream Environmental Impact Statement. 01215B_23_v5. December. Unpublished report to Total E&P PNG Limited.

Table 11.4 – Summary of Assessment for Residual Impact Significance for Transport and Access

Activity	Potential Impact	Direct/ Indirect/ Induced	Location of Impact/ Receptor	Project Phase	Mitigation and Management*	Residual Assessment	
						Sensitivity/ Magnitude	Significance
Logistics and transport (barging along the Purari River)	Short-term disturbance of access to community services, and natural resources	Direct	Project-affected and local communities along the main river transport corridor	C, O, D	• SM027 • SM001 • SM002 • SEM002 • SEM003	High/ Negligible	Negligible
			Pokore Hamlet	C, O, D	• SM027 • SM001 • SM002 • SEM002 • SEM003 • SM031	High/ Negligible	Negligible
	Loss or damage to assets as a result of increased river traffic	Direct	Project affected communities along the main river transport corridor	C, O, D	• SM027	Medium/Low	Minor
			Pokore Hamlet	C, O, D	• SM027 • SM031	Medium/Low	Minor

C = Construction, O = Operations, D = Decommissioning and closure.
*Mitigation measure identifier, described in in Chapter 20 of the 2019 Upstream EIS and Chapter 17 of this addendum.

12. Impacts: Cultural

12.1 Overview

A number of revisions are required to the assessment of impacts on cultural heritage in the 2019 Upstream EIS (ERIAS, 2019) to consider the changes to the Project described in Chapter 4 of this addendum and cultural heritage site data collected during pre-clearance surveys (PCS), which have both occurred since submission of the 2019 Upstream EIS.

Table 12.1 identifies the sections of the cultural heritage impact assessment that require a revision. Impact assessments in this addendum are undertaken using methods described in the 2019 Upstream EIS. Note preliminary sensitivities have been assigned to three sites and the significance of impacts assessed using these preliminary sensitivities, which may change pending consultation with relevant communities and NMAG.

Mitigation measures considered in the assessments are as described in the 2019 Upstream EIS. Specific management measures are identified by the unique identification codes provided in summary assessment tables included in the following sections, with complete descriptions of these measures provided in Chapter 20 of the 2019 Upstream EIS. Mitigation measures include a Cultural Heritage and Chance Finds Procedure (TEP PNG, 2023a) in anticipation of potential impacts associated with ground altering work activities to prevent any damage and/or destruction of potentially unknown sensitive cultural heritage and archaeological sites and objects. The procedure describes the recommended actions, in the case of a chance find in the Project's footprint, with priority given to avoiding sites identified as highly sensitive and important.

Table 12.1 – Summary of Existing Cultural Heritage Revisions

2019 Upstream EIS Chapter Number	Upstream EIS Heading	Reasons Revisions Required in EIS Addendum
14.1	Context	Information on cultural heritage and archaeology from additional surveys undertaken for PCS
14.2	Cultural Heritage Impact Assessment Method	No change required
14.3	Identification and Initial Assessment of Potential Impacts	Information on cultural heritage and archaeology from additional surveys undertaken for PCS
14.4	Proposed Mitigation and Management Measures	No change required
14.5	Assessment of Residual Impacts	Information on cultural heritage and archaeology from additional surveys undertaken for PCS
14.6	Summary of Residual Cultural Heritage Impacts	Information on cultural heritage and archaeology from additional surveys undertaken for PCS
14.7	References	References provided in Section 12.6

12.2 2019 Upstream EIS Section 14.1 Context

Three tangible and four intangible cultural heritage sites have been formally recorded within, or near, the VCA associated with the CPF P3 site and associated infrastructure, e.g., approaching trunkline and export pipeline route. These include archaeological, ceremonial sites and one settlement site.

All sites identified in and close to the Project area of influence (PAOI) are considered part of the culturally connected landscape[1] and therefore, are a representative sample of site types that are present inside the PAOI in the absence of full archaeological surveys being undertaken at this time. However, a cultural heritage item, attribute or quality that is not in the direct Project footprint related to the substantial changes is not assessed in this cultural heritage impact assessment. Many other cultural heritage sites have been identified during the PCS program within PRL-15; only those sites identified in Chapter 8 are being assessed.

12.3 2019 Upstream EIS Section 14.3 Identification and Initial Assessment of Potential Impacts

The following potential impacts to tangible and intangible cultural heritage required reassessment considering the relocation of the CPF to site P3:

- Potential direct disturbance, loss or damage to cultural heritage sites.
- Potential indirect disturbance, loss or damage to cultural heritage sites.
- Potential changed traditional site use or access and therefore loss of ancestral knowledge related to identified and unidentified cultural heritage sites.

It is acknowledged that most tangible cultural heritage sites, except archaeological sites, have associated intangible elements as defined in Section 9.11 of the 2019 Upstream EIS, e.g., myths, legends and stories. Therefore, impacts (direct or indirect) to a physical site (tangible cultural heritage site) will likely have an impact on the intangible elements, e.g., a site can't be accessed to hold ceremonies and share stories.

PRL-15 has most likely always been sparsely populated; although, archaeological sites will not be entirely absent, as evidenced by the sites recorded around during the PCS program. The Project has developed a Cultural Heritage and Chance Finds Procedure (TEP PNG, 2023a) in anticipation of potential impacts associated with ground altering work activities and to prevent any damage and/or destruction of potentially sensitive cultural heritage and archaeological sites and objects. This procedure guides company, contractors' and sub-contractors' employees on how to address tangible cultural heritage properties prior to and during works. The procedure describes the recommended actions, in the case of a chance find in the Project's footprint, with priority given to avoiding sites identified as highly sensitive and important.

1 In the context of this cultural heritage impact assessment, a culturally connected landscape is characterised as a living landscape, changing as the culture, climate and natural surroundings change in and around it. The character of the cultural landscape thus reflects the values of the people who have shaped it, and who continue to live in it.

Sections 8.7.1 and 8.7.2 assign a significance for each site. Table 12.2 assigns a sensitivity rating considering the cultural heritage impact assessment sensitivity criteria defined in the EIS (ERIAS, 2019).

Table 12.2 – Sensitivity of Cultural Heritage Sites

Site Code	Site Category (Type)	Local Significance Rating*	Sensitivity	Location
Tangible				
PUR_059	Archaeological (surface or subsurface scatters)	High	High	Within the Road R03 VCA
CA_JP_006	Archaeological (isolated surface artefact)	High#	High#	Within the export pipeline route VCA
PUR_043	Archaeological (isolated surface artefact)	High	High	Within the export pipeline route VCA
Intangible				
PUR_SAB_005†	Settlement (lookout)	Low	Low	Within the CPF P3 site VCA
JP_007	Oral tradition (ceremonial site + spirit tree)	High#	High#	Within the export pipeline route VCA
PUR_SAB_003	Oral tradition (ceremonial site)	High	High	Within the trunkline VCA
JP_001	Oral tradition (ceremonial site + Initiation site)	High#	High#	Outside the trunkline VCA but within the survey buffer

Note: Grey shading indicates sites that have been salvaged/or shovel test pit excavated.
* Local significance ratings as defined in the TEP PNG Cultural Heritage Survey and Salvage Procedure (2023b).
The significance of this site requires confirmation following consultation with communities and NMAG site inspections.
† Further to 2019 EIS, and consistent with TEP Cultural Heritage and Salvage Procedure, a new category has been defined (i.e., settlement sites).

12.3.1 Initial Impact Assessment Tangible Cultural Heritage

Sites PUR_059 and PUR_043 have a ***High*** sensitivity as these cultural heritage values are highly valued by the Nemina clan. Both these sites are within the Project footprint, i.e., Road R03 and the export pipeline route, respectively, and will be directly impacted. If these sites can't be avoided, and there are no further mitigation or management measures in place, there will be disturbance to these sites and permanent and irreversible loss of access to these sites by the community, hence a ***High*** impact magnitude is applied, resulting in an initial impact significance of ***Major***.

Site CA_JP_006 has a preliminary sensitivity of ***High,*** which is to be confirmed with the Nemina clan, and is located within the export pipeline route footprint where it will be directly impacted by vegetation clearance and earthworks. If tactical realignment of the pipeline is not possible to avoid this site, and there are no further mitigation or management measures in place, the site will be disturbed and there will be permanent and irreversible loss of access to the site by the

community, hence a ***High*** impact magnitude is applied, resulting in an initial impact significance of ***Major***.

Currently unidentified, potential tangible cultural heritage values may be damaged by the Project; therefore, a ***Medium*** magnitude rating has been applied, as any damage to tangible cultural heritage would be an adverse change from baseline conditions. These potential unidentified sites could have national and international significance, but this is not known. Such sites or finds may be deemed non-replicable, and highly valued by the local communities, thus cultural heritage would be highly vulnerable to impacts, hence conservatively, a ***High*** sensitivity rating is applied. This results in an initial impact significance of ***Moderate.***

A number of tangible cultural heritage sites have been identified during the PCS program within PRL-15, but outside the Project footprint, and there is the potential for indirect disturbance, loss or damage to cultural heritage, e.g., loss of access, or interference with these sites. Given the distance to these sites from the footprint – i.e., more than 130 m – and that the sites remain accessible, indirect impact is considered unlikely and these sites are not assessed further.

Any unidentified archaeological sites potentially within Project footprint may be at risk of loss, disturbance or damage from construction earthworks and vegetation clearance leading to direct, indirect or induced impacts to Project-affected persons, communities and/or local communities.

12.3.2 Initial Impact Assessment Intangible Cultural Heritage

Site PUR_SAB_005 has a ***Low*** sensitivity given it has less value to the Nemina clan and is replicable. This site is within the CPF P3 site footprint, and will be directly impacted by construction and operations. If this site can't be avoided, and no further mitigation or management measures in place, there will be disturbance to the site and permanent and irreversible loss of access to this site by the community, hence a ***High*** impact magnitude is applied, resulting in an initial impact significance of ***Moderate***.

Site PUR_SAB_003 has a ***High*** sensitivity as these cultural heritage values are highly valued by the Nemina clan. This site is within the trunkline footprint as the pipeline approaches the CPF P3 site, and will be directly impacted by construction. If this site can't be avoided, and there are no further mitigation or management measures in place, there will be disturbance to the site and permanent and irreversible loss of access to this site by the community, hence a ***High*** impact magnitude is applied, resulting in an initial impact significance of ***Major***.

Sites JP_007 and JP_001 have a preliminary sensitivity of ***High,*** which is to be confirmed with the Nemina clan. Site JP_007 is located within the export pipeline route footprint. If tactical realignment of the pipeline is not possible to avoid this site, and there are no further mitigation or management measures in place, the site will be disturbed and damaged during construction with permanent and irreversible loss of access to the site by the community, hence a ***High*** impact magnitude is applied, resulting in an initial impact significance of ***Major***. Site JP_001 is located outside, but close to, the trunkline footprint and will be avoided. While there will be no direct impact to this site, there may be a temporary loss of access to this site during construction, therefore a ***Low*** impact magnitude is assigned, resulting in a ***Moderate*** initial impact significance.

12.4 2019 Upstream EIS Section 14.5 Assessment of Residual Impacts

The mitigation and management measures described in Section 14.4 of the 2019 Upstream EIS remain relevant and will be implemented.

NMAG is systematically completing site inspections of identified cultural heritage sites, and together with the community, identifying appropriate mitigation and management for each site. Such measures may include site salvage, site relocation (e.g., for burial sites), avoidance, application of buffer zones, ceremonies. These measures are consistent with those described in the 2019 Upstream EIS. Four of the sites in Table 12.2 have been verified by NMAG and the community has given consent for these sites to be salvaged. Management of the remaining sites is yet to be defined. If avoidance of sites CA_JP_006 and JP_007 is not possible, consultation with the community will be undertaken to determine the appropriate mitigation and management measures to be implemented, e.g., a ceremony to placate any spirits associated with the sites. This strategy emphasizes collaboration, community involvement, education, and documentation, ensuring that the cultural heritage value of these site is respected and preserved. JP_001 is located outside the Project footprint, but within approximately 20 m and will not be directly impacted. However, appropriate mitigation measures will be identified in consultation with NMAG and local affected communities.

PUR_059, PUR_043, PUR_SAB_003 and PUR_SAB_005 have been salvaged/shovel test pits excavated consistent with discussions with NMAG and consent from the local communities. Salvage material comprising chert flakes/chips, charcoal and other undefined weathered andesitic was found at PUR_059. No tools, retouched artefacts or cores were noted in the assemblage and hence the material is indicative of general stone reduction and casual discard. The material identified offered low research or educational value. Site PUR_043 contained a surface scatter of chert flakes/chips and other stone tools. No archaeological evidence or material culture was identified at the surface of sites PUR_SAB_003 and PUR_SAB_005 and these sites have been 'cleared' and will not be subject to further archaeological salvage. TEP PNG's chance find procedure will be implemented during construction to monitor for, and manage impacts to, any unidentified cultural heritage sites. Given the localized disturbance to these sites, the magnitude of impact is ***Medium,*** resulting in a reduction of the residual impact significance to ***Minor*** for site PUR_SAB_005 and ***Moderate*** for sites PUR_SAB_003, PUR_059 and PUR_043.

Similarly, assuming the successful implementation of mitigation measures for sites CA_JP_006 and JP_007 results in a reduction of the impact magnitude to ***Medium*** and the residual impact significance to ***Moderate.*** There is no change to the impact assessment for site JP_001 and the residual impact significance remains ***Moderate.***

Table 12.3 provides a summary of the assessment of residual impacts to intangible cultural heritage, including when and where these impacts are expected to occur.

All residual risk ratings are rated as ***Moderate***, except for site PUR_SAB_005 which has been rated as ***Minor*** due to its low sensitivity.

12.5 2019 Upstream EIS Section 14.6 Summary of Residual Cultural Heritage Impacts

A summary of the assessment of residual impacts to tangible and intangible cultural heritage is provided in Table 12.3, including in which Project phase and location these impacts are expected to occur. The table should be read with the specific mitigation measures provided in Chapter 20 of the 2019 Upstream EIS.

12.6 References

ERIAS. 2019. Papua LNG Project Upstream Environmental Impact Statement. 01215B_23_v5. December. Unpublished report to Total E&P PNG Limited.

TEP PNG. 2023a. Cultural Heritage and Chance Finds Procedure. TotalEnergies EP PNG Limited. Port Moresby.

TEP PNG. 2023b. Cultural Heritage Survey and Salvage Procedure. TotalEnergies EP PNG Limited. Port Moresby.

Table 12.3 – Summary of Assessment of Impacts on Cultural Heritage

Key Sensitivity	Main Activity	Potential Impact	Location of Activity	Project Phase	Mitigation and Management*	Residual Assessment	
						Sensitivity/ Magnitude	Significance
Tangible Cultural Heritage							
PUR_059	Earthworks, vegetation clearance, logistics and transport	Potential direct disturbance, loss, damage to cultural heritage sites.	Road R03 VCA	C, O	• CHM001 • CHM002 • CHM003 • CHM004 • EM001 • EM028 • Salvage (undertaken)	High/Medium	Moderate
PUR_043	Earthworks, vegetation clearance, logistics and transport	Potential direct disturbance, loss, damage to cultural heritage sites.	Export pipeline route VCA	C, O	• See above	High/Medium	Moderate
CA_JP_006					• CHM001 • CHM002 • CHM003 • CHM004 • EM001 • EM028	High/Medium	Moderate†
Intangible Cultural Heritage							
PUR_SAB_005	Earthworks, vegetation clearance, logistics and transport	Potential changed traditional site use or access and; therefore, loss of ancestral knowledge related to identified and unidentified cultural heritage sites.	CPF P3 site VCA	C, O	• CHM001 • CHM002 • CHM003 • CHM004 • EM001 • EM028 • Salvage (undertaken)	Low/Medium	Minor
PUR_SAB_003			Trunkline VCA	C, O		High/Medium	Moderate

Key Sensitivity	Main Activity	Potential Impact	Location of Activity	Project Phase	Mitigation and Management*	Residual Assessment	
						Sensitivity/ Magnitude	Significance
JP_007	Earthworks, vegetation clearance, logistics and transport	Potential changed traditional site use or access and; therefore, loss of ancestral knowledge related to identified and unidentified cultural heritage sites.	Export pipeline route VCA	C, O	• CHM001 • CHM002 • CHM003 • CHM004 • EM001 • EM028	High/Medium	Moderate†
JP_001			Outside the trunkline VCA but within the survey buffer	C, O		High/Low	Moderate†

C = Construction and O = Operations.
* Mitigation measure identifier, described in Chapter 20 of the 2019 Upstream EIS and Chapter 17 of this addendum.
†To be confirmed pending confirmation of the local site significance and mitigation and management measures in consultation with NMAG and the Nemina clan.

13. Impacts: Amenity and Climate Change

13.1 Overview

Chapter 15 of the 2019 Upstream EIS (ERIAS, 2019) describes impacts to amenity and climate change including air quality, greenhouse gases and climate change, noise, landscape and visual amenity and commercial traffic and transport. A number of revisions are required to the assessment of these impacts to consider the changes to the Project described in Chapter 4 of this addendum, which have occurred since submission of the 2019 Upstream EIS.

Table 13.1 identifies the sections of the amenity and climate change impact assessment that require a revision. Impact assessments undertaken in this addendum are undertaken using assessment methods described in the 2019 Upstream EIS. Information that has not changed has not been reproduced and can be found in the 2019 Upstream EIS.

Mitigation measures considered in the assessments are as described in the 2019 Upstream EIS. Specific management measures are identified by the unique identification codes. Any new mitigations proposed in this addendum are specifically described in the following sections.

Table 13.1 – Summary of Amenity and Climate Change Impact Revisions

2019 Upstream EIS Chapter Number	Upstream EIS Heading	Reasons Revisions Required in EIS Addendum
15.1	Air quality	Relocation of CPF from site P2C to P3 and change in acid gas management
15.2	Greenhouse Gases and Climate Change	Change in acid gas management
15.3	Noise	Relocation of CPF from site P2C to P3
15.4	Landscape and Visual Amenity	Relocation of CPF from site P2C to P3
15.5	Commercial Traffic and Transport	No change required
15.6	References	References provided in Section 13.3

13.2 Revisions to 2019 Upstream EIS Impacts Amenity and Climate Change

This section summarizes the findings of air quality and noise impact assessments undertaken for the Project, as detailed in Appendix 1 and Appendix 2.

13.2.1 2019 Upstream EIS Section 15.1 Air Quality

The following potential impacts to air quality required reassessment considering the relocation of the CPF from site P2C to P3 and the change in acid gas management:

- CPF construction: Clearing, earthworks and construction activities have the potential to emit dust (i.e., total suspended particulate matter (TSP) and particulate matter with an aerodynamic diameter of 10 μm or less (PM_{10}) predominantly, with small amounts of particulate matter with an aerodynamic diameter of 2.5 μm or less ($PM_{2.5}$)) from operation of vehicles, machinery and equipment movement which will occur for an extended period, e.g., years. These emissions have been assessed for their potential to cause adverse human health, amenity and vegetation impacts.

- CPF operations: Air emissions from the gas turbines, heating boilers and flares at the CPF. The key pollutants requiring assessment due to potential adverse human health impacts are oxides of nitrogen (NO_X), carbon monoxide (CO), sulfur dioxide (SO_2) and particulate matter. Volatile organic compound (VOC) concentrations were predicted to be < 0.1% of the adopted air quality criteria in the 2019 Upstream EIS, hence were not reassessed.[1]

- CPF operations: Sulfur dioxide emissions from the acid gas removal unit. Potential adverse vegetation and fauna impacts may occur due to acid rain or acidification associated with SO_2 emissions from the CPF. Acid gas is now being re-injected under normal operating conditions from the start of gas production.

Assessment of dust impacts from construction activities and air dispersion modelling was undertaken using the same approach as described in Section 15.1.2 of the 2019 Upstream EIS. As in the 2019 Upstream EIS, it is expected that background air quality reflects the virtual absence of industrial sources and baseline concentrations of gaseous pollutants (i.e., NO_2, SO_2, CO) are assumed to be negligible (i.e., 0 micrograms per cubic meter ($\mu g/m^3$)).

For CPF operations, three operating scenarios were modelled:

- Scenario 1: normal operations. Acid gas reinjection.

- Scenario 2: no acid gas reinjection. Acid gas flare offline. Reduce processing by 35%. Acid gas sent to high pressure (HP) flare.

- Scenario 3: no acid gas reinjection. Acid gas flare online. Reduce processing by 35%. Acid gas sent to HP flare and gas-assisted acid gas flare.

13.2.1.1 Sensitive Receptors

The closest sensitive receptor to CPF P3 site is the new settlement Pokore Hamlet. This receptor was not included in the 2019 Upstream EIS as it was only established after the Coronavirus disease (COVID-19) pandemic in 2021. Other receptors that remain relevant to the CPF P3 site location include the villages Poroi 1, Purari Airstrip House, Ne'ea Creek (formerly Mapaio Fish Camp), and Herd Base. The locations of these receptors are summarized in Table 13.2.

1 In-stack pollutant concentrations were not re-assessed as this is an International Finance Corporation (IFC), rather than CEPA, requirement.

Table 13.2 – Identified Sensitive Human Receptors

Village	Separation Distance from Closest CPF P3 Boundary
Pokore Hamlet	0.7 km southeast
Poroi 1	3.8 km south, southwest
Purari Airstrip House	5.8 km southwest
Ne'ea Creek (formerly Mapaio Fish Camp)	9.9 km west
Herd Base	0.8 km east

Ecological receptors remain the same as described in the 2019 Upstream EIS (see Section 15.1.1.2.2).

13.2.1.2 Ambient Air Quality Guidelines

The assessment criteria used in the 2019 Upstream EIS were reviewed and updated to reflect the latest World Health Organization (WHO) air quality guidelines that were released in 2021. The 2021 WHO air quality guidelines for NO_2 and CO are more stringent than the assessment criteria adopted for the 2019 assessment, while the 24-hour average criteria for SO_2 is twice that used in the 2019 assessment. Given that ambient monitoring data are not available, assessment of potential impacts of the CPF emissions on local PM_{10} and $PM_{2.5}$ concentrations is based on the incremental concentrations predicted by the modelling and the IFC recommendation that project-related emissions do not exceed 25% of the applicable air quality standards (IFC, 2007).

The air quality assessment criteria for the EIS Addendum are summarized in Table 13.3.

Table 13.3 – Ambient Air Quality Criteria Used in the EIS Addendum

Pollutants	Averaging Period	Limit ($\mu g/m^3$)	Source
NO_2	1-hour	200	WHO (2021)
	24-hour	**25**	
	Annual	**10**	
SO_2	10-minute	500	WHO (2021)
	1-hour	200	US EPA (2016)
	24-hour	**40**	WHO (2021)
CO	1-hour	**35,000**	WHO (2021)
	8-hour	10,000	
	24-hour	**4,000**	
TSP*	24-hour	150	US EPA (2017)
	Annual	60	US EPA (2017)
PM_{10}	24-hour	**45**	WHO (2021)
	Annual	**15**	
	24-hour	**11.25 (25%)**	IFC (2007)
	Annual	**3.75 (25%)**	
$PM_{2.5}$	24-hour	**15**	WHO (2021)
	Annual	**5**	
	24-hour	**3.75 (25%)**	IFC (2007)
	Annual	**1.25 (25%)**	

Note: Bold values represent changes in adopted assessment criteria. International Finance Corporation (IFC) and United States Environmental Protection Agency (US EPA).

Different plant species, and even individuals of the same species, may vary considerably in their sensitivity to SO_2. The United Nations Economic Commission for Europe has identified 'critical levels' for various air pollutants to protect vegetation. These European-based guidelines may have limited relevance to the types of vegetation and the growing conditions associated with the Papua LNG Project (i.e., warm temperatures and high rainfall), particularly given that SO_2 impacts on vegetation are exacerbated by cold temperatures (Ashmore et. al., 2003). However, in the absence of local guidelines or data, the limit for forest ecosystems described in the European guidelines has been adopted to assess the potential for adverse impacts on vegetation due to SO_2 emissions from the Project (Table 13.4).

Table 13.4 – Critical SO_2 Levels for Forest Ecosystems

Vegetation Type	SO_2 Limit ($\mu g/m^3$)	Averaging Period
Forest ecosystems	20	Annual mean and half-year mean (October to May)

13.2.1.3 Residual Impact Assessment

Earthworks and Construction

Based on the risk categories derived using the Institute of Air Quality Management (IAQM) method, it is concluded that there is a ***Negligible*** or ***Low*** risk of human health or dust nuisance impacts associated with the earthworks and construction activities proposed as part of the construction of CPF P3, even if the dust mitigation measures in Section 15.1.4 of the 2019 Upstream EIS were not implemented (Table 13.5). This is due to the separation distances between the site and the nearest inhabited areas.

Table 13.5 – Assessment of Potential Fugitive Dust Impacts from Construction Prior to Mitigation

Value	Construction Activity	Sensitivity of the Area	Magnitude of Dust Emissions		Risk of Air Quality Impacts	
			Earthworks	Construction	Earthworks	Construction
Dust soiling and human heath	CPF P3	Low	Large	Large	Low	Low
	Revised trunkline and export pipeline routes	Low	Medium	Small	Low	Negligible
	Road (Road R03)	Low	Medium	-	Low	-
Ecology	CPF P3	Low	Large	Large	Low	Low
	Revised trunkline and export pipeline routes	Medium	Medium	Small	Medium	Low
	Road (Road R03)	Medium	Medium	-	Medium	-

Note: While pre-mitigation risk assessment is not generally applied in this EIS, an exception is made in this instance due to application of the IAQM method.

The risks of any potential ecological impacts are also concluded to be ***Low***, even if no dust mitigation measures were to be implemented, except for the pipeline and road earthworks, which are indicated to have a medium risk of impacts. The implementation of dust controls during

construction will reduce the risks of any off-site ecological impacts occurring to ***Low*** for all Project components; however, the above assessment indicates that particular care should be taken to reduce dust emissions during pipeline and road earthworks. Any residual impacts for the road and pipeline alignments would be mainly located in the area immediately adjacent to these activities and will move along as the works progress. Therefore, any affected vegetation can be expected to recover rapidly, particularly given the high rainfall in the region.

Operations

The results of the air emissions modelling are provided in Tables 13.6 to 13.8 for each of the CPF operating scenarios.

Table 13.6 – Scenario 1 Normal Operations

Pollutant	Averaging Period	Pokore Hamlet	Poroi 1	Purari Airstrip House	Ne'ea Creek*	Herd Base	Ambient Air Quality Criteria (µg/m³)
Maximum Predicted Ground-level Concentrations (µg/m³)							
NO_2	1-hour	67	25	15	5.7	44	200
	24-hour	4.6	2.7	2.6	0.42	3.7	25
	Annual	1.0	0.13	0.05	0.02	1.0	10
SO_2	10-minute	100	26	12	5.7	56	500
	1-hour	70	18	8.4	4.0	39	200
	24-hour	4.4	1.2	1.4	0.27	3.2	40
CO	1-hour	14.7	7.7	3.9	1.6	13.9	35,000
	8-hour	3.3	4.9	4.4	0.7	3.2	10,000
	24-hour	1.9	1.8	1.5	0.2	1.7	4,000
Incremental Ground-level Concentrations (µg/m3)							
Particulate matter	24-hour	0.53	0.29	0.68	0.05	0.29	3.75 (25% of $PM_{2.5}$)
	Annual	0.12	<0.1	0.15	<0.1	<0.1	1.25 (25% of $PM_{2.5}$)

Notes: * Formerly Mapaio Fish Camp.

Table 13.7 – Scenario 2 Acid Gas Flare Off Line

Pollutant	Averaging Period	Pokore Hamlet	Poroi 1	Purari Airstrip House	Ne'ea Creek*	Herd Base	Ambient Air Quality Criteria (µg/m³)
Maximum Predicted Ground-level Concentrations (µg/m³)							
NO_2	1-hour	32	8.9	6.8	2.7	20	200
	24-hour	2.1	1.6	1.4	0.20	1.6	25
	Annual	0.55	0.08	0.03	0.01	0.44	10
SO_2	10-minute	44	9.4	6.4	2.7	24	500
	1-hour	31	6.6	4.5	1.9	17	200
	24-hour	1.9	0.88	0.87	0.14	1.4	40
CO	1-hour	19	4.7	4.3	3.5	22	35,000
	8-hour	7.8	2.6	2.3	1.9	8.1	10,000
	24-hour	3.2	0.9	0.8	0.6	3.3	4,000

Pollutant	Averaging Period	Pokore Hamlet	Poroi 1	Purari Airstrip House	Ne'ea Creek*	Herd Base	Ambient Air Quality Criteria ($\mu g/m^3$)
Incremental Ground-level Concentrations ($\mu g/m3$)							
Particulate matter	24-hour	0.3	0.2	0.2	0.03	0.2	15 ($PM_{2.5}$) 3.75 (25% of $PM_{2.5}$)
	Annual	<0.1	<0.1	<0.1	<0.1	<0.1	5 ($PM_{2.5}$) 1.25 (25% of $PM_{2.5}$)

Notes: * Formerly Mapaio Fish Camp.

Table 13.8 – Scenario 3 Acid Gas Flare On Line

Pollutant	Averaging Period	Pokore Hamlet	Poroi 1	Purari Airstrip House	Ne'ea Creek*	Herd Base	Ambient Air Quality Criteria ($\mu g/m^3$)
Maximum Predicted Ground-level Concentrations ($\mu g/m^3$)							
NO_2	1-hour	30	7.5	5.8	2.2	18	200
	24-hour	1.9	1.4	1.2	0.17	1.5	25
	Annual	0.53	0.08	0.03	0.01	0.40	10
SO_2	10-minute	44	9.4	6.4	2.7	24	500
	1-hour	31	6.6	4.5	1.9	17	200
	24-hour	2.0	0.9	0.9	0.1	1.4	40
CO	1-hour	21	4.5	4.6	3.8	23	35,000
	8-hour	8.0	2.7	2.1	2.0	8.5	10,000
	24-hour	3.3	0.9	0.7	0.7	3.5	4,000
Incremental Ground-level Concentrations ($\mu g/m3$)							
Particulate matter	24-hour	0.3	0.2	0.2	0.02	0.2	15 ($PM_{2.5}$) 3.75 (25% of $PM_{2.5}$)
	Annual	<0.1	<0.1	<0.1	<0.1	<0.1	5 ($PM_{2.5}$) 1.25 (25% of $PM_{2.5}$)

Notes: * Formerly Mapaio Fish Camp.

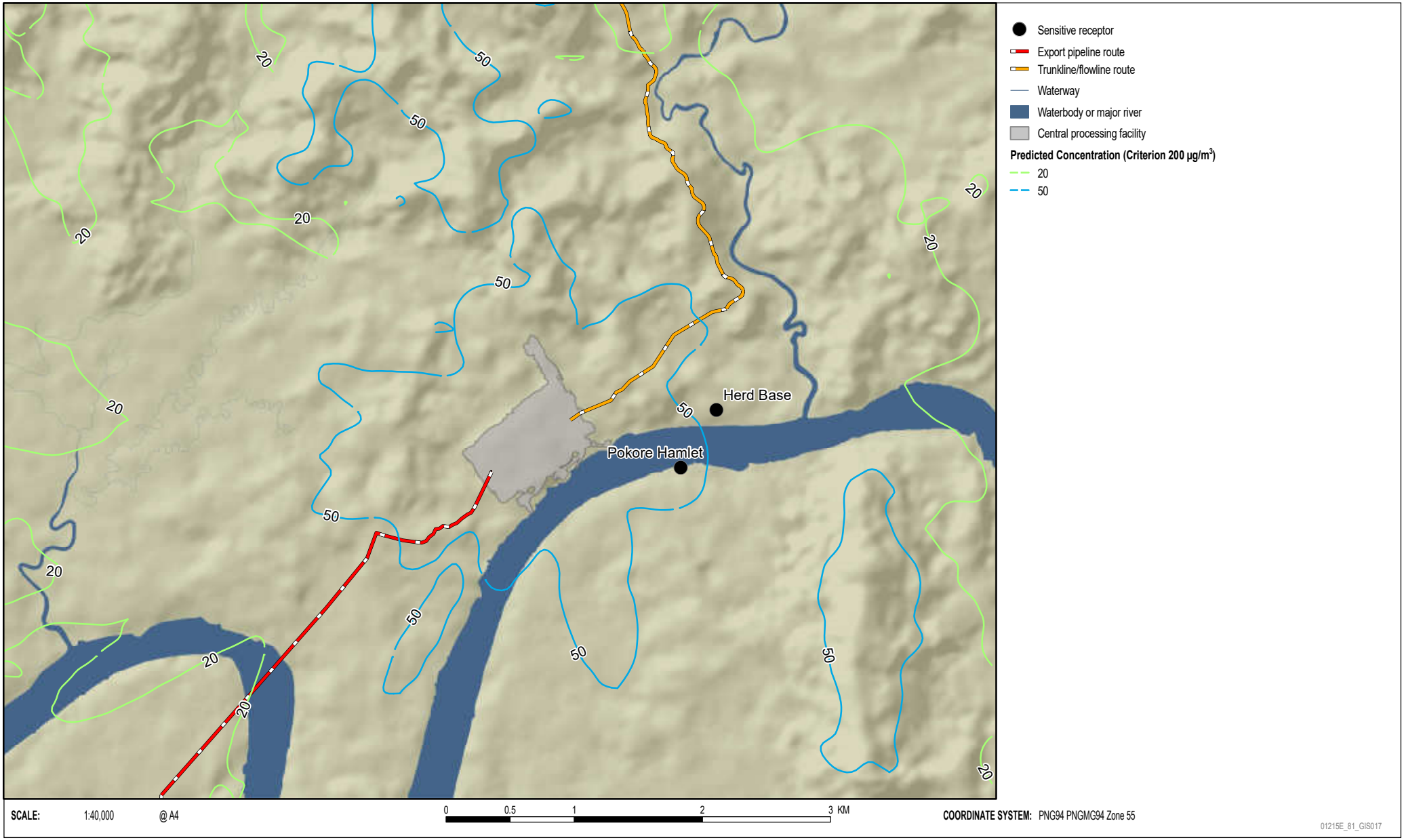
Tables 13.6 to 13.8, and Figures 13.1 and 13.2, show that for all operational scenarios assessed, the maximum ground-level NO_2, SO_2 and CO concentrations predicted at the sensitive receptors are well below the relevant ambient air quality criteria.

Modelling of particulate matter was not broken down into $PM_{2.5}$ and PM_{10}; however, as combustion-related particulate matter is mainly in the $PM_{2.5}$ range it is therefore appropriate to compare the results to the $PM_{2.5}$ assessment criteria. The incremental particulate matter impacts predicted as a result of Project emissions are very low, all less than 1 $\mu g/m^3$. The predicted incremental concentrations are well below the recommended threshold of 25%. Given this, the Project is unlikely to result in any measurable increases in $PM_{2.5}$ or PM_{10} concentrations at any of the identified sensitive receptor locations.

Maximum Predicted 1-Hour Average NO_2 Concentrations - Normal Operations

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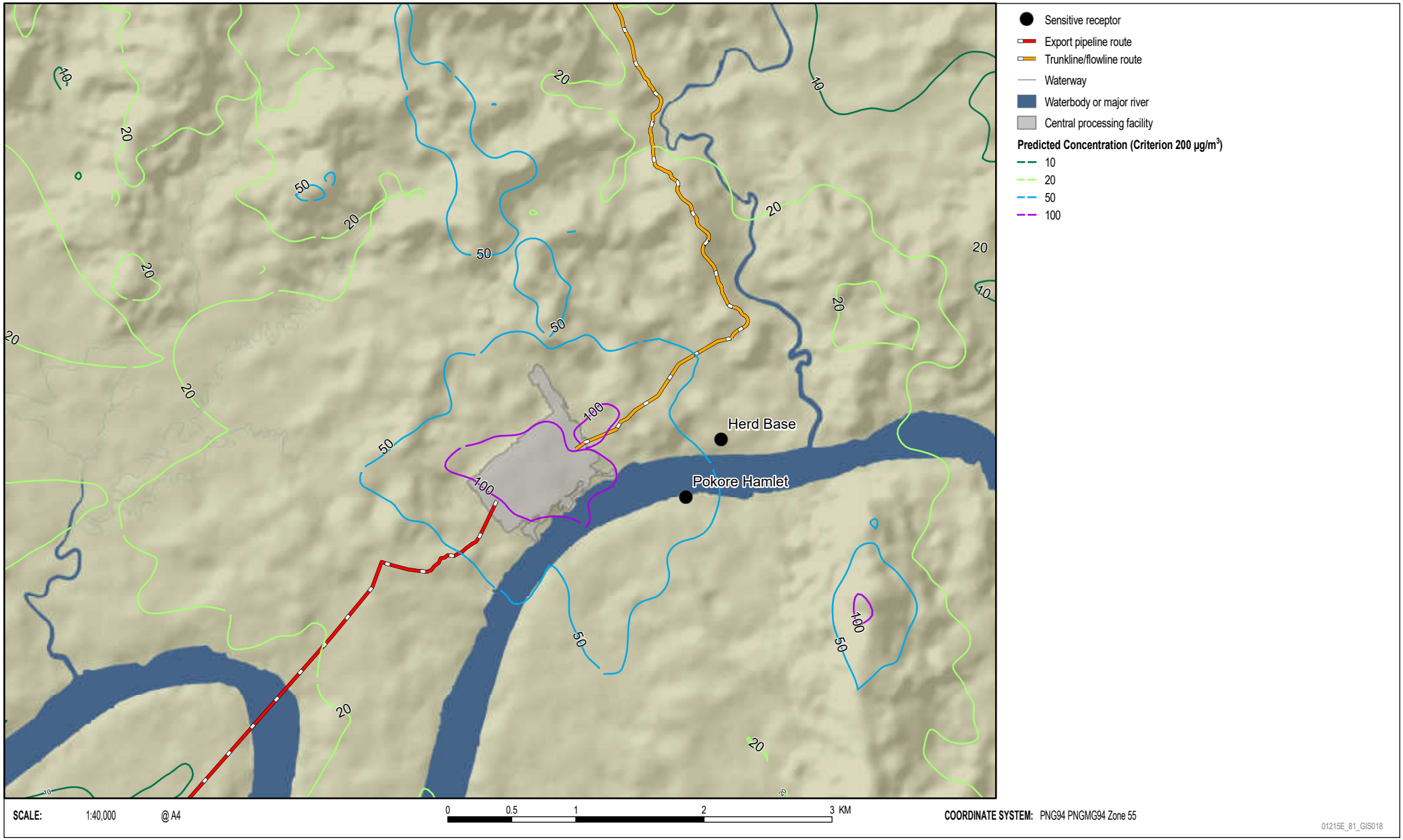
FIGURE 13.1



Maximum Predicted 1-Hour Average SO_2 Concentrations - Normal Operations

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FIGURE 13.2



The air dispersion modelling in Appendix 1 predicted that the 24-hour average SO_2 concentration does not exceed the air quality criterion for adverse impacts on vegetation and forest ecosystems, being an annual/6-month average of 20 µg/m^3. No adverse impacts on vegetation would therefore be anticipated due to SO_2 emissions from the CPF.

13.2.2 2019 Upstream EIS Section 15.2 Greenhouse Gases and Climate Change

Section 15.2 of the 2019 Upstream EIS assesses the Project's potential contribution to climate change by presenting a greenhouse gas (GHG) emissions inventory covering the life of the Project, including construction, operations and decommissioning. The significance of the Project's estimated annual emissions was assessed in relation to PNG's national GHG emission inventory.

Since completion of the 2019 Upstream EIS, TEP PNG has been refining the Project design during the progress of the front end engineering design (FEED). This process will continue throughout the FEED phase. A key difference since completion of the 2019 Upstream EIS is the decision to change the acid gas management strategy to full reinjection of acid gas into the Antelope reservoir from the start of production. As described in Chapters 4 and 5, this will result in a reduction in emissions associated with acid gas management compared to the partial reinjection concept.

TEP PNG is currently undertaking a climate change risk assessment (CCRA) that comprises a number of elements including GHG calculations, climate change risk and renewable energy transition risk. The CCRA will ultimately reflect the final Project detailed design and the Project changes since the 2019 Upstream EIS. As there is the potential for further design changes that will affect the CCRA, the assessment of total Project GHG emissions and potential impacts will be undertaken at the completion of FEED and the mitigations in the Construction and Environment and Social Management Plan (CESMP) revised as required [EM051].

13.2.3 2019 Upstream EIS Section 15.3 Noise

The following potential impacts to noise required reassessment considering the relocation of the CPF to site P3:

- CPF construction: Clearing, earthworks and construction activities that have potential to emit noise from operation of vehicles, equipment and machinery for civil works, and erection of plant. This will initially involve site preparation and significant bulk earthworks to grade the site before the CPF modules are assembled. Noise emissions associated with these works have been assessed for their potential to impact the amenity of existing villages near the CPF and terrestrial fauna that inhabit surrounding area.
- CPF operations: Noise emissions from the 24-hour operation of gas processing equipment (e.g., gas turbines, compressors, pipework, pumps, and flaring when required) at the CPF have been assessed to determine the potential amenity and fauna noise impacts.

The same methods for assessing noise impacts from construction activities and noise modelling were used as described in Section 15.3.2 of the 2019 Upstream EIS. Five scenarios were modelled:

- Construction Scenario 1: early construction works such as site clearing, excavation and concreting.

- Construction Scenario 2: late construction works that involves the erection of structures.
- Operating Scenario 1: normal operations.
- Operating Scenario 2: Acid gas flare off line. Reduce processing by 35%. Acid gas sent to high pressure (HP) flare.
- Operating Scenario 3: Acid gas flare on line. Reduce processing by 35%. Acid gas sent to HP flare and gas-assisted acid gas flare.

13.2.3.1 Sensitive Receptors

Sensitive receptors are the same as those described in Section 13.2.1.1.

13.2.3.2 Ambient Noise Guidelines

The noise assessment criteria for impacts on humans for the EIS Addendum are based on IFC guidelines (IFC, 2007); however, in the absence of recent background noise monitoring, the IFC guideline criteria has been adopted (Table 13.9), rather than the IFC background plus 3 dBA criteria that was used in the 2019 Upstream EIS.

Table 13.9 – Ambient Noise Criteria Used in the EIS Addendum

Activity/Receptor	Day/Evening 7.00 am -10.00 pm	Night 10.00 pm -7.00 am
Continuous noise/human	55 dBA L_{Aeq} (1 hour)	45 dBA L_{Aeq} (1 hour)

Note: Guidelines values are for noise levels measured out of doors.

The impact of noise on wildlife is a new field of study, and many knowledge gaps remain. Research is most lacking for non-avian terrestrial species, long-term exposure effects and nocturnal species (Shannon et al., 2016; Jerem & Mathews, 2021). There have been few studies in tropical environments, and none in New Guinea (Jerem & Mathews, 2021).

Based on recent literature, a review of the 2019 Upstream EIS noise criteria for impacts on fauna from construction and general operational noise is prudent. Some measurable adverse reactions may be expected from some fauna species when industrial noise levels reach 50 dBA Leq and these reactions can be expected to be notably greater (level of response, number of species responding) at 65 dBA Leq.

Many studies have shown a variety of direct and indirect responses to noise pollution, including (but not limited to) reduced diversity and abundance of birds and other animals, changes in faunal community structure (species composition), behavioral changes (e.g., avoidance, vocal, foraging, vigilance, reproduction), reduced reproductive success, and adverse physiological changes (Shannon et al., 2016; Kok et al., 2023). These responses are taxa specific, with some species being more susceptible to noise than others.

In their recent review, Shannon et al. (2016) showed that almost half of studies reported a biological response at noise levels above 60 dBA, and >60% of studies reported a response above 65 dBA. Many bird studies have documented changes in song, reproduction, abundance, stress hormone levels, and species richness at levels above 45 dBA, and terrestrial mammals have shown an increase in stress levels and reduced reproductive efficiency at levels above 52 dBA (Shannon et al., 2016; Senzaki et al., 2020).

Larger birds with lower song frequencies and narrower vocal repertoires may be most susceptible to chronic industrial noise pollution (Rheindt, 2003; Francis et al., 2011). Relevant species include cassowaries, large pigeons including the International Union for Conservation of Nature (IUCN) Vulnerable (VU) Scheepmeker's Crowned Pigeon (*Goura scheepmakeri*), and large owls. These species may be particularly susceptible to the marked increase in low frequency volumes predicted to arise from Project construction and operation (Appendix 2).

However, given the uncertainty regarding noise impacts on fauna and species variation, definitive noise criteria for fauna can't be defined and impacts can't be looked at in isolation of other impacting processes. Therefore, impacts to terrestrial fauna is discussed in Chapter 10 considering noise as one of many impacting processes.

13.2.3.3 Impact Assessment

The results of the noise modelling are provided in Table 13.10 for each of the construction and operating scenarios (assuming 24-hr construction and operations). Figures 13.3 and 13.4 show noise contours for neutral (calm meteorological conditions) and enhanced (worst-case meteorological conditions) propagation for construction and normal operations (operating scenario 1).

Table 13.10 – Predicted Project Noise Levels ($L_{Aeq\ (1\ hr)}$ dBA)

Scenario	Pokore Hamlet	Poroi 1	Purari Airstrip House	Ne'ea Creek	Herd Base
Neutral Propagation					
CS1	48	22	24	14	33
CS2	45	19	19	5	33
OS1	52	25	25	17	37
OS2	**79**	**55**	51	38	**67**
OS3	**81**	**57**	52	40	**69**
Enhanced Propagation					
CS1	53	27	28	18	38
CS2	50	24	24	9	39
OS1	**56**	30	30	21	41
OS2	**79**	**58**	54	41	**67**
OS3	**81**	**60**	**56**	43	**69**

Notes: Bold values indicate an exceedance of the day noise criteria and shaded cells indicate an exceedance of the night noise criteria. CS1 = construction scenario 1, CS2 = construction scenario 1, OS1 = operating scenario 1, OS2 = operating scenario 2, OS3 = operating scenario 3.

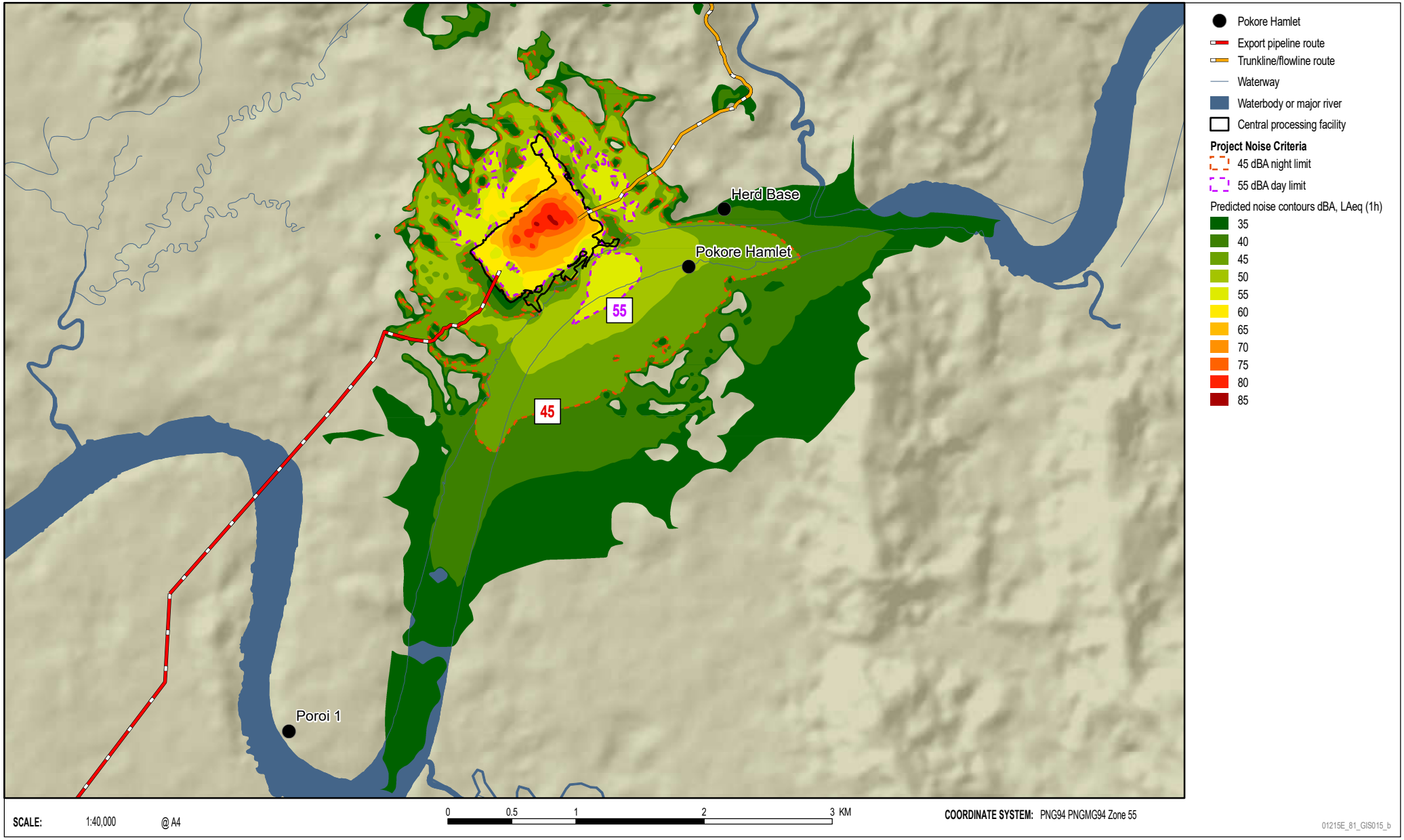
Construction

Noise levels are predicted to meet the day time limit of 55 DBA L_{Aeq} at all receptors under neutral and enhanced propagation for both construction scenarios.

Noise Contours Operational Scenario 1 (Normal Operations) Neutral Propagation

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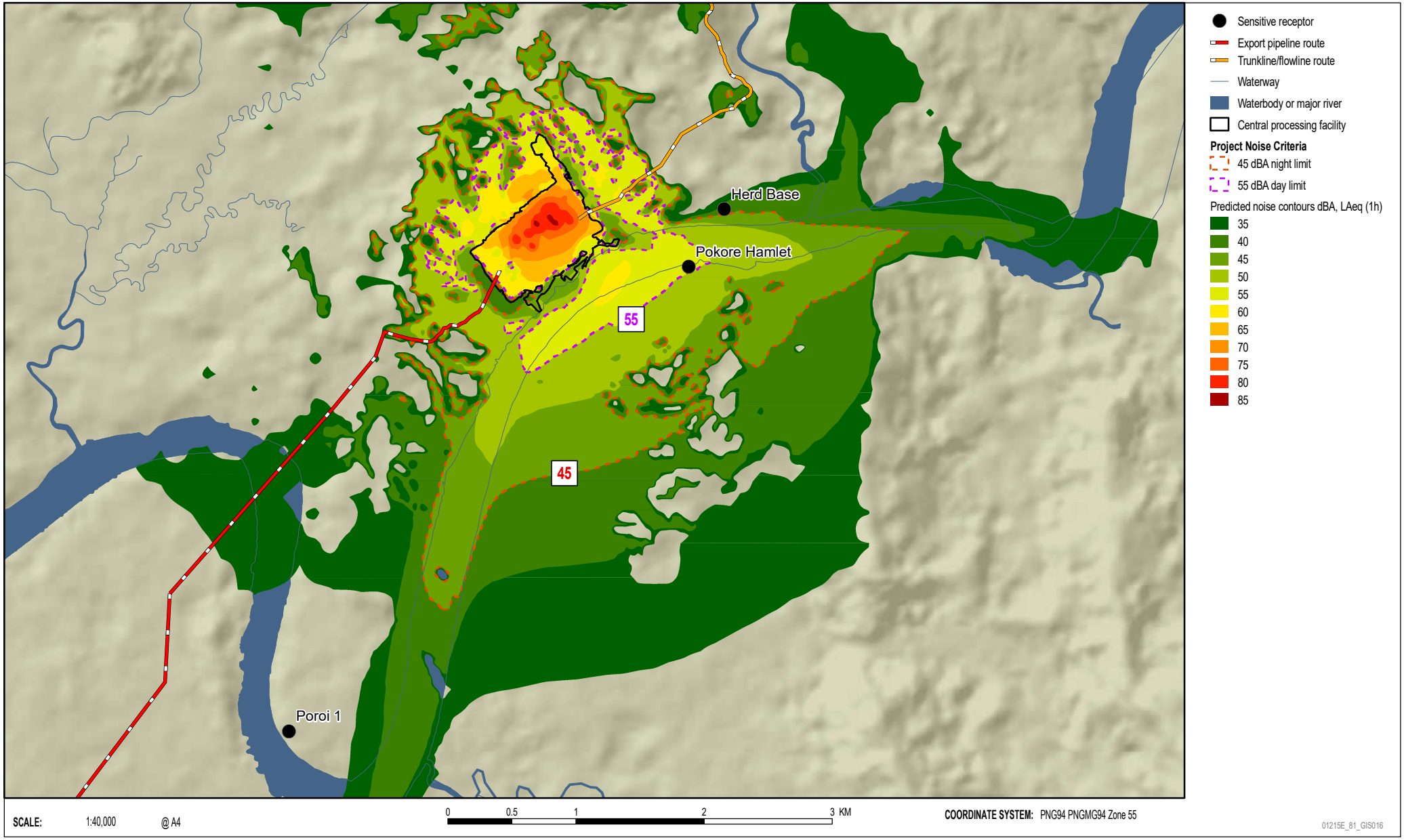
FIGURE 13.3



Noise Contours Operational Scenario 1 (Normal Operations) Enhanced Propagation

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FIGURE 13.4



However, the night time limit of 45 dBA LAeq is exceeded at Pokore Hamlet in the following scenarios:

- CS1: neutral and enhanced propagation by 3 dBA and 8 dBA, respectively.
- CS2: enhanced conditions by 5 dBA. Note, the limit is equaled under neutral propagation.

Operations

During normal operations (OS1), noise limits were met during neutral and enhanced propagation at all receptors except Pokore Hamlet.

At Pokore Hamlet, the following noise limit exceedances occurred:

- Night time limit of 45 dBA LAeq under neutral propagation (by 8 dBA).
- Both the day and night time limits under enhanced propagation (by 1 dBA and 9 dBA, respectively).

The marginal day time exceedance would be considered imperceptible and therefore not acoustically material, as changes in noise levels of 1 or 2 dBA are imperceptible to the human ear (or expressed differently, a noise level of 55 dBA would be perceived the same as a noise level of 56 dBA).

During flaring, the noise emissions from the flare is the dominant noise source. The operation of the CPF at normal or reduced capacity (e.g., 35%) would be of no significance considering the calculated noise emission of the flare.

During abnormal conditions, i.e., both flaring scenarios (i.e., OS2 and OS3), a number of noise exceedances occur:

- Neutral propagation: the daytime limit of 55 dBA is exceeded at Pokore Hamlet, Poroi 1 and Herd Base. Noise at the same receptors, and the Purari Airstrip House, similarly exceed the nighttime limit.
- Enhanced propagation: the nighttime limit is exceeded at all receptors except Ne'ea Creek. The daytime limit is exceeded at Pokore Hamlet, Poroi 1 and Herd Base for OS2 and at Pokore Hamlet, Poroi 1, Herd Base plus Purari Airstrip House for OS3.

13.2.3.4 Mitigation and Management

Noise mitigation measures and embedded design controls are described in Sections 15.3.3 and 15.3.4 of the 2019 Upstream EIS. The predicted noise limit exceedances at Pokore Hamlet have contributed to TEP PNG's approach to the resettlement of Pokore Hamlet (this is discussed further in Chapters 11 and 13 where other contributing factors, and the resettlement process are discussed) [SM031].

It is not possible to assess noise impacts to the residents of Pokore Hamlet at the site of their resettlement as the need for resettlement, and resettlement site(s), have not yet been determined (see Chapter 11). The site selection process for resettling Pokore Hamlet will consider the results of the noise modelling to ensure that noise limits are not exceeded at the new site [EM053].

13.2.3.5 Residual Impact Assessment

No exceedance of noise limits are predicted during normal operating scenarios (neutral and enhanced propagation) considering the resettlement of Pokore Hamlet.

Abnormal operating conditions, during which noise limit exceedances are expected at Poroi 1, Purari Airstrip House and Herd Base during neutral and enhanced propagation, are expected to occur very infrequently:

- OS2: One to two times per year for a duration of 4 to 6 hours.
- OS3: One to two times per year for a maximum of 24 hrs.

As described in Section 4.11.1.2 (Flares) of the 2019 Upstream EIS, TEP PNG has officially endorsed the World Bank Zero Routine Flaring by 2030 initiative and the Project has been designed so that flaring is only required during process upset events. In the event that the acid gas injection system is offline beyond the acceptable design parameters, the CPF would shutdown (if necessary) to eliminate the need to flare. Therefore, noise exceedances due to abnormal operation conditions and flaring are not expected for more than 2 to 3 days per year.

Further, noise mitigation measures and embedded design controls described in Sections 15.3.3 and 15.3.4 of the 2019 Upstream EIS will be implemented, particularly during the times of day when community dwellings are expected to be occupied, i.e. during the early morning and evenings. Implementation of such measures will reduce the predicted noise levels.

13.2.4 2019 Upstream EIS Section 15.4 Landscape and Visual Amenity

13.2.4.1 Sensitive Receptors

The potential visual impact of the CPF P3 was assessed by considering the visual sensitivity of a receptor from a specific viewpoint, and the magnitude of visual effect of the CPF development from each viewpoint using the matrices shown in Section 15.4.2.1 of the 2019 Upstream EIS. There are limited viewpoints in the PAOI where receptors (viewers) are likely to experience significant visual divergence from the surrounding visual landscape due to the dense vegetative cover, remoteness, and topographical features. Viewpoints were selected to represent the range of views and receptors likely to be affected by the CPF, and considered:

- Places of habitation and other areas of land use or transit from which the CPF development may be seen.
- Whether viewpoints are permanent (e.g., villages) or transient (e.g., river traffic).

On this basis, viewpoints have been identified in Table 13.11.

Table 13.11 – Viewpoints Assessed

Location	Description
Places of habitation near the CPF	• Poroi 1 (Viewpoint 2) and Ne'ea Creek (Viewpoint 4) are approximately 3.1 km to the south and 9.2 km to the west of the CPF, respectively, on the northern banks of the Purari River (see Figure 13.5). • Pokore Hamlet (Viewpoint 1) and the Purari Airstrip House (Viewpoint 3) are approximately 0.3 km southeast and 5.2 km southwest of the CPF, respectively, on the southern bank of the Purari River. • **High sensitivity** for Pokore Hamlet (Viewpoint 1) (Views are experienced over several hours by local community, i.e., direct view to CPF, but the CPF is not where people's attention is focused as they undertake their daily activities). • **Low sensitivity** for Viewpoints 2, 3 and 4 (less than 500 people per day; only used by people from local communities; views are temporary; high use for primary subsistence activities).
PRL-15 oxbow wetlands	• The PRL-15 oxbow wetlands (Viewpoint 5) are approximately 11 km west-northwest of the CPF and 2.5 km north of Ne'ea Creek (formerly Mapaio Fish Camp; see Figure 13.5. • The wetlands are accessed by local communities year-round for subsistence collection of natural resources and for cultural reasons. • **Minimal sensitivity** (area with no permanent settlement accessed rarely by people from local communities).
River transport corridor	• The Purari River is used for transport daily by both the community and commercial operators. • **Low sensitivity** (riverways have daily but often transient use mostly less than 500 people per day, predominantly from local communities; daily use for primary subsistence activities).

13.2.4.2 Approach to Impact Assessment

The approach to the visual impact assessment is as described in Section 15.4.2.1 of the 2019 Upstream EIS. Relevant assumptions are provided below:

- Heights of the CPF P3 flare and hot water stack are 170 m and 99 m, respectively. These heights are measured from sea level and include the platform for each piece of infrastructure.[2]
- The MOF is 45 m above sea level (ASL).
- Buildings at the CPF P3 site are 8 m high, i.e., height above the CPF P3 platform which is at 37 m ASL.
- Canopy cover in the onshore Project area is 60 to 80%, and canopy height varies considerably. The vegetation canopy height included in the viewshed analysis is 20 m, as a conservative value based on advice of the Project biodiversity specialists (noting that vegetation canopy height can often be 40 to 50 m).
- Modelling from viewpoints has applied a viewer eye level of 1.5 m above the ground surface, within a 100-m buffer around each land-based receptor.

2 The heights stated in the 2019 Upstream EIS are measured from ground level as opposed to sea level.

13.2.4.3 Impact Assessment

There are two components to the impact assessment:

- Landscape: the landscape assessment in the 2019 Upstream EIS remains relevant to the CPF P3 and does not require reassessment.
- Visual amenity: the following potential impacts to visual amenity required reassessment considering the relocation of CPF from site P2C to P3 and the establishment of Pokore Hamlet since 2019:
  - Decline, loss of or change to existing visual amenity or landscape character, including illumination from night lighting.
  - Decline or change to existing visual amenity for river users near the CPF.

Viewshed Analysis

Figure 13.5 shows the viewshed analysis[3] from village viewpoints. Current views from each receptor indicates that the most expansive views are from Ne'ea Creek and the PRL-15 oxbow wetlands. In comparison there are more restricted views from Poroi 1 and Pokore Hamlet. Views from the Purari Airstrip House are mostly constrained to along the Purari River.

Change to Visual Amenity

The construction and operation of CPF facilities and infrastructure, some of which may be temporary in nature, may change, reduce or lose existing visual amenity or landscape character for viewers from representative viewpoints (i.e., Project receptors). Figures 13.6 to 13.8 provide schematic images of the CPF, module offloading facility (MOF) and construction offloading facility (COF).

3 Based on a canopy height from LIDAR data, 20-m vegetation height elsewhere, viewer eye level of 1.5 m, clearance footprint and elevation based on LIDAR, hence this is a conservative assessment.

Viewshed Analysis from Villages and Static Viewpoints

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FIGURE 13.5

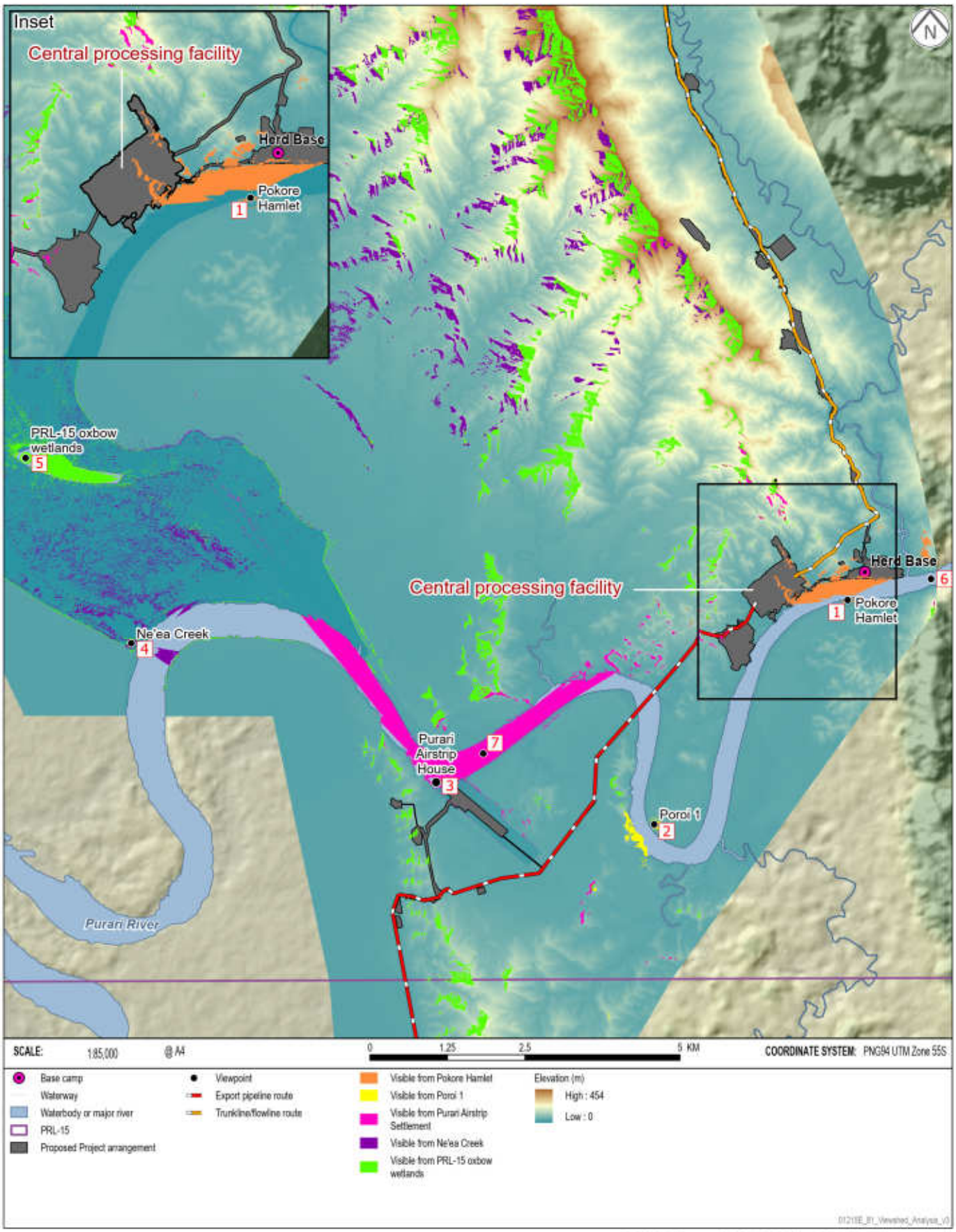


Figure 13.6 – CPF Schematic

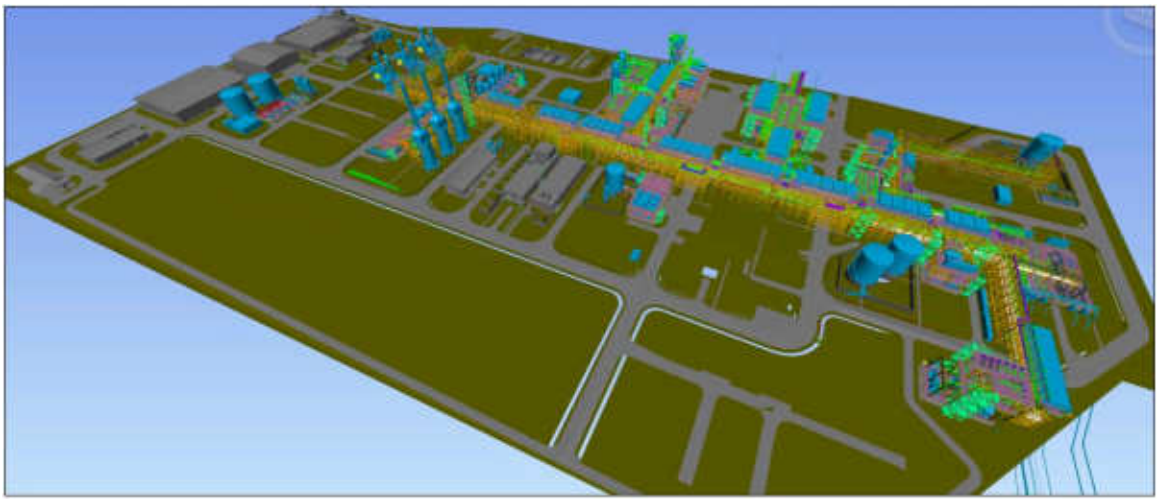


Figure 13.7 – MOF Schematic

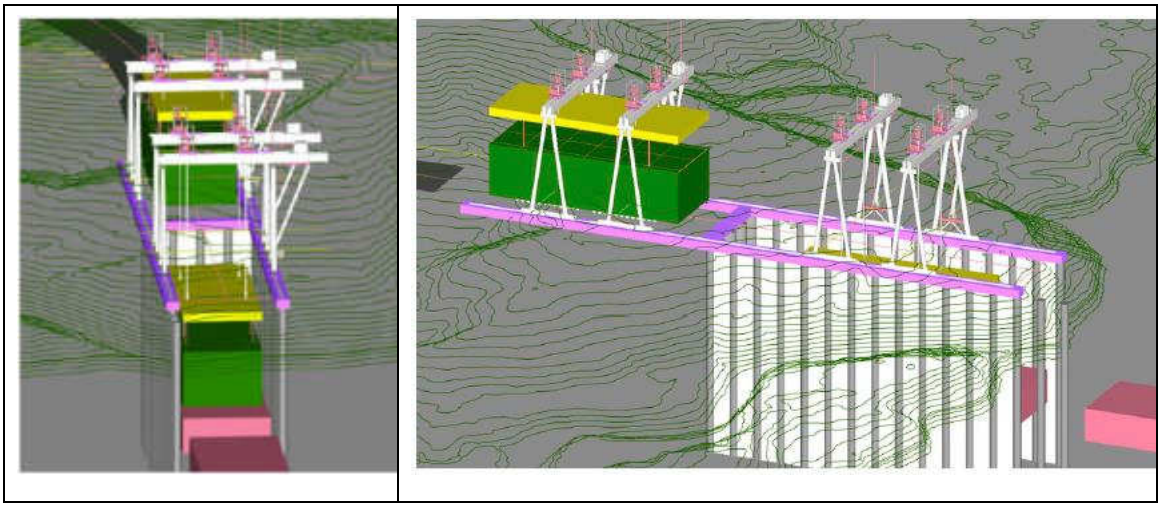
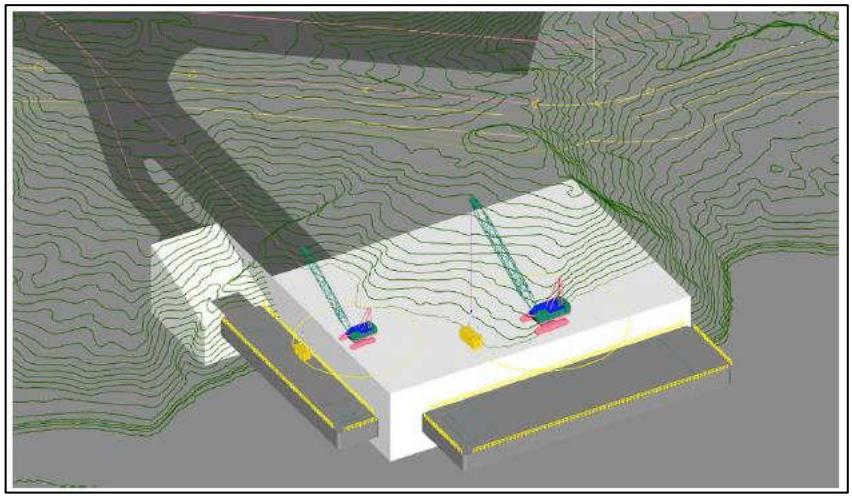


Figure 13.8 – COF Schematic



A viewshed analysis considering the constructed Project was completed to identify the extent of potential visual impacts to human receptors (Figures 13.9A, 13.9B, 13.10, 13.11, 13.12 and 13.13 and Table 13.12). As the more distant villages of Poroi 2, Subu 1, Subu 2 and Wabo won't be able to see the CPF and the associated infrastructure, they have been excluded from the assessment.

The CPF P3 flare and MOF will be the most visible aspects of the CPF P3 location, while facilities such as the COF and ramp will be less visible due to their lower profiles. The shorter of the Project components, e.g., CPF buildings, will theoretically be visible for 5 km or more, while the flare and hot water towers could potentially be visible above the tree line for 12 km or more. In both cases, little of this area is inhabited, and the screening effects of existing tall, dense vegetation and topography will limit the visibility of these features considerably.

Table 13.12 – Visibility of Project Features from Viewpoints

Viewpoint*	Ability to View Project Features				
	CPF P3 Flare	CPF P3 Hot Water Stack	CPF P3 Buildings	MOF	COF
1. Pokore Hamlet	Yes	Yes	No	Yes	Yes
2. Poroi 1	No	No	No	No	No
3. Purari Airstrip House	Yes	Yes	No	No	No
4. Ne'ea Creek	Yes	Yes	No	No	No
5. PRL-15 Oxbow wetlands	Yes	No	No	No	No
6. Purari River upstream from Herd Base	Yes	Yes	No	Yes	Yes
7. Purari River upstream from Purari Airstrip House	Yes	No	No	No	No

Note: * See Figure 13.5 for viewpoint locations.

The CPF P3 (and associated infrastructure) has the potential to cause the following potential impacts to landscape and visual amenity:

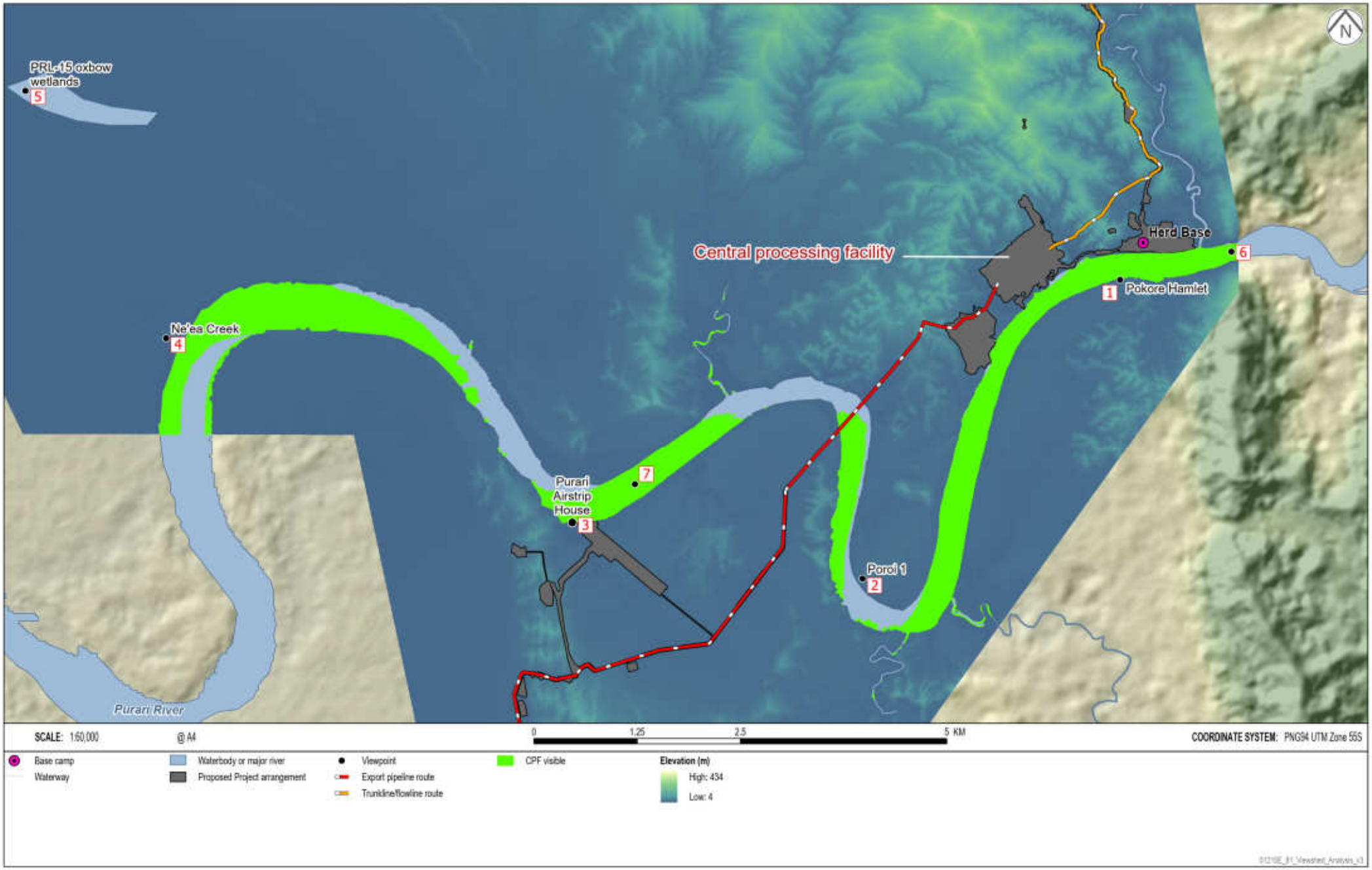
- Decline, loss of or change to existing visual amenity or landscape character, including illumination from night lighting for the Purari Airstrip House, Ne'ea Creek and Pokore Hamlet.
- Decline or change to existing visual amenity, landscape character or connectivity for people using the PRL-15 oxbow wetlands for fishing, hunting or cultural activities.
- Decline or change to existing visual amenity for river users near the CPF, COF and MOF.

Given the location and the screening effects of the local environment, viewers at Poroi 1 will not be able to see any Project features and impacts to this village have not been assessed.

Locations Along the Purari River from Which the CPF P3 Site (and Associated Infrastructure) is Visible

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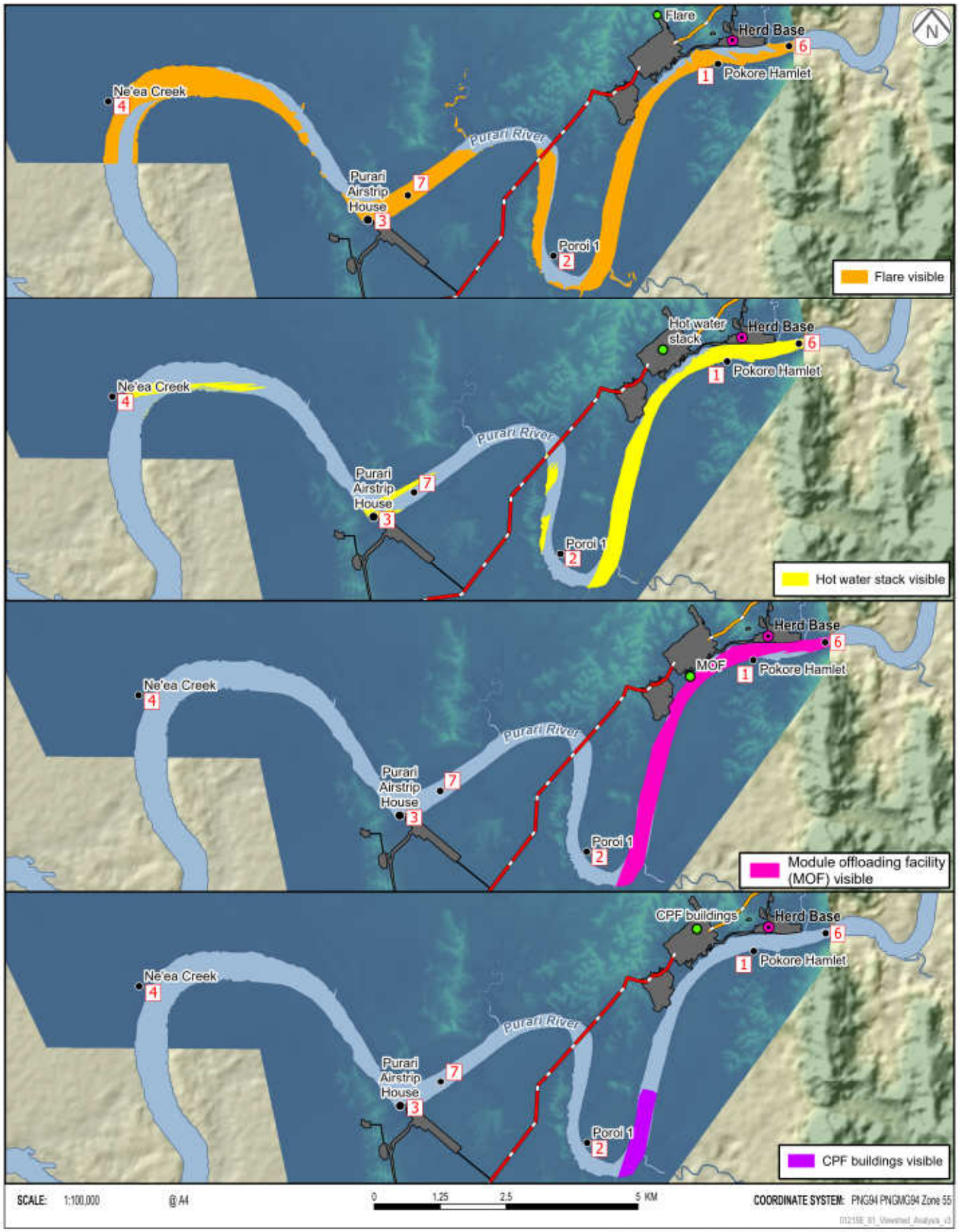
FIGURE 13.9A



Locations Along the Purari River from Which the CPF P3 Site (and Associated Infrastructure) is Visible

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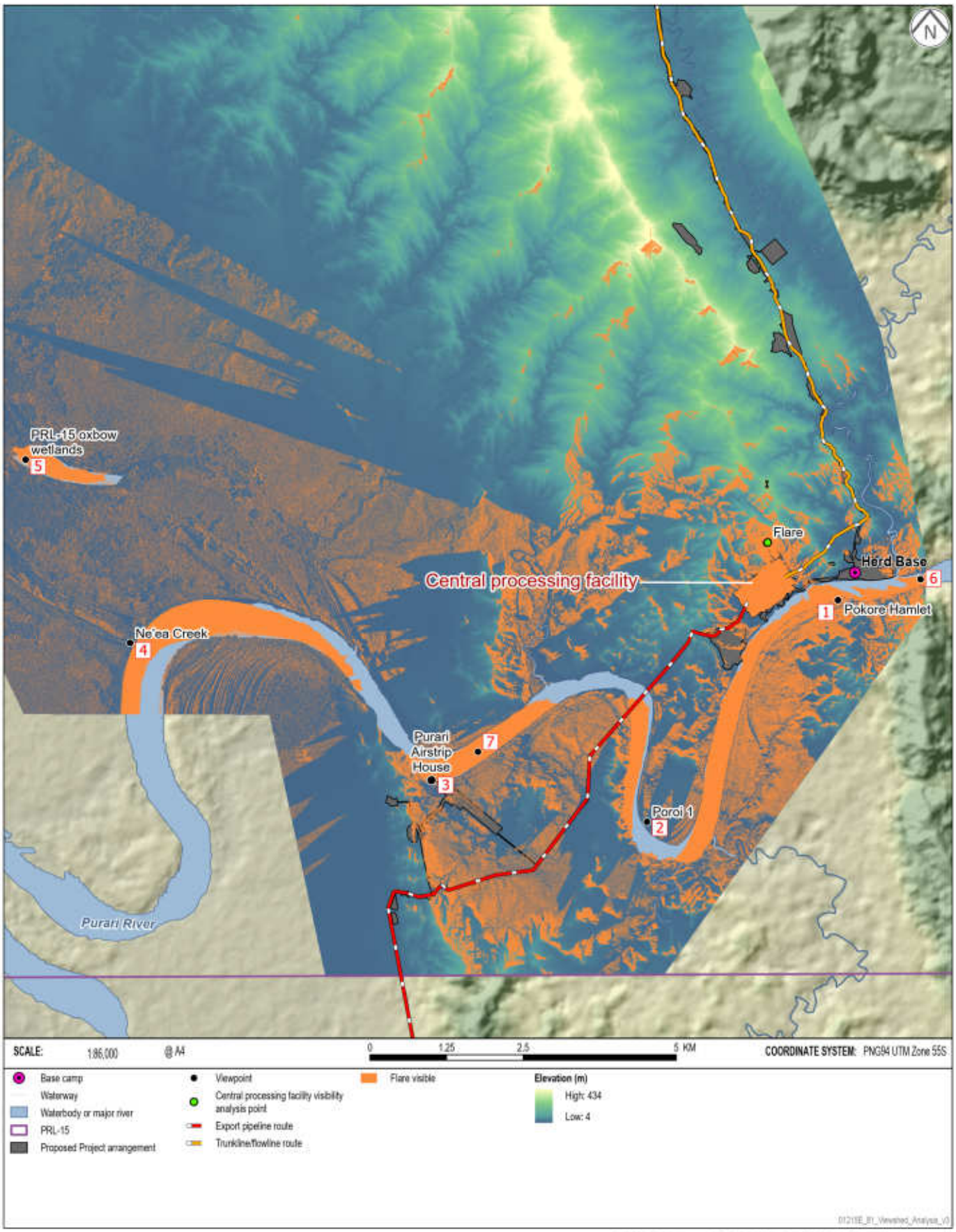
FIGURE 13.9B



Areas from Which the Flare is Visible

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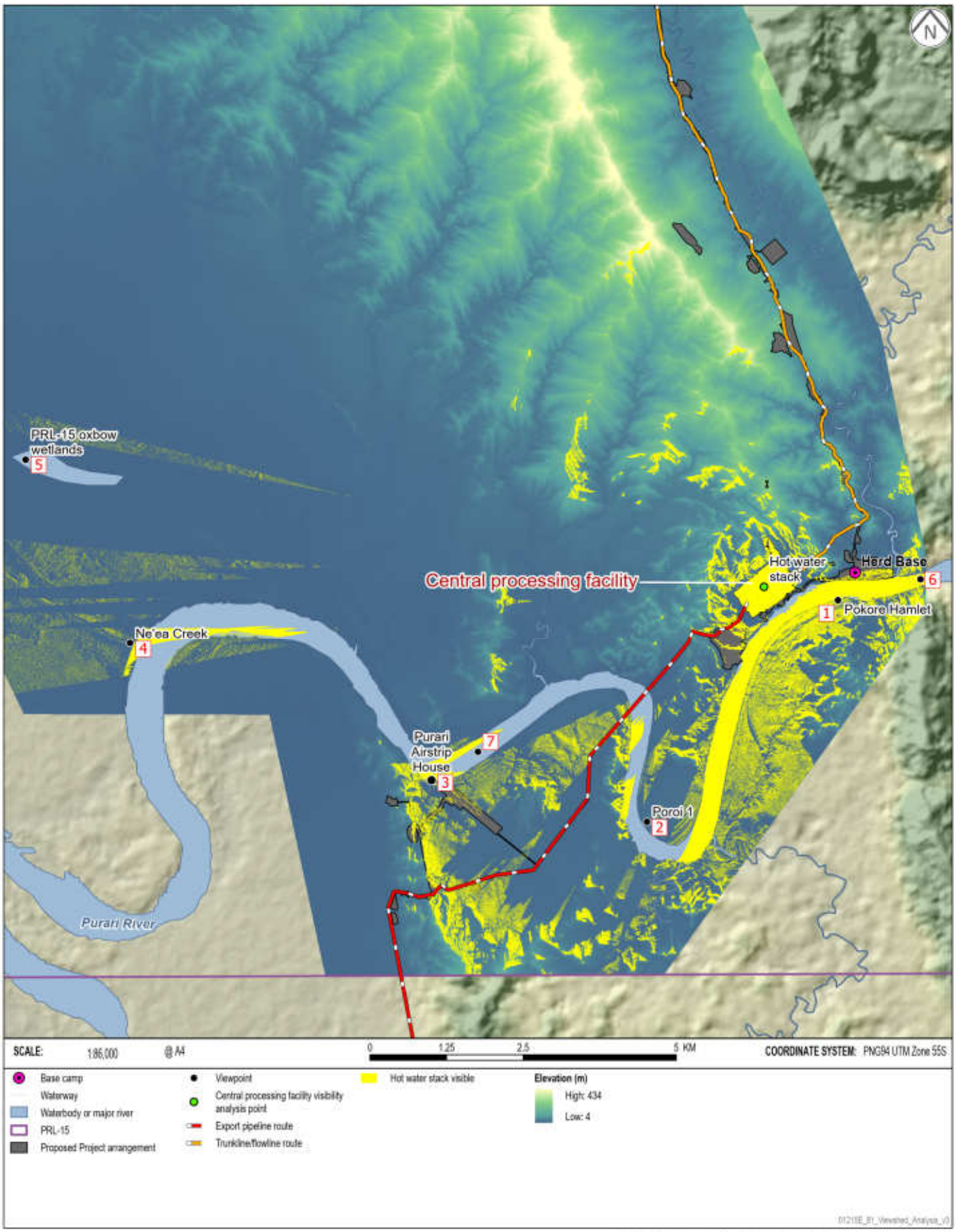
FIGURE 13.10



Areas from Which the Hot Water Stack is Visible

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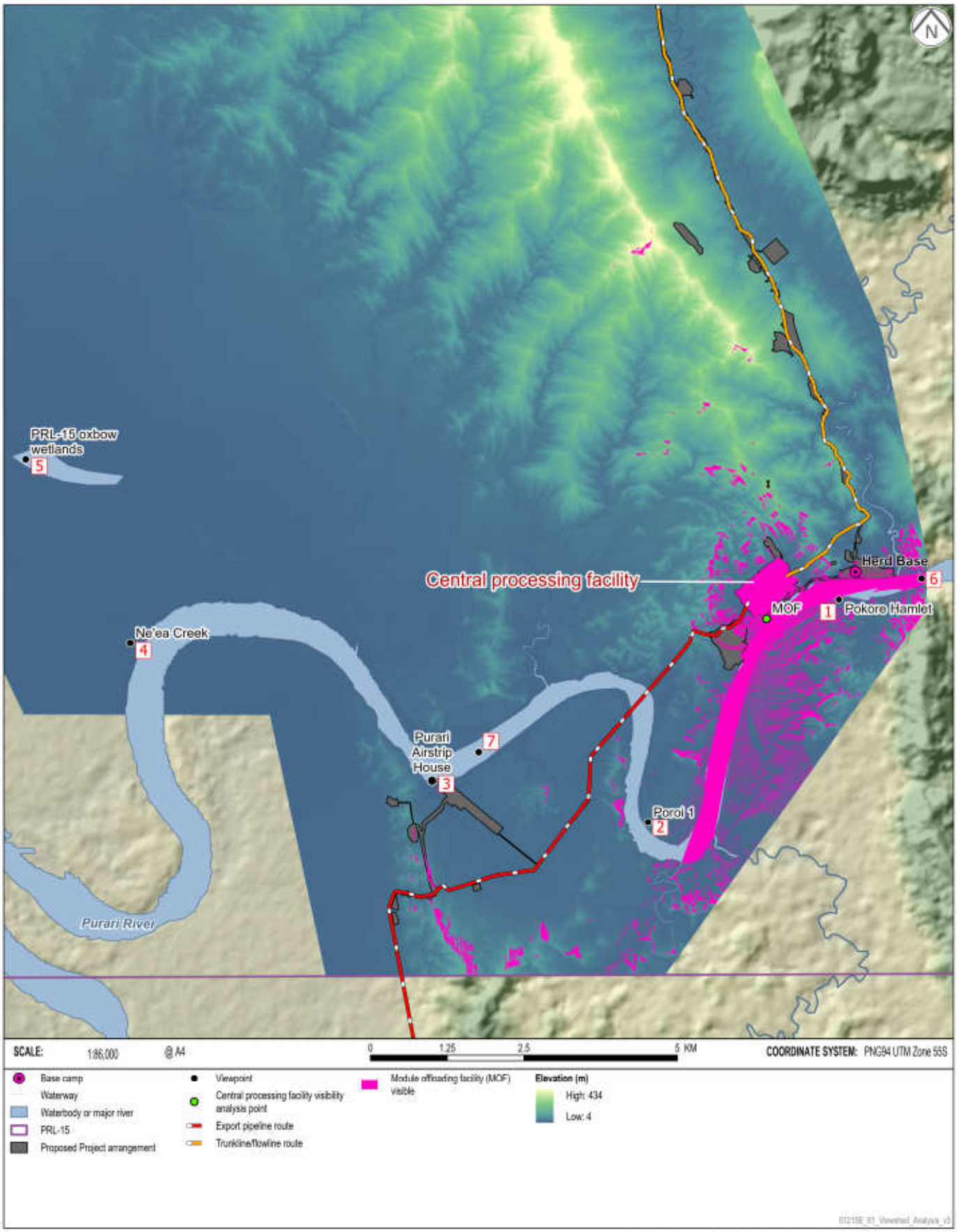
FIGURE 13.11



Areas from Which the MOF is Visible

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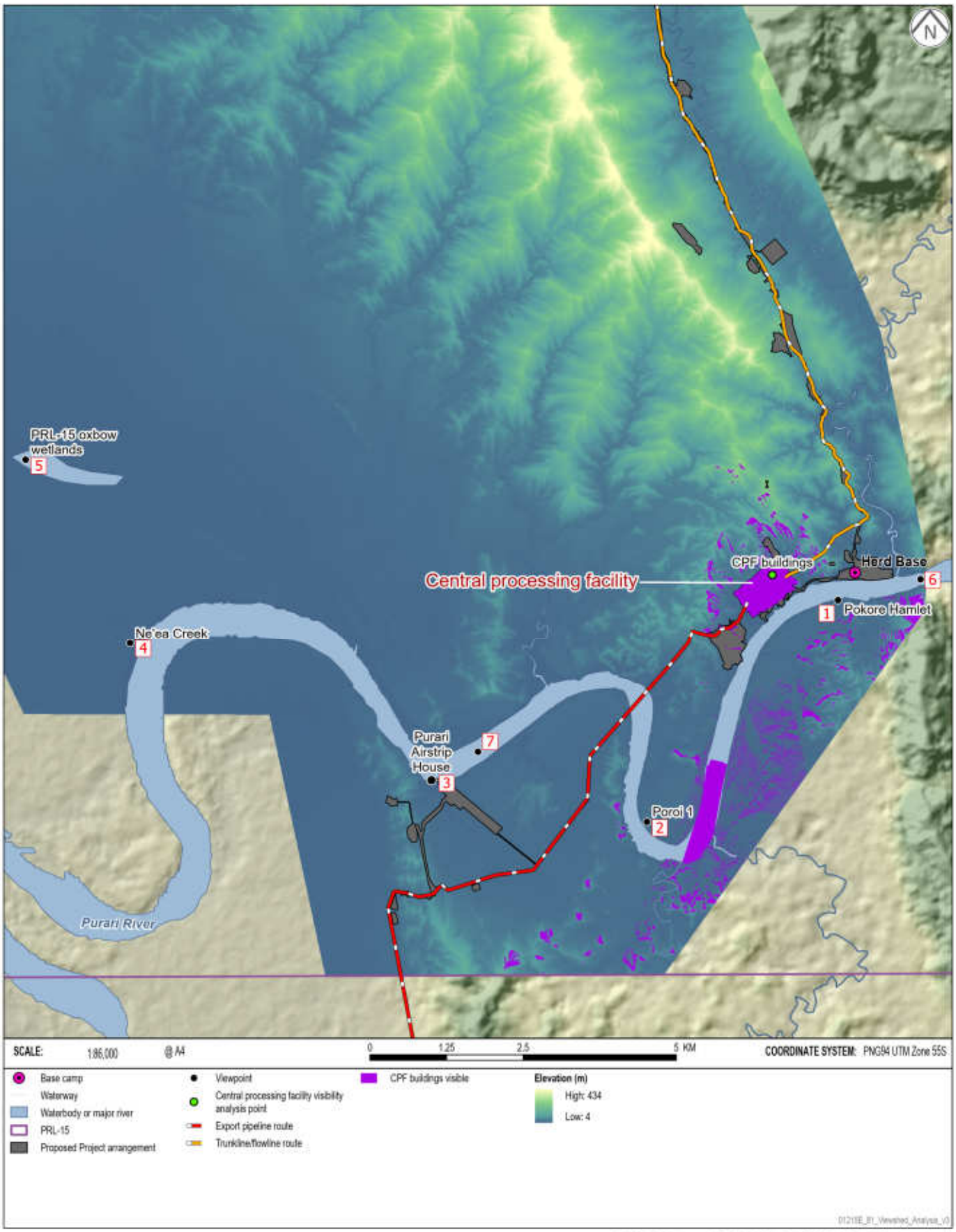
FIGURE 13.12



Areas from Which the CPF P3 Site Buildings are Visible

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FIGURE 13.13



Places of habitation near the CPF P3 site have been assigned a ***Low*** sensitivity rating, with the exception of Pokore Hamlet which is ***High***. Impacts to visual amenity are assessed as follows considering the Project will be operational for at least 25 years:

- Viewers at Ne'ea Creek and the family house at the Purari Airstrip may be able to see some of the Project components in PRL-15. However, the presence of dense vegetation, elevated topographical features (ridgelines) and the meandering Purari River will help to conceal views. The flare and hot water stack will be the most visible components. While they are new modifications to visual amenity, they are slender in appearance and will be more difficult to see at greater distances such as those to the Purari Airstrip (6.7 km) and Ne'ea Creek (10.5 km). Therefore, the magnitude of the change to visual amenity at these receptors is assessed as ***Low***, resulting in an impact significance assessment of ***Minor***.

- Pokore Hamlet has direct views across the Purari River to the CPF P3 site and the associated infrastructure. During construction, dust plumes will likely be visible during dry weather, especially during the earthworks stage. Residents from this village will be able to see the flare, hot water stack, MOF and COF at distances of 800 m to 1.5 km. The lower level CPF buildings will not be visible, screened by vegetation. While components of the infrastructure, such as the MOF and COF, are similar to parts of the existing Herd Base (opposite where the residents of Pokore Hamlet chose to settle), these views will occupy approximately 55° of the field of vision. Therefore, the magnitude of the change to visual amenity at Pokore Hamlet is assessed as ***High***, resulting in an impact significance assessment of ***Major***.

Individuals using the PRL-15 oxbow wetlands may see part of the flare, approximately 12 km in the distance. Viewers will not see the hot water stack, CPF buildings or the COF and MOF due to the screening effects of terrain. Although the flare will be a permanent change to the visual landscape from this viewpoint, it is slender in profile and will form a very narrow part of the field of vision, providing an overall visual impact magnitude rating of ***Low***. Given the ***Minimal*** sensitivity rating attributed to viewers at this viewpoint, this results in a residual impact significance assessment of ***Negligible***.

A sensitivity rating of ***Low*** was assigned to viewers on the Purari River since, while the river is used frequently as a primary transport method, it is used by few people (estimated at fewer than 100 per day based on nearby village and settlement sizes), and views are temporary as people approach and pass the CPF. Despite the meandering Purari River there is an approximate 7-km continuous stretch of the river from where the flare, hot water stack and MOF will all be visible. Further, there are additional sections of the river where the flare and hot water stack are visible (see Figures 13.10 and 13.11). Although some of these views will be in the immediate foreground as river users pass the CPF, the magnitude of the change to visual amenity to river users as they pass, or catch glimpses of, the CPF at points along the river, is assessed as ***Low*** given the temporary nature of these views. This results in an impact significance assessment of ***Minor***.

Lighting Impacts

Operations at the CPF will be 24 hours a day, and night-time lighting is planned for safety and security, although the MOF/COF are primarily a day-use area. There is potential for direct lighting impacts, or line of sight exposure, to the closest human receptors (i.e., Pokore Hamlet), given the distance (0.8 km). However, Pokore Hamlet was established opposite Herd Base which also has night lighting; therefore, night lighting at the COF and MOF will be similar to what they already

experience, and at a greater distance. Direct lighting impacts are not expected at more distant villages, i.e., Purari Airstrip House and Ne'ea Creek, as the CPF buildings, COF and MOF are not visible. Indirect light, which is defined as the contribution that CPF lighting has to the 'glow' effect visible in a dark night sky, may occur but substantial topographic features, and dense vegetation coverage will restrict views from places of habitation. Lighting impacts will depend upon the final lighting design and are summarized in Table 13.13.

Table 13.13 – Assessment of Lighting Impacts

Receptor	Sensitivity	Magnitude	Significance
1. Pokore Hamlet	High	Low	Moderate
3. Purari Airstrip House	Low	Minimal	Negligible
4. Ne'ea Creek	Low	Minimal	Negligible

Gas Flaring

Gas flaring from the CPF will be required occasionally during start-up, maintenance and upset conditions. The 170-m tall, high-pressure flare stack may be seen from all sensitive viewpoints except Poroi 1. If flaring is required at night, the flare may reduce visual amenity at these locations due to the brightness and apparent movement of the flame, but this would decrease with increasing distance from the flare. Upset condition flaring is rare, temporary (see Section 13.2.3.5) and would not adversely affect residents of the Pokore Hamlet, Ne'ea Creek, Purari Airstrip House. Hence the magnitude of impact would be ***Minimal***.

In addition to flaring, aircraft warning lights on the flare stack will be visible, though more so at night. Given the nature of these lights (i.e., height, directionality, purpose), these are not expected to adversely affect residents of Pokore Hamlet, Ne'ea Creek, Purari Airstrip House.

13.2.4.4 Mitigation and Management

As described in Section 13.2.3.4, TEP PNG is considering the resettlement of Pokore Hamlet [SM031]. It is not possible to assess landscape and visual amenity impacts to the residents of Pokore Hamlet at the resettlement site as the site has not yet been determined (see Chapter 11). A visual impact assessment will be included in the process of site selection for Pokore Hamlet [EM052].

13.2.4.5 Residual Impact Assessment

A summary of the assessment of residual impacts related to landscape and visual amenity of the substantial changes being assessed in this EIS Addendum, including the Project phase and location, and when and where impacts are expected to occur, is provided in Table 13.14. The table should be read in conjunction with the mitigation measures provided in Section 15.4.4 of the 2019 Upstream EIS and considering resettlement of Pokore Hamlet. The residual visual impacts due to the Project were assessed as ***Minor*** or ***Negligible*** for all receptors, given the low sensitivity of receptors or the mitigation and management measures that result in the minimal to low magnitude of visual impacts.

Table 13.14 – Summary of Assessment of Residual Impact Significance Landscape and Visual Amenity

Key Sensitivity	Main Activity	Potential Impact	Location of Activity	Project Phase	Mitigation and Management*	Residual Assessment	
						Sensitivity/ Magnitude	Significance
Pokore Hamlet	Gas flaring. Vegetation clearing. Earthworks. Construction works (CPF and flare, COF, MOF). CPF operations. Logistics and transport.	Decline, loss of or change to existing visual amenity or landscape character.	PRL-15	C, O, D	• EM052 • SM031	High/Minimal	Minor
Purari Airstrip House, Ne'ea Creek	Gas flaring. Vegetation clearing. Earthworks. Construction works (CPF and flare, COF, MOF). CPF operations. Logistics and transport.	Decline, loss of or change to existing visual amenity or landscape character.	PRL-15	C, O, D	None	Low/Low	Minor
PRL-15 oxbow wetlands	Vegetation clearing. Gas flaring.	Decline, loss of or change to existing visual amenity, landscape character or connectivity.	PRL-15	C, O, D	None	Minimal/Low	Negligible
Users of the Purari River CPF, COF and MOF	Gas flaring. Vegetation clearing. Earthworks. Construction works (CPF, COF and MOF). CPF operations. Logistics and transport.	Decline, loss of or change to existing visual amenity.	PRL-15	C, O, D	• EM029 • EM048	Low/Medium	Minor
Villages – Pokore Hamlet	Project facilities lighting emissions.	Illumination from night lighting, which may	PRL-15	O	• EM029 • EM048	High/Minimal	Minor

Key Sensitivity	Main Activity	Potential Impact	Location of Activity	Project Phase	Mitigation and Management*	Residual Assessment	
						Sensitivity/ Magnitude	Significance
		reduce visual amenity for residents.					
Villages – Purari Airstrip House and Ne'ea Creek			PRL-15	O	None	Low/Minimal	Negligible

C = Construction, O = Operation, D = Decommissioning and closure. * Mitigation measure identifier, described in Chapter 20 of the 2019 Upstream EIS and Chapter 17 of this addendum.

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WHO. 2021. WHO global air quality guidelines. Particulate matter ($PM_{2.5}$ and PM_{10}), ozone, nitrogen oxide, sulfur dioxide and carbon monoxide. Geneva. World Health Organization

14. Impacts: Ecosystem Services

14.1 Overview

The ecosystem services assessment follows the assessment method described in Section 16.2 of the 2019 Upstream EIS.

Additional data has been collected on ecosystem services through the ERIAS pre-clearance surveys (PCS), IDP community directory update and ecosystem services walkthrough (IDP, 2023; IDP, 2024) and TEP PNG project-induced in-migration (PIIM) monitoring. However, despite the available additional information, the value rating assigned to the ecosystem services remains unchanged from the 2019 Upstream EIS (see Tables 16.7 and 16.8). Therefore, the same priority ecosystem services (i.e., high and very high value) are relevant to the Project (see Table 16.10 from the 2019 Upstream EIS).

Of these priority ecosystem services, only the following have been considered in the EIS Addendum given the location of the services and potential impacts associated with the substantial Project changes:

- Provisioning services:
  - Fuel (firewood).
  - Timber and wood products.
  - Rivers and nearshore marine environment (transportation).
  - Commercial forestry.
- Cultural services:
  - Intangible heritage.

Assessments of these priority ecosystem services have been completed in the preceding impact assessment chapters. In each case, the resulting residual significance of impact rating has not increased from the related assessment in the 2019 Upstream EIS. Therefore, for the priority ecosystem services mentioned above, the residual significance impact of assessment is as reported in Chapter 16 of the 2019 Upstream EIS.

Similar to the 2019 Upstream EIS, cultural services were identified but are not assessed in this chapter as they are considered and assessed in Chapter 12.

As in the 2019 Upstream EIS, Type II ecosystem services have not been included in this addendum[1].

1 Type II ecosystem services are considered in a separate ecosystem services assessment.

14.2 References

IDP. 2023. Ecosystem Services Walk-through for PRL-15 FPIC Inventory. Report prepared by IDP Consulting for TotalEnergies EP PNG Limited. Confidential and unpublished.

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15. Major Hazards

15.1 Introduction

Chapter 18 of the 2019 Upstream EIS (ERIAS, 2019) identified the following principal major hazards:

- Loss of containment of product, gas, fuel and other hazardous materials through failure or damage to equipment from natural causes (e.g., earthquake, landslide, wildfire, tsunami, storm surge and flood events), equipment or system failures or third-party interference, (including intentional or unintentional vessel collisions).
- Fire and explosion, caused by ignition (e.g., from wildfire, lightning strike or electrical equipment) of a product release or leakage (e.g., of fuel, gases or chemicals).

Major hazards considered at the CPF included seismic events damaging processing facilities causing a large-scale hazardous material release. This hazard is discussed below considering the proposed relocation of the CPF to site P3, approximately 1 km southwest of Herd Base. This location is adjacent to the Purari River therefore the hazard from flooding is also discussed below.

Information on other major hazards and mitigation and control measures has not changed and can be found in the 2019 Upstream EIS (ERIAS, 2019). This includes Fire and Gas Detection (Section 18.4.3.4) and Fire Protection and Fire-fighting Philosophy (Section 18.4.3.6). Emergency preparedness and response is described in Section 18.4.4 of the 2019 Upstream EIS and includes response procedures. The location of the CPF at site P3 considers the requirements for safety exclusion zones and Project operational requirements. Emergency access to the CPF would be supported by helicopters and the Project's helipad complies with the International Civil Aviation Organization regulations. The helipad is located upstream of prevailing winds to avoid smoke dispersion in the event of a fire. Safety studies that have been completed to support the safety and evacuation strategy in the event of an emergency include:

- Flare radiation and vent dispersion study.
- Hazard analysis study.
- Escape and evacuation risk assessment.

Site access during an emergency would be via vehicles, boat, helicopter (to the Purari airstrip or Herd Base) or plane (to the Purari airstrip) depending on the location and the circumstances.

15.2 Seismicity and Landslide Risk

The presence of geohazards is a key criterion that has been used to define facilities' locations as identified in Chapter 5 (Project Options and Analysis). Seismicity and landslide risk have been considered when defining design and safety requirements.

15.2.1 Seismicity

Active faults present a potential risk to the integrity of the CPF as the high seismicity in PNG can result in significant ground displacement. This displacement due to earthquakes can cause stress on buildings and pipelines and result in major hazard events, such as loss of containment. PRL-15 is affected by active faults, which have the potential to generate permanent ground deformations. Permanent ground deformation (up to several meters) may occur along the fault trace. Numerous geotechnical analyses and investigations have been undertaken for the evaluation of Project seismic hazard. The latest revision of seismic hazard occurred following the magnitude 7.5 earthquake on 26 February 2018 and post-earthquake reconnaissance (Seister, 2020a, 2020b).

The potential displacement of Kuku fault (a major fault), shown on Figure 15.1, is estimated to be between 1.1 to 2.2 m (Fugro, 2010). This fault extends over the south side of the river where it is known as the Goigi fault. An exclusion zone of 1 km from major faults was applied during the earlier CPF site selection process (TEP, 2015). Given the high seismicity of the Project area and considering other constraints such as topography and soil properties, 1 km from major faults is adopted by TEP PNG as the minimum acceptable distance to support safe and sustained operations for the lifetime of the CPF (TEP PNG, 2023a. The CPF P3 site is located more than 1 km from the Kuku fault.

Figure 15.1 also shows secondary faults, known as Herd faults, west of Herd Base near CPF P3 site. Identification of this fault derives from hypothetical interpretation of LIDAR data coupled with a 2D seismic line acquired in the vicinity of Herd Base. More recent geohazard mapping provides no firm and factual evidence of their existence (Fugro, 2019). If the faults do exist, the displacement that could be generated at the surface is now regarded to be negligible (less than 0.2 m at 2 km depth) and will not generate any impact on integrity of the CPF ground installations such as the drainage or flare networks and equipment foundations (TEP PNG, 2023a).

Further survey consisting of geological mapping, core boreholes and trench characterization has been undertaken along the Herd faults to narrow uncertainties regarding their presence and movements. The location of the CPF P3 site is assessed to have the same seismic conditions and risk as previously proposed site P2C (TEP PNG, 2023a).

15.2.2 Landslides and Slope Failures

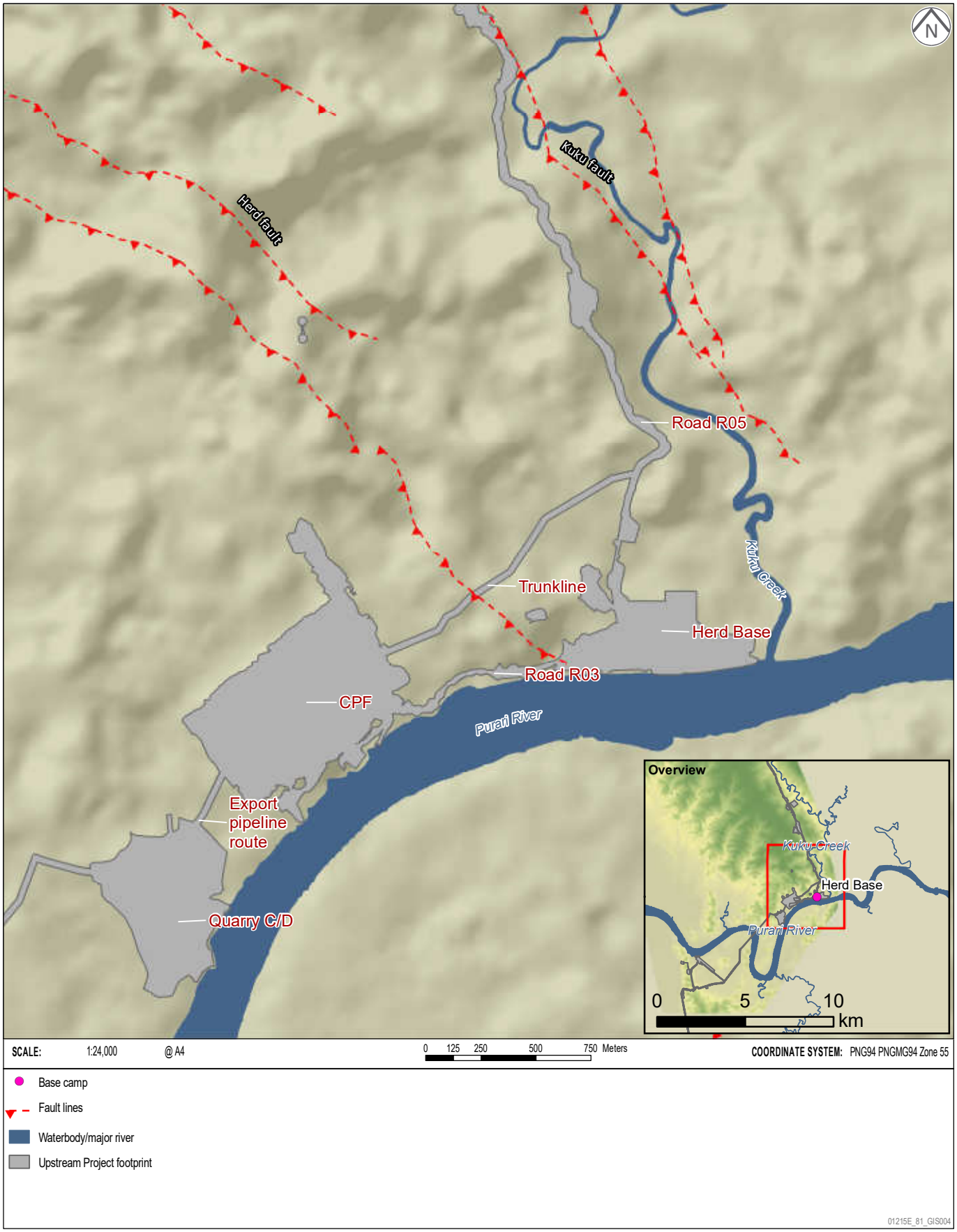
The presence of active and historical landslides is common throughout the PRL-15 area because of the terrain nature and topography, together with tectonic activity and heavy rainfall acting as triggering factors. Earthworks may trigger landslide movement if not properly designed and managed.

Slope failure analysis and mapping of landslides shows that landslide susceptibility is high for Orubadi formation (Tmup1), moderate for Era formation (TQe) and low for undifferentiated alluvium (Qa5) (Fugro, 2019). The soil type at site P3 is TQe and therefore has moderate landslide susceptibility.

Locations of Fault Lines

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FIGURE 15.1



Limited landslide zones have, however, been encountered in the area of CPF P3 site due to the presence of competent subsoils such as gravel, pebble, and mudstone on slopes. Any areas prone to landslide will be removed during the cut activities of the site preparation, and the site is considered to have favorable conditions regarding landslide hazards (TEP PNG, 2023a).

15.3 Flooding Risk

The flooding hazard is very high in the low areas near the Purari River, especially for the PRL-15 zone south of the Purari River.

The flooding risk is an important consideration in the identification of potential suitable alternative CPF sites. To protect the integrity of the CPF facility and ensure safe operations, the infrastructure must be placed on ground which is not subject to flooding and can be accessed in all weather conditions. The preference is therefore to place the CPF on naturally occurring high ground which is above the 1 in 100-year flood zone (TEP PNG, 2023b).

As described in Section 7.3, flood modelling has been undertaken to define the flood hazard from the Purari River and catchment streams (HR Wallingford, 2018). This modelling was undertaken for flood events of the Purari River and localized rainfall events within its catchments for return periods of 10 years, 100 years, 1,000 years and 10,000 years. Modelling results for the 1 in 100-year Purari River flooding event are shown in Figure 7.3 (Chapter 7), along with the footprint of the CPF P3 site.

The preferred approach to create the CPF platform is to use a cut/fill method where the excess cut material from elevated areas within the footprint can be used to fill the low points within the footprint. This method reduces the requirement for importing aggregate from alternative sources. The CPF P3 site will have an elevation of approximately 37 m above mean sea level (amsl) after completion of site preparation, which is 18 m above 100-year return period flooding level of the Purari River (TEP PNG, 2023a). This will require backfilling part of the eastern area of the site that is within the 1 in 100-year flood zone (as shown in Figure 7.3).

The elevation of the road between Herd Base and the CPF (Road R3) is designed to be above the 1:10 year flood level of 14 m MSL. In the event that road access is blocked between the CPF and Herd Base due to flooding of the road, transport between the two sites will occur via helicopter. Emergency accommodation can also be provided at the CPF site.

15.4 References

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16. Mitigation, Management and Monitoring

16.1 Introduction

TEP PNG's environmental and social management framework for the Upstream Project is described in Chapter 19 of the 2019 Upstream EIS. The following sections describe the relationship between the Upstream CESMP, developed in support of the 2019 Upstream EIS, and the updated Project environmental and social management plans developed since, and updated regularly, to manage Project impacts.

Project ESMPs will also be prepared for the operations and decommissioning phases and will be submitted to CEPA. These detailed management plans will be developed based on the Project's environmental and social management framework to implement commitments and define monitoring requirements.

16.2 Construction Environment and Social Management Plan

Embedded design controls and mitigation and management measures to avoid and minimize potential environmental and social impacts are described in the 2019 Upstream EIS (ERIAS, 2019) and further developed in the Upstream CESMP (ERIAS, 2020), which describes the overall environmental and social management framework applicable to the Project. Mitigation and management measures were developed based on the mitigation hierarchy. The hierarchy involves avoiding impacts where possible, minimizing impacts when avoidance is impossible and when impacts remain, considering rehabilitation or restoration, and ultimately compensation/offsetting.

The CESMP's objectives are to:

- Demonstrate compliance with regulations, and internal and Lender requirements.
- Provide supporting documentation for regulatory approvals.
- Document the implementation of the environmental and social management system at the Project level.
- Assign responsibilities for environmental and social management so that all requirements are understood and completed, and actions and outcomes are appropriately documented and communicated.
- Provide consolidated guidance to line management on the implementation of Project-specific environmental and social management commitments identified in this environmental impact statement.
- Identify and communicate the legal obligations and expected standards in relation to contractors' environmental performance.

- Facilitate the modification to, or addition of new, management measures as new potential impacts or risks are identified.
- Provide information on the mitigation and management measures, monitoring requirements and activities, objectives, performance indicators, corrective actions, and procedures for communication, evaluation and reporting.
- Manage the potential for unplanned events and incidents including prevention, response, reporting and corrective action.

The Upstream CESMP (ERIAS, 2020) has since been updated and is now referred to as the CESMP (L2-PLN-SDV-30).[1] The CESMP comprises discipline-specific environmental and social management plans and procedures that describe how the impacts associated with the Project will be managed, consistent with the embedded design controls and mitigation and management commitments made in the 2019 Upstream EIS.

Figure 16.1 shows the structure of the environmental and social management system (ESMS) and the CESMP for the overall Project. Environmental, socioeconomic, occupational, health, safety and security, and multi-discipline management plans have been or will be developed by Company, as part of the CESMP, to provide guidance for environmental and social management (Table 16.1). An Oil Spill Contingency Plan is an additional management plan that will be drafted.

The CESMP applies to works completed by both Company and Contractors. Company's plans, procedures and other documents will be provided to Contractors to set the expectations for environmental and social performance on the Project.

The locations of sensitive habitats and species are mapped in the PCS reports. Retention priorities are applied to each of the environmental features recorded in the survey area, with each feature ranked as low, moderate, high or very high retention priority based on its abundance and replaceability. The retention priorities assigned drive the management implications which are set out in the PCS reports for both habitat features (e.g., alluvial forest, hill forest pools, oxbow lakes) and threatened species (i.e., IUCN or restricted-range species).

Contractors will be required to submit their own implementation procedures for works, which are specific to their scope which detail the specific nature of their planned activities' mitigations and control measures. These Contractor implementation procedures are to be submitted to Company for approval prior to activities commencing.

1 Note, a draft version of the CESMP has been provided to CEPA.

Table 16.1 – Papua LNG Project Environmental and Social Management Plans

No.	Reference Number	Title
1	L2-PLN-HRA-01	Labour and Working Conditions Management Plan
2	L2-PLN-SDV-03	Acid Sulphate Soil Management Plan
3	L2-PLN-SDV-04	Air Emissions and Greenhouse Gas Management Plan
4	L2-PLN-SDV-06	Community Health, Safety and Security Management Plan
5	L2-PLN-SDV-07	Culture Heritage Management Plan
6	L2-PLN-SDV-09	Ecology Management Plan
7	L2-PLN-SDV-10	Chemical and Hazardous Materials Management Plan
8	L2-PLN-SDV-13	Land Access and Livelihood Framework
9	L2-PLN-SDV-15	Noise and Vibration Management Plan
10	L2-PLN-SDV-17	Project-induced In-migration Management Plan
11	L2-PLN-SDV-20	Raw Material Management Plan
12	L2-PLN-SDV-21	Site Restoration and Rehabilitation Management Plan
13	L2-PLN-SDV-22	Soil Management Plan
14	L2-PLN-SDV-25	Surface and Groundwater Management Plan
15	L2-PLN-SDV-26	Traffic and Transport Management Plan
16	L2-PLN-SDV-24	Stakeholder Engagement Management Plan
17	L2-PLN-HSE-07	Waste Management Plan
18	L2-PLN-SDV-05	Community Development Management Plan
19	L2-PLN-SDV-11	Dredge Management Pan – Early Works Dredging
20	L2-PLN-SDV-34	Biodiversity And Ecosystem Services Action Plan
21	L2-PRO-SDV-08	Quarantine Management Procedure
22	L2-PRO-SDV-09	Environmental Monitoring Verification Audit and Reporting (EMVAR)
23	L2-PLN-HSE-01	Affiliate Emergency Response Plan

16.3 Monitoring, Auditing, Reporting and Review

Monitoring is a key component of the ESMS and is required to determine the effectiveness of the design, and construction and operational measures implemented to mitigate predicted environmental and social impacts. Monitoring will consider internal and regulatory requirements, including the environment permit conditions.

The Individual management plans and the EMVAR contain details of relevant performance indicators and the monitoring approach.

Inspecting and auditing of contractor activities is also a key component of the ESMS and comprises self-assessment and assessment of the contractor at regular intervals by TEP PNG or external independent resources when required, for quality assurance and control, and to guarantee integrity. Audit frequency depends on the HSE level of risk of the contracted services, as defined in TEP PNG's HSE requirements for contractors. A corrective action plan will be established when non-conformance or non-compliance is identified.

Figure 16.1 – Environmental and Social Management Framework



Social and environmental performance reporting will be undertaken according to applicable company requirements, and relevant statutory and Lender requirements. TEP PNG will prepare an environmental and social performance report at a frequency to be agreed with CEPA that will provide the information required to satisfy any conditions stipulated in the environment permit.

Monitoring, auditing and reporting documentation will be recorded and retained according to applicable document retention policies.

16.4 References

ERIAS. 2019. Papua LNG Project Upstream Environmental Impact Statement. 01215B_23_v5. December. Unpublished report to Total E&P PNG Limited.

ERIAS. 2020. Papua LNG Project upstream construction environmental and social management plan. Report prepared by ERIAS for TotalEnergies EP PNG Limited.

17. Commitments Register

This chapter collates the new mitigation and management measures that have been identified in Chapters 10 to 14 of this addendum (Table 17.1), to address potential impacts caused by the Project. Existing mitigation and management measures from the 2019 Upstream EIS can be found in Chapter 20 of that document.

Table 17.1 – Additional Mitigation and Management Measures/Commitments

No.	Discipline	Mitigation Measure/Commitment
Environmental Mitigation and Management Measures		
EM049	Terrestrial biodiversity; freshwater and estuarine biodiversity	Develop and implement a comprehensive International Union for Conservation of Nature (IUCN) Threatened Freshwater Turtle Species Management Program, that will: • Engage with Piku Biodiversity Network (PNG non-government organization (NGO)) and/or other ecologists as required. • Educate/train and engage local resident landowners in an effort to curb currently unsustainable hunting levels. • Initiate studies into the location and timing of nesting and to document harvesting rates. • Monitor local populations.
EM050	Terrestrial biodiversity; freshwater and estuarine biodiversity	Targeted baseline studies will be undertaken to better understand the ecology and population status of the study area's IUCN threatened freshwater turtles and the harvesting practices of local residents. These studies will be undertaken prior to construction and will be followed by long-term monitoring of breeding and harvesting activity. The results of these studies may lead to amendment of or addition to existing mitigation measures.
EM051	Greenhouse gas (GHG)	Assess total Project GHG emissions and potential impacts at the completion of front-end engineering design (FEED) and include relevant mitigations in the Construction Environmental and Social Management Plan (CESMP).
EM052	Landscape and visual amenity	A visual assessment will be included in the site selection process for resettling Pokore Hamlet.
EM053	Noise	The site selection process for resettling Pokore Hamlet will consider the results of the noise modelling to ensure that noise limits are not exceeded at the new site.
Social Mitigation and Management Measures		
SM031	Resettlement	Resettlement of Pokore Hamlet according to a Resettlement Action Plan (RAP) to be developed and assess social impacts associated with the new location.

18. Study Team

18.1 Company

The TEP PNG management team and advisors that led and oversaw the EIS Addendum are listed in Table 18.1.

Table 18.1 – TEP PNG EIS Addendum Team

Name	Title/Role
Marie-Alix Dognin	Health, Safety, Sustainability and Environment Director
Christian Ille	Biodiversity and Environment Manager
Thomas Kevaro	Environment Operations Coordinator
Kobus Meulenbroeks/Nick Hannaford	Senior Environmental Advisor
Jane Mogina	Biodiversity Coordinator
Geoffrey Callister/Marisa Smit	Land Access and Societal Studies Advisor

The TotalEnergies Project team that oversaw the EIS Addendum are listed in Table 18.2.

Table 18.2 – TotalEnergies Project EIS Addendum Team

Name	Title/Role
Guillaume Rat	Health, Safety and Environment Manager
Charlotte Moore	Senior Environment and Societal Engineer
Erwin Santosa	Environment and Societal Engineer

18.2 Lead Consultant

ERIAS was engaged by TEP PNG as the environmental and social consultant to deliver this EIS Addendum. ERIAS's team of consultants have in-depth knowledge of extractive industries and infrastructure developments, many of whom have been involved since the 2019 Upstream EIS.

Table 18.3 identifies the key personnel who contributed to the preparation and management of the EIS Addendum and associated tasks.

Table 18.3 – ERIAS EIS Addendum Team

Name	Title/Role
Management Team	
Luci David	Project Director
Andrew Todd-Weckmann	Project Manager
Technical Support	
Clark Monahan	EIS Addendum author
Imogen Pym	EIS Addendum author
Anita Togolo	EIS Addendum author

Name	Title/Role
Iain Woxvold	EIS Addendum author
Caryn Dixon	EIS Addendum author
Arianna Wright	EIS Addendum author
Tim Burke Karen Hansen Dan Kennedy	Spatial data management and presentation
Contract/Finance Support	
David Browne	Contract Manager
Casey Mortlock	Finance Manager

ERIAS was engaged by TEP PNG to complete the pre-clearance surveys (PCS), commencing in 2022 and has collected a large volume of data that has been drawn upon for this EIS Addendum. Table 18.4 identifies the core PCS team. Full lists of PCS personnel are provided in the individual PCS reports. The names of the PNG consultants and technical specialists are indicated by an asterisk (*).

Table 18.4 – ERIAS Core PCS Field Team

Name	Title/Role
Management and Logistics	
Julie Crawford	Field lead, HSSE, logistics and coordination
Ben Salleras	HSSE, logistics and coordination
Nicole Frani*	Logistics and coordination
Terrestrial Biodiversity	
Penniel Lamei*	Botanist
Tiberius Jimbo*	Botanist
Fanie Venter	Botanist
Benjamin Kelimbua*	Botanist
David van den Hoek	Botanist
Hayden Wagia*	Botanist
Stephen Richards	Ecologist
Iain Woxvold	Ecologist
Wilson James*	Ecologist
Aquatic/Soils	
Robin Kipefa*	Aquatic scientist
Brandon John*	Aquatic scientist
Jastin Kasi*	Aquatic scientist
Nathan Lumaso*	Aquatic scientist
Sarah Farquhar	Aquatic scientist
Cultural Heritage	
Joseph Crouch	Archaeologist
Jean-Pierre de Saint-Aubert	Archaeologist

Name	Title/Role
Chloe Apo*	Archaeological assistant
Rien Ben*	Archaeological assistant
Mary Koro*	Archaeological assistant

18.3 Specialists

Technical specialists engaged by TEP PNG, to undertake modeling studies and support the impact assessment are provided in Table 18.5.

Table 18.5 – Amenity Specialist Team

Name	Specialty	Role	Organization
Kirsten Lawrence/ Fardausur Rahaman/ Danroy D'Souza	Air quality and noise	Technical specialist	SLR Consulting Australia Pty Ltd

Appendix 1
SLR Papua LNG CPF P3 Relocation. Air Quality Impact Assessment

Papua LNG CPF P3 Relocation

Air Quality Impact Assessment

Papua LNG Development Pty Ltd

182 Cecil Street, #27-01 Frasers Tower
SINGAPORE 069547

Prepared by:

SLR Consulting Australia

Level 16, 175 Eagle Street, Brisbane QLD 4000,
Australia

SLR Project No.: 620.040581.00001

Client Reference No.: PG-P15-31-OTHE-000001

23 April 2024

Revision: 1.0

Revision Record

Revision	Date	Prepared By	Checked By	Authorised By
1.0	23 April 2024	F Rahaman, D D'Souza	K Lawrence	K Lawrence

Basis of Report

This report has been prepared by SLR Consulting Australia (SLR) with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with Papua LNG Development Pty Ltd (the Client). Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

This report is for the exclusive use of the Client. No warranties or guarantees are expressed or should be inferred by any third parties. This report may not be relied upon by other parties without written consent from SLR.

SLR disclaims any responsibility to the Client and others in respect of any matters outside the agreed scope of the work.

Executive Summary

Background

SLR Consulting (Australia) Pty Ltd (SLR) prepared an Air Quality Impact Assessment (AQIA) in 2015 as part of the Environmental Impact Statement (EIS) for the Papua LNG Project (ERIAS 2019), which included a detailed meteorological and air dispersion modelling study for the CPF operations (SLR 2019), and a qualitative risk assessment of potential air quality impacts associated with the construction phase.

As part of the Front-End Engineering Design (FEED) stage of the Papua LNG Project, opportunities have been sought to optimise the Project footprint by reconsidering the placement of infrastructure to maximise re-use of areas degraded by the previous operator during the exploration and appraisal phases. These optimisation activities have identified a possible alternative site for the CPF (referred to as 'CPF-P3') nearer Herd Base, which is the existing logistics hub for the Papua LNG Project upstream development. This proposed change in the CPF location would result in less road construction being required, a shorter pipeline route and the ability to combine the CPF footprint with the construction camp.

This report presents updated air emissions inventories, meteorological modelling and plume dispersion modelling for the CPF-P3 location, incorporating currently available plant design data developed during the 2023 FEED, to provide a revised assessment of the potential air quality impacts and associated compliance aspects for the CPF.

Assessment Methodology

The main emissions to air associated with the proposed CPF operations are products of combustion from the burning of fuel gas in gas turbines for power generation and the heating boilers, as well as from flaring during commissioning and upset operating conditions. The key pollutants considered in this updated assessment of operational phase air emissions were therefore:

- NO_X
- CO
- SO_2
- Particulate matter (as $PM_{2.5}$ and PM_{10})

Modelling of particulate matter emissions was not performed in the 2019 AQIA as emission data were not available. The currently available design data includes estimates of particulate emissions, and these emissions were included in the updated air dispersion modelling study.

The 2019 AQIA also included quantification and modelling of VOCs, including benzene, toluene, ethylbenzene and xylenes. That modelling study showed that the predicted VOC concentrations were far below (less than 0.1% of) the adopted ambient air quality criteria for the relevant pollutants. Emissions of VOCs were therefore not reassessed in this study.

The dispersion of stack emissions from the CPF operations were modelled using the US EPA approved CALPUFF (Version 6.42) air dispersion modelling system. The meteorological data inputs were compiled using the Weather Research and Forecast (WRF) (NCAR 2023) and CALMET meteorological models. to compile a one-year, three-dimensional meteorological dataset covering the proposed new CPF and surrounding area. The 2019 AQIA used a one year meteorological dataset compiled based on meteorological records for the 2015 calendar year. For this assessment, the data inputs were updated with regional meteorological records for the most recent calendar year available, being 2022.



Emissions estimation and dispersion modelling was performed for three different operational scenarios for the CPF, being:

- Case 1: Normal Operations
- Case 2 – Flaring: 35% Turndown with gas production flared
- Case 3 – Flaring: 35% Turndown with acid gas compressor off-line

Similar to the 2015 AQIA, the assessment of potential air quality impacts associated with construction of the Project at the CPF P3 location was performed using the methodology outlined in the Institute of Air Quality Management (IAQM) document, *Guidance on the Assessment of Dust from Demolition and Construction* (IAQM 2024). The IAQM method uses a four-step process for assessing dust impacts from construction activities:

- Step 1: Screening based on distance to the nearest sensitive receptor; whereby the sensitivity to dust deposition, human health impacts and ecological impacts of the identified sensitive receptors is determined.
- Step 2: Assessing the risk of dust effects from activities based on:

  (a) the scale and nature of the works, which determines the potential dust emission magnitude.

  (b) the sensitivity of the area surrounding dust-generating activities.
- Step 3: Determining site-specific mitigation for remaining activities with greater than negligible effects.
- Step 4: Assessing the residual risk of dust effects from activities after management measures have been considered.

Conclusions

The main conclusions from this updated AQIA for the proposed relocated CPF are as follows:

- Construction Phase:
  - Based on the IAQM construction dust risk assessment methodology, there is a ***Negligible*** or ***Low*** risk of human health or dust nuisance impacts associated with the earthworks and construction activities proposed at the CPF-P3 site, even if no dust mitigation measures were to be implemented. This is due to the low population density in the surrounding area.
  - The risks of any potential ecological impacts are concluded to be ***Medium*** during earthworks and ***Low*** during construction, if no dust mitigation measures were to be implemented. As these impacts will be localised and short-term in duration, any affected vegetation can be expected to recover rapidly, particularly given the high rainfall in the region.
  - The above assessment findings are unchanged from the 2015 AQIA findings.
- Operational Phase:
  - The results of the air dispersion modelling study for the latest available emissions data and plant layout for the CPF-P3 site show that for all operational scenarios assessed, the maximum ground-level NO_2, SO_2, CO and particulate matter concentrations predicted at the sensitive receptors are well below the relevant ambient air quality criteria. Concentrations predicted at all off-site locations are also well below the relevant ambient air quality criteria.

- The maximum ground-level VOC concentrations predicted for the CPF in the 2015 AQIA were negligible compared to the relevant ambient air quality criteria and have not been reassessed.
- Annual average off-site SO_2 concentrations will be far below the ICP (2017) guidelines for adverse impacts on vegetation and forest ecosystems of 20 $\mu g/m^3$. No adverse impacts on vegetation would therefore be anticipated due to SO_2 emissions from the CPF.
- The above assessment findings are unchanged from the 2015 AQIA findings.

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Acronyms and Abbreviations

%	percent
°C	degrees Celsius
µg/m^3	micrograms per cubic metre
AG	acid gas
AQIA	Air Quality Impact Assessment
asl	above sea level
CEPA	Conservation and Environment Protection Authority (PNG)
CO	carbon monoxide
CO_2	carbon dioxide
CPF	Central Processing Facility
DEC	Department of Environment and Conservation (PNG)
EC	European Commission
EHS	Environmental, Health and Safety
EIS	Environmental Impact Statement
ENSO	El Niño-Southern Oscillation
FEED	Front-End Engineering Design
GIIP	Good International Industry Practice
ha	hectares
H_2S	hydrogen sulphide
HP	high-pressure (gas)
IAQM	Institute of Air Quality Management (UK)
IFC	International Finance Corporation
km	kilometres
LIDAR	Light Detection and Ranging
LNG	Liquified Natural Gas
LP	low-pressure (gas)
m	metres
m^3	cubic metres
mm	millimetres
m/s	metres per second
Mtpa	million tons per annum
NO_2	nitrogen dioxide
NO_X	oxides of nitrogen
$PM_{2.5}$	particulate matter with an aerodynamic diameter of 2.5 micrometres or less
PM_{10}	particulate matter with an aerodynamic diameter of 10 micrometres or less
PNG	Papua New Guinea

SO_2	sulfur dioxide
SO_X	sulfur oxides
SRTM	Shuttle Radar Topography Mission
TSP	total suspended particulate
US EPA	United States Environmental Protection Agency
VOCs	volatile organic compounds
WHO	World Health Organization
WRF	Weather Research and Forecast (meteorological model)

1.0 Introduction

The Elk-Antelope field is a significant gas discovery located within the Gulf Province in Papua New Guinea (PNG). The field lies south of the mountains and is located approximately 120 kilometres (km) inland from the township of Kerema and 360 km northwest of Port Moresby, the capital city and major industrial centre.

To access the Elk Antelope natural gas and condensate resources, the Papua Liquified Natural Gas (LNG) Project includes construction of in-field drilling pads connected by flowlines to a Central Processing Facility (CPF), with subsequent delivery of the natural gas and condensate to the existing PNG LNG Facility located at Caution Bay on the southern coastline of the Gulf of Papua, via onshore and offshore export pipelines.

SLR Consulting (Australia) Pty Ltd (SLR) prepared an Air Quality Impact Assessment (AQIA) in 2015 as part of the Environmental Impact Statement (EIS) for the Papua LNG Project (ERIAS 2019), which included a detailed meteorological and air dispersion modelling study for the CPF operations (SLR 2019), and a qualitative risk assessment of potential air quality impacts associated with the construction phase.

As part of the Front-End Engineering Design (FEED) stage of the Papua LNG Project, opportunities have been sought to optimise the Project footprint by reconsidering the placement of infrastructure to maximise re-use of areas degraded by the previous operator during the exploration and appraisal phases. These optimisation activities have identified a possible alternative site for the CPF (referred to as 'CPF-P3') nearer Herd Base, which is the existing logistics hub for the Papua LNG Project upstream development (see **Figure 1**). This proposed change in the CPF location would result in less road construction being required, a shorter pipeline route and the ability to combine the CPF footprint with the construction camp.

The purpose of this report is to present updated air emissions inventories, meteorological modelling and plume dispersion modelling for the CPF-P3 location, incorporating currently available plant design, and provide a revised assessment of the potential air quality impacts and associated compliance aspects.

Figure 1 Papua LNG Project – CPF Relocation



1.1 Assessment Objectives

The key objective of this air quality impact assessment is to provide an updated air quality impact assessment for the CPF construction and operations, based on the new CPF-P3 location, as well as addressing relevant design changes since the AQIA was prepared for the EIS in 2019.

This information will be used to prepare an Environmental Impact Statement for submission to regulators and to satisfy International Finance Corporation (IFC) environmental assessment requirements associated with this proposed change in location of critical infrastructure.

1.2 Scope of the Assessment

The scope of this updated AQIA included:

- Compilation of updated air emission inventories for normal and worst case operating conditions based on the latest CPF design information. The air pollutants addressed were:
  - oxides of nitrogen (NOx)
  - carbon monoxide (CO)
  - sulfur dioxide (SO_2)
  - particulate matter
- Compilation of an updated site-representative meteorological file for the CPF-P3 site and surrounding area.
- Update of sensitive receptor locations considered in the assessment to include new dwellings constructed in the last five years.
- Review of the ambient air quality criteria used in the 2019 AQIA to address any changes in guidelines and standards.
- Updated air dispersion modelling of operational phase air pollutant emissions under normal and worst case operating conditions and assessment of predicted ground level concentrations against the relevant ambient air quality criteria.
- Update of the qualitative risk-based assessment of potential air quality impacts during construction of the CPF, based on the design updates and relative location of the CPF-P3 site to existing sensitive receptor locations.

2.0 Project Description

The Papua LNG Project's upstream facilities are situated in a hilly area, between 50 to 400 metres (m) above sea level, covered by a dense tropical forest and irrigated by several rivers including the Purari River, which constitutes the main access from the coastline located about 60 km to the south. The region is sparsely populated with little infrastructure.

The gas fields comprise two discrete gas reservoirs (Elk and Antelope). More than 95% of the combined Elk–Antelope gas reserves are in the Antelope gas field. The gas composition is comprised primarily of methane, ethane and propane. The gas and condensate from the Elk-Antelope gas fields contains low levels of sulfur compounds that are considered impurities.

The proposed Papua LNG Project development architecture includes several surface facilities (see **Figure 2**):

- The wellpads and upstream gathering network, including a field manifold at the Antelope production wellpad (ANT-10), two parallel multiphase Elk flowlines to ANT-10 and two parallel multiphase trunklines between ANT-10 and the CPF-P3 site.
- The upstream / midstream CPF, located 30 km from the Antelope field manifold.
- The approximately 325 km long single-phase gas and condensate export pipelines from the CPF-P3 site to the PNG LNG facility.
- The brownfield development of three new LNG liquefaction trains at the existing PNG LNG facility in Caution Bay for the export of 5.6 million tons per annum (Mtpa) of LNG, with a 6.0 Mtpa of Stream Day Capacity (including 2 Mtpa reserved in the existing PNG LNG Plant), and associated condensate products.

2.1 Wellpads and Gathering Systems

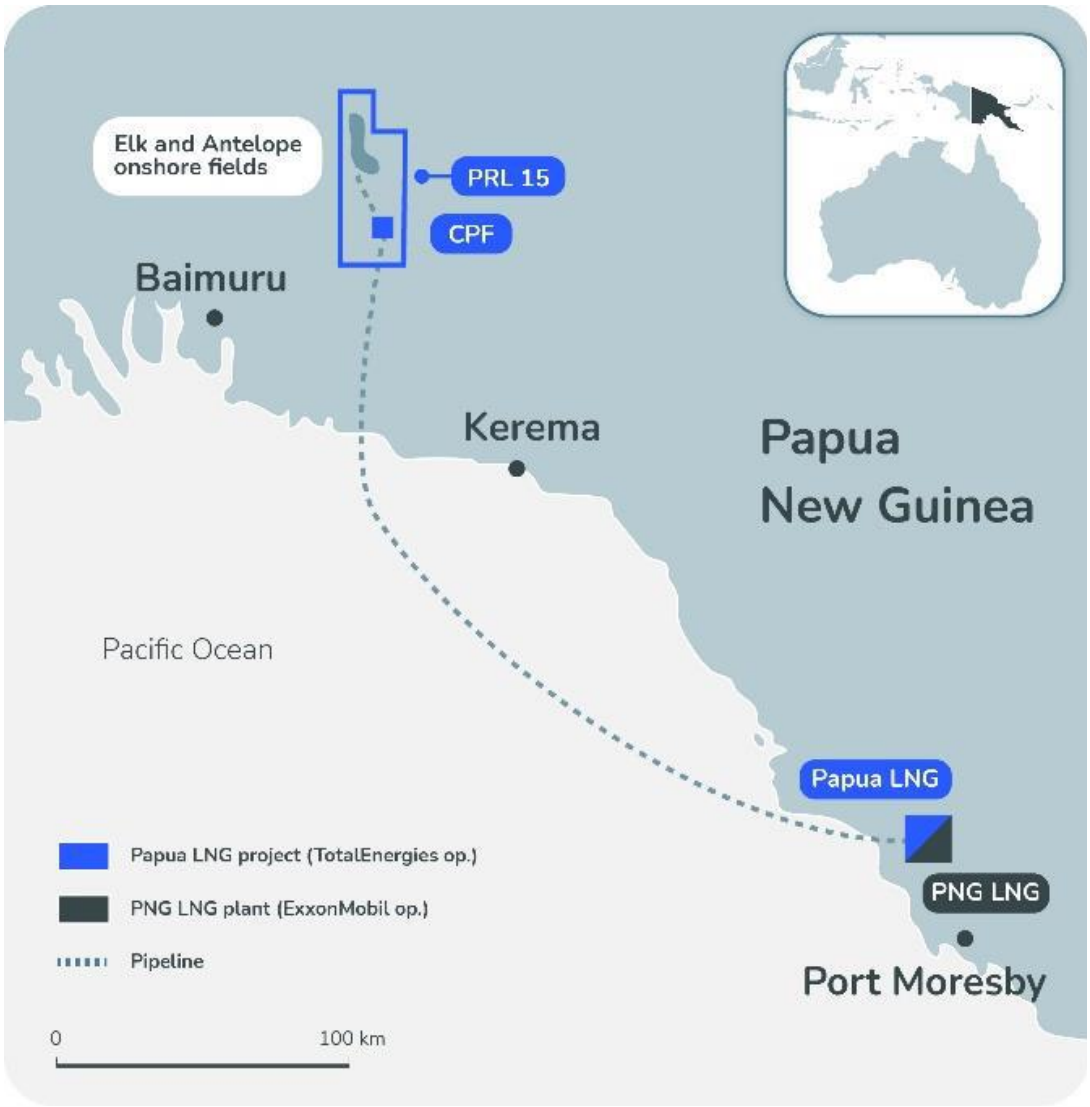
The Elk-Antelope gas fields will be developed with up to eight production wells, one produced water disposal well and one acid gas[1] disposal well. The production wells will be drilled from three wellpads (ELK-10, ANT-10 and ANT-11).

Acid gas will be disposed by reinjection from the commencement of operations. In the first phase, production from the smaller Elk reservoir will be accelerated and the acid gas from production of both Elk and Antelope reservoirs will be disposed of in a dedicated acid gas re-injection well downdip in the Antelope reservoir. The second phase begins when Elk reservoir is adequately depleted, at this time the Elk gas producers will be converted into acid gas re-injectors and will re-inject all future acid gas production from Antelope reservoir.

The gathering system is made up of pipelines (flowlines and trunklines) that collect and transport the raw gas and associated liquids (wellstream fluids) from individual gas production wells to the CPF-P3 site. The flowlines will be used to pipe acid gas and produced water from the CPF to the reinjection wells.

[1] The acid gases hydrogen sulphide (H_2S) and carbon dioxide (CO_2) are removed from the produced gas by the CPF to ensure that the gas fulfills pipeline specifications and meets environmental, health, and safety standards.

Figure 2 Overall Development Architecture



2.2 Central Processing Facility

The raw gas and condensate will be processed at the CPF before being piped to the PNG LNG facility. Processing is required to separate the natural gas from the condensate and to remove carbon dioxide, water and sulphur compounds so that the natural gas and condensate compositions meet the export specifications.

The CPF includes a process area, utilities area, services area, flare system, and condensate storage. An operations camp will be located near the CPF and maintenance facilities will be co-located with the CPF.

2.3 Export Pipelines

The natural gas and condensate will be transported by separate export pipelines in the same corridor from the CPF-P3 site to the PNG LNG Facility. The export pipelines will include:

- approximately 60 km of onshore pipelines from the CPF to Orokolo Bay; and
- about 250 km of offshore pipelines from Orokolo Bay to the PNG LNG facility.

The onshore pipelines will be buried approximately 1 m below the ground.

The offshore pipelines will be parallel to the existing PNG LNG pipelines that export natural gas and condensate from the existing Hides CPF to the PNG LNG Facility for over their length. The offshore pipelines will generally be laid on the seabed, in about 85 m water depth.

In shallow water near the shore crossings, the pipelines will be buried between 1.0 m and 2.5 m below the seabed to protect the pipelines from vessels or anchor damage.

2.4 Associated Infrastructure

The Project will require a combination of existing infrastructure, such as port facilities in Port Moresby and newly constructed infrastructure such as a logistics base, waste facilities, roads, quarries, and an extension to the existing Purari airstrip.

Transport of people to and from PRL 15 will be via air, whereas materials will mostly be transported by sea and river to PRL 15. River transport routes include the Purari River and the Urika and Ivo rivers when the Purari River is impassable.

During the Project construction phase, camps will be constructed to house a peak workforce of a few thousand people at various locations within the Project area. A 250 person camp will be constructed near the CPF for the operations phase.



3.0 Identification of Project Air Emissions

3.1 Construction Phase

As per the 2019 AQIA, the main emissions to air expected to result during the construction phase of the Project are fugitive emissions of particulate matter (dust) from earthworks, wind erosion of disturbed areas and stockpiles, and wheel-generated dust. Mechanically-generated total suspended particulate (TSP) emitted by construction activities predominately comprises larger size fractions of particles, which have the potential to give rise to off-site nuisance impacts.

During construction, there will also be products of combustion from the diesel-powered construction equipment such as trucks, excavators, and cranes, and from the transport of workers and equipment by road and by barge. These emissions will include oxides of nitrogen (NOx), carbon monoxide (CO), carbon dioxide (CO_2), sulphur dioxide (SO_2), volatile organic compounds (VOCs) and fine particulate matter. Compared to mechanical sources, the particulate matter emitted by combustion sources has a much higher proportion of fine particulate matter (i.e. particulate matter with an aerodynamic diameter of 10 micrometres or less (PM_{10}) and particulate matter with an aerodynamic diameter of 2.5 micrometres or less ($PM_{2.5}$)).

There will also be other minor air emissions associated with the construction works, such as VOC venting emissions from fuel storage and handling, and odours associated with sewage treatment facilities and from the storage, handling and disposal of municipal waste from the construction camps. These emissions would not be expected to give rise to any adverse air quality impacts beyond the Project's proposed state lease boundary and have therefore not been considered further.

3.2 Commissioning and Operational Phases

The main emissions to air associated with the proposed operations are products of combustion from the burning of fuel gas in gas turbines for power generation and the heating boilers, as well as from flaring during commissioning and upset operating conditions. The key pollutants considered in this updated assessment of operational phase air emissions were therefore:

- NO_X
- CO
- SO_2
- Particulate matter (as $PM_{2.5}$ and PM_{10})

Modelling of particulate matter emissions was not performed in the 2019 AQIA as emission data were not available. The currently available design data includes estimates of particulate emissions, and these emissions have been included in the air dispersion modelling study.

The 2019 AQIA also included quantification and modelling of VOCs, including benzene, toluene, ethylbenzene and xylenes. That modelling study showed that the predicted VOC concentrations were far below (less than 0.1% of) the adopted ambient air quality criteria for the relevant pollutants. Quantification and remodelling of VOCs has therefore not been included in this study.

As for the construction phase, the Papua LNG Project will result in other minor air emissions associated with the CPF and pipeline operational activities, such as VOC venting emissions from fuel storage and handling, wheel-generated dust and products of combustion from the

transport of workers and equipment, and from general maintenance activities (e.g., from sanding, welding and the use of solvents for cleaning equipment parts). These emissions will be minimal compared to the main CPF operations and would not be expected to give rise to any adverse air quality impacts beyond the Project lease boundaries. They have therefore not been considered further in this assessment.



4.0 Regulatory Requirements and Assessment Criteria

4.1 PNG Regulatory Requirements

In February 2014, the Papua New Guinea (PNG) Parliament passed an Act to set up a new Conservation and Environment Protection Authority (CEPA). CEPA has replaced the Department of Environment and Conservation (DEC) as the government agency responsible for administering the *Environment Act 2000*.

The *Environment Act 2000* (Environment Act) is the primary legislation in PNG that regulates the environmental impact of development activities and how adverse effects of such activities should be avoided, remedied or mitigated. The Environment Act caters for the sustainable management of the biological and physical components of the land, air and water resources of the country.

Several guidelines have also been published by the then DEC relevant to the assessment of air emissions from proposed developments, including:

- *Guideline for submission of an application for an environmental permit to discharge waste* (DEC 2004a).
- *Technical Guideline (Additional Information) Air Discharges* (DEC 2004b)

The *Technical Guideline (Additional Information) Air Discharges* sets out the information that should be provided as part of an application for an Environment Permit where air emissions may be generated. This includes:

- Details of the source, nature, composition and rate of air emissions.
- Information on emissions control equipment and proposed methods to minimise air discharges (specific information for fabric filters, afterburners and wet scrubbers is requested).
- Maintenance procedures and contingency procedures to avoid air discharges from process failure and shut down.
- Stack emission details.
- Calculated ground level concentrations of pollutants proposed to be discharged to air under normal and maximum operating conditions and start up and shutdown conditions.
- An assessment of the impact of the proposal on the environment.

The *Technical Guideline (Additional Information) Air Discharges* also requires that in assessing the potential impacts on air quality the '*effects of existing on-site discharges and existing loadings from neighbouring industries*' must be considered. As the CPF-P3 site is located approximately 1 km west of Herd Base, which is the existing logistics hub for the Papua LNG upstream development, consideration has been given to the potential for cumulative air quality impacts associated with emissions from Herd Base.

4.2 IFC Environmental, Health and Safety Guidelines

4.2.1 IFC General EHS Guidelines: Environmental – Air Emissions and Ambient Air Quality

The International Finance Corporation (IFC) *Environmental, Health and Safety Guidelines: Environmental – Air Emissions and Ambient Air Quality* (IFC 2007) provides an approach to

the management of significant sources of air emissions, including specific guidance for assessment and monitoring of impacts. This guideline states that:

'*Where possible, facilities and projects should avoid, minimize, and control adverse impacts to human health, safety, and the environment from emissions to air. Where this is not possible, the generation and release of emissions of any type should be managed through a combination of:*

- *Energy use efficiency*
- *Process modification*
- *Selection of fuels or other materials, the processing of which may result in less polluting emissions*
- *Application of emissions control techniques*.'

Projects with significant sources of air emissions, and potential for significant impacts to ambient air quality, should prevent or minimise impacts by ensuring that:

- Emissions do not result in pollutant concentrations that reach or exceed relevant ambient quality guidelines and standards by applying national legislated standards or, in their absence, the current WHO Air Quality Guidelines (refer **Section 4.3**), or other internationally recognised sources.
- Emissions do not contribute a significant portion to the attainment of relevant ambient air quality guidelines or standards (as a general rule, the guideline suggests 25% of the applicable air quality standards to allow additional, future sustainable development in the same airshed).

The 'general approach' outlined in the IFC *Air Emissions and Ambient Air Quality* guideline (IFC 2007) states that impacts on air quality of a proposed development should be estimated through qualitative or quantitative assessments by the use of baseline air quality assessments and atmospheric dispersion models to assess potential ground level concentrations. Local atmospheric, climatic, and air quality data should be applied when modelling plume dispersion, taking into account atmospheric downwash, wakes, or eddy effects of the source, nearby structures and terrain features. The dispersion model applied should be internationally recognised, or comparable.

4.2.2 IFC Environmental, Health and Safety Guidelines for Onshore Oil and Gas Development

The IFC industry sector *Environmental, Health and Safety (EHS) Guidelines for Onshore Oil and Gas Development* (IFC 2007) is designed to be used together with the General EHS Guidelines document and provides general and industry-specific examples of Good International Industry Practice (GIIP). This document applies to seismic exploration; exploration and production drilling; development and production activities; transportation activities including pipelines; other facilities including pump stations, metering stations, pigging stations, compressor stations and storage facilities; ancillary and support operations; and decommissioning.

This document notes that principal air emission sources from onshore oil and gas development facilities include:

- Combustion for power and heat generation, and the use of compressors, pumps, and reciprocating engines (boilers, turbines, and other engines)
- Emissions resulting from flaring and venting
- Fugitive emissions.



Principal pollutants from these sources are identified as:

- NO_X
- sulfur oxides (SO_X)
- CO
- Particulate matter.

Additional pollutants can include H_2S and VOCs.

The IFC EHS guideline document for onshore oil and gas development provides guidance on recommended air emissions mitigation strategies for combustion units, venting and flaring operations, boil-off gas management and fugitive emissions. It states that air quality impacts should be estimated by the use of baseline air quality assessments and atmospheric dispersion models to establish potential ground level ambient air concentrations during facility design and operations planning.

4.3 Ambient Air Quality Criteria Adopted for this Assessment

PNG does not currently have any specific statutory air quality requirements. Therefore, to identify appropriate ambient air quality criteria, a review of relevant guidelines set by other agencies was performed for the 2019 AQIA, including:

- World Health Organization (WHO) Air Quality Guidelines, (WHO 2000) (WHO 2005)
- European Commission Air Quality Standards, (EC 2008)
- United States Environmental Protection Agency (US EPA) standards, (US EPA 2016)

The ambient air quality guidelines adopted for use in the 2019 AQIA for the pollutants of interest in this updated study are summarised in **Table 1**. As noted in **Section 3.2**, operational phase particulate matter emissions were not quantified or modelled in the 2019 AQIA as emission data were not available.

As shown in **Table 1**, reference was made to the WHO air quality guidelines current at the time of preparing that assessment. WHO updates their air quality guidelines on a regular basis to assure their continued relevance and to support a broad range of policy options for air-quality management in various parts of the world, taking into account new health studies that have been published in the meantime (WHO 2005). The latest update of the WHO air quality guidelines was released in 2021 (WHO 2021).

The updated WHO guidelines were therefore reviewed and the assessment criteria used in the 2019 AQIA were updated for use in this study to adopt the 2021 WHO guidelines in all cases where they have been revised by WHO, given that they are based on the latest available scientific evidence. The adopted assessment criteria used in this study are also presented in **Table 1**, with changes in the adopted criteria highlighted with bold text. It is noted that the 2021 WHO guidelines for NO_2 (annual average) and CO (1-hour) are more stringent than the 2005 limits used in the 2019 AQIA for some averaging periods. Conversely, the current WHO guideline for 24-hour average concentrations of SO_2 is twice that used in the 2019 AQIA.

Table 1 Adopted Ambient Air Quality Criteria

Pollutant	Averaging Time	2019 AQIA		This AQIA	
		Assessment Criteria (µg/Nm^3)	Source	Assessment Criteria (µg/Nm^3)	Source
Nitrogen dioxide (NO_2)	1-hour	200	IFC 2007, WHO 2005, EU 2010	200	WHO 2021
	24-hours	-		**25**	
	Annual	40		**10**	
Carbon monoxide (CO)	1-hour	35,000	WHO 2000	35,000	WHO 2021
	8-hours	10,000	WHO 2000, EU 2010	10,000	
	24-hours	-		**4,000**	
Sulfur dioxide (SO_2)	10-minutes	500	IFC, 2007, WHO, 2005	500	WHO 2021
	1-hour	200	US EPA, 2016	200	US EPA, 2016
	24-hours	20	IFC, 2007, WHO, 2005	**40**	WHO 2021
PM_{10}	24-hours	-	Not modelled	**45**	WHO 2021
	Annual	-		**15**	
$PM_{2.5}$	24-hours	-	Not modelled	**15**	WHO 2021
	Annual	-		**5**	

5.0 Existing Environment

5.1 Environmental Values

For the purposes of this assessment, an environmental value is defined as a quality or physical characteristic of the environment that is important to ecological and human health. In relation to air quality, the following environmental values have been identified:

- an air environment that is conducive to human health and wellbeing
- an air environment that is conducive to protecting the health and biodiversity of ecosystems
- an air environment that is conducive to protecting the aesthetics of the environment, including protection against nuisance odour and dust impacts
- an air environment that is conducive to protecting agricultural uses

Potential impacts of the Project on the above environmental values were assessed based on a review of the existing air quality in the study area, and through a compliance assessment for the proposed CPF Plant with the ambient air quality guidelines set for the key air pollutants that have been identified as being generated by the Project.

5.2 Climate

PNG has a tropical, monsoonal climate. The coastal and islands regions tend to be hot and humid, with temperature averages ranging between 20°C to 32°C, relative humidity levels ranging from 70% to 90% and high rainfall year-round.

Seasonal climate changes in the study area are controlled by two mass air movements. Typically the easterly trade wind season occurs from April/May to October/November and the northwest monsoon occurs from November/December to March/April. There are transitions at the cross over of each season.

PNG's climate varies considerably from year to year due to the El Niño-Southern Oscillation (ENSO). This is a natural climate pattern that affects weather across the world. El Niño is a warming of the Pacific Ocean, resulting in longer and cooler dry seasons (i.e. periods of drought) and a delay to the start of monsoon season. La Niña, the cold phase of ENSO, typically results in higher than average rainfall and warmer temperatures during the wet season, often leading to flooding events and landslides (PACCSAPP 2015). PNG also experiences neutral phases.

A dominant climatic factor in the upland areas is cloud and fog; and for most of the year, they are important sources of moisture. Western and northern parts of PNG experience the most precipitation, since the north- and westward-moving monsoon clouds are heavy with moisture by the time they reach these more distant regions. However, on rare occasions, vegetation of the uplands can become dry enough to burn, as happened during a severe drought in 2015 when fires spread from the Highlands to West New Britain across to Milne Bay province in the latter half of the year. Towards the coast, rainfall is lower and more evenly spread throughout the year (averaging around 300 mm/month) (Evesson 1983).

Temperatures in the study area are mild and remain relatively consistent throughout the year. Temperature is altitude dependent, with hot and humid conditions associated with lower altitudes and cooler conditions at higher altitudes.

Tropical cyclones tend to affect southern Papua New Guinea between November and April. In the 41-year period between 1969 and 2010, 23 tropical cyclones passed within 400 km of Port Moresby, an average of less than one cyclone per season. From 1969–2010, cyclones

occurred more frequently in neutral phases of the El Niño-Southern Oscillation (PCCSPP 2011).

5.3 Topography

The topography and land use of the study area have the potential to impact on the baseline air quality as well as the dispersion of air emissions from the Project. Local wind patterns will be influenced by hills and valleys which will act to channel winds. Night-time drainage flows will create downslope winds which will also influence the direction in which emissions from the Project will be dispersed. The natural vegetation in the study area also has the potential to affect wind speeds and atmospheric turbulence through changes in surface roughness associated with changes in canopy heights. Ambient particulate levels are also affected by vegetation, which reduces wind erosion but also has the potential to contribute to increased pollen levels.

Mountains, hills and levee plains characterise PRL 15. The northern two-thirds of PRL 15 comprises southeast to northwest trending ridges and folded terrain of the lower Eastern Highlands, up to approximately 450 m above sea level (asl) in places, and with Crater Mountain located to the north. The existing wellpads from previous appraisal drilling are primarily located on steep ridges, some up to 250 m asl. Terrain in the southwestern portion of PRL 15 lowers to the plains of the Purari River basin that are typically subject to frequent inundation from overbank river flows during the wet season.

The proposed CPF-P3 site is bounded to the south by the Purari River main tributary. The topographical data used in the meteorological modelling study for the CPF-P3 site and surrounds is discussed in **Section 6.1.3**.

From the north, the export pipeline corridor traverses extensive ranges of asymmetrical mountains and hills, which descend into alluvial plains and composite levee plains, coastal mangroves and finally beach ridges and beach plains.

5.4 Land Use

PRL 15 is largely unsettled but owned and used by the Pawaian people, who reside in villages along the Purari River. Most of these villages are outside of but near to PRL 15 except for two small villages (Poroi 1 and Ne'ea Creek (previously referred to as the Mapaio Fish Camp)) that are located on the Purari River within the southern part of the licence area and a small hamlet located on the southern side of the Purari River near Herd Base.

Aside from subsistence livelihood activities by the Pawaian people, the main anthropogenic activities in PRL-15 relate to the recent and ongoing gas exploration activities, including the main operations camp at Herd Base, temporary camps at Antelope-3 Operations Camp and Hou Creek Base (both now demobilised), and activities and disturbances relating to wellpads, access roads, and helipads.

The inland section of the export pipeline corridor is largely unpopulated, however it has been modified by large-scale industrial logging. Near to and along the coast, the number and size of villages, and hence population density, increases. Anthropogenic activities include clearing of forest for settlements, subsistence agriculture (food gardens, sago planting, hunting and fishing) and historical clearing for coconut plantations.

Along the Purari riverways, villages are predominately located on or in the vicinity of the upper reaches of the tidal influence where there is likely to be a greater availability of resources. In addition to subsistence agriculture activities, logging and Project-commissioned barges transporting supplies and equipment to the base, regularly travel along the Purari channels.

PRL-15 and the surrounding areas are densely forested by tropical forest. Limited clearing has been performed by the local population for subsistence farming and construction of dwellings and small villages. Sago cultivation is the principal staple in the lowland areas, with production restricted to the river zones (e.g. Purari River and its tributaries). Sago is supplemented by other garden crops such as banana, kaukau and greens. There is extensive commercial logging in parts of the Purari River catchment and growing oil and gas exploration activity: both industries provide employment for local people.

Along the export pipeline corridor, remote inland communities rely almost entirely on native flora and fauna for their livelihoods and wellbeing. Coconuts and sago are the most important food staples. These are supplemented by hunting and trapping of wild animals and birds, and fishing in rivers and creeks. Transport is limited to waterways and established tracks.

In coastal villages, the main staple food is sago harvested from sago palms that have mostly been planted along the banks of creeks or in swampy areas or alluvial plains. Coconuts are also an important staple and nypa palm nuts are harvested as a food resource on a seasonal basis. Fishing occurs in the sago swamps, creeks, mangroves and the sea.

5.5 Existing Sensitive Receptors

As indicated above, the ecosystem within the study area is characterised by largely intact tropical forest with disturbance related to petroleum exploration within PRL 15, logging along the export pipeline corridor and the pressures of human settlement including clearances for gardens, plantations and housing closer to the coast. The riverways are generally banked by intact forest, with the exception of clearing associated with villages and their gardens and some areas used extensively during commercial logging operations.

The nearest existing human receptors to the CPF-P3 site are a new hamlet (not included in the 2019 AQIA) located on the southern side of the Purari River directly across from Herd Base, as well as the previously assessed receptors, Poroi 1 village (approximately 4 km to the south of the CPF-P3 site), and Ne'ea Creek (approximately 10 km to the west of the CPF-P3 site). The relative locations of the identified sensitive receptor locations and the proposed CPF-P3 site are shown in **Figure 3**, with further details shown in **Table 2**.

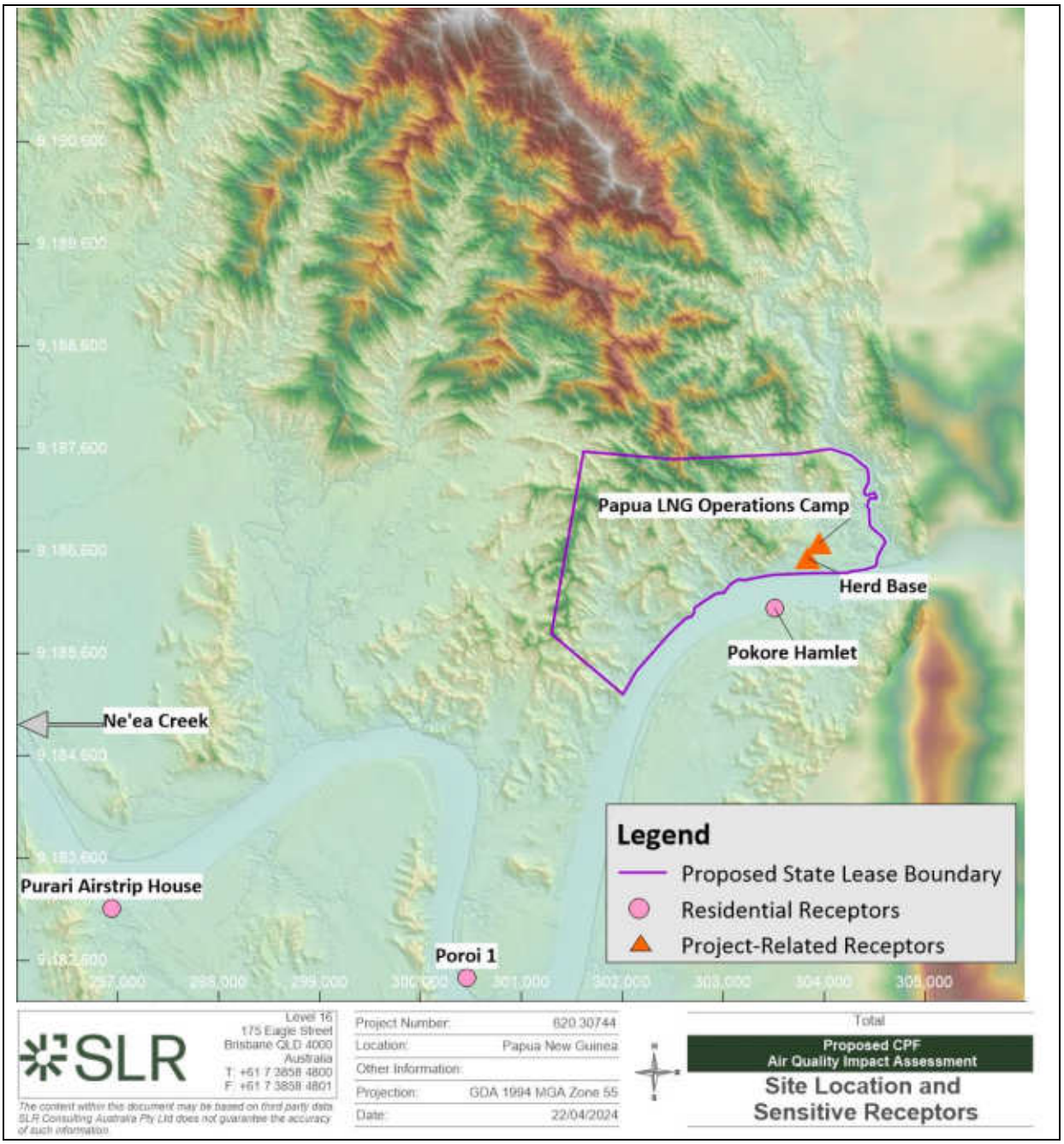
Villages are generally not common along much of the export pipeline corridor until close to the coastline.

Table 2 Identified Receptor Locations

Receptor	Location [MGA 94 Zone 55] (m)		Distance/Direction from CPF-P3
Poroi 1	300,457	9,182,433	3.1 km south
Ne'ea Creek	292,023	9,185,351	9.2 km west
Purari Airstrip House	296,941	9,183,112	5.2 km southwest
Pokore Hamlet*	303,510	9,186,040	0.3 km southeast
Papua LNG Operations Camp *	303,951	9,186,675	Within site boundary
Herd Base	303,840	9,186,527	Within site boundary

* New receptors not assessed in the 2019 AQIA
Shaded cells denote locations that are Project-related and are therefore not considered as sensitive receptors

Figure 3 Identified Sensitive Receptor Locations



5.6 Existing Air Quality

The closest existing source of air emissions to the proposed CPF site is Herd Base, where diesel-powered generators are currently used to provide power. Localised areas of elevated air pollutant concentrations would also be expected immediately adjacent to existing unsealed roads, as well as areas adjacent to river traffic (e.g. barges).

Upon commissioning of the CPF, Herd Base will be supplied power from the CPF via a medium voltage cable to a substation to be constructed at Herd Base. Subsequently, the following backup generators would only be used in the event of power failure from the CPF (i.e., cable failure or CPF shutdown):

- One 2 MVA diesel generator to power the operation camp
- Three 1 MVA diesel generators for the logistics base (two operating, one spare).

Given the above, the background air quality will reflect the virtually ubiquitous absence of industrial sources and the ambient air quality can be assumed to be generally good. The study area would be regarded as a 'non-degraded' airshed in relation to IFC assessment requirements and a baseline ambient air quality monitoring program has not been conducted.

With the diesel generators at Herd Base only being used in case of power failure, concentrations of gaseous pollutants (i.e., NO_2, SO_2, CO and VOCs) in the vicinity of the CPF would be negligible compared to relevant international guidelines for ambient air quality.

Background concentrations of particulate matter were estimated by SLR in the 2019 AQIA as shown in **Table 3** based on our experience in the collection and review of TSP, PM_{10} and $PM_{2.5}$ monitoring data for other projects in PNG and with consideration given to the local land use and high rainfall in the study area. As shown in the table the background levels assumed in the 2019 AQIA are higher than or equivalent to the current WHO guidelines for annual average PM_{10} and 24-hour average and annual $PM_{2.5}$ concentrations. Given that ambient monitoring data are not available for the CPF site and the levels shown in **Table 3** are estimates only, this assessment has assessed the potential impacts of the CPF emissions on local PM_{10} and $PM_{2.5}$ concentrations based on the incremental impacts predicted by the modelling and the recommendation in the IFC *Environmental, Health and Safety Guidelines: Environmental – Air Emissions and Ambient Air Quality* (IFC 2007), that project-related emissions do not exceed 25% of the applicable air quality standards (see **Section 4.2.1**).

Table 3 Estimated Baseline Particulate Concentrations Used in the 2019 AQIA

Pollutant	Averaging Period	Range of Background Particulate Concentrations Expected to Occur in the Study Area (µg/m³)	Background Concentration Assumed (µg/m³)	Adopted Assessment Criteria (µg/m³)
PM_{10}	24-hours	5 – 35	25	**45**
	Annual	10 – 15	15	**15**
$PM_{2.5}$	24-hours	2 – 20	15	**15**
	Annual	5 – 8	8	**5**

As noted above, baseline concentrations of gaseous pollutants (i.e., NO_2, SO_2, CO and VOCs) are assumed to be negligible (i.e., 0 micrograms per cubic metre (µg/m³)) compared to the adopted ambient air quality criteria presented and discussed in **Section 4.3**.

6.0 Assessment Methodology

This section presents the method, inputs and results of an air dispersion modelling study undertaken to assess the potential off-site air quality impacts associated with the proposed stack emission sources at the CPF P3 Site, as well as the method, inputs and assumptions used to perform a qualitative risk-based assessment of potential air quality impacts associated with fugitive dust emissions from the construction activities proposed as part of the Project.

6.1 Dispersion Modelling Methodology

6.1.1 The CALPUFF Model

Emissions from the Project have been modelled using the US EPA approved CALPUFF (Version 6.42) air dispersion modelling system. CALPUFF (SRC 2011) is a transport and dispersion model that advects 'puffs' of material emitted from modelled sources, simulating dispersion and transformation processes along the way. In doing so, it typically uses the fields generated by a meteorological pre-processor CALMET (Scire, Robe and Strimaitis 2000), a meteorological modelling system, discussed further below. Temporal and spatial variations in the meteorological fields selected are explicitly incorporated in the resulting distribution of puffs throughout a simulation period. The primary output files from CALPUFF contain either hourly concentration or hourly deposition fluxes evaluated at selected receptor locations. The CALPOST post-processing package (SRC 2011) is then used to process these files, producing tabulations that summarise results of the simulation for user-selected averaging periods.

The CALPUFF model requires inputs of hourly temperature, wind and other meteorological data on a three-dimensional gridded modelling domain. For this study, the meteorological data inputs have been compiled using the Weather Research and Forecast (WRF) (NCAR 2023) and CALMET meteorological models as described in **Section 6.1.2**.

6.1.2 Meteorological Modelling

Meteorological modelling was performed using the WRF and CALMET V6.334 models to compile a one-year, three-dimensional meteorological dataset based on an hourly time step, covering the proposed new CPF-P3 site and surrounding area.

The 2019 AQIA used a one year meteorological dataset compiled based on meteorological records for the 2015 calendar year. The 2015 meteorological dataset was then validated by comparison of the predicted and observed records of wind speed, wind direction and temperature at the site of a weather station installed at Wabo. The conclusions of this analysis was that the method and model configurations used in the meteorological models provided a synthetic three-dimensional meteorological dataset that was representative of the key meteorological features of the study area relevant to pollutant dispersion, suitable for use in the atmospheric dispersion modelling.

For this assessment, the data inputs were updated with regional meteorological records for the most recent calendar year available, being 2022. The same method and model configurations were used in the updated meteorological modelling study, however surface observational data from Wabo was not available to perform an updated validation.

A summary of the meteorological dataset compiled using this approach is provided in **Section 6.2**.



6.1.3 Topographical and Land Use Data

Topographical data was sourced from the Shuttle Radar Topography Mission (SRTM3) dataset, which is three-second arc (90 m) resolution data. LIDAR data provided to SLR for the study area was integrated into the GEO file to replace the SRTM3 data in areas where LIDAR data is available. To account for future topography across the CPF-P3 site after construction (and to ensure accurate base height elevations for the stacks within the model), the topographical data across the proposed CPF-P3 plant area was then levelled to a pad height of 35 m above mean sea level. This refined topographical dataset was used in the model runs to predict ground level pollutant concentrations.

6.1.4 Receptor Locations

The modelling was performed using a 13 km by 12 km receptor grid with 100 m spacing, centred over the CPF-P3 site. In addition to the gridded receptors, six discrete receptors were included in the model to represent the closest identified human receptor locations in the surrounding area, as listed in **Table 2**.

Modelling results are also presented in **Section 7.3** for the 'maximum off-site' prediction. These concentrations have been extracted from the model output files based on the Project's proposed state lease boundary shown in **Figure 3**.

6.1.5 Building Wake Effects

Given the open nature of the proposed infrastructure, which will allow wind flow through and around pipe racks and process columns with minimal impedance, building wakes were not considered in the modelling. Building wakes for the sources being modelled are also expected to have a minor impact on the model predictions, as the emissions are being discharged via elevated stacks (17 m to 125 m release heights).

6.1.6 Background Concentrations

Background concentrations of NO_X, SO_2 and CO were assumed to be negligible given the absence of any significant combustion or industrial sources in the region surrounding the CPF, noting that the diesel generators at Herd Base would no longer be used routinely.

While there are no significant industrial emission sources of particulate matter in the region, local natural sources of particulate matter such as pollen, wind erosion and forest fires, as well as long-range transboundary transport of particulate matter will contribute to background $PM_{2.5}$ and PM_{10} concentrations. As ambient monitoring data are not available for the CPF-P3 site, the potential impacts of the CPF emissions on local PM_{10} and $PM_{2.5}$ concentrations has been based on the incremental impacts predicted by the modelling.

6.1.7 Modelling of NOx Chemistry

NO_X emissions from fossil fuel combustion are primarily nitric oxide (NO), with only a few volume percent as nitrogen dioxide (NO_2). However, once the gases are discharged into the atmosphere, chemical reactions take place which result in the transformation of NO to NO_2 in the plume.

There are various methods for estimating NO_2 concentrations from model predictions of NO_X as the plume is emitted from the emission point. For this assessment, maximum off-site ground level NO_2 concentrations were estimated from the downwind NO_X concentrations predicted by CALPUFF using the US EPA's Ozone Limited Method (OLM) (US EPA 2015). The OLM is based on the assumption that approximately 10% of the NO_X emissions are generated as NO_2 (Alberta Environment 2003). If the ozone (O_3) concentration is greater

than 90% of the predicted NO_X concentrations, all the NO_X is assumed to be converted to NO_2, otherwise:

$$NO_2 = 0.1* NO_X + (46/48)*O_3.$$

A background ozone concentration of 40 parts per billion (ppb) (86 µg/m^3) was used in the calculations based on studies that have shown that ambient ozone concentrations in remote dense tropical forest locations typically range from 20 to 40 ppb (CGER 1991).

6.1.8 Assumptions and Limitations

Other key assumptions made in relation to the modelling method were:

- The effects of the surrounding vegetation are not accounted for in the prediction downwind ground level concentrations. The dense vegetation surrounding the CPF-P3 site can be expected to assist in the dispersion and filtration of pollutants prior to the plume reaching ground level. Air dispersion models like CALPUFF are not able to account for these effects, and there is very limited information available in the literature to enable the impact of vegetation on plume behaviour and pollutant concentrations to be assessed. The fact that vegetation effects are not included is expected to provide conservative predictions of ground level pollutant concentrations, i.e., predicted concentrations would be higher.
- To estimate NO_2 concentrations from the ground level NO_X concentrations predicted by the modelling, the background ozone concentration was assumed to be 40 ppb. If a higher background ozone concentration was assumed, then the estimated NO_2 concentrations would be higher than the levels presented in this report. However use of the Ozone Limiting Method to perform these calculations is a very conservative approach as it assumes instantaneous conversion of NO to NO_2 close to source, where NO_X predictions will be highest. Thus even if the background ozone concentration is higher than that assumed, the methodology is still expected to be conservative.

6.2 Meteorological Data Used in this Assessment

The key parameters relating to the dispersion of air pollutants, wind direction, wind speed, stability class and mixing height are discussed in detail below. It is noted that rainfall is not included in the CALMET modelling file compiled for use in the air quality impact assessment.

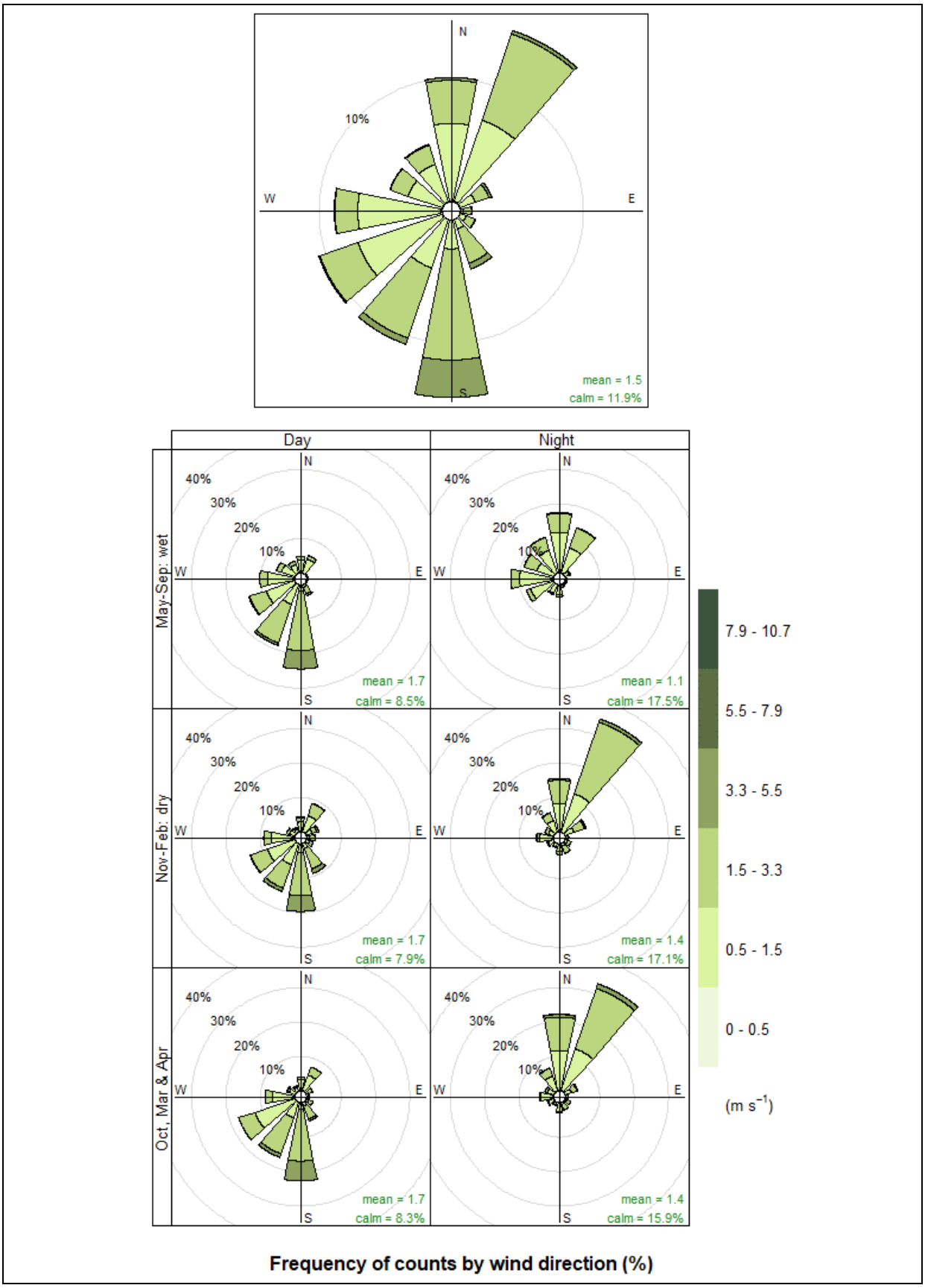
6.2.1 Wind Speed and Direction

Wind roses compiled from the predicted on-site wind data are shown in **Figure 4**. Presented in a circular format, wind roses show the frequency of winds blowing from particular directions over a specified period. The length of each ‘spoke’ around the circle is related to the frequency that the wind blows from a particular direction per unit time. Each spoke is also broken down into color-coded bands to show the frequency of specific wind speed ranges.

The windroses show a low frequency of winds blowing from the eastern quadrant. Winds from the southwestern quadrant dominate during the day across the year, and the strongest winds tend to blow from the south during the day. Winds from the northeast dominate during the night during the dry season and the shoulder seasons, most likely associated with night-time drainage flows down the elevated terrain to the northeast of the Site. Northerly winds become more frequent at night during the wet season.

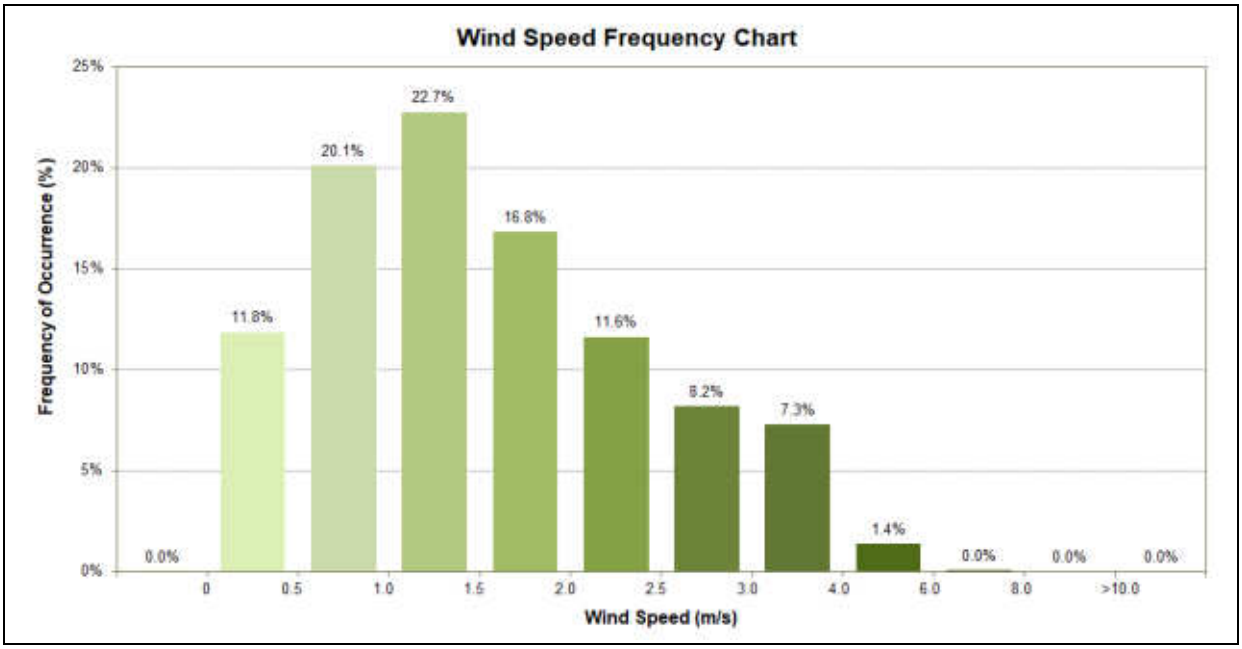
Calm conditions (wind speeds less than 0.5 m/s) were predicted approximately 8% of the time during the day and 16-17% of the time during the night, consistently throughout the year.

Figure 4 Wind Roses for the CPF-P3 Site (CALMET) - 2022



A plot of the wind speed frequencies predicted by the modelling at the CPF-P3 site for 2022 is presented in **Figure 5**, which indicates that the site predominantly experiences low to moderate wind speeds, with a very low frequency of wind speeds above 5 m/s predicted during 2022. Compared to the meteorological dataset used in the 2015 AQIA, the predicted wind speeds at the CPF-P3 site are notably lower (lighter).

Figure 5 Wind Speed Frequency Distributions for the CPF-P3 Site (CALMET) - 2022



6.2.2 Atmospheric Stability

Atmospheric stability refers to the tendency of the atmosphere to resist or enhance vertical motion. The Pasquill assignment scheme identifies six stability classes, A to F, to categorize the degree of atmospheric stability as follows:

- A = Extremely unstable conditions.
- B = Moderately unstable conditions.
- C = Slightly unstable conditions.
- D = Neutral conditions.
- E = Slightly stable conditions.
- F = Moderately stable conditions.

The meteorological conditions defining each Pasquill stability class are shown in **Table 4**.

The frequencies of each stability class predicted by CALMET to occur in the 2022 hourly dataset for the proposed CPF-P3 site are presented in **Figure 6**. The model predicts a relatively high frequency of stability class F conditions. Stability class F is indicative of very stable night-time conditions (i.e. low wind speeds), leading to a low level of mechanical mixing and poor dispersion.

Table 4 Meteorological Conditions Defining Pasquill Stability Classes

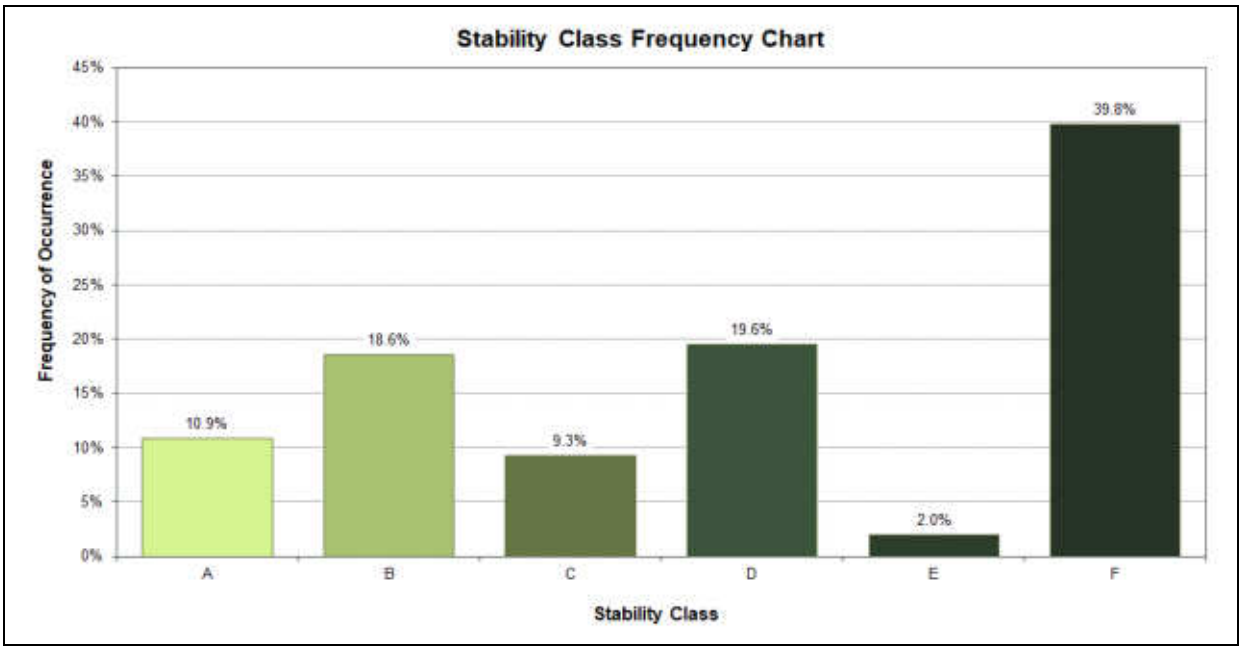
Surface wind speed (m/s)	Daytime insolation [3]			Night-time conditions [2]	
	Strong [1]	Moderate	Slight [1]	Thin overcast or > 4/8 low cloud [4]	≤ 4/8 cloudiness
< 2	A	A - B	B	E	F
2 - 3	A - B	B	C	E	F
3 - 5	B	B - C	C	D	E
5 - 6	C	C - D	D	D	D
> 6	C	D	D	D	D

(Source: Pasquill, 1961)

Notes:

1. Strong insolation corresponds to midday on a sunny midsummer day; slight insolation corresponds to similar conditions in midwinter
2. Night refers to the period from 1 hour before sunset to 1 hour after sunrise
3. The neutral category D should also be used, regardless of wind speed, for overcast conditions during day or night and for any sky conditions during the hour preceding or following night as defined above
4. An 'okta' is a unit of measurement used to describe the amount of cloud cover at any given location. Sky conditions are estimated in terms of how many eighths of the sky are covered in cloud, ranging from 0 oktas (completely clear sky) through to 8 oktas (completely overcast). In addition, an extra cloud cover indicator of '9' can be used which indicates that the sky is totally obscured (i.e. hidden from view), usually due to dense fog or heavy snow

Figure 6 Stability Class Frequency Distributions for the CPF Site (CALMET) - 2022



The 2015 meteorological dataset used in the 2019 AQIA for the previous CPF site also contained a similar high frequency of stability class F conditions. The frequency of predicted neutral (stability class D) conditions at the CPF-P3 site is higher however, compared to the 2015 meteorological dataset for the previously assessed CPF location.

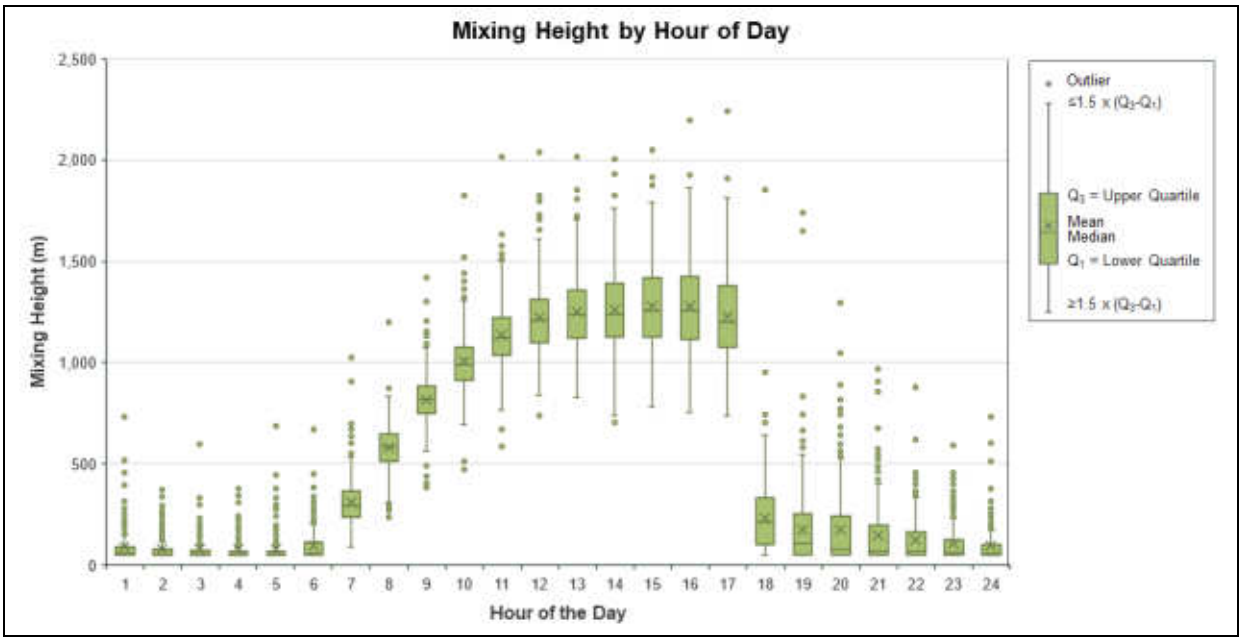
6.2.3 Mixing Heights

The term *mixing height* refers to the height of the turbulent layer of air near the Earth's surface, into which ground-level emissions will be rapidly mixed. A plume emitted above the mixed-layer will remain isolated from the ground until such time as the mixed-layer reaches the height of the plume. The height of the mixed-layer is controlled mainly by convection (resulting from solar heating of the ground) and by mechanically generated turbulence as the wind blows over the rough ground.

An analysis of the diurnal pattern in the mixing heights predicted at the proposed CPF-P3 site was performed and is presented in **Figure 7**. As would be expected, an increase in the mixing depth during the morning is apparent, arising due to the onset of vertical mixing following sunrise. Maximum mixing heights occur in the mid- to late-afternoon, due to the dissipation of ground-based temperature inversions and the growth of the convective mixing layer. In the early evening, the mixing height rapidly drops back to night-time levels.

The data shown in **Figure 7** indicate that the model is adequately simulating the expected diurnal variation in mixing heights and is suitable for use in modelling the dispersion of emissions from the CPF-P3 site. The mixing height data presented in the 2015 meteorological dataset for the previous CPF site showed a similar diurnal variation.

Figure 7 Diurnal Variation in Mixing Height for the CPF Site (CALMET) - 2022



6.3 Construction Dust Assessment

Due to the high rainfall and dense vegetation present in the onshore Project area, published fugitive dust (i.e., TSP) emission factors are unlikely to be representative of the emissions of dust from construction activities in Papua New Guinea. In addition, modelling of dust emissions from construction projects is generally not considered appropriate, as emission rates can vary depending on a combination of the construction activity and prevailing meteorological conditions (e.g., rainfall and wind speed), which cannot be reliably predicted.

For this reason, and similar to the 2015 AQIA, the methodology outlined in the Institute of Air Quality Management (IAQM) document, *Guidance on the Assessment of Dust from*

Demolition and Construction (IAQM 2024), has been used to provide a qualitative approach to assess the potential for Project construction activities to result in off-site air quality impacts. It is noted that the IAQM method has been developed for an urbanized environment and has limitations in its applicability to a remote undeveloped location such as the Project area. However, it is anticipated to provide a conservative assessment of the potential risks and has been adopted in a number of PNG air quality impact assessments.

The IAQM method uses a four-step process for assessing dust impacts from construction activities:

- Step 1: Screening based on distance to the nearest sensitive receptor; whereby the sensitivity to dust deposition, human health impacts and ecological impacts of the identified sensitive receptors is determined.
- Step 2: Assessing the risk of dust effects from activities based on:

  (a) the scale and nature of the works, which determines the potential dust emission magnitude.

  (b) the sensitivity of the area surrounding dust-generating activities.
- Step 3: Determining site-specific mitigation for remaining activities with greater than negligible effects.
- Step 4: Assessing the residual risk of dust effects from activities after management measures have been considered.

Further details of the IAQM assessment methodology are provided in **Appendix A**.

7.0 Operational Phase Dispersion Modelling Results

7.1 Operating Scenarios and Pollutants Modelled

In order to address the potential impacts on local air quality of the Project, emissions estimation and dispersion modelling has been performed for three different operational scenarios for the CPF. The operational scenarios selected for modelling were identified in consultation with TOTAL and were chosen to represent normal and upset operations at different stages in the life of Project. The operational scenarios modelled are summarised in **Table 5**.

Table 5 Operating Scenarios Assessed

Case	Operating Mode	Description	Sources Modelled (On-Line)		
			Power Gas Turbines	Heating Boilers	Flare
1	Normal Operations	Typical operations	3 units	3 units	Pilot only
2	Flaring - AG Flare off-line	35% Turndown, gas production flared	2 units	2 units	HP/LP Flare
3	Flaring - AG Flare on-line	35% Turndown, acid gas compressor off-line	2 units	2 units	HP/LP Flare and AG Flare

7.2 Stack and Emission Data Used in the Modelling

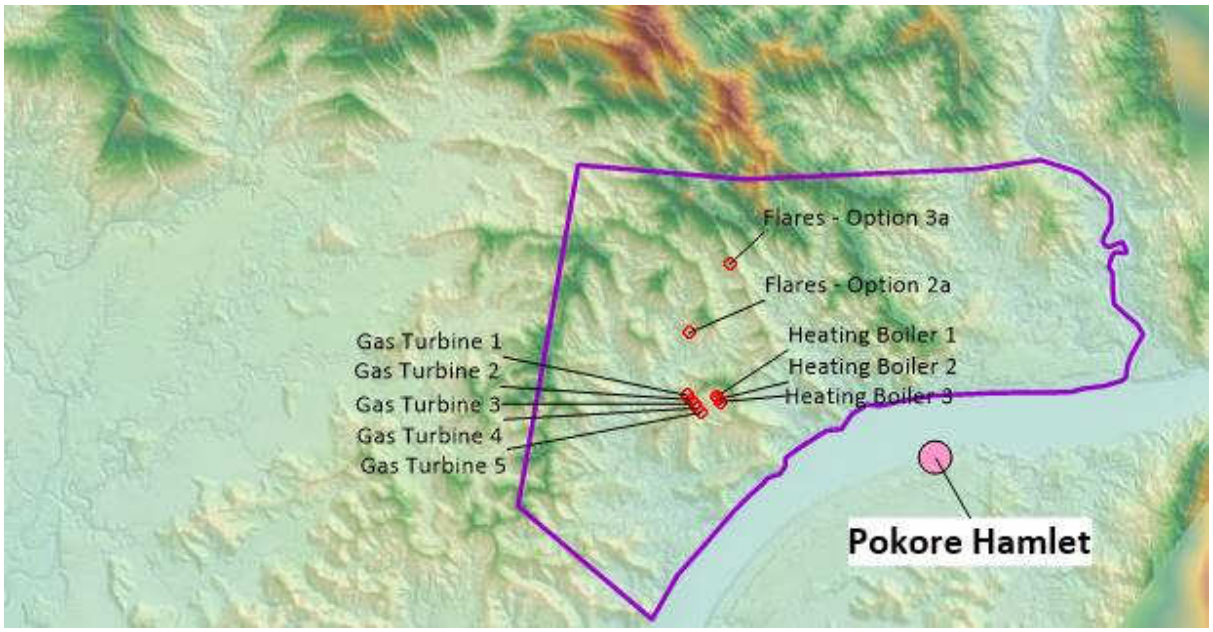
A summary of the stack parameters used in the modelling study for the new CPF location and current design is provided in **Table 6**. The locations of stacks within the proposed lease boundary are shown in **Figure 8**.

Table 6 CPF Stack Parameters

Source	Stack Location (m) *		Base Elevation (m)	Stack Height (m)	Exit Diameter (m)
	Easting	Northing			
Gas Turbine 1	302,200	9,186,299	35	17.3	2.6
Gas Turbine 2	302,218	9,186,276	35	17.3	2.6
Gas Turbine 3	302,237	9,186,254	35	17.3	2.6
Gas Turbine 4 ^	302,255	9,186,232	35	17.3	2.6
Gas Turbine 5 ^	302,274	9,186,209	35	17.3	2.6
Heating Boiler 1	302,357	9,186,294	35	61.7	1.9
Heating Boiler 2	302,369	9,186,280	35	61.7	1.9
Heating Boiler 3	302,380	9,186,266	35	61.7	1.9
Flares - Option 2a #	302,207	9,186,630	41	125	-
Flares - Option 3a #	302,428	9,186,997	48	125	-

* Coordinate System: PNG94
Location of the proposed flare is yet to be finalised. Two options (Location 2a and Location 3a) have been assessed as part of this study.
^ Not modelled, assumed to be off-line in all operating scenarios assessed.

Figure 8 Stack Locations Relative to the Proposed State Lease Boundary



The exhaust conditions and pollutant emission rates used in the modelling are listed in **Table 7** (Case 1: Normal Operations), **Table 8** (Case 2: 35% Turndown with Gas Production Flared) and **Table 9** (Case3: 35% Turndown with Acid Gas Compressor Off-Line).

Table 7 Emission Data - Normal Operations

Description	Exit Velocity (m/s)	Exit Temperature (°C)	Gas Flowrate (Nm^3/s dry)	NOx		SO_2		CO		Particulate Matter	
				(mg/Nm^3)	(kg/hr)	(mg/Nm^3)	(kg/hr)	(mg/Nm^3)	(kg/hr)	(mg/Nm^3)	(kg/hr)
Gas Turbine 1	22.6	160	60.3	51	11.1	0.05	0.012	42.6	9.25	3.4	0.74
Gas Turbine 2	22.6	160	60.3	51	11.1	0.05	0.012	42.6	9.25	3.4	0.74
Gas Turbine 3	22.6	160	60.3	51	11.1	0.05	0.012	42.6	9.25	3.4	0.74
Heating Boiler 1	8.4	257	9.7	240	8.4	400	13.97	25	0.87	50	1.75
Heating Boiler 2	8.4	257	9.7	240	8.4	400	13.97	25	0.87	50	1.75
Heating Boiler 3	8.4	257	9.7	240	8.4	400	13.97	25	0.87	50	1.75
Total site emissions					**58.3**		**41.9**		**30.37**		**7.44**

Table 8 Emission Data - 35% Turndown with Gas Production Flared

Description	Exit Velocity (m/s)	Exit Temperature (°C)	Gas Flowrate (Nm^3/s dry)	NOx		SO_2		CO		Particulate Matter	
				(mg/Nm^3)	(kg/hr)	(mg/Nm^3)	(kg/hr)	(mg/Nm^3)	(kg/hr)	(mg/Nm^3)	(kg/hr)
Gas Turbine 1	11.9	160	31.6	51	5.8	0.05	0.006	42.6	4.86	3.4	0.39
Gas Turbine 2	11.9	160	31.6	51	5.8	0.05	0.006	42.6	4.86	3.4	0.39
Heating Boiler 1	4.4	257	5.1	240	4.4	400	7.33	25	0.46	50	0.92
Heating Boiler 2	4.4	257	5.1	240	4.4	400	7.33	25	0.46	50	0.92
Flare [1]	20.0	1,000	-	-	29.0	-	319.22	-	2,300	-	0
Total site emissions					**49.4**		**333.9**		**2,311**		**2.61**

[1] Using the methodology set out in Ohio EPA's *Engineering Guide #69: Air Dispersion Modeling Guidance* (OHIO EPA 2018), and a flared gas heat release rate of 4,017 MJ/s, the effective release height was calculated to be 214.8 m above ground level and the effective diameter was calculated to be 20.43 m.

Table 9 Emission Data - 35% Turndown with Acid Gas Compressor Off-Line

Description	Exit Velocity (m/s)	Exit Temperature (°C)	Gas Flowrate (Nm^3/s dry)	NOx		SO_2		CO		Particulate Matter	
				(mg/Nm^3)	(kg/hr)	(mg/Nm^3)	(kg/hr)	(mg/Nm^3)	(kg/hr)	(mg/Nm^3)	(kg/hr)
Gas Turbine 1	8.4	160	31.6	51	4.1	0.05	0.004	42.6	3.45	3.4	0.27
Gas Turbine 2	8.4	160	31.6	51	4.1	0.05	0.004	42.6	3.45	3.4	0.27
Heating Boiler 1	4.4	257	5.1	240	4.4	400	7.33	25	0.46	50	0.92
Heating Boiler 2	4.4	257	5.1	240	4.4	400	7.33	25	0.46	50	0.92
Flare [1]	20.0	1,000	-	-	29.0	-	319.22	-	2,300	-	0
Acid Gas Flare [2]	20.0	1,000	-	-	7.54	-	160.21	-	192.0	-	0
Total site emissions					**53.59**		**494.10**		**2,500**		**2.38**

[1] Using the methodology set out in Ohio EPA's *Engineering Guide #69: Air Dispersion Modeling Guidance* (OHIO EPA 2018), and a flared gas heat release rate of 4,017 MJ/s, the effective release height was calculated to be 214.8 m above ground level and the effective diameter was calculated to be 20.4 m.

[2] Using the methodology set out in Ohio EPA's *Engineering Guide #69: Air Dispersion Modeling Guidance* (OHIO EPA 2018), and a flared gas heat release rate of 336 MJ/s, the effective release height was calculated to be 152.4 m above ground level and the effective diameter was calculated to be 5.9 m.



7.3 Modelling Results and Impact Assessment

7.3.1 Case 1: Normal Operating Mode

The incremental maximum ground level pollutant concentrations predicted at the discrete receptor locations for the normal operating scenario are presented and compared against the identified assessment criteria in **Table 10** (NO_2), **Table 11** (SO_2),**Table 12** (CO) and **Table 13** ($PM_{2.5}$). Contour plots presenting the maximum predicted ground level pollutant concentrations for each pollutant for this scenario are presented in **Appendix B**.

As outlined in **Section 5.6**, baseline concentrations of gaseous pollutants can be considered negligible. Given this, the modelling results showed that predicted ground level NO_2, SO_2, and CO concentrations for the normal operations scenario are well below the relevant ambient air quality guidelines adopted for use in this study at all identified sensitive receptor locations, and across the entire modelling domain beyond the site boundary.

Table 10 Normal Operations – Predicted Incremental NO_2 Concentrations

Location	Predicted Ground Level NO_2 Concentration (µg/m^3)		
	Maximum 1-Hour Average	Maximum 24-Hour Average	Annual Average
Poroi 1	25	2.7	0.13
Ne'ea Creek	5.7	0.42	0.02
Purari Airstrip House	15	2.6	0.05
Pokore Hamlet	67	4.6	1.0
Maximum outside lease boundary	*86*	*11.6*	*2.5*
Papua LNG Operations Camp	36	3.9	0.87
Herd Base	44	3.7	1.0
Assessment Criteria	**200**	**25**	**10**

Table 11 Normal Operations – Predicted Incremental SO_2 Concentrations

Location	Predicted Ground Level SO_2 Concentration (µg/m^3)		
	Maximum 10-Minute Average	Maximum 1-Hour Average	Maximum 24-Hour Average
Poroi 1	26	18	1.2
Ne'ea Creek	5.7	4.0	0.27
Purari Airstrip House	12	8.4	1.4
Pokore Hamlet	100	70	4.4
Maximum outside lease boundary	*158*	*110*	*7.3*
Papua LNG Operations Camp	50	35	3.3
Herd Base	56	39	3.2
Assessment Criteria	**500**	**200**	**40**

Table 12 Normal Operations – Predicted Incremental CO Concentrations

Location	Predicted Ground Level CO Concentration (µg/m^3)		
	Maximum 1-Hour Average	Maximum 8-Hour Average	Maximum 24-Hour Average
Poroi 1	7.7	4.9	1.8
Ne'ea Creek	1.6	0.7	0.2
Purari Airstrip House	3.9	4.4	1.5
Pokore Hamlet	14.7	3.3	1.9
Maximum outside lease boundary	*65.1*	*18.6*	*7.3*
Papua LNG Operations Camp	13.0	3.3	1.8
Herd Base	13.9	3.2	1.7
Assessment Criteria	**35,000**	**10,000**	**4,000**

The incremental ground level 24-hour and annual average suspended particulate matter concentrations predicted at all identified surrounding sensitive receptor locations, as well as the maximum ground level concentration predicted across the modelling domain, are presented in **Table 13** for the normal operation scenario. The incremental impacts predicted as a result of Project emissions are very low, and well below the recommended threshold of 25% of the relevant WHO guideline levels for $PM_{2.5}$. Given this, the Project is unlikely to result in any measurable increases in $PM_{2.5}$ or PM_{10} concentrations at any of the identified sensitive receptor locations.

Table 13 Normal Operations – Predicted Incremental Particulate Concentrations

Location	Predicted Ground Level Particulate Concentration (µg/m^3)			
	Maximum 24-Hour Average	% of $PM_{2.5}$ Criterion	Annual Average	% of $PM_{2.5}$ Criterion
Poroi 1	0.29	2%	<0.1	<2%
Ne'ea Creek	0.05	0.3%	<0.1	<2%
Purari Airstrip House	0.68	5%	0.15	3%
Pokore Hamlet	0.53	4%	0.12	2%
Maximum outside lease boundary	*1.2*	*8%*	*0.32*	*6%*
Papua LNG Operations Camp	0.52	3%	0.14	3%
Herd Base	0.29	2%	<0.1	<2%
Assessment Criteria - PM_{10}	**45**		**15**	
Assessment Criteria - $PM_{2.5}$	**15**		**5**	



7.3.2 Case 2: Flaring – Acid Gas Flare Off-Line

The maximum ground level pollutant concentrations predicted at the discrete receptor locations for this scenario and for both flare location options (Location 2a and Location 3a) are presented and compared against the identified assessment criteria in **Table 14** (NO_2), **Table 15** (SO_2),**Table 16** (CO) and **Table 17** ($PM_{2.5}$). Contour plots presenting the maximum predicted ground level pollutant concentrations for this scenario are included in **Appendix B**.

The modelling results tables show that the maximum predicted ground level NO_2, SO_2, and CO concentrations for this flaring scenario are well below the relevant ambient air quality guidelines adopted for use in this study at all identified sensitive receptor locations and across the entire modelling domain beyond the site boundary. There are no appreciable differences in the ground level pollutant concentrations predicted by the model as a result of the change in the flare location. This is because emission from the flare are more buoyant and do not disperse down to ground level, and the peak off-site impacts are being driven by the other stack sources.

The maximum predicted incremental 24-hour and annual average particulate concentrations at all identified surrounding sensitive receptors for this flaring scenario are also negligible compared to the adopted WHO guidelines for PM_{10} and $PM_{2.5}$. Given this, the Project is unlikely to make any notable increase in particulate matter concentrations at any of the identified sensitive receptor locations.

Table 14 Case 2 Flaring – Predicted Incremental NO_2 Concentrations

Location	Predicted Ground Level NO_2 Concentration (µg/m^3)		
	Maximum 1-Hour Average	Maximum 24-Hour Average	Annual Average
Flare at Location 2A			
Poroi 1	8.9	1.6	0.08
Ne'ea Creek	2.7	0.2	0.01
Purari Airstrip House	6.8	1.4	0.03
Pokore Hamlet	32	2.1	0.55
Maximum outside lease boundary	*47*	*6.6*	*1.1*
Papua LNG Operations Camp	15	1.4	0.38
Herd Base	20	1.6	0.44
Flare at Location 3A			
Poroi 1	8.9	1.6	0.08
Ne'ea Creek	2.7	0.20	0.01
Purari Airstrip House	6.8	1.4	0.03
Pokore Hamlet	32	2.1	0.55
Maximum outside lease boundary	*47*	*6.6*	*1.0*
Papua LNG Operations Camp	15	1.4	0.38
Herd Base	20	1.6	0.44
Assessment Criteria	**200**	**25**	**10**

Table 15 Case 2 Flaring – Predicted Incremental SO_2 Concentrations

Location	Predicted Ground Level SO_2 Concentration (µg/m^3)		
	Maximum 10-Minute Average	Maximum 1-Hour Average	Maximum 24-Hour Average
Flare at Location 2A			
Poroi 1	9.4	6.6	0.88
Ne'ea Creek	2.7	1.9	0.14
Purari Airstrip House	6.4	4.5	0.87
Pokore Hamlet	44	31	1.9
Maximum outside lease boundary	*72*	*50*	*3.5*
Papua LNG Operations Camp	18	13	1.2
Herd Base	24	17	1.4
Flare at Location 3A			
Poroi 1	9.4	6.6	0.88
Ne'ea Creek	2.7	1.9	0.14
Purari Airstrip House	6.4	4.5	0.87
Pokore Hamlet	44	31	1.9
Maximum outside lease boundary	*72*	*50*	*3.5*
Papua LNG Operations Camp	18	13	1.2
Herd Base	24	17	1.4
Assessment Criteria	**500**	**200**	**40**

Table 16 Case 2 Flaring – Predicted Incremental CO Concentrations

Location	Predicted Ground Level CO Concentration (µg/m^3)		
	Maximum 1-Hour Average	Maximum 8-Hour Average	Maximum 24-Hour Average
Flare at Location 2A			
Poroi 1	4.7	2.6	0.9
Ne'ea Creek	4.4	2.0	0.7
Purari Airstrip House	5.3	2.3	0.8
Pokore Hamlet	15	6.6	3.3
Maximum outside lease boundary	*182*	*36*	*13*
Papua LNG Operations Camp	30	11	3.8
Herd Base	23	9.4	3.7
Flare at Location 3A			
Poroi 1	4.7	2.6	0.9
Ne'ea Creek	3.5	1.9	0.6
Purari Airstrip House	4.3	2.3	0.8
Pokore Hamlet	19	7.8	3.2
Maximum outside lease boundary	*144*	*30*	*12*
Papua LNG Operations Camp	25	8.5	3.3
Herd Base	22	8.1	3.3
Assessment Criteria	**35,000**	**10,000**	**4,000**



Table 17 Case 2 Flaring – Predicted Incremental Particulate Concentrations

Location	Predicted Ground Level Particulate Concentration (µg/m³)			
	Maximum 24-Hour Average	% of $PM_{2.5}$ Criterion	Annual Average	% of $PM_{2.5}$ Criterion
Flare at Location 2A				
Poroi 1	0.2	*1%*	<0.1	<2%
Ne'ea Creek	0.03	*<1%*	<0.1	<2%
Purari Airstrip House	0.3	*2%*	<0.1	<2%
Pokore Hamlet	0.2	*1%*	<0.1	<2%
Maximum outside lease boundary	*0.7*	*5%*	*0.1*	*2%*
Papua LNG Operations Camp	0.2	*1%*	<0.1	<2%
Herd Base	0.2	*1%*	<0.1	<2%
Flare at Location 3A				
Poroi 1	0.2	*1%*	<0.1	<2%
Ne'ea Creek	0.03	*<1%*	<0.1	<2%
Purari Airstrip House	0.2	*1%*	<0.1	<2%
Pokore Hamlet	0.3	*2%*	<0.1	<2%
Maximum outside lease boundary	*0.7*	*5%*	*0.1*	*2%*
Papua LNG Operations Camp	0.2	*1%*	<0.1	<2%
Herd Base	0.2	*1%*	<0.1	<2%
Assessment Criteria - PM_{10}	**45**		**15**	
Assessment Criteria - $PM_{2.5}$	**15**		**5**	

7.3.3 Case 3: Flaring – Acid Gas Flare On-Line

The maximum ground level pollutant concentrations predicted at the discrete receptor locations for this scenario and for both flare location options (Location 2a and Location 3a) are presented and compared against the identified assessment criteria in **Table 18** (NO_2), **Table 19** (SO_2), **Table 20** (CO) and **Table 21** ($PM_{2.5}$). Contour plots presenting the maximum predicted ground level pollutant concentrations for this scenario are included in **Appendix D**.

Similar to Flaring Case 2, and considering the assumed negligible background levels for gaseous pollutants, the modelling results show that the predicted NO_2, SO_2, and CO concentrations for this flaring scenario are well below the relevant ambient air quality guidelines adopted for use in this study at all identified sensitive receptor locations, and across the entire modelling domain beyond the site boundary. Also consistent with Case 2, there are no appreciable differences in the ground level pollutant concentrations predicted by the model as a result of the change in the flare location.

Predicted incremental 24 hour and annual average $PM_{2.5}$ concentrations at all identified surrounding sensitive receptors for this flaring scenario are negligible compared to the adopted background levels. Given this, the Project is unlikely to make any notable increase in $PM_{2.5}$ concentrations at any of the identified sensitive receptor locations.

Table 18 Case 3 Flaring – Predicted Incremental NO_2 Concentrations

Location	Predicted Ground Level NO_2 Concentration (µg/m^3)		
	Maximum 1-Hour Average	Maximum 24-Hour Average	Annual Average
Flare at Location 2A			
Poroi 1	7.5	1.4	0.08
Ne'ea Creek	2.2	0.17	0.01
Purari Airstrip House	5.8	1.2	0.03
Pokore Hamlet	30	1.9	0.53
Maximum outside lease boundary	*49*	*5.9*	*0.9*
Papua LNG Operations Camp	14	1.2	0.34
Herd Base	18	1.5	0.40
Flare at Location 3A			
Poroi 1	7.5	1.4	0.08
Ne'ea Creek	2.2	0.17	0.01
Purari Airstrip House	5.8	1.2	0.03
Pokore Hamlet	30	1.9	0.53
Maximum outside lease boundary	*49*	*5.9*	*0.9*
Papua LNG Operations Camp	14	1.2	0.34
Herd Base	18	1.5	0.40
Assessment Criteria	**200**	**25**	**10**

Table 19 Case 3 Flaring – Predicted Incremental SO_2 Concentrations

Location	Predicted Ground Level SO_2 Concentration (µg/m³)		
	Maximum 10-Minute Average	Maximum 1-Hour Average	Maximum 24-Hour Average
Flare at Location 2A			
Poroi 1	9.4	6.6	0.9
Ne'ea Creek	2.8	1.9	0.1
Purari Airstrip House	6.4	4.5	0.9
Pokore Hamlet	44	31	1.9
Maximum outside lease boundary	*72*	*50*	*3.6*
Papua LNG Operations Camp	18	13	1.2
Herd Base	24	17	1.4
Flare at Location 3A			
Poroi 1	9.4	6.6	0.9
Ne'ea Creek	2.7	1.9	0.1
Purari Airstrip House	6.4	4.5	0.9
Pokore Hamlet	44	31	2.0
Maximum outside lease boundary	*72*	*50*	*3.5*
Papua LNG Operations Camp	18	13	1.2
Herd Base	24	17	1.4
Assessment Criteria	**500**	**200**	**40**

Table 20 Case 3 Flaring – Predicted Incremental CO Concentrations

Location	Predicted Ground Level CO Concentration (µg/m^3)		
	Maximum 1-Hour Average	Maximum 8-Hour Average	Maximum 24-Hour Average
Flare at Location 2A			
Poroi 1	4.6	2.8	1.0
Ne'ea Creek	4.7	2.2	0.7
Purari Airstrip House	5.7	2.1	0.8
Pokore Hamlet	16	7.2	3.6
Maximum outside lease boundary	*198*	*39*	*14*
Papua LNG Operations Camp	31	11	4.0
Herd Base	25	10	3.9
Flare at Location 3A			
Poroi 1	4.5	2.7	0.9
Ne'ea Creek	3.8	2.0	0.7
Purari Airstrip House	4.6	2.1	0.7
Pokore Hamlet	21	8.0	3.3
Maximum outside lease boundary	*156*	*32*	*12*
Papua LNG Operations Camp	27	9.0	3.5
Herd Base	23	8.5	3.5
Assessment Criteria	**35,000**	**10,000**	**4,000**

Table 21 Case 3 Flaring – Predicted Incremental Particulate Concentrations

Location	Predicted Ground Level Particulate Concentration (µg/m^3)			
	Maximum 24-Hour Average	% of $PM_{2.5}$ Criterion	Annual Average	% of $PM_{2.5}$ Criterion
Flare at Location 2A				
Poroi 1	0.2	1%	<0.1	<2%
Ne'ea Creek	0.02	<1%	<0.1	<2%
Purari Airstrip House	0.3	1%	<0.1	<2%
Pokore Hamlet	0.2	2%	<0.1	<2%
Maximum outside lease boundary	*0.7*	*5%*	*0.1*	*2%*
Papua LNG Operations Camp	0.2	1%	<0.1	<2%
Herd Base	0.2	1%	<0.1	<2%
Flare at Location 3A				
Poroi 1	0.2	1%	<0.1	<2%
Ne'ea Creek	0.02	<1%	<0.1	<2%
Purari Airstrip House	0.2	1%	<0.1	<2%
Pokore Hamlet	0.3	2%	<0.1	<2%
Maximum outside lease boundary	*0.7*	*5%*	*1.0*	*2%*
Papua LNG Operations Camp	0.2	1%	<0.1	<2%
Herd Base	0.2	1%	<0.1	<2%
Assessment Criteria - PM_{10}	**45**		**15**	
Assessment Criteria - $PM_{2.5}$	**15**		**5**	

8.0 Construction Phase Risk Assessment

An updated construction phase risk assessment for potential adverse air quality impacts is presented below based on the same approach and methodology used in the 2015 AQIA. The key changes to the Project accounted for in the updated assessment in the relocation of the CPF and the inclusion of Pokore Hamlet as a new sensitive receptor location. The pipeline alignments have also changed due to the relocation of the CPF.

8.1 Step 1 – Screening Criteria

The Step 1 screening criteria set out by the IAQM guidance (IAQM 2024) to identify when an assessment is required are as follows:

- For human receptors: within 350 m of the boundary of the site, 50 m from the route used by construction vehicles on public roads, or within 500 m of the site entrance.
- For ecological receptors: within 50 m of the boundary of the site, 50 m from the route used by construction vehicles on public roads, or within 500 m of the site entrance.

Construction activities that will occur within 350 m of human receptors, and therefore require an assessment of the potential for human health or nuisance impacts, that require an updated assessment due to Project changes adopted during the 2023 FEED and the inclusion of Pokore Hamlet as a new sensitive receptor location, are:

- construction of the CPF at the P3 site
- construction of the Papua LNG Operations Camp adjacent to Herd Base
- construction of pipelines leading to and from the CPF-P3 site (i.e. changes in alignment within approximately 5 km of the CPF-P3 site compared to that previously assessed)
- construction of access roads for the CPF-P3 site.

The above construction activities will also be undertaken in areas surrounded by dense vegetation, i.e., within 50 m, therefore an updated assessment of the potential effects on ecological receptors has also been performed for these activities.

8.2 Step 2(a) - Dust Emission Magnitude

The descriptions given in the IAQM guidance document for small, medium and large earthworks and construction activities have been used to categorise the magnitude of works proposed during the construction of the CPF and pipelines as shown in **Table 22**.

The assessment of impacts associated with demolition activities and track-out (the movement of site material onto public roads by vehicles) are not relevant to the Project as there will be no demolition of existing structures associated with the CPF construction, and there are no public sealed roads in the area that soils could be tracked out onto.

Table 22 Categorisation of Dust Emission Magnitudes for Construction Activities

Construction Site	Dust Emission Magnitude		Basis
	Earthworks	Construction	
CPF-P3	Large	Large	Total platform footprint of approximately 53 hectares (ha), more than ten heavy earth moving vehicles active at any one time, formation of bunds greater than 8 m in height, total material moved will be more than 100,000 tonnes. Total building volume will be greater than 100,000 m^3, and works will include piling and on-site concrete batching.
Operations Camp (adjacent to Herd Base)	Large	Large	Total area cleared estimated at 7 ha, more than ten heavy earth moving vehicles active at any one time, total material moved expected to be more than 100,000 tonnes. Total building volume will be greater than 100,000 m^3, and works will include piling and on-site concrete batching
Changed pipeline routes (within approximately 5 km of CPF-P3)	Medium	Small	Total active work area up to approximately 2.5 ha (based on a nominal 700 m long and 35 m wide work zone), 5 to 10 heavy earth moving vehicles assumed to be active at any one time. Will involve minimal construction-type activities aside from earthworks.
Access roads	Medium	N/A	Total active work area of approximately 0.7 ha, (based on a nominal 700 m long and 10 m wide work zone), and 5 to 10 heavy earth moving vehicles assumed to be active at any one time

N/A = Not applicable.

8.3 Step 2(b) - Sensitivity of the Area

The sensitivity of the identified human receptors in the onshore Project area (villages and dwellings) was concluded in the 2015 AQIA to be of high sensitivity for both dust soiling and health impacts, based upon the following assumptions:

- The identified sensitive receptor locations are dwellings where members of the local community have the potential to be exposed to PM_{10} levels for eight hours (or more) in a day.
- In general, the local community could reasonably expect a high level of amenity (i.e., low TSP concentrations and dust deposition rates) given the high rainfall and highly vegetated nature of the area, which would result in little natural wind-blown dust and low background dust levels.

Details of the dust sensitivity of plant species in areas close to the proposed construction activities is not available, although it may be expected that vegetation in the area would be accustomed to a low dust environment. Nonetheless, the high rainfall in the region means that dust will be regularly washed from leaves, thereby naturally mitigating the impact of fugitive dust emissions from construction activities. In addition, the dense and tall vegetation

present in the area around the construction sites will assist in screening and filtering dust particles from the air. This will assist in containing the dust within the area close to the works, compared to a more open environment.

Based on the above, the ecological sensitivity of vegetation in the Project area is assumed to be of medium sensitivity, as per the 2015 AQIA.

On the basis of the information provided above, the sensitivity of the areas surrounding the proposed construction activities has been determined as shown in **Table 23**.

Table 23 Assessment of Sensitivity of Areas Surrounding Construction Sites

Value	Construction Site	Sensitivity of Receptors	Number of Receptors	Distance from Source	Sensitivity of Area
Dust soiling	CPF-P3 site and Operations Camp	High	1	300 - 350 m	Low
	Changed pipeline routes near CPF-P3	High	0	No receptors within 350 m	Low
	Access roads for CPF-P3 and Operations Camp	High	1	300 - 350 m	Low
Human health	CPF-P3 site and Operations Camp	High	1	300 - 350 m	Low
	Changed pipeline routes near CPF-P3	High	0	No receptors within 350 m	Low
	Access roads for CPF-P3 and Operations Camp	High	1	300 - 350 m	Low
Ecological	CPF-P3 site and Operations Camp [#]	Medium		>20 m	Low
	Changed pipeline routes near CPF-P3	Medium		<20 m	Medium
	Access roads for CPF-P3 and Operations Camp	Medium		<20 m	Medium

[#] Distance between the main dust-generating construction activities (earthworks, haul routes, plant foundations, stockpiles etc.) and the edge of the cleared area where sensitive vegetation may be located was assumed to be greater than 20 m for the CPF site and Operations Camp. For the export pipeline and access roads, it has been assumed that construction activities will potentially occur within 20 m of areas where sensitive vegetation may be located.

8.4 Risk Assessment

Based on the area sensitivities derived in **Table 23**, the resulting risk of air quality impacts has been derived for each construction activity using the IAQM impact matrix in **Appendix A**, as presented in **Table 24**. As per the IAQM impact matrices, the risk of air quality impacts assumes no mitigation is applied, in order to identify what level of control may be required to mitigate potential off-site impacts.

Table 24 Assessment of Potential Fugitive Dust Impacts from Construction

Value	Construction Activity	Sensitivity of the Area	Magnitude of Dust Emissions		Risk of Air Quality Impacts	
			Earthworks	Construction	Earthworks	Construction
Dust soiling and Human heath	CPF-P3 site and Operations Camp	Low	Large	Large	Low	Low
	Changed pipeline routes near CPF-P3	Low	Medium	Small	Low	Negligible
	Access roads for CPF-P3 and Operations Camp	Low	Medium	-	Low	-
Ecological	CPF-P3 site and Operations Camp	Low	Large	Large	Low	Low
	Changed pipeline routes near CPF-P3	Medium	Medium	Small	Medium	Low
	Access roads for CPF-P3 and Operations Camp	Medium	Medium	-	Medium	-

9.0 Air Quality Impact Assessment

Proposed Project activities with the greatest potential for adverse off-site air quality impacts, (i.e., decline in human health, amenity or vegetation condition), at the nearest sensitive receptors have been assessed as part of this updated AQIA for the new CPF location.

Potential human health, amenity or vegetation impacts include:

- Human health impacts, due to emissions of:
  - Finer inhalable particulate matter (i.e., PM_{10} and $PM_{2.5}$) associated with fuel combustion processes, that are small enough to penetrate the thoracic region of the respiratory system. The health effects of inhalable particulate matter include the aggravation of asthma and other respiratory symptoms, and an increased incidence of cardiovascular and respiratory diseases and lung cancer.
  - Emissions of NO_X, CO, and SO_2 from the combustion of fuel gas and diesel, which can adversely impact human health by irritating the airways of the lungs, aggravating asthma and other existing respiratory illnesses, and increasing the incidence of acute respiratory illness in children.
  - Emissions of VOCs, as chronic long-term exposure to elevated concentrations can adversely impact human health including cancer, central nervous system disorders, liver and kidney damage, reproductive disorders and birth defects. Many VOCs are also highly odorous and can adversely impact on amenity values due to odour nuisance.
- Amenity impacts, specifically:
  - Nuisance impacts due to the larger-sized particles of fugitive dust settling rapidly close to the source and soiling of surfaces in and around residential areas.
- Vegetation impacts, due to:
  - Larger-sized particles of fugitive dust settling into leaves, blocking sunlight and disrupting photosynthesis, thereby damaging nearby vegetation.

9.1 Construction Phase

The screening and assessment of dust emission magnitudes for the proposed key construction activities was undertaken as per steps 1, 2a and 2b of the IAQM guidance and is detailed in **Section 8.0**. Based on the area sensitivities and dust emission magnitudes, the resulting risk of air quality impacts from fugitive dust has been derived for each construction activity using the impact matrix, and the results are presented in **Table 24**. As per the IAQM guidance, the risk of air quality impacts assumes no mitigation is applied, in order to identify what level of control may be required to mitigate potential off-site impacts.

Based on the risk categories derived using the IAQM method, it is concluded that there is a ***Negligible*** or ***Low*** risk of human health or dust nuisance impacts associated with the earthworks and construction activities proposed as part of the Project, even if no dust mitigation measures were to be implemented. This is due to the large separation distances between the worksites and the nearest inhabited areas.

The risks of any potential ecological impacts are also concluded to be ***Low***, even if no dust mitigation measures were to be implemented, except for the pipeline and access road earthworks and for the Purari Airstrip extension earthworks and construction activities, which are indicated to have a ***Medium*** risk of impacts. The implementation of dust controls during construction will reduce the risks of any off-site ecological impacts occurring to ***Low*** for all Project components; however, the above assessment indicates that particular care should



be taken to reduce dust emissions during the pipeline and access road earthworks, and the Purari Airstrip extension earthworks and construction. Any residual impacts would be highly localised to the area immediately adjacent to these activities, which for the road and pipeline alignments will move along as the works progress. As these impacts will be localised and short-term in duration, any affected vegetation can be expected to recover rapidly, particularly given the high rainfall in the region.

The above assessment findings are unchanged from the 2015 AQIA findings.

9.2 Operational Phase

The only operational phase activity identified as requiring assessment in the 2015 AQIA was air emissions from the CPF. All other operational activities (i.e. barging, aircraft movements, vehicle movements, waste incineration) will have lower impacts in the operations phase than in the construction phase. As no significant off-site impacts were identified for these activities during the construction phase, they were not considered further and have not been reassessed as part of this study.

The results of the air dispersion modeling study for the latest available emissions data and plant layout for the CPF are presented in **Section 7.0** for both normal and upset operating conditions. Results are presented for the nearest sensitive receptors identified in the vicinity of the CPF-P3 site and as predicted 'maximum off-site' concentrations. These maximum off-site concentrations have been extracted from the model output files based on the proposed state lease boundary in **Figure 3**.

The modelling results presented in **Section 7.0** show that for all operational scenarios assessed, the maximum ground-level NO_2, SO_2, CO and particulate matter concentrations predicted at the sensitive receptors are well below the relevant ambient air quality criteria. Concentrations predicted at all off-site locations are also well below the relevant ambient air quality criteria.

The maximum ground-level VOC concentrations predicted for the CPF in the 2015 AQIA were negligible compared to the relevant ambient air quality criteria and have not been reassessed.

In addition to human health impacts, air emissions from the CPF operations may adversely impact on the surrounding vegetation. The pollutant emitted from the CPF with the greatest potential to cause damage to vegetation is SO_2. At high concentrations, SO_2 can produce acute injury in plants in the form of foliar necrosis even after relatively short duration exposure. Long-term exposure of plants to much lower concentrations of SO_2 can result in chronic injury, taking the form of reduced growth and yield, often with no clear visible symptoms or else with some degree of yellowing of the leaves.

Different plant species and varieties and even individuals of the same species may vary considerably in their sensitivity to SO_2. The United Nations Economic Commission for Europe has identified 'critical levels' for various air pollutants to protect vegetation, with those for SO_2 listed in **Table 25** (ICP 2017)**.** These European-based guidelines may have limited relevance to the types of vegetation and the growing conditions that exist in PRL-15 (i.e. warm temperatures and high rainfall), particularly given that SO_2 impacts on vegetation are exacerbated by cold temperatures (Ashmore, Emberson and Murray 2003). However, in the absence of local guidelines or data, they have been used to provide guidance on the potential for adverse impacts on vegetation due to SO_2 emissions from the Project.

Table 25 Critical Levels for SO_2 by Vegetation Category

Vegetation Type	Critical SO_2 Level ($\mu g/m^3$)	Averaging Period
Cyanobacterial lichens	10	Annual mean
Forest ecosystems	20	Annual mean and half-year mean (Oct to Mar)
(Semi-) natural	20	Annual mean and half-year mean (Oct to Mar)
Agricultural crops	30	Annual mean and half-year mean (Oct to Mar)

The air dispersion modelling performed as part of this assessment predicted that worst case 24-hour average SO_2 concentrations beyond the site boundary would range up to a maximum of 7.3 $\mu g/m^3$. It can therefore be concluded that annual average off-site SO_2 concentrations will be far below the ICP (2017) guidelines for adverse impacts on vegetation and forest ecosystems of 20 $\mu g/m^3$. No adverse impacts on vegetation would therefore be anticipated due to SO_2 emissions from the CPF.

The above assessment findings are unchanged from the 2015 AQIA findings.

10.0 Mitigation and Monitoring

The engineering design information upon which this AQIA is based incorporates design mitigation measures that will reduce the potential for adverse off-site air quality impacts from CPF operations. These include:

- Discharging air emissions from fuel-burning equipment at the CPF via appropriately designed stacks so that air pollutants are dispersed adequately.
- Installing flares to combust gases discharged during upset operating conditions (and during startup and maintenance activities) to minimise emitting air pollutants and maximise dispersion of the combustion gases.
- Disposing of acid gas from the acid gas removal unit by injecting it into the Elk reservoir once the reservoir has been depleted (expected to occur after approximately the first four years of production), reducing SO_2 emissions from the CPF.

In addition to these, and consistent with the 2015 AQIA (with updated air quality criteria to reflect the updated WHO guidelines (WHO 2021)), the mitigation and management measures in **Table 26** will be implemented to further reduce impacts on air quality.

Table 26 Air Quality Mitigation Strategies and Management Plans

Potential Impact	Mitigation Strategy	Relevant Management Plans
Adverse human health, nuisance effects and vegetation effects due to fugitive dust from construction activities, quarry operations, and roads.	• Implement dust control, where required. • Locate fixed and mobile equipment (e.g., generators and pneumatic equipment) in consideration of local people and other sensitive receptors. • Reduce the Project footprint by: ○ Accurately estimating the land area required for different Project facilities and infrastructure. ○ Siting infrastructure and facilities as close to existing or previously used roads as practicable. ○ Clearly identifying the boundaries of areas to be disturbed at each Project site prior to works commencing. • Limit disturbance associated with vegetation clearance and earthworks for construction activities and by confining traffic and machinery to designated roads and tracks, as far as practicable. • Promote natural regeneration of any cleared areas as soon as practicable after disturbance, if going to be regenerated, taking into account the nature of subsequent Project activities that will be undertaken at the same site, and Project approved end uses. • Comply with current international air quality criteria: ○ TSP – 50 µg/m^3, 24-hour averaging period. – 60 µg/m^3, annual averaging period.	Air Emissions and GHG Management Plan

Potential Impact	Mitigation Strategy	Relevant Management Plans
	○ PM_{10} – 45 µg/m^3, 24-hour averaging period. – 15 µg/m^3, annual averaging period. ○ $PM_{2.5}$ – 15 µg/m^3, 24-hour averaging period. – 5 µg/m^3, annual averaging period.	
Adverse human health and nuisance effects due to fuel combustion emissions from operation of vehicles, machinery, fixed and mobile plant and equipment, and marine, river and air transport.	• Maintain vehicles and equipment to limit air emissions and remove from service any vehicles or equipment from which emissions are excessive. • Maintain vessels to limit air emissions and remove from service any vessels from which emissions are excessive. • Maintain aircraft to limit air emissions and remove from service any aircraft from which emissions are excessive. • Use low sulfur fuel, as far as practicable.	Air Emissions and GHG Management Plan
Adverse human health effects from combustion emissions of air pollutants associated with waste incineration.	• Incinerate combustible waste where appropriate and practicable. • Implement controls so that only wastes that can be effectively combusted are incinerated and consider additional controls for incineration of restricted waste. • Design high-temperature incinerators commensurate with proposed waste inventories. • Operate incinerators (temporary and permanent) within specifications using designated, competent personnel.	Air Emissions and GHG Management Plan; Waste Management Plan
Adverse human health and vegetation effects from air emissions at the CPF.	• Treat BTEX emissions by thermal destruction or industry good practice. • Consider use of low NOx burners, selective catalytic reduction and selective con-catalytic reduction on fired heaters and boilers. • Comply with Project air quality criteria: ○ SO_2 – 500 µg/m^3, 10-minute averaging period – 200 µg/m^3, 1-hour averaging period – 40 µg/m^3, 24-hour averaging period ○ NO_2 – 200 µg/m^3, 1-hour averaging period – 25 µg/m^3, 24-hour averaging period – 10 µg/m^3, annual averaging period ○ CO – 35,000 µg/m^3, 1-hour averaging period. – 10,000 µg/m^3, 8-hour averaging period. – 4,000 µg/m^3, 24-hour averaging period	Air Emissions and GHG Management Plan

Potential Impact	Mitigation Strategy	Relevant Management Plans
	○ Benzene – 170 µg/m^3, 1-hour averaging period. – 4.5 µg/m^3, annual averaging period. ○ Toluene – 4,500 µg/m^3, 1-hour averaging period. – 1,200 µg/m^3, annual averaging period.	

An air quality monitoring program would be developed for the construction and operational phases of the Project that would include details on pollutants to be monitored for, sampling locations (stack emissions and/or ambient air quality as appropriate), monitoring methods to be used, frequency and duration of sampling, and the associated reporting and data management requirements. The objective of the monitoring programs would be to demonstrate that the Project is complying with the ambient air quality criteria and stack emission limits presented in this assessment and as set out in the Project's environmental approvals.

11.0 Conclusions

The main conclusions from this updated AQIA for the proposed relocated CPF are as follows:

- Construction Phase:
  - Based on the IAQM construction dust risk assessment methodology, there is a ***Negligible*** or ***Low*** risk of human health or dust nuisance impacts associated with the earthworks and construction activities proposed at the CPF-P3 site, even if no dust mitigation measures were to be implemented. This is due to the low population density in the surrounding area.
  - The risks of any potential ecological impacts are concluded to be ***Medium*** during earthworks and ***Low*** during construction, if no dust mitigation measures were to be implemented. As these impacts will be localised and short-term in duration, any affected vegetation can be expected to recover rapidly, particularly given the high rainfall in the region.
  - The above assessment findings are unchanged from the 2015 AQIA findings.
- Operational Phase:
  - The results of the air dispersion modelling study for the latest available emissions data and plant layout for the CPF show that for all operational scenarios assessed, the maximum ground-level NO_2, SO_2, CO and particulate matter concentrations predicted at the sensitive receptors are well below the relevant ambient air quality criteria. Concentrations predicted at all off-site locations are also well below the relevant ambient air quality criteria.
  - The maximum ground-level VOC concentrations predicted for the CPF in the 2015 AQIA were negligible compared to the relevant ambient air quality criteria and have not been reassessed.
  - Annual average off-site SO_2 concentrations will be far below the ICP (2017) guidelines for adverse impacts on vegetation and forest ecosystems of 20 $\mu g/m^3$. No adverse impacts on vegetation would therefore be anticipated due to SO_2 emissions from the CPF.
  - The above assessment findings are unchanged from the 2015 AQIA findings.

12.0 References

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Appendix A IAQM Methodology

Papua LNG CPF P3 Relocation

Air Quality Impact Assessment

Papua LNG Development Pty Ltd

SLR Project No.: 620.040581.00001

23 April 2024

IAQM Construction Phase Risk Assessment Methodology

Step 1 – Screening Based on Separation Distance

The Step 1 screening criteria provided by the IAQM Guidance (IAQM 2024) suggests an assessment may be required where:

- a 'human receptor' is located within:
  - 350 m of the boundary of the site; or
  - 50 m of the route(s) used by construction vehicles on public roads, up to 500 m from the site entrance.
- an 'ecological receptor' is located within:
  - 50 m of the boundary of the site; or
  - 50 m of the route(s) used by construction vehicles on public roads, up to 500 m from the site entrance.

This step is noted as having deliberately been chosen to be conservative and will require assessments for most projects.

Step 2a – Assessment of Scale and Nature of the Works

Step 2a of the assessment provides "dust emissions magnitudes" for each of four dust generating activities; demolition, earthworks, construction, and track-out (the movement of site material onto public roads by vehicles). The magnitudes are: Large; Medium; or Small, with suggested definitions for each category. The definitions given in the IAQM guidance for demolition, earthworks, construction activities and track-out, are as follows:

- Demolition *(Any activity involved with the removal of an existing structure [or structures]. This may also be referred to as de-construction, specifically when a building is to be removed a small part at a time)*:
  - **Large**: Total building volume greater than 50,000 m^3, potentially dusty construction material (e.g. concrete), on-site crushing and screening, demolition activities higher than 20 m above ground level.
  - **Medium**: Total building volume 20,000 m^3 – 50,000 m^3, potentially dusty construction material, demolition activities 10-20 m above ground level.
  - **Small**: Total building volume less than 20,000 m^3, construction material with low potential for dust release (e.g. metal cladding or timber), demolition activities less than 10 m above ground, demolition during wetter months.
- Earthworks *(Covers the processes of soil-stripping, ground-levelling, excavation and landscaping)*:
  - **Large**: Total site area greater than 10,000 m^2, potentially dusty soil type (e.g. clay, which will be prone to suspension when dry due to small particle size), more than 10 heavy earth moving vehicles active at any one time, formation of bunds greater than 8 m in height, total material moved greater than 100,000 tonnes.
  - **Medium**: Total site area 2,500 m^2 to 10,000 m^2, moderately dusty soil type (e.g. silt), 5 to 10 heavy earth moving vehicles active at any one time, formation of bunds 4 m to 8 m in height, total material moved 20,000 tonnes – 100,000 tonnes.

  - **Small**: Total site area less than 2,500 m^2, soil type with large grain size (e.g. sand), less than 5 heavy earth moving vehicles active at any one time, formation of bunds less than 4 m in height, total material moved less than 20,000 tonnes.

- Construction (*Any activity involved with the provision of a new structure (or structures), its modification or refurbishment. A structure will include a residential dwelling, office building, retail outlet, road, etc.)*:
  - **Large**: Total building volume greater than 100,000 m^3, on site concrete batching; sandblasting.
  - **Medium**: Total building volume 25,000 m^3 to 100,000 m^3, potentially dusty construction material (e.g. concrete), on site concrete batching.
  - **Small**: Total building volume less than 25,000 m^3, construction material with low potential for dust release (e.g. metal cladding or timber).
- Track-out *(The transport of dust and dirt from the construction / demolition site onto the public road network, where it may be deposited and then re-suspended by vehicles using the network)*:
  - **Large**: More than 50 heavy vehicle (>3.5 t) outward movements in any one day, potentially dusty surface material (e.g. high clay content), greater than 100 m of unpaved road length.
  - **Medium**: Between 10 and 50 heavy vehicle (>3.5 t) outward movements in any one day, moderately dusty surface materials (e.g. high clay content), between 50 m and 100 m of unpaved road length.
  - **Small**: Less than 10 heavy vehicle (>3.5 t) outward movements in any one day, surface materials with a low potential for dust release, less than 50 m of unpaved road length.

In order to provide a conservative assessment of potential impacts, it has been assumed that if at least one of the parameters specified in the 'large' definition is satisfied, the works are classified as large, and so on.

Step 2b – Assessment of the Sensitivity of the Area

Step 2b of the assessment process requires the sensitivity of the area to be defined. The sensitivity of the area takes into account:

- The specific sensitivities that identified sensitive receptors have to dust deposition and human health impacts
- The proximity and number of those receptors
- In the case of PM_{10}, the local background concentration
- Other site-specific factors, such as whether there are natural shelters such as trees to reduce the risk of wind-blown dust.

Individual human receptors are classified as having high, medium or low sensitivity to either dust deposition or human health impacts. The IAQM method provides guidance on the sensitivity of different human receptor types to dust soiling and health effects as summarised in **Table A-1**. The definitions and examples given in the IAQM Guidance for ecological receptors have been modified in **Table A-1** to be relevant to the Australian context based on advice from SLR's ecological specialist team.

It is noted in the IAQM Guidance that people's expectations of amenity levels (dust soiling) is also dependent on existing deposition levels.

Table A-1 IAQM - Guidance for Categorising Receptor Sensitivity

Value	High Sensitivity Receptor	Medium Sensitivity Receptor	Low Sensitivity Receptor
Dust soiling	• Users can reasonably expect a high level of amenity; or • The appearance, aesthetics or value of their property would be diminished by soiling, and the people or property would reasonably be expected to be present continuously, or at least regularly for extended periods as part of the normal pattern of use of the land.	• Users would expect to enjoy a reasonable level of amenity, but would not reasonably expect to enjoy the same level of amenity as in their home; or • The appearance, aesthetics or value of their property could be diminished by soiling; or • The people or property would not reasonably be expected to be present here continuously or regularly for extended periods as part of the normal pattern of use of the land.	• The enjoyment of amenity would not reasonably be expected; or • Property would not reasonably be expected to be diminished in appearance, aesthetics or value by soiling; or • There is transient exposure, where the people or property would reasonably be expected to be present only for limited periods of time as part of the normal pattern of use of the land.
	Examples: Dwellings, museums other culturally important collections, medium and long term car parks and car showrooms.	*Examples: Parks and places of work.*	*Examples: Playing fields, farmland (unless commercially sensitive horticultural), footpaths, short term car parks and roads.*
Health effects	• Locations where the public are exposed over a time period relevant to the air quality objective for PM_{10} (in the case of the 24-hour objectives, a relevant location would be one where individuals may be exposed for eight hours or more in a day).	• Locations where the people exposed are workers, and exposure is over a time period relevant to the air quality objective for PM_{10} (in the case of the 24-hour objectives, a relevant location would be one where individuals may be exposed for eight hours or more in a day).	• Locations where human exposure is transient.
	Examples: Residential properties, hospitals, schools and residential care homes.	*Examples: Office and shop workers, but will generally not include workers occupationally exposed to PM_{10}.*	*Examples: Public footpaths, playing fields, parks and shopping streets.*
Ecological	• Locations that support International or National (EPBC) level species or ecological communities of conservation significance that may be affected by dust soiling; or	• Locations that support National or State level species or ecological communities of conservation significance, where its dust sensitivity is uncertain or unknown; or • Locations that are protected under the EPBC Act or State	• Locations that support State or Local Government level species of conservational significance where the features may be affected by dust deposition.

Value	High Sensitivity Receptor	Medium Sensitivity Receptor	Low Sensitivity Receptor
	• Locations that are protected under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act), that will require approval from the Commonwealth Government Minister for the Environment (the minister) if the action has, will have, or is likely to have, a significant impact on Matters of National Environmental Significance (MNES).	legislation (e.g. Biodiversity Conservation Act), that will require approval from the Commonwealth or State Government Minister for the Environment (the minister) if the action has, will have, or is likely to have, a significant impact on MNES or State listed conservation significant species or communities.	• Locations that are protected under State legislation (e.g. Biodiversity Conservation Act) or Local Government Environmental Management Plans, that will require approval from the State Government Minister for the Environment (the minister) if the action has, will have, or is likely to have, a significant impact on State listed conservation significant species or communities.
	Examples: Threatened avifauna that are impacted from air pollution through the ingestion of fine dust particles into the liver and lungs due to their high metabolic rate and special respiratory systems.	*Examples: Threatened or Priority Ecological Communities that are sensitive to dust by inhibiting photosynthesis and respiration of species.*	*Examples: a local Nature Reserve with dust sensitive vegetation communities.*

According to the IAQM methods, the sensitivity of the identified individual receptors (as described above) is then used to assess the *sensitivity of the area* surrounding the active construction area, taking into account the proximity and number of those receptors, and the local background PM_{10} concentration (in the case of potential health impacts) and other site-specific factors. Additional factors to consider when determining the sensitivity of the area include:

- Any history of dust generating activities in the area
- The likelihood of concurrent dust generating activity on nearby sites
- Any pre-existing screening between the source and the receptors
- Any conclusions drawn from analysing local meteorological data which accurately represent the area and if relevant
- The season during which the works will take place
- Any conclusions drawn from local topography
- The duration of the potential impact (as a receptor may become more sensitive over time)
- any known specific receptor sensitivities which go beyond the classifications given in the IAQM document.

The IAQM guidance for assessing the sensitivity of an area to dust soiling is shown in **Table A-2**. The sensitivity of the area should be derived for each of activity relevant to the Project (i.e. construction and earthworks).

Table A-2 IAQM - Categorising the Sensitivity of an Area to Dust Soiling Impacts

Receptor Sensitivity	Number of Receptors	Distance from the Source (m)			
		<20	<50	<100	<350
High	>100	High	High	Medium	Low
	10-100	High	Medium	Low	Low
	1-10	Medium	Low	Low	Low
Medium	>1	Medium	Low	Low	Low
Low	>1	Low	Low	Low	Low

Note: Estimate the total number of receptors within the stated distance. Only the *highest level* of area sensitivity from the table needs to be considered. For example, if there are 7 high sensitivity receptors < 20m of the source and 95 high sensitivity receptors between 20 and 50 m, then the total of number of receptors < 50 m is 102. The sensitivity of the area in this case would be high.

A modified version of the IAQM guidance for assessing the *sensitivity of an area* to health impacts is shown in **Table A-3**. For high sensitivity receptors, the IAQM methods takes the existing background concentrations of PM_{10} (as an annual average) experienced in the area of interest into account and is based on the air quality objectives for PM_{10} in the UK. As these objectives differ from the ambient air quality criteria adopted for use in this assessment (i.e. an annual average of 25 µg/m^3 for PM_{10}) the IAQM method has been modified slightly.

This approach is consistent with the IAQM guidance, which notes that in using the tables to define the *sensitivity of an area*, professional judgement may be used to determine alternative sensitivity categories, taking into account the following factors:

- any history of dust generating activities in the area
- the likelihood of concurrent dust generating activity on nearby sites
- any pre-existing screening between the source and the receptors
- any conclusions drawn from analysing local meteorological data which accurately represent the area, and if relevant the season during which the works will take place
- any conclusions drawn from local topography
- duration of the potential impact
- any known specific receptor sensitivities which go beyond the classifications given in the IAQM document.

Table A-3 IAQM - Categorising the Sensitivity of an Area to Dust Health Impacts

Receptor sensitivity	Annual Mean PM_{10}	Number of receptors [a,b]	Distance from the source (m)				
			<20	<50	<100	<200	<350
High	>25 µg/m^3	>100	High	High	High	Medium	Low
		10-100	High	High	Medium	Low	Low
		1-10	High	Medium	Low	Low	Low
	21-25 µg/m^3	>100	High	High	Medium	Low	Low
		10-100	High	Medium	Low	Low	Low
		1-10	High	Medium	Low	Low	Low
	17-21 µg/m^3	>100	High	Medium	Low	Low	Low
		10-100	High	Medium	Low	Low	Low
		1-10	Medium	Low	Low	Low	Low
	<17 µg/m^3	>100	Medium	Low	Low	Low	Low
		10-100	Low	Low	Low	Low	Low
		1-10	Low	Low	Low	Low	Low
Medium	>25 µg/m^3	>10	High	Medium	Low	Low	Low
		1-10	Medium	Low	Low	Low	Low
	21-25 µg/m^3	>10	Medium	Low	Low	Low	Low
		1-10	Low	Low	Low	Low	Low
	17-21 µg/m^3	>10	Low	Low	Low	Low	Low
		1-10	Low	Low	Low	Low	Low
	<17 µg/m^3	>10	Low	Low	Low	Low	Low
		1-10	Low	Low	Low	Low	Low
Low	-	>1	Low	Low	Low	Low	Low

Notes: (a) Estimate the total within the stated distance (e.g. the total within 350 m and not the number between 200 and 350 m); noting that only the highest level of area sensitivity from the table needs to be considered.

(b) In the case of high sensitivity receptors with high occupancy (such as schools or hospitals) approximate the number of people likely to be present. In the case of residential dwellings, just include the number of properties.

The IAQM Guidance matrix used to categorise the sensitivity of the area to ecological impacts from dust is presented in **Table A-4**.

Table A-4 IAQM - Categorising the Sensitivity of an Area to Ecological Impacts

Receptor Sensitivity	Distance from the Source (m)	
	<20	<50
High	High	Medium
Medium	Medium	Low
Low	Low	Low

Notes: (a) The sensitivity of the area should be derived for each of the four activities: demolition, construction, earthworks and trackout and for each designated site.

(b) Only the highest level of area sensitivity from the table needs to be considered.

(c) For trackout, the distances should be measured from the side of the roads used by construction traffic. Without site-specific mitigation, trackout may occur from roads up to 500 m from large sites, 200 m from medium sites and 50 m from small sites, as measured from the site exit. The impact declines with distance from the site.

Step 2c - Risk Assessment

The dust emission magnitude from Step 2a and the receptor sensitivity from Step 2b are then used in the matrices shown in **Table A-5** (demolition), **Table A-6** (earthworks and construction) and **Table A-7** (track-out) to determine the risk category with no mitigation applied.

Table A-5 Risk Category from Demolition Activities

Sensitivity of Area	Dust Emission Magnitude		
	Large	Medium	Small
High	High Risk	Medium Risk	Medium Risk
Medium	High Risk	Medium Risk	Low Risk
Low	Medium Risk	Low Risk	Negligible

Table A-6 Risk Category from Earthworks and Construction Activities

Sensitivity of Area	Dust Emission Magnitude		
	Large	Medium	Small
High	High Risk	Medium Risk	Low Risk
Medium	Medium Risk	Medium Risk	Low Risk
Low	Low Risk	Low Risk	Negligible

Table A-7 Risk Category from Track-out Activities

Sensitivity of Area	Dust Emission Magnitude		
	Large	Medium	Small
High	High Risk	Medium Risk	Low Risk
Medium	Medium Risk	Low Risk	Negligible
Low	Low Risk	Low Risk	Negligible

Step 3 - Site-Specific Mitigation

Once the risk categories are determined for each of the relevant activities, site-specific management measures can be identified based on whether the Site is a low, medium or high risk site.

Step 4 – Residual Impacts

Following Step 3, the residual impact is then determined after management measures have been considered.

Appendix B Case 1 Contour Plots

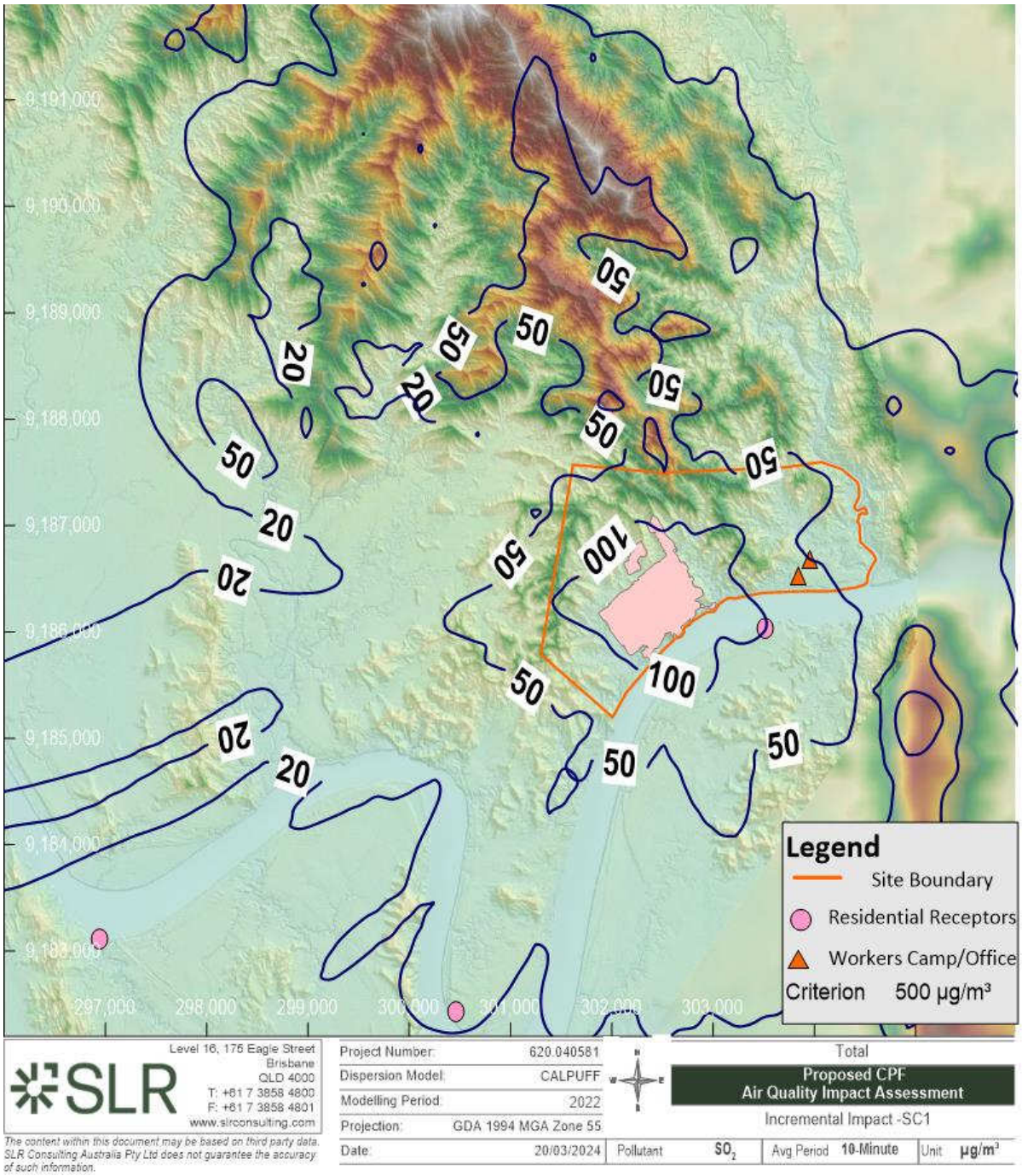
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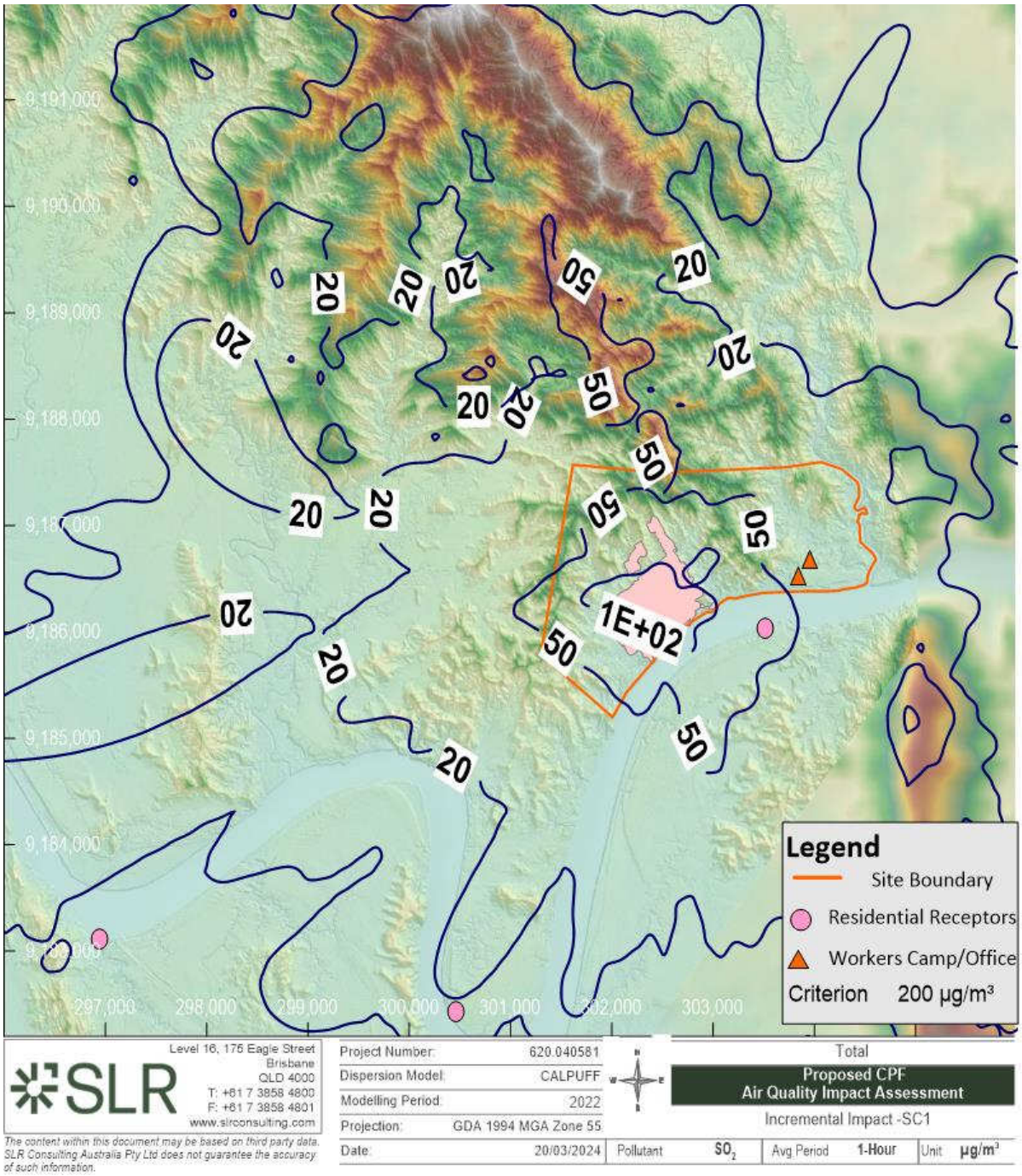
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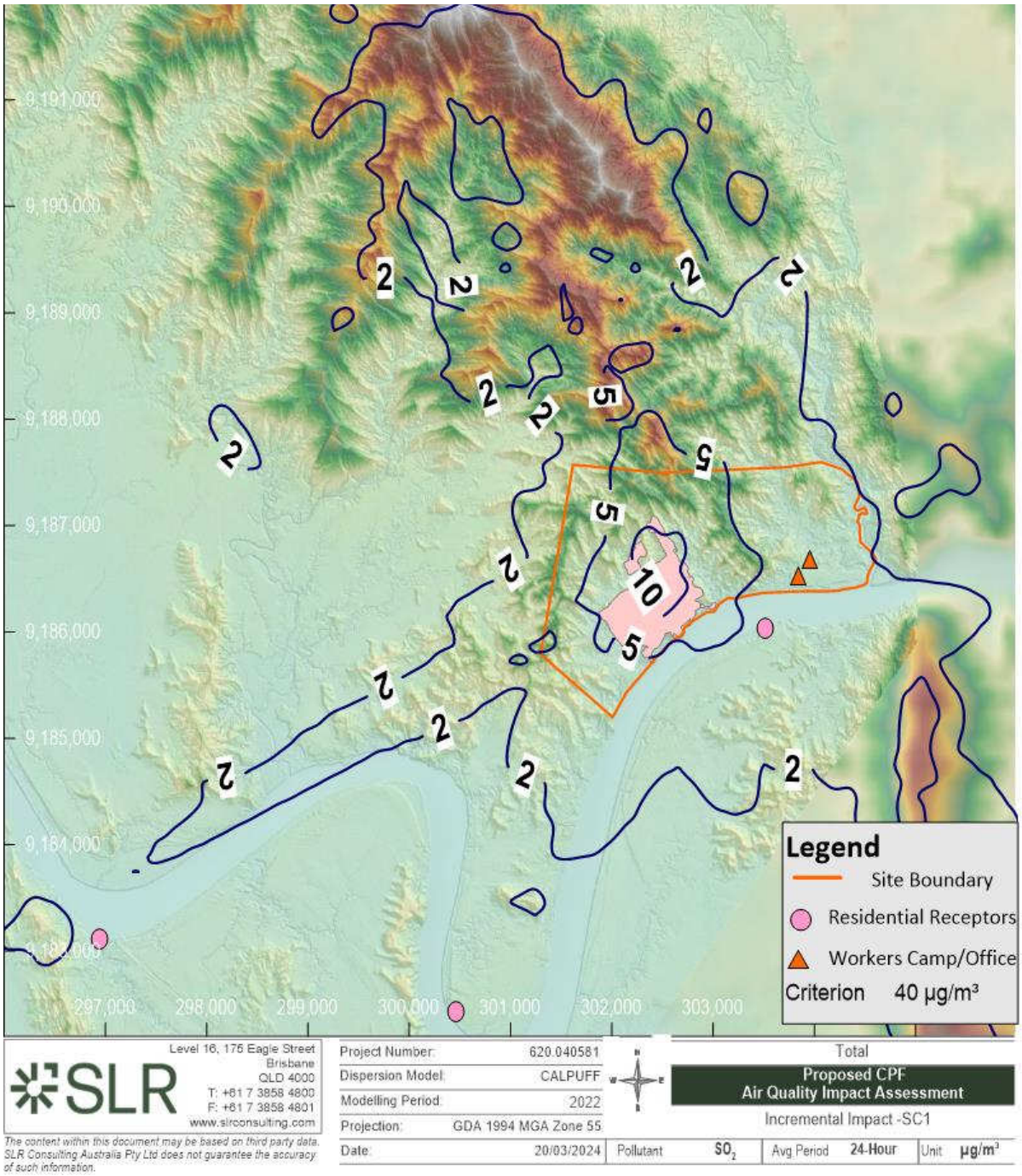
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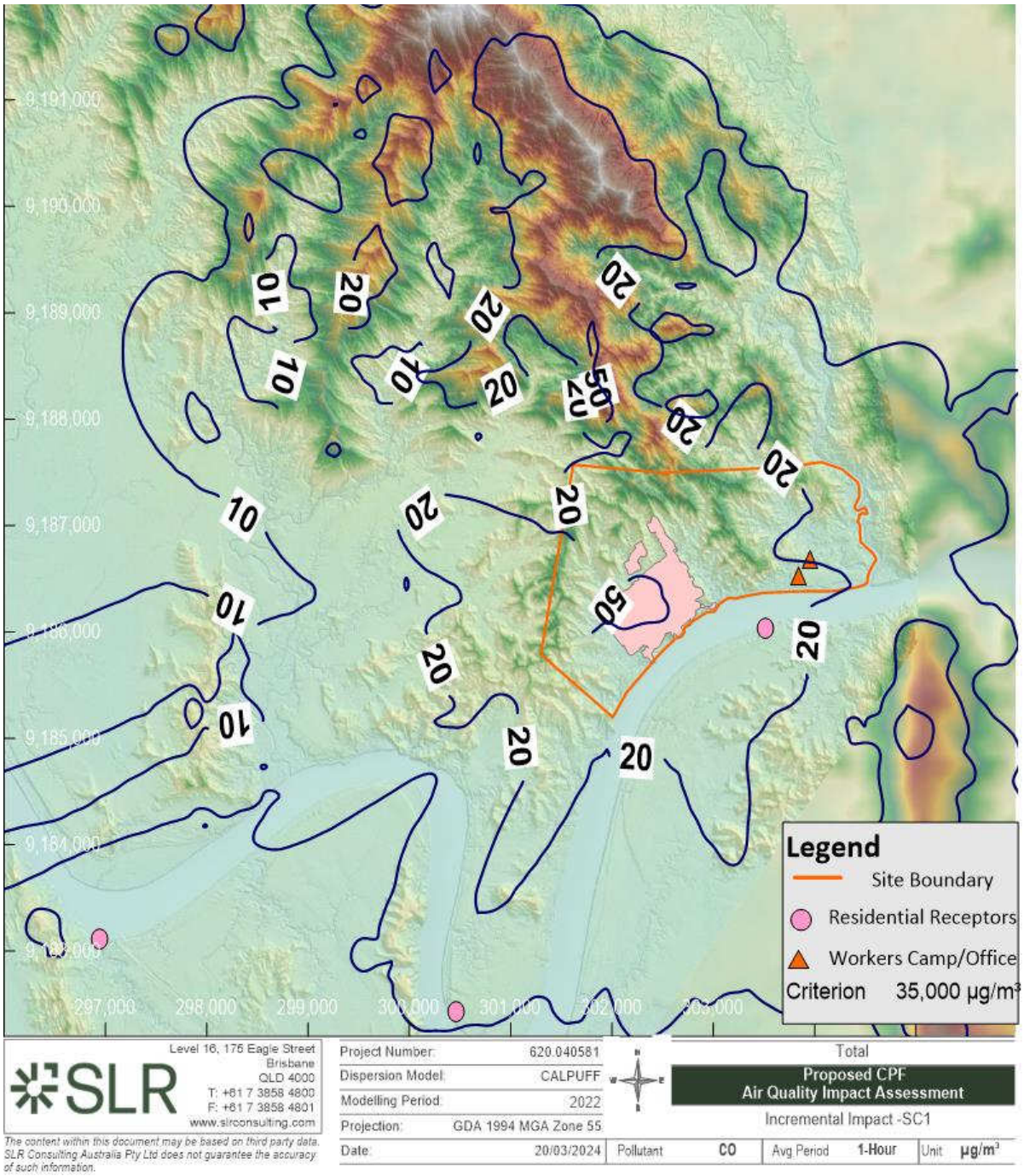
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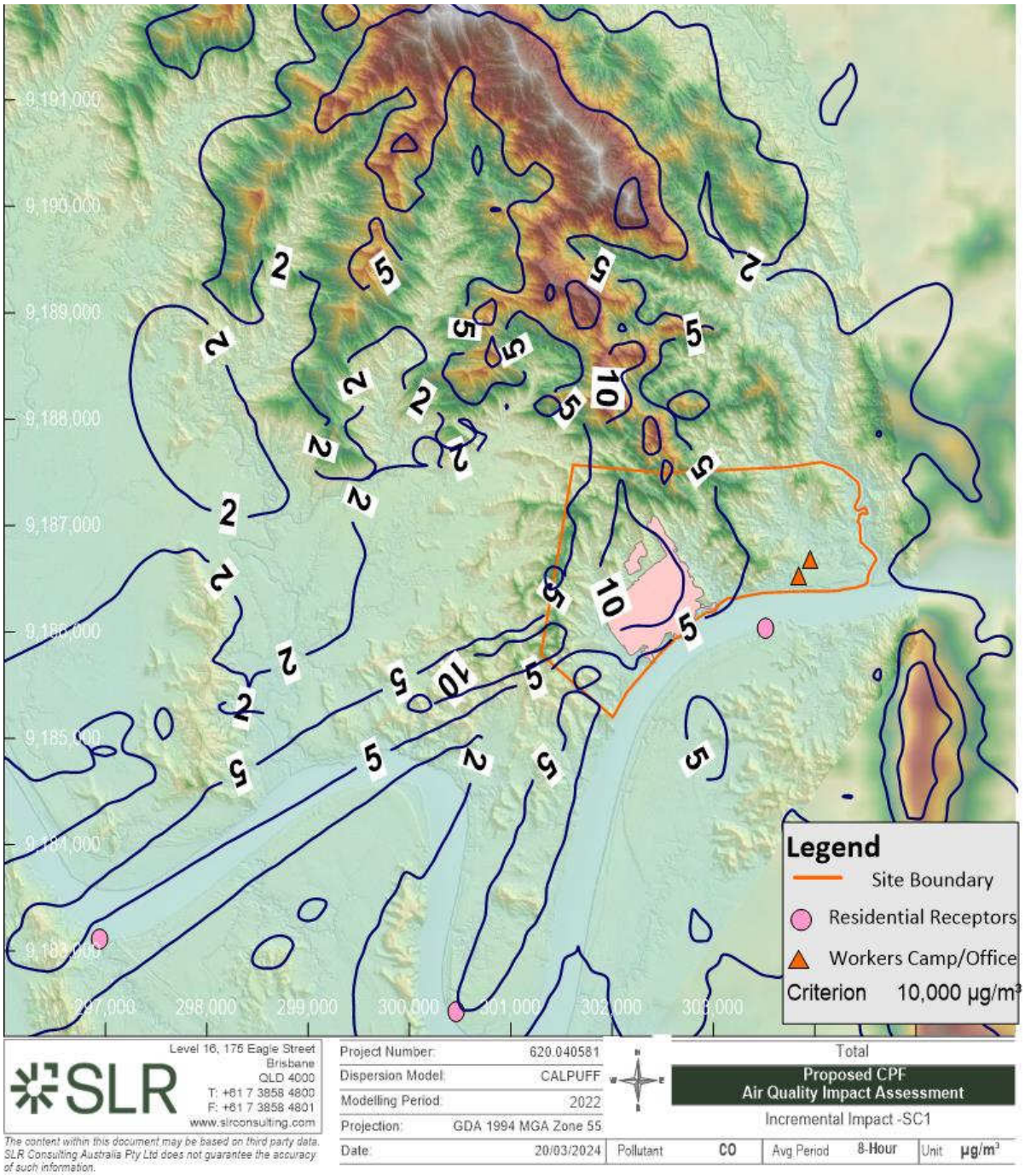
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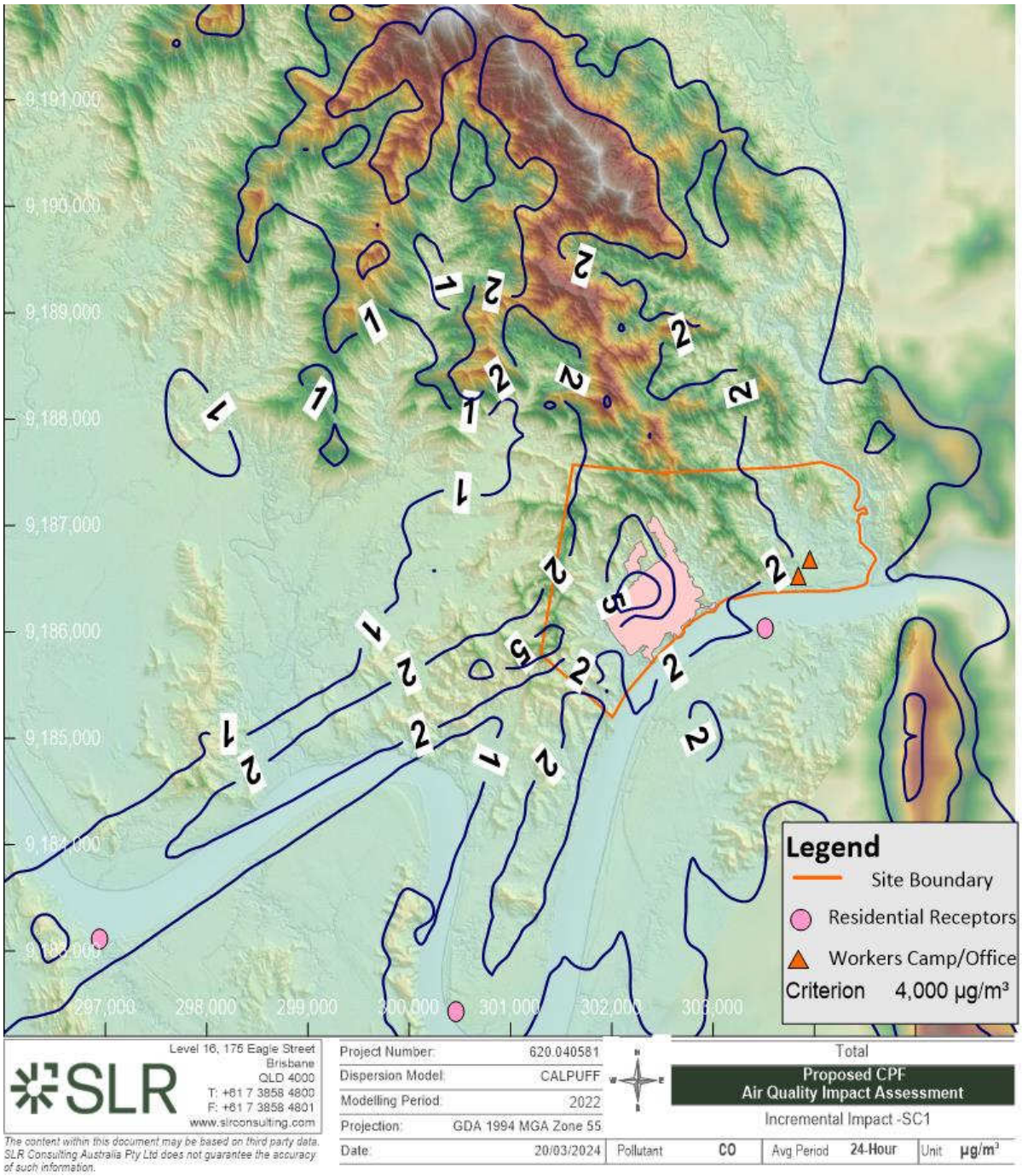

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Residential Receptors
Workers Camp/Office
Criterion 500 µg/m³
SLR
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Brisbane
QLD 4000
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Dispersion Model: CALPUFF
Modelling Period: 2022
Projection: GDA 1994 MGA Zone 55
Date: 20/03/2024
Total
Proposed CPF
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Pollutant SO_2
Avg.Period 10-Minute
Unit µg/m³

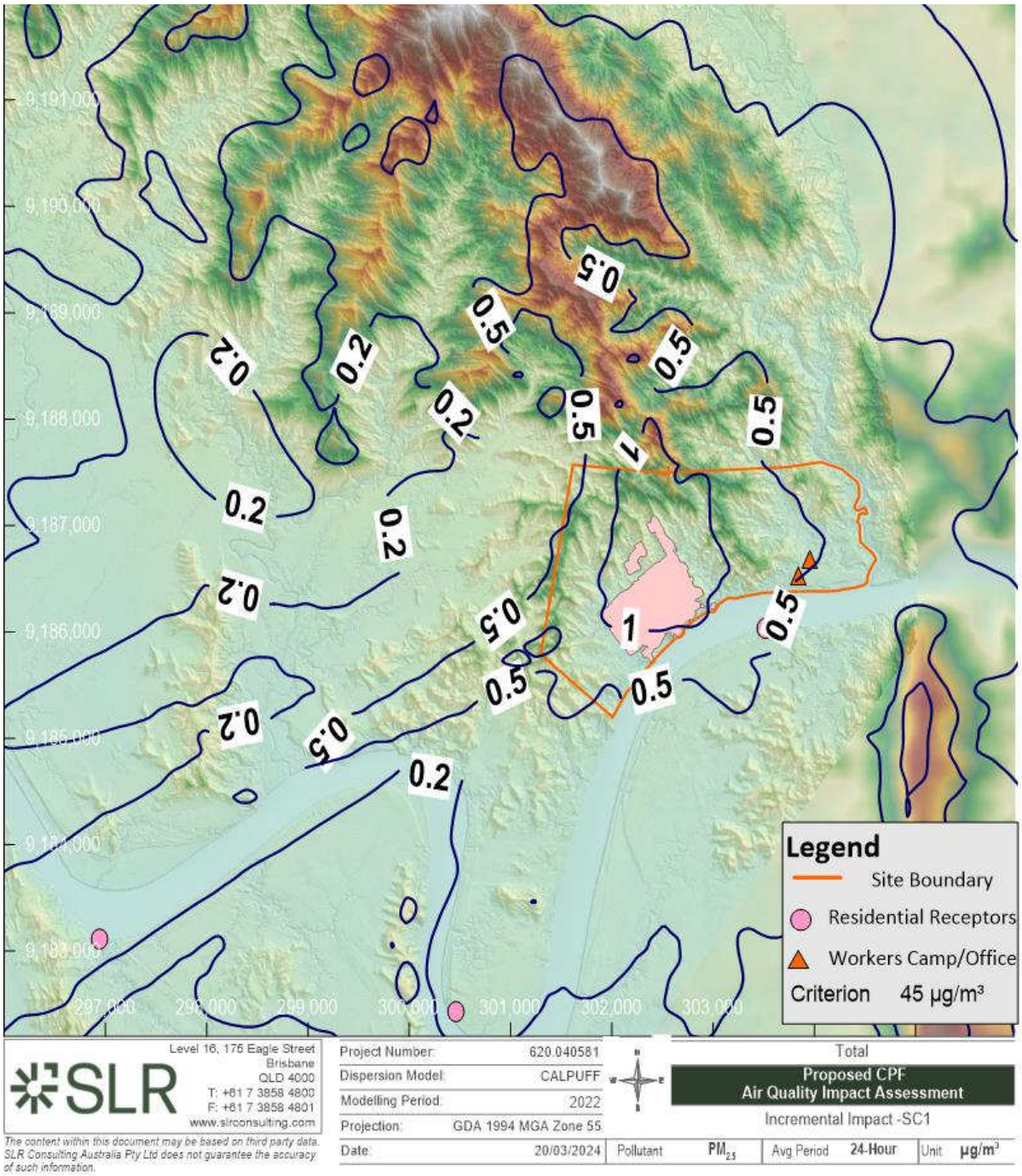

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Brisbane
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Avg.Period 1-Hour
Unit µg/m³

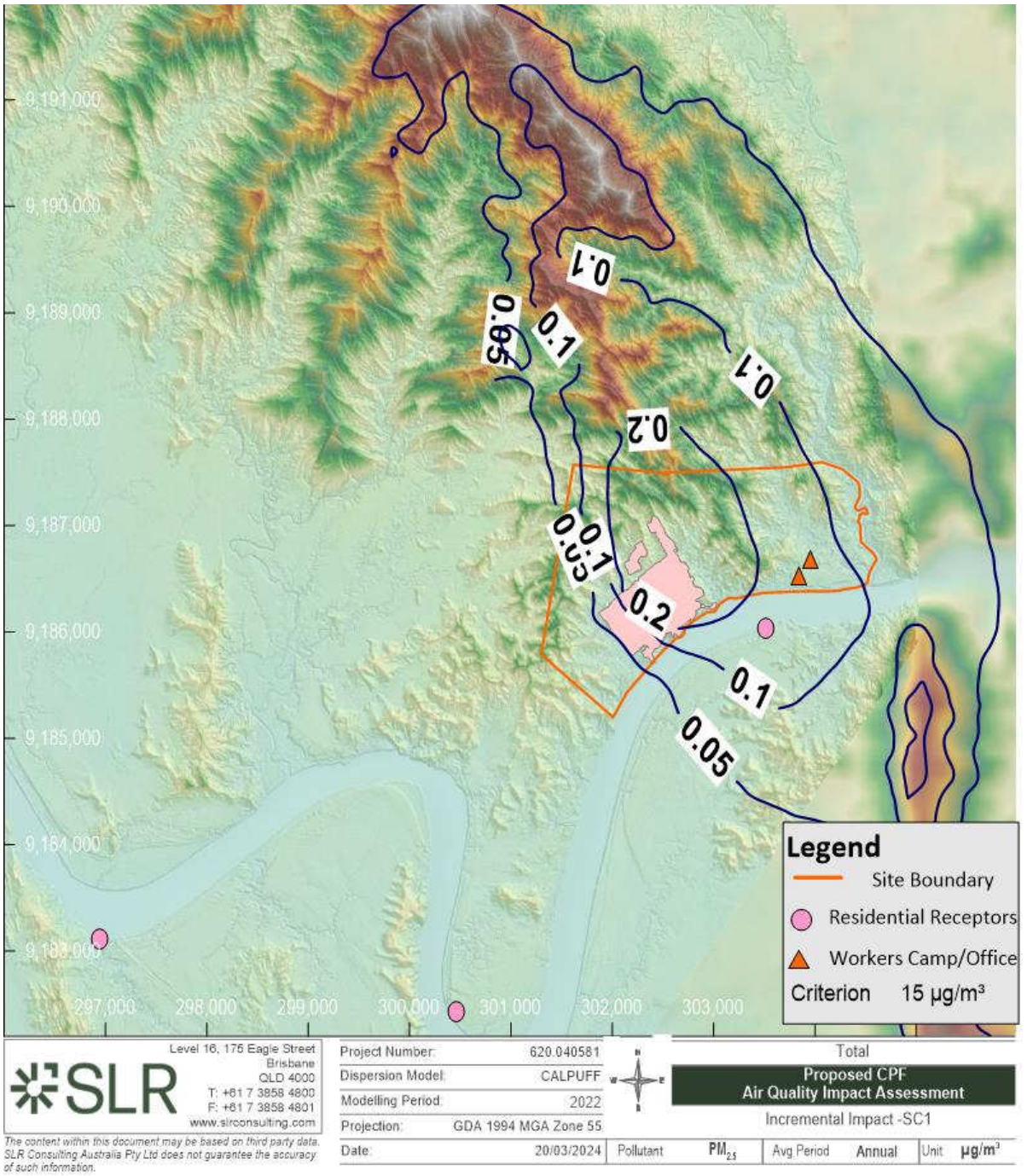

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Workers Camp/Office
Criterion 40 µg/m³
SLR
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Avg.Period 24-Hour
Unit µg/m³

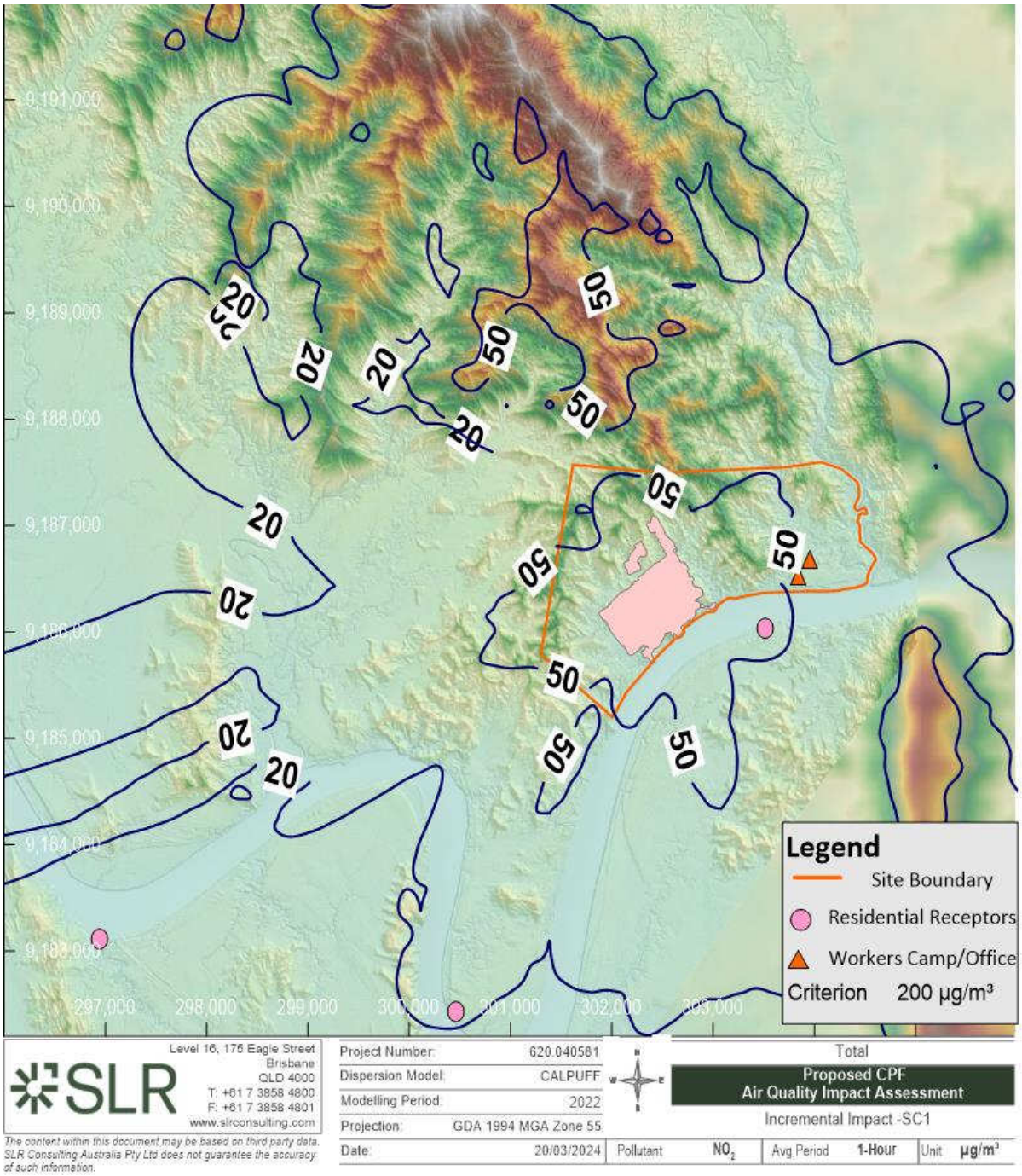

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Brisbane
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Avg.Period 1-Hour
Unit µg/m³

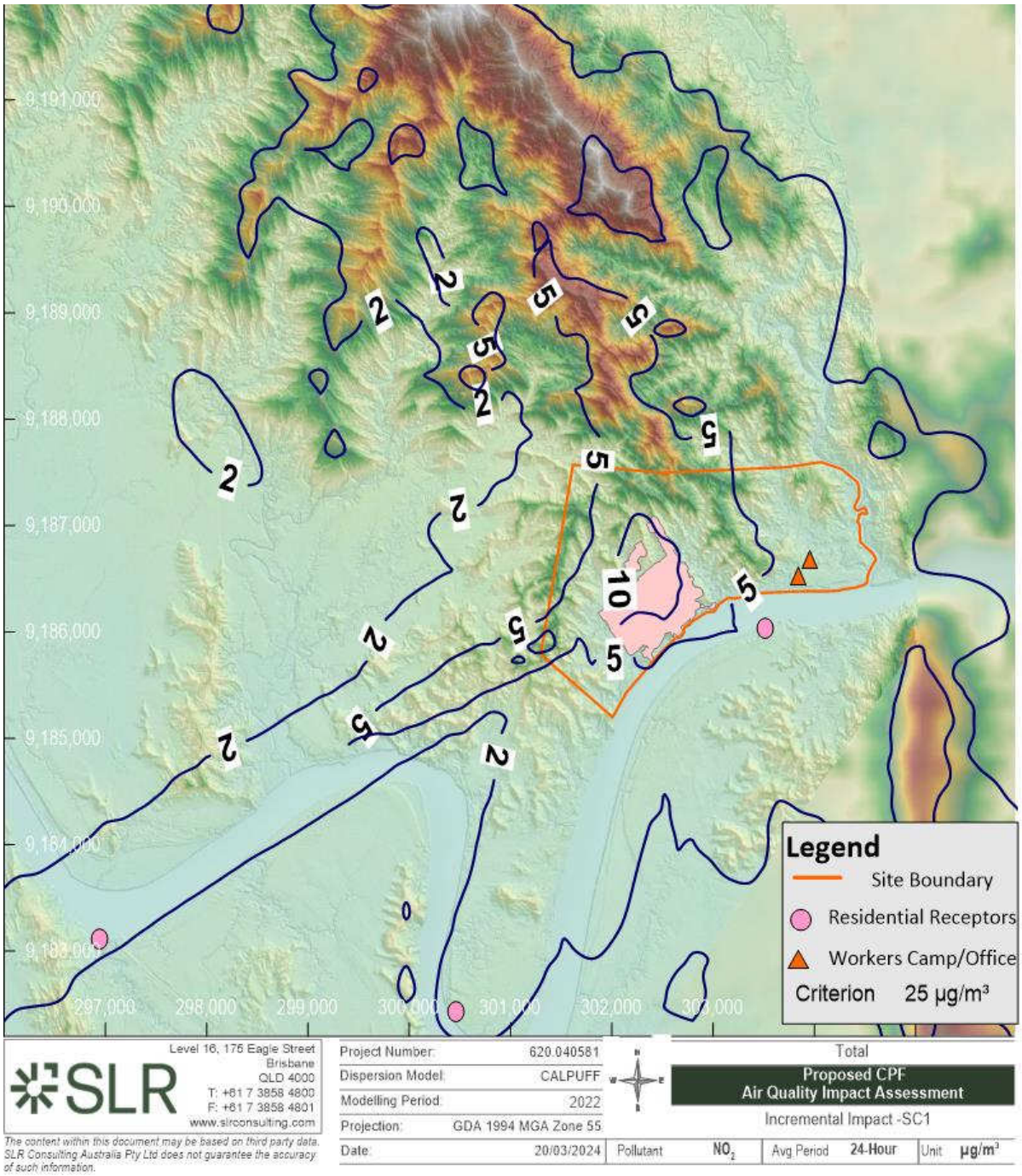

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Avg.Period 8-Hour
Unit µg/m³

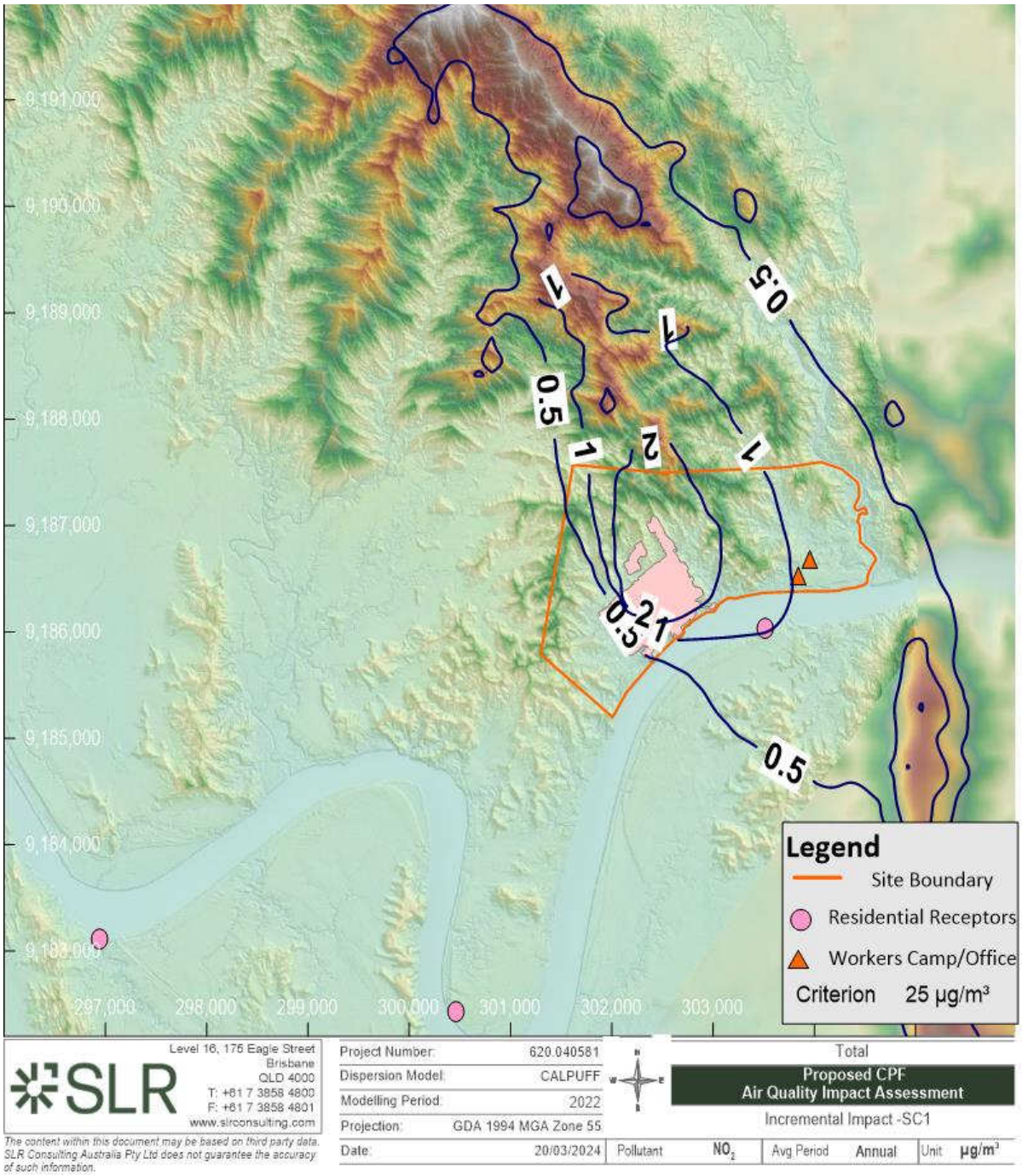

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Pollutant CO
Avg.Period 24-Hour
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Pollutant PM2.5
Avg.Period 24-Hour
Unit µg/m³


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Date: 20/03/2024
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Air Quality Impact Assessment
Incremental Impact -SC1
Pollutant PM2.5
Avg Period Annual
Unit µg/m³


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Residential Receptors
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Modelling Period: 2022
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Date: 20/03/2024
Total
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Air Quality Impact Assessment
Incremental Impact -SC1
Pollutant NO2
Avg Period 1-Hour
Unit µg/m³


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Date: 20/03/2024
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Pollutant NO2
Avg.Period 24-Hour
Unit µg/m³


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Modelling Period: 2022
Projection: GDA 1994 MGA Zone 55
Date: 20/03/2024
Total
Proposed CPF
Air Quality Impact Assessment
Incremental Impact -SC1
Pollutant NO2
Avg.Period Annual
Unit µg/m³

Appendix C Case 2 Contour Plots

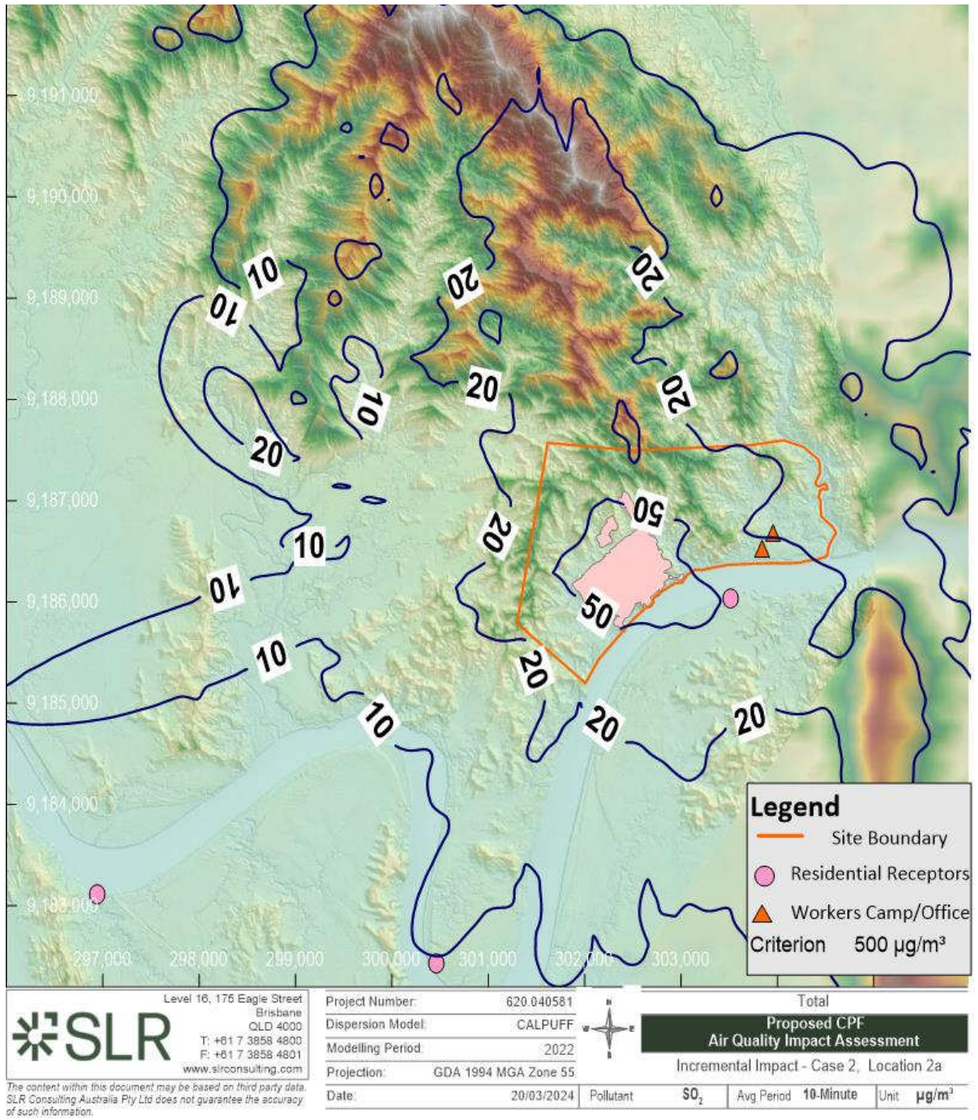
Papua LNG CPF P3 Relocation

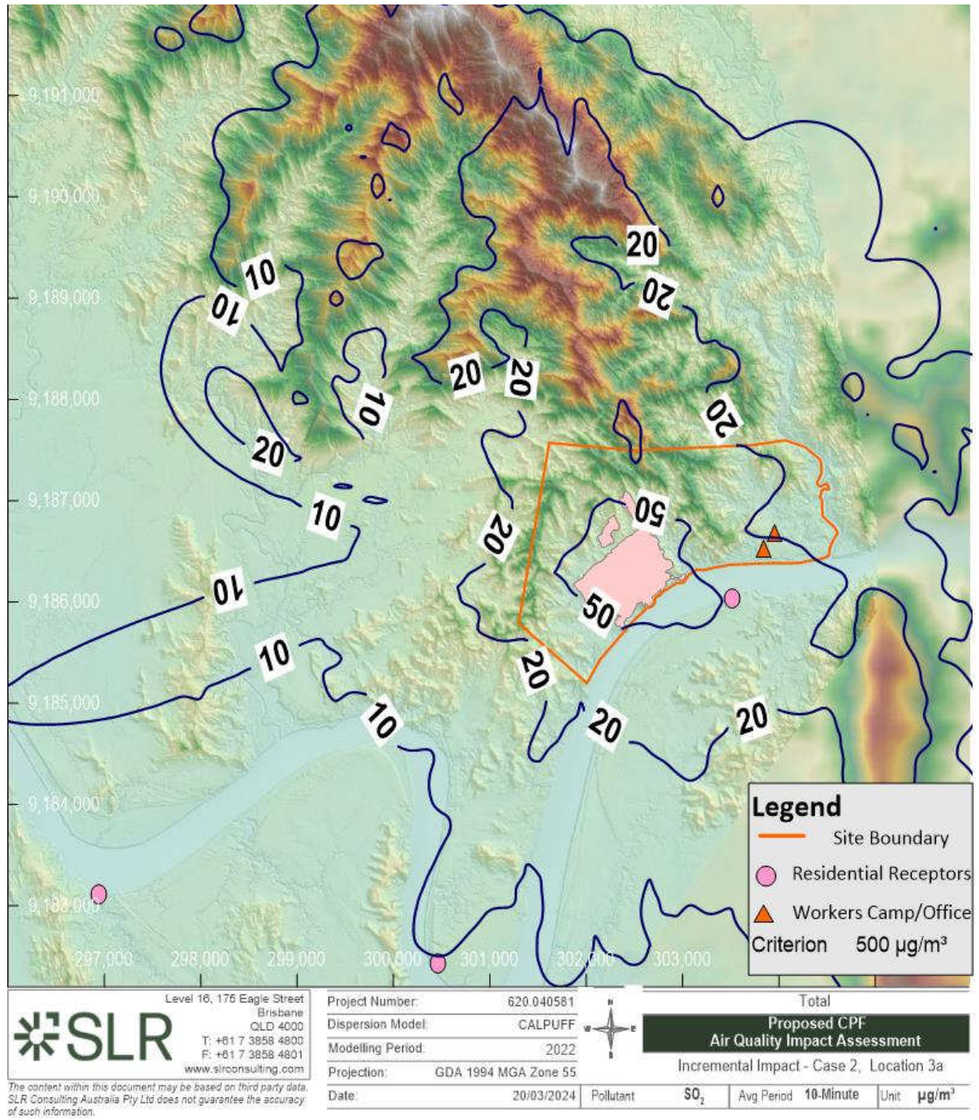
Air Quality Impact Assessment

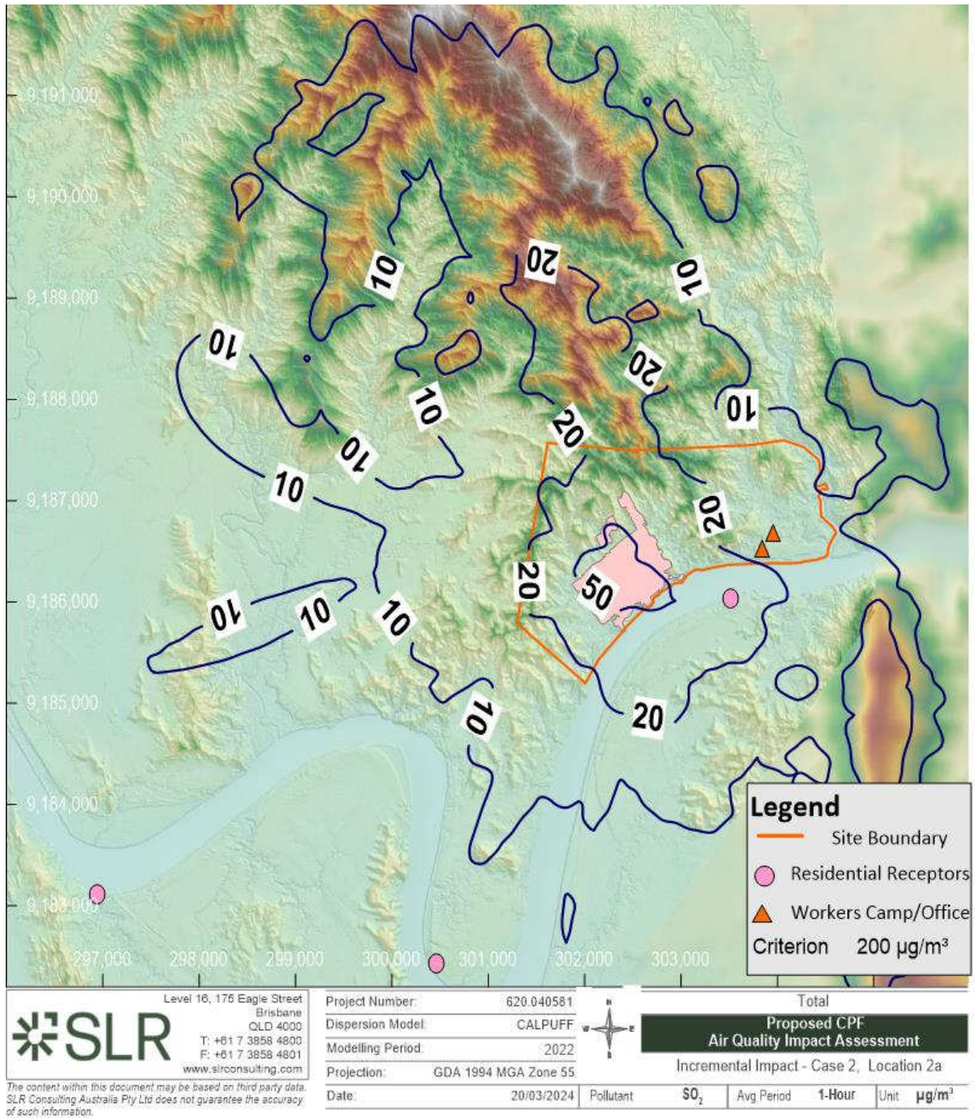
Papua LNG Development Pty Ltd

SLR Project No.: 620.040581.00001

23 April 2024


9,191,000
9,190,000
9,189,000
9,188,000
9,187,000
9,186,000
9,185,000
9,184,000
9,183,000
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300,000
301,000
302,000
303,000
10
20
50
Legend
Site Boundary
Residential Receptors
Workers Camp/Office
Criterion 500 µg/m³
Level 16, 175 Eagle Street
Brisbane
QLD 4000
T: +61 7 3858 4800
F: +61 7 3858 4801
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Project Number: 620.040581
Dispersion Model: CALPUFF
Modelling Period: 2022
Projection: GDA 1994 MGA Zone 55
Date: 20/03/2024
Total
Proposed CPF
Air Quality Impact Assessment
Incremental Impact - Case 2, Location 2a
Pollutant SO2
Avg Period 10-Minute
Unit µg/m³


9,191,000
9,190,000
9,189,000
9,188,000
9,187,000
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9,184,000
9,183,000
297,000
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299,000
300,000
301,000
302,000
303,000
10
20
50
Legend
Site Boundary
Residential Receptors
Workers Camp/Office
Criterion 500 µg/m³
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Date: 20/03/2024
Total
Proposed CPF
Air Quality Impact Assessment
Incremental Impact - Case 2, Location 3a
Pollutant SO2
Avg Period 10-Minute
Unit µg/m³



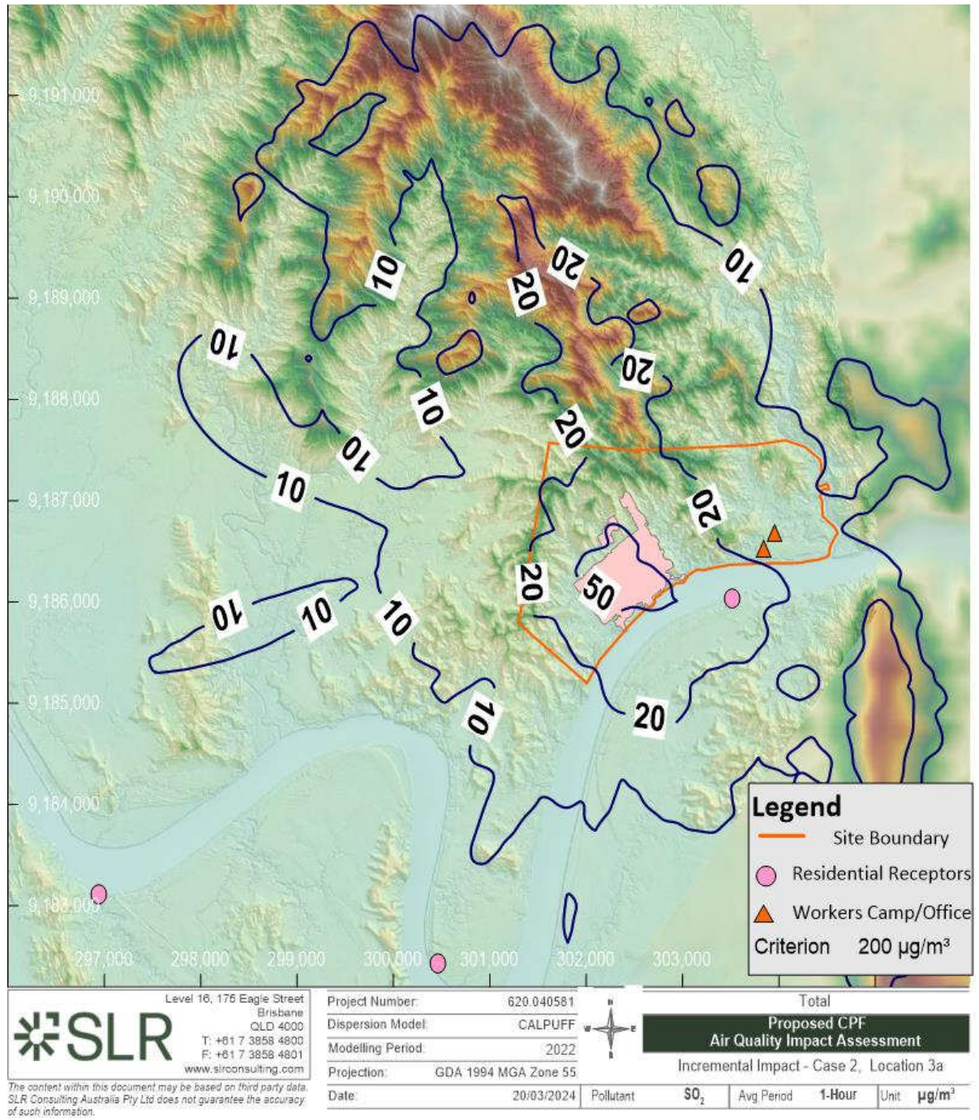
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Modelling Period:	2022
Projection:	GDA 1994 MGA Zone 55
Date:	20/03/2024

Total
Proposed CPF
Air Quality Impact Assessment
Incremental Impact - Case 2, Location 2a

Pollutant	SO_2	Avg Period	1-Hour	Unit	µg/m³



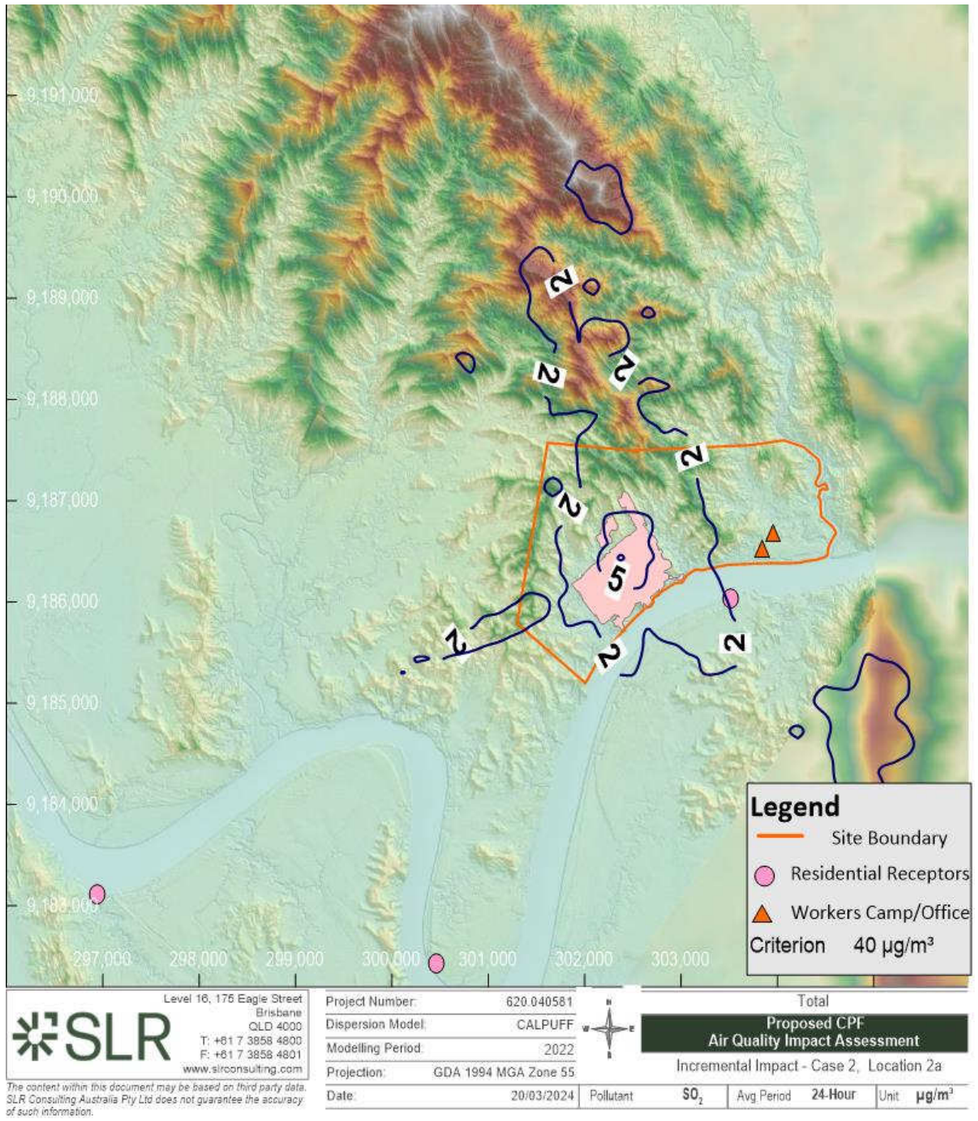
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Project Number:	620.040581
Dispersion Model:	CALPUFF
Modelling Period:	2022
Projection:	GDA 1994 MGA Zone 55
Date:	20/03/2024

Total
Proposed CPF
Air Quality Impact Assessment
Incremental Impact - Case 2, Location 3a

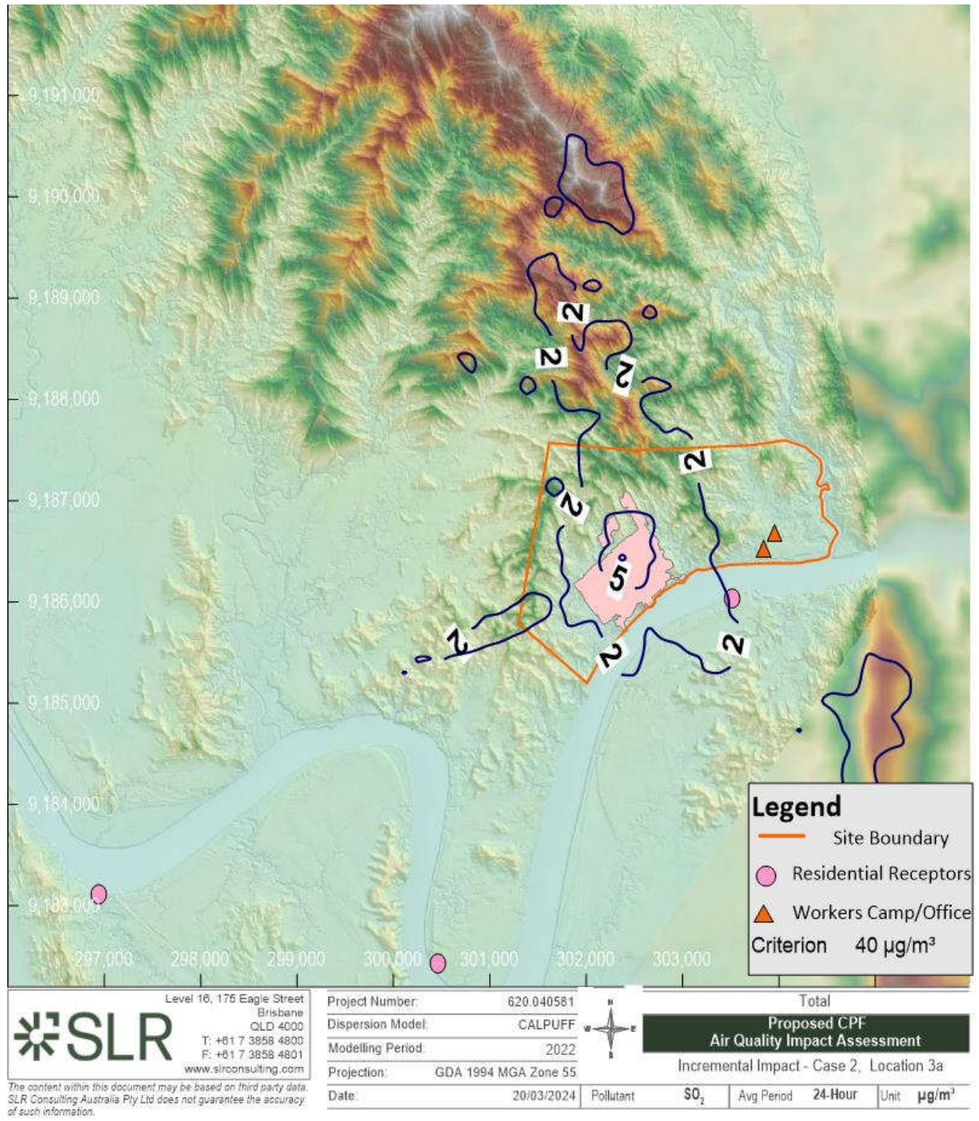
Pollutant	SO_2	Avg Period	1-Hour	Unit	µg/m³



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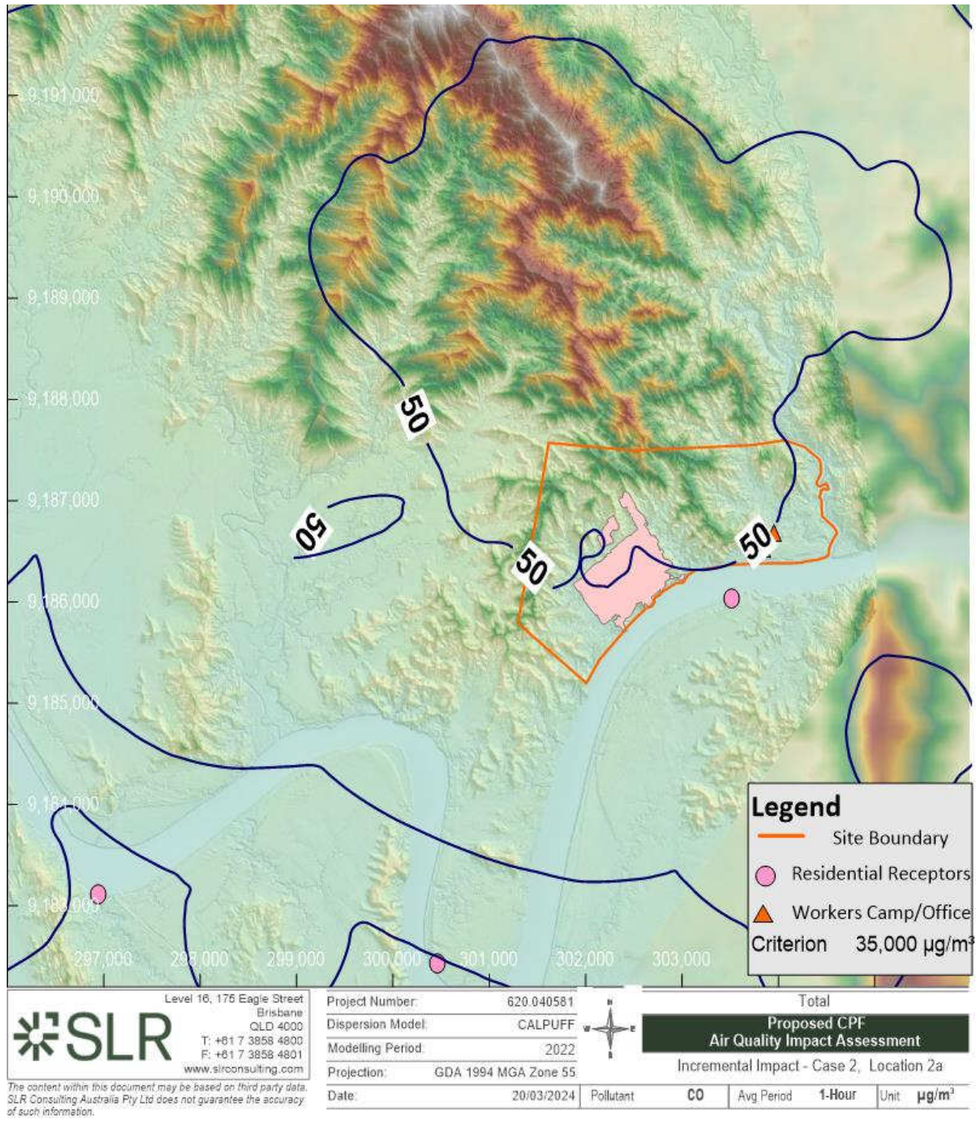
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Modelling Period:	2022					Incremental Impact - Case 2, Location 2a	
Projection:	GDA 1994 MGA Zone 55						
Date:	20/03/2024	Pollutant	SO_2	Avg Period	24-Hour	Unit	µg/m³

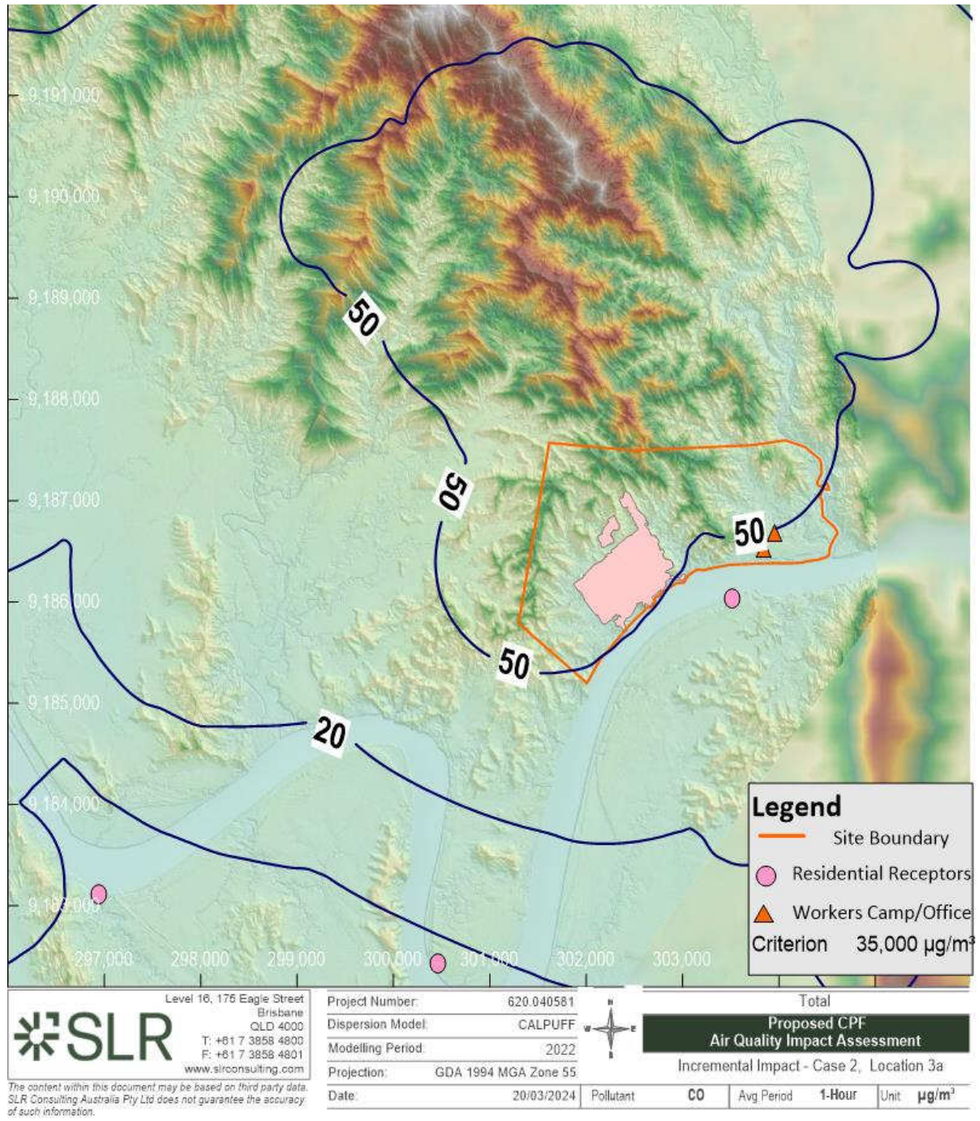


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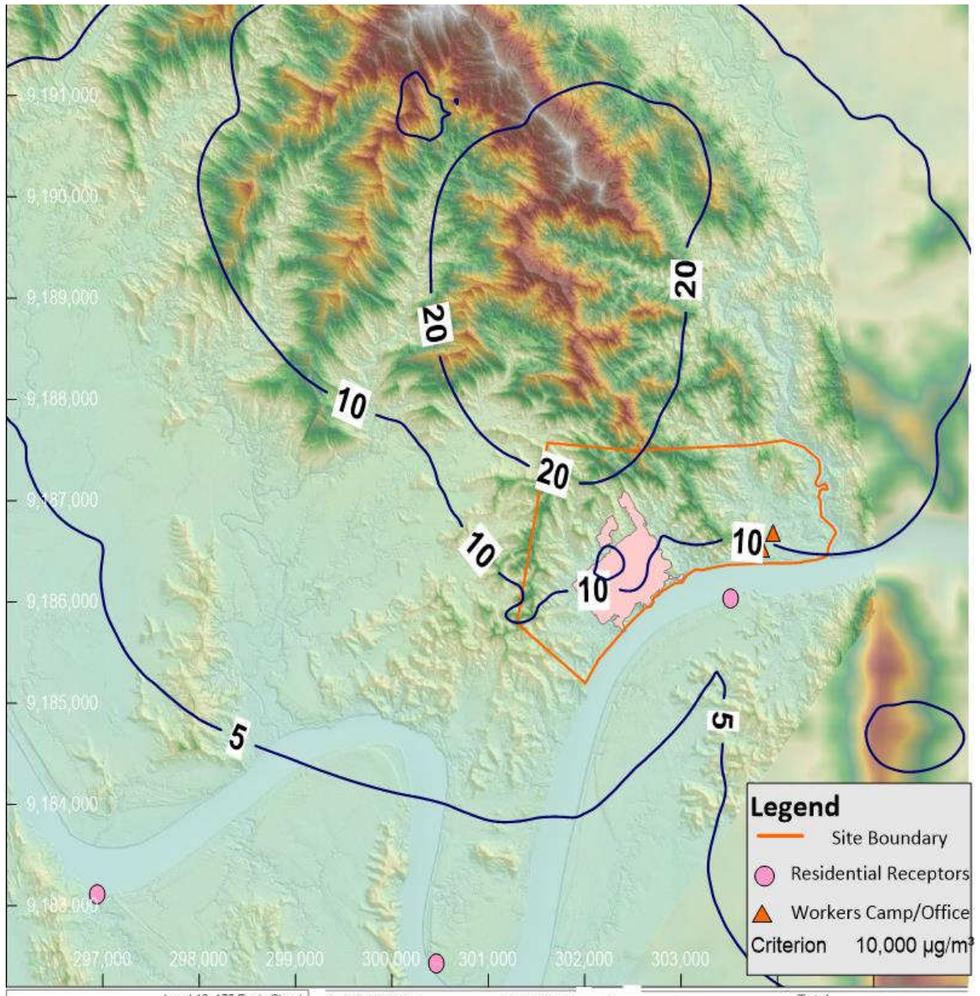
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Project Number:	620.040581					Total	
Dispersion Model:	CALPUFF					Proposed CPF Air Quality Impact Assessment	
Modelling Period:	2022					Incremental Impact - Case 2, Location 3a	
Projection:	GDA 1994 MGA Zone 55						
Date:	20/03/2024	Pollutant	SO_2	Avg Period	24-Hour	Unit	µg/m³


9,191,000
9,190,000
9,189,000
9,188,000
9,187,000
9,186,000
9,185,000
9,184,000
9,183,000
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300,000
301,000
302,000
303,000
50
50
50
50
Legend
Site Boundary
Residential Receptors
Workers Camp/Office
Criterion 35,000 µg/m³
SLR
Level 16, 175 Eagle Street
Brisbane
QLD 4000
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F: +61 7 3858 4801
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Project Number: 620.040581
Dispersion Model: CALPUFF
Modelling Period: 2022
Projection: GDA 1994 MGA Zone 55
Date: 20/03/2024
Total
Proposed CPF
Air Quality Impact Assessment
Incremental Impact - Case 2, Location 2a
Pollutant CO
Avg Period 1-Hour
Unit µg/m³


9,191,000
9,190,000
9,189,000
9,188,000
9,187,000
9,186,000
9,185,000
9,184,000
9,183,000
297,000
298,000
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300,000
301,000
302,000
303,000
50
50
50
20
Legend
Site Boundary
Residential Receptors
Workers Camp/Office
Criterion 35,000 µg/m³
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Modelling Period: 2022
Projection: GDA 1994 MGA Zone 55
Date: 20/03/2024
Total
Proposed CPF
Air Quality Impact Assessment
Incremental Impact - Case 2, Location 3a
Pollutant CO
Avg Period 1-Hour
Unit µg/m³

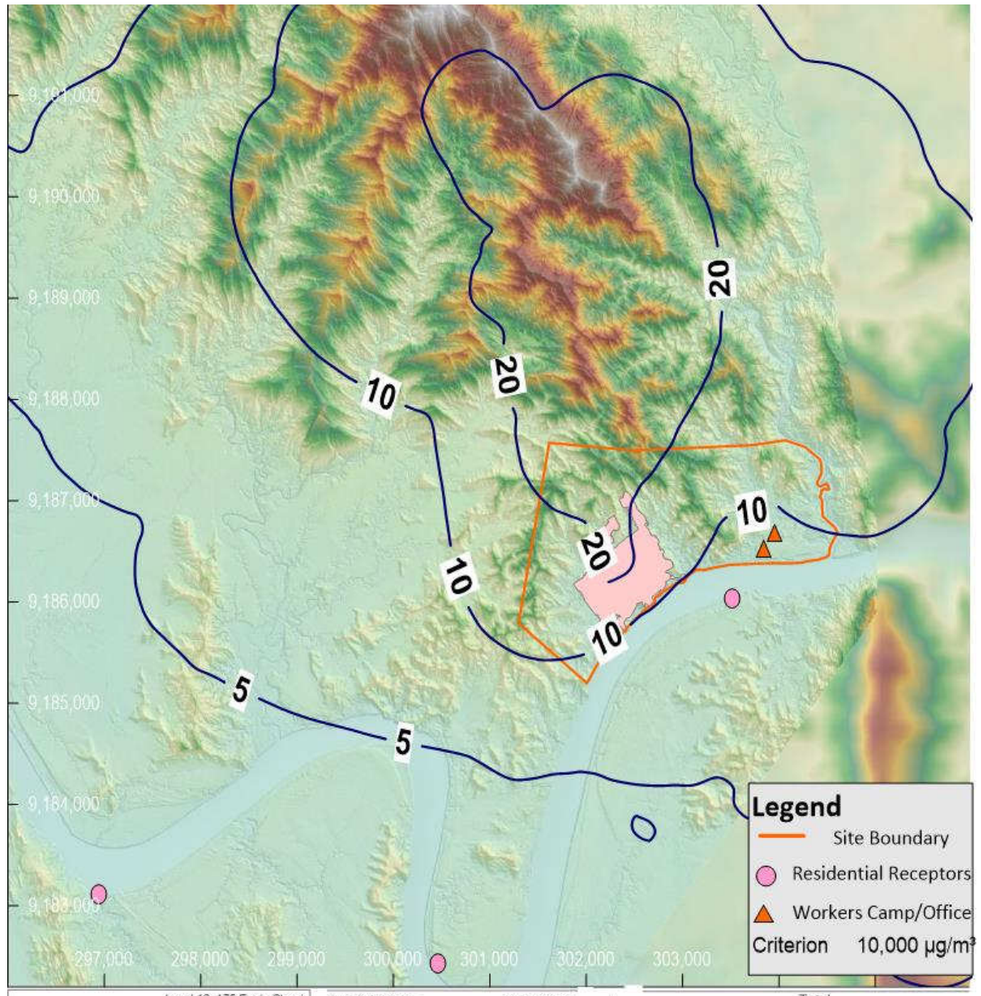
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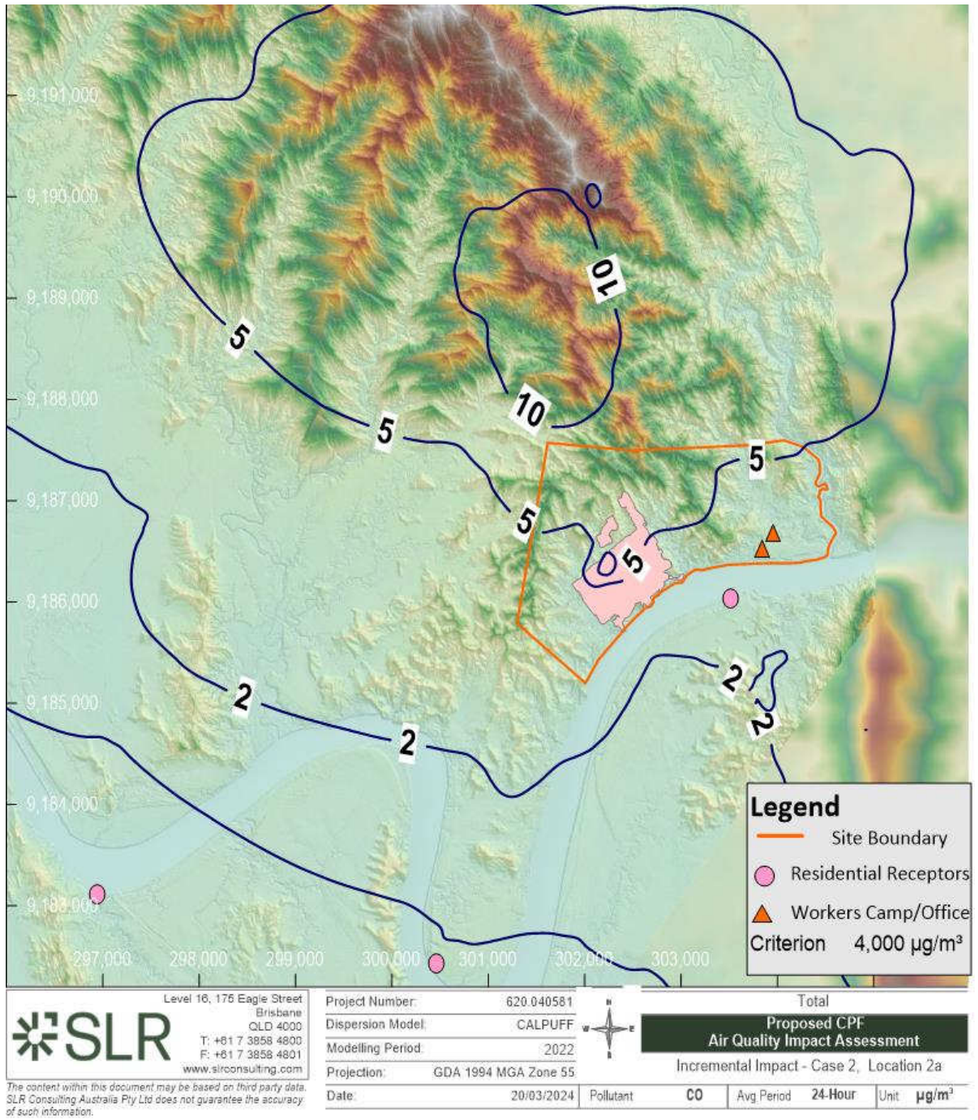
Project Number:	620.040581					Total	
Dispersion Model:	CALPUFF					Proposed CPF Air Quality Impact Assessment	
Modelling Period:	2022					Incremental Impact - Case 2, Location 2a	
Projection:	GDA 1994 MGA Zone 55						
Date:	20/03/2024	Pollutant	CO	Avg Period	8-Hour	Unit	µg/m³

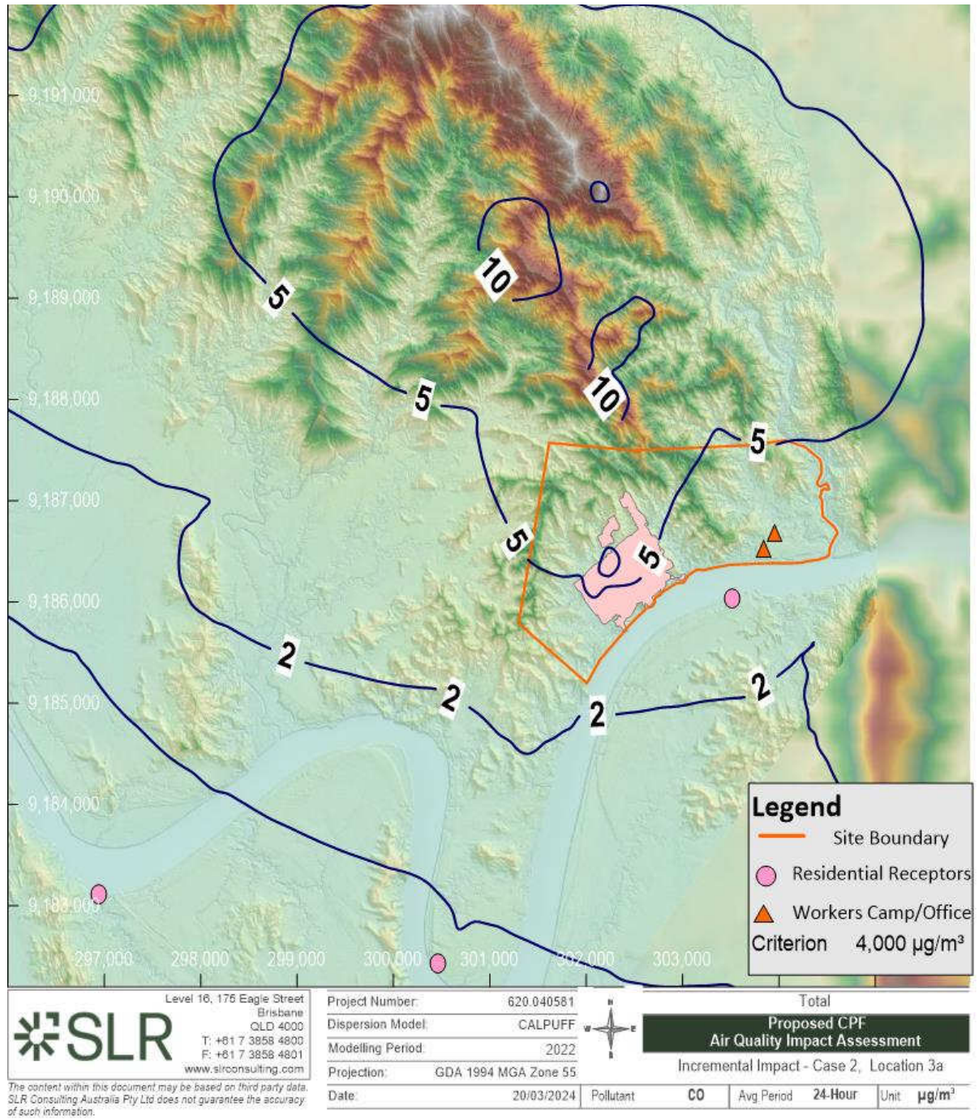


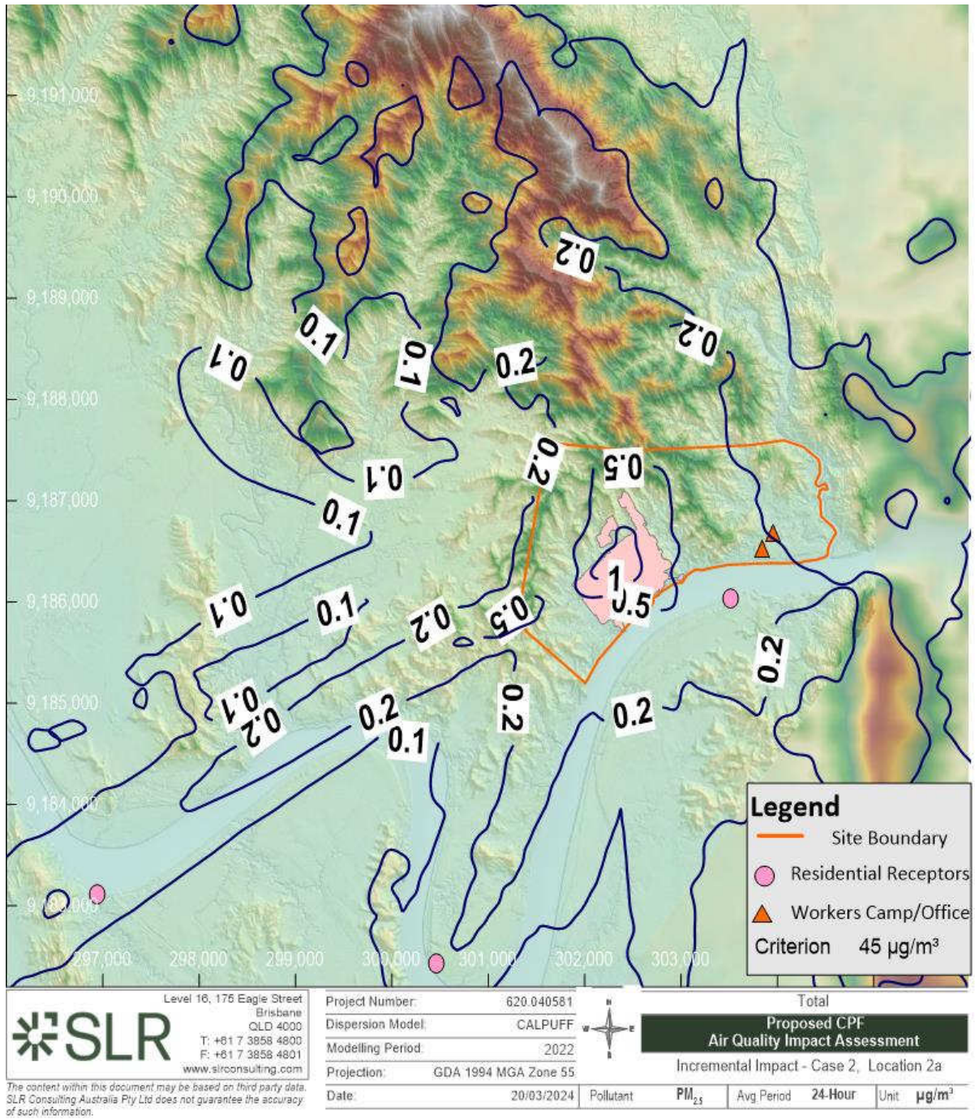
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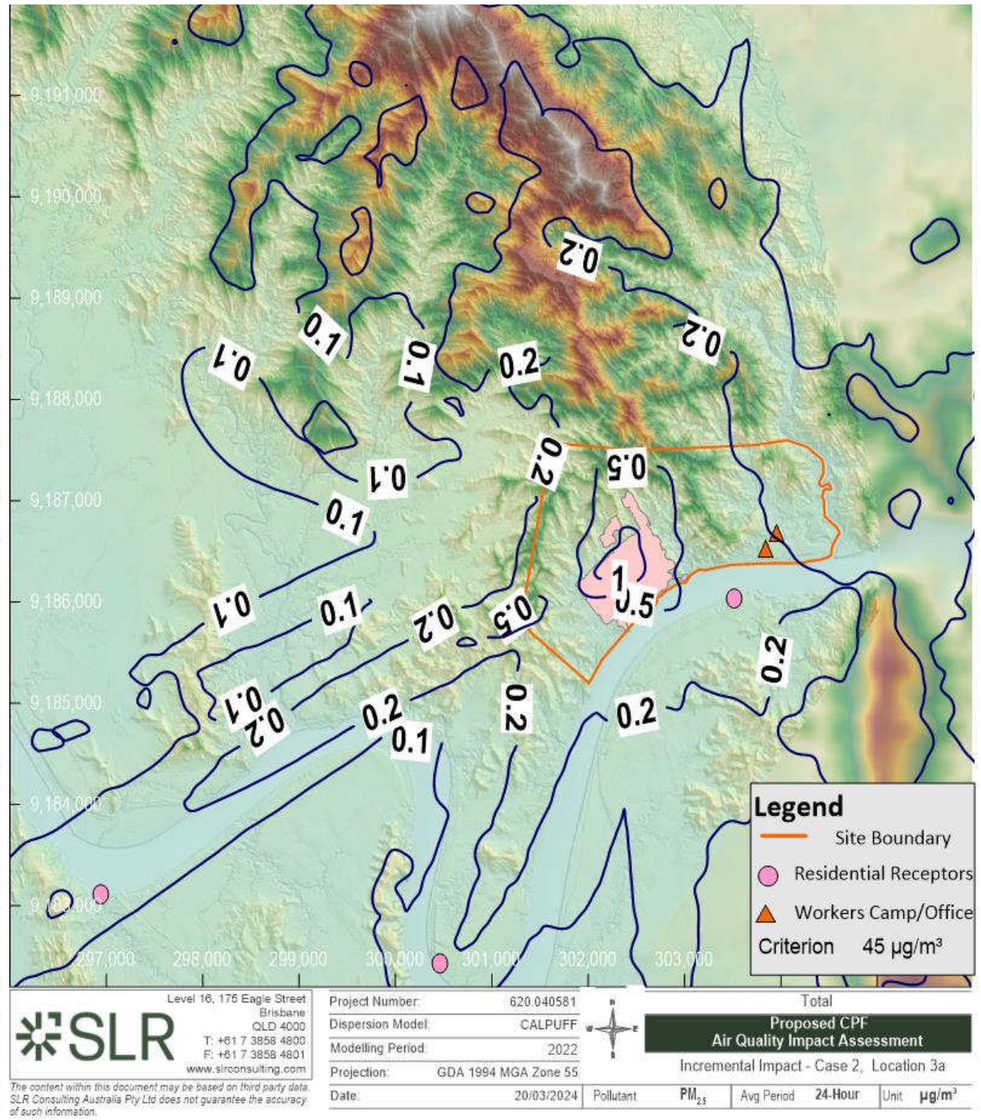
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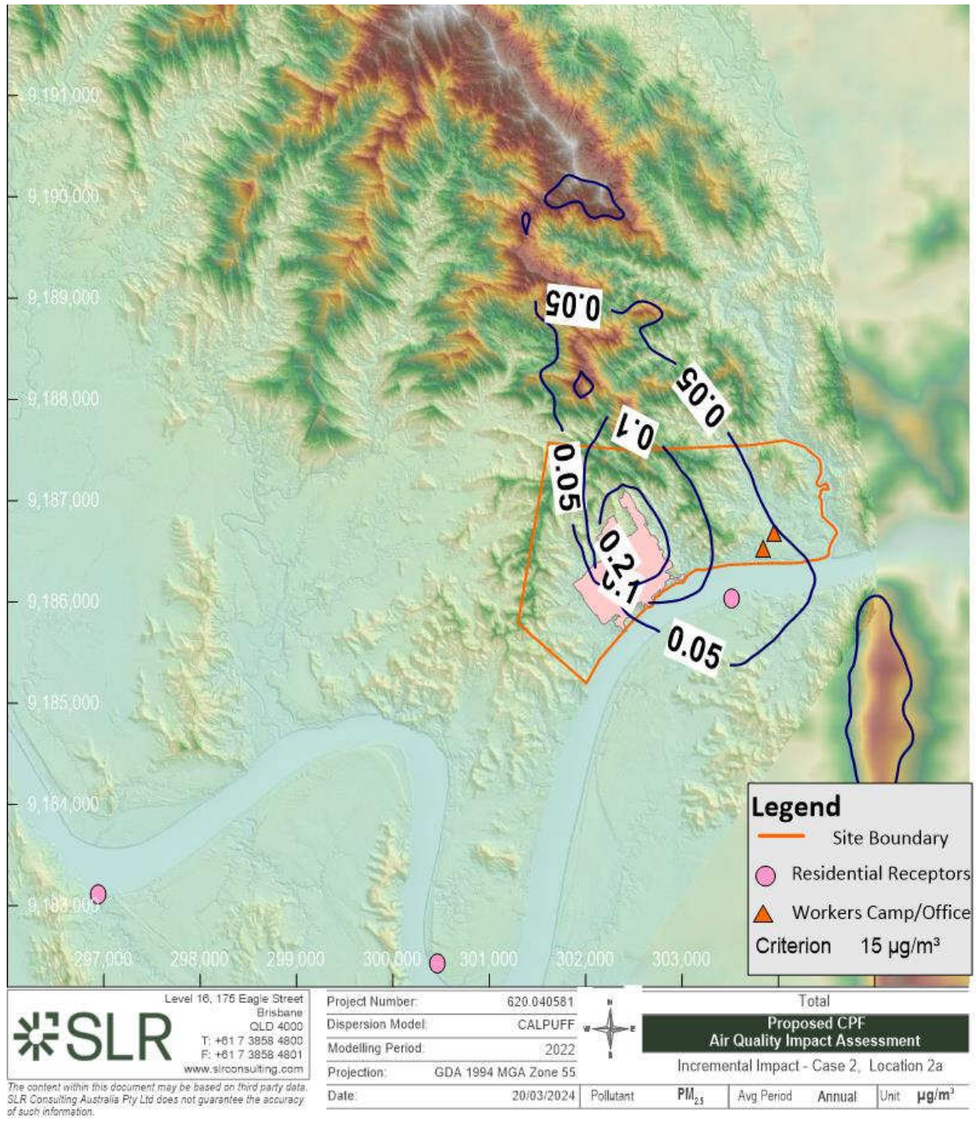
Project Number:	620.040581					Total	
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Modelling Period:	2022					Incremental Impact - Case 2, Location 3a	
Projection:	GDA 1994 MGA Zone 55						
Date:	20/03/2024	Pollutant	CO	Avg Period	8-Hour	Unit	µg/m³

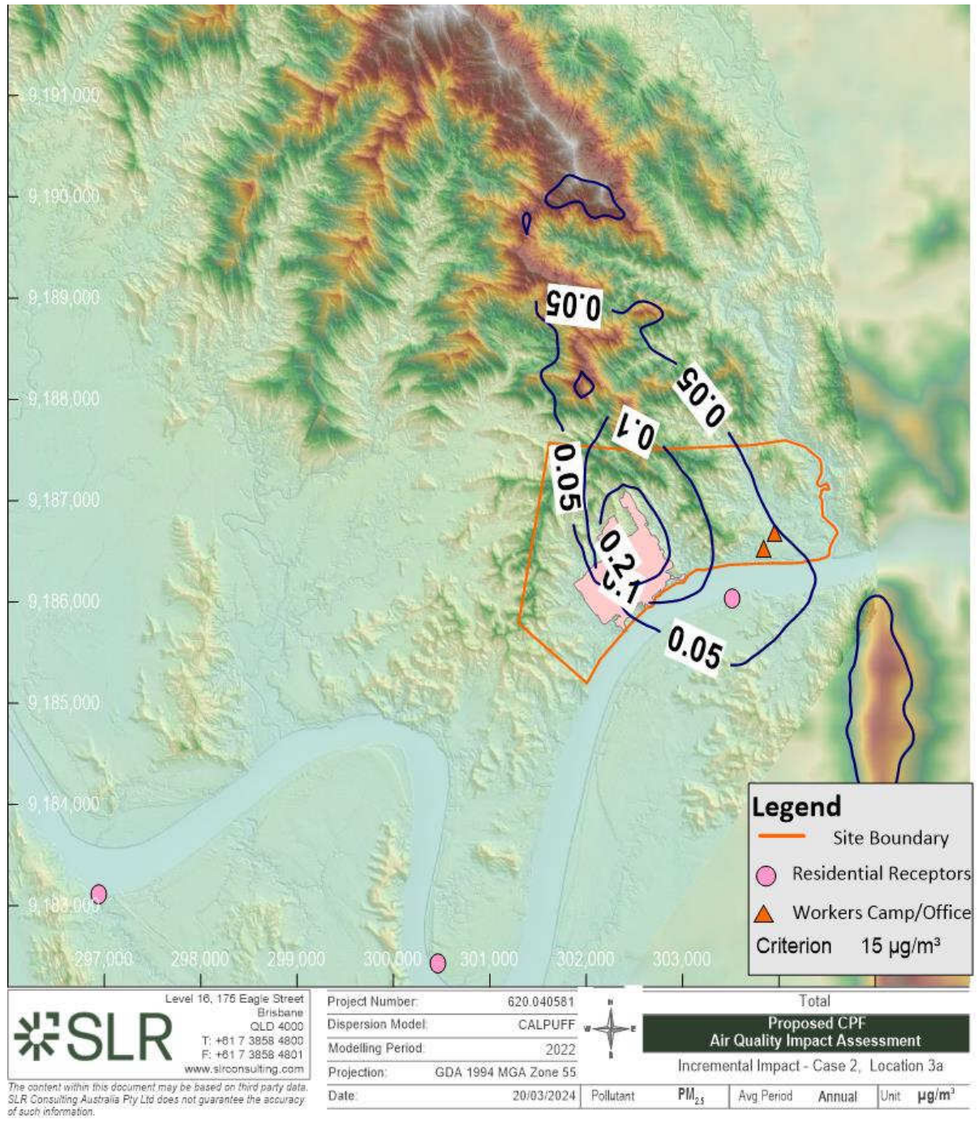

9,191,000
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297,000
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301,000
302,000
303,000
0
10
5
5
5
5
5
2
2
2
Legend
Site Boundary
Residential Receptors
Workers Camp/Office
Criterion 4,000 µg/m³
Level 16, 175 Eagle Street
Brisbane
QLD 4000
T: +61 7 3858 4800
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Project Number: 620.040581
Dispersion Model: CALPUFF
Modelling Period: 2022
Projection: GDA 1994 MGA Zone 55
Date: 20/03/2024
Total
Proposed CPF
Air Quality Impact Assessment
Incremental Impact - Case 2, Location 2a
Pollutant CO
Avg Period 24-Hour
Unit µg/m³

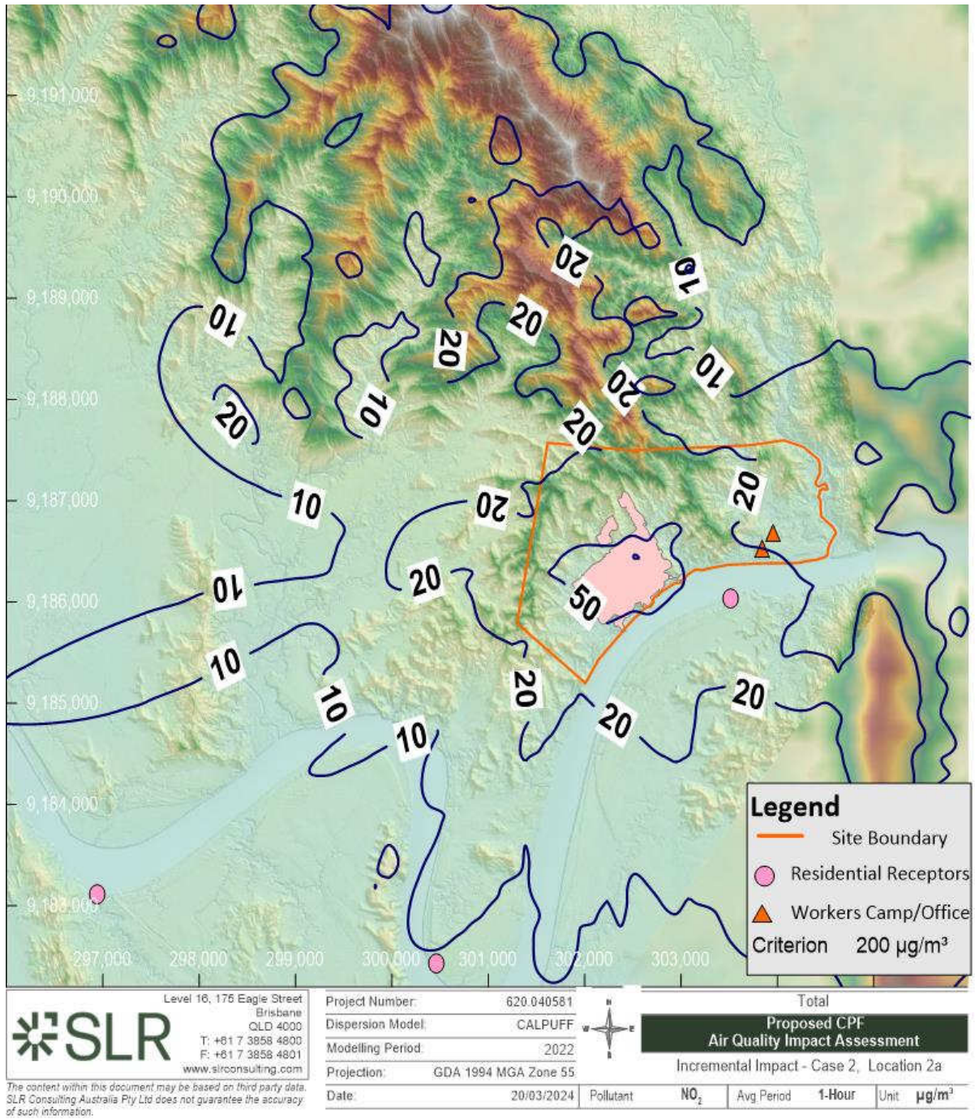

9,191,000
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297,000
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302,000
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Legend
Site Boundary
Residential Receptors
Workers Camp/Office
Criterion 4,000 µg/m³
Level 16, 175 Eagle Street
Brisbane
QLD 4000
T: +61 7 3858 4800
F: +61 7 3858 4801
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Project Number: 620.040581
Dispersion Model: CALPUFF
Modelling Period: 2022
Projection: GDA 1994 MGA Zone 55
Date: 20/03/2024
Total
Proposed CPF
Air Quality Impact Assessment
Incremental Impact - Case 2, Location 3a
Pollutant CO
Avg Period 24-Hour
Unit µg/m³


Legend
Site Boundary
Residential Receptors
Workers Camp/Office
Criterion 45 µg/m³
Level 16, 175 Eagle Street
Brisbane
QLD 4000
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Dispersion Model: CALPUFF
Modelling Period: 2022
Projection: GDA 1994 MGA Zone 55
Date: 20/03/2024
Total
Proposed CPF
Air Quality Impact Assessment
Incremental Impact - Case 2, Location 2a
Pollutant PM2.5
Avg.Period 24-Hour
Unit µg/m³


Legend
Site Boundary
Residential Receptors
Workers Camp/Office
Criterion 45 µg/m³
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QLD 4000
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Modelling Period: 2022
Projection: GDA 1994 MGA Zone 55
Date: 20/03/2024
Total
Proposed CPF
Air Quality Impact Assessment
Incremental Impact - Case 2, Location 3a
Pollutant PM2.5
Avg.Period 24-Hour
Unit µg/m³


9,191,000
9,190,000
9,189,000
9,188,000
9,187,000
9,186,000
9,185,000
9,184,000
9,183,000
297,000
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300,000
301,000
302,000
303,000
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0.05
0.1
0.05
0.2
0.1
0.05
Legend
Site Boundary
Residential Receptors
Workers Camp/Office
Criterion 15 µg/m³
Level 16, 175 Eagle Street
Brisbane
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Projection: GDA 1994 MGA Zone 55
Date: 20/03/2024
Total
Proposed CPF
Air Quality Impact Assessment
Incremental Impact - Case 2, Location 2a
Pollutant PM2.5
Avg Period Annual
Unit µg/m³


9,191,000
9,190,000
9,189,000
9,188,000
9,187,000
9,186,000
9,185,000
9,184,000
9,183,000
297,000
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299,000
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303,000
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0.05
0.1
0.05
0.2
0.1
0.05
Legend
Site Boundary
Residential Receptors
Workers Camp/Office
Criterion 15 µg/m³
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Modelling Period: 2022
Projection: GDA 1994 MGA Zone 55
Date: 20/03/2024
Total
Proposed CPF
Air Quality Impact Assessment
Incremental Impact - Case 2, Location 3a
Pollutant PM2.5
Avg Period Annual
Unit µg/m³



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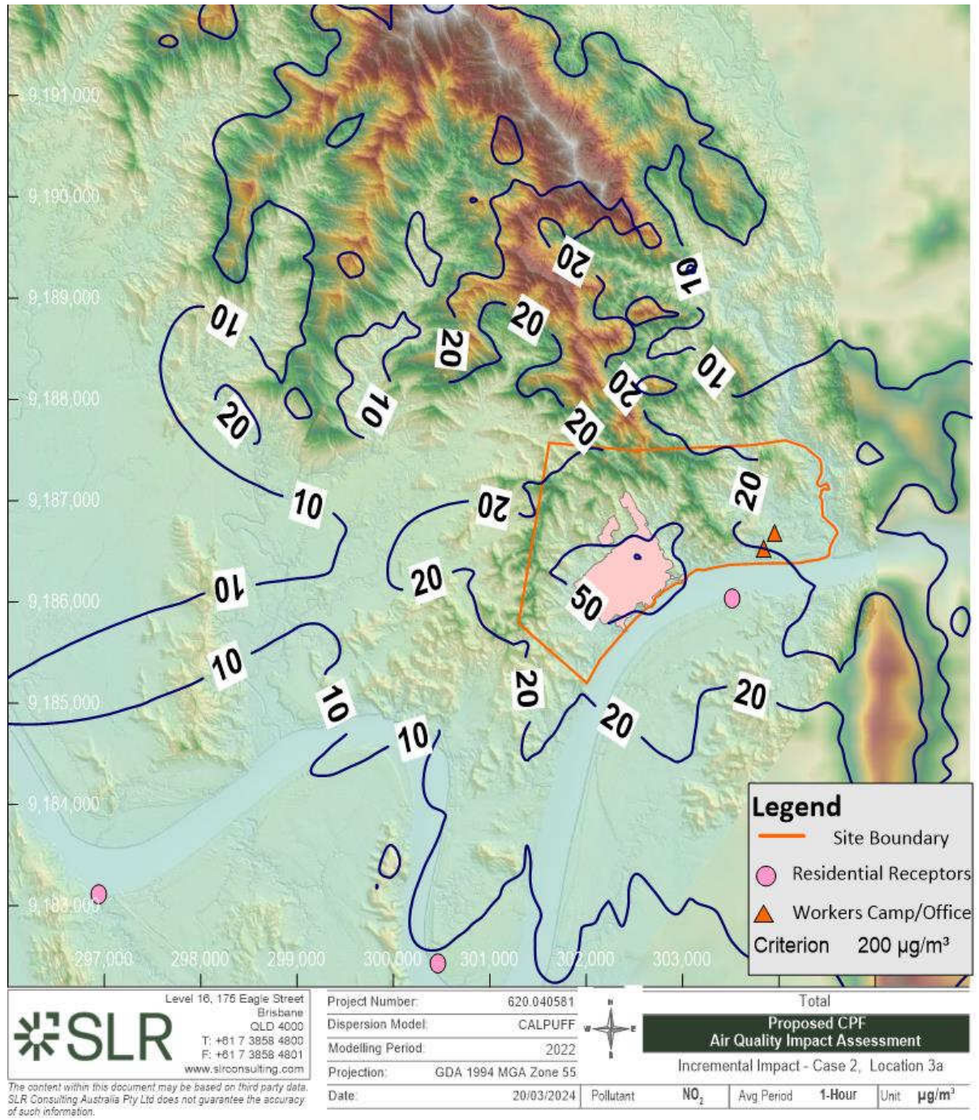
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Dispersion Model:	CALPUFF
Modelling Period:	2022
Projection:	GDA 1994 MGA Zone 55
Date:	20/03/2024

Total

Proposed CPF
Air Quality Impact Assessment

Incremental Impact - Case 2, Location 2a

Pollutant	NO_2	Avg Period	1-Hour	Unit	µg/m³



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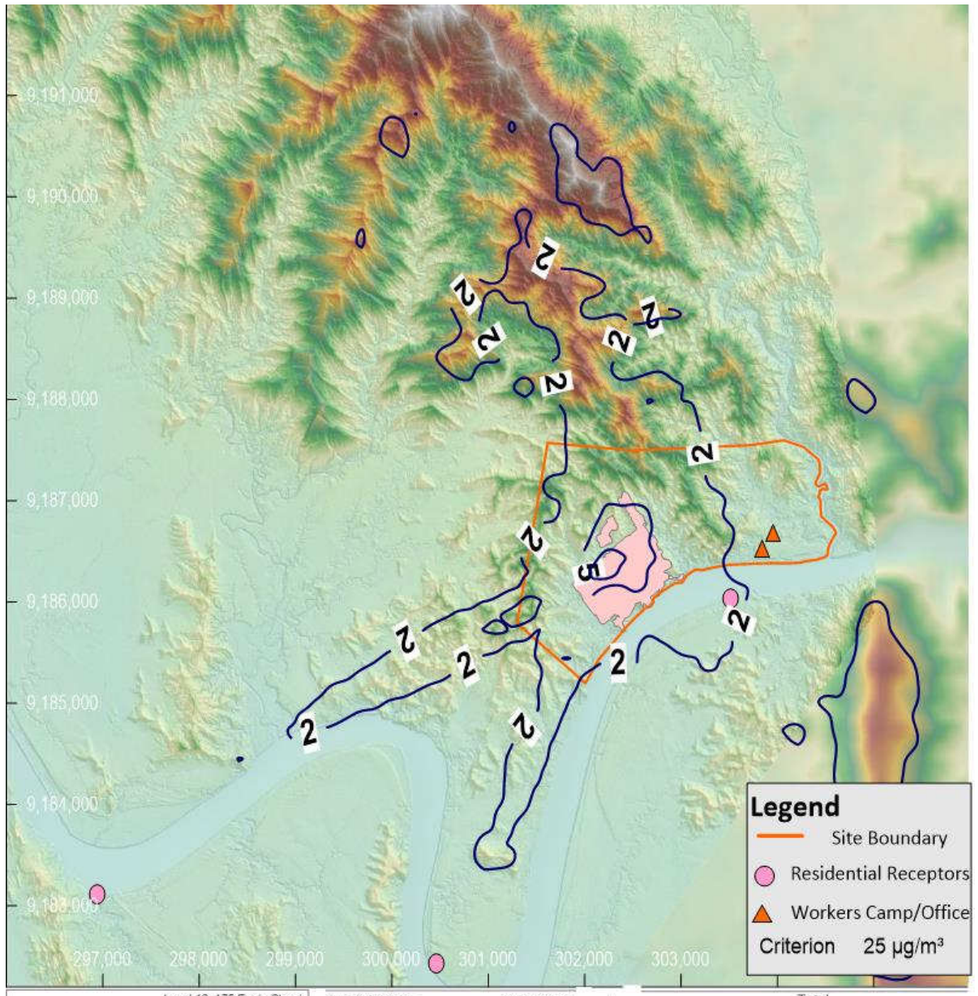
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Dispersion Model:	CALPUFF
Modelling Period:	2022
Projection:	GDA 1994 MGA Zone 55
Date:	20/03/2024

Total

Proposed CPF
Air Quality Impact Assessment

Incremental Impact - Case 2, Location 3a

Pollutant	NO_2	Avg Period	1-Hour	Unit	µg/m³



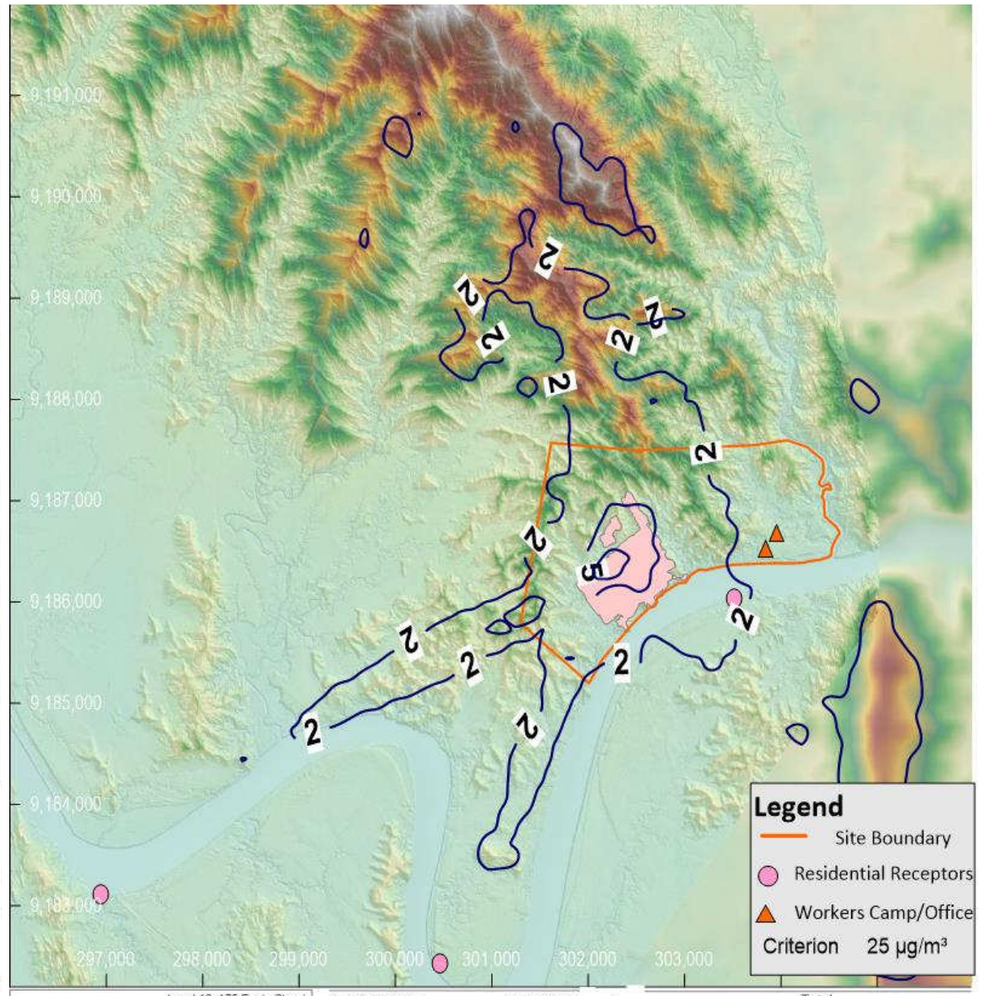
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Modelling Period:	2022
Projection:	GDA 1994 MGA Zone 55
Date:	20/03/2024

Total
Proposed CPF
Air Quality Impact Assessment
Incremental Impact - Case 2, Location 2a

Pollutant	NO_2	Avg Period	24-Hour	Unit	µg/m³



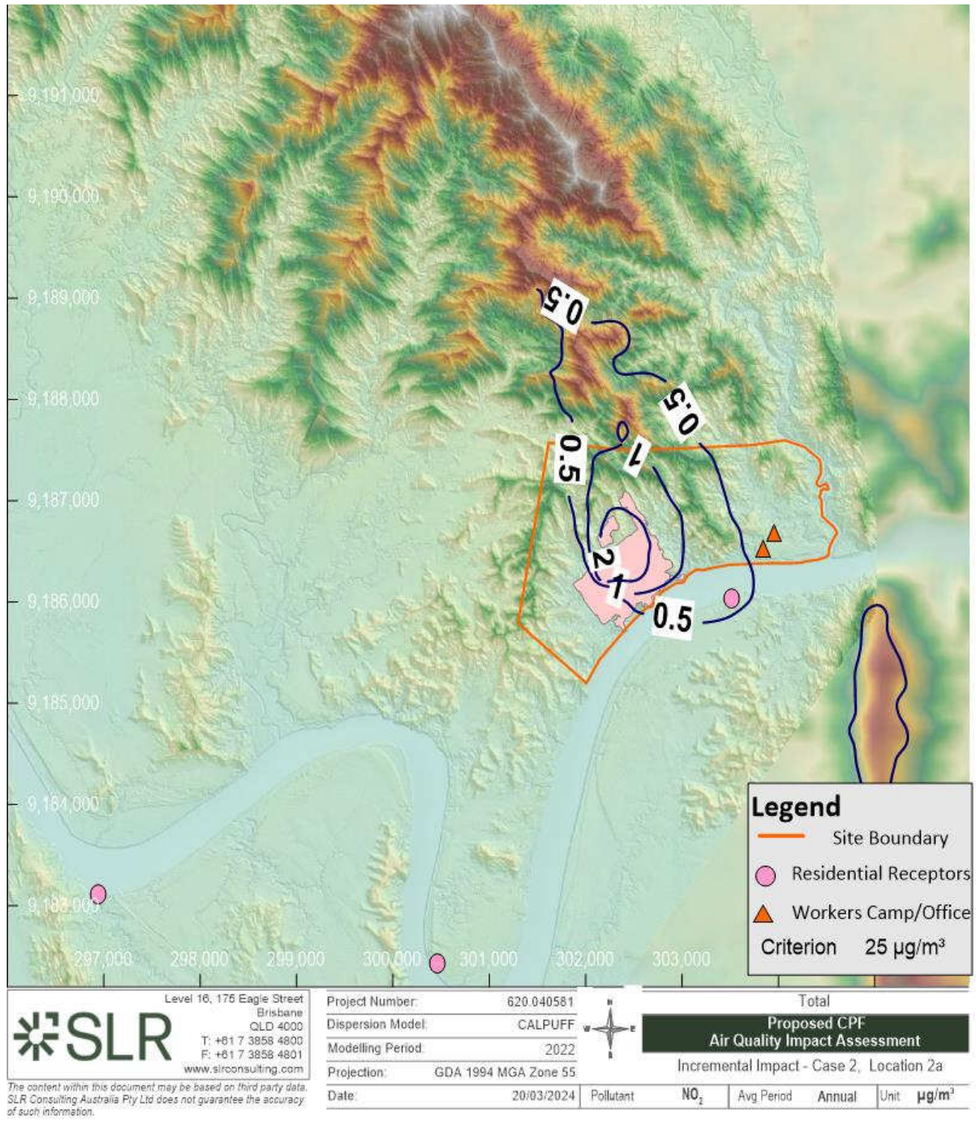
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Date:	20/03/2024

Total
Proposed CPF
Air Quality Impact Assessment
Incremental Impact - Case 2, Location 3a

Pollutant	NO_2	Avg Period	24-Hour	Unit	µg/m³

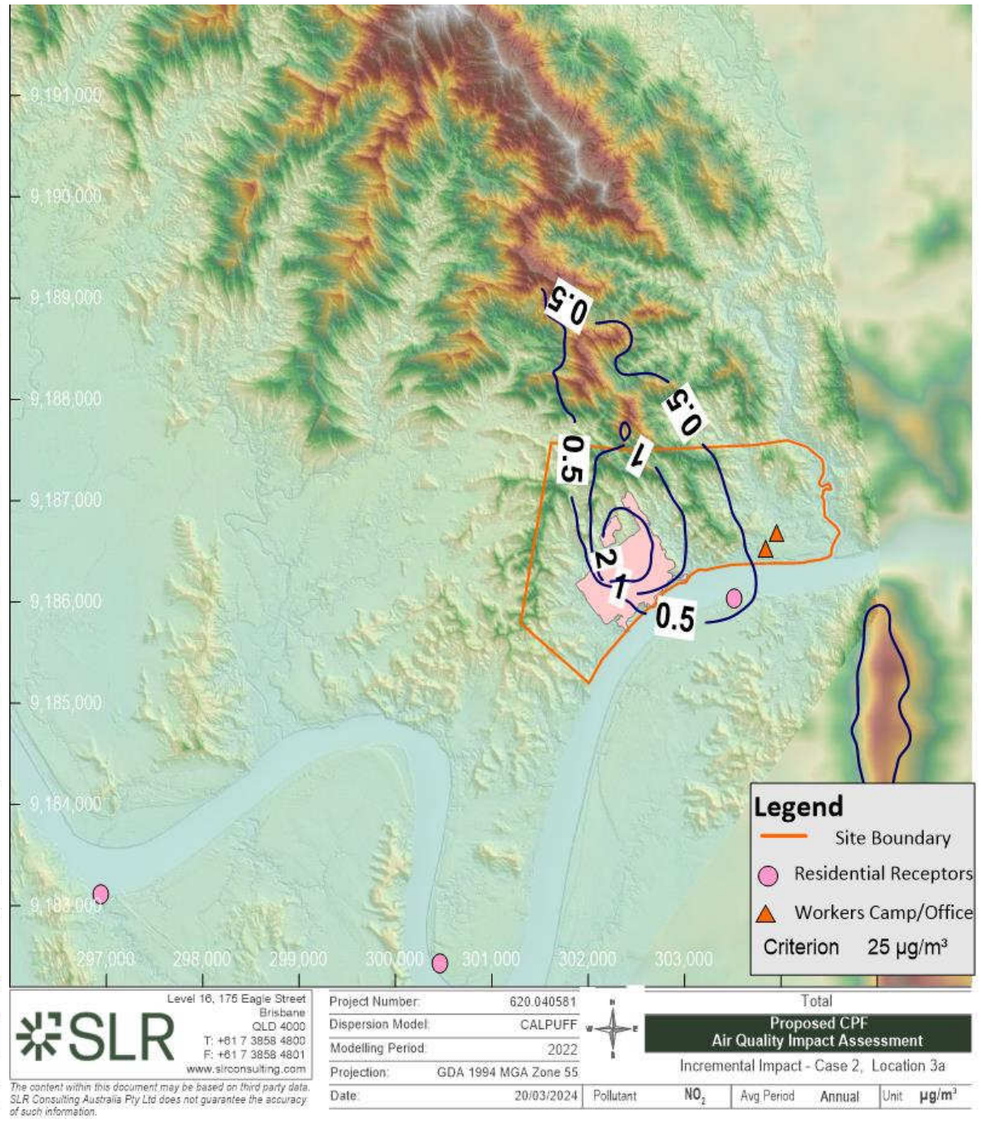


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Dispersion Model:	CALPUFF						
Modelling Period:	2022						
Projection:	GDA 1994 MGA Zone 55						
Date:	20/03/2024	Pollutant	NO_2	Avg Period	Annual	Unit	µg/m³

Total
Proposed CPF
Air Quality Impact Assessment
Incremental Impact - Case 2, Location 2a



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Project Number:	620.040581						
Dispersion Model:	CALPUFF						
Modelling Period:	2022						
Projection:	GDA 1994 MGA Zone 55						
Date:	20/03/2024	Pollutant	NO_2	Avg Period	Annual	Unit	µg/m³

Total
Proposed CPF
Air Quality Impact Assessment
Incremental Impact - Case 2, Location 3a

Appendix D Case 3 Contour Plots

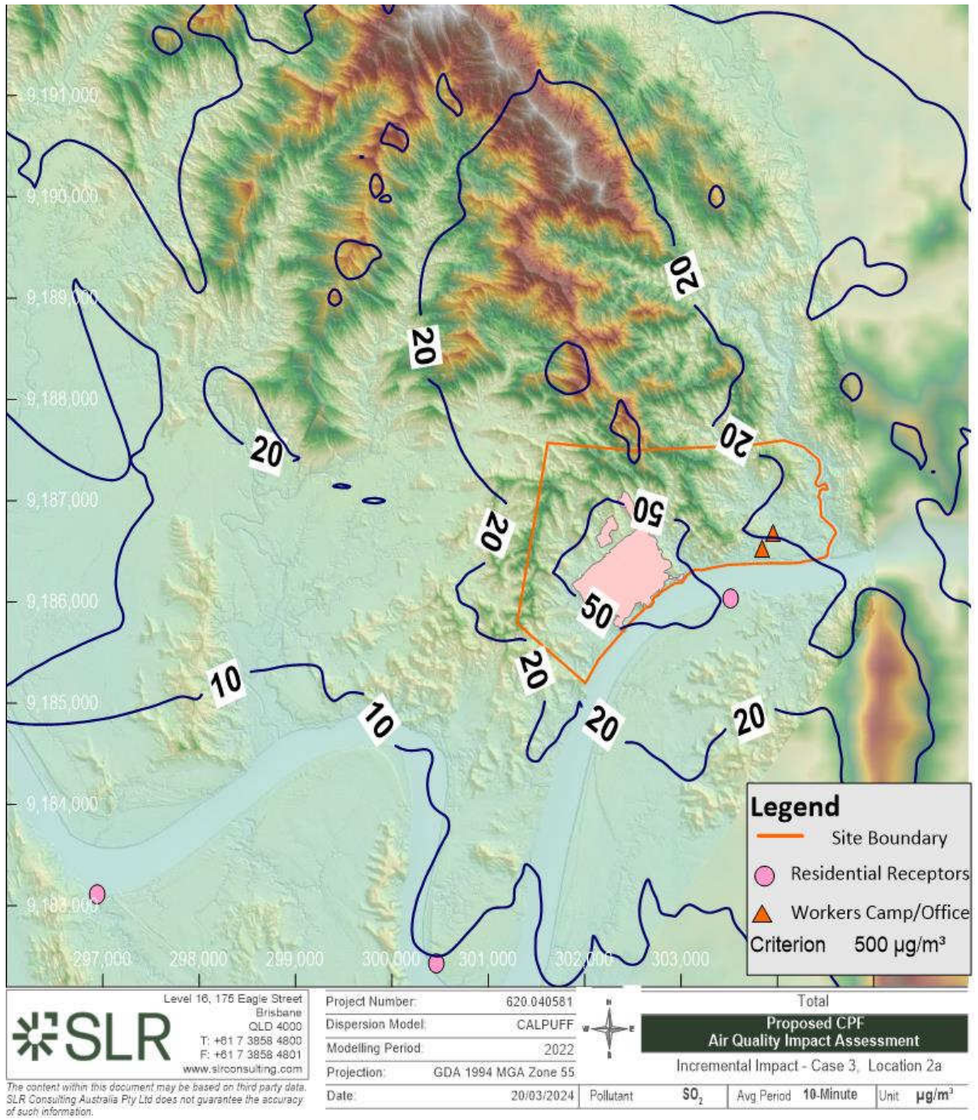
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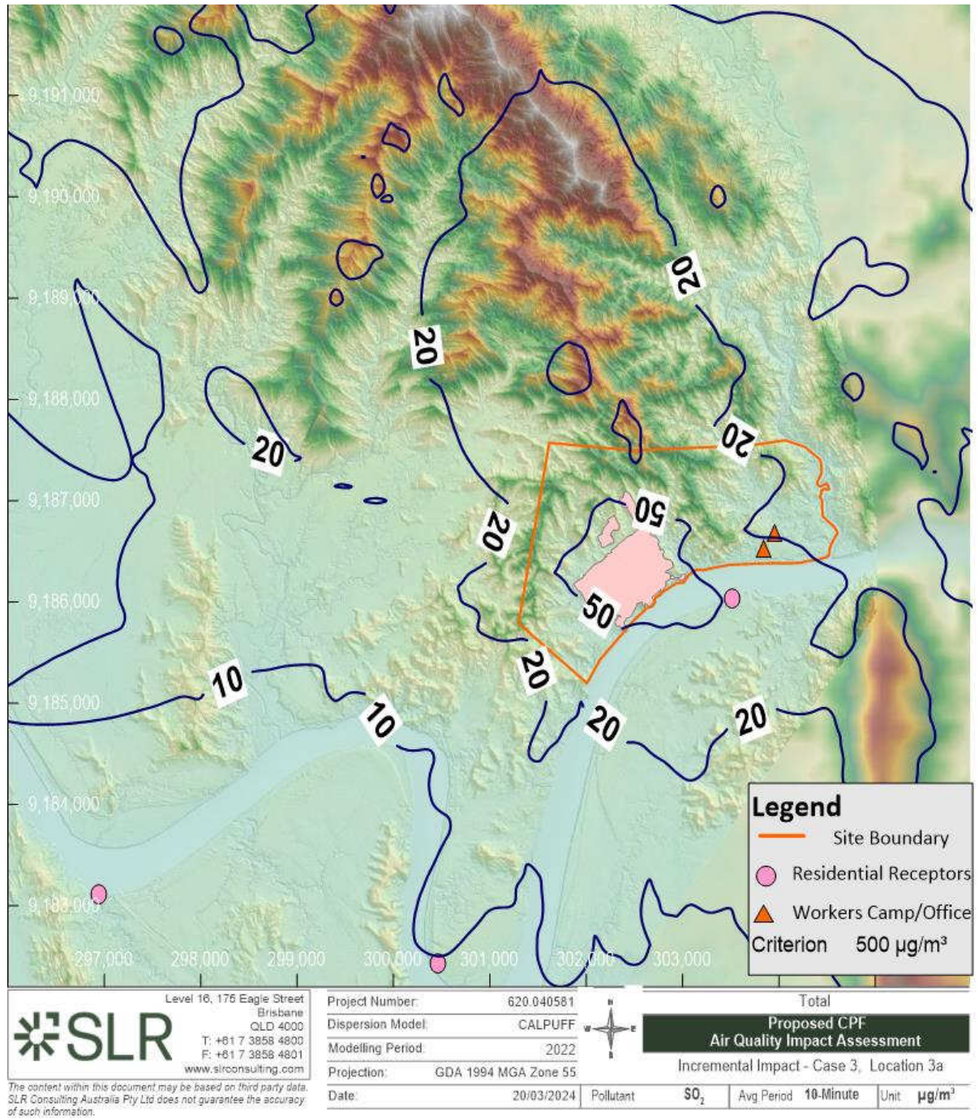
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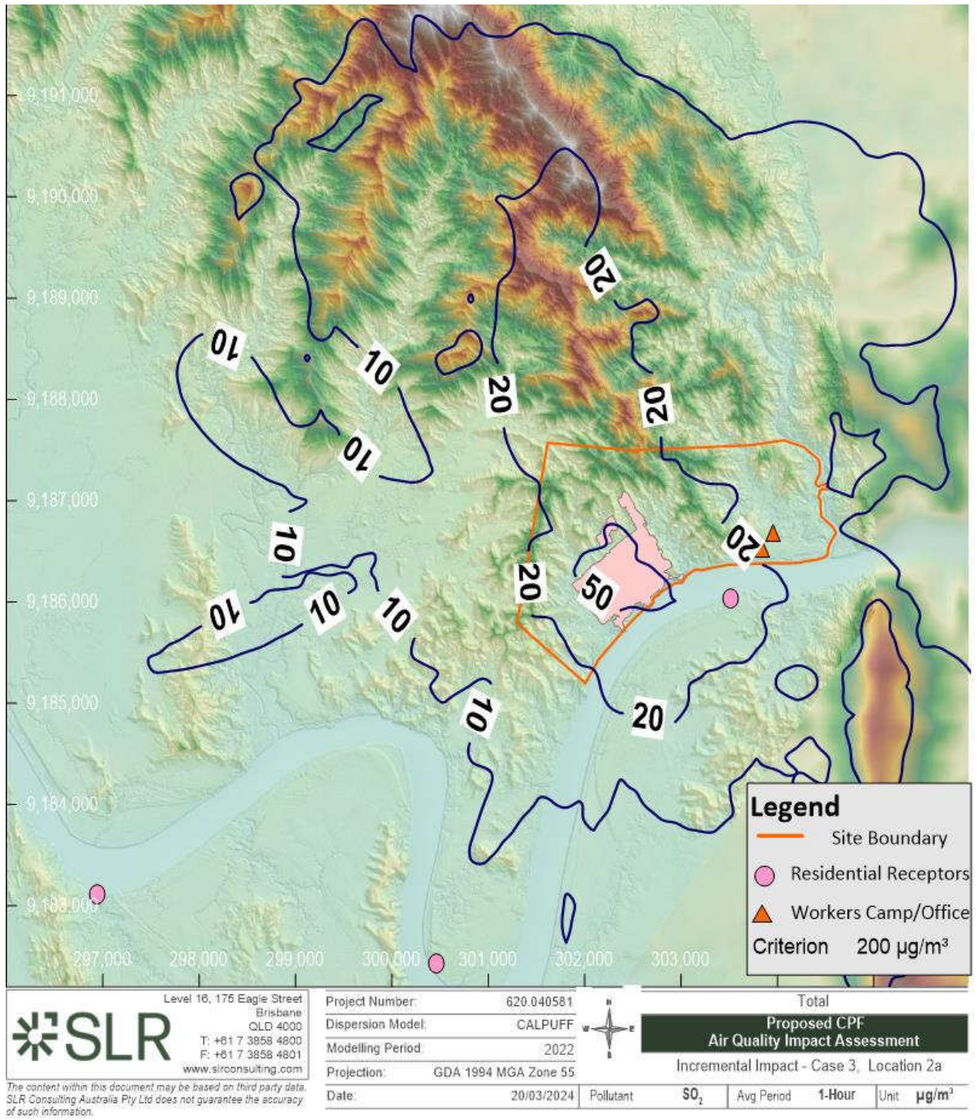
Papua LNG Development Pty Ltd

SLR Project No.: 620.040581.00001

23 April 2024


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Legend
Site Boundary
Residential Receptors
Workers Camp/Office
Criterion 500 µg/m³
Level 16, 175 Eagle Street
Brisbane
QLD 4000
T: +61 7 3858 4800
F: +61 7 3858 4801
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Project Number: 620.040581
Dispersion Model: CALPUFF
Modelling Period: 2022
Projection: GDA 1994 MGA Zone 55
Date: 20/03/2024
Total
Proposed CPF
Air Quality Impact Assessment
Incremental Impact - Case 3, Location 2a
Pollutant SO2
Avg Period 10-Minute
Unit µg/m³

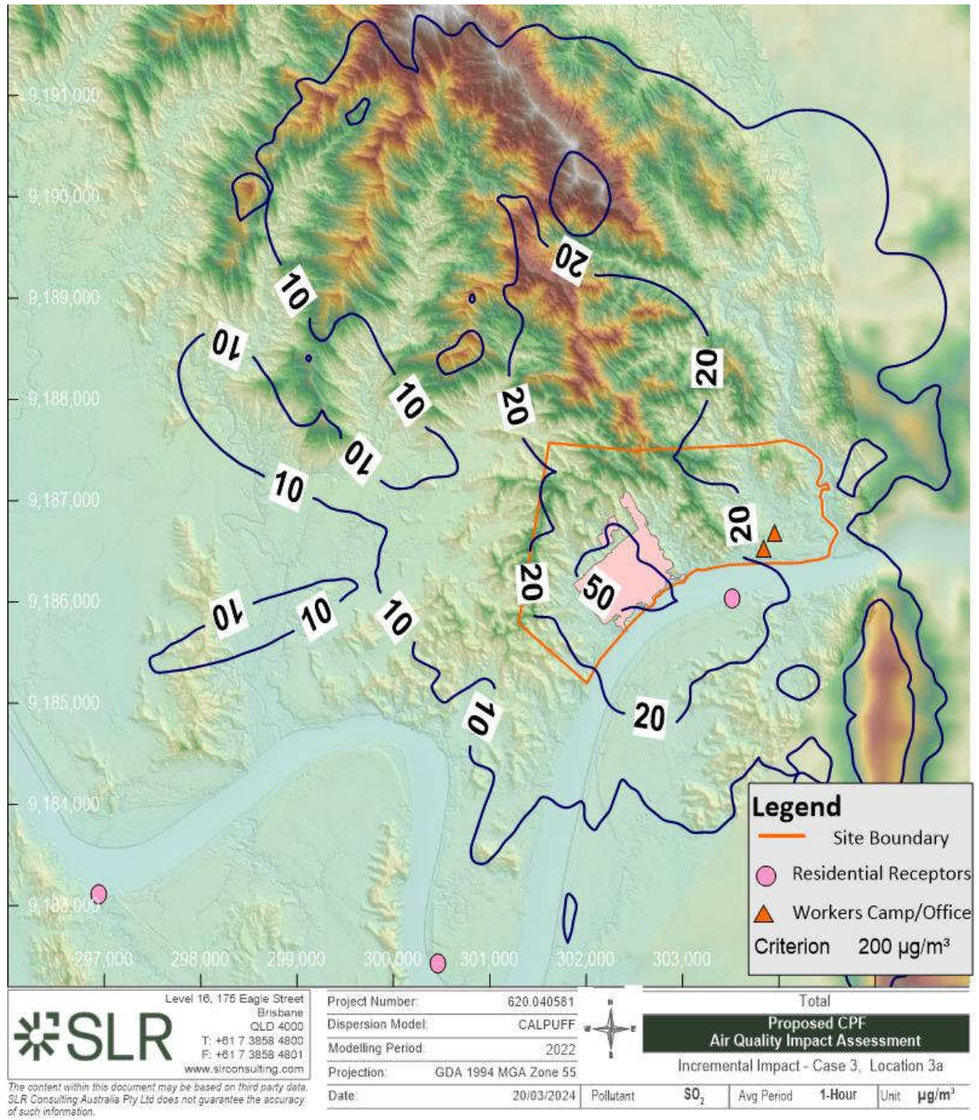

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Site Boundary
Residential Receptors
Workers Camp/Office
Criterion 500 µg/m³
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Project Number: 620.040581
Dispersion Model: CALPUFF
Modelling Period: 2022
Projection: GDA 1994 MGA Zone 55
Date: 20/03/2024
Total
Proposed CPF
Air Quality Impact Assessment
Incremental Impact - Case 3, Location 3a
Pollutant SO2
Avg Period 10-Minute
Unit µg/m³



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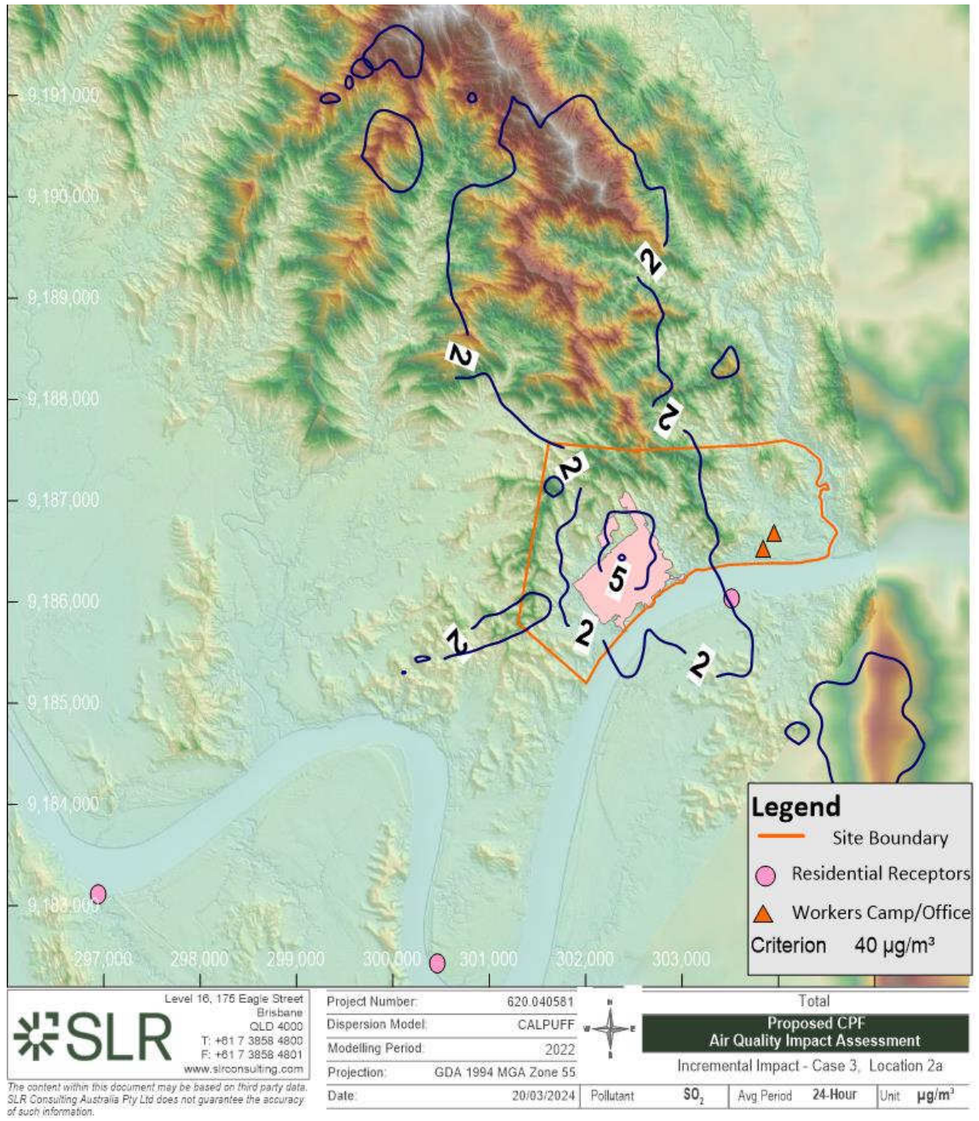
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Date:	20/03/2024	Pollutant	SO_2	Avg.Period	1-Hour	Unit	µg/m³

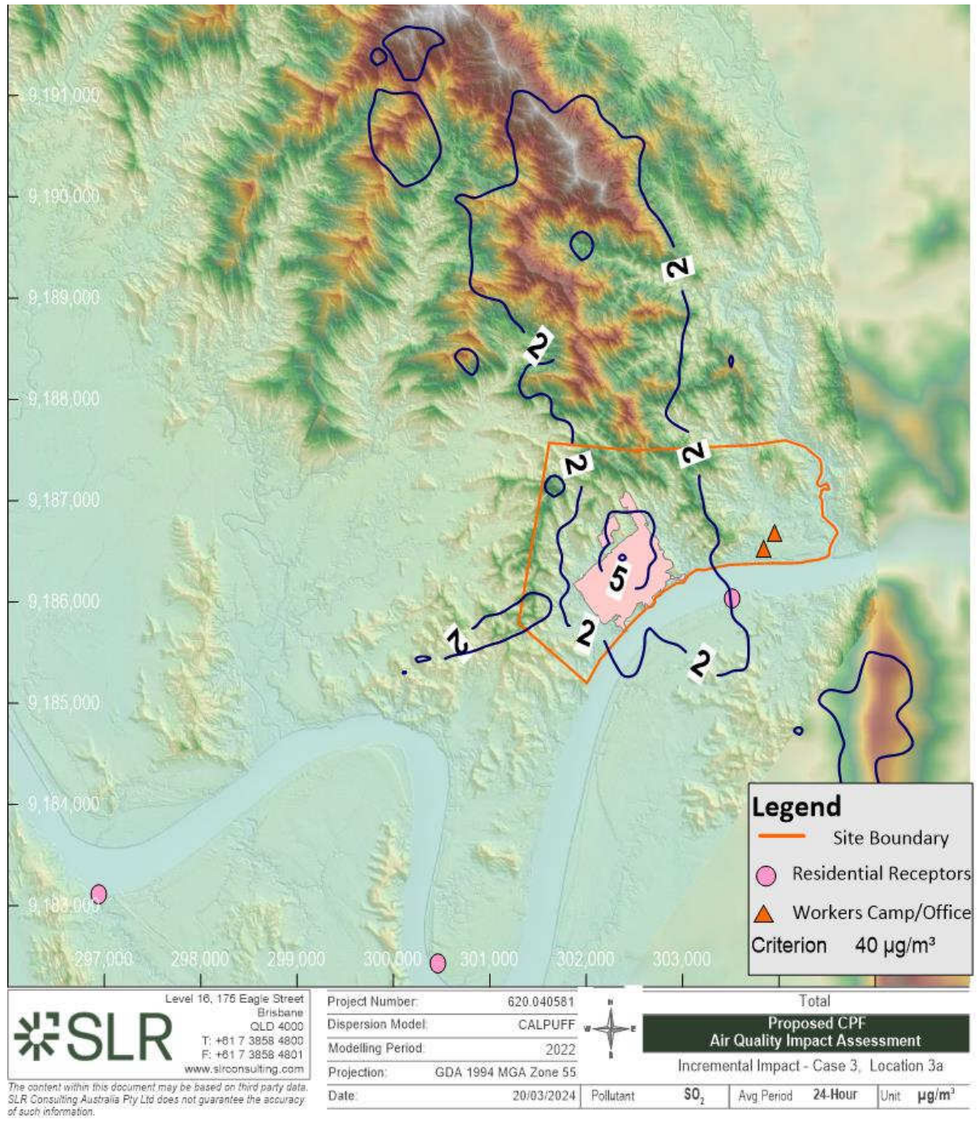


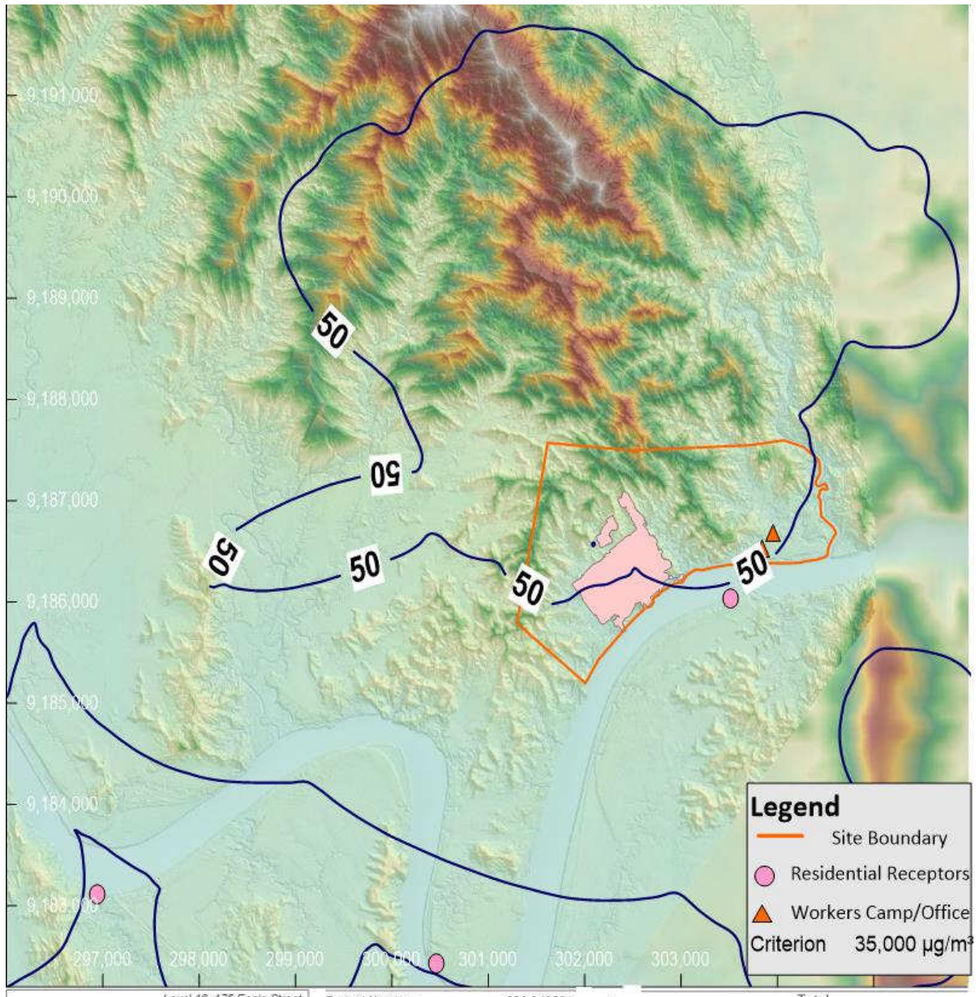
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Project Number:	620.040581					Total	
Dispersion Model:	CALPUFF					Proposed CPF Air Quality Impact Assessment	
Modelling Period:	2022					Incremental Impact - Case 3, Location 3a	
Projection:	GDA 1994 MGA Zone 55						
Date:	20/03/2024	Pollutant	SO_2	Avg.Period	1-Hour	Unit	µg/m³


9,191,000
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2
5
Legend
Site Boundary
Residential Receptors
Workers Camp/Office
Criterion 40 µg/m³
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Modelling Period: 2022
Projection: GDA 1994 MGA Zone 55
Date: 20/03/2024
Total
Proposed CPF
Air Quality Impact Assessment
Incremental Impact - Case 3, Location 2a
Pollutant SO_2 Avg Period 24-Hour Unit µg/m³


9,191,000
9,190,000
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9,186,000
9,185,000
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Legend
Site Boundary
Residential Receptors
Workers Camp/Office
Criterion 40 µg/m³
Level 16, 175 Eagle Street
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Modelling Period: 2022
Projection: GDA 1994 MGA Zone 55
Date: 20/03/2024
Total
Proposed CPF
Air Quality Impact Assessment
Incremental Impact - Case 3, Location 3a
Pollutant SO_2 Avg Period 24-Hour Unit µg/m³

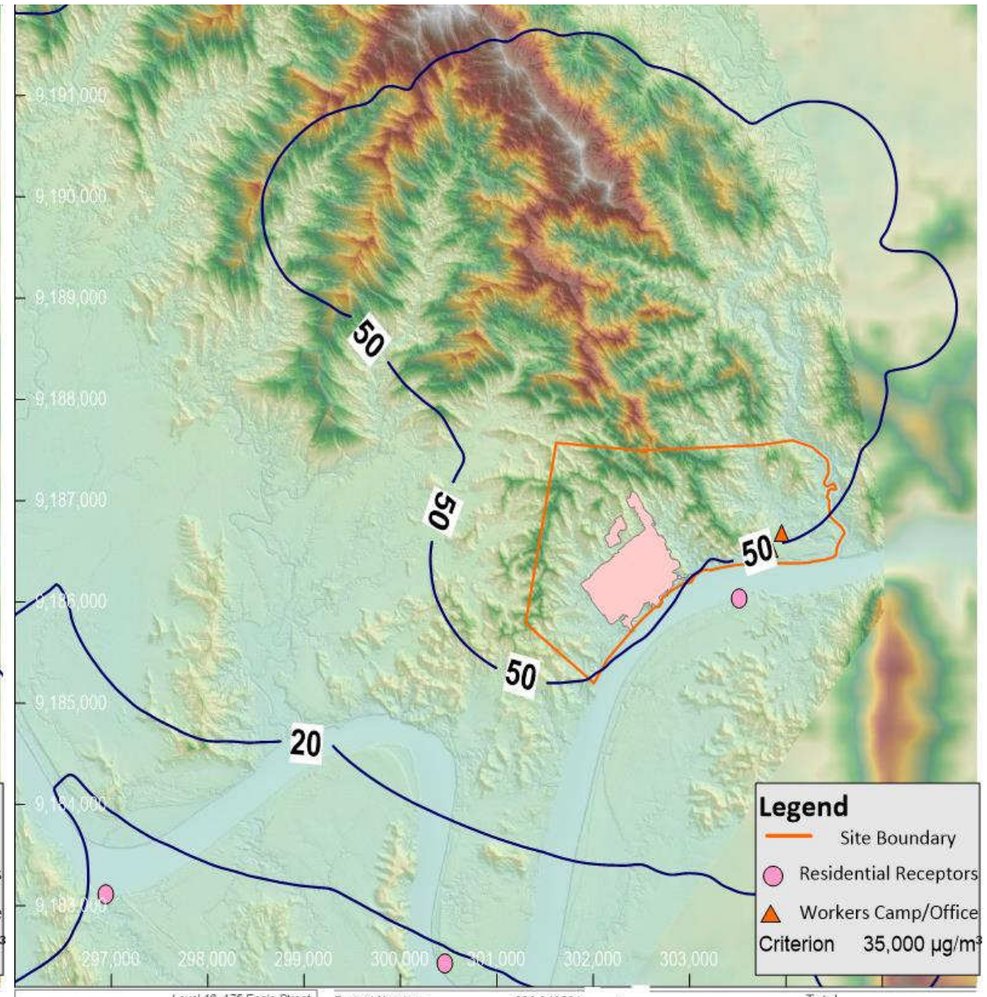


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Project Number:	620.040581						
Dispersion Model:	CALPUFF						
Modelling Period:	2022						
Projection:	GDA 1994 MGA Zone 55						
Date:	20/03/2024	Pollutant	CO	Avg Period	1-Hour	Unit	µg/m³

Total
Proposed CPF
Air Quality Impact Assessment
Incremental Impact - Case 3, Location 2a

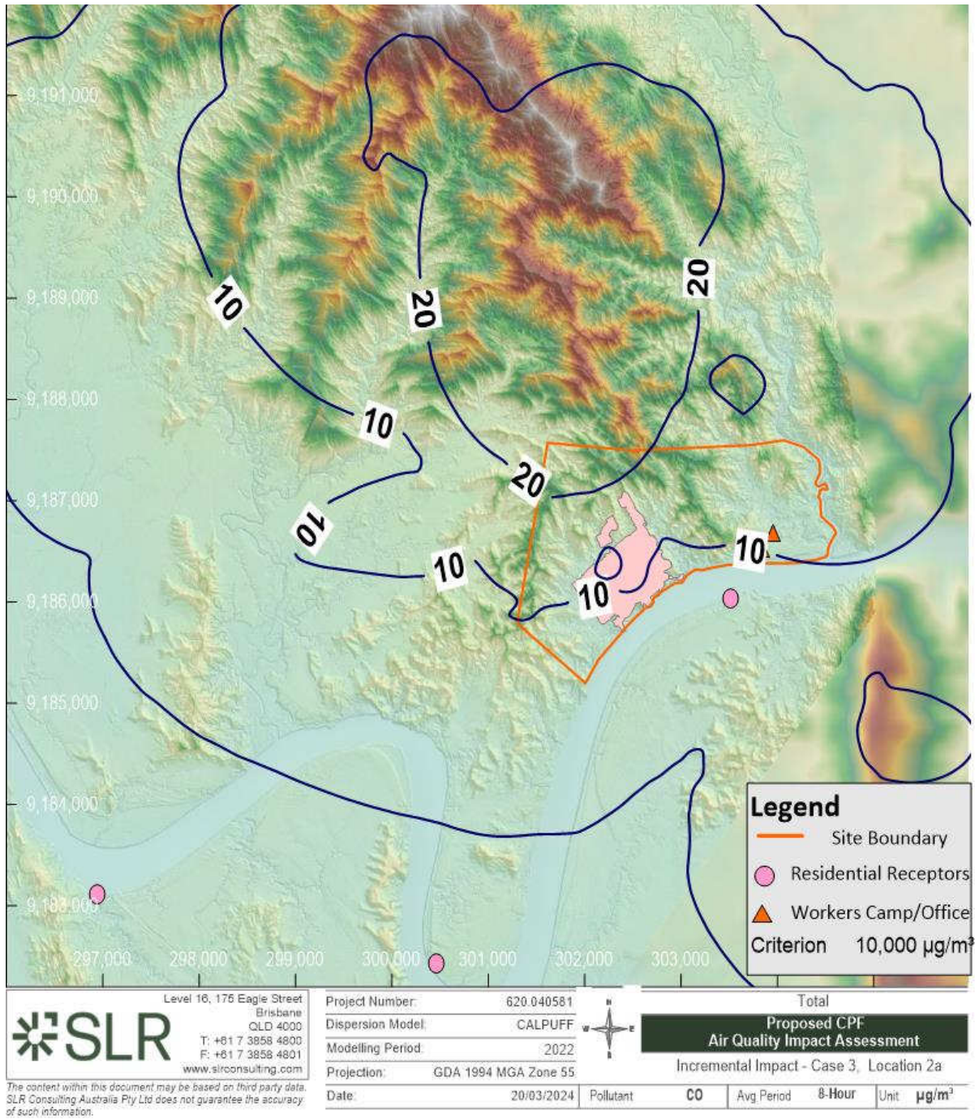


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Dispersion Model:	CALPUFF						
Modelling Period:	2022						
Projection:	GDA 1994 MGA Zone 55						
Date:	20/03/2024	Pollutant	CO	Avg Period	1-Hour	Unit	µg/m³

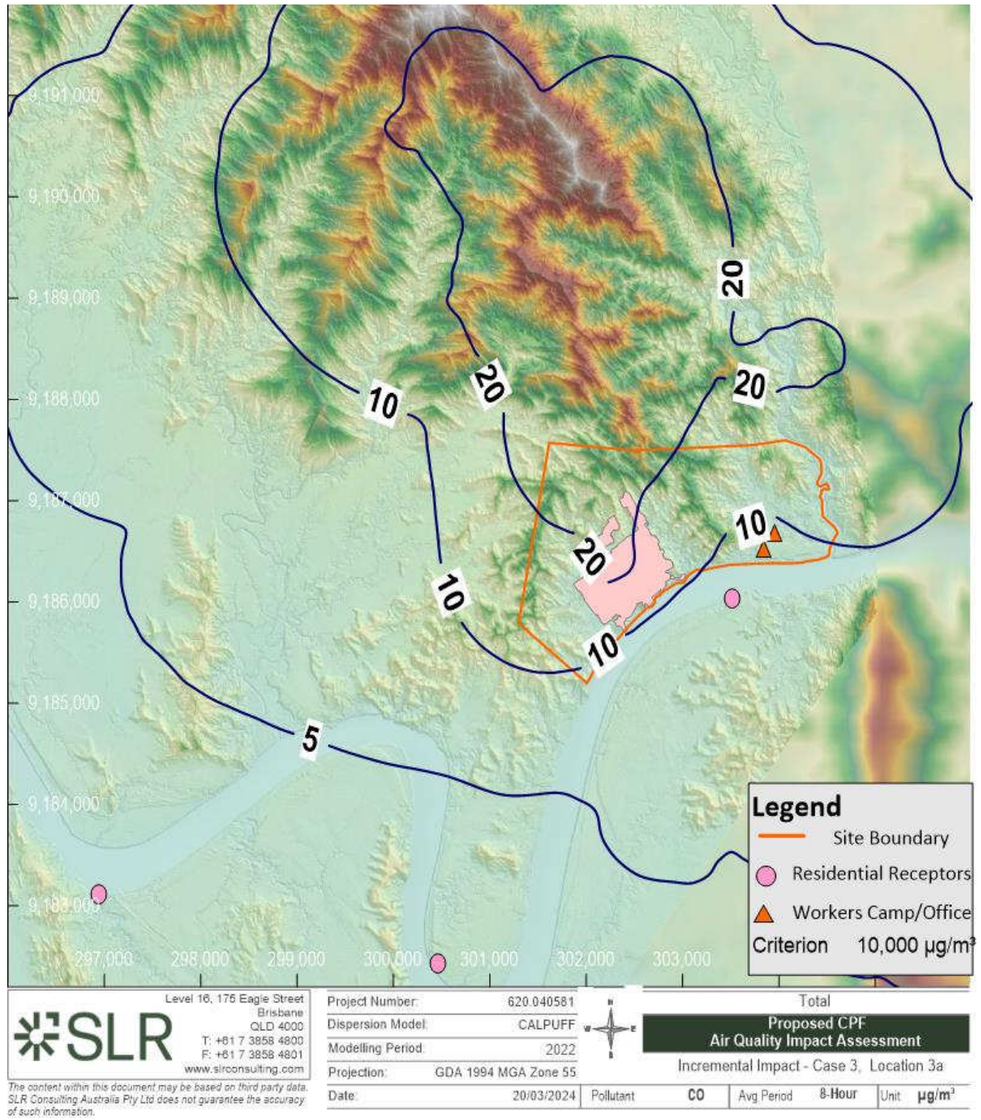
Total
Proposed CPF
Air Quality Impact Assessment
Incremental Impact - Case 3, Location 3a



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Project Number:	620.040581					Total	
Dispersion Model:	CALPUFF					Proposed CPF Air Quality Impact Assessment	
Modelling Period:	2022					Incremental Impact - Case 3, Location 2a	
Projection:	GDA 1994 MGA Zone 55						
Date:	20/03/2024	Pollutant	CO	Avg Period	8-Hour	Unit	µg/m³

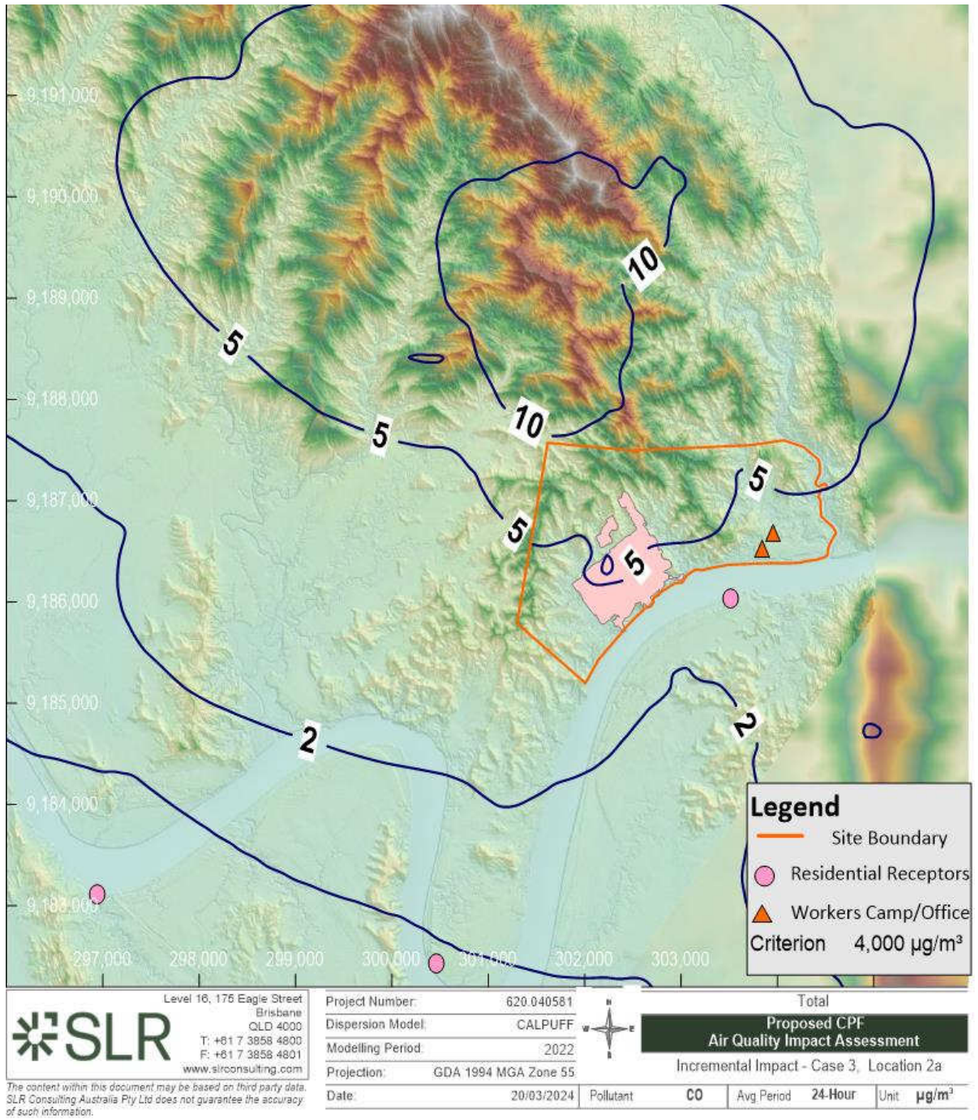


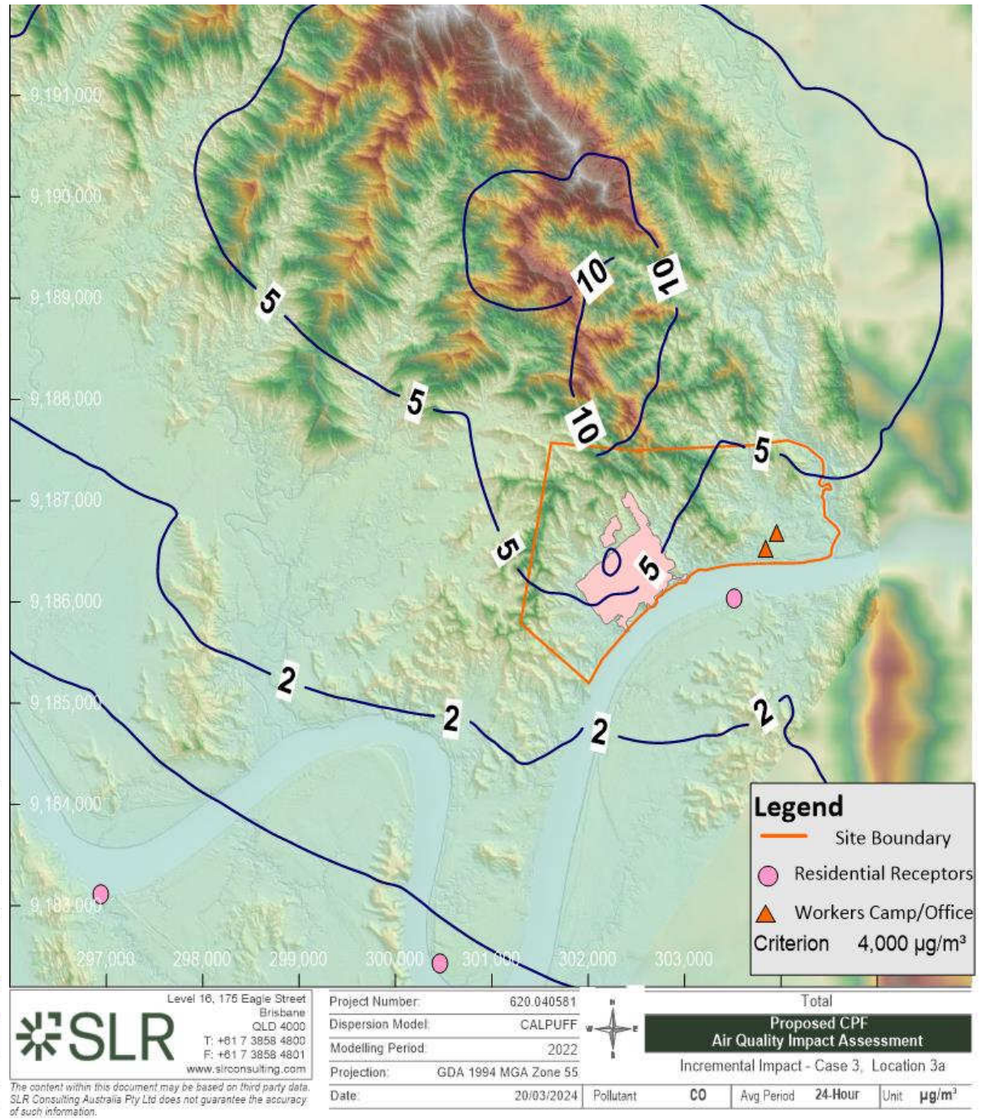
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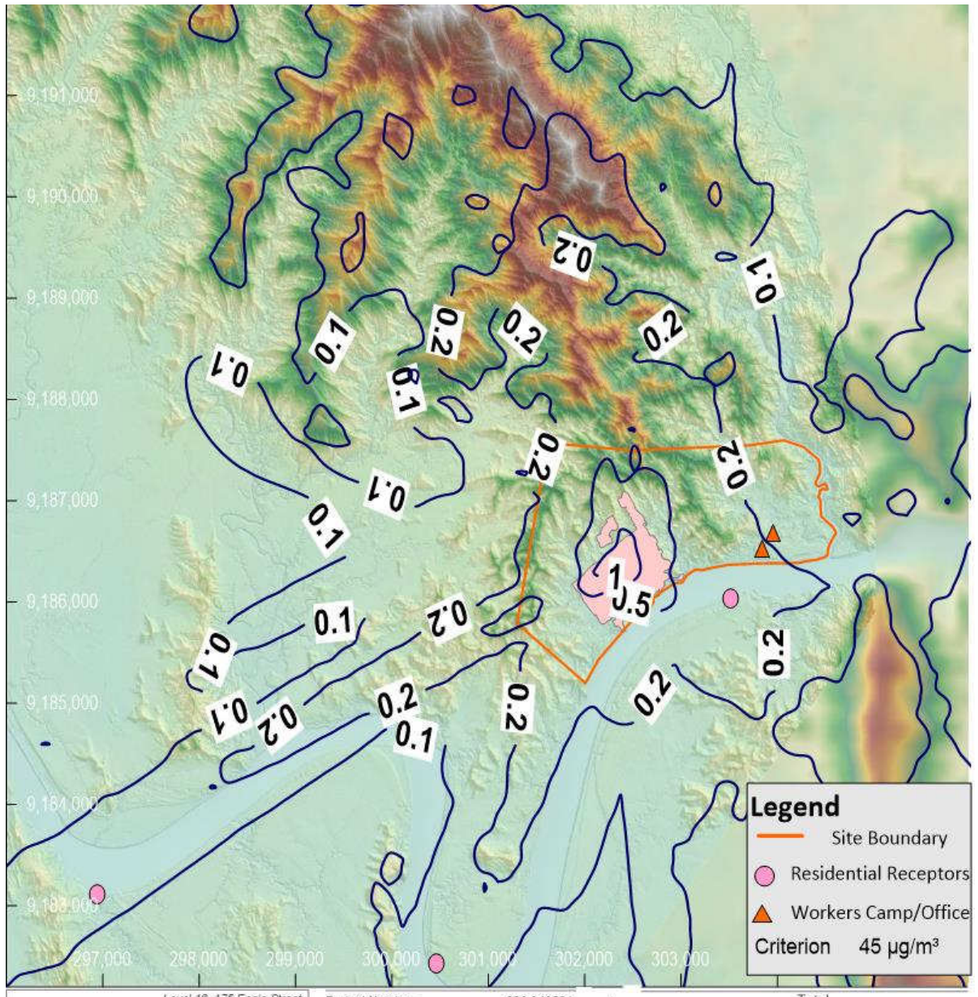
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Modelling Period:	2022					Incremental Impact - Case 3, Location 3a	
Projection:	GDA 1994 MGA Zone 55						
Date:	20/03/2024	Pollutant	CO	Avg Period	8-Hour	Unit	µg/m³

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Legend
Site Boundary
Residential Receptors
Workers Camp/Office
Criterion 4,000 µg/m³
Level 16, 175 Eagle Street
Brisbane
QLD 4000
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F: +61 7 3858 4801
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Project Number: 620.040581
Dispersion Model: CALPUFF
Modelling Period: 2022
Projection: GDA 1994 MGA Zone 55
Date: 20/03/2024
Total
Proposed CPF
Air Quality Impact Assessment
Incremental Impact - Case 3, Location 2a
Pollutant CO
Avg Period 24-Hour
Unit µg/m³


9,191,000
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Site Boundary
Residential Receptors
Workers Camp/Office
Criterion 4,000 µg/m³
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Brisbane
QLD 4000
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Modelling Period: 2022
Projection: GDA 1994 MGA Zone 55
Date: 20/03/2024
Total
Proposed CPF
Air Quality Impact Assessment
Incremental Impact - Case 3, Location 3a
Pollutant CO
Avg Period 24-Hour
Unit µg/m³

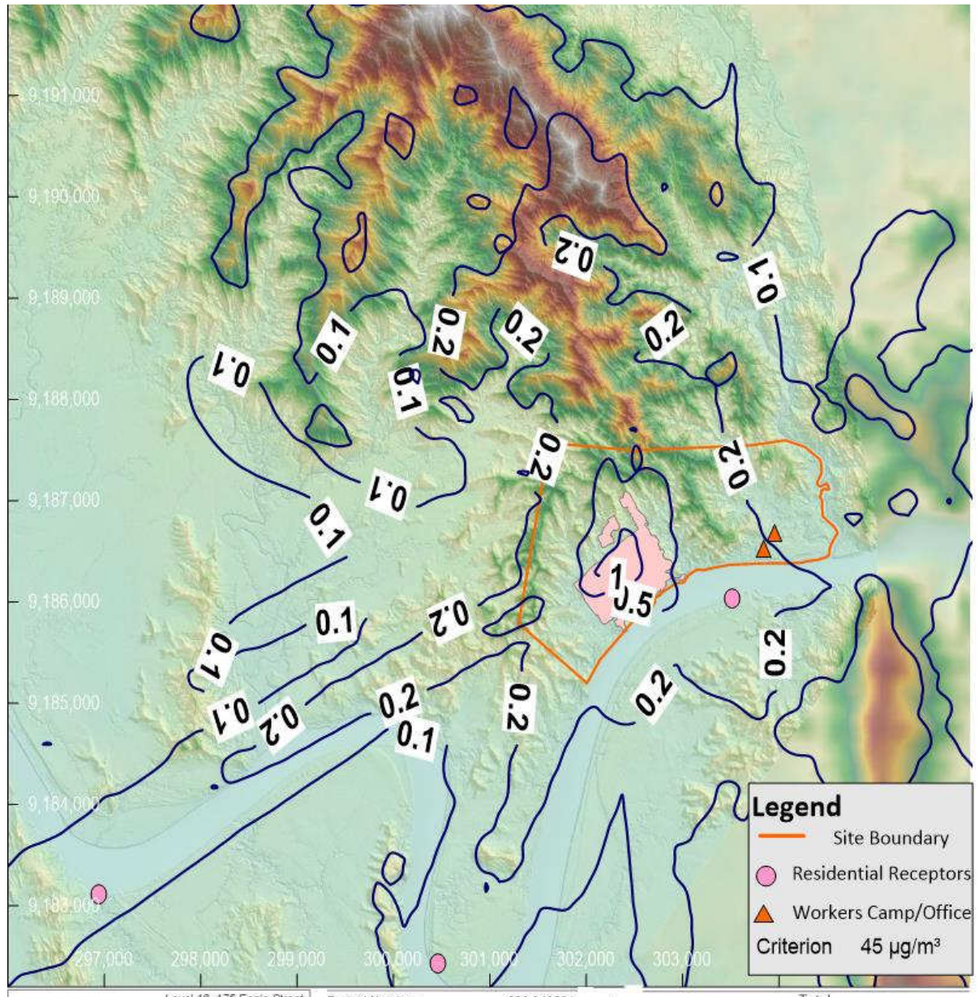


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Dispersion Model:	CALPUFF				
Modelling Period:	2022				
Projection:	GDA 1994 MGA Zone 55				
Date:	20/03/2024	Pollutant	$PM_{2.5}$	Avg Period	24-Hour

Total
Proposed CPF
Air Quality Impact Assessment
Incremental Impact - Case 3, Location 2a

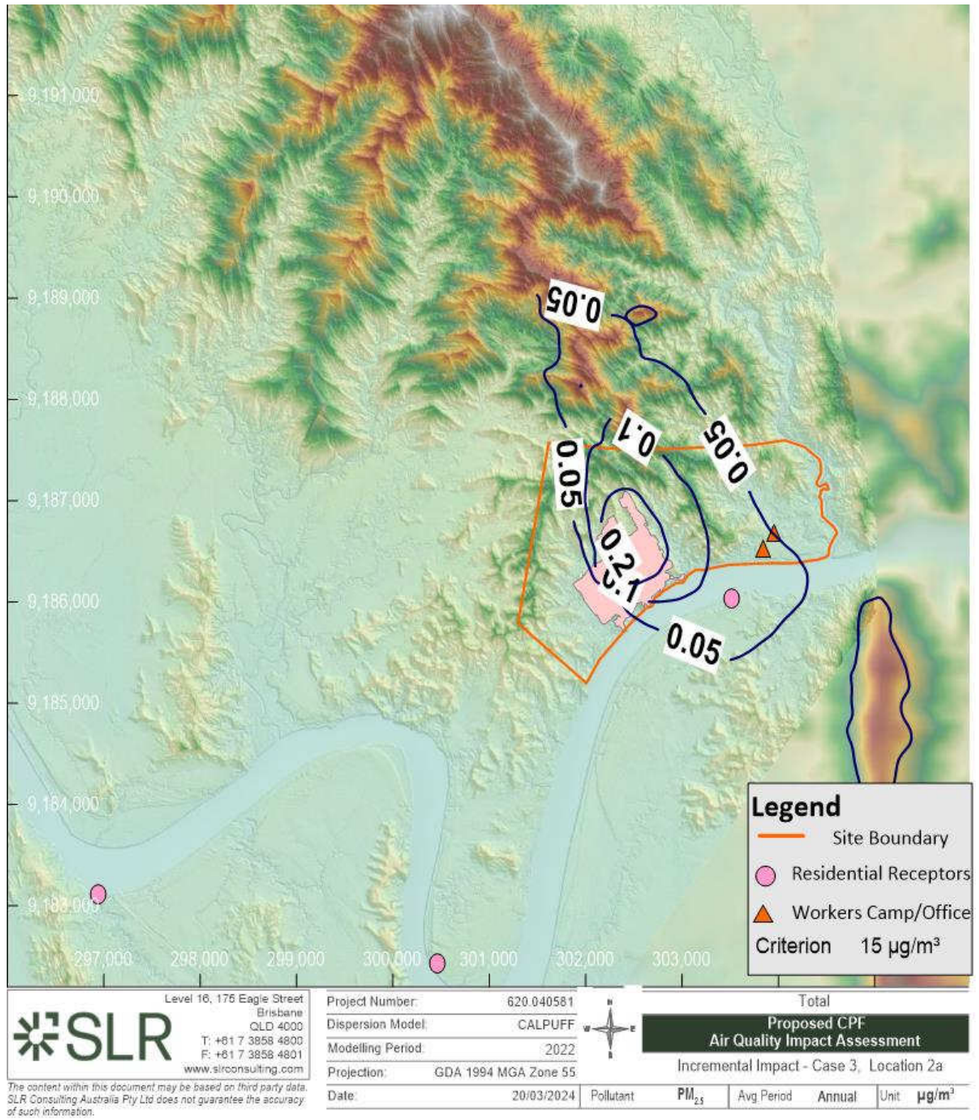


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Projection:	GDA 1994 MGA Zone 55				
Date:	20/03/2024	Pollutant	$PM_{2.5}$	Avg Period	24-Hour

Total
Proposed CPF
Air Quality Impact Assessment
Incremental Impact - Case 3, Location 3a



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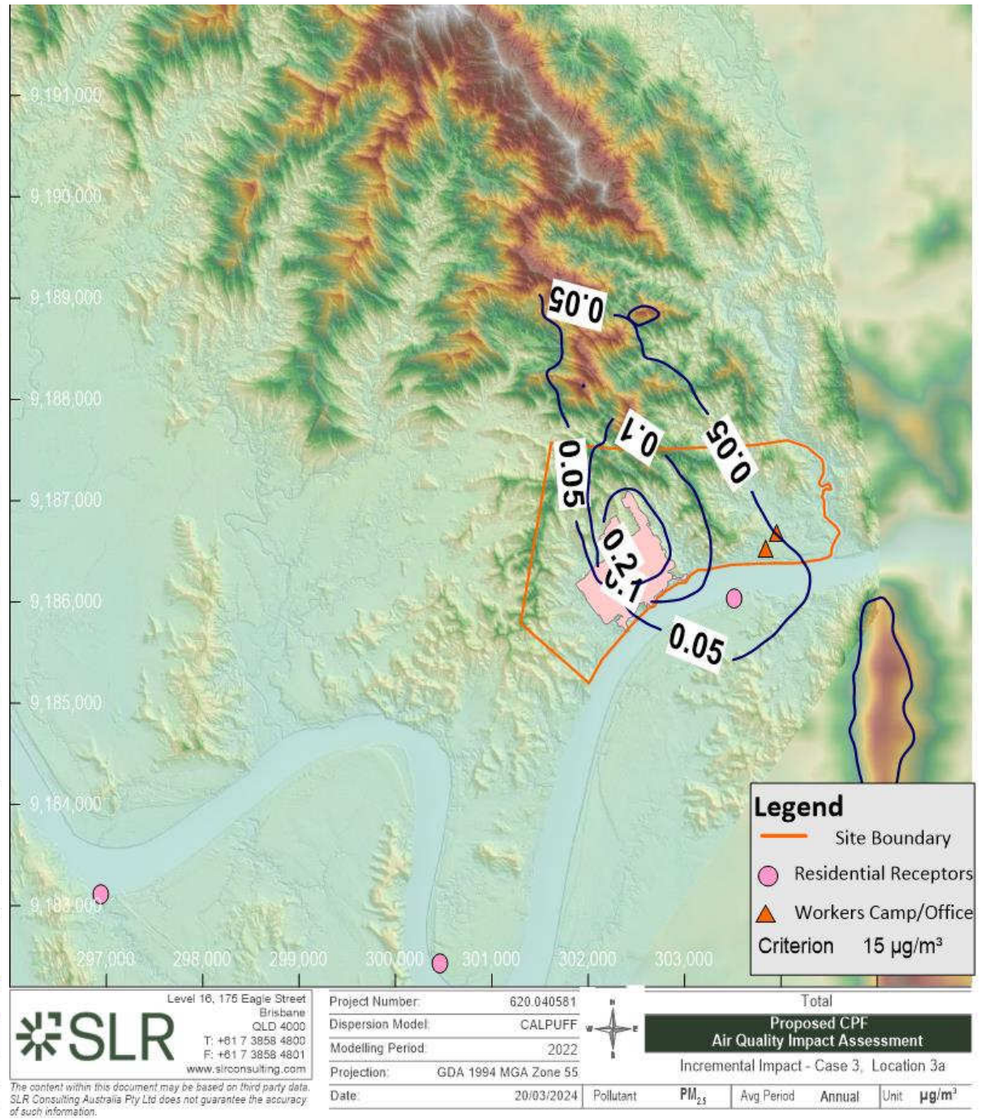
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Projection:	GDA 1994 MGA Zone 55
Date:	20/03/2024

Total

Proposed CPF
Air Quality Impact Assessment

Incremental Impact - Case 3, Location 2a

Pollutant	$PM_{2.5}$	Avg Period	Annual	Unit	µg/m³



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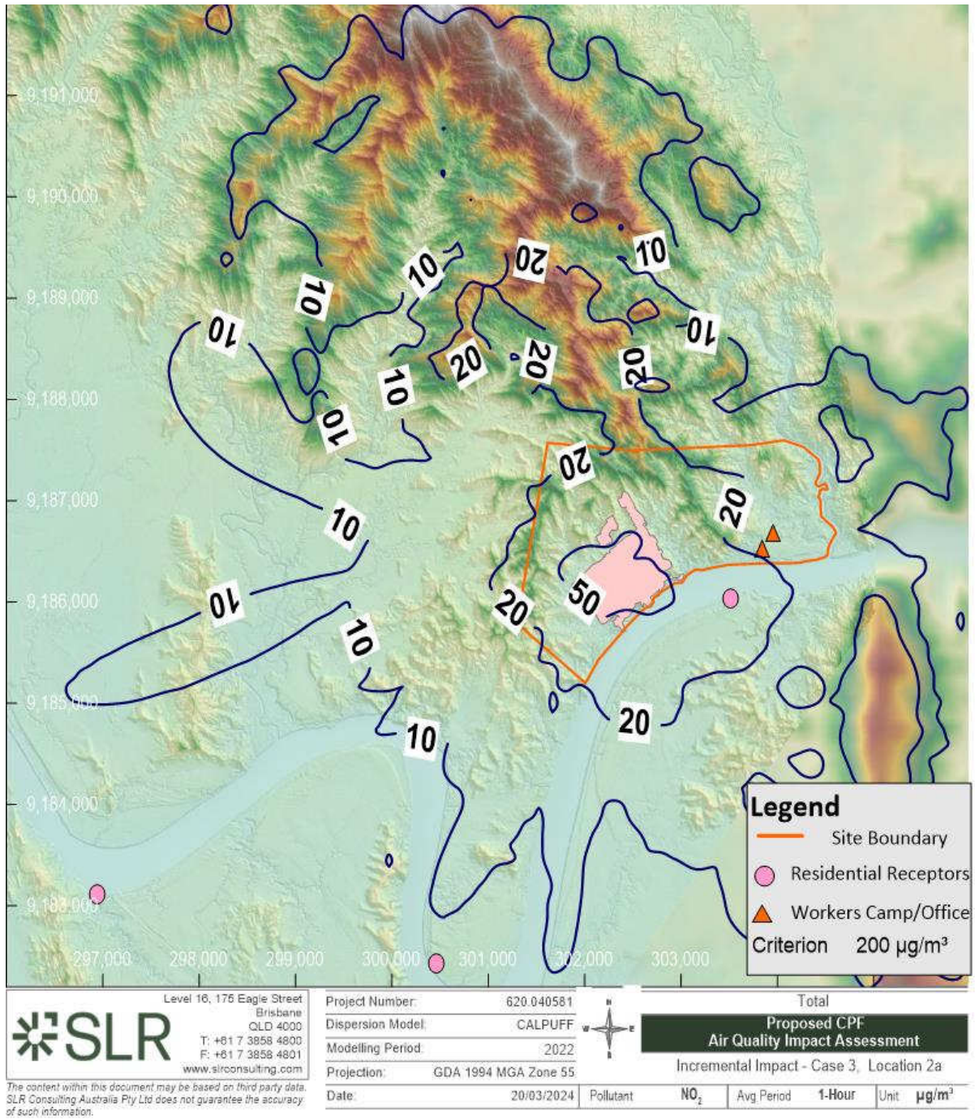
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Date:	20/03/2024

Total

Proposed CPF
Air Quality Impact Assessment

Incremental Impact - Case 3, Location 3a

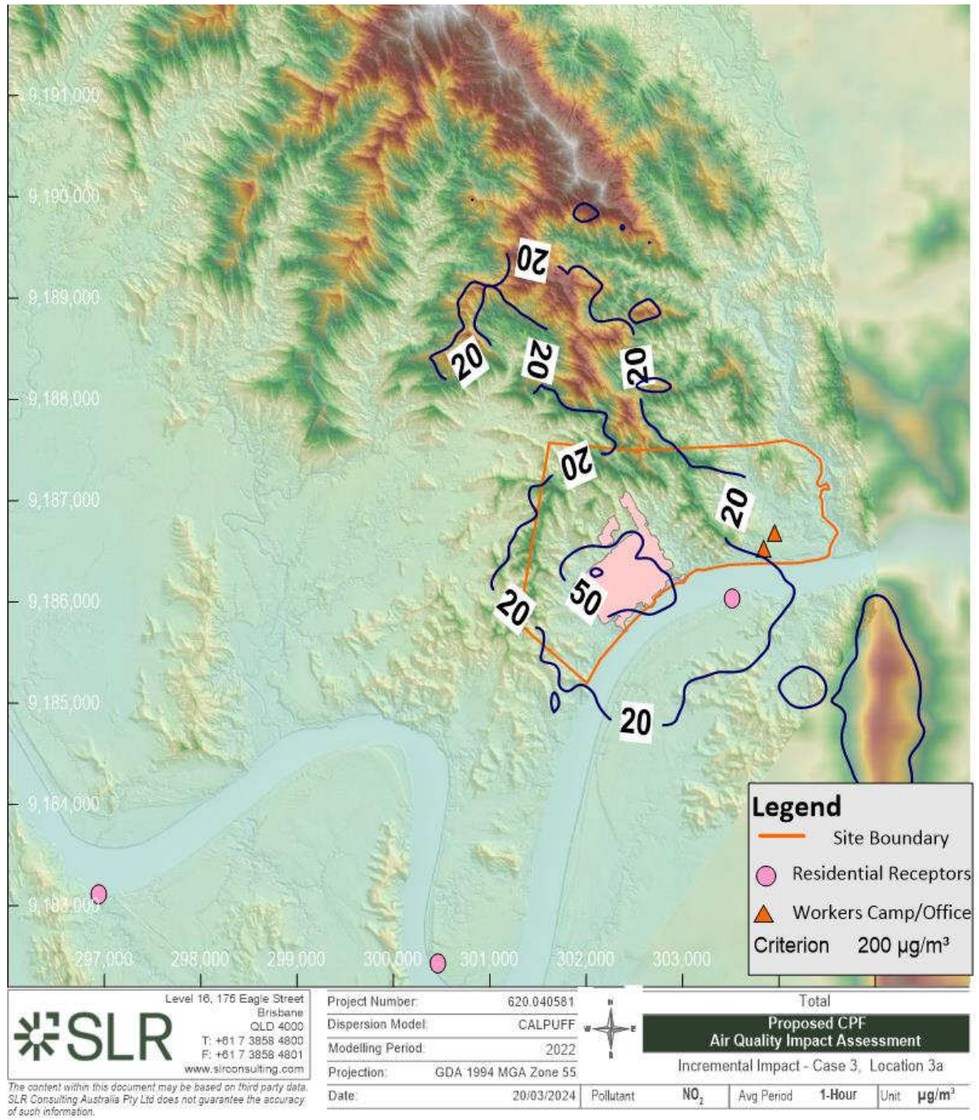
Pollutant	$PM_{2.5}$	Avg Period	Annual	Unit	µg/m³



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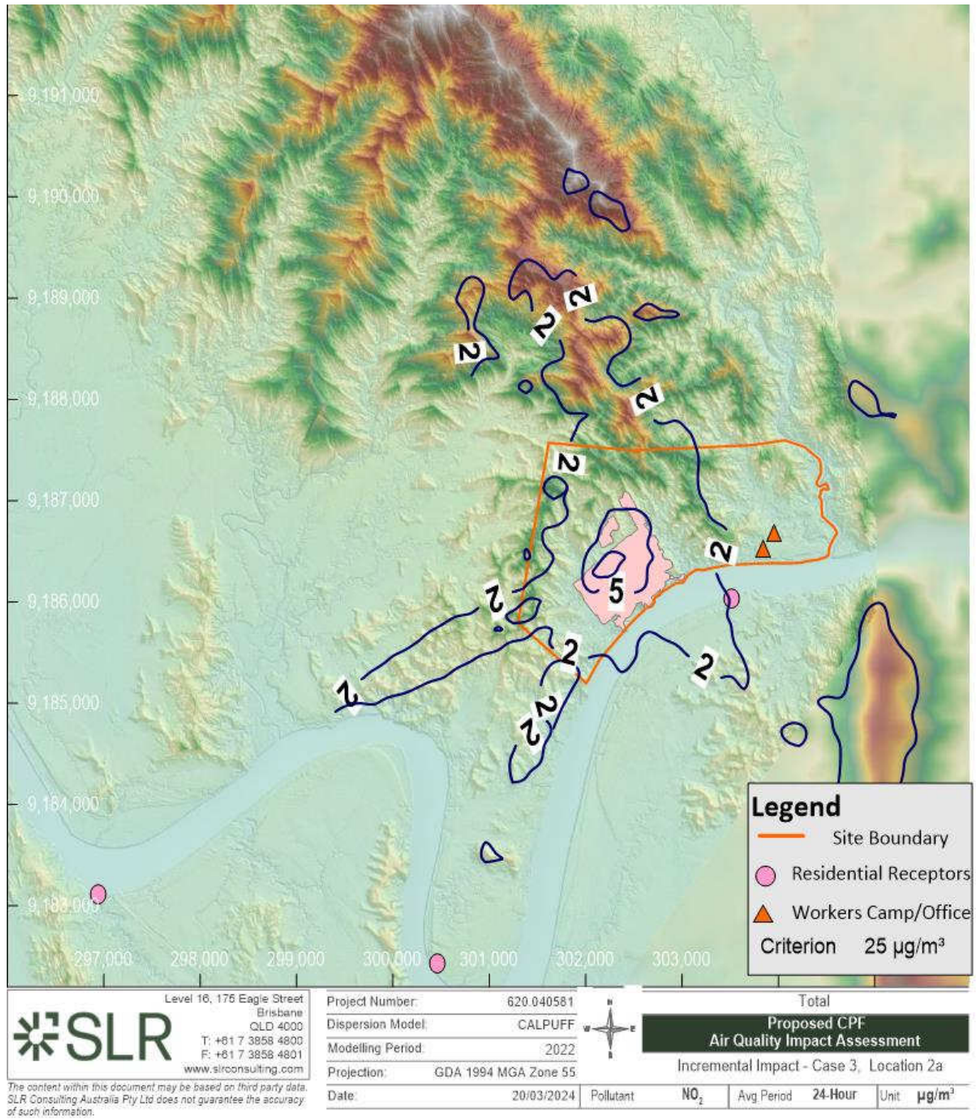
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Dispersion Model:	CALPUFF					Proposed CPF Air Quality Impact Assessment	
Modelling Period:	2022					Incremental Impact - Case 3, Location 2a	
Projection:	GDA 1994 MGA Zone 55						
Date:	20/03/2024	Pollutant	NO_2	Avg Period	1-Hour	Unit	µg/m³



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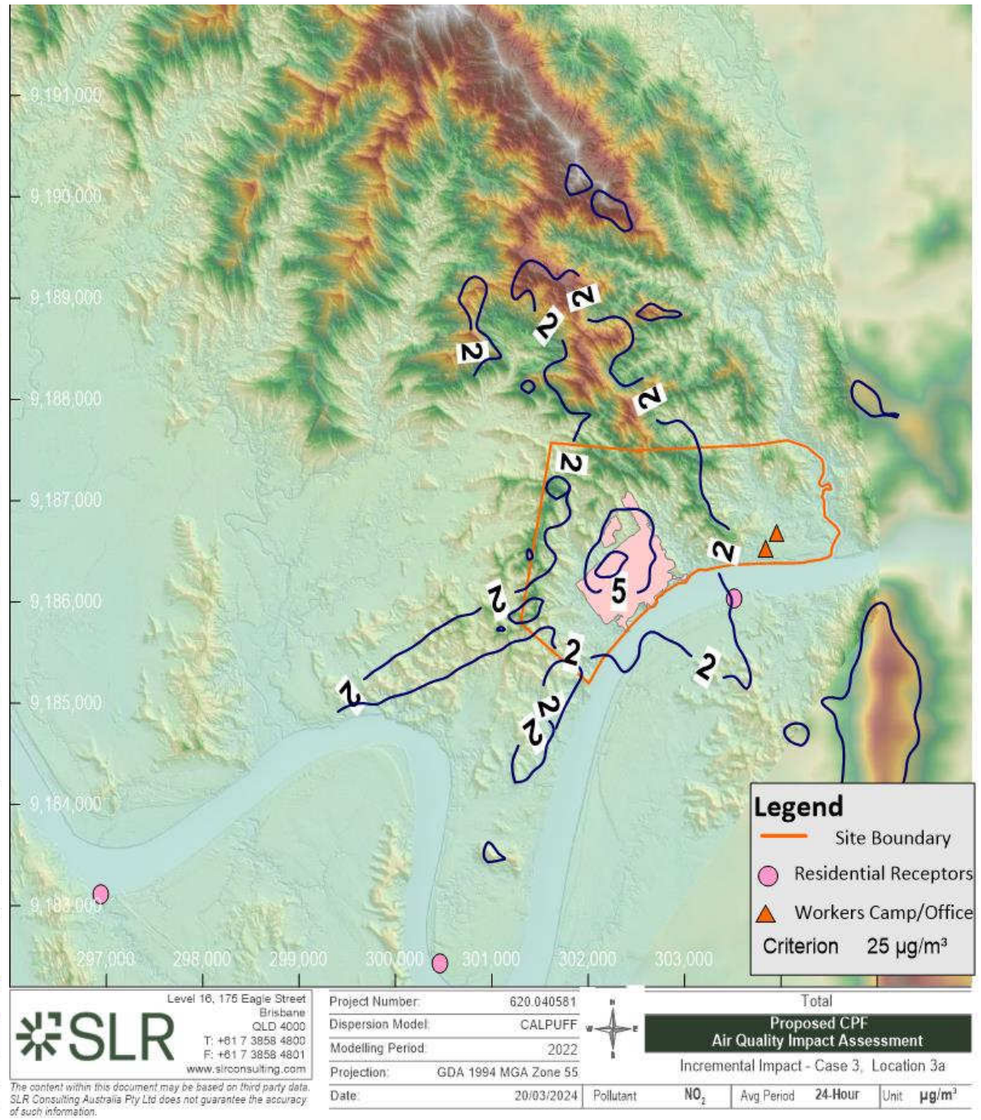
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Modelling Period:	2022					Incremental Impact - Case 3, Location 3a	
Projection:	GDA 1994 MGA Zone 55						
Date:	20/03/2024	Pollutant	NO_2	Avg Period	1-Hour	Unit	µg/m³



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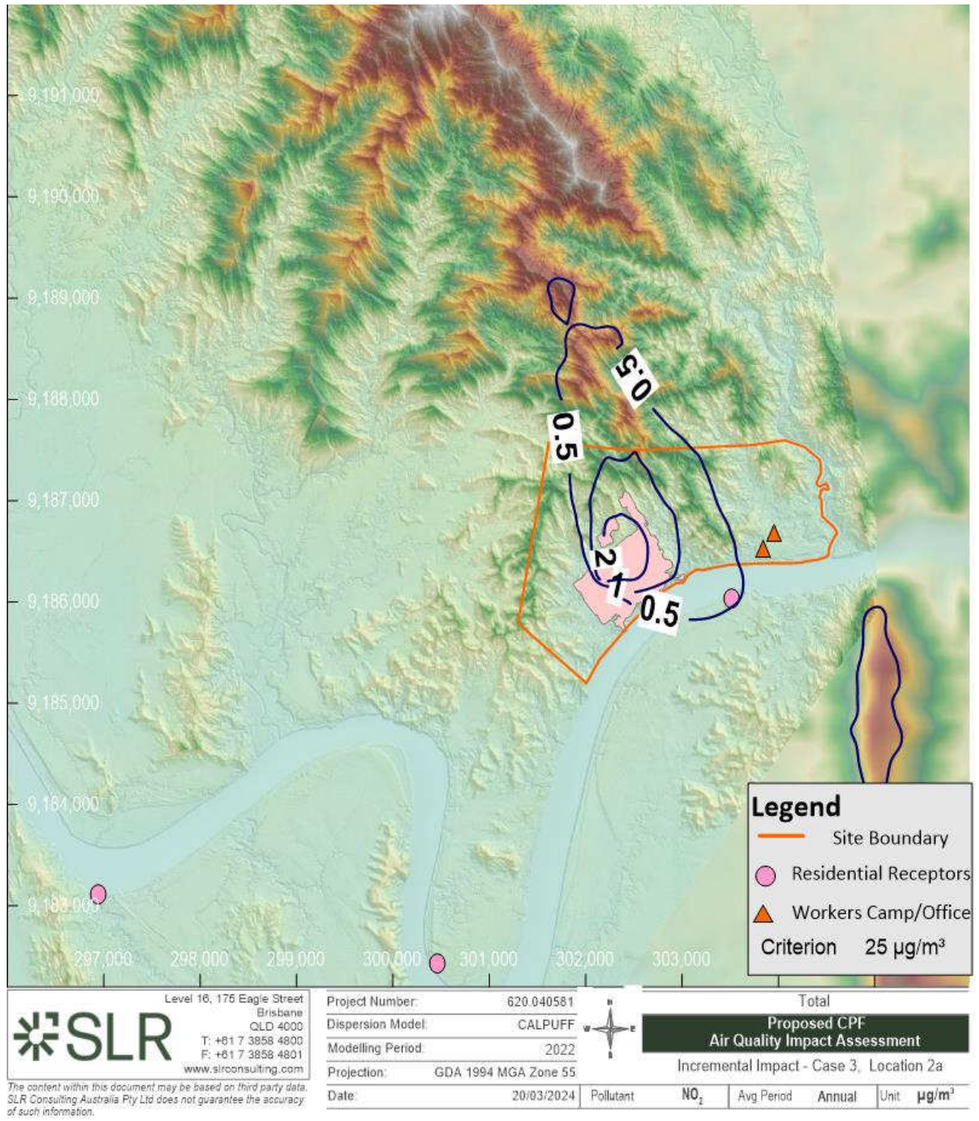
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Modelling Period:	2022					Incremental Impact - Case 3, Location 2a	
Projection:	GDA 1994 MGA Zone 55						
Date:	20/03/2024	Pollutant	NO_2	Avg Period	24-Hour	Unit	µg/m³



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Modelling Period:	2022					Incremental Impact - Case 3, Location 3a	
Projection:	GDA 1994 MGA Zone 55						
Date:	20/03/2024	Pollutant	NO_2	Avg Period	24-Hour	Unit	µg/m³

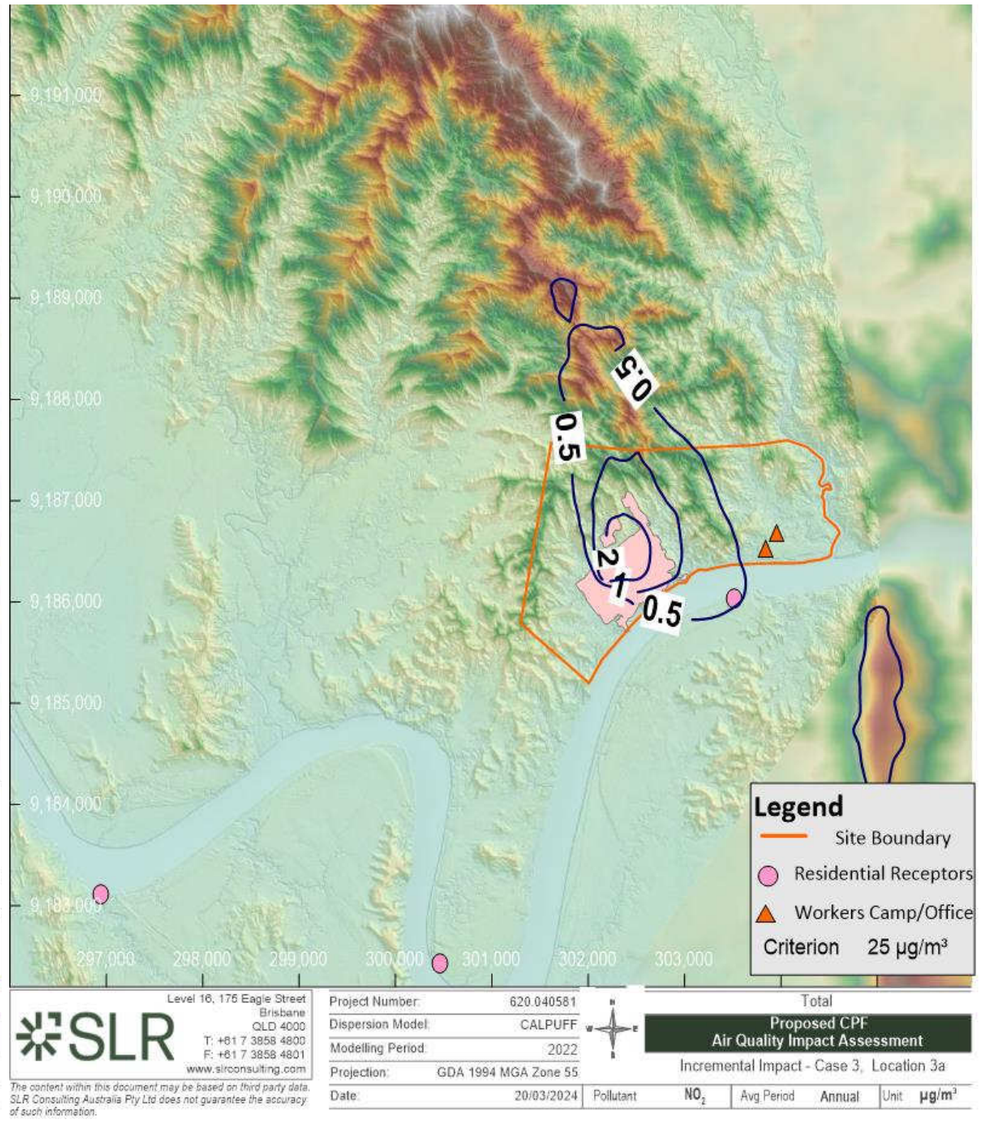


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Project Number:	620.040581						
Dispersion Model:	CALPUFF						
Modelling Period:	2022						
Projection:	GDA 1994 MGA Zone 55						
Date:	20/03/2024	Pollutant	NO_2	Avg Period	Annual	Unit	µg/m³

Total
Proposed CPF
Air Quality Impact Assessment
Incremental Impact - Case 3, Location 2a



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Dispersion Model:	CALPUFF						
Modelling Period:	2022						
Projection:	GDA 1994 MGA Zone 55						
Date:	20/03/2024	Pollutant	NO_2	Avg Period	Annual	Unit	µg/m³

Total
Proposed CPF
Air Quality Impact Assessment
Incremental Impact - Case 3, Location 3a



Making Sustainability Happen

Appendix 2
SLR Papua LNG CPF P3 Relocation. Noise Impact Assessment

Papua LNG CPF Relocation

Noise Impact Assessment

Papua LNG Development Pty Ltd

Cecil Street, #27-01 Frasers Tower
SINGAPORE 069547

Prepared by:

SLR Consulting Australia

SLR Project No.: 620.040581.00002

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Revision Record

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1.0	19 June 2024	Rodrigo Olavarria	Mark Caslin	Mark Caslin
0.1	18 April 2024	Rodrigo Olavarria	Glyn Cowie	Glyn Cowie

Basis of Report

This report has been prepared by SLR Consulting Australia (SLR) with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with Papua LNG Development Pty Ltd (the Client). Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

This report is for the exclusive use of the Client. No warranties or guarantees are expressed or should be inferred by any third parties. This report may not be relied upon by other parties without written consent from SLR.

SLR disclaims any responsibility to the Client and others in respect of any matters outside the agreed scope of the work.

Executive Summary

SLR consulting Australia Pty Ltd (SLR) was engaged to prepare a noise assessment of the proposed CPF-P3 LNG facility (referred hereto as 'the Project') in support of the Environmental Impact Statement required for submission to regulators and to satisfy International Finance Corporation (IFC) environmental assessment requirements associated with the proposed change in location of critical infrastructure.

The noise assessment comprised the prediction of construction and operational noise levels from the CPF-P3 onto external Noise Sensitive Receptors (NSR) and Project involved Noise Receptors (NR) using computational analysis.

NSR3 (Pokore Hamlet) has been identified as the closest noise sensitive receptor. Compliance with noise limit at this receptor results in compliance at other receptors, by default.

Construction noise predictions were based on a typical equipment list expected to be required during the early and later construction works.

The operational noise predictions were based on a plant list and noise emissions produced by the Saipem-Tripatra-Daewoo joint venture.

Noise predictions were conducted for typical weather parameters conducive of neutral and enhanced noise propagation.

The noise predictions were assessed against the International Finance Corporation (IFC) World Bank Group Environmental, Health and Safety (EHS) Guidelines with consideration of environmental noise emissions. A daytime (7:00 am to 10:00 pm) noise limit of 55 dBA $L_{Aeq(1hr)}$ and night time (10:00 pm to 7:00 am) noise limit of 45 dBA $L_{Aeq(1hr)}$ were applied.

Construction noise emissions

The assessment showed that the construction stage can be expected to meet the daytime noise limit at the closest NSR3. However, with minimal safety margin depending on the intensity of the works.

Construction activities can be expected to exceed the night time limit at this receptor by up to 8 dBA. The night time exceedance is considered manageable to compliant levels via the implementation of reasonable and feasible measures.

Recommendations are made in this report which are to be considered for subsequent versions of the Project Noise and Vibration Management Procedure (NVMP),which may include (but is not limited to) the guidance provided in **Section 8.2.2**.

Operational noise emissions

The assessment showed that the normal operation of the CPF-P3 site can be expected to meet or marginally exceed the daytime noise limit, depending on the noise propagation conditions.

At night, the normal operation was predicted to exceed the noise limit at NSR3 by up to 11 dBA. The noise limit is largely exceeded during all weather conditions.

During abnormal operation (which includes a reduced plant noise emission, plus gas flaring), the noise emission from the flare is predicted to be the dominant noise source, whereby the noise emission from other plant, whilst exceeding the night time limit by itself, is of no significance in comparison to the flare noise. In other words, to achieve compliance with the noise limits during abnormal operation, noise mitigation will be required for both the CPF plant and the flare, irrespective of the flare location option (2a or 3a) selected.

Noise management

The following strategies have been considered to manage the noise emissions to compliant levels:

- Relocate the CPF plant site away from sensitive receptors; or
- Relocate receptor NSR3; and/or
- Introduce localised noise controls to reduce the plant noise emission to a compliant noise level.

Further engineering design incorporating the selection of plant specific noise controls will be required where the CPF-P3 site location is retained. Indicative maximum allowable plant and flare noise emissions are presented in **Section 8.2.3**, which were calculated to meet the noise limits assuming both the retention as well as the relocation of NSR3.

The maximum allowable noise emissions are indicative only as they assume that all plant noise emission is reduced proportionally by the same amount to achieve the site wide maximum noise emission. In practise, noise controls will introduce variable noise reductions. Therefore, the total noise emission may vary from the stated values and should be confirmed via further noise assessment.

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Appendix A **Noise Source Emission Database**

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1.0 Introduction

The Elk-Antelope field is a significant gas discovery located within the Gulf Province in Papua New Guinea (PNG). The field lies south of the mountains and is located approximately 120 kilometres (km) inland from the township of Kerema and 360 km northwest of Port Moresby, the capital city and major industrial centre.

To access the Elk Antelope natural gas and condensate resources, the Papua Liquified Natural Gas (LNG) Project includes construction of in-field drilling pads connected by flowlines to a Central Processing Facility (CPF), with subsequent delivery of the natural gas and condensate to the existing PNG LNG Facility located at Caution Bay on the southern coastline of the Gulf of Papua, via onshore and offshore export pipeline.

In 2019, SLR Consulting (Australia) Pty Ltd (SLR) prepared a Noise Impact Assessment (NIA) as part of the Environmental Impact Statement (EIS) for the Papua LNG Project (SLR report 620.11227.00100-R02-v1.7 – *Papua LNG Project, Noise Modelling for Impact Assessment*, dated 14 August 2019, referred hereto as the 'previous CPF LNG Noise report'), which included a detailed acoustic modelling of the CPF construction and operation at the "P2C" location.

As part of the Front-End Engineering Design (FEED) stage of the Papua LNG Project, opportunities have been sought to optimise the Project footprint by reconsidering the placement of infrastructure to maximise re-use of areas degraded by the previous operator during the exploration and appraisal phases. These optimisation activities have identified a possible alternative site for the CPF (referred to as 'CPF-P3') nearer to Herd Base, which is the existing logistics hub for the Papua LNG Project upstream development (see **Figure 1**). This proposed change in the CPF location would result in less road construction being required, a shorter pipeline route and the ability to combine the CPF footprint with the construction camp.

Figure 1 Papua LNG Project CPF Relocation



The purpose of this report is to present the updated noise emission inventory and noise modelling results for the CPF-P3 location, incorporating currently available plant design, and provide a revised environmental noise assessment for the PLNG CPF Relocation Project.

Potential impacts of the Project on the above environmental values were assessed based on a compliance assessment for the expanded PLNG Plant with the noise guidelines for the noise emissions that have been identified as being generated by the new facilities at the site.

Noise emission in relation to occupational health matters is not addressed in this report.

1.1 Assessment Objectives

The key objective of this report is to provide an updated noise impact assessment for the CPF construction and operations based on the new CPF-P3 location, as well as addressing relevant design changes since the NIA prepared in 2019.

This information will be used to supplement overall updates to the EIS for submission to regulators and to satisfy International Finance Corporation (IFC) environmental assessment requirements associated with this proposed change in location of critical infrastructure.

1.2 Scope of the Assessment

The scope of the updated NIA included:

- Compilation of updated noise emissions for normal and emergency (Flaring) operating conditions based on the latest CPF design information.
- Compilation of an updated site-representative meteorological file for the CPF-P3 site and surrounding area.
- Update of sensitive receptor locations considered in the assessment to include new dwellings constructed in the last five (5) years.
- Review of the noise criteria used in the 2019 NIA to address any changes in guidelines and standards.
- Updated operational noise modelling under normal and emergency operating conditions and assessment of predicted noise levels against the relevant noise criteria.
- Updated construction noise modelling to assess the potential noise impacts during construction, based on the typical plant and equipment inventories.
- Assessment of impacts on Noise Sensitive Receptors (NSR), from the construction and operation of the relocated facilities.
- Propose in-principle measures to manage noise exceedances of relevant assessment criteria.

1.3 Referenced Documents

The following Policies and standards form the basis of this noise assessment:

- Independent State of Papua New Guinea Environment Act No. 64 of 2000 (Environment Act).
- World Health Organization (WHO) Guidelines for Community Noise (WHO, 1999).
- International Finance Corporation (IFC) World Bank Group Environmental, Health and Safety (EHS) Guidelines: General EHS Guidelines: Environmental (General EHS Guidelines). Section 1.7 Noise (IFC, 2007a).
- Conservation of Clean Air and Water Europe report no.4/1981 – The propagation of noise from petroleum and petrochemical complexes to neighbouring communities (CONCAWE 1981).
- ISO 9613-2:1996 Attenuation of sound during propagation outdoors — Part 2: General method of calculation (ISO 9613-2).
- German standard VDI 3732 – Standard noise levels of technical sound sources – Flares, 1999.

The following documents were also reviewed to inform the assessment inputs:

- Project Ref.: EP/DSO/ONS/EDI-PNG/ENOC01902-EGI-030-RT-001 "Earthworks Management Plan".
- Project Ref.: EP/DSO/ONS/EDI-PNG/PJM-800437 Preliminary-Constructability-Report_Draft.pdf “Preliminary Upstream Constructability Study”.
- Project Ref.: EP/DSO/ED/EDI-PNG/CIV-800235 "Pipelines Routing and Constructability Assessment Study PHASE 1”.
- Project Ref.: EP/DSO/ED/EDI-PNG/CIV-800302 “Papua LNG Pre-Project Civil Engineering Study”.
- SLR Memorandum 01215B_M057_20190219_v1 TOTAL2.pdf "PAPUA LNG/EIS ASSUMPTIONS FOR NOISE IMPACT STUDY”, latest version/edits dated 08/03/2019.
- Papua LNG Upstream Project – Project Noise and Vibration Management Procedure, document PG-P15-00-PHSE-000030, rev 00 23-10-2023 (NVMP).
- Saipem-Tripatra-Daewoo E&C report 870330-PTS-SAF-STU-200045 – Papua LNG Upstream Project, dated 20 October 2023.



2.0 Project Description

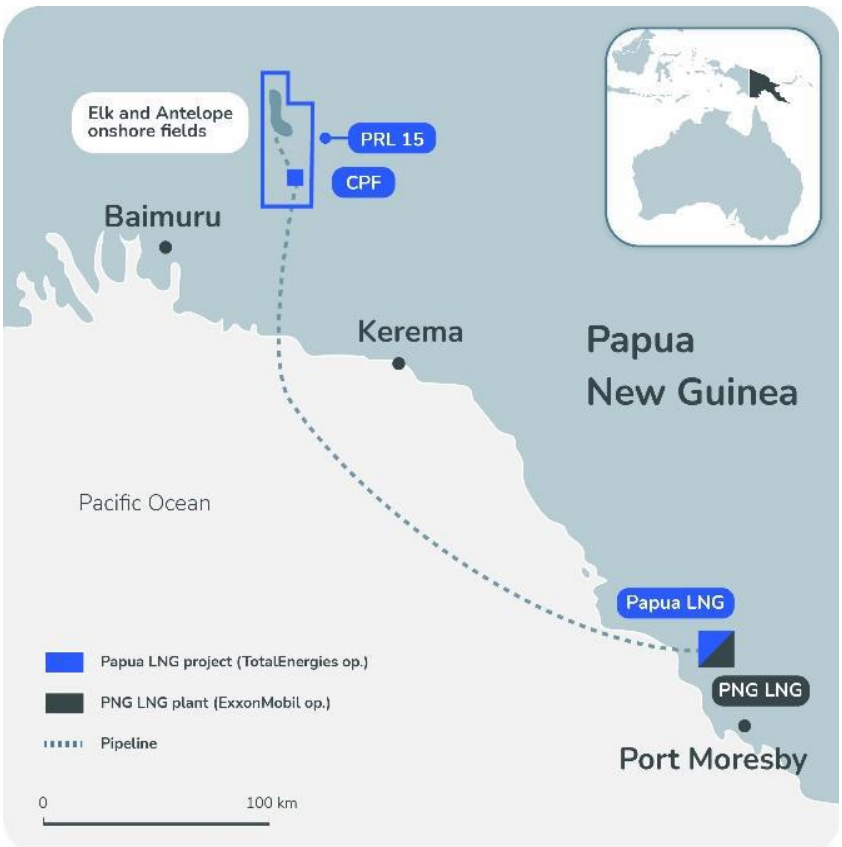
The Papua LNG Project's upstream facilities are situated in a hilly area, between 50 to 400 metres (m) above sea level, covered by a dense tropical forest and irrigated by several rivers including the Purari River, which constitutes the main access from the coastline located about 60 km to the south. The region is sparsely populated with little infrastructure.

The gas fields comprise two (2) discrete gas reservoirs, being the Elk and Antelope reserves. More than 95% of the combined Elk–Antelope gas reserves are in the Antelope gas field. The gas composition is comprised primarily of methane, ethane and propane. The gas and condensate from the Elk-Antelope gas fields contains low levels of sulphur compounds that are considered impurities.

The proposed Papua LNG Project development architecture includes several surface facilities (see **Figure 2**):

- The wellpads and upstream gathering network, including a field manifold at the Antelope production wellpad (ANT-10), two (2) parallel multiphase Elk flowlines to ANT-10 and two (2) parallel multiphase trunklines between ANT-10 and the CPF.
- The upstream/midstream CPF, located 30 km from the Antelope field manifold.
- The approximately 325 km long single-phase gas and condensate export pipelines to the PNG LNG facility.
- The brownfield development of three (3) new LNG liquefaction trains at the existing PNG LNG facility in Caution Bay for the export of 5.6 million tons per annum (Mtpa) of LNG, with a 6.0 Mtpa of Stream Day Capacity (including 2 Mtpa reserved in the existing PNG LNG Plant), and associated condensate products.

Figure 2 Overall Development Architecture



2.1 Wellpads and Gathering Systems

The Elk–Antelope gas fields will be developed with up to eight (8) production wells, one (1) produced water disposal well and one (1) acid gas[1] disposal well. The production wells will be drilled from three (3) wellpads (ELK-10, ANT-10 and ANT-11).

Acid gas will be disposed by reinjection into the well at ELK-10 once the Elk gas reservoir is depleted. Acid gas and produced water will be reinjected into the Elk reservoir by converting an existing production well into a reinjection well at wellpad ELK-11, as the reservoir depletes.

The gathering system is made up of pipelines (flowlines and trunklines) that collect and transport the raw gas and associated liquids (well stream fluids) from individual gas production wells to the CPF. The flowlines will be used to pipe acid gas and produced water from the CPF to the reinjection wells.

2.2 Central Processing Facility

The raw gas and condensate will be processed at the CPF before being piped to the PNG LNG facility. Processing is required to separate the natural gas from the condensate and to remove carbon dioxide, water, and sulphur compounds so that the natural gas and condensate compositions meet the export specifications.

The CPF includes a process area, utilities area, services area, flare system, and condensate storage. An operations camp will be located near the CPF and maintenance facilities will be co-located with the CPF.

2.3 Export Pipelines

The natural gas and condensate will be transported by separate export pipelines in the same corridor from the CPF to the PNG LNG Facility. The export pipelines will include:

- Approximately 60 km of onshore pipelines from the CPF to Orokolo Bay; and
- About 250 km of offshore pipelines from Orokolo Bay to the PNG LNG facility.

The onshore pipelines will be buried approximately 1 m below the ground.

The offshore pipelines will be parallel to the existing PNG LNG pipelines that export natural gas and condensate from the existing Hides CPF to the PNG LNG Facility for over their length. The offshore pipelines will generally be laid on the seabed in about 85 m water depth.

In shallow water near the shore crossings, the pipelines will be buried between 1.0 m and 2.5 m below the seabed to protect the pipelines from vessels or anchor damage.

2.4 Associated Infrastructure

The Project will require a combination of existing infrastructure, such as port facilities in Port Moresby and newly constructed infrastructure such as a logistics base, waste facilities, roads, quarries, and an extension to the existing Purari airstrip.

Transport of people to and from PRL 15 will be via air, whereas materials will mostly be transported by sea and river to PRL 15. River transport routes include the Purari River and the Urika and Ivo rivers when the Purari River is impassable.

[1] The acid gases hydrogen sulphide (H_2S) and carbon dioxide (CO_2) are removed from the produced gas by the CPF to ensure that the gas fulfills pipeline specifications and meets environmental, health, and safety standards.

During the Project construction phase, camps will be constructed to house a peak workforce of a few thousand people at various locations within the Project area. A 250-person camp will be constructed near the CPF for the operations phase.

3.0 Noise Receptors

The nearest existing human receptors to the CPF-P3 site are a new hamlet (known as 'Pokore Hamlet') located on the southern side of the Purari River directly across from Herd Base. This new receptor was established after the 2016 NIA surveys.

Other previously assessed receptors include Poroi 1 village (approximately 4 km to the south of the CPF-P3 site), and Ne'ea Creek (approximately 10 km to the west of the CPF-P3 site). The relative locations of the identified receptor locations and the proposed CPF-P3 site are shown in **Figure 3**, with further details shown in **Table 1**.

Table 1 Identified Receptor Locations

Receptor	Details	Location [MGA 94 Zone 55] (m)		Horizontal Distance/Direction from CPF-P3 industrial area centre
NSR1	Poroi 1	300,457	9,182,433	4.4 km southwest
NSR2	Ne'ea Creek	292,023	9,185,351	10.4 km west
NSR3	Pokore Hamlet	303,510	9,186,040	1.1 km southeast
NSR4	Purari Airstrip House	296,941	9,183,112	6.3 km southwest
NR1	Herd Base	303,840	9,186,527	1.4 km, but within site boundary
NR2	Papua LNG Operations Camp	303,951	9,186,675	1.6 km, but within site boundary

NSR denotes Noise Sensitive Receptors external to the Project.

NR denotes Noise Receptors that are Project-related. Therefore, not considered sensitive receptors as the project proponent can implement at receptor noise mitigation as required.



Customer:
Papua LNG Development Pty Ltd
Project: Papua CPF LNG Relocation
SLR Project: 620.040581.00001

SLR

Figure 3: Identified Noise Receptors

NSR: Noise Sensitive Receptors (external to Project)
NR : Noise Receptors (Project involved)

NSR 2 not shown (located left of the Image >10Km West of CPF site)

Project engineer: Rodrigo Olavarria
Created: 13/06/2024
Processed with SoundPLAN 8.2, Update 20/06/2023

Signs and symbols

- NSR / NR
- Project lease boundary
- Project site

N

Length scale 1:35000

0 300 600 1200 1800 2400 m

4.0 Study Area Details

4.1 Climate

Papua New Guinea has a tropical, monsoonal climate. The coastal and islands regions tend to be hot and humid, with temperature averages ranging between 20°C to 32°C, relative humidity levels ranging from 70% to 90% and high rainfall year-round.

Seasonal climate changes in the study area are controlled by two (2) mass air movements. Typically the easterly trade wind season occurs from April/May to October/November and the northwest monsoon occurs from November/December to March/April. There are transitions at the cross over of each season.

Papua New Guinea's climate varies considerably from year to year due to the El Niño-Southern Oscillation (ENSO). This is a natural climate pattern that affects weather across the world. El Niño is a warming of the Pacific Ocean resulting in longer and cooler dry seasons (i.e. periods of drought), and a delay to the start of monsoon season. La Niña, the cold phase of ENSO, typically results in higher than average rainfall and warmer temperatures during the wet season, often leading to flooding events and landslides[2]. Papua New Guinea also experiences neutral phases.

A dominant climatic factor in the upland areas is cloud and fog; and for most of the year, they are important sources of moisture. Western and northern parts of Papua New Guinea experience the most precipitation, since the north- and westward-moving monsoon clouds are heavy with moisture by the time they reach these more distant regions. However, on rare occasions, vegetation of the uplands can become dry enough to burn, as happened during a severe drought in 2015 when fires spread from the Highlands to West New Britain across to Milne Bay province in the latter half of the year. Towards the coast, rainfall is lower and more evenly spread throughout the year (averaging around 300 mm/month)[3].

Temperatures in the study area are mild and remain relatively consistent throughout the year. Temperature is altitude dependent, with hot and humid conditions associated with lower altitudes and cooler conditions at higher altitudes.

Tropical cyclones tend to affect southern Papua New Guinea between November and April. In the 41-year period between 1969 and 2010, 23 tropical cyclones passed within 400 km of Port Moresby, an average of less than one cyclone per season. From 1969–2010, cyclones occurred more frequently in neutral phases of the El Niño-Southern Oscillation[4].

4.2 Meteorological Data Used in this Assessment

The key parameters relating to the dispersion of air pollutants, wind direction, wind speed, stability class and mixing height are discussed in detail below[5].

4.2.1 Wind Speed and Direction

A plot of the predicted wind speed frequencies predicted by the modelling at the CPF-P3 site for 2022 is presented in **Figure 4**, which shows that the site predominantly experiences low

[2] PACCSAPP. 2015. Current and future climate of Papua New Guinea. Pacific-Australia Climate Change Science and Adaptation Planning Program.

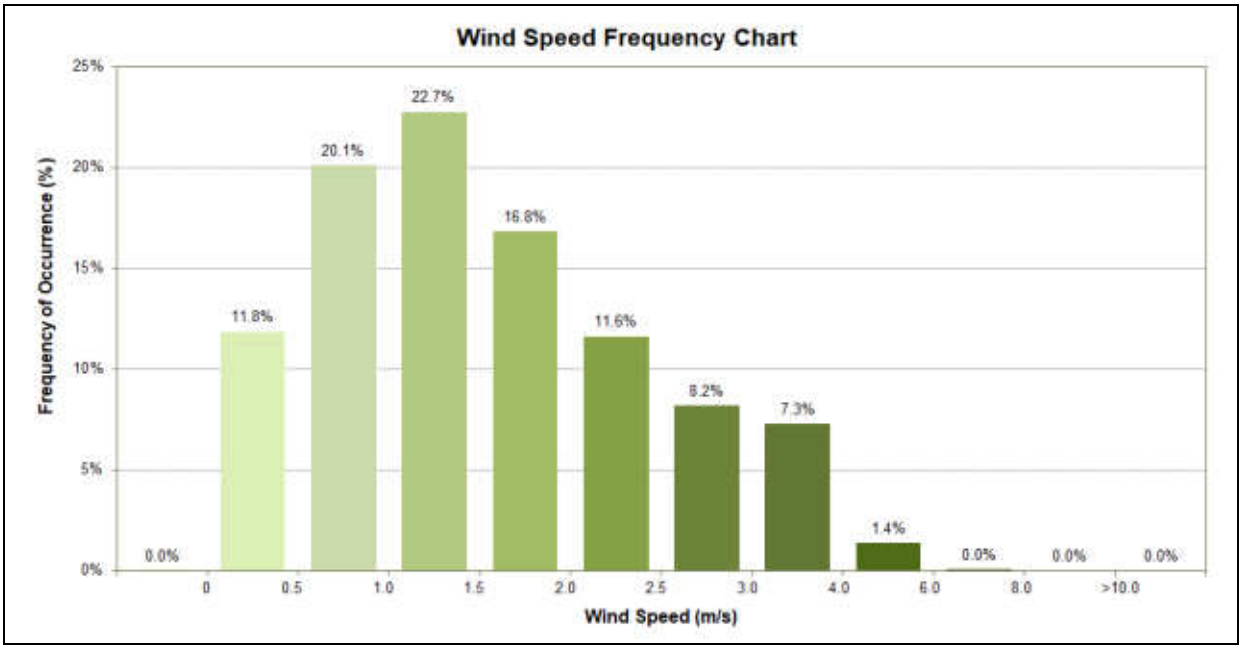
[3] Evesson, D T. 1983. "The Climate of the Purari River Basin." In The Purari — Tropical Environment of a High Rainfall River Basin, by T Petr. The Hague/Boston/Lancaster: Dr W. Junk Publishers.

[4] PCCSPP. 2011. Current and Future Climate of Papua New Guinea. Pacific Climate Change Science Program Partners.

[5] Refer to SLR Air Quality report 620.040581-R1-v1.0 for details.

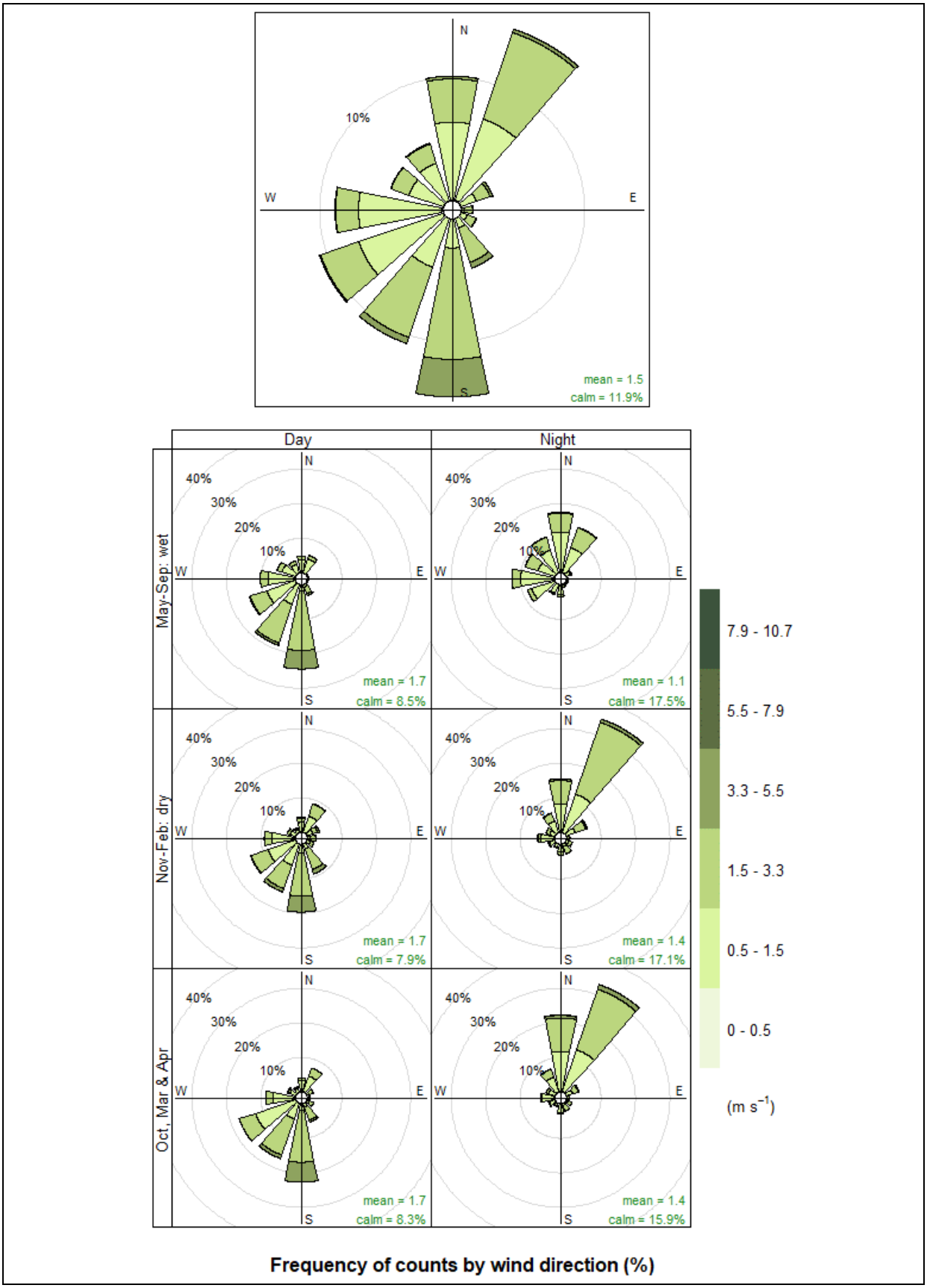
to moderate wind speeds, with a very low frequency of wind speeds above 5 m/s predicted during 2022.

Figure 4 Wind Speed Frequency Distributions for the CPF-P3 Site (CALMET) - 2022



Wind roses compiled from the predicted on-site wind data are shown in **Figure 5**. Presented in a circular format, wind roses show the frequency of winds blowing from particular directions over a specified period. The length of each 'spoke' around the circle is related to the frequency that the wind blows from a particular direction per unit time. Each spoke is also broken down into color-coded bands to show the frequency of specific wind speed ranges.

Figure 5 Wind Roses for the CPF-P3 Site (CALMET) - 2022



4.2.2 Atmospheric Stability

Atmospheric stability refers to the tendency of the atmosphere to resist or enhance vertical motion. The Pasquill assignment scheme identifies six Stability Classes, A to F, to categorize the degree of atmospheric stability as follows:

- A = Extremely unstable conditions.
- B = Moderately unstable conditions.
- C = Slightly unstable conditions.
- D = Neutral conditions.
- E = Slightly stable conditions.
- F = Moderately stable conditions.

The meteorological conditions defining each Pasquill stability class are shown in **Table 2**.

Table 2 Meteorological Conditions Defining Pasquill Stability Classes

Surface wind speed (m/s)	Daytime insolation [3]			Night-time conditions [2]	
	Strong [1]	Moderate	Slight [1]	Thin overcast or > 4/8 low cloud [4]	≤ 4/8 cloudiness
< 2	A	A - B	B	E	F
2 - 3	A - B	B	C	E	F
3 - 5	B	B - C	C	D	E
5 - 6	C	C - D	D	D	D
> 6	C	D	D	D	D

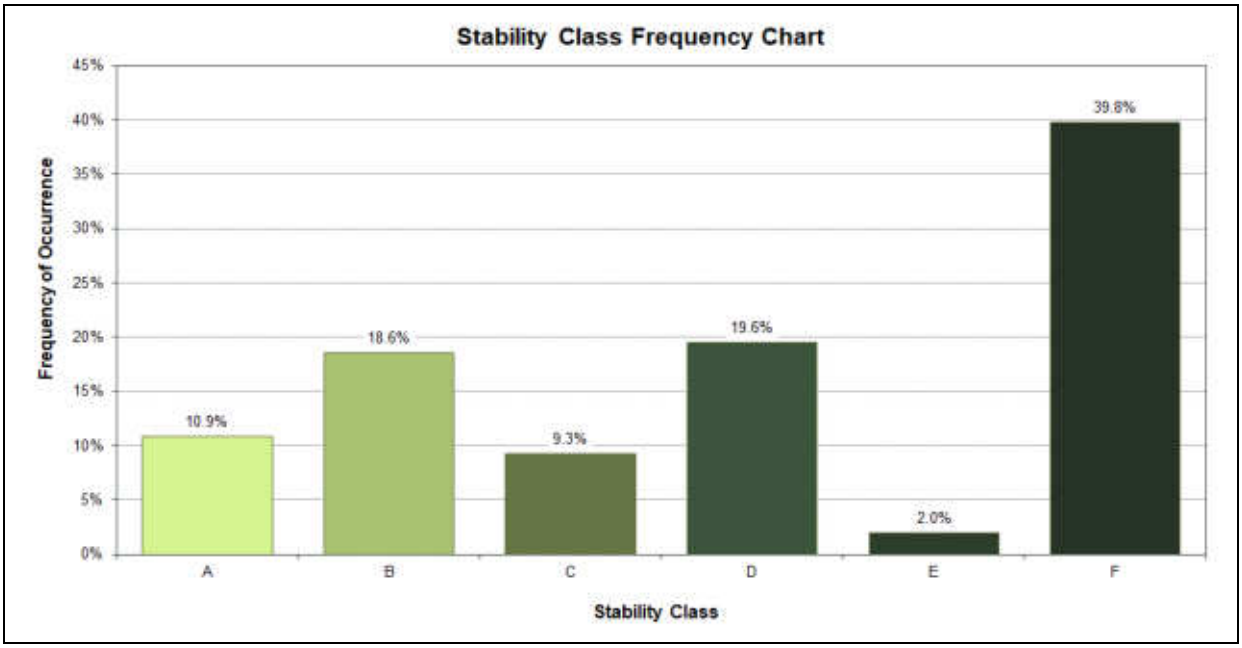
(Source: Pasquill, 1961)

Notes:

1. Strong insolation corresponds to midday on a sunny midsummer day; slight insolation corresponds to similar conditions in midwinter
2. Night refers to the period from 1 hour before sunset to 1 hour after sunrise
3. The neutral category D should also be used, regardless of wind speed, for overcast conditions during day or night and for any sky conditions during the hour preceding or following night as defined above
4. An 'okta' is a unit of measurement used to describe the amount of cloud cover at any given location. Sky conditions are estimated in terms of how many eighths of the sky are covered in cloud, ranging from 0 oktas (completely clear sky) through to 8 oktas (completely overcast). In addition, an extra cloud cover indicator of '9' can be used which indicates that the sky is totally obscured (i.e. hidden from view), usually due to dense fog or heavy snow

The frequencies of each stability class predicted to occur in the 2022 hourly datasets for the proposed CPF-P3 site are presented in **Figure 6**. The results indicate a relatively high frequency of stability class F conditions. Stability class F is indicative of very stable night-time conditions (i.e. low winds), leading to a low level of mechanical mixing and poor dispersion.

Figure 6 Stability Class Frequency Distributions for the CPF Site - 2022



4.2.3 Noise Modelling Meteorological Assumptions

Based on the analysis of available meteorological data described above, both 'neutral' and 'enhanced' (worst-case) meteorological conditions have been modelled.

Both neutral and enhanced noise modelling parameters adopted for the CPF-P3 area are shown in **Table 3**.

Table 3: Neutral (Calm) and Enhanced (worst-case) noise modelling meteorological parameters

Season	Air Temp.	Relative Humidity	Barometric Pressure	Wind Velocity	Atmospheric Stability Class
"Neutral" normal noise propagation	25°C	90%	1013 mBar	0 m/s	D
"Enhanced" worst-case noise propagation	25°C	90%	1013 mBar	2 m/s (worst-case in the direction source to receptor)	F

4.3 Topography

The topography of the study area has the potential to impact on the noise levels from the Project. Local hills will provide screening to the noise at some receptors reducing the noise, whilst valleys will provide a direct path for noise propagation.

Mountains, hills and levee plains characterise PRL-15. The northern two-thirds of PRL-15 comprises southeast to northwest trending ridges and folded terrain of the lower Eastern Highlands, up to approximately 450 m above sea level (asl) in places, and with Crater Mountain located to the north. The existing wellpads from previous appraisal drilling are primarily located on steep ridges, some up to 250 m asl. Terrain in the southwestern portion of PRL-15 lowers to the plains of the Purari River basin that are typically subject to frequent inundation from overbank river flows during the wet season.

The proposed CPF-P3 site is located on the flood plain of the Purari River bounded to the south by the Purari River main tributary and to the east by the tributary Kuku Creek. Oyomo Creek lies to the west and southwest, with its minor tributaries running through the CPF site itself. The generally flat swampy terrain of the site has a maximum elevation of about 50 m asl but is more generally below this elevation. The site is prone to inundation from the Purari River.

From the north, the export pipeline corridor traverses extensive ranges of asymmetrical mountains and hills, which descend into alluvial plains and composite levee plains, coastal mangroves and finally beach ridges and beach plains.

4.4 Land Use

PRL-15 is largely unsettled but owned and used by the Pawaian people, who reside in villages along the Purari River. Most of these villages are outside of but near to PRL-15 except for two small villages (Poroi 1 and Ne'ea Creek) and the newly identified Pokore Hamlet receptor that are located on the Purari River within the southern part of the licence area. Aside from subsistence livelihood activities from the Pawaian people, the main anthropogenic activities in or near PRL-15 relate to logging (south of the Purari River), recent and ongoing gas exploration activities, including the main operations camp at Herd Base, temporary camps at Antelope-3 Operations Camp and Hou Creek Base (both now demobilised), and activities and disturbances relating to wellpads, access roads, and helipads.

The inland section of the export pipeline corridor is largely unpopulated; however it has been modified by large-scale industrial logging. Near to and along the coast, the number and size of villages, and hence population density, increases. Anthropogenic activities include clearing of forest for settlements, subsistence agriculture (food gardens, sago planting, hunting, and fishing) and historical clearing for coconut plantations.

Along the Purari riverways, villages are predominately located on or in the vicinity of the upper reaches of the tidal influence where there is likely to be a greater availability of resources. In addition to subsistence agriculture activities, logging and Project-commissioned barges transporting supplies and equipment to the base, regularly travel along the Purari channels.

PRL-15 and the surrounding areas are densely forested by tropical forest. Limited clearing has been performed by the local population for subsistence farming and construction of dwellings and small villages. Sago cultivation is the principal staple in the lowland areas, with production restricted to the river zones (e.g. Purari River and its tributaries). Sago is supplemented by other garden crops such as banana, kaukau and greens. There was previous extensive commercial logging in parts of the Purari River catchment. Currently, there is growing oil and gas exploration activity, which provides employment for local people.

Along the export pipeline corridor, remote inland communities rely almost entirely on native flora and fauna for their livelihoods and wellbeing. Coconuts and sago are the most important food staples. These are supplemented by hunting and trapping of wild animals and birds, and fishing in rivers and creeks. Transport is limited to waterways and established tracks.

In coastal villages, the main staple food is sago harvested from sago palms that have mostly been planted along the banks of creeks or in swampy areas or alluvial plains. Coconuts are also an important staple and nypa palm nuts are harvested as a food resource on a seasonal basis. Fishing occurs in the sago swamps, creeks, mangroves and the sea.

5.0 Regulatory Framework and Assessment Criteria

5.1 Environmental Values

For the purposes of this assessment, an environmental value is defined as a quality or physical characteristic of the environment that is important to human health. Based on this definition, the environmental values related to noise are:

- Human health and wellbeing, including a suitable acoustic environment for individuals to sleep, study or learn, or be involved in recreation, including relaxation and conversation.
- Amenity of the community and the enjoyment of the ambient environment.

5.2 PNG Environment Act No. 64 of 2000

In February 2014, the PNG Parliament passed an Act to set up a new Conservation and Environment Protection Authority (CEPA). CEPA has replaced the Department of Environment and Conservation (DEC) as the government agency responsible for administering the Environment Act 2000.

The Environment Act 2000 (Environment Act) is the primary legislation in PNG that regulates the environmental impact of development activities and how adverse effects of such activities should be avoided, remedied or mitigated. The Environment Act caters for the sustainable management of the biological and physical components of the land, air and water resources of the country.

Section 133 'Regulations' of the Act contains general guidance regarding the enforcement of environmental noise as reproduced below:

> *(1) The Head of State, acting on advice, may make Regulations not inconsistent with this Act, prescribing all matters that by this Act are required or permitted to be prescribed or that are necessary or convenient to be prescribed for carrying out or gaining effect to this Act, and in particular for prescribing penalties of fines not exceeding K100,000.00 or imprisonment for a term not exceeding two years for offences against the Regulations […].*
>
> *(3) Without limiting the generality of Subsection (1), but subject to this Act, the Regulations may prescribe in relation to noise –*
>
> *a) Standards or levels for emission of various types of noise and the procedure by which they are to be tested or ascertained; and*
>
> *b) Prohibiting the use of any equipment, facility, instrument, device, vehicle or ship capable of emitting noise that does not meet a prescribed standard, and regulating the construction, installation or operation of any of them so as to prevent or minimize the emission of noise; and*
>
> *c) Providing for the delegation of power to Provincial Governments and Local-level Governments to make laws or rules consistent with this Act, to deal with noise in their respective areas; and;*
>
> *d) Making provision for officers of other governmental authorities including Provincial Governments and Local-level Governments, to enforce provisions of this Act in relation to noise; and*
>
> *e) The circumstances in which emission of noise amounts to unreasonable noise under this Act; and;*
>
> *f) Issue of noise abatement notices; and*

g) Offences in relation to noise emission.

While the emission of unreasonable noise is deemed an enforceable offence in accordance with the Act, it is noted that it does not include or nominate any specific criteria or methodology outlining how environmental noise should be measured or assessed. In particular, there are no specific local requirements stated in the Act (or in related Regulations or Guidelines) with regard to the undertaking of a baseline noise survey other than to limit the general environmental impact of a development.

5.3 International Standards and Guidelines

In the absence of statutory criteria or limits for noise (and vibration), a review of relevant guidelines on environmental noise and the effects of potentially excessive noise has been performed to identify criteria for the assessment and management of noise impacts from the Project.

The following international documents provide indicative guidelines relevant to the noise study. The guidelines were developed with consideration to previous studies on environmental noise and analysis of community reaction to various levels of noise.

- World Health Organization (WHO) Guidelines for Community Noise (WHO, 1999).
- International Finance Corporation (IFC) World Bank Group Environmental, Health and Safety (EHS) Guidelines: General EHS Guidelines: Environmental (General EHS Guidelines). Section 1.7 Noise (IFC, 2007a).

5.3.1 WHO Guidelines for Community Noise

The World Health Organisation (WHO) Guidelines for Community Noise 1999 have been prepared as a practical response to the need for action on community noise at the local level, as well as the need for improved legislation, management and guidance at the national and regional levels.

WHO Day Period Noise Level Recommendation

WHO recommends day period noise levels on balconies, terraces and in outdoor living areas as follows:

- 55 dBA L_{Aeq} to protect the majority of people from being seriously annoyed.
- 50 dBA L_{Aeq} to protect the majority of people from being moderately annoyed.

In addition, the Guidelines nominate an internal noise level inside dwellings of 35 dBA L_{Aeq} for the purpose of allowing the understanding of complicated messages (at school, foreign languages, telephone conversation) with a voice level of 50 dBA.

WHO Night Period Noise Level Recommendation to Protect Against Sleep Disturbance

The WHO Guidelines generally prescribe two (2) noise levels at indoor residential locations to ensure that sleep is not adversely affected, with these being:

- Up to 30 dBA L_{Aeq} for continuous noise.
- Up to 45 dBA L_{Amax} for single events.

According to WHO, at night-time, outside sound levels about 1 metre from facades of living spaces should not exceed 45 dBA L_{Aeq} and 60 dBA L_{Amax}, so that people may sleep with minimal interruption. This value assumes that the noise reduction from outside to inside is 15 dBA, which may not be applicable to all types of building construction at the identified NSRs.

5.3.2 IFC / World Bank Group Noise Management Guidelines

Section 1.7 of the IFC/World Bank Group General EHS Guidelines, referred hereafter as the 'EHS Guidelines for Noise', prescribe noise levels for the day and night period as follows:

> *Noise impacts should not exceed the levels presented in Table 1.7.1 or result in a maximum increase in background levels of 3 dB at the nearest receptor location off-site.*

Table 1.7.1 Noise Level Guidelines

Receptor	One Hour LAeq (dBA)	
	Day (0700-2200)	Night (2200-0700)
Residential / Institutional /educational	55	45
Industrial / Commercial	70	70

The above guidelines are commonly applied as design standards for industrial facilities, and whilst they relate to threshold of noise effects in a general sense, the IFC has indicated that they are not directly applicable to transport or mobile noise sources. In addition to the numerical goals presented indicated above, the IFC Guidelines for noise require emissions to not exceed the existing (pre-project) background noise levels by a margin of 3 dBA.

To quantify the existing background noise levels a standard approach is to undertake a baseline noise monitoring survey in the area of the Project, as described in the Monitoring Section of the EHS Guidelines for Noise.

5.4 Noise Assessment Criteria

5.4.1 Operational Noise Assessment Criteria

The noise assessment criteria detailed in **Table 4** for the operation of the CPF has been derived from the abovementioned Guidelines for the long-term management of noise.

Adopting the requirements of the IFC Guidelines, three (3) sets of criteria can be established for the operational noise emission:

- **'IFC background + 3dBA'** noise criteria - The noise criteria are defined from the existing ambient noise in the absence of the gas development. Depending on the existing urbanisation and other activity from the natural environment (e.g. insect noise at night) it may be greater or lower than the IFC Guideline criteria.

  The background +3dBA criteria are defined from the IFC Guidelines which are designed to manage the potential increase in environmental noise with the introduction of new sources of noise. Background noise levels from previous studies were used to provide a range of indicative background +3 dBA criteria in **Table 4** in the absence of current long-term monitoring data captured at the closest CPF-P3 receptors. As the table shows, the criteria can have wide variation depending on the location of the monitoring. Therefore, the criteria are provided for information purposes only and are to be confirmed via noise monitoring at the nearest sensitive receptors to the CPF site. On this basis, the IFC background + 3dBA criteria has not been applied to this assessment.

- **'IFC Guideline criteria'** - These are fixed levels independent of the existing ambient noise levels in the absence, ie independent of the industrial noise.

- **'Maximum noise criteria'** - The WHO L_{AFmax} criteria are utilised to assess the loudest noise emissions, noting that as most of the noise emission from the Project is expected to be constant noise from fixed plant. Given the constant noise nature of

the industrial site, compliance with the strictest IFC Guideline $L_{Aeq(1hour)}$ criteria externally is expected to result in compliance with the WHO internal L_{AFmax} criteria.

Table 4: Summary of Noise Policy Levels

Receptor type	Time period	Criteria for continuous noise	
		IFC background + 3dBA (indicative) criteria	IFC Guideline criteria
Residential, institutional and educational	Day (0700-2200)	$L_{Aeq(1hour)}$ 38-46 dBA	$L_{Aeq(1hour)}$ 55 dBA
	Night-time (2200-0700)	$L_{Aeq(1hour)}$ 37-59 dBA	$L_{Aeq(1hour)}$ 45 dBA
Commercial/ industrial	At any time	$L_{Aeq(1hour)}$ 70 dBA (fixed limit)	$L_{Aeq(1hour)}$ 70 dBA
Receptor type	**Time period**	**Criteria for intermittent noise**	
		WHO guideline	
Residential	Night-time (2200-0700)	L_{AFmax} 60 dBA	

In the absence of current noise monitoring data to confirm the CPF-P3 specific IFC background + 3dBA criteria at NSRs, the IFC Guideline Criteria has been applied as follows:

- Day (0700-2200) noise limit: 55 dBA $L_{Aeq(1hour)}$.
- Night-time (2200-0700) noise limit: 45 dBA $L_{Aeq(1hour)}$.

Given the noise emission of the plant will remain largely constant, compliance with the night time limit would result in compliance with the daytime limit by default.

5.4.2 Construction Noise Assessment

Construction of the Project may extend a number of years and the noise levels emitted can be expected to be comparable to the operational noise emissions. Therefore, an assessment of construction noise is considered warranted.

For the purpose of this assessment, the operational noise criteria have also been applied to the assessment of construction noise.

6.0 Noise Modelling

The following sections present the noise prediction methodology, the investigated modelling scenarios and the modelling results.

6.1 Noise Model Details

A SoundPLAN (Version 8.2) noise model was developed to predict noise levels at the identified NSRs. SoundPLAN is a software package enabling calculation of environmental noise by combining a digitised ground map (topography), the location and acoustic sound power levels of potentially critical noise sources on site, and the location of NSRs for assessment purposes.

The software was used to predict the noise levels resulting from the Project noise emission alone, i.e. the results exclude the noise levels currently experienced at the receptors.

The model calculates noise levels considering factors such as the sound power levels and locations of noise sources, distance attenuation, ground absorption, air absorption, shielding attenuation due to building structures and topographic features, as well as meteorological conditions, including wind effects.

The noise model was developed based on an engineering design by Saipem-Tripatra-Daewoo E&C (noise report 870330-PTS-SAF-STU-200045 – *Papua LNG Upstream Project*, dated 20 October 2023). The noise sources detailed in the report have been applied in the noise model at the CPF-P3 site to predict the noise levels at the NSRs relevant to this new site location.

Large building structures were included in the model for completeness, such as tanks and other future buildings.

NSRs and NRs identified in **Table 1** were modelled as point receptors at 1.8 m above the ground.

Noise contour maps were calculated from a noise grid of calculated noise levels at 30 m intervals, at 1.8 m above the ground.

6.2 Noise Modelling Standard

The Conservation of Clean Air and Water Europe (CONCAWE 1981) prediction methodology was utilised within SoundPLAN. The CONCAWE prediction method is specifically designed for large industrial facilities and incorporates the influence of wind effects and the stability of the atmosphere and was selected due to the ability to model meteorological effects on noise propagation over large distances.

The CONCAWE method is a research paper especially designed and originally developed for the requirements of large facilities, specifically petrochemical complexes, in Europe. It was published in 1981 under the title, ‘The propagation of noise from petroleum and petrochemical complexes to neighbouring communities’.

The statistical accuracy of environmental noise predictions using CONCAWE was investigated by Marsh (Applied Acoustics 15 – 1982). Marsh concluded that CONCAWE was accurate to ±2 dBA in any one octave band between 63 hertz (Hz) and 4 kHz and ±1 dBA overall.

Noise levels for the Project have been calculated using CONCAWE for both neutral and adverse weather (i.e., enhanced propagation) conditions. The parameters used to assess the weather effects are discussed in **Section 4.1**.

6.3 Digital Elevation Model

A 3D Digital Elevation Model (DEM) model was built from a digital survey of existing terrain contours covering the closest NSR locations, and a detailed civil works model of the Project provided by Total Energies.

6.4 Ground Absorption

Ground absorption coefficients for different ground surfaces utilised within the noise model are defined below:

- For all the Plant trafficable areas, for pad mounted equipment or compacted earth and Purari River, a ‘hard surface’ sound absorption coefficient of 0 dB has been used.
- For all other receptor areas, a volume attenuation area has been applied to represent the foliage encountered in the PNG highlands. A dense vegetation forest with canopies averaging 5.0 m tall has been assumed. The default attenuation spectrum per metre of foliage defined in ISO 9613-2:1996 *Attenuation of sound during propagation outdoors — Part 2: General method of calculation* has been applied in the absence of a foliage attenuation definition in CONCAWE.

6.5 Modelled Operational Scenarios and Source Emissions

The construction and operation of the Project will incorporate a large number of processes, activities and equipment which produce noise emissions. The following scenarios were modelled and assessed against the day time and night time limits.

- **Construction Scenario (CS1).** This scenario represents early works, such as site clearing, excavation and concreting.
- **Construction Scenario (CS2).** This scenario represent late construction works involving the erection of structures.

  Based on the previous CPF Noise report, a noise emission database was previously developed for CS1 and CS2 upon review of the following documents:

  - Project Ref.: EP/DSO/ONS/EDI-PNG/ENOC01902-EGI-030-RT-001 "Earthworks Management Plan".
  - Project Ref.: EP/DSO/ONS/EDI-PNG/PJM-800437 Preliminary-Constructability-Report_Draft.pdf “Preliminary Upstream Constructability Study”.
  - Project Ref.: EP/DSO/ED/EDI-PNG/CIV-800235 "Pipelines Routing and Constructability Assessment Study PHASE 1”.
  - Project Ref.: EP/DSO/ED/EDI-PNG/CIV-800302 “Papua LNG Pre-Project Civil Engineering Study”.
  - SLR Memorandum 01215B_M057_20190219_v1 TOTAL2.pdf "PAPUA LNG/EIS ASSUMPTIONS FOR NOISE IMPACT STUDY”, latest version/edits dated 08/03/2019.

  Further equipment usage assumptions were made (% use per hour indicated in **Table A-1** and **Table A-2** in **Appendix A**) and implemented in the noise model as source-specific time histograms.

  It is acknowledged that the final construction equipment selection may differ from the construction noise source database presented in this report. Nevertheless, the



construction noise source database is considered representative of typical plant and equipment which will be required during the construction of the industrial area.

- **Operational Scenario 1 (OS1)**. This Scenario comprises the normal every day operation of the Project. The noise model was based on the noise emissions stated in the following report:
  - Saipem-Tripatra-Daewoo E&C report 870330-PTS-SAF-STU-200045 – Papua LNG Upstream Project, dated 20 October 2023. The operational noise emissions were relocated to the new CPF-P3 site.
- **Operational Scenario 2 (OS2) and Scenario 3 (OS3).** Abnormal case, facility blowdown (i.e. flaring). The flare noise emission was modelled for location options '2a' and '3a', for both OS2 and OS3. The flare noise emissions stated in **Table 5** were calculated using the formulae from the following standard:
  - German standard VDI 3732 – *Standard noise levels of technical sound sources – Flares*, 1999.

  The flares were modelled at 125 m above the ground relative to the ground elevation at '2a' and '3a', as omnidirectional noise sources. To determine the noise emission form other plant operating at the time of flaring, the following first principle formulae was used to determine the reduced noise emission of all plant, as equivalent to operating a reduced number of operating plant:

$$Reduced\ capacity\ correction = 10 * \log\left(\frac{\%\ reduced\ Capacity}{100\ \%\ Normal\ Capacity}\right)$$

  For 35% of the plant running at the time of flaring, as indicated in in **Table 5**, the correction applied to the noise prediction at 100% capacity is calculated as follows:

$$Reduced\ capacity\ correction = 10 * \log\left(\frac{35\ \%}{100\ \%}\right) = -4.6\ dB$$

Table 5: Operational scenario flare noise emission levels

Operational Scenario	Description	Frequency	Flare gas flow, tonnes/hr	Flare noise emission, (Sound power in dBA)
OS1	Normal operation	24 hours, 7 days a week when not flaring	0	0
OS2	35% turndown with gas production flared	1-2 times per year for 4-6 hours	357.8 High pressure Flare	155.4 dBA
OS3	35% turndown with acid gas compressor off-line	1-2 times per year for maximum 24 hours	357.8 High Pressure Flare 91.8 Assisted Gas Flare	157.1 dBA
Elevated flare type has been assumed for the VDI 3732 calculation. Elevated flares are generally used in an emergency operation scenario as safety devices to burn large quantities of gas, up to 1,000 tonnes/hr (tonnes per hour). Ground flares are used during a normal operation scenario for burning quantities of gas up to 100 tonnes/hr. OS3 HP and AG flare assumed to combine gas flows in the same flare.				

The plant and equipment noise emission database associated with the modelled construction and operational scenarios listed above is presented in **Appendix A**.

7.0 Noise Assessment

7.1 Construction Noise Predictions

Noise predictions have been conducted for construction scenarios CS1 and CS2.

Results for neutral and enhanced noise propagation are presented in **Table 6** and **Table 7** (noise contour maps for all the assessed scenarios are provided in **Appendix B**). The noise predictions have been assessed in the tables against the daytime and night time noise limits, assuming 24 hour construction.

Table 6: CS1 predicted construction noise levels at NSRs, $L_{Aeq(1hr)}$ in dBA

ID	Detail	Neutral propagation			Enhanced propagation		
		Noise level, dBA	Meets 55 dBA daytime limit	Meets 45 dBA night limit	Noise level, dBA	Meets 55 dBA daytime limit	Meets 45 dBA night limit
NSR1	Poroi 1	22	Yes	Yes	27	Yes	Yes
NSR2	Ne'ea Creek	14	Yes	Yes	18	Yes	Yes
NSR3	Pokore Hamlet	48	Yes	**No**	53	Yes	**No**
NSR4	Purari Airstrip House	24	Yes	Yes	28	Yes	Yes
NR1	Herd Base	33	Yes	Yes	38	Yes	Yes
NR2	Papua LNG Operations Camp	24	Yes	Yes	29	Yes	Yes

Table 7: CS2 predicted construction noise levels at NSRs, $L_{Aeq(1hr)}$ in dBA

ID	Detail	Neutral propagation			Enhanced propagation		
		Noise level, dBA	Meets 55 dBA daytime limit	Meets 45 dBA night limit	Noise level, dBA	Meets 55 dBA daytime limit	Meets 45 dBA night limit
NSR1	Poroi 1	19	Yes	Yes	24	Yes	Yes
NSR2	Ne'ea Creek	5	Yes	Yes	9	Yes	Yes
NSR3	Pokore Hamlet	45	Yes	Yes	50	Yes	**No**
NSR4	Purari Airstrip House	19	Yes	Yes	24	Yes	Yes
NR1	Herd Base	33	Yes	Yes	39	Yes	Yes
NR2	Papua LNG Operations Camp	23	Yes	Yes	29	Yes	Yes

7.2 Operational Noise Predictions

Noise predictions have been conducted for operational scenarios OS1 and OS2.

Results for neutral and enhanced noise propagation are presented in **Table 8** to **Table 12** (noise contour maps for all the assessed scenarios are provided in **Appendix B**). The noise predictions have been assessed in the tables against the daytime and night time noise limits, assuming 24 hour operations.

The OS2 noise levels shown in the tables are for the total noise contribution from the flare (dominant noise) and the additional plant operating at reduced capacity during emergency turndown, as detailed in **Table 5**.

As shown in the tables, the OS2 noise levels exceed the limits at the NSRs. In the case of NSR3, further analysis of results showed that in the absence of the flare, noise emissions from the other plant operating at reduced numbers/capacity would still exceed the night time noise limit by 2 dBA and 6 dBA during neutral and enhanced noise propagation respectively.

Table 8: OS1 predicted operational noise levels at NSRs, $L_{Aeq(1hr)}$ in dBA

ID	Detail	Neutral propagation			Enhanced propagation		
		$L_{Aeq(1hr)}$, dBA	Meets 55 dBA daytime limit	Meets 45 dBA night limit	$L_{Aeq(1hr)}$, dBA	Meets 55 dBA daytime limit	Meets 45 dBA night limit
NSR1	Poroi 1	25	Yes	Yes	30	Yes	Yes
NSR2	Ne'ea Creek	17	Yes	Yes	21	Yes	Yes
NSR3	Pokore Hamlet	52	Yes	No	56	No	No
NSR4	Purari Airstrip House	25	Yes	Yes	30	Yes	Yes
NR1	Herd Base	37	Yes	Yes	41	Yes	Yes
NR2	Papua LNG Operations Camp	30	Yes	Yes	33	Yes	Yes

Table 9: OS2 (2a) predicted operational noise levels at NSRs, $L_{Aeq(1hr)}$ in dBA

ID	Detail	Neutral propagation			Enhanced propagation		
		$L_{Aeq(1hr)}$, dBA	Meets 55 dBA daytime limit	Meets 45 dBA night limit	$L_{Aeq(1hr)}$, dBA	Meets 55 dBA daytime limit	Meets 45 dBA night limit
NSR1	Poroi 1	57	No	No	60	No	No
NSR2	Ne'ea Creek	39	Yes	Yes	42	Yes	Yes
NSR3	Pokore Hamlet	79	No	No	81	No	No
NSR4	Purari Airstrip House	53	Yes	No	56	No	No
NR1	Herd Base	78	No	No	77	No	No
NR2	Papua LNG Operations Camp	77	No	No	77	No	No

Table 10: OS2 (3a) predicted operational noise levels at NSRs, $L_{Aeq(1hr)}$ in dBA

ID	Detail	Neutral propagation			Enhanced propagation		
		$L_{Aeq(1hr)}$, dBA	Meets 55 dBA daytime limit	Meets 45 dBA night limit	$L_{Aeq(1hr)}$, dBA	Meets 55 dBA daytime limit	Meets 45 dBA night limit
NSR1	Poroi 1	55	No	No	58	No	No
NSR2	Ne'ea Creek	38	Yes	Yes	41	Yes	Yes
NSR3	Pokore Hamlet	79	No	No	79	No	No
NSR4	Purari Airstrip House	51	Yes	No	54	Yes	No
NR1	Herd Base	67	No	No	67	No	No
NR2	Papua LNG Operations Camp	78	No	No	78	No	No

Table 11: OS3 (2a) predicted operational noise levels at NSRs, $L_{Aeq(1hr)}$ in dBA

NSR	Detail	Neutral propagation			Enhanced propagation		
		$L_{Aeq(1hr)}$, dBA	Meets 55 dBA daytime limit	Meets 45 dBA night limit	$L_{Aeq(1hr)}$, dBA	Meets 55 dBA daytime limit	Meets 45 dBA night limit
NSR1	Poroi 1	59	No	No	62	No	No
NSR2	Ne'ea Creek	41	Yes	Yes	44	Yes	Yes
NSR3	Pokore Hamlet	81	No	No	82	No	No
NSR4	Purari Airstrip House	54	Yes	No	57	No	No
NR1	Herd Base	79	No	No	79	No	No
NR2	Papua LNG Operations Camp	78	No	No	78	No	No

Table 12: OS3 (3a) predicted operational noise levels at NSRs, $L_{Aeq(1hr)}$ in dBA

NSR	Detail	Neutral propagation			Enhanced propagation		
		$L_{Aeq(1hr)}$, dBA	Meets 55 dBA daytime limit	Meets 45 dBA night limit	$L_{Aeq(1hr)}$, dBA	Meets 55 dBA daytime limit	Meets 45 dBA night limit
NSR1	Poroi 1	57	No	No	60	No	No
NSR2	Ne'ea Creek	40	Yes	Yes	43	Yes	Yes
NSR3	Pokore Hamlet	81	No	No	81	No	No
NSR4	Purari Airstrip House	52	Yes	No	56	No	No
NR1	Herd Base	69	No	No	69	No	No
NR2	Papua LNG Operations Camp	80	No	No	80	No	No

8.0 Discussion and recommendations

8.1 Noise Assessment Summary

Following the noise predictions at NSR external to the Project and Project involved NR, the outputs of the noise model are summarised in the following subsections.

8.1.1 Construction noise emissions

The CS1 noise emissions during the daytime are predicted to meet the 55 dBA L_{Aeq} noise limit. The worst case noise prediction of 53 dBA L_{Aeq} at NSR3 indicates a minimum 2 dBA margin of predicted compliance. In theoretical terms, this would permit a 60% increase in the number of plant (like-for-like), compared to the plant items assumed for CS1.

Similarly, the CS2 noise emissions during the daytime are predicted to meet the 55 dBA L_{Aeq} noise limit. The worst case noise prediction of 50 dBA at NSR3 indicates a minimum 5 dBA margin of predicted compliance. Again, in theoretical terms, this would permit a three-fold increase in the number of plant (like-for-like), compared to the plant items assumed for CS2.

Notwithstanding the above, noise mitigation measures should be considered to manage the construction noise emissions, particularly during the times of day when the NSR dwellings are expected to be occupied, i.e. during the early morning and evenings.

The night time 45 dBA L_{Aeq} noise limit during CS1 is predicted to be exceeded at NSR3 by 3 dBA and 8 dBA, during neutral and enhanced noise propagation respectively.

The CS2 noise prediction shows a predicted exceedance of 5 dBA at NSR3 during enhanced propagation only. During neutral noise propagation, the predicted noise level is 45 dBA L_{Aeq}, therefore compliance with the 45 dBA L_{Aeq} noise limit is marginal.

The night time construction noise predictions exceeding the 45 dBA L_{Aeq} noise limit during both CS1 and CS2 would warrant mandatory noise mitigation and management to achieve compliance at NSR3.

It is noted that the predicted CS1 and CS2 noise levels meet both the daytime and night time noise limits at all other sensitive and Project involved noise receptors with adequate margin.

8.1.2 Operational noise emissions

Normal operation (OS1)

The normal operational noise emissions represented by OS1 is predicted to meet the 55 dBA L_{Aeq} day time noise limit at NSR3 during normal noise propagation with a 3 dBA margin, but marginally exceeds the daytime limit by 1 dBA during enhanced noise propagation conditions.

The marginal day time exceedance would be considered imperceptible and therefore are not acoustically material, as changes in noise levels of 1 or 2 dBA are imperceptible to the human ear (or expressed differently, a noise level of 55 dBA would be perceived the same as a noise level of 56 dBA.

The night time noise limit is predicted to be exceeded by 7 dBA and 11 dBA during neutral and enhanced noise propagation conditions, respectively.

With consideration of the predicted daytime and night time noise exceedances, noise mitigation is considered warranted.

Abnormal operation (flaring) (OS2)

During flaring, the noise emission from the flare is the dominant noise source. The operation of the remaining plant at normal or reduced capacity would be of no significance considering the calculated noise emission of the flare for the stated gas flows.

As noted previously, in the absence of the flare, noise emissions from the other plant operating at reduced numbers/capacity would still exceed the night time noise limit by 2 dBA and 6 dBA at NSR3 during neutral and enhanced noise propagation respectively. Therefore, the reduced operation of the plant would also require noise mitigation to meet the noise limit.

The above statements are irrespective of the chosen flare location option.

During the daytime:

- The OS2 noise emission exceeds the daytime noise limit at NSRs by up to 26 dBA and 24 dBA L_{Aeq} for location options 2a and 3a, respectively, under enhanced propagation.
- The OS3 noise emission exceeds the daytime noise limit at NSRs by up to 27 dBA and 26 dBA L_{Aeq} for location options 2a and 3a, respectively, under enhanced propagation.

During the night time:

- The OS2 noise emission exceeds the daytime noise limit at NSRs by up to 36 dBA and 34 dBA L_{Aeq} for location options 2a and 3a, respectively, under enhanced propagation.
- The OS3 noise emission exceeds the daytime noise limit at NSRs by up to 37 dBA and 34 dBA L_{Aeq} for location options 2a and 3a, respectively, under enhanced propagation.

8.2 Recommendations

Following the assessment presented in the sections above, this sections presents recommendations to manage the project noise emissions.

8.2.1 Baseline Noise Monitoring

In the absence of current noise monitoring data to confirm the CPF-P3 specific IFC background + 3dBA criteria at NSRs, the IFC Guideline Criteria was adopted as follows:

- Day (0700-2200) noise limit: 55 dBA $L_{Aeq(1hour)}$.
- Night-time (2200-0700) noise limit: 45 dBA $L_{Aeq(1hour)}$.

The above criteria are guideline values based on fixed limits and does not consider the existing ambient noise levels at the NSRs. Noise monitoring may be conducted to further inform the assessment of noise impacts and associated noise controls at the closest receptors:

- If the IFC background + 3dBA noise criteria levels are lower than the IFC Guideline Criteria at the closest receptors, additional noise controls may be required. Given the low noise predictions of 17-30 dBA at NR1, NR2 and NR4, it is not likely that additional noise controls will be required.

  The exception to this may be at NSR3 where operational noise levels are predicted to exceed the 45 dBA IFC Guideline Criteria during normal operation (OS1).

- Where the ‘IFC background + 3dBA’ noise criteria levels are higher than the ‘IFC Guideline Criteria’, the ‘IFC Guideline Criteria’ as presented in this report would be



applied conservatively. However, the noise controls required to mitigate noise impacts at NSR3 may be rationalised pending assessment of the existing impacts.

8.2.2 Construction Noise Management

As indicated in **Section 8.1.1**, the CS1 and CS2 noise emissions were predicted to meet the 55 dBA L_{Aeq} daytime noise limit at NSR3 with a 2 dBA and 0 dBA margin of predicted compliance, respectively (under enhanced noise propagation).

At night, the 45 dBA L_{Aeq} noise limit was predicted to be exceeded at NSR3 by up to 3 dBA and 8 dBA under neutral and enhanced noise propagation, respectively. This is considered manageable to compliant levels via the implementation of reasonable and feasible measures.

The following is recommended during construction planning:

- Confirm the plant list to be used during construction and confirm the total noise emission. Where the total noise emission (assuming all plant is used simultaneously) does not exceed 128 dBA sound power level including tonal corrections, no further mitigation measures are predicted to be required to meet the 55 dBA daytime noise limit.

Notwithstanding the compliance, given the daytime noise limit extends from 7:00 am to 10:00 pm (which includes the more sensitive evening hours), it will be good practise to implement noise mitigation to reduce the noise emissions and resulting impact at receptors. Noise mitigation required to be introduced to meet the night time noise limit would be suitable during the daytime.

A Noise and Vibration Management Procedure (NVMP) has been developed to avoid and minimise potential adverse impacts on sensitive receptors from noise and vibration. It is recommended that subsequent reviews of the NVMP consider the planning of the construction works to occur during the day (7:00 am to 10:00 pm) period only and with consideration of the following recommended general good practise measures:

- Whilst construction is typically conducted on shifts between 6:00 am and 6:00 pm, plan the loudest noise emitting activities to occur within 7:00 am to 5:00 pm, ie. outside the night time / early morning period, and outside the 6:00 pm to 10:00 pm evening period, where possible.
- Conduct works between Monday to Friday and avoid Sundays and outside public holidays.
- Follow guidance from accepted standards, such as Australian Standard AS2436-2010 - *Guide to Noise Control on Construction, Maintenance and Demolition Sites* and BS 5228-1:2009 - *Code of Practice for noise and vibration control on construction and open sites, Part 1: Noise*.
- Use of lowest possible noise emitting plant and equipment that can economically and efficiently undertake the work should be selected, wherever possible and implementation of a maintenance programme to keep these in good working order and operating at the lowest feasible noise level.
- Limit the number of equipment used concurrently at any given time, where practical.
- Locate generators (if required) and other ‘fixed’ sources as far as practical from adjacent receptors. Procure ‘low noise’ generators and other plant.
- Introduce temporary localised noise screening. Pending the noise emission of the plant, shipping containers which can also double up as site offices may be used.

- Adequate design of truck travel within the site to minimise the use of reversing alarms.
- Do not permit idle plant and equipment unless this is strictly required.
- Site induction training and workshops to create awareness of the issues above and the workers responsibilities in relation to the noise emissions.
- If construction is identified as audible at the receptors, short-term attended or unattended noise monitoring at sensitive receptors may be used to quantify the cumulative noise levels during the early operation of heavy machinery on site to inform the future planning of works.
- Ongoing (attended and/or unattended) noise monitoring during the planned works which include high noise emitting equipment may also be considered.

The NVMP may require further assessment of the planned works noise emissions via acoustic modelling.

8.2.3 Operational Noise Management

As indicated in **Section 8.1.2**, the normal operation of the plant is predicted to exceed the daytime noise limit (during enhanced noise propagation) and the night time noise limit (during both neutral and enhanced noise propagation).

Similarly, during abnormal operation (i.e. flaring) the daytime and night time noise limits are predicted to be exceeded during both neutral and enhanced noise propagation.

The following strategies may be considered to manage the noise emissions to compliant levels:

- Relocate the CPF plant site away from sensitive receptors; or
- Relocate receptor NSR3; and/or
- Introduce localised noise controls to reduce the plant noise emission to a compliant noise level.

The following noise control recommendations are made:

Normal operation

- Design the CPF such that the combined sound power level of the industrial site does not exceed 117 dBA to permit 24-hour operation regardless of noise propagation conditions to meet the night time noise limit.

  This measure is required to meet the limits at NSR3 only. The noise emission as currently modelled would not be required to be further reduced to meet the limits if NSR3 is relocated to a noise compliant location.

Abnormal operation (flaring), Flare Option 2a

- If the NSR3 location is retained, design the noise emission (plant plus flare) to meet the noise limits at this receptor as follows:
  - Daytime noise emission: 124 dBA sound power level.
  - Night time noise emission: 117 dBA sound power level.

  Compliance with noise limits at NSR3 ensures compliance at other NSR and NR.
- If NSR3 is relocated, design the noise emission (plant plus flare) to meet the noise limits at the next nearest NSRs and NRs as follows:

- Daytime noise emission: Plant combined noise emission of 128 dBA sound power level (as currently modelled). Flare noise emission of 132 dBA sound power level.
- Night time noise emission: Plant combined noise emission of 128 dBA sound power level (as currently modelled). Flare noise emission of 119 dBA sound power level.

Abnormal operation (flaring), Flare Option 3a

- If the NSR3 location is retained, design the noise emission (plant plus flare) to meet the noise limits at this receptor as follows:
  - Daytime noise emission: 124 dBA sound power level.
  - Night time noise emission: 117 dBA sound power level.

  Compliance with noise limits at NSR3 ensures compliance at other NSR and NR.
- If NSR3 is relocated, design the noise emission (plant plus flare) to meet the noise limits at the next nearest NSRs and NRs as follows :
  - Daytime noise emission - Plant combined noise emission of 128 dBA sound power level (as currently modelled). Flare noise emission of 132 dBA sound power level.
  - Night time noise emission - Plant combined noise emission of 128 dBA sound power level (as currently modelled). Flare noise emission of 118 dBA sound power level.

The maximum allowable noise emissions are indicative only as they assume that all plant noise emission is reduced proportionally by the same amount to achieve the site wide maximum noise emission and considers penalties such as for tonal noise. In practise, noise controls will introduce variable noise reductions. Therefore, the total noise emission will vary from above stated values and should be confirmed during the detailed design phase noise assessment.

9.0 Conclusion

A noise assessment of the operation of the proposed CPF-P3 LNG Facility has been conducted. The assessment comprised the prediction of construction and operational noise levels from the Project onto external NSR and Project involved NR using computational analysis.

Construction noise predictions were based on a typical equipment list expected to be required during the early and later construction works.

The operational noise predictions were based on a plant list and noise emissions produced by the Saipem-Tripatra-Daewoo joint venture. The operational noise emissions were modelled at the CPF-P3 site.

The noise predictions were assessed against the International Finance Corporation (IFC) World Bank Group Environmental, Health and Safety (EHS) Guidelines.

Construction noise emissions

The assessment showed that the construction stage can be expected to meet the daytime noise limit at the closest NSR (NSR3, Pokore Hamlet). However, construction activities can be expected to exceed the night time limit at this receptor.

The night time exceedance is considered manageable to compliant levels via the implementation of reasonable and feasible measures. The implementation of a Construction Noise Management Plan (CNMP) is recommended, which may include (but is not limited to) the guidance provided in this report.

Operational noise emissions

The assessment showed that the normal operation of the CPF-P3 site can be expected to meet or marginally exceed the daytime noise limit, depending on the noise propagation conditions.

At night time, the normal operation was predicted to largely exceed the noise limit at NSR3.

During abnormal operation (which includes a reduced plant noise emission plus gas flaring), the noise emission from the flare is predicted to be the dominant noise source.

In the absence of the flare, noise emissions from the other plant operating at reduced numbers/capacity would still exceed the night time noise limit. Therefore, the reduced operation of the plant would also require noise mitigation to meet the noise limit.

The noise outcomes are irrespective of the two flare options locations assessed.

The following strategies may be considered to manage the noise emissions to compliant levels:

- Relocate the CPF plant site away from sensitive receptors; or
- Relocate receptor NSR3; and/or
- Introduce localised noise controls to reduce the plant noise emission to a compliant noise level.

Further engineering design incorporating the selection of plant specific noise controls will be required where the CPF-P3 site location is retained. Indicative maximum allowable plant and flare noise emissions were presented to meet the noise levels assuming both the retention as well as the relocation of NSR3.

Noise controls may be further refined and rationalised after assessment of the existing ambient noise levels at NSR3 and other receptors via noise monitoring.



Appendix A Noise Source Emission Database

Papua LNG CPF Relocation

Noise Impact Assessment

Papua LNG Development Pty Ltd

SLR Project No.: 620.040581.00002

19 Jun 2024