TOTAL
TOTAL E&P PNG LIMITED

PAPUA LNG PROJECT

UPSTREAM ENVIRONMENTAL IMPACT STATEMENT

VOLUME 1: MAIN REPORT

Chapter 10: Existing Environment – Amenity

TOTAL E&P PNG LIMITED

December 2019
(Report No. 01215B_23_v5)

Table of Contents

Chapter

10. Existing Environment - Amenity 10–1

10.1 General Setting 10–1

10.2 Air Quality 10–2

10.3 Noise 10–11

10.4 Landscape and Visual Amenity 10–15

10.5 Commercial Marine and River Transport 10–25

10.6 Waste Characterization 10–29

10.7 References 10–33

Tables

Table 10.1 – CPF Site Estimated Baseline Particulate Concentrations 10–9

Table 10.2 – Measured (Unattended) Background and Residential Guideline Noise Levels 10–14

Table 10.3 – Production, Processing and Related Facilities (PRL-15) Landscape Character Description 10–17

Table 10.4 – Onshore Export Pipeline Corridor Landscape Character Description 10–19

Table 10.5 – River Transport Corridor Landscape Character Description 10–21

Table 10.6 – Offshore Export Pipeline Corridor Landscape Character Description 10–23

Table 10.7 – Main Coastal Shipping Routes in the Gulf of Papua and Inland Waterways 10–26

Table 10.8 – Existing Waste Management Facilities in Papua New Guinea 10–30

Table 10.9 – Recycling and Reuse Options 10–32

Figures

Figure 10.1 – Air Quality Modeling Domains and Potential Receptors 10–4

Figure 10.2 – CPF Site Wind Roses 10–6

Figure 10.3 – CPF Site Predicted Stability Class Frequency Distributions 10–7

Figure 10.4 – CPF Site Predicted Diurnal Variation in Mixing Height (CALMET) 10–8

Figure 10.5 – Onshore Export Pipeline Corridor Wind Roses 10–10

Figure 10.6 – Noise Field Survey Sites 10–13

Figure 10.7 – Coastal and River Shipping Routes 10–27

Plates

Plate 10.1 – Herd Base (Southeastern Aspect) 10–16

Plate 10.2 – Dense Tropical Forest and Mountainscape of PRL-15 10–17

Plate 10.3 – PRL-15 Oxbow Wetlands 10–17
Plate 10.4 – Dense Tropical Forest and Purari River 10–17
Plate 10.5 – Mapaio Fish Camp Located on the Purari River 10–18
Plate 10.6 – Traditional Dwelling at Mapaio Fish Camp 10–18
Plate 10.7 – Purari River and Dense Forest Surrounds 10–18
Plate 10.8 – River, Lowlands and Dense Vegetation 10–19
Plate 10.9 – Coastal Villages and Inundation Areas 10–19
Plate 10.10 – Coastal Village Flanked by Waterway 10–19
Plate 10.11 – Coastal Villages 10–20
Plate 10.12 – Coastal Village Buildings 10–20
Plate 10.13 – Coconut Grove 10–20
Plate 10.14 – Aerial View of Nipa Palm Expanse 10–21
Plate 10.15 – Typical Dense Riparian Vegetation 10–21
Plate 10.16 – Purari River at Herd Base 10–21
Plate 10.17 – Prawn Netting (Gulf of Papua Coast) 10–23
Plate 10.18 – Onshore View (Aerial) of Orokolo Bay Coast 10–23
Plate 10.19 – Onshore View (Sea Level) of Orokolo Bay Coast 10–23
Plate 10.20 – Densely Vegetated Mountain Foothills 10–24
Plate 10.21 – ANT-3 Wellpad from the Air 10–24
Plate 10.22 – TEP PNG's Contracted Barge Landing Craft MV *Balimo Chief* 10–29
Plate 10.23 – TEP PNG's Contracted Barge Landing Craft MV *GFS Marine 01* 10–29
Plate 10.24 – Log Barge MV *Swift No. 5* at Evara Logging Camp 10–29
Plate 10.25 – TEP PNG's Exploration Barge-punt *Baimuru Bullet* 10–29

10. Existing Environment - Amenity

This chapter has been prepared from information generated by a series of independent studies (where more detailed information can be found) that have involved detailed bibliographical reviews, numerical modeling and field surveys (both when required). Based on this information, a description is provided of the following components of the amenity setting:

- Air quality (Section 10.2), derived from the Upstream Air Quality Baseline Report (Part 19 of Volume 2).
- Noise (Section 10.3), derived from the Upstream Noise Baseline Report (Part 20 of Volume 2).
- Landscape and visual amenity (Section 10.4), derived from the Upstream Landscape and Visual Amenity Baseline Report (Part 21 of Volume 2).
- Commercial transport (both marine and river) (Section 10.5), derived from the Marine and River Traffic and Transport Baseline Report (Part 22 of Volume 2). Information on community travel and transport is presented in Section 9.10.
- Waste (Section 10.6), providing an overview of the waste-receiving environment in Papua New Guinea.

10.1 General Setting

Onshore Project components are mainly in the Purari River catchment, which is in a remote part of Gulf Province.

The inland terrain in the Project area is characterized by rugged mountainscapes of dense tropical forest that descend to densely vegetated deltaic and coastal lowlands covered in swamp forests and grasslands and to mangroves located at or below sea level. The Gulf Province climate, as described in Section 7.3, is characterized by high rainfall and low wind speeds.

In relation to the amenity baseline and setting, human settlement, infrastructure and development have been limited primarily due to the difficulty in accessing the deltaic, floodplain and inland terrains. Thus, population density remains low across most of the Project area, except for the coastal villages, which are generally larger and more accessible than the inland villages. Inland villages located in the river transport corridor are generally smaller than the coastal villages but are more accessible (by boat) than other inland villages.

Human activity includes subsistence farming, with small areas of forest cleared for swidden agriculture and gardens. Nearly all villages burn firewood for cooking and lighting.

In this setting, industrial activities in the Project area comprise discreet areas of logging operations (Section 9.4.1) and ongoing gas exploration activities in PRL-15.

Public or government roads do not exist in the Project area; however, logging tracks do occur. None of the communities reports owning motor vehicles or motorbikes: and transport is generally by boat or on foot, although logging operators use vehicles. Helicopters transport Project personnel between Herd Base and the gasfield wellpads and temporary operations camp.

The Purari, Ivo-Urika and Wame-Varoi rivers, in the river transport corridor, facilitate access for Project barges between Herd Base and further upstream and the Gulf of Papua. These rivers are also used by villagers from the river transport corridor for transport and subsistence purposes and by log ships and barges accessing the logging camp near Evara.

Current sources of pollution are negligible due to the sparse population and limited industrial development in the onshore Project area.

The offshore export pipeline traverses Orokolo Bay and the Gulf of Papua to a landfall at Caution Bay (Central Province). Small watercraft owned by coastal villagers primarily use the nearshore areas of Orokolo Bay for subsistence fishing and to access other coastal villages for trade (Section 9.10), while larger commercial vessels use the Gulf of Papua for prawn trawling and transporting crude oil and LNG (Section 10.5).

This chapter characterizes the baseline amenity of the Project area in terms of air quality, noise, landscape and visual amenity, and commercial transport and waste, considering this setting.

10.2 Air Quality

10.2.1 Study Overview

A baseline air quality study was undertaken in the upstream Project area to characterize the existing ambient air quality and meteorological patterns that have the potential to affect the dispersion of Project-related air emissions.

The air quality is likely to be good due to minimal anthropogenic development in the Project area to date. In the study area, it is expected that gaseous pollutants levels are negligible, and particulate levels are low. Therefore, field monitoring of gaseous pollutants (i.e., nitrogen dioxide (NO_2), sulfur dioxide (SO_2), carbon monoxide (CO), volatile organic compounds (VOCs) and particulate concentrations (i.e., $PM_{2.5}$, PM_{10}[1] and total suspended particulate matter (TSP)) was not undertaken. The baseline air quality characterization was completed, as a desktop study incorporating a detailed bibliographic review and modeling. Existing particulate matter concentrations have been estimated based on:

- Information in air quality baseline and assessment studies for other projects in Papua New Guinea.
- A review of ambient particulate monitoring data in Papua New Guinea and in remote and undeveloped areas in other countries, considering the local land use and high rainfall in the study area.

This approach is consistent with the guidance note for the International Finance Corporation's Performance Standard 1 (IFC, 2012).

The study area for the air quality baseline assessment is defined as any area where air quality may be directly impacted due to Project activities, including construction and operation of Project facilities and infrastructure. It includes PRL-15; the onshore and offshore export pipeline corridor; and locations along the Purari, Urika-Ivo and Wame-Varoi river transport routes in which potential sensitive receptors (e.g., villages) are located. In the study area, the air quality baseline study focused on the Central Processing Facility (CPF) as the main source of air emissions in the upstream area and on the onshore export pipeline corridor. Other emission sources will include the wellpads and associated gathering system, trunkline and transport routes.

Existing long-term baseline meteorological data available for Wabo was insufficient for the study area due to extended gaps in the data record. Modeling was therefore required to establish meteorological conditions that will be used in the dispersion model to predict potential air quality

1 $PM_{2.5}$ – particulate matter less than or equal to 2.5 µm in diameter; PM_{10} – particulate matter less than or equal to 10 µm in diameter.

impacts at a later stage. The data from Wabo was instead used to validate the performance of the model.[2] Two models were used:

- Weather Research and Forecasting: A next generation mesoscale numerical weather prediction system used in the baseline study to produce the meteorological data required as an input to the CALMET model. Two modeling domains were used:
  - Domain 1 – a coarse run with a 30 km grid resolution, the geographical extent of which was chosen to best cover the area of interest, including the effects of large-scale weather events, while keeping the computational requirements for the atmosphere model as low as possible.
  - Domain 2 – a finer run with a 10 km grid resolution, using the input from Domain 1.
- CALMET: A meteorological model that develops hourly wind and other meteorological fields on a 3-dimensional gridded modeling domain. Four modeling domains were used:
  - Outer domain: A 60 x 60 km grid, modeled with a resolution of 3 km using the 3D output from the Weather Research and Forecasting model.
  - Mid domain 1: A 40 x 40 km grid, modeled with a resolution of 1 km using the 3D output from the CAMLET outer domain.
  - Mid domain 2: An 18.8 x 18.8 km grid, modeled with a resolution of 0.4 km using the 3D output from the CAMLET mid domain 1.
  - Inner domain: A 15 x 12 km grid, modeled with a resolution of 0.1 km using the 3D output from the CAMLET mid domain 2.

Figure 10.1 shows the modeling domains used to generate the meteorological model.

Meteorological data was extracted from two locations (Figure 10.1) in the study area:

1. The center of the CPF site, which shows nearby villages (sensitive receptors).
2. Halfway along the onshore export pipeline corridor.

The meteorological data predicted by the modeling at the onshore export pipeline corridor location is only indicative of the types of conditions experienced along the onshore export pipeline and river transport corridors. Both of these areas cover large distances and include a range of topographical features; consequently, wind patterns, rainfall, ambient temperatures and humidity levels can be expected to vary along the corridors. The types of activities proposed in these corridors will only have potential for very localized and temporary impacts on air quality. A detailed analysis of meteorological conditions along each corridor is therefore unwarranted. Indicative baseline conditions, at a point halfway along the export pipeline corridor, provide the information required for the impact assessment of potential air quality impacts from activities in these corridors.

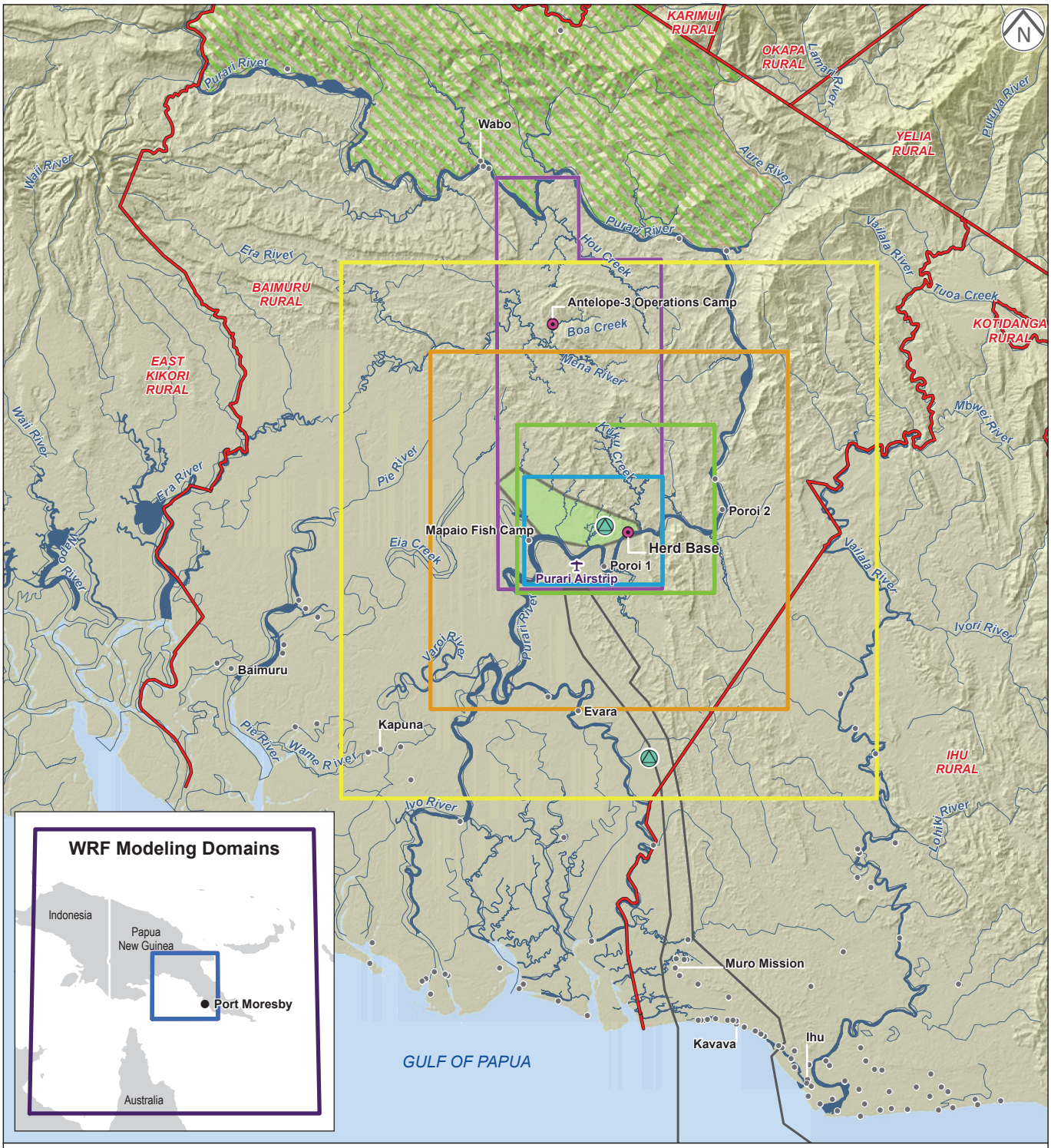
Additionally, detailed meteorological modeling was only undertaken for the parameters related to dispersion modeling (Section 10.2.2).

2 This could not be undertaken if the data was used in the model, as the results would be identical. Using data excluded from the model to validate the model's performance is a more robust approach to validating the model's performance.

AIR QUALITY MODELING DOMAINS AND POTENTIAL RECEPTORS

Papua LNG Project | Environmental Impact Statement

FIGURE 10.1



Communities outside of the Project area of influence have not been verified. Only government administrative centers and notable locations have been labeled for context.

10.2.2 Factors Affecting Air Quality

The key meteorological parameters of interest for air quality modeling are wind speed, wind direction, stability class, mixing height and ambient temperature. Information on these is presented in Part 19 of Volume 2, while rainfall and temperature are detailed in Section 7.3.

The study area topography and land use can impact on the baseline air quality and air pollutant dispersal. Hills and valleys channel winds, which influences local wind patterns. During the night, drainage flows create downslope winds, which also influence the direction in which air pollutants are dispersed. In addition, the natural vegetation in the study area can affect wind speeds and atmospheric turbulence through changes in surface roughness associated with variations in canopy height. Vegetation also affects ambient particulate levels, which reduces wind erosion, and can contribute to increased pollen levels. Further information about the study area terrain can be found in Section 7.2, while vegetation is described in Section 7.7.5.

Community activities, e.g., cooking and fires, provide an anthropogenic source of particulate matter; and the anthropogenic setting of the area has been discussed in Chapter 9.

10.2.3 Air Quality Baseline Characterization

10.2.3.1 Production, Processing and Related Facilities (PRL-15)

Figure 10.2 presents wind roses showing the wind data predicted by the modeling at the CPF site for 2014 and 2015. The site generally experiences low to moderate wind speeds (i.e., less than 5.5 m/s), predominately from the north-northeast and northeast. Calm wind conditions (i.e., wind speeds less than 0.5 m/s) were predicted to occur 4% to 5% of the time. While not evident from the wind roses in Figure 10.2, the bibliographic review of available meteorological data has shown that wind speeds are typically highest during October to January, coinciding with the start of the northwest monsoon season.

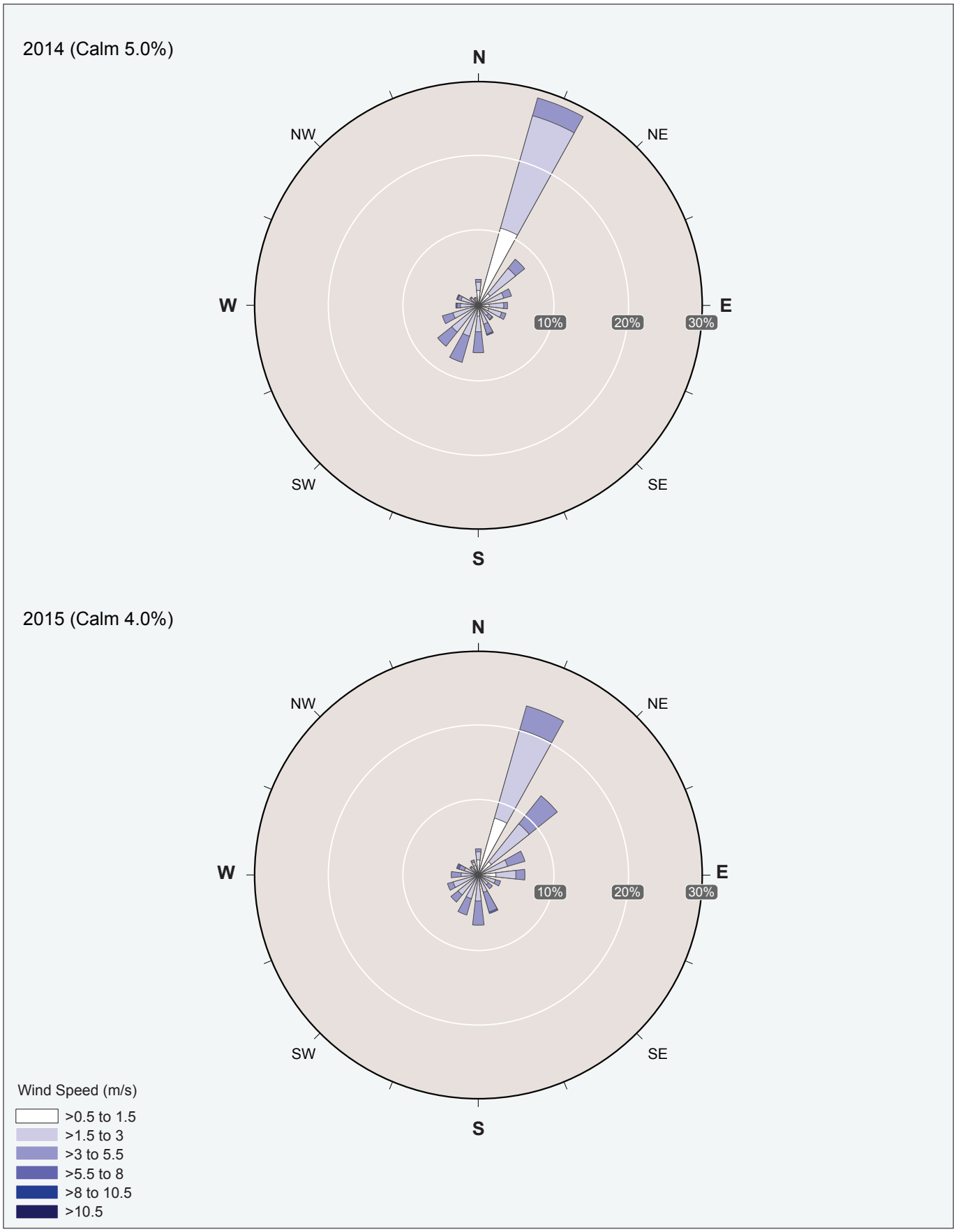
Atmospheric stability refers to the atmospheric tendency to resist or enhance vertical motion. At the CPF site, stability class F (i.e., moderately stable conditions) was predicted to occur approximately 40 to 44% of the modeled year which is indicative of very stable nighttime conditions (i.e., low winds), leading to a low level of mechanical mixing and poor dispersion. Stability class B (i.e., moderately unstable conditions), predicted to occur 22% to 23% of the year, is associated with low to moderate wind speeds and strong to moderate solar insolation, giving rise to a moderate level of atmospheric turbulence and mixing. Figure 10.3 presents the frequency of each atmospheric stability class predicted by the model for the CPF site.

The height of the turbulent layer of air near the earth's surface is referred to as the mixing height. Ground-level emissions from the proposed CPF will be rapidly mixed in this layer. This baseline information has been used in the dispersion model to predict potential air quality impacts. 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. After the onset of vertical mixing at sunrise, the mixing height at the CPF site increases over the morning. It reaches the maximum mixing height around the mid to late afternoon, i.e., approximately 3.00 p.m., at a height of around 1,700 to 1,900 m, occurring around this time 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 10.4 shows the variation in mixing height as would be expected for the diurnal variation of mixing heights.

CPF SITE WIND ROSES

Papua LNG Project | Environmental Impact Statement

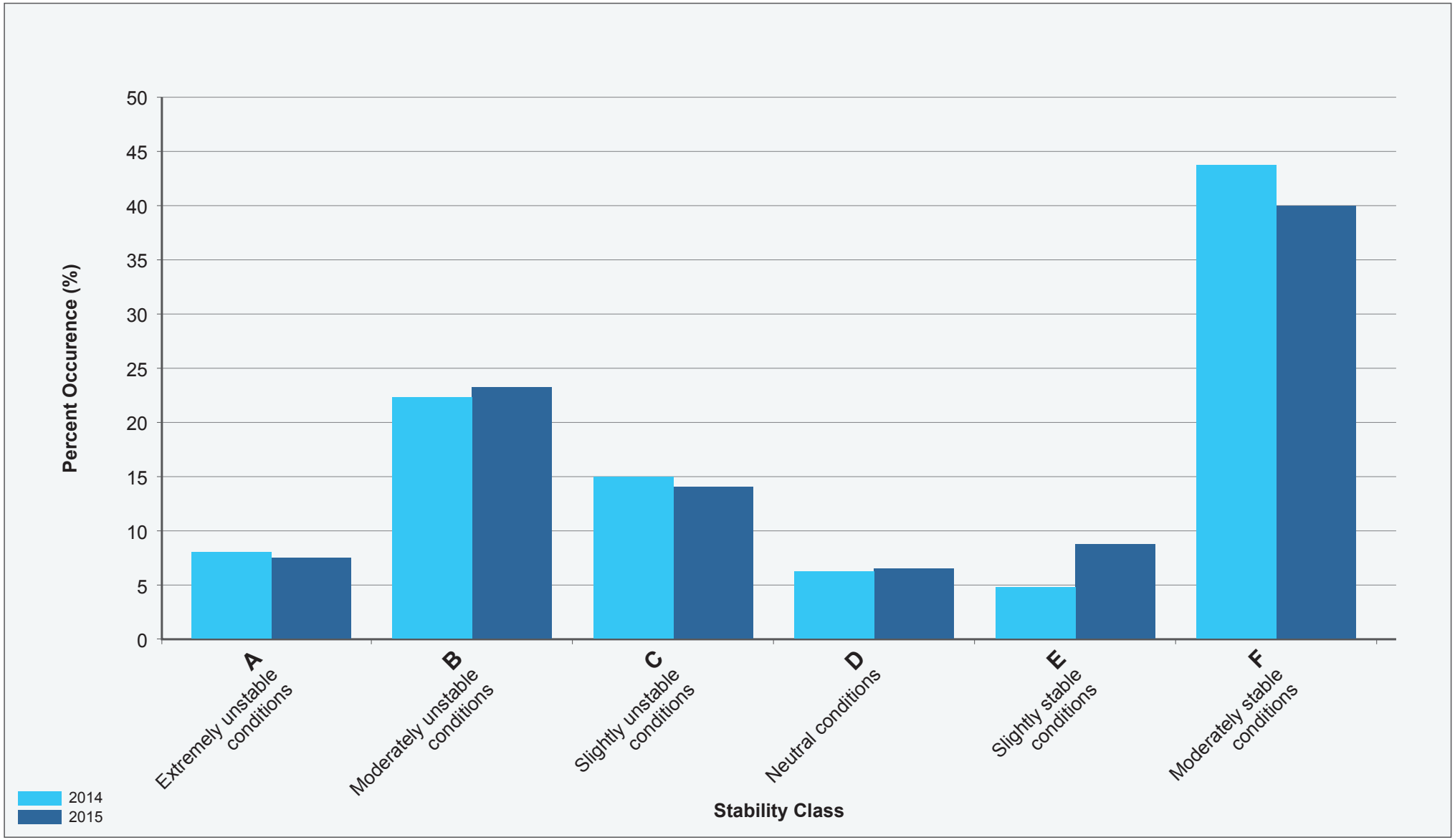
FIGURE 10.2



CPF SITE PREDICTED STABILITY CLASS FREQUENCY DISTRIBUTIONS

Papua LNG Project | Environmental Impact Statement

FIGURE 10.3

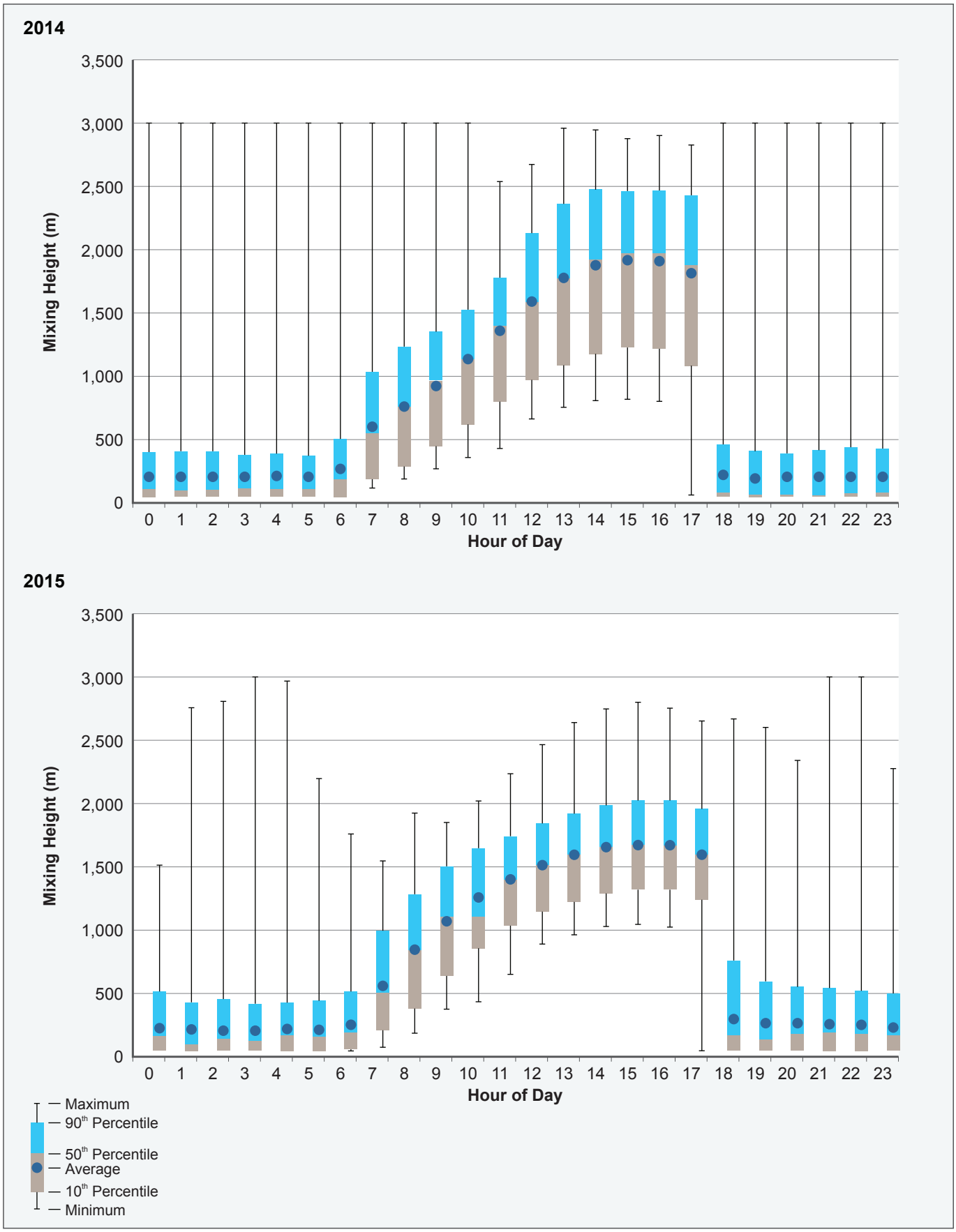


ERIAS Group | 01215B_23_F10.3_v1

CPF SITE PREDICTED DIURNAL VARIATION IN MIXING HEIGHT (CALMET)

Papua LNG Project | Environmental Impact Statement

FIGURE 10.4



ERIAS Group | 01215B_23_F10.4_v1

The existing air quality for the CPF site would be expected to reflect the virtual absence of industrial pollution sources, and the ambient air quality can be assumed to be generally good. Gaseous pollutant concentrations would be negligible (i.e., 0 µg/m^3) compared to relevant international guidelines for ambient air quality (Part 19 of Volume 2) and the study area would be regarded as a 'non-degraded' airshed in relation to IFC assessment requirements.

Table 10.1 shows the estimated baseline particulate concentrations for the CPF site.

Table 10.1 – CPF Site Estimated Baseline Particulate Concentrations

	Pollutant					
	TSP		PM_{10}		$PM_{2.5}$	
Averaging period	24-hours	Annual	24-hours	Annual	24-hours	Annual
Range of background particulate concentrations expected to occur in the CPF site (µg/m^3)	10 to 70	20 to 40	5 to 35	10 to 15	2 to 20	5 to 8
Background concentration assumed (µg/m^3)	50	40	25	15	15	8
WHO (2005) ambient air quality (µg/m^3)	–	–	50	20	25	10
EC (2016) ambient air quality for Europe (µg/m^3)			50	40	–	25
USEPA (2017) ambient air quality (µg/m^3)	150 (260)*	60 (75)*	150	–	35	12 (15)

Source: Part 19 of Volume 2.
* The USEPA primary standards are set to protect public health, including the health of 'sensitive' populations, such as asthmatics, children and the elderly. Secondary standards, shown in parentheses, which are set for some pollutants, were developed to protect public welfare, including protection against decreased visibility and damage to animals, crops, vegetation and buildings. In all cases, the secondary standards are either equal to or higher than the primary standards.

Annual long-term average concentrations have been conservatively assumed to be at the maximum of the expected range, as short-term localized or regional events do not have any significant impact on the annual average concentrations. The 24-hour average concentrations have been assumed to be at the upper end of the range, but not at the maximum, to exclude monitoring data that may be significantly influenced by localized or regional events such as fires or burning crops. The particulate estimates are below the World Health Organization (WHO) air quality guidelines (WHO, 2005), the European Commission air quality limit values (EC, 2016) and the US Environmental Protection Agency national ambient air quality standards (USEPA, 2017) (see Table 10.1), which are used for comparison in the absence of PNG statutory air quality standards. The air quality guidelines in Table 10.1 are provided for comparison only and do not communicate commitment by the Project. The modeling detailed in Chapter 15 assesses the most appropriate standards for Project development.

10.2.3.2 Onshore Export Pipeline Corridor

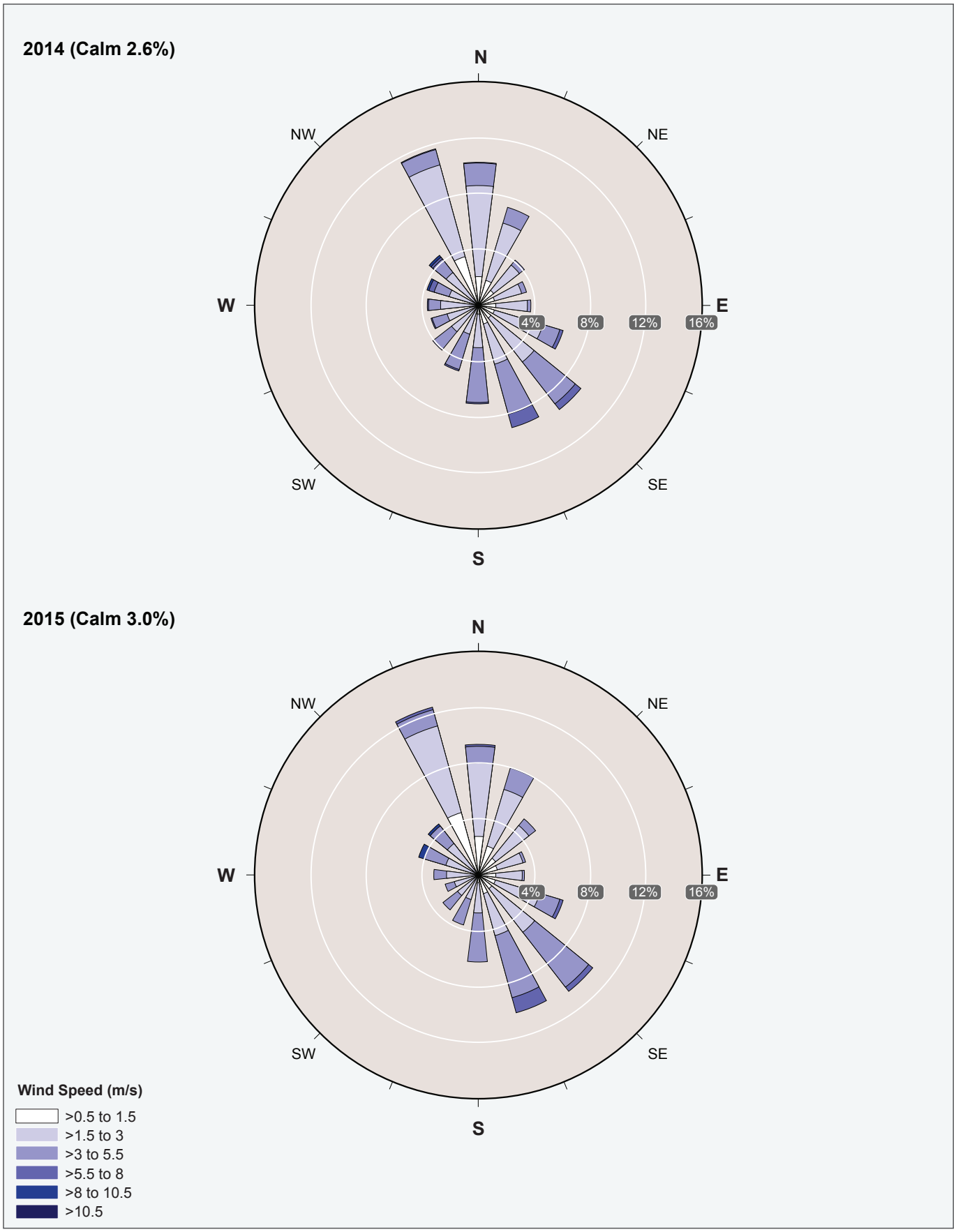
Wind speed and wind direction will be the key meteorological parameters that will influence the dispersion of pollutants (e.g., dust emissions) during construction of the onshore export pipeline. Air emissions during the operational phase are expected to be negligible.

Wind direction predicted for the onshore export pipeline corridor area is more varied and slightly stronger than at the CPF site. The corridor was predicted to experience mainly light to moderate winds (i.e., less than 5 m/s), with winds predominantly from the northern and southeastern quadrants, while calm wind conditions (i.e., less than 0.5 m/s) were predicted to occur 2.6% to 3% of the time (Figure 10.5).

ONSHORE EXPORT PIPELINE CORRIDOR WIND ROSES

Papua LNG Project | Environmental Impact Statement

FIGURE 10.5



The ambient air quality for the export pipeline corridor can be assumed to be similar to the CPF and related facilities areas, i.e., generally good with negligible gaseous pollutant concentrations.

Baseline particulate levels are expected to be low along the onshore export pipeline corridor; however, levels may be higher near the coast where there is a greater concentration of villages than inland along the more remote sections of the corridor. The same background particulate concentrations assumed for the CPF and related facilities areas are considered appropriate for the onshore export pipeline corridor (see Table 10.1).

The gaseous pollutant values and particulate estimates for the onshore export pipeline corridor are below the air quality guidelines identified in Part 19 of Volume 2.

10.2.3.3 River Transport Corridor

As explained in Section 10.2.1, the meteorological information presented in Section 10.2.3.2 is also relevant for the river transport corridor.

Some existing air emissions from boat activities exist along the river corridors; however, these are likely to be isolated and short-lived in occurrence and are; therefore, not expected to be significant in the context of air quality. Consequently, baseline gaseous pollutant concentrations along the river corridors can be assumed to be negligible, and the same background particulate concentrations assumed for the CPF and related facilities areas are considered appropriate for the river transport corridor (see Table 10.1).

Both the gaseous pollutant values and the particulate estimates for the river transport corridor are below the air quality guidelines identified in Part 19 of Volume 2.

10.2.3.4 Offshore Export Pipeline

No significant potential for air quality impacts are expected during the construction or operational phases of the Project's offshore export pipeline, as this Project-component area is primarily under water; therefore, no modeling or detailed analysis of the meteorology has been performed; however, the winds in this component area are discussed in Section 8.3.1.

The existing air quality in this part of the study area can be expected to be very good, with potential for low levels of particulate concentrations associated with salt spray and the transport of dust from the mainland by offshore winds. All other baseline pollutant concentrations can be expected to be negligible.

10.3 Noise

10.3.1 Study Overview

A baseline noise study was undertaken in the upstream Project area to characterize the existing ambient background noise levels and to allow the future prediction of potential impacts to be assessed.

Minimal information regarding the existing ambient baseline noise environment was available in the upstream Project area; therefore, a field survey was undertaken at potential sensitive receptors surrounding upstream Project infrastructure.

The baseline noise study area is defined as an area where noise impacts may be experienced due to Project activities, including the construction and operation of facilities and infrastructure. The upstream noise survey focused on gathering baseline information at key locations, i.e., sensitive receptors, such as existing villages, potential future in-migration locations and fauna-

sensitive areas that will potentially be impacted by noise from the Project during both construction and operations.

The baseline survey was undertaken in November 2016 when weather conditions were predominantly calm and dry, and involved unattended noise monitoring at nine locations and attended noise monitoring at 10 locations (Figure 10.6):

- An unattended noise logger was deployed in a secure location at each identified site. The noise logger was set to continuously measure the ambient background noise levels over a minimum 48-hour monitoring period to quantify the day and night-time ambient noise levels for the area.
- Attended noise monitoring measurements were generally taken when the noise loggers were deployed and retrieved, using a hand-held sound level meter.[3] During the measurements, ambient noise sources were quantified, and surrounding noise sources with the potential to affect the noise impact assessment were identified. In addition, the landform surrounding the study sites was assessed, particularly around the proposed CPF site, for features that provide localized shielding, such as that provided by hills, which may have an impact on future noise emissions across the site.

Noise related to the offshore export pipeline corridor (i.e., underwater noise) is characterized in Section 8.7.

10.3.2 Factors Affecting Noise

Weather conditions can significantly affect the transmission of noise outdoors. Where background noise levels are measured in the absence of any mechanical plant noise, the effects of weather are limited to either sustained periods of heavy rainfall (i.e., noise from the impact of rain on the ground or building structures) or strong winds, which can cause either wind-induced microphone noise or can disturb the nearby foliage (i.e., the rustling of leaves in trees). As described in Section 7.3, weather conditions, including high rainfall and seasonally strong southeasterly winds, are expected to influence ambient noise levels in the study area.

An area's surrounding landform and topography can also significantly affect noise propagation due to the natural shielding provided by hills and mountain ranges, and the level of effect will depend on the proximity of the noise sources and receptors. If sound is propagating over ground, attenuation will occur due to acoustic energy losses on reflection depending on the surface; for example, smooth, hard surfaces, such as concrete or water, will provide little absorption, whereas thick grass may significantly reduce sound levels at higher frequencies. As described in Section 7.3 and shown in Figure 7.4, the complexity of the terrain, including complex ridges, escarpments and hills, in parts of the Project area, and in particular surrounding the proposed production, processing and related facilities in PRL-15 and along the onshore export pipeline corridor generally, may provide opportunities for shielding and attenuating noise emissions from Project activities. In general, the typically dense tropical forests described in Section 7.7.5 and occasional subsistence agricultural cover across most of the Project area will provide increased ground absorption relative to hardstand areas, roads and water surfaces, and will help attenuate noise propagation from the various works.

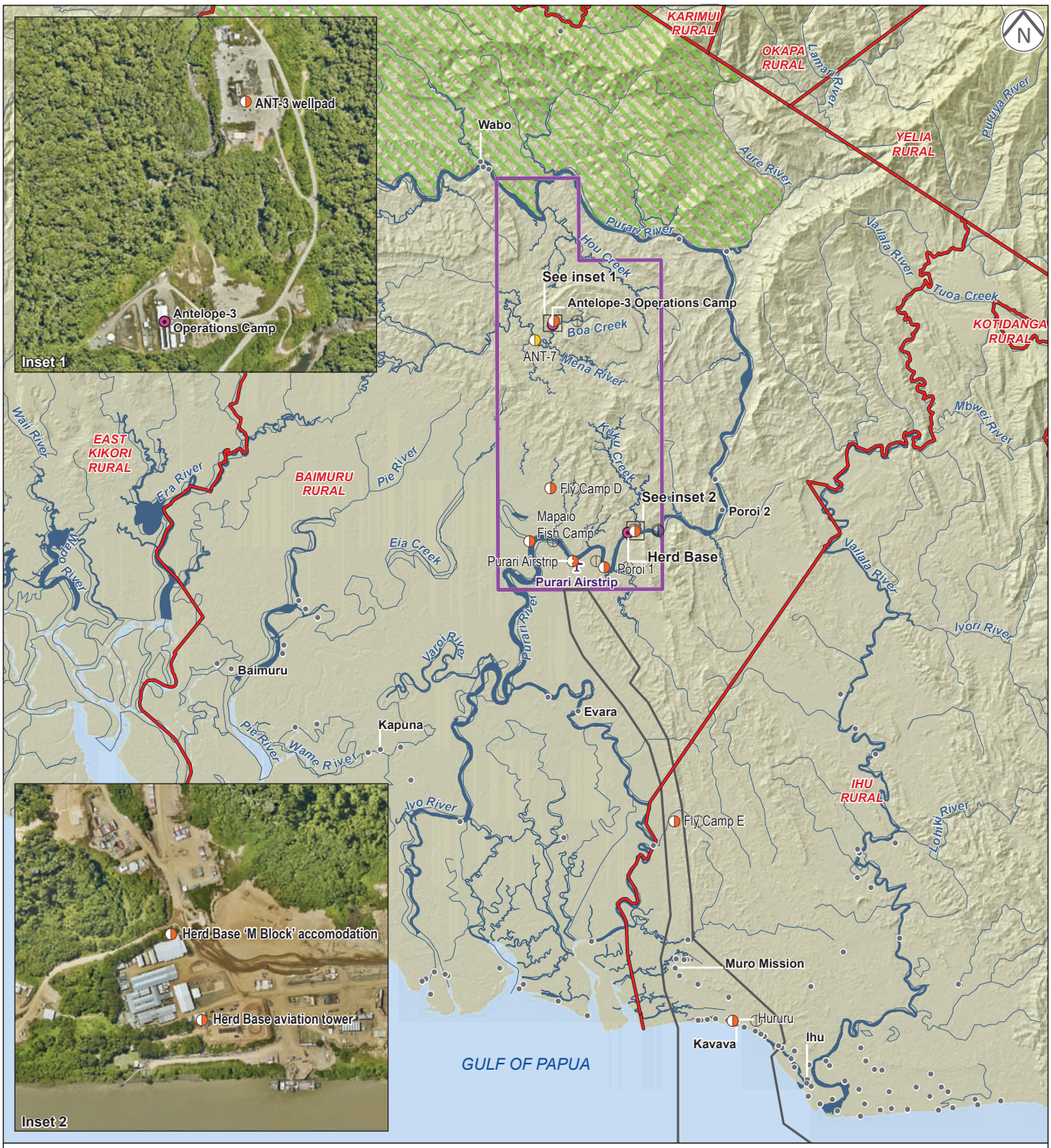
The anthropogenic setting of the area has been discussed previously in Chapter 9.

3 Attended noise surveys conducted at ANT-7 and Herd Base collected data that will be used in the noise impact assessment to be undertaken at a later stage. The data from these attended noise surveys is not discussed in this chapter but is included in Part 20 of Volume 2 for completeness.

NOISE FIELD SURVEY SITES

Papua LNG Project | Environmental Impact Statement

FIGURE 10.6



SCALE: 1:650,000 @ A4

0 5 10 15 20 25 km

COORDINATE SYSTEM: PNG94 PNGMG94 Zone 55

- Town and village
- Base camp
- Airstrip
- Local level government boundary
- Waterway
- Waterbody
- PRL-15
- Export pipeline corridor
- Crater Mountain Wildlife Management Area

Noise Monitoring Locations

- Attended monitoring
- Attended and unattended monitoring

Communities outside of the Project area of influence have not been verified. Only government administrative centers and notable locations have been labeled for context.

10.3.3 Noise Baseline Characterization

Average background noise levels from areas in the production, processing and related facilities of PRL-15, and the onshore export pipeline corridor are presented in Table 10.2, with ambient noise level guidelines for residential receptors provided in the Environmental, Health and Safety General Guidelines (IFC, 2007).

Table 10.2 – Measured (Unattended) Background and Residential Guideline Noise Levels

Study Area	General Description of Receptor Location	Receptor	Period	Average Background Noise Level dBA, L_{90}	IFC Noise Level Guidelines# dBA, $L_{eq(1h)}$
Production, processing and related facilities (PRL-15)	Remote uninhabited historic wellpad*	ANT-3 wellpad	Day, 7-22 hr	38	55
			Night, 22-7 hr	46	45
	Uninhabited forest	Fly Camp D†	Day, 7-22 hr	42	55
			Night, 22-7 hr	56	45
	Established villages	Poroi 1	Day, 7-22 hr	40	55
			Night, 22-7 hr	42	45
		Mapaio Fish Camp	Day, 7-22 hr	35	55
			Night, 22-7 hr	41	45
	Single dwelling near the operational airstrip	Purari Airstrip	Day, 7-22 hr	44	55
			Night, 22-7 hr	47	45
Onshore export pipeline	Uninhabited forest	Fly Camp E†	Day, 7-22 hr	46	55
			Night, 22-7 hr	56	45
	Established coastal village	Hururu	Day, 7-22 hr	42	55
			Night, 22-7 hr	38	45

* Remote, vegetation has been cleared from the edge of this wellpad.
# In accordance with Section 1.7 for off-site residential receptors (IFC, 2007).
† Remote and temporary camp locations used by the terrestrial biodiversity survey team.

The background noise levels recorded at three of the sites along the Purari River, i.e., Mapaio Fish Camp, Purari Airstrip and Poroi 1, are considered representative of other villages along the main river transport corridor. At each of these sites, monitoring was conducted close to the river, although it was set further back at Poroi 1, reflecting normal variation in the background noise environment. In addition, transient-noise emission sources were present, such as boats with outboard motors and passing barges, which would be typical of other locations along rivers in the corridor.

Observations from the field and analysis process suggest that the background noise environment is generally dominated by insect noise at all locations and shows a distinct increase at night at many locations due to the increase in insect activity.

At the established villages and settlements, where the surrounding undergrowth and forest has been cleared, the resultant night-time background noise levels were noticeably quieter (i.e., 38 to 42 dBA, L_{90}) than the remote undisturbed forest locations (i.e., fly camps), where night-time levels of around 55 to 56 dBA, L_{90} were recorded. This is attributed to the increased presence and close proximity of insects and, at night, other nocturnal fauna (e.g., frogs and bats) in the more remote and densely vegetated undisturbed locations. Correspondingly, the lower background noise levels at the villages and settlements are attributed to the clearing of vegetation resulting in lower levels of wildlife. Nearby turbulent river flows affected the background noise for some villages; however, the contribution of this noise was minimal when compared to that generated by fauna, particularly insects. The villages were also affected by intermittent noise associated with normal habitation,

e.g., voices, domestic animals and equipment such as chainsaws and generators; however, these activities mostly occurred for short periods and were excluded from the analysis in accordance with standard procedure (Part 20 of Volume 2).

10.4 Landscape and Visual Amenity

10.4.1 Study Overview

The landscape and visual amenity baseline characterization has been developed considering the proposed approach that will be undertaken for the landscape and visual impact assessment, which comprises two components:

- Landscape effects assessment: Broader assessment that focuses on potential impacts on the landscape as a community resource; aesthetically driven assessment concerned with overall landscape change.
- Visual effects assessment: Concerned with potential changes to the general surrounds and views due to Project facilities, and therefore the effect on the visual amenity experienced by individuals and groups of people.

Part 21 of Volume 2 contains further information on the approach to the landscape and visual amenity baseline study.

10.4.2 National and Regional Setting

Papua New Guinea has a varied landscape. The rugged volcanic mountainscape of dense tropical forest in the New Guinea Highlands gives way to coastal lowlands, including wetlands. The coastline consists of coral and sand beaches, islands and offshore reef areas.

The Gulf Province landscape is typical of Papua New Guinea. Mountainscapes with elevations up to 1,673 m above sea level (asl) rapidly give way to coastal lowlands. Notable features are the Purari River, which is the third largest river in Papua New Guinea, and the Purari River delta. In addition, significant human disturbance is absent; population density is low, and human activity is primarily focused on subsistence farming and fishing (Sections 9.4 and 9.8). Anthropogenic disturbances, such as extensive commercial logging activities, and previous and contemporary commercial plantations (e.g., coconut) closer to coastal areas, are present; however, changes brought about by these disturbances are generally neither evident nor significant at a regional landscape scale due to the indiscernible changes at forest canopy level, which are described in Section 7.7.5.3.

10.4.3 Landscape Character Description

Tables 10.3 to 10.6 summarize the landscape character surrounding Project components (i.e., production, processing and related facilities in PRL-15; the onshore pipeline corridor outside PRL-15; the river transport corridor; and the offshore pipeline corridor). A brief description is also provided for Herd Base and the CPF area, the logistics base and the airstrip. The description of the ANT-3 wellpad and the surrounding area is considered representative of other wellpads in PRL-15.

10.4.3.1 Production, Processing and Related Facilities (PRL-15)

PRL-15 will contain most of the production, processing and related facilities components. Table 10.3 summarizes the landscape character of PRL-15.

Herd Base

The landscape at Herd Base is modified and not particularly unique. It is located along a fairly typical stretch of the Purari River and is geographically constrained by the river, the mountain foothills and the adjacent Kuku Creek. The base has been established on the northern river bank, which is elevated above the southern bank. Elevations at the base are from 6 m asl at the river's edge to 15 to 20 m asl where most infrastructure has been constructed. Steep foothills rise quickly to the north and west, to elevations of 75 to 95 m asl.

The base has been cleared of vegetation (Plate 10.1) for access and logistics purposes. The vegetation immediately surrounding the base is partially disturbed while further afield the vegetation is dense, undisturbed forest.

The vegetation clearance for operational purposes is evident, and this does generate an area of visual deviation from the surrounding undisturbed landscape, particularly from vantage points on or along the river.

Plate 10.1 – Herd Base (Southeastern Aspect)

Photo: SLR Consulting.

Table 10.3 – Production, Processing and Related Facilities (PRL-15) Landscape Character Description

Landscape Character	Landscape Description		
Topography	♦ Mountain foothills and a dominant southeast to northwest trending range are located north of alluvial flats around the Purari River (see Figure 7.4) Elevations range from close to sea level near the Purari River up to 430 m asl in the foothills. ♦ Foothills are dominated by a rugged and steeply sloped ridge-and-ravine landform that is underlain by thickly bedded to massive sandstone, with significant cliffs forming prominent topographic features. Landform is recurrently scarred by slumps, landslides and gullying. ♦ Low-relief (i.e., 10 to 50 m) ridge-and-ravine country is typical of soft mudstone adjacent to Purari River. ♦ Alluvial flatlands and floodplain in the southern area adjoin the Purari River delta. ♦ Oxbow wetlands occur in the southwestern part of PRL-15 (see Figure 7.28; Plate 10.3).		
Vegetation/ land cover	♦ Mountainscape is dominated by dense tropical forest with very limited access (Plate 10.2). ♦ Alluvial floodplains in southern and western areas are densely vegetated with tropical forest. ♦ Oxbow wetlands in PRL-15 include open lake and cut-off wetland areas with herbaceous and swamp forest species (Plate 10.4). Sago palm and aquatic vegetation feature throughout this area.		
	Plate 10.2 – Dense Tropical Forest and Mountainscape of PRL-15 Photo: SLR Consulting.	**Plate 10.3 – PRL-15 Oxbow Wetlands** Photo: SLR Consulting.	**Plate 10.4 – Dense Tropical Forest and Purari River** Photo: SLR Consulting.

Table 10.3 – Production, Processing and Related Facilities (PRL-15) Landscape Character Description (cont'd)

Landscape Character	Landscape Description		
Built forms/ structures	♦ Two small communities are located along the Purari River (Plate 10.5): Mapaio Fish Camp (Plate 10.6) and Poroi 1. Built forms are simple traditional dwellings comprising locally sourced timbers, with traditional thatch roofs and woven walls. ♦ The existing Project logistics base, Herd Base, is located immediately adjacent to the Purari River (Plate 10.7). Built forms include demountable buildings, sheds, storage facilities and aircraft hangers.		
	Plate 10.5 – Mapaio Fish Camp Located on the Purari River Photo: SLR Consulting.	**Plate 10.6 – Traditional Dwelling at Mapaio Fish Camp** Photo: SLR Consulting.	**Plate 10.7 – Purari River and Dense Forest Surrounds** Photo: SLR Consulting.
Land use	♦ Natural, largely undisturbed dense forest with very limited access. ♦ Small, subsistence-based settlements located adjacent to the Purari River. ♦ Discreet disturbances related to gas exploration, including isolated well pads, operations camps, access roads and an airstrip in PRL-15. ♦ No urban land uses and no evidence of forestry operations (during the survey).		
Landscape value	♦ Landscape varies considerably, from foothills of the southern extension of the central ranges to low-lying intermittent swampy wetlands. ♦ Dense vegetation and restricted access are consistent across PRL-15. ♦ There is a very limited network of existing tracks and trails; therefore, the Purari River is the primary access point into the area. ♦ The PRL-15 oxbow wetlands consist of a freshwater lake and wetlands. It is an area of potentially high environmental and social sensitivity, as it is a regionally rare example of an isolated open-water lake ecosystem. ♦ The large size of PRL-15 and the dense vegetation masks the limited significant visual divergence from most vantage points.		

Table 10.4 – Onshore Export Pipeline Corridor Landscape Character Description

Landscape Character	Landscape Description		
Topography	♦ South of the Purari River, the corridor initially crosses ridge-and-ravine country that is typically steeply sloped. Further south, the landform gives way to low- to moderate-relief (i.e., 10 to 100 m asl) ridge-and-ravine country. ♦ The coastal lowlands in the south comprise beaches and plains with elevations from below sea level to 190 m asl. ♦ Toward the coast, the southern part of the corridor encompasses soft mudstone areas typical of the low-lying Purari River delta (Plate 10.8). ♦ Coastal villages are low-lying and occur adjacent to creek and channel networks that pass into tidal inlets, lagoons, swamps and inundation areas (Plates 10.9 to 10.11).		
Vegetation/ land cover	♦ Dense forest on the ridges and ravines to the north gives way to dense scrub, marsh and mangroves in the far south (Plate 10.8). ♦ Small areas are cleared around villages for subsistence and plantation agriculture. ♦ Many areas are at or below sea level and are subject to inundation (Plate 10.9). ♦ Most of the area is undisturbed, with only partially cleared access tracks and trails between villages.		
	Plate 10.8 – River, Lowlands and Dense Vegetation Photo: SLR Consulting.	**Plate 10.9 – Coastal Villages and Inundation Areas** Photo: SLR Consulting.	**Plate 10.10 – Coastal Village Flanked by Waterway** Photo: SLR Consulting.
Built forms/ structures	♦ Non-coastal villages are small; and due to their relative isolation and remoteness, buildings tend to be small and to use traditional and locally sourced building materials. ♦ Away from the coastal and lowland villages, there is little to no built infrastructure. ♦ Simple traditional dwellings are typical in coastal villages (Plate 10.12).		

Table 10.4 – Onshore Export Pipeline Corridor Landscape Character Description (cont'd)

Landscape Character	Landscape Description		
Land use	♦ The area is predominantly densely vegetated with limited access. ♦ Village areas are mostly for housing and subsistence farming. ♦ A few small areas of agricultural activity occur. Crops are cultivated for consumption and trading (Plate 10.13). ♦ Substantial logging activity is evident throughout the upper sections of the onshore export pipeline corridor (Section 7.7.5.3 (including Plate 7.19) describes commercial logging activities in the study area).		
	Plate 10.11 – Coastal Villages Photo: SLR Consulting.	**Plate 10.12 – Coastal Village Buildings** Photo: SLR Consulting.	**Plate 10.13 – Coconut Grove** Photo: SLR Consulting.
Landscape value	♦ Landscapes vary considerably across onshore pipeline corridor areas, from the foothills of the ranges to low-lying intermittent swampy wetlands and coastal plains. ♦ Dense vegetation and limited accessibility is consistent across the whole area. ♦ Notwithstanding disturbance from logging activities, large expanses of the 70-km onshore export pipeline corridor and the dense vegetation shows limited visual divergence from most vantage points.		

Table 10.5 – River Transport Corridor Landscape Character Description

Landscape Character	Landscape Description		
Topography	♦ Varying topography as the corridor extends from the mountain foothills, beginning near the southern boundary of PRL-15 to the coast. Elevations range from below sea level to approximately 20 m asl. ♦ The Purari River's main channel varies in width, from approximately 300 m at Herd Base (Plate 10.16) to nearly 1 km at the coastal inlet, while the Varoi-Warne and Ivo-Urika rivers provide consistent corridors of 200 to 300 m wide. ♦ Known as the Purari River delta, the areas adjacent to the Purari River consist of low-lying creek and channel networks that pass into tidal inlets, lagoons, swamps and inundation areas.		
Vegetation/ land cover	♦ Dominated by wetland communities and forest on ridges and ravines to the north with dense scrub, marsh and mangroves in the far south. ♦ Riparian vegetation (Plate 10.15) is thick. ♦ Many minor tributaries close to the coast have areas that are close to or below sea level and are subject to inundation, consequently, many lowland and swamp forest vegetation species are present, notably nipa palm and mangrove (Plate 10.14).		
	Plate 10.14 – Aerial View of Nipa Palm Expanse Photo: SLR Consulting.	**Plate 10.15 – Typical Dense Riparian Vegetation** Photo: SLR Consulting.	**Plate 10.16 – Purari River at Herd Base** Photo: SLR Consulting.

Table 10.5 – River Transport Corridor Landscape Character Description (cont'd)

Landscape Character	Landscape Description
Built forms/ structures	♦ The few villages located along the river corridor (e.g., Aivai) consist mainly of simple traditional dwellings. ♦ Riverside villages are small, and buildings tend to be small, and to use traditional and locally sourced building materials. Some non-traditional building materials can be found due to the villages' close proximity to the river, which is used for transport. ♦ Little to no built infrastructure exists away from the river.
Land use	♦ The rivers are used for transportation, both for Project and non-Project activities. Multiple routes from the coast to Herd Base (Plate 10.16) and further upstream facilitate movement of people, supplies and equipment. The rivers are used for fishing and access to hunting grounds away from the villages. ♦ Clearing for gardens and plantations is evident in and around the villages. ♦ River village areas are mostly for housing, fishing and subsistence farming; beyond this the area is mainly undisturbed vegetation.
Landscape value	♦ Vegetation, including the riparian zone close to the river edges, is dense and limits accessibility. ♦ The rivers and other waterways are significant in their function as transport corridors, providing access to villages and natural resources inland. ♦ Riverine traffic may impact on the landscape character of rivers in terms of the presence of community and commercial vessels, water form (e.g., wave action and wakes) and riparian quality (e.g., disturbance from access to river banks; erosion and foam in riparian zones).

Table 10.6 – Offshore Export Pipeline Corridor Landscape Character Description

Landscape Character	Landscape Description		
Topography	Irrelevant to this part of the study area.		
Vegetation/ land cover	Irrelevant to this part of the study area.		
Built forms/ structures	Irrelevant to this part of the study area.		
Land use	♦ Commercial prawning and fishing occur offshore in designated fishing zones while villagers use the entire coastline for transportation, fishing and other subsistence uses (Plate 10.17). ♦ Fishing and other commercial vessels, including LNG carriers, commonly navigate the waters of the Gulf of Papua farther off the coast.		
Landscape value	♦ Low-lying intermittent wetland, coastal plains and coastal foothills landscape (Plate 10.18) tend to be heavily vegetated along the coastline traversed by the offshore pipeline corridor, and views of densely vegetated coastal plains and northern foothills are common (Plate 10.19). ♦ Shipping traffic and other sea craft are intermittently present offshore and visible from various vantage locations along the coast.		
	Plate 10.17 – Prawn Netting (Gulf of Papua Coast) Photo: SLR Consulting.	**Plate 10.18 – Onshore View (Aerial) of Orokolo Bay Coast** Photo: SLR Consulting.	**Plate 10.19 – Onshore View (Sea Level) of Orokolo Bay Coast** Photo: SLR Consulting.

CPF, Logistics Base and Airstrip Area

Although the precise location of the CPF, logistics base and airstrip has not been determined, the landscape of the wider area in which these components are proposed (see Figure 7.19) varies considerably, from low-lying intermittent swampy wetlands to mountain foothills (Plate 10.20). The landscape is densely vegetated and predominantly undisturbed, and the vegetation provides limited visual diversity from the river transport corridor, which contains most of the currently traversed vantage points into this area.

Plate 10.20 – Densely Vegetated Mountain Foothills

Photo: SLR Consulting.

ANT-3 Wellpad Landscape Character Description

The ANT-3 wellpad is located in mountainous terrain, typical of PRL-15 (see Figure 7.19). Vegetation has been cleared for gas exploration drilling and for the associated operations camp (Plate 10.21). Disturbance associated with existing drilling activities has generated an area visually divergent from the immediate surrounds; however, the cleared area of ANT-3 wellpad and the associated operations camp is surrounded by dense vegetation and steep topography.

Plate 10.21 – ANT-3 Wellpad from the Air

Photo: SLR Consulting. Note: The cleared area in the center is for the operations camp; the cleared area to the right is for the wellpad.

10.4.3.2 Onshore Pipeline Corridor

The onshore pipeline corridor component of the Project area is south of PRL-15 and stretches from the southern boundary of PRL-15 to the Gulf of Papua coastline. Table 10.4 summarizes the onshore pipeline corridor landscape character.

The onshore pipeline corridor encompasses existing villages along the Gulf of Papua coast (see Figure 9.2). These villages support most of the communities in the study area.

Sand and mud or silt beaches backed to the north by beach ridge complexes and beach plains comprise the Orokolo Bay area. Beach ridge systems and beach plains comprise recent sediments shaped as long parallel ridges and swales (Löffler et al., 1977).

Elevations range from below sea level to the coastal ridges at 100 m asl (see Figure 7.4). Creek and channel networks pass into tidal inlets, lagoons, swamps and inundation areas.

The visual environment in this coastal area varies; however, the low-lying and partially disturbed landscape is typical across the different villages in the study area.

10.4.3.3 River Transport Corridor

The river transport corridor lies west of the onshore export pipeline corridor and includes the Purari, Urika-Ivo and Warne-Varoi rivers (see Figure 7.10). Table 10.5 summarizes the landscape character of these riverways.

10.4.3.4 Offshore Export Pipeline Corridor

The offshore export pipeline corridor stretches from Orokolo Bay to an LNG plant proposed in Caution Bay in Central Province (see Figure 3.2). Table 10.6 summarizes the landscape character of the offshore export pipeline corridor.

10.5 Commercial Marine and River Transport

10.5.1 Study Overview

A baseline marine and river traffic and transport study (Part 22 of Volume 2) was undertaken in the upstream Project area to characterize commercial shipping, fishing vessels and village watercraft in the area. This section presents the findings of the commercial aspects of the marine and river traffic and transport study. The characterization of community traffic and transport is presented in Section 9.10.

The primary means of assessment for characterizing the commercial traffic and transport baseline included:

- A bibliographic review of existing published and unpublished literature.
- Examination of internet databases (i.e., marinetraffic.com and fleetmon.com) to obtain information on vessel type, size and frequency; existing international shipping lanes; coastal shipping routes; and key river transport corridors.
- A review of the Gulf of Papua Prawn Fishery (GOPPF) areas and trawler routes in the Gulf of Papua.

The study area for this study corresponds with the Project area of influence (PAOI), with a key focus on the offshore export pipeline corridor in the eastern Gulf of Papua and on the Purari River and its distributaries, the Urika-Ivo and Wame-Varoi rivers.

10.5.2 International and Coastal Shipping

No international shipping lanes traverse the Gulf of Papua near the offshore export pipeline corridor, although tankers arrive and depart from the PNG LNG Facilities in Caution Bay.

Shipping routes in the Gulf of Papua mainly center on commercial vessels sailing to and from Port Moresby and the inland river ports in Western Province (e.g., Kiunga) and Gulf Province (e.g., Kikori, Kopi, Baimuru and Herd Base) (Table 10.7 and Figure 10.7).

Table 10.7 – Main Coastal Shipping Routes in the Gulf of Papua and Inland Waterways

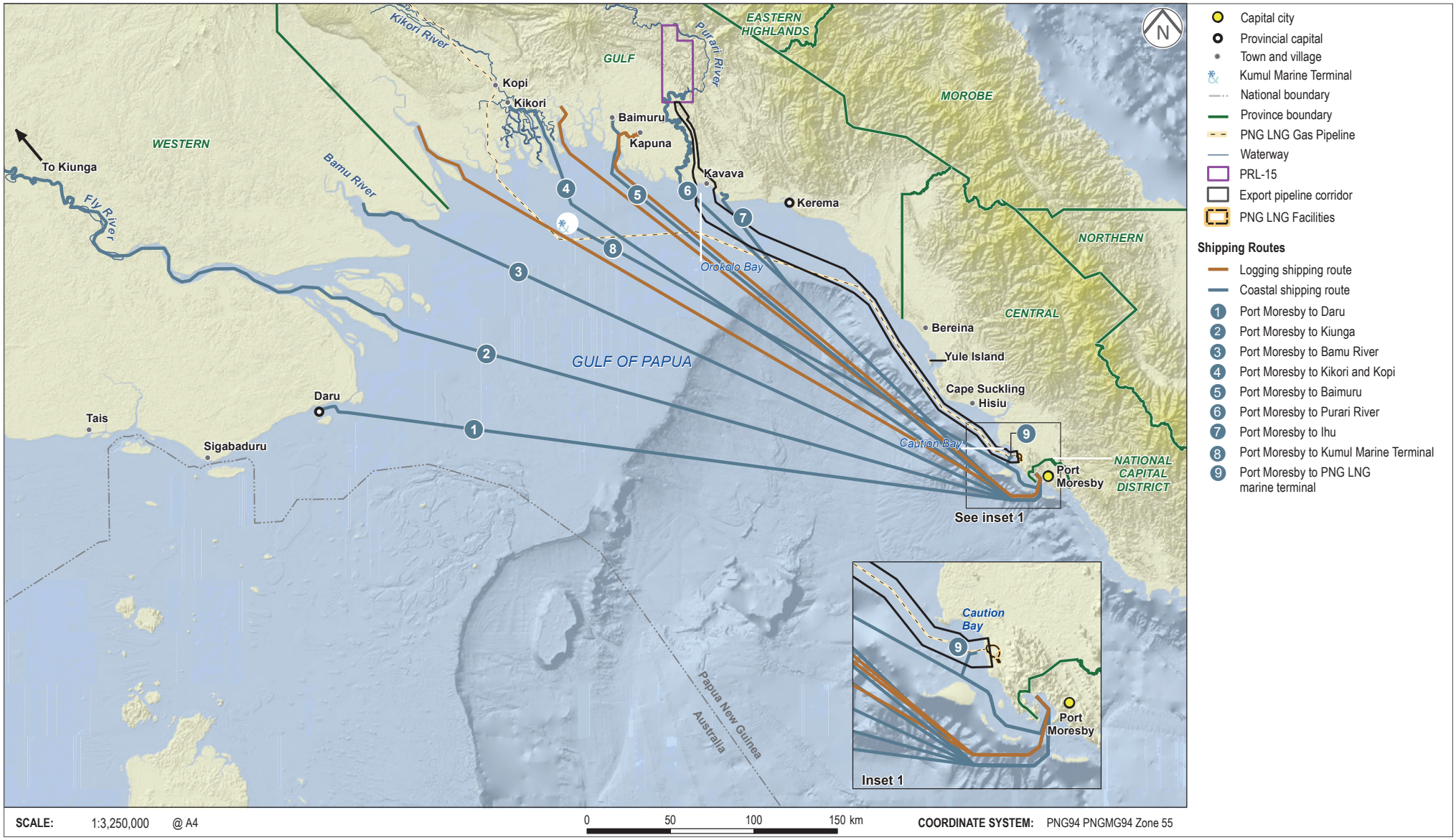
Route No.	Details	Typical Vessels or Purpose	Return Trips Per Year
1	Port Moresby to Daru	Cargo vessels and fuel tankers supplying Daru township	15*
2	Port Moresby to Kiunga#	Ok Tedi Mining Limited (OTML) copper concentrate bulk carriers	102
		OTML cargo (barges and containers)	25*
		Horizon Oil's Elevala Gas Condensate Project	15*
		Talisman Energy's Stanley Gas Condensate Project	15*
		P'nyang Gas Project	10*
		Shallow-draft container ships and towed barges serving Kiunga township	45*
		Subtotal	**212**
3	Port Moresby to Bamu River	Panakawa timber processing (veneer) and Kamusie Sawmill in the Wawoi and Guavi tributaries of the Bamu River	15*
4	Port Moresby to Kikori and Kopi	Supplies to oil and gas exploration activities and operating facilities owned by ExxonMobil and Oil Search and other businesses using Kikori township	120*
5	Port Moresby to Baimuru	Supplies to Baimuru township	15*
6	Port Moresby to Purari River	Supplies to TEP PNG's gas exploration in PRL-15	190†
		Log ships to Evara logging camp on the Purari River	24
7	Port Moresby to Ihu	Supplies to Ihu township	26*
8	Port Moresby to Kumul Marine Terminal	Svitzer's tugs or offshore supply vessels servicing the Kumul Marine Terminal	35
9	Port Moresby to PNG LNG marine terminal**	Four tugs and a pilot boat servicing the PNG LNG marine terminal in Caution Bay	200*
10	Port Moresby to PNG ports	Coastal shipping to PNG's eastern and northern ports	550*

* Estimates.
# The number of copper concentrate bulk carrier trips was based on the 381,075 t/yr of bulk dried concentrate exported from the Ok Tedi mine during 2014 via Kiunga River port (OTML, 2014) and OTML's two dedicated bulk carriers, which have a dried concentrate carrying capacity of 3,700 t each. Other shallow-draft general cargo and container ships, barge landing craft and tug-towed barges serve other hydrocarbon exploration activities, including the P'nyang Gas Development Project, the Horizon Oil and Repsol Elevala Gas/Condensate Project, and the Stanley Gas Field Development Project.
† Information provided by TEP PNG.
** Located in the PNG LNG Facilities.
Note: Shading denotes a coastal or river shipping route that overlaps with the PAOI.

COASTAL AND RIVER SHIPPING ROUTES

Papua LNG Project | Environmental Impact Statement

FIGURE 10.7



ERIAS Group | 01215B_23_F10-7_v1

The busiest route is the Port Moresby to Kiunga route (i.e., 212 return trips/year), which is also the key route for shallow-draft copper concentrate bulk carriers (i.e., 102 return trips/year) transshipping copper concentrate from the Ok Tedi copper mine to a silo ship moored in Port Moresby harbor.

The shipping routes in the PAOI are:

- Route 6 – Port Moresby to Purari River. Herd Base is the river port and destination for TEP PNG's two contracted barge landing craft, which supply goods and equipment to the Project's current exploration activities. Log ships travel to and from Evara logging camp on the Purari River.
- Route 7 – Port Moresby to Ihu in Gulf Province. Gulf Province currently has three passenger vessels that service ports in the province, namely, the MV East/West Kikori, MV Baimuru and MV Ahi. One of these vessels is anticipated to serve Ihu part-time, although the frequency of the service to Ihu is currently unknown. The anticipated frequency is fortnightly visits (i.e., 26 return trips/year) to Ihu.
- Route 9 – Port Moresby to PNG LNG marine terminal. Besides the international LNG carriers visiting the PNG LNG marine terminal to load LNG, four tugs have been contracted to assist in towing and maneuvering LNG carriers in the shipping channel and turning basins and in berthing and unberthing LNG carriers at the PNG LNG marine terminal.

10.5.3 Commercial Fishing

The GOPPF has nine trawl-fishing grounds, three of which cross the Project's offshore export pipeline corridor (see Figure 8.26). These are the GOPPF reporting areas of Orokolo Bay, West Kerema and Iokea, which include the transit routes of trawlers accessing the trawling grounds in these areas. In addition, almost all trawlers to and from Port Moresby to the GOPPF reporting areas cross the export pipeline corridor near its approach to and in Caution Bay.

The GOPPF operates a current fleet of eight trawlers in the Gulf of Papua. The National Fisheries Authority currently licenses ten trawlers, but two are non-operational as they are either being overhauled or re-equipped. Due to prevailing weather and changeable sea states, the trawlers are generally large at 24 to 30 m long, although smaller vessels occasionally trawl in the more sheltered inshore waters. Trawling takes place 24 hours a day for approximately 250 days per year during the April to November open season.

In general, the fishing grounds extend seaward of the 3 nautical mile limit to approximately 40 m deep but typically the trawlers operate in the depth range of 10 m to 35 m. A small number of licensed trawlers have access to the 2 to 3 nautical mile zone based on joint venture agreements with the prawn resource owners, i.e., local Gulf Province communities that have customary rights to the marine biological resources out to the 3 nautical mile limit adjacent to their lands. This allows profit sharing on the value of the prawn catch by trawlers operating within the 3 nautical mile limit (Liviko, pers. com., 2015).

Section 8.6 provides baseline information on commercial marine fisheries resources.

10.5.4 Commercial River Traffic

Commercial river traffic on the Purari River or its delta distributaries includes vessels contracted by TEP PNG to supply goods and equipment services to exploration activities in PRL-15 via Herd Base (Plates 10.22 and 10.23) and log barges that travel along the Purari River to Evara logging camp (Plate 10.24).

In 2016, the two main TEP PNG barges made 190 return trips. In addition, TEP PNG uses two small, high-speed barge-punts from Herd Base to transfer local staff, goods and equipment to various locations across PRL-15 and to neighboring villages (Plate 10.25).

Frontier Holdings Limited, a subsidiary of Rimbunan Hijau (PNG) Limited[4] make approximately 24 log ship return trips a year to Evara logging camp. The logging barge, MV *Swift No. 5*, is 44.9 m long and has a mean draft of 3.1 m.

Plate 10.22 – TEP PNG's Contracted Barge Landing Craft MV *Balimo Chief*

Photo: EnviroGulf Consulting.

Plate 10.23 – TEP PNG's Contracted Barge Landing Craft MV *GFS Marine 01*

Photo: EnviroGulf Consulting.

Plate 10.24 – Log Barge MV *Swift No. 5* at Evara Logging Camp

Photo: ERIAS Group.

Plate 10.25 – TEP PNG's Exploration Barge-punt *Baimuru Bullet*

Photo: ERIAS Group.

10.6 Waste Characterization

10.6.1 Study Overview

A preliminary desktop study was undertaken to provide a high-level characterization of the receiving waste management environment in Papua New Guinea. This preliminary study has drawn on:

- Available public information, through internet searches, notably on waste classifications and regulatory requirements.
- Interviews with TEP PNG personnel about existing company waste management practices.
- Interviews with PNG's Conservation and Environment Protection Authority (CEPA) representatives and with current PNG waste facilities operators who were available.

4 Log barge routes were not confirmed during the study; however, log barges are likely to use all three distributaries and choose the route most suitable for navigation given the environmental conditions when traveling (similar to TEP PNG barges).

The focus of this section is to classify waste types and to outline the current practices of waste management facilities that the Project may consider using.

10.6.2 Waste Classifications

In the absence of specific definitions for hazardous and non-hazardous waste types and characteristics for Papua New Guinea, definitions from the following international conventions and guidelines have been considered:

- Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal (UNEP, 1989).
- The Convention to Ban the Importation into Forum Island Countries of Hazardous and Radioactive Wastes and to Control the Transboundary Movement and Management of Hazardous Wastes within the South Pacific Region (Waigani Convention) (SPFS, 1995).
- The Stockholm Convention on Persistent Organic Pollutants (SESC, 2001).
- IFC/World Bank Group's Environmental, Health and Safety General Guidelines, Section 1.6 Waste Management (IFC, 2007).
- TOTAL General Specification: Environment: Environmental requirements for project design and E&P activities (GS EP ENV 001).
- A report from the International Association of Oil and Gas Producers regarding naturally occurring radioactive material (NORM) (IOGP, 2016).[5]

10.6.3 Waste Management Facilities – Receiving Environment

The existing receiving environment, i.e., the waste management facilities that are currently available in Papua New Guinea and confirmed by CEPA, are outlined in Table 10.8.

Table 10.8 – Existing Waste Management Facilities in Papua New Guinea

Facility	Operator	Capacity	Comments
Baruni Landfill – Port Moresby	Division of Waste Management - National Capital District Commission	More than 300 tonnes/ day	The facility receives municipal solid waste generated from households, settlements, institutions, and commercial facilities.
PNG Recycling – Port Moresby	Sims Metal Management	Unknown	PNG Recycling is a subsidiary of the international Sims Metal Management. It is one of Papua New Guinea's leading metal recyclers, with operations in Port Moresby, Lae and Tabubil. The facility provides customer-specific metal, tire, plastic and battery recycling solutions. It accepts used batteries, which are on-sold to PEC Trade in Lae. The company holds permits to export wastes, as required under the Waigani Convention.

5 'The Project is not expecting naturally occurring radioactive material (NORM) to be generated.

Table 10.8 – Existing Waste Management Facilities in Papua New Guinea (cont'd)

Facility	Operator	Capacity	Comments
Napa Napa refinery - Port Moresby	Puma Energy	Unknown	Limited information is available on this facility; however, it includes an oil recycling facility.
AES Waste and Resource Management Facility - Ruvuvu and TWM waste storage and transfer facility, Badili, Port Moresby	Total Waste Management (TWM PNG)	Waste oil treatment facility: 1 million m^3/yr. TWM PNG advised that waste management capacity is not constrained if a potential client and TWM PNG preplan how waste is collected, transferred and stored. TWM PNG can ramp up, as required to accommodate any contracted service.	The initial waste collection location and the waste oil treatment facility is located at Ruvuvu. TWM PNG offers a range of waste management services including solid general wastes, construction wastes, liquid wastes (industrial, grease trap and septic), security and contraband wastes and hazardous wastes. In Port Moresby, TWM PNG also offers recycling services for a range of products including waste oils and greases, ferrous metals, paper and cardboard, aluminum cans, tires, timber and some plastics.
ECE	Eco Care Engineering Ltd	Not applicable	An engineering firm based in Port Moresby. It currently has no infrastructure in place for waste management, but is investigating a commercial project southeast of Port Moresby.
Branis Recycling	Branis Recycling Ltd	Unknown	Based in Port Moresby, this company specializes in exporting high-value, non-ferrous metals. They also collect ferrous metals to on-sell to PNG Recycling.
Toxfree	Toxfree Australia	Unknown	An Australia-based company currently offering waste management services in Papua New Guinea. Wastes collected by Toxfree are reportedly shipped offshore to Australia under the Waigani Convention. Limited information is available on this company.
PEC Trade	PEC Trade	Unknown	A PNG company specializing in battery recycling based in Lae. Limited information is available on this company.

These existing waste management facilities offer the following waste management options, which consider national and international legislation, and good international industry practice, described in Chapter 2:

- Recycling (beneficial reuse) of select hazardous and non-hazardous wastes.
- Burial or on-site disposal of select non-hazardous wastes.
- Incineration and disposal of ash at a landfill for select hazardous and non-hazardous wastes.
- Disposal at a landfill for hazardous and non-hazardous wastes that cannot be recycled, treated or incinerated.
- Export of select wastes.

10.6.3.1 Recycling

Table 10.9 summarizes the current recycling and reuse options in Papua New Guinea.

Table 10.9 – Recycling and Reuse Options

Waste Facility/ Operator	Waste Accepted							
	Ferrous	Non-ferrous	Plastic	Paper and Cardboard	Glass	Waste Oil	Batteries	Rubber Tires
TWM PNG*	✓	✓	✓	✓	✓	✓	✓[#]	✓
PNG Recycling*	✓	✓	-	-	-	-	✓	-
Puma Energy	Limited information available					✓	Limited information available	✓
Branis	✓	✓	-	-	-	-	-	-
Toxfree	Limited information available					✓[†]	Limited information available	✓
Pec Trade	Limited information available						✓	Limited information available

* TWM PNG and PNG Recycling export materials (e.g., glass, plastic, paper and cardboard) to Australia for beneficial reuse, if they cannot be recycled in Papua New Guinea.
[#] TWM PNG recycles batteries via PNG Recycling.
[†] Toxfree exports all waste for recycling.

In addition, the following reuse options are available for non-hazardous wastes:

- Whole glass drink bottles may be returned to the bottling plant.
- Wood may be recycled and distributed to local communities.
- Geotechnically suitable and uncontaminated drill cuttings may be used for forming hardstand areas or as road fill.
- Spoil material may be used as general fill or for landscaping depending on its properties.

10.6.3.2 Incineration

Incineration is used to reduce the waste volume that would otherwise need to be transported whole to a waste management facility for disposal in a landfill or for export. In Papua New Guinea, incineration is regulated by national legislation, international conventions and good international industry practice.

The following types of waste can be incinerated:

- Hazardous inert wastes:
  - Medical wastes.
  - Oily debris, including used lubricated oils.
  - Plastic materials.
  - Unused, spent, expired and contaminated solvents, chemicals and additives.
  - Combustible drums and containers.
- Non-hazardous wastes:
  - Paper and cardboard.
  - Food scraps.
  - Vegetation.
  - Scrap wood (untreated).

Ashes that meet acceptance criteria can be transported to a landfill for disposal. Medical waste disposal is via incineration at public hospitals; however, reports suggest many hospital incinerators are not operational due to old age and maintenance issues, resulting in the burial of medical waste in pits. TWM PNG accepts, incinerates and disposes of medical waste.

10.6.3.3 Disposal at a Landfill

The Baruni Landfill is the only remaining legally gazetted landfill servicing the Port Moresby area. It accepts more than 300 tonnes/day of municipal solid waste from households, settlements, institutions and commercial facilities and is expected to remain in service for the next 10 years. The landfill site has limited fencing, and waste is disposed of in unconfined and uncontrolled piles.

10.6.3.4 Export of Select Waste

Two commercial recycling operators (i.e., PNG Recycling and TWM PNG) collect, process and export non-ferrous metals and batteries from Port Moresby to Australia, Singapore and the Republic of Korea. Branis Recycling also exports non-ferrous metals. In addition to non-ferrous material and batteries, mercury may be recovered from adsorbent material and then transported for recovery and recycling, or mercury adsorbent may be exported for disposal in accordance with applicable international convention.

Toxfree exports a variety of hazardous wastes, including halogenated and non-halogenated solvents, oily water, acids and alkalis, catalysts, oxidants and resins for either recycling or disposal in Australia. TWM PNG also exports hazardous sludge from wastewater ponds and amine facilities.

Export of hazardous wastes requires permits under the Waigani Convention.

10.7 References

EC. 2016. Air Quality Standards. A WWW publication accessed on 14 February 2017 at http://ec.europa.eu/environment/air/quality/standards.htm. European Commission, Brussels, Belgium.

IFC. 2007. Environmental, Health and Safety General Guidelines. International Finance Corporation, World Bank Group, Washington, D.C.

IFC. 2012. Guidance Notes. Performance Standards on Environmental and Social Sustainability. International Finance Corporation, World Bank Group, Washington, D.C.

IOGP. 2016. Managing Naturally Occurring Radioactive Material (NORM) in the oil and gas industry. IOGP Report 412. The International Association of Oil & Gas Producers, London.

Liviko, I. 2012. Status Report: Gulf of Papua Prawn Fishery. PNG National Fisheries Authority, Port Moresby.

Löffler, E. 1977. Geomorphology of Papua New Guinea. Commonwealth Scientific and Industrial Research Organisation and Australian National University Press, Canberra, ACT.

OTML. 2014. Ok Tedi Mining Limited Annual Review 2014. A WWW publication accessed 12 February 2019 at https://www.oktedi.com/index.php/media-items/publications/annual-review/373-2014-annual-review/file. Ok Tedi Mining Limited, Port Moresby.

SESC. 2001 (as amended). The Stockholm Convention on Persistent Organic Pollutants. A WWW publication accessed 4 March 2019 at http://www.pops.int/TheConvention/Overview/tabid/3351/Default.aspx#. The Secretariat of the Stockholm Convention, Stockholm.

SPFS. 1995. The Convention to Ban the Importation into Forum Island Countries of Hazardous and Radioactive Wastes and to Control the Transboundary Movement and Management of Hazardous Wastes within the South Pacific Region (Waigani Convention). A WWW publication accessed 4 March 2019 at https://treaties.un.org/doc/Publication/UNTS/Volume%202161/v2161.pdf. South Pacific Forum Secretariat, Waigani.

UNEP. 1989 (as amended). Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal. A WWW publication accessed 4 March 2019 at http://www.basel.int/Portals/4/Basel%20Convention/docs/text/BaselConventionText-e.pdf. United Nations Environment Programme, Nairobi.

USEPA. 2017. National Ambient Air Quality Standards Table. A WWW publication accessed 14 February 2017 at https://www.epa.gov/criteria-air-pollutants/naaqs-table. United States Environmental Protection Authority, Durham, North Carolina.

WHO. 2005. Air Quality Guidelines For Particulate Matter, Ozone, Nitrogen Dioxide and Sulfur Dioxide - Global Update 2005. World Health Organization Regional Office for Europe, Copenhagen, Denmark.