









TOTAL E&P PNG LIMITED

PAPUA LNG

Upstream Environmental Impact Statement

Volume 2: Environmental and Social Baseline

Part 23
Field Survey Scope and Methods Documents

TOTAL
TOTAL E&P PNG LIMITED

Part 23

Field Survey Scope and Methods Documents

A	Groundwater and Geology, Terrain and Soils Baseline Scope and Methods
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Part 23A
Groundwater and Geology, Terrain and Soils Baseline Scope and Methods

PAPUA LNG PROJECT

GROUNDWATER AND GEOLOGY, TERRAIN & SOILS BASELINE - SCOPE AND METHODS

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1. Project Overview

TOTAL Exploration and Production Papua New Guinea Limited (TEP PNG) is planning the development of the Elk-Antelope gas field in Papua New Guinea as part of the proposed Papua LNG Project (the Project).

The Elk-Antelope gas field is located within Petroleum Retention License 15 (PRL-15) in Baimuru District, Gulf Province, approximately 120 km inland from the township of Kerema and 360 km northwest of Port Moresby. The gas field is a highly significant gas discovery in Papua New Guinea and consists of a deep, high pressure, elevated temperature gas reservoir with several trillion cubic feet of gas reserves.

The Project development includes the following facilities:

- Wellpads and upstream gathering system.
- An upstream central processing facility (CPF) to separate and condition gas and condensate streams.
- Export gas and condensate pipeline system, comprising separate single gas and condensate export pipelines in the same route. The pipeline will traverse both onshore and offshore environments (approximately 70 km and 255 km, respectively).
- A liquefied natural gas (LNG) plant and support infrastructure, and associated coastal marine export facilities.

This document describes the scope and methods for baseline characterization of groundwater, soils and terrain, and geology and geomorphology required as part of the environmental and social impact assessment for the Project. The assessment described here is limited to the upstream terrestrial components of the Project.

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2. Study Objectives

2.1 Geology and Geomorphology

The geology of the gulf region is quite complex with moderate slopes and potential stability issues, active seismicity, thrust faulting, although limited compared to highlands, and complex structural geology. The Project area is located in the Purari catchment within the gulf region of Papua New Guinea (PNG). The Purari catchment exemplifies many of the central features of Papua New Guinea's geology and geomorphology. Foremost of these are the recent geological origin of much of the island, with late Tertiary marine sediments now considerably uplifted and deformed, the intense erosion that has taken place since uplift, and the influence of volcanism. Only small areas of rocks are older than the Tertiary, and most of the catchment did not emerge from the sea until after the Eocene. Since then, however, uplift volcanism and erosion have been rapid, and have led to some spectacular landforms. Large strato-volcanoes, bold limestone scarps and deeply incised gorges are marked features of the landscape. Slopes are predominantly steep and lead down to rivers that almost always flow as swift, muddy streams. The Purari catchment provides a good example of the geology and landforms of tectonically active areas.

Given the change in elevation from PRL-15 to the coast, the Project will encounter a variety of geomorphological environments. In the alluvial plains nearer the coast, soft alluvial soils are anticipated and are likely to have erosion potential, as well as potential acid sulfate soils, owing to the presence of brackish tidal creeks.

The objectives of the geology and geomorphology component of this study are to:

- Characterize geology of the Project area.
- Collect information on geology and geomorphological aspects that may impact on other studies (e.g., soils and terrain component) and provide support in assessing potential impacts on resources uses (ecosystem services).

For the purposes of this rationale document the geology and geomorphology component has been combined with the soils and terrain component. The proposed fieldwork for these studies will be undertaken by a geologist and two soil scientists working alongside each other investigating the same sites and soil profiles.

2.2 Soils and Terrain

The soils in Papua New Guinea are relatively young, particularly in areas where sedimentation is occurring or volcanoes are depositing ash. Papua New Guinea uses the United States Department of Agriculture (USDA) Soil Taxonomic System in soil text books, publications and on the PNG Resource Information System (PNG RIS). Information from PNG RIS shows that the study area is dominated by the Inceptisol USDA soil order, with other minor soil orders likely present including Entisols and Ultisols.

The objective of this study is to provide soil profile based evidence (ground truthing) to confirm the existing base mapping of soil types in the proposed disturbance areas of the Project. Furthermore, the soils and terrain assessment will be integrated with the geology and geomorphological study to deliver an integrated earth science baseline characterization that will

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inform the impact assessment of these aspects of the Project area. In the absence of a national PNG soil classification system, the USDA Soil Taxonomic System will be adopted to classify soil taxonomic units. This is a widely accepted international method for describing soil units..

Similarly, the adopted standard for the land capability component of the assessment will be the USDA Land Capability Classification System in the absence of a local PNG standard.

The purpose of the soils and terrain assessment is to provide an inventory of topography (terrain), soil units and relevant characteristics of the soil units within the Project area. The specific objectives of the soils and terrain assessment are to:

- Describe, classify and map soils within the Project area.
- Characterize the different soils units in terms of land capability, where agricultural (e.g., community garden and plantation) activities may be impacted by the Project.
- Analyse the various soil units within the Project area to identify inherent/natural features that may be difficult or problematic to manage when disturbed (e.g., highly erodible/dispersive soils or potential acid sulfate soils) and/or difficult to rehabilitate.
- Support the assessment of project-related impacts on soil productivity and natural resource uses (ecosystem services) that are dependent on the retention of productive soils, which may potentially be lost from disturbed areas to downslope depositional areas (i.e., colluvium) or to the natural drainage through rainfall-based erosion and scour and overland sediment transport.
- Identify any soil and terrain issues that may impact or constrain the project, including seismicity, potential for mass movement or ground instability, erodibility, problem soil types (e.g., potential acid sulfate soils, dispersive soils, etc.).

2.3 Groundwater

The geology of the gulf region is characterized by active seismicity, thrust faulting, and complex geological structure particularly in the inland areas. Carbonaceous geology in the area has potential for increased secondary porosity as a result of dissolution processes. Alluvial aquifers towards the coast act as an important water resource in areas where surface water is often brackish (PNGNARI, 2015).

The objectives of the hydrogeological study are to:

- Outline the overall hydrogeological context of the Project area.
- Describe aquifer characteristics.
- Assess groundwater vulnerability to Project activities employing a risk management framework approach.
- Provide information and data to support the assessment of potential project-related impacts to groundwater and groundwater-based resource uses (ecosystem services).

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3. Study Area and Project Areas

The study area includes the areas surrounding the upstream components of the Project. The areas to be assessed include:

- The Elk-Antelope gas field within Petroleum Retention License 15 (PRL-15).
- The proposed pipeline corridor between PRL-15 and the coast.

Specific focus will be on areas of existing or planned development such as:

- Wellpads and upstream gathering system, within PRL-15.
- The upstream central processing facility (CPF) including supporting infrastructure, within PRL-15.
- Export gas and condensate pipeline system, comprising separate single gas and condensate export pipelines along the same route. This study is restricted to the upstream pipeline section between PRL-15 and the coast.

The Project area of influence relevant to groundwater, soils and terrain, and geology and geomorphology is expected to be restricted to within close vicinity of areas of direct disturbance from these developments.

The downstream area at Caution Bay will be assessed as part of a separate survey to be described and conducted at a later date.

Preliminary assessment of potential risks to groundwater, soils and terrain, and geology and geomorphology aspects of the Project area based on initial bibliographic review is described in Section 4. Details of specific study and investigation locations are included in Section 9.

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4. Study Approach

The approach for the geology and geomorphology, terrain and soils and groundwater studies includes a bibliographic review supplemented by field surveys to fill identified data gaps. The approach was guided by the following assessment and study criteria/standards:

- PNG Conservation and Environmental Protection Authority (CEPA) guideline GLEnv02/2004.
- Guideline for Conduct of Environmental Impact Assessment & Preparation of Environmental Impact Statement (CEPA, 2004).
- TOTAL general specification GS EP ENV 111: Environmental Baseline and Monitoring Studies: Onshore Sites (Total, 2012).
- TOTAL general specification GS EP ENV 120: Environmental Impact Assessment of E & P Activities (Total, 2007).
- International Finance Corporation (IFC) Performance Standards (especially Performance Standards 1 and 3 and guidance notes).

4.1 Bibliographic Review

The desktop review identified that the most recent and detailed soil mapping is provided by the 2014 report by Fugro Geoconsulting S.A.S, titled Engineering Consultancy Report Desktop Study, Elk-Antelope Block PRL 15, Papua New Guinea (Fugro, 2014), and the GIS soils map for the Project area), sourced from Mipela Geosolutions based on data from PNGNARI (2015). The Fugro (2014) report distinguished only two subsurface conditions within the onshore pipe corridor soil province: low-lying alluvial valley soils and upslope residual soils. Very limited information was provided in Fugro (2014) on potential soil types or soil characteristics of soils within the Project area. The GIS mapping (PNGNARI 2015) showed a greater detail of soil units classified using the USDA soil taxonomy system, the use of which is also proposed in this study.

The following information sources were used in this desktop review:

Bourke, R.M. and Harwood, T. (eds). 2009. Food and Agriculture in Papua New Guinea. ANU E Press, The Australian National University, Canberra.

ERIAS Group. 2015. Societal and Environmental Screening Study Report: Elk-Antelope Project Facilities. Report No. 01215A_3_v2. Report prepared for TOTAL Exploration & Production, Camberwell.

Evesson, D.T. 1983. The Climate of the Purari River Basin. Chapter 2 in Part 1 of Petr, T (ed.) The Purari – Tropical Environment of a High Rainfall River Basin, Dr W Junk Publishers, The Hague.

Fugro Geoconsulting S.A.S. 2014. Engineering Consultancy Report, Desktop Study, Elk Antelope Block PRL15, Papua New Guinea. Report prepared for TOTAL SA, Paris.

GHD. 2015a. Antelope South-1 – Environmental Impact Assessment and Environmental Management Plan. Report prepared for InterOil SPI (208) Ltd.

GHD. 2015b. Antelope 4 – Environmental Impact Assessment and Environmental Management Plan. Report prepared for InterOil SPI (208) Ltd.

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GHD. 2015c. Antelope 6 – Environmental Impact Assessment and Environmental Management Plan. Report prepared for InterOil SPI (208) Ltd.

Pajimans, K. 1983. The Vegetation of the Purari Catchment. Chapter 1 in Part 2 of Petr, T (ed.) The Purari – Tropical Environment of a High Rainfall River Basin, Dr W Junk Publishers, The Hague.

PNGNARI. 2015. Papua New Guinea National Agricultural Research Institute. PNG National Papua New Guinea Resource Information System (PNGRIS) Data.

Pickup, G. and Chewings, V.H. 1983. The Hydrology of the Purari and its Environmental Implications. Chapter 8 in Part 1 of Petr, T (ed.) The Purari – Tropical Environment of a High Rainfall River Basin, Dr W Junk Publishers, The Hague.

SKM. 2008. Groundwater Impact Assessment – Upstream Facilities. PNG LNG Environmental Impact Statement. Report prepared for ExxonMobil.

Soil Survey Staff USDA. 2014. Soil Taxonomy: A Basic System of Soil Classification for Making and Interpreting Soil Surveys. Twelfth edition. Natural Resources Conservation Service.

Information on groundwater resources in the Project area, including location of village wells, was also obtained from the social baseline surveys undertaken for the Project.

4.2 Preliminary Risk Assessment

To identify a suitable study approach for the assessment, including a soil sampling and groundwater assessment program, a high level, preliminary risk assessment of the Project area has been undertaken by SLR based on likely levels of soil disturbance including potential impacts from erosion and sedimentation, acid sulfate soils and potential soil related problems for rehabilitation. The preliminary risk assessment also considered potential vulnerability of groundwater within the Project area. The risk assessment identified soil disturbance at the well pads to be the highest risk in regard to soils and management of soils. The construction of the pipeline route was considered low risk with the exception of potential acid sulfate soils occurrence in coastal lowland areas and where the pipeline requires excavation along ridges, both of which were considered to present medium risk.

The soil survey sites proposed in this study rationale reflect the abovementioned risk assessment in regard to sampling site location and density.

The initial high level risk assessment with respect to groundwater within the Project area has identified the most vulnerable groundwater element to be shallow and perched water likely to be present in upper weathered material overlying harder more impermeable geology. Literature sources describe three distinct groundwater types in the upstream Project area although it is reasonable to separate the upper shallow system into two systems – shallow perched and shallow permanent. The hydrogeology in the upstream Project area is therefore considered to comprise four hydro-stratigraphic units (HSU):

1) Perched groundwater within upper weathered material and alluvium is considered to represent the primary source of creek discharge in their upper reaches. In the gas field areas this groundwater may not be present year round and is unlikely to be laterally continuous. In the lower coastal areas this groundwater may be very shallow (<1 m below ground level (bgl))

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and is a primary water supply for a number of villages. Perched groundwater configuration is likely to be a subdued reflection of topography.

2) Shallow permanent groundwater within sandstones, siltstones, mudstones and minor conglomerates of the Era Beds in certain areas of the Project (Era Beds are largely absent from the gas field area) is understood to exist at depths corresponding to the levels of nearby watercourses. Beneath ridgelines and high points groundwater could be greater than 200 m bgl.
3) Formation water within the Orubadi mudstones is likely to be present at various levels throughout the formation. The hydraulic conductivity of this material is likely to be low and only low volumes of water have been encountered during the drilling of exploration wells (this HSU is not considered to represent an aquifer).
4) Deep groundwater within the Kapau Limestone (>3500 m bgl) that contains the gas reservoir is expected, although only in low quantities as pore space in this geology is occupied by hydrocarbons.

The formation water and deep groundwater are understood to be confined systems with little or no connectivity to overlying aquifers or surface water. These HSUs are therefore not considered likely to be impacted by Project activities with the exception of direct depressurisation of the reservoir associated with abstraction of gas.

The upper two HSUs may potentially be impacted by Project activities both during drilling and construction and during operations. Potential sources of impact include drilling fluids, fuels, sewage and wastewater. The uppermost HSU within weathered material and alluvium is considered to be most at risk, particularly in the upper Project areas where this shallow groundwater is a major contributor to surface waters and in the coastal area where this groundwater is utilised by villages as a domestic water source. The deeper groundwater within the Era Beds is considered to be at medium risk from Project activities as it is protected to some degree by overlying material though is likely to contribute to surface water base flow.

4.3 Preliminary Conceptual Site Model

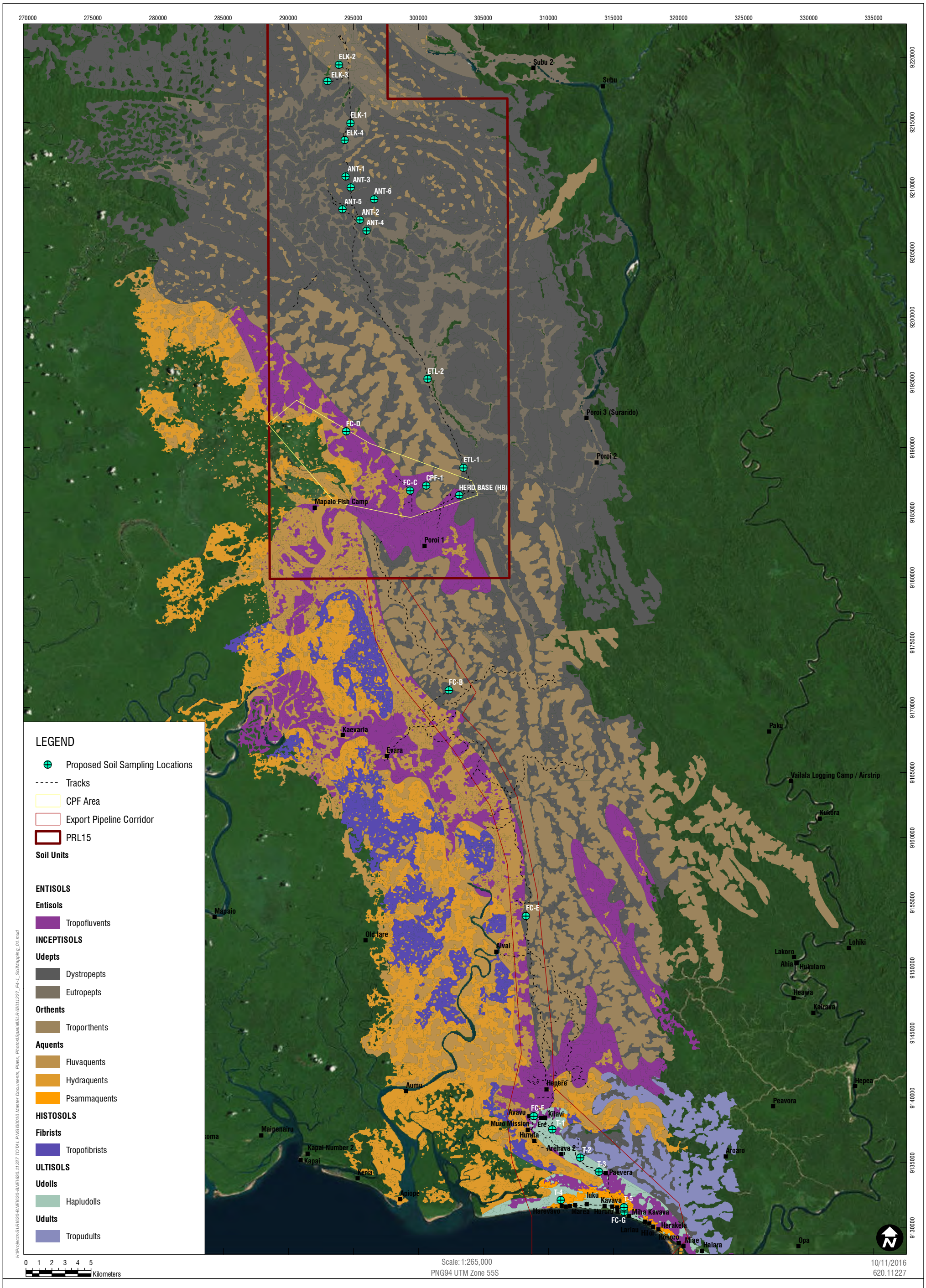
The results of the bibliographic review yielded base maps as sourced from PNGRIS of USDA soil taxonomy units and resource management units. These soil units have been produced using various soil survey studies and remote sensing techniques detailing topography, geology and vegetation maps, and are shown in Figure 4.1. This base soil units map forms the foundation of the ground-truthing and sampling program proposed.

The preliminary groundwater risk assessment described above discusses the various HSU present within the Project area. A conceptual understanding of theses HSUs and their interactions in terms of recharge and discharge has been developed.

4.3 Gap Analysis

The preliminary conceptual site model for soils is limited to mapping undertaken at a usable scale of 1:500,000. Mapping at this scale is inadequate to predict soils that may be encountered and their characteristics and management requirements for the proposed construction activities. There is no evidence of the location of soil profile investigations that may have been undertaken in the production of this conceptual mapping and therefore no evidence of on ground assessment of soil profiles within the Project area.

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Soil Units

FIGURE 4.1

The soil component of this study aims to provide ground soil profile information to confirm/modify the base mapping provided by PNGRIS.

Groundwater assessment in the Project area to date has been limited and little detail is known about groundwater in any of the HSUs. There are few groundwater access points within the Project area, with only a single bore near to the gas field and no bores along the pipeline alignment. Groundwater springs are understood to be relatively common in the upper reaches of the Project area, as are hand dug village wells used for domestic consumption in the lower coastal areas. There is little quantitative data regarding levels, flow or quality or water from these shallow groundwater features.

The groundwater survey is intended to build on this understanding through investigation of the upper Project areas to identify spring and discharges (where possible). In addition, known shallow groundwater wells within coastal villages will be assessed. Groundwater samples will be collected to allow ‘water typing’ that will improve understanding of the relationships between groundwater, surface water and recharge. Through these assessments the baseline condition of groundwater will be characterised and an understanding obtained of the vulnerability of groundwater to potential impacts from Project activities.

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5. Survey Period

The seasons in Papua New Guinea (and rainfall patterns) are generally defined by the southeast trade winds that occur from May to October (dry season) and northwest monsoons winds that occur from December to March (wet season). April and November are doldrum periods in between these seasons. However, in the Purari River area near PRL-15, there is reverse seasonality, with more rain from June to September and drier, hot weather from October to March.

The baseline field surveys are being conducted at the beginning of the drier period in the upstream Project area, which potentially allows greater access to survey sites. With respect to groundwater, the timing of works close to the end of the region's wetter period means that water levels in village wells are likely to be at their maximum and there is greater potential that seasonal springs will be observed.

Seasonal variation in groundwater will not specifically be assessed by repeat surveys during this study however anecdotal information regarding seasonality of water sources will be recorded. In addition photographic data from the social baseline survey (conducted in May 2016) will be compared with observations during this field survey. Seasonal variation is not relevant to consideration of soils and terrain, or geology and geomorphology.

Considering the above, it is expected that the weather will generally be dry during the survey period in November 2016 and suitable for the planned studies.

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6. Survey Parameters

6.1 Soils and Terrain, and Geology and Geomorphology

Parameters that will be measured as part of the soils and terrain, and geology and geomorphology studies are listed in Table 6.1

Table 6.1 – Parameters to be Measured during Soils and Terrain and Geology and Geomorphology Field Studies

Dataset	Description of Parameters	Justification
Surface geology	Physical evidence and observations of rock types that occur at each of the investigated sites will be recorded	The recording of available rock types located at the investigation sites will facilitate the ground-truthing of geology and geomorphology mapping at a more detailed scale. The identification of rock types will also assist in soil taxonomy and mapping
Geomorphology and landform features	Landform features will be recorded at each site in accordance with *Australian Soils and Land Survey Field Handbook* (NCST 2009); including: ♦ Landform element ♦ Landform pattern ♦ Aspect ♦ Elevation ♦ Drainage ♦ Erosion presence ♦ Rock outcrop	Geomorphology information provides specific details to allow for areas exhibiting similar or dissimilar landforms to be grouped or separated, for the creation of detailed geomorphology maps, soil landscapes and soils maps
In situ soil physical parameters	Horizon distinctions and depths	Determining factor in soil taxonomy, also indicates weathering characteristics and soil development
	Field color (Munsell Color Chart)	Determining factor in soil taxonomy, also indicates permeability, susceptibility to dispersion/erosion
	Field texture grade	Determining factor in soil taxonomy, also indicates erodibility, hydraulic conductivity, moisture retention and root penetration
	Boundary distinctness and shape	Determining factor in soil taxonomy, also indicates erosional/dispositional status
	Soil pedality grade, ped size and shape	Determining factor in soil taxonomy, in particular soil structure, root penetration, permeability and aeration
	Stones – amount and size	Contributing factor to water holding capacity, weathering status, erosional/depositional character
	Rooting depth	Effective rooting depth, vegetative sustainability
	Slaking test	Preliminary indicator of dispersion and potential for erosion
Soil samples for laboratory analysis	Particle-size distribution (<2 mm)	Nutrient retention; exchange properties; erodibility; droughtiness; workability; permeability; sealing; drainage; interpretation of most other physical and chemical properties and soil qualities
	Soil reaction (pH) (1:5, soil: water suspension)	Nutrient availability; nutrient fixation; toxicities (especially Al, Mn); liming; sodicity; correlation with other physical, chemical and biological properties

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Table 6.1 – Parameters to be Measured during Soils and Terrain and Geology and Geomorphology Field Studies (cont'd)

Dataset	Description of Parameters	Justification
Soil samples for laboratory analysis (cont'd)	Total organic carbon (TOC) Total organic matter (TOM)	Nutrient availability; retention and fixation (especially N, P, S); cation exchange capacity; soil stability and workability; permeability; correlation with other physical, chemical and biological properties
	Cation exchange capacity and exchangeable cations	Nutrient status; calculation of exchangeable sodium percentage (ESP); assessment of other physical and chemical properties, especially dispersivity, shrink – swell, water movement, aeration
	Electrical conductivity (EC_e) (1:5, soil: water suspension)	Appraisal of salinity hazard in soil substrates or groundwater, total soluble salts
	Aggregate stability (Emerson aggregate test)	Susceptibility to surface sealing under rainfall or irrigation; effect of raindrop impact and slaking; permeability; infiltration; aeration; seedling emergence; correlation with other properties
	Total nitrogen	Nutrient status for rehabilitation of agricultural pursuits
	Total phosphorus	Nutrient status for rehabilitation of agricultural pursuits
	Water content	Current status of moisture content
	Heavy metals: Ba, Cd, Cu, Pb, Zn, Fe, Co, Ni, V, Cr, Sr, Al, Hg.	Background levels/possible contamination
	Total petroleum hydrocarbons (TPH)	Background levels/possible contamination In the event TPH is greater than detection limits, further testing may be required as per GS EP ENV 111

6.2 Groundwater

Parameters that will be measured as part of the groundwater field study are listed in Table 6.2.

Table 6.2 – Parameters to be Measured during Groundwater Field Studies

Dataset	Description of Parameters	Justification
Groundwater level	Depth to groundwater measured below wellhead/ground level and corrected to elevation based on LIDAR data	Groundwater elevation to give an understanding of groundwater vulnerability and behaviour at the sampling location
Groundwater field parameters	In situ field parameters including: ♦ Temperature °C ♦ pH ♦ Salinity ♦ Electrical conductivity (µS/cm) ♦ Dissolved oxygen (% & mg/L) ♦ Turbidity ♦Oxidation-reduction potential (ORP mV)	Parameters as per GS EP ENV 111. Field measurement of parameters indicative of water quality, water source and water relationships. Temperature, pH, DO and ORP are not stable in transit and laboratory measurement cannot be relied upon

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Table 6.2 – Parameters to be Measured during Groundwater Field Studies (cont')

Dataset	Description of Parameters	Justification
Water quality samples	Samples collected for laboratory analysis. Analytical suite to include: ♦ Total petroleum hydrocarbon (TPH), benzene, toluene, ethylbenzene and xylenes (BTEX) and poly aromatic hydrocarbons (PAHs) ♦ Total suspended solids (TSS) ♦ Total nitrogen, total phosphorous, nitrate/nitrite, ammonia and orthophosphate ♦ Total and dissolved metals - (Al, As, Ba, Cd, Co, Cr, Cu, Fe, Hg, Ni, Pb, Sn, V, Zn) ♦ Coliforms ♦ Total organic carbon (TOC) ♦ Dissolved organic carbon (DOC) ♦ Major cations and anions ♦ Alkalinity	Parameters as per GS EP ENV 111 Alkalinity and major cations and anions provide an indication of geochemical signature of waters and assist establishing water interactions within the project area. While nitrates/nitrites and coliforms will be tested, these samples are expected to have breached holding times (1-2 days) before reaching certified laboratory for analysis. Arsenic (As) was added to the metals suite as historical artisanal mining in the Purari River basin is understood to have resulted in As impact elsewhere in the area. Water quality criteria have been selected to meet the GS EP ENV 111 and to assess the existing environment against relevant PNG water quality criteria

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7. Survey Methods

7.1 Soils and Terrain, and Geology and Geomorphology

7.1.1 Remote Sensing – Flyover

Helicopter flyovers and access flights will be used to assess the geomorphology and terrain changes. Should suitable target sites be observed or identified during these flights these will be added to the ground survey where practical and within the allotted timeframe.

7.1.2 Geology and Soil Profiles

The geology ground-truthing and soil profile inspection sites (described in Section 9) will be inspected via excavation (using hand tools) to the B horizon, to a maximum depth of 1.0 m. Assessment measurement and sampling will be undertaken at all detailed inspection sites. Following completion of the field program, samples from specific sites will be chosen (12 to 16) for laboratory analysis. The sites designated for laboratory analysis will be determined in the field, based on the technical expertise of the soil consultants, to ensure a coverage of all observed soil types is achieved.

Sampling depths will be determined once the soil profile is exposed and horizons can be determined. The 0–10 cm sample will be a bulked homogenous sample, however lower samples will be from a single source from within the exposed soil profile. Excavation will be undertaken to capture the B horizon to a maximum depth of 1 m if the B horizon is not encountered within that depth. The number of samples and depths will be determined in the field.

The assessment of acid sulfate soils (ASS) is limited to a preliminary field investigation, which aims to provide a map of high and low risk areas. The purpose of this assessment is to provide preliminary evidence to identify risk areas and allow impact assessment to be completed.

Hand tools to be utilised for excavation to the B horizon will include shovels, crowbars and trowels. The soil exposure will be made in order to present the soil profile to enable photography, sampling and description of the various soil horizons in situ.

The information to be recorded at each detailed inspection site consists of the following:

- Site information:
  - Site identification number.
  - Date.
  - Project location.
  - Assessors.
  - Nature of exposure.
  - GPS coordinates.
- Location characteristics:
  - Geology unit or lithology.
  - Landform pattern and element.

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- Aspect.
- Slope characteristics.
- Current land use.
- General vegetation.

- Soil profile properties:
  - Soil type field name.
  - Horizon and boundary information.
  - Texture and pedality grades.
  - Fragments and segregations.
  - Consistence (hardness).
  - Colour and field pH (of suspected potential acid forming (PAF) soils).
  - Mottles and drainage characteristics.
- Samples taken and depths.
- Sample technique (bulked or non bulked).
- Description of packing technique.
- Comments.

In addition to the above information, photographs of the rock outcrop, soil profile, landscape, and vegetation will be taken for further reference. Also, in line with TOTAL GS requirements, a photograph of each sample will be taken. Redox measurements will be undertaken in the laboratory.

7.1.3 Soil Type Description

The applicable international technical and management standard adopted by for the Project is the USDA system. This standard is routinely used as the soil classification system in Papua New Guinea and has been adopted to assess the soil taxonomic types. Recent mapping (PNG Resource Information System (PNGRIS)) sourced from Mipela Geosolutions covering the Project area also classifies soils under the USDA system, which will ensure consistency across mapping and reports.

The USDA has developed a soil taxonomy and classification system and this has increasingly been adopted around the world. The USDA soil taxonomy system provides a classification of soil types into 12 orders, followed by further classifications such as Suborder, Great group, Subgroup, Family and Series. The twelve ‘orders’ include Alfisols, Andisols, Aridisols, Entisols, Gelisols, Histosols, Inceptisols, Mollisols, Oxisols, Spodosols, Ultisols and Vertisols.

7.1.4 Land Capability Methodology

The land capability assessment system adopted for this study is also the USDA classification system. This system consists of eight categories that classify the land based on the severity of long-term limitations. Limitations are the result of the interaction between physical resources and a specific land use. A range of factors are used to assess this interaction. These factors include

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climate, soils, geology, geomorphology, soil erosion, topography, and the effects of past land uses. The principal limitation recognized by these capability classifications is the stability of the soil mantle.

A description of the USDA Land Capability Classification System is provided in Table 7.1

Table 7.1 – USDA Land Capability Classification

Classes	Descriptions
I	Soils in Class I have few limitations that restrict their use
II	Soils in Class II have some limitations that reduce the choice of plants or require moderate conservation practices
III	Soils in Class III have severe limitations that reduce the choice of plants or require special conservation practices, or both
IV	Soils in Class IV have very severe limitations that restrict the choice of plants, require very special management, or both
V	Soils in Class V have little or no erosion hazards but have other limitations, impracticable to remove, that limit their use largely to pasture or range, woodland, or wildlife food and cover
VI	Soils in Class VI have severe limitations that make them generally unsuited to cultivation and limit their use largely to pasture or range, woodland, or wildlife food and cover
VII	Soils in Class VII have very severe limitations that make unsuited to cultivation and that restrict their use largely to grazing, woodland or wildlife
VIII	Soils and landforms in Class VIII have limitations that preclude their use for commercial plant production and restrict their use to recreation, wildlife, or water supply, or for aesthetic purposes

Source: Klingebiel and Montgomery (1961)

7.2 Groundwater

7.2.1 Remote Sensing – Flyover

Helicopter flyovers and access flights will be used to assess the broad environment and to identify potential groundwater issues, springs and spring lines. Should suitable target sites be observed or identified during these flights, these may be added to the ground-based assessment schedule if possible.

7.2.2 Inspection

The survey locations described in Section 9 will be assessed through visual inspection as well as measurement. Initial assessment will include the recording of the following information:

- Unique location identification number and/or local identifier.
- Location (description and GPS co-ordinates).
- Location photograph.
- Owner/users.
- Use – including estimation of daily abstraction or flow via flow meters present, pump capacities, anecdotal evidence and bucket testing or a combination of these evidence sources.
- Installed equipment.

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- Condition.
- Depth data (bores and wells):
  - Depth to water.
  - Depth to base.
  - Depth to pump intake (if available).
- Installation data:
  - Casing diameter.
  - Casing material.
  - Screened section details.
- Any other data available.

Data will be collected through both direct field measurement and observation. Where possible, liaison with bore owners/users will also be used as a source of information and data. Assessment will be guided and recorded using a Baseline Groundwater Assessment pro-forma (appended to the associated Field Execution Plan (FEP)).

Any additional groundwater bores, wells or other features (springs/seeps) identified in the Project study area will also be assessed (time permitting).

7.2.3 Groundwater Gauging

Where possible, depth to groundwater in bores and wells will be measured using an electronic water level dip meter. At each bore the datum point used will be recorded such that consistency with historical and future measurements can be maintained. In general the datum used will the top of bore or well casing (where not level, the highest point); the distance by which casing protrudes above surface (collar height) will also be measured using a tape measure.

7.2.4 Groundwater Sampling

Where possible, samples will be collected from groundwater features located during the field survey. Known groundwater features are identified and shown in Section 9. Sampling will be undertaken by the most appropriate means dependent on the type of groundwater feature, the nature and condition of the feature and any installed equipment present. Where possible, features will be purged prior to sampling such that a sample representative of formation water is collected. Methods may include sampling of active flow (at springs), sampling from pump outlets where bores or wells are in use and have functioning pump equipment, and/or the use of dedicated bailers (for monitoring bores, unequipped bores, abandoned bores, or wells/bores where pumping equipment is not functioning).

Where practical, three wet well volumes will be purged prior to the collection of groundwater samples. During purging the following field parameters will be measured using a multi parameter water quality meter:

- Temperature.
- pH.
- Salinity.

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- Electrical conductivity (EC).
- Dissolved oxygen (DO).
- Turbidity.
- Oxidation-reduction potential (ORP).

Selected field parameters will be used to determine that a representative sample is collected, with sample collected once these parameters have stabilized. The following criteria will be used to indicate that a representative groundwater sample can be collected:

- 10% DO.
- 3% EC.
- 0.05 pH.
- 10 mv ORP.

A minimum of three consecutive readings several minutes apart will be taken to assess that parameters are stable.

In cases where existing bore pumps are used, estimates of casing volume will be made based on field measurements and observations and pumping rates measured periodically during purging using a bucket flow test.

Sample collection will be performed as close as possible to the groundwater source (e.g., close to pump outlet or spring issue). Laboratory supplied sample containers suitable for the specific analysis and containing the relevant preserving additive will be used. Where dissolve metals analysis is required samples will be field filtered using dedicated disposable 0.45 µm filters. Between sampling locations sampling equipment will be disposed or cleaned to prevent cross contamination.

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8. Survey Personnel and Equipment

8.1 Technical Specialists

The survey team will comprise the following technical personnel:

- Clayton Richards – soils specialist.
- Murray Fraser – soils specialist.
- John Leyland – groundwater specialist.
- Chris Armit – geology specialist.

Curriculum vitae describing the qualifications and expertise of the specialists are provided in Appendix 1.

8.2 Survey Equipment

8.2.1 Geology, Geomorphology, Soils and Terrain

The following equipment will be used for the field survey:

- Excavating soil profiles and cleaning exposures for assessment (see Plate 8.1):
  - Long handled shovel.
  - Digging bar.
  - Small geologist's hammer.
- Recording site information:
  - Compass.
  - Suunto clinometer.
  - Field sheets and pencils.
  - I-pad (IGIS program) with GPS.
- Recording soil parameters;
  - Munsell soil-colour charts.
  - Suunto clinometer.
  - Field sheets and pencils.
  - Peroxide solution (30% H_2O_2) for pH_{FOX} test only.
  - Hydrochloric acid solution (0.1 M) for carbonate test only.
  - Distilled water for preliminary slaking test.
  - Tape measure.
  - Camera (Lumix DMC-FT5) with GPS.
  - 10x hand lens.

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Plate 8.1 – Soil Pit Equipment





8.2.2 Groundwater

The following technical equipment will be used for groundwater field survey (see Plate 8.2):

- Bore sampling equipment:
  - Bailers.
  - Filters.
  - Sample bottles as provided by laboratory for the specific analytes.
  - Sample preservation (cool boxes).
  - Decontamination equipment.
- Electronic dip tape (Heron Mini Dipper).
- Multi-parameter water quality meter (YSI 556 MPS) to measure:
  - Temperature.
  - pH.
  - Dissolved oxygen.
  - Oxidation-reduction potential.
  - Electrical conductivity.

In addition to the above, the field team will also carry a GPS and digital camera for the purpose of recording site observations.

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Plate 8.2 – Groundwater Monitoring Equipment

 Heron mini dipper – Electronic dip tape	 Disposable groundwater bailer	 FHT 45 – 45um disposable field water filter	 Multi-parameter water quality meter

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9. Sampling Sites

9.1 Soils and Terrain, and Geology and Geomorphology

The focus of the soils and terrain, and the geology and geomorphology investigation will be on areas of existing or potential disturbance, where factors such as erosion potential, contamination, structural failure, rehabilitation risks and acid sulfate soils may be important. There are 25 proposed sites for investigation, with the aim being to undertake a detailed assessment of between 12 and 16 of these sites, with the assumption that there is a potential that not all sites will be available to assess during the field program due to accessibility, logistics, physical risks, weather etc. (those marked with an * in the table below are considered highest priority). These sites are listed in Table 9.1 and shown on Figure 9.1. Table 9.1 also provides the justification for site selection and the USDA soil type expected at the location, based on PNGRIS data. Coordinates of sampling sites are provided in Appendix 2.

General observations will also be made from helicopter flyovers along the route of the pipeline to obtain an appreciation of the terrain changes and potential influences on soils and geomorphology. If additional potential landing sites are identified during the flyovers, these sites may be included in the assessment/sampling campaign if determined valuable to the survey and time/logistics permitting.

Table 9.1 – Proposed Soil Sampling Sites

Site	Description	Justification
Elk-1*	Elk-1 Well Pad	Proposed or existing high disturbance area (Eutrodepts RMU276)
Elk-2*	Elk-2 Well Pad	Proposed or existing high disturbance area (Troporthents RMU75)
Elk-3	Elk-3 Well Pad	Proposed or existing high disturbance area (Dystrudepts RMU276)
Elk-4	Elk-4 Well Pad	Proposed or existing high disturbance area (Eutrodepts RMU276)
ANT-1	Antelope-1 Well Pad	Proposed or existing high disturbance area (Troporthents RMU100)
ANT-2*	Antelope-2 Well Pad	Proposed or existing high disturbance area (Eutrodepts RMU95)
ANT-3*	Antelope-3 Well Pad	Proposed orexisting high disturbance area (Dystrudepts RMU100)
ANT-4	Antelope-4 Well Pad	Proposed or existing high disturbance area (Dystrudepts RMU95)
ANT-5	Antelope-5 Well Pad	Proposed orexisting high disturbance area (Dystrudepts RMU100)
ANT-6	Antelope-6 Well Pad	Proposed or existing high disturbance area (Dystrudepts RMU100)
HB*	Herd Base	Proposed or existing high disturbance area and CPF area (Tropofluvents RMU250)
FC-B*	Fly Camp - B	Representative of nearby pipeline disturbance area (Dystrudepts RMU275)
FC-C*	Fly Camp - C	Representative of nearby pipeline disturbance area and CPF area (Tropofluvents RMU250)
FC-D*	Fly Camp - D	Representative of nearby pipeline disturbance area and CPF area (Fluvaquents)

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Table 9.1 – Proposed Soil Sampling Sites (cont.)

Site	Description	Justification
FC-E*	Fly Camp - E	Representative of nearby pipeline disturbance area (Troporthents RMU125)
FC-F*	Fly Camp - F	Representative of nearby pipeline disturbance area (Hapludolls RMU91)
FC-G*	Fly Camp – G	Representative of nearby pipeline disturbance area (Psammaquents RMU91)
T-1*	Kilavi to Paevera Track	Representative of nearby pipeline disturbance area (Hapludolls RMU91)
T-2*	Kilavi to Paevera Track	Representative of nearby pipeline disturbance area (Hapludolls RMU91)
T-3*	Kilavi to Paevera Track	Representative of nearby pipeline disturbance area (Tropofluvents RMU91)
T-4	Coastal village area	Representative of nearby pipeline disturbance area (Psammaquents RMU91)
T-5	Coastal village area	Representative of nearby pipeline disturbance area (Hapludolls RMU91)
ETL-1*	Eastern Trunkline	Proposed or existing high disturbance area (Dystrudepts RMU95)
ETL-2*	Eastern Trunkline	Proposed or existing high disturbance area (Dystrudepts RMU95)
CPF-1	CPF	Proposed or existing high disturbance area (Troporthents RMU274)

- Priority sites for sampling

9.2 Groundwater

Review of existing Project data has confirmed the presence of a single groundwater abstraction bore at Herd Base and groundwater bores and or wells in villages in the southern (coastal) Project area. These locations are shown in Figure 9.2 and briefly outlined in Table 9.2 below. Coordinates of sampling site locations are provided in Appendix 2.

Table 9.2 – Description of Groundwater Sampling Sites

Site	Description	Justification
H1	Groundwater abstraction bore	Known groundwater bore in project area
V1-01	Harevavo*	Village primary water supply groundwater
V1-02	Kaivukavu *	Village primary water supply groundwater
V1-03	Iuku *	Village primary water supply groundwater
V1-04	Avavu*	Village primary water supply groundwater
V1-05	Ere*	Village primary water supply groundwater
V1-06	Kilavi*	Village primary water supply groundwater
V1-07	Paevera*	Village primary water supply groundwater
V1-08	Mareke	Village primary water supply groundwater
V1-09	Kavava*	Village primary water supply groundwater
V1-10	Herakela *	Village primary water supply groundwater
V1-11	Lariau*	Village primary water supply groundwater
V1-12	Oru*	Village primary water supply groundwater
V2-01	Marea	Village secondary water supply groundwater
V2-02	Larihairu	Village secondary water supply groundwater

*Priority sites/villages

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Table 9.2 includes 14 villages identified during social baseline studies as using groundwater as a water resource. These villages are primarily located in the coastal area in or close to the proposed pipeline corridor. Although the number and location of wells in each village are known, the nature and suitability (from a sampling perspective) are unknown at present; villages marked with * in Table 9.2 will be the primary targets for field survey and sampling. If time and well conditions permit the other three villages marked in Table 9.2 will also be sampled.

Further sampling and assessment sites for groundwater will be selected opportunistically if possible, as identified during fieldwork. The focus of investigation and exploration for potential groundwater portals (springs, seeps, bores and wells) will be areas around existing and proposed infrastructure.

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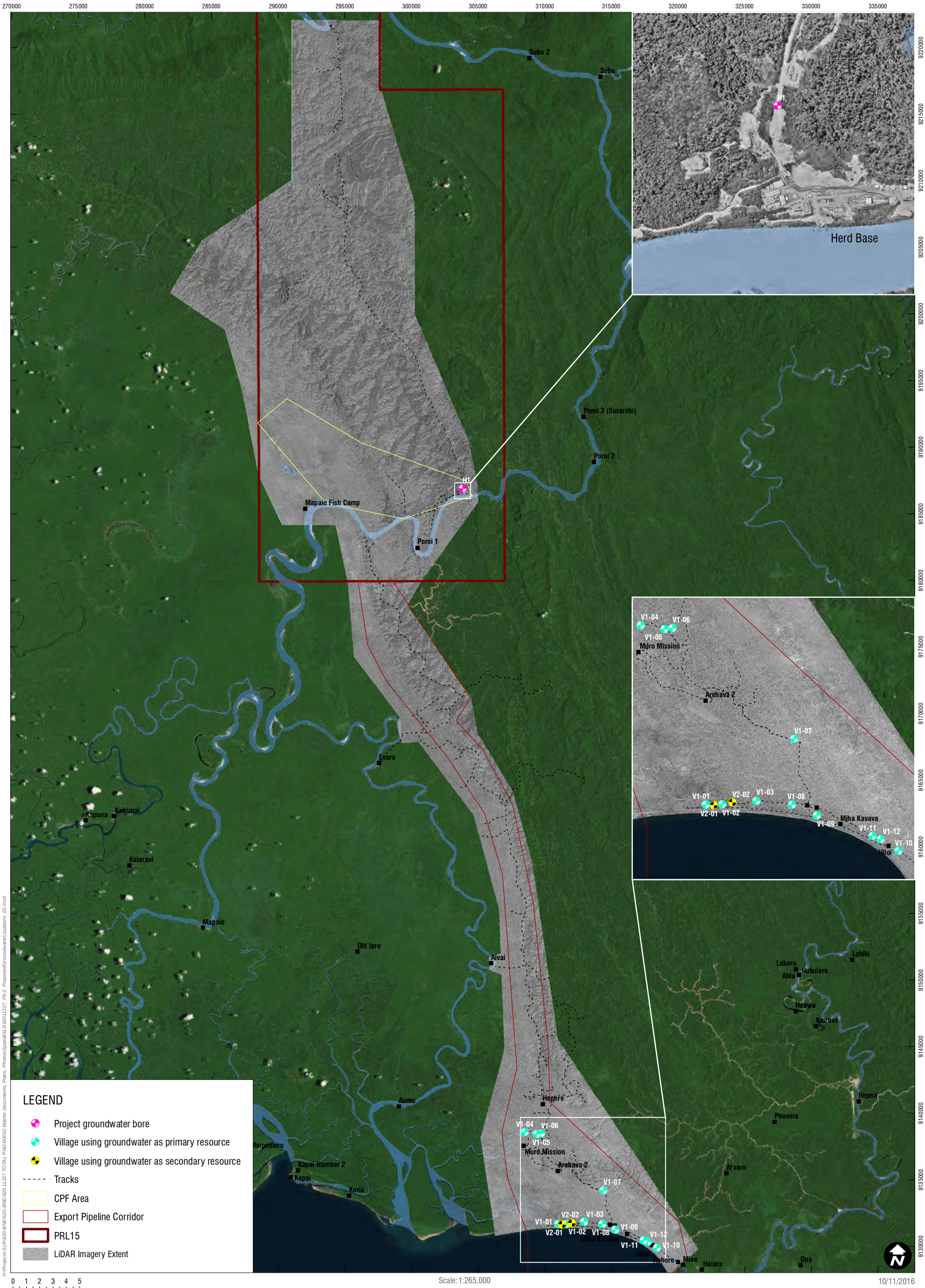
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Proposed Soil Sampling Locations

FIGURE 9.1



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Known Groundwater Locations

FIGURE 9.2

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10. Collected Samples

10.1 Soil Samples

10.1.1 Sampling and Storage

Soil samples will be preserved as per recommendations provided by the primary analytical laboratory, Australian Laboratory Services (ALS) Brisbane. Samples will be transported to ALS under their import permits.

The procedure for collecting and packaging soil samples for the proposed suite of testing is as follows:

- The individual samples will be collected and packaged in clearly labelled plastic zip lock bags, then all samples from the one profile will be placed in a large clearly labelled plastic zip lock bag and packed into stable heavy duty clean produce bags for transport.
- Soil samples targeted for Potentially Acid Sulfate Soil (PASS) assessment will be placed in suitable jars supplied by ALS and bubble wrapped as required prior to packing in refrigerators or cooler boxes.
- Ice packs will then be used to maintain a temperature of ~4°C within cooler boxes during transit back to Herd Base, where they will be stored in a refrigerator until they are shipped back to Australia for analysis.

10.1.2 Sample Analysis

The soil samples will be analyzed by Australian Laboratory Services (ALS) Brisbane, which is accredited by NATA for the required analyses. Laboratory accreditation certificates are provided in Appendix 3. Table 10.1 lists the parameters to be tested along with the associated testing methods.

Table 10.1 – Soils Analytical Suite

Parameter	Analysis Method
Particle Size Analysis (PSA)	Sieve & hydrometer
pH	1:5 soil/water extract
Electrical conductivity	1:5 soil/water extract
Chloride	Saturated extract
Emerson Aggregate Test	Emerson
Total Organic Carbon	Walkley & Black
Total Organic Matter	H_2O_2 or fire loss (550 degrees C)
Cation exchange capacity and exchangeable cations	(AgTU)+ extraction
Total nitrogen	Spectrophotometry (630 nm)
Total phosphorus	Spectrophotometry (720 / 880 nm)
Water content	Drying up
Heavy Metals: Ba, Cd, Cu, Pb, Zn, Fe, Co, Ni, V, Cr, Sr, Al, Hg.	On the fine fraction <63um and control on totality: Spectrometer with AA Hg: Atomic fluorescence
Total petroleum hydrocarbons (TPH)	Spectrometry Infra Red

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Further to the above analytical suite, soil samples from profiles suspected to be at risk of becoming acid sulfate soils if disturbed will be tested using the PASS test methods described in Table 10.2.

Table 10.2 – Acid Sulfate Soils Analytical Suite

Parameter	Application	Test Methods
Acid sulfate soil analysis Includes: ♦ pH_{KCL} & titratable actual acidity (TAA) ♦ Peroxide pH & titratable peroxide acidity (TPA) ♦ Potassium chloride extractable sulfur (S_{KCl}) ♦ Peroxide sulfur (S_p)	Existing and potential acid generation upon exposure, disturbance or inversion	AS4969.1 AS4969.2 AS4969.3 AS4969.4 AS4969.5

10.2 Groundwater Samples

10.2.1 Sampling and Storage

Water samples will be preserved as per recommendations provided by the primary analytical laboratory, Australian Laboratory Services (ALS) Brisbane. Sample containers are provided pre-dosed with appropriate volumes of preservatives where required. Samples will be transported to ALS under their import permits.

Procedures for containing and preserving samples are as follows:

- The samples will be collected in the appropriate laboratory cleaned and supplied containers for each specific analysis required.
- Once filled, the exterior of the sample containers will be rinsed clean (if necessary) with de-ionised water and wiped to avoid contamination of people handling the sample and/or other sampling materials.
- Sample jars/containers will be bubble wrapped as required prior to packing.
- Ice packs will then be used to maintain a temperature of ~4°C within cooler boxes during transit back to Herd Base, where they will be stored in a refrigerator until they are shipped back to Australia for analysis.

10.2.2 Sample Analysis

Groundwater quality samples will be analysed by ALS Brisbane. No laboratories accredited to undertake the required analysis are available in Papua New Guinea at present.

Table 10.3 lists the parameters proposed to be tested and the associated analysis method and the laboratory limits of reporting. These methods are consistent with those described in GS EP ENV 111 and as far as possible provide suitable limits of detection for comparison with environmental quality criteria. ALS is accredited by NATA and under ISO 17025 for the required analytical suite.

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Table 10.3 – Groundwater Analytical Suite

Parameter	Analysis Method	Limit of Reporting
From GS EP ENV 111		
TPH	Gas chromatography-flame ionisation detector (GC-FID)	20–100 µg/L
PAH	Gas chromatography-mass spectrometry (GC-MS)	1–5 µg/L
BTEX	Gas chromatography-mass spectrometry (GC-MS)	1–5 µg/L
TSS	APHA 2540 D (gravimetric, dried at 103-105ºC)	1 mg/L
Nitrite and nitrate	APHA 4500-NO_2 - I/NO_3 - I (flow injection analysis)	0.01 mg/L
Total phosphorus	APHA 4500 P-H	0.01 mg/L
Reactive phosphorus	APHA 4500 P-G	0.01 mg/L
Metals (total/dissolved): Ba, Cd, Co, Cr, Cu, Ni, Pb, Sn, Zn,	USEPA 6020 (inductively coupled plasma - mass spectrometry (ICP/MS))	Cd: 0.0001 mg/L Others: 0.001 mg/L
Hg (total and dissolved)	Cold vapour atomic absorption spectrometry (CV AAS)	0.0001 mg/L
TOC	APHA 5310 B (high temperature combustion)	1 mg/L
Coliforms	TBC	-
Additional Analytes		
Major cations (Ca, Mg, Na, K)	APHA 3120 (inductively coupled plasma - atomic emission spectrometry (ICP/AES)) Hardness: APHA 2340 B (by calculation)	1 mg/L
Major anions (Cl, SO_4, alkalinity)	Various (turbidimetric, flow injection analysis, titration)	0.1–1.0 mg/L
DOC	APHA 5310 B (high temperature combustion)	1 mg/L
Ammonia	APHA 4500 NH_3 - H (flow injection analysis phenate method)	0.01 mg/L
Total nitrogen	APHA 400 Norg/NO3 (flow injection analysis)	0.1 mg/L
Metals (total/dissolved): Ag, Al, As, Fe, Se, Sr, V.	USEPA 6020 (inductively coupled plasma - mass spectrometry (ICP/MS))	Al: 0.01 mg/L Fe: 0.05 mg/L V: 0.01 mg/L Others: 0.001 mg/L

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11. Quality Control

11.1 Sample Collection, Handling, Storage and Transport

To ensure good quality data are collected during the field program, a number of quality assurance (QA) and quality control (QC) procedures will be implemented during fieldwork, as follows:

- Use and maintenance of appropriate sampling equipment, and implementation of appropriate calibration procedures (including use of controlled standard solutions supplied by ALS in Brisbane).
- Sampling techniques in accordance with relevant water quality sampling guidelines and standards (e.g., AS/NZS 5667.11:1998).
- Sample containers clearly and accurately labelled and a log of collected samples maintained and updated.
- Chain of custody forms maintained and included with samples.
- Data validation including cross check by a second scientist after entry into the database.
- Water sample preservation and handling procedures will be followed and samples supplied to the laboratory within nominated holding times where practicable.

11.2 Control Samples

A range of additional samples will be collected for QC purposes to assess the repeatability and precision of laboratory results. These will include the following:

- Intra-laboratory duplicates – water samples will be split into two duplicate subsamples and tested as separate (blind) samples by the primary laboratory (ALS). Intra-laboratory duplicates will be collected at 10% of sampling sites.
- Inter-laboratory duplicates – water samples will be split into two duplicate subsamples and tested as separate (blind) samples by the primary laboratory (ALS) and a second independent laboratory (TBC). Inter-laboratory duplicates will be collected at 5% of sampling sites.
- Field blanks – samples taken in the field using laboratory supplied deionised distilled water which is placed into sample containers the same way as normal samples (i.e., using sampling equipment such as the sample pole, syringes and filters). Field blanks are taken once per monitoring event, and are used to test for sample contamination from sampling personnel, equipment, and/or the atmosphere.
- Trip blank samples – pre-filled sample bottles (with deionised distilled water) supplied by ALS to test for contamination of volatile substances (such as hydrocarbons) during storage and transport of samples.

11.3 Laboratory Quality Control Measures

ALS Brisbane will be the primary laboratory used for water sample analysis. Inter-laboratory duplicates will be sent to a secondary laboratory (TBC). Both these laboratories are NATA-accredited and as such have strict quality assurance and quality control procedures in place.

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Routine laboratory control procedures at ALS include:

- Certified reference materials.
- Laboratory duplicates.
- Laboratory control spikes.
- Matrix spikes.
- Surrogates.
- Secondary and project standards.
- Inter-laboratory (proficiency) testing.
- Client and industry managed independent audits and accreditations.

Water samples will be stored by the laboratory for a minimum of two weeks after release of analysis results in case follow up analysis is required.

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Appendix 1

Survey Team Credentials

JOHN LEYLAND

Associate Hydrogeologist

Curriculum Vitae

QUALIFICATIONS

Cardiff University, MSc Environmental Hydrogeology (2005-2006)

University of Southampton, BSc (Hons) Geology (2000-2003)

MEMBERSHIP

Fellow of the Geological Society of London

Member of the International Association of Hydrogeologists

TRAINING

2014 St Johns First Aid - HLTCPR201B, HLTFA201B, HLTFA301C

2013 R1120209 Certificate II in surface Extraction Operations (Std 11)

2012 CPCCOHS1001A - Work Safely in the Construction Industry 2011 IOSH, Foundations of Risk Management

2011 HSG47 - CAT and Genny - avoidance of underground cables and pipes

2010 Loss Prevention System and OIMS, ExxonMobil Environmental Services

BACKGROUND

John has ten years' experience as a hydrogeologist in environmental consultancy with a focus on contaminated land and groundwater management based in the UK, South Africa and Australia.

John's project experience spans a variety of geographic locations and a range of industry sectors including construction, waste management, oil and gas and mining.

SPECIAL EXPERTISE

- Groundwater characterisation and risk assessment
- Contaminated land assessment and management
- Construction environmental management

SELECTED PROJECT EXPERIENCE

- Westside Corporation – Meridian SeamGas Project, QLD. Hydrogeologist and Project Manager: Preparation and delivery of underground water impact reports (UWIR), considering cumulative impact of unconventional (coal seam) gas developments in the Bowen Basin. Project included hydrogeological conceptualisation, development of a 3D groundwater model predict impact to groundwater level and quality due to gas abstraction the development area. Regulatory submissions required review of technical modelling reports to make recommendations for ongoing monitoring of groundwater including development of trigger values for both level and quality indicators. All reports were subject to public comment.

- Harcourt Petroleum N.L. - Multiple petroleum lease areas, QLD. Hydrogeologist and Project Manager: Baseline assessment of existing groundwater abstraction and monitoring bores within coal seam gas development areas. Planning and co-ordination of field work undertaken by junior staff. Findings were used to establish baseline conditions prior to gas development to inform "make good" agreements should impact to groundwater occur.

- Exxon Mobil - Environmental assessment and improvement program, National, UK. Risk Assessor and Site Engineer: Management of site investigations on operating and disused oil terminals, refineries and forecourts including the procurement of contractors and third party service providers. The role involved the management of site staff and the compilation of reports. Site works included supervision of drilling works, geological/geotechnical logging, groundwater monitoring and sampling, vapour sampling, hydraulic testing, infiltration testing, borehole development and renovation works, and remediation and product recovery system design, installation and commissioning. Preparation of detailed quantitative groundwater risk assessment reports based on site works.

- Exxon Mobil, UK, Ireland, Cyprus, Tunisia and Egypt. Site Engineer: Environmental assessment and improvement program. Arrangement and supervision of site works on oil terminals, refineries and forecourts.

- Idemitsu – Boggabri Coal Mine, NSW. Hydrogeologist and Project Manager: Assessment of groundwater to supply an

additional 5ML/day to satisfy the water requirement of a mine expansion program. Work included design, installation and testing of abstraction bores. Project included modelling the proposed abstractions to assess potential interference and to establish optimized abstraction regimes taking into account the effect of abstraction on existing water bores and the areas wider water management plans.

- Metro Mining Limited – Bundi Coal Project, QLD. Hydrogeologist and Project Manager: Groundwater assessment including desk studies, pump testing, groundwater sampling, design and installation of vibrating wire piezometers (>300mbgl), stygo-fauna sampling and assessment. Findings were used to prepare environmental impact statements.

- Bandanna Energy Limited – Springsure Creek Project, QLD. Hydrogeologist: Fieldworks to inform groundwater assessment as part of the environmental approvals process for a proposed underground coal mine. Works included installation of monitoring bores and fully grouted vibrating wire piezometers (>400mbgl), pumping tests and routine sampling.

- MGT Mining – Mine Closure Assessment, QLD. Project Manager and Risk Assessor: review and assessment of potential environmental impact related to historic tailings present on the site in order to establish appropriate rehabilitation strategies for the site.

- Metro Mining Limited - Bauxite Hills Project, QLD. Hydrogeologist: Field assessment and conceptualisation of groundwater and surface water to inform environmental approvals and project operational aspects including water balance and supply considerations.

- Australian Country Choice Ltd – Opal Creek, QLD, Australia. Hydrogeologist: investigation of groundwater supply options to meet requirements of intensive beef agriculture expansion project. Work included design and appraisal of deep (1.2km) bore targeting the Great Artesian Basin with equipment (pump etc.) specifications needs and recommendations to client. In addition an existing supply bore was replaced, with design, drilling services procurement and supervision undertaken.

- Eskom Enterprises - Medupi Power Station Construction Project, Limpopo, South Africa. Assistant Environmental Manager: Responsible for monitoring and reporting environmental compliance and providing specialist technical advice to the Project Execution Team whilst working toward ISO 14001 accreditation. Reporting requirement included preparation of routine written reports as well as verbal presentations to the board, local stakeholders, regulators and international funding bodies (World Bank, African Development Bank). Assessment of compliance to the project EMP, national legislation, and international best practice. Auditing of contractors and the project as a whole and tracking and closing out audit findings in a timely manner. Management of environmental incidents including co-ordination of emergency response, incident reporting and incident investigation. Procurement of specialist services and review of technical reports from consultants. Management of the environmental team including training and development through mentoring of client staff such that an independent and sustainable local environmental team was established.

- Abu Dhabi Authority for Culture and Heritage (ADACH) - Cultural/Commercial Development, Abu Dhabi, UAE. Site Engineer and Hydrogeologist: Supervision of a hydrogeological site investigation including pumping tests and trial dewatering works to inform a dewatering feasibility study. Reporting of the investigation findings and input to the dewatering study.

- Caltex Australia – Site Risk Assessment, NSW, Australia. Risk Assessor: preparation of 1D analytical fate and transport model using BIOSCREEN to demonstrate natural attenuation of dissolved hydrocarbon in groundwater to establish the level of risk and to inform the site management strategy.

- Puma Energy, QLD, Australia. Project Manager and Site Engineer: Site investigation to delineate hydrocarbon impact to shallow groundwater to satisfy the requirements of DEHP compliance notice. Design, installation, commissioning and operation of an active source recovery system. Development of Remedial Acton Plan and implementation of pilot hydraulic containment trial.

- City of Canterbury Council - Closed Landfill Assessment, Sydney, NSW, Australia. Contracting Site Assessor and Hydrogeologist: Preparing Landfill Leachate and Gas Management Plan incorporating preliminary concept designs to improve capping and other management aspects to mitigate environmental risk at a closed landfill.

CLAYTON RICHARDS

SLR Curriculum Vitae

QUALIFICATIONS & TRAINING

- Certified Practicing Soil Scientist – (CPSS-2)
- Bachelor of Natural Resources (B. Nat Res (Hons)) 1998
- Graduate Diploma in Education (Grad. Dip. Ed) 2006
- Certificate IV Workplace Trainer & Assessor (Cert IV Trainer) 2006

BACKGROUND

The majority of Clayton's 18 year professional career has been spent as an Environmental Consultant (14 Years) within the NSW and QLD resources sector, focussing on soil survey and land capability assessments for mining and associated linear infrastructure projects such as rail lines, access roads and pipelines. These projects have often integrated other assessments into the soils work including agricultural impact statements, erosion and sediment control, mine rehabilitation, mine closure strategies and mine planning approvals. Clayton is a Certified Professional Soil Scientist (CPSS - 2) and is currently a Principal level Consultant for SLR.

After graduating from a B. Natural Resources with his honours, Clayton became an Environmental Consultant in the mining industry with Global Soil Systems (1999 – 2002). Clayton's work focussed on mine site rehabilitation projects, erosion and sediment control, and operational mine secondment roles. In 2002, Clayton ventured out into the education sector for 4 years (2002-06) as a teacher at high school and TAFE levels, in Physics, Chemistry, Earth Science, Soil Science and Conservation & Land Management. In 2006, Clayton returned to the mining industry, joining GSS Environmental as a Senior Consultant, where he built and managed the GSSE 'Soils, Agriculture and Rehabilitation' team.

At the start of 2013 Clayton relocated to Tamworth NSW and stepped out of the team management role, moving into a pure project role to focus on providing technical expertise in the areas of soil assessment, agricultural impacts and mine rehabilitation. The purpose of this move is to ensure clients in the resources sector will continue to be provided with first class service in these disciplines.

SPECIALIST EXPERTISE

- Soil Survey & Land Resource Assessments;
- Strategic Agricultural Land Impact Assessments;
- Land Rehabilitation – Planning, Implementation & Project Management;
- Mine Closure Planning and Rehabilitation Liability Assessments;

PROFESSIONAL HISTORY

2013 – Current:	Principal Consultant – Soil Science (SLR Consulting, Tamworth NSW)
2011 – 2013:	Managing Associate (GSS Environmental, Newcastle NSW)
2006 – 2011:	Senior Project Consultant (GSS Environmental, Newcastle NSW)
2003 – 2006:	Teacher of Natural Resource Mgt (East Gippsland TAFE, VIC)
2002 – 2003:	Teacher High School Science (NEGS, Armidale NSW)
1999 – 2002:	Environmental Consultant (Global Soil Systems, NSW)
1995 – 1999:	Bachelor of Natural Resources (UNE, Armidale NSW)

PROJECT EXPERIENCE

Soil Survey & Land Resource Assessments

- New Acland Project Stage 3, Rail Line and Access Road - Land Resource Assessment and SCL Assessment (2015)
- Tarrawonga Alluvial Survey (2015)
- West Muswellbrook Soil and Land Capability Assessment (2014)
- Red Hill Soil and Land Suitability Assessment (2012)
- Kevin's Corner Project including access road - Soil & Land Suitability Assessment (2011)
- Goonyella Riverside Mine Land Resource Assessment (2009 & 2011)

- Shenhua Watermark Project and Rail Loop - Soil & Land Capability Assessment (2011-2013)
- Hunter Quarries Soil & Land Suitability Assessment (2011)
- Werris Creek Soil & Land Capability Assessment (2010)
- Grosvenor Coal Soil & Land Suitability Assessment (2010)
- Maules Creek Mine Soil & Land Suitability Assessment (2010)
- Foxleigh Soil & Land Suitability Assessment (2010)
- Rocglen Coal Soil & Land Suitability Assessment (2010)
- Angus Place Mine Expansion Desktop soils study (2010)
- HVO Carrington Mine Soil & Land Capability (2009)
- Codrilla Mine Soil & Land Capability (2009)
- Boggabri Coal Mine Soil & Land Capability (2009)
- Coppabella Mine Soil & Land Capability (2009)
- Cobbora Soil Survey (2009)
- Donaldson Coal Mine Soil Loss Modelling (2008)
- Caval Ridge Soil & Land Capability (2008)
- Charbon Soil Survey (2008)
- Integra Coal Soil & Land Capability & Topsoil balance (2008)
- Mineral Hill Soil & Land Capability (2008)
- Cumnock Soil & Rehabilitation Assessment (2008)
- Olstan Coal Soil & Land Capability (2008)
- Bengalla Mine Soil Loss Modelling (2007)
- Bengalla Mine Topsoil Balance (2007)

Strategic Cropping Land (SCL) Impact Assessments

- Curragh Project Extension SCL Assessment (2015)
- QER Strategic Cropping Land Assessment (2011)
- Winchester South Strategic Cropping Land Assessment (2014)
- Watermark Alluvial Agricultural Land Assessment (2011)

Land Rehabilitation – Planning, Implementation & Project Management

- Bengalla Mine South Dump Rehab Project (2006)
- Tambo River 'Riparian Restoration Project' (2005)
- Hilderbrandts Wetland Rehab Project Design (2005)
- TFN 'Bush Family Reserve' Revegetation (2004)
- Maringa Creek Rainforest Restoration Project (2003)
- Sedgenhoe Horse Stud Tree Planting Program (2001)
- Donaldson Mine Seed Collection Program (2001)
- Singleton Army Base Gully Revegetation (2000)
- Wambo Mine Direct Tree Seeding Program (2000)
- Mt Owen Vegetation Establishment Program (2000)
- Liddell Coal Direct Tree Seeding Program (2000)
- Mt Thorley Mine Tree Planting and Seeding (1999)
- Bengalla Mine Rail Loop Tree Screen (1999)
- Ravensworth Direct Tree Seeding and Planting (1999)
- Wambo Mine Creek Repair Project (1999)
- Penrith Lakes Scheme Quarry Rehab Project (1998)
- Woodsreef Derelict Mine Rehabilitation Strategy (1998)
- Armidale Riparian Recovery Program (1998)

MURRAY FRASER – Senior Agronomist

Curriculum Vitae

QUALIFICATIONS

Bachelor of Science (Honours), University of NSW, Wool and Pastoral Science, March 1998.

BACKGROUND

Murray Fraser is a **Senior Agronomist** with SLR and has been with the company since March 2012. Prior to commencing work with SLR Murray was employed as a consulting Agronomist with Pro-Ag CRT in Forbes for 14 years.

Soil assessment projects Murray has completed or currently working on at SLR include:

- Bylong Land Assessment and Agricultural Productivity Audit (Cockatoo Coal) including determination of agricultural potential, recommendation of agricultural enterprises and farm management practices over 11,500 hectares of cropping and grazing land, including 2,000 hectares of irrigated crop and pasture.
- Cobbora Holding Company Land Aggregation & Integrated Land Management Plan, recommendation and justification of multiple property aggregations for improved farm management and profitability of 38,000 hectares of cropping and grazing land. This included an agricultural property condition assessment of licenced aggregations 18 months post-licencing.
- Hume Agricultural Assessment and Farm Plan (Cockatoo Coal), including determination of agricultural potential and development of a whole of farm plan incorporating multiple properties into one management model.
- Ashton Coal Agricultural Productivity Audit (Yancoal) which included recommendations for future agricultural activities and recommendations for productivity improvements over 2,400 hectares of grazing and cropping land.
- Drayton South Agricultural Land Use Strategy (Anglo American Coal) developing land management practices for the improvement of 2,700 hectares of mixed farming land for a proposed Agricultural Land Reserve.
- Werris Creek Pre-Agricultural Void Water Use Assessment (Werris Creek Coal) which involved the assessment of soil, crop and water suitability for sustainable irrigation with mine void water.
- Centennial Coal On & Off Tenement Agricultural Land Assessments, including agricultural potential of all Centennial owned land.
- Kandos Cement Soil Assessment and Rehabilitation Study, including use of alternative topsoil sources (bottom furnace ash) for quarry rehabilitation.
- Balranald Soil & Land Capability Assessment (Iluka Resources), including determination of agricultural potential against current management practices.
- Land Capability Class Gross Margin Estimation Mt Arthur (BHP Billiton), determination of potential gross margins for differing Land and Soil Capability Classes.
- Lidsdale Siding Soil Inventory Assessment (Centennial Coal), determination of soil suitability for rehabilitation, including possible contamination assessment.
- Bees Creek Land Capability Assessment and Constraints Analysis, determination of environmental constraints as part of the Development Application process for construction of a workers accommodation village on the outskirts of Darwin.
- Origin Asbestos Investigation, sampling of gas well heads, hardstand areas, sumps and flare pits for possible asbestos contamination on a coal seam gas field north of Roma.
- Centennial Biophysical Strategic Agricultural Land Site Verification, determination of land status according to the Interim Protocol at various Centennial sites including Angus Place, Springvale, Mandalong South and Newstan.
- West Muswellbrook Biophysical Strategic Agricultural Land Site Verification (Muswellbrook Coal), determination of cropping and grazing land status according to the Interim Protocol.

- Coolalinga Land Capability Assessment and Constraints Analysis, determination of environmental constraints as part of the Development Application for sub-division.

- West Wallsend Sediment Dam & Groundwater Contamination Assessment, sampling of various water control structures as part of the OCAL Mine Closure Plan.

- West Wallsend Subsidence Remediation Investigation. Sugarloaf State Conservation Area, assessment of various subsidence crack remediation materials and delivery methods.

- Maules Creek Rehabilitation Soil Investigation, investigation and recommendation of remediation required for the establishment of 900 hectares of Box Gum Grassy Woodland on historical grazing and cropping land.

- Clump Pont Marina Soils & Geology Assessment, impacts assessment for the redevelopment of a marina in Far North Queensland.

- Devils Pulpit to Richmond River W2B Portion C Soil Survey, assessment of the suitability of soils and amelioration requirements for re-use in rehabilitation as part of the Pacific Highway upgrade

- Mandalong Extraction Plan LW22 – 24A Land & Agricultural Resource Assessment, determination of agricultural potential and potential subsidence impact over 290 hectares of grazing land and native bushland.

- Ulan Biophysical Strategic Agricultural Land Site Verification (Glencore), determination of grazing land status according to the Interim Protocol.

- Santos Biophysical Strategic Agricultural Land Site Verification, soil sampling for determination of grazing and cropping land according to the Interim Protocol.

- Rankin Creek Strategic Cropping Land Assessment, determination of cropping land status according to the *Regional Planning Interests Act 2014.I*

- Mandalong Subsidence Investigation (Centennial) involved the economic assessment of subsidence impacts on an 18 ha turf farm.

- Neubeck Biophysical Strategic Agricultural Land Site Verification (Centennial), determination of grazing land status according to the Interim Protocol.

- Curragh Mine Blackwater (Landmark) Strategic Cropping Land Assessment, determination of cropping land status according to the *Regional Planning Interests Act 2014.*

- Hermitage Road Land Assessment (Belford Land Group), determination of suitability of grazing land for the establishment of vineyard and olive grove production on rural lifestyle blocks with on-site sewage treatment at Pokolbin.

- Soil Assessment and Recommendations for Rehabilitated Areas at Enhance Place Mine and Pine Dale Mine, advice and recommendations for pasture improvement strategies required to achieve agreed rehabilitation completion criteria.

- Metford Road Reconstruction Acid Sulfate Soil Assessment, GIS risk assessment for areas of potential ASS followed by ground truthing via field sampling.

- Charbon Acid Sulfate Soil investigation, interpretation of soil test results to determine the potential for acid sulfate forming soils within the mine expansion footprint.

- Mandalong TL24 Land Resource Assessment (Centennial), involving determination of grazing land status according to the Interim Protocol for Site Verification of Biophysical Strategic Agricultural Land, a Land and Soil Capability Assessment and an Agricultural Impact Statement.

- New Acland Land Resource Assessment (New Hope Group), determination of Priority Agricultural Land Use and Strategic Cropping Land over approximately 2,500 hectares according to the RPI Act.

- Drayton South Biophysical Strategic Agricultural Land Site Verification (Anglo American Coal)), determination of cropping and grazing land status according to the Interim Protocol

- Tarrawonga Alluvial Boundary Soil Survey (Whitehaven Coal), determination of the location of an alluvial soil boundary relating to a proposed mine extension.

- Stratford Coal Pad Rehabilitation (Yancoal), providing recommendations for soil ameliorants and species selection for rehabilitation of a former coarse reject emplacement area.

- Bulga Biophysical Strategic Agricultural Land Site Verification (Glencore), determination of grazing land status according to the Interim Protocol.

- Werris Creek Irrigation Assessment, analysis of soil and water suitability for irrigated grain production using mine void water

- Tomingley Soils Assessment (Tomingley Gold Operations), determination soil suitability for use in mine rehabilitation.

Murray has a keen interest in improved pasture establishment and management of native pastures and sees these areas as a huge opportunity for natural resource companies to develop offsets, and further giving these companies opportunity to be portrayed as leaders in sustainable grazing practices and across the agricultural industry as a whole.

Murray believes mining and agriculture can benefit from each other and enjoys the challenge of working between these key industries.

More recently to increase his skill base, Murray has begun training in Contaminated Land Assessment and was involved in field sampling for the Karabar Contamination Assessment in Canberra, and also sampling of in-situ ENM for the Wetherill Street Widening and the Cumberland Highway Intersection Widening for Fairfield City Council. Murray also holds a current DAMSTRA Induction for the North-West Rail Link.

Murray is responsible for monthly surface and groundwater contamination monitoring of over twenty sites at Aurizon's Rail Maintenance Facility at Hexham.

For the past three years Murray has taken on the role of environmental co-ordinator for the Newcastle office and has organised the past three corporate Clean-Up Australia days and other environmentally conscious initiatives.

SPECIAL EXPERTISE

- Agricultural Impact Assessment
- Progressive Mine Lease Relinquishment
- Native and Improved Pasture Agronomy
- Broadacre Cropping Agronomy
- Irrigated Cropping & Pasture Agronomy
- Soil & Water Testing & Analysis
- Agricultural Liaison & Consultation
- Whole Farm Planning
- Gross Margin Determination
- Turf Management & Horticulture
- Animal Health & Livestock Production
- Alternate Topsoil Sources for Rehabilitation
- Agricultural Bio-Solid Use
- Agricultural Land Aggregation Planning
- Hydraulic Soil Corer Operation
- Acid Sulfate Soil Assessment

PROFESSIONAL HISTORY

Senior Agronomist – SLR Consulting
March 2012 to Present

Agronomist – Pro-Ag CRT, Forbes NSW
March 1998 – January 2012
Murray's position as a consulting agronomist with CRT was extremely wide ranging and covered numerous roles within the business including the following:

- Provide agronomic advice for optimum crop and pasture production to maximise client income, for both dryland and irrigated farming systems.
- Build strong business relationships with existing clients based on trust leading to good results.
- Organise and attend networking events to secure new clients.
- Maintain business relationships through tough situations, e.g. drought, floods and economic fluctuations.
- Tailor advice to individual farming situations and practices.
- Develop individual animal health management plans.
- Provide horticultural advice to fruit and vegetable growers.
- Act as Consulting Agronomist to Twynam Agriculture's "The Mount", "Jemalong" & the Twynam Polo Complex.
- Provide green and turf maintenance advice to the Forbes Bowling Club and Forbes Golf Club
- Negotiate, order and price agricultural chemicals and animal health products.
- Selection and management of trial sites for crop, pasture and herbicide types.
- Organise field days and grower meetings.
- Liaise with CRT agronomists and DPI staff.
- Retail customer service at store level.
- Provide advice to home gardeners.
- Advise clients on companion animal products.
- Warehouse management and forklift operation.
-

During the 14 years Murray was employed in Forbes as a consulting agronomist much of his time involved landholder liaison through property visits, providing crop and pasture recommendations and animal health advice. Over this time Murray developed and excellent rapport with all his clients.

Shire Councillor – Forbes Shire Council
January 2004- March 2008

Whilst living in Forbes Murray was elected as a Councillor on the Forbes Shire Council, which enabled him to develop the following skills:

- Function as a constant representative of the council, fielding suggestions, complaints and concerns from local residents and community groups.
- Effectively and formally convey these suggestions and concerns at council meetings.
- Scrutinise meeting agenda papers and isolate areas requiring further debate or scrutiny.
- Liaise with senior business leaders regarding the broader future direction of the town.
- Initiate and follow-through with ideas to boost the local economy and provide safe recreational facilities for youth.
- Contributed to the development of the Draft Local Environment Plan.
- Council representative on community Youth and Sport Committee, projects including upgrade and refurbishment of local pool, construction of skate-park and revival of youth centre.

Murray was the youngest ever Councillor elected onto Forbes Shire Council.

TRAINING

- Wormald Fire Awareness Training
- Construction Induction (White Card)
- St. John's Apply First Aid
- Standard 11 Safety Induction
- Out of Town 4WD Training Course
- AGSAFE Chemical Handling
- NSW Firearms Licence
- Forklift Truck Operator Licence
- NSW Drivers Licence
- Tocal Agricultural Impact Statement Workshop
- Hydraulic Soil Corer Operation
- North-West Rail Link DAMSTRA Induction
- Rail Industry Workers Card (RIWC) Induction, Safely Access the Rail Corridor

CHRISTOPHER MARK ARMIT

Consultant

Curriculum Vitae

QUALIFICATIONS

Diploma in Conservation and Land Management (TOCAL)

Masters of Mining Eng, Mining Geomechanics/Management (UNSW)

Certificate IV in Underground Coal Mining

Bachelor of Applied Science (Geology) (QUT)

Minor (Indonesian Language)

Intensive Program in Indonesian Language and Culture (Satya Wacana Christian University, Central Jawa)

MEMBERSHIP

20 year member of the Australasian Institute of Mining and Metallurgy (AusIMM)

CONSULTING BACKGROUND

July 2016 - August 2016
Relief Geotechnical Engineer, Tahmoor Colliery, Glencore

July 2014 - Current
Environment/Geotech Operations Engineer, West Wallsend/Westside

Skills Developed/Responsibilities:
- Sugarloaf Grout remediation project manager
- Subsidence Management co-ordinator, approvals, monitoring, remediation
- Management Plan authoring and review
- Local and State government, private, community relations
- Operations and approval audits
- Water management and rehabilitation projects

July 2009
Operations Engineer/Project Controller, Westside Mine

July 2014
Skills Developed/Responsibilities
- Westside Site Environmental Supervisor
- EPL compliance monitoring – noise, blast, dust and water sample collection, remittance and results analysis
- Rehabilitation and Land Management for Oceanic Coal
- Mine Closure project management
- Relief Operations Manager
- Civil projects management
- AEMR/MOP/management plan authoring and review
- Environmental Management System implementation
- Coal quality co-ordination/reconciliation/ marketing

2008
Mine Planning Engineer, West Wallsend Colliery

2009
Skills developed/Responsibilities
- Life of Mine, Budget and JORC reporting/planning
- XPAC / MS Project Mine Scheduling
- Mine Production Reporting and Reconciliations from the pit to plant

2006
Technical Services Manager/Mining Engineer, West Wallsend Colliery

2008
Skills Developed/Responsibilities
- Management of Environmental, Geology, Engineering and survey teams
- Life of Mine, Budget and JORC reporting/ planning
- Senior Management Reporting and Presentations
- Mine Production Reporting and Reconciliations from the pit to plant

November 2005 - December 2006
Mine Geologist/Geotechnical Engineer, West Wallsend

July 2005 - November 2005
Underground coal mine worker, Nareena Pty Ltd

May 2004 - Nov 2005
Geotechnical Engineer, Strata Engineering (Aust) Pty Ltd

Sept 2003 - May 2004
Central Colliery Site Project Geologist, Anglo Coal

Sept 2001 - Sept 2003
Graduate Geologist, Anglo Coal

June 2001 - Sept 2001
Exploration Geologist, Geotechnical Consulting Services

Dec 2000 - June 2001
Student Geologist, Anglo Coal Pty Ltd, Brisbane Coal Office

REFEREES

Ben Clibborn
Oceanic Coal Environment and Community Manager
0422 930 418

Elliot Tembo
Senior Geotechnical Engineer
0407 907 403

Appendix 2

GPS Coordinates for Proposed Sampling Sites

Soils & Terrain, and Geology & Geomorphology

The sites listed in Table 1 are proposed survey sites for the Soils & Terrain, and Geology & Geomorphology studies.

Table 1 – Description of Study Sites – Soils & Terrain, and Geology & Geomorphology

Site	Description	Justification	Latitude	Longitude	Priority
ELK-1	ELK-1 Well Pad	Proposed or Existing high disturbance area (Eutropepts RMU276)	-7° 5' 55.27" S	145° 8' 31.16" E	1
ELK-2	ELK-2 Well Pad	Proposed or Existing high disturbance area (Troporthents RMU75)	-7° 3' 28.71" S	145° 8' 2.57" E	1
ELK-3	ELK-3 Well Pad	Proposed or Existing high disturbance area (Dystropepts RMU276)	-7° 4' 10.16" S	145° 7' 33.49" E	1
ELK-4	ELK-4 Well Pad	Proposed or Existing high disturbance area (Eutropepts RMU276)	-7° 6' 37.93" S	145° 8' 15.78" E	2
ANT-1	Antelope-1 Well Pad	Proposed or Existing high disturbance area (Troporthents RMU100)	-7° 8' 8.253" S	145° 8' 17.71" E	1
ANT-2	Antelope-2 Well Pad	Proposed or Existing high disturbance area (Eutropepts RMU95)	-7° 9' 57.06" S	145° 8' 53.15" E	1
ANT-3	Antelope-3 Well Pad	Proposed or Existing high disturbance area (Dystropepts RMU100)	-7° 8' 35.36" S	145° 8' 31.32" E	2
ANT-4	Antelope-4 Well Pad	Proposed or Existing high disturbance area (Dystropepts RMU95)	-7° 10' 24.58" S	145° 9' 10.12" E	2
ANT-5	Antelope-5 Well Pad	Proposed or Existing high disturbance area (Dystropepts RMU100)	-7° 9' 30.50" S	145° 8' 9.43" E	2
ANT-6	Antelope-6 Well Pad	Proposed or Existing high disturbance area (Dystropepts RMU100)	-7° 9' 6.025" S	145° 9' 29.63" E	1
HB	Herd Base	Proposed or Existing high disturbance area and CPF area (Tropofluvents	-7° 21' 28.00" S	145° 12' 59.06" E	1
FC-B	Fly Camp -B	Representative of nearby pipeline disturbance area (Dystropepts RMU275)	-7° 29' 35.05" S	145° 12' 31.52" E	1
FC-C	Fly Camp -C	Representative of nearby pipeline disturbance area and CPF area	-7° 21' 14.78" S	145° 10' 56.44" E	1
FC-D	Fly Camp -D	Representative of nearby pipeline disturbance area and CPF area	-7° 18' 46.78" S	145° 8' 16.79" E	1
FC-E	Fly Camp -E	Representative of nearby pipeline disturbance area (Troporthents RMU125)	-7° 39' 1.060" S	145° 15' 42.36" E	1
FC-F	Fly Camp -F	Representative of nearby pipeline disturbance area (Hapludolls RMU91)	-7° 47' 21.42" S	145° 15' 59.99" E	1
FC-G	Fly Camp –G 0 ASS 2	Representative of nearby pipeline disturbance area (Psammaquents	-7° 51' 22.42" S	145° 19' 46.42" E	1
T1	Kilavi to Paevera Track	Representative of nearby pipeline disturbance area (Hapludolls RMU91)	-7° 47' 55.302" S	145° 16' 46.13" E	2
T2	Kilavi to Paevera Track	Representative of nearby pipeline disturbance area (Hapludolls RMU91)	-7° 49' 5.676" S	145° 17' 56.03" E	1
T3	Kilavi to Paevera Track	Representative of nearby pipeline disturbance area (Tropofluvents RMU91)	-7° 49' 41.803" S	145° 18' 43.23" E	1
T4	Coastal Village Area	Representative of nearby pipeline disturbance area (Psammaquents	-7° 50' 52.470" S	145° 17' 6.90" E	2
T5	Coastal Village Area	Representative of nearby pipeline disturbance area (Hapludolls RMU91)	-7° 51' 9.99" S	145° 19' 45.62" E	2
CPF 1	CPF	Proposed or Existing high disturbance area (Troporthents RMU274)	-7° 21' 3.474" S	145° 11' 36.40" E	1
ETL 1	Eastern Trunkline	Proposed or Existing high disturbance area (Dystropepts RMU95)	-7° 20' 18.340" S	145° 13' 10.42" E	1
ETL 2	Eastern Trunkline	Proposed or Existing high disturbance area (Dystropepts RMU95)	-7° 16' 36.300" S	145° 11' 41.23" E	1

The sampling locations have been prioritized to ensure that sufficient areal coverage is achieved to meet the project assessment objectives within the constraints of fieldwork logistics. Priority 1 sites will be the primary focus of assessment with subordinate sites assessed where the schedule allows.

Groundwater

Review of existing project data has confirmed the presence of a single groundwater abstraction bore at the Herd Camp and groundwater bores and or wells in villages in the southern (coastal) project area. The sites listed in Table 2 are proposed survey sites for the Groundwater Study.

Table 2 – Description of Study Sites – Groundwater

Site	Description	Justification	Latitude	Longitude	Priority
H1	Abstraction bore	Known bore in project area	-7°21'8.85" S	145°13'22.50"E	1
V1-01	Harevavo	Village primary water supply	-7° 51' 7.154" S	145° 17' 8.664" E	1
V1-02	Kaivukavu	Village primary water supply	-7° 51' 6.844" S	145° 17' 29.45" E	1
V1-03	Iuku	Village primary water supply	-7° 51' 2.311" S	145° 18' 12.12" E	1
V1-04	Avavu	Village primary water supply	-7° 47' 22.39" S	145° 15' 48.42" E	1
V1-05	Ere	Village primary water supply	-7° 47' 27.11" S	145° 16' 17.85" E	1
V1-06	Kilavi	Village primary water supply	7° 47' 25.73" S	145° 16' 27.85" E	1
V1-07	Paevera	Village primary water supply	-7° 49' 45.26" S	145° 19' 0.084" E	1
V1-08	Mareke	Village primary water supply	-7° 51' 7.454" S	145° 18' 56.83" E	3
V1-09	Kavava	Village primary water supply	-7° 51' 21.21" S	145° 19' 28.51" E	3
V1-10	Herakela	Village primary water supply	-7° 52' 6.130" S	145° 21' 10.69" E	3
V1-11	Lariau	Village primary water supply	-7° 51' 47.33" S	145° 20' 37.64" E	3
V1-12	Oru	Village primary water supply	-7° 51' 51.49" S	145° 20' 48.22" E	3
V2-01	Marea	Village secondary water supply	-7° 51' 8.005" S	145° 17' 19.00" E	2
V2-02	Larihairu	Village secondary water supply	7° 51' 4.667" S	145° 17' 42.30" E	2

Appendix 3

Laboratory Accreditation Certificates

NATA Accredited Laboratory

National Association of Testing Authorities, Australia
(ABN 59 004 379 748)

has accredited

ALS Laboratory Group
Brisbane Laboratory

following demonstration of its technical competence
to operate in accordance with

ISO/IEC 17025

This facility is accredited in the field of

Chemical Testing

for the tests shown on the *Scope of Accreditation* issued by NATA

Alan Patterson
Chief Executive

Date of accreditation: 10 April 1970
Accreditation number: 825
Corporate site number: 818

NATA
WORLD RECOGNISED
ACCREDITATION

NATA is Australia's government-endorsed laboratory accreditor, and a leader in accreditation internationally. NATA is a signatory to the international mutual recognition arrangements of the International Laboratory Accreditation Cooperation (ILAC) and the Asia Pacific Laboratory Accreditation Cooperation (APLAC).

Part 23B
Freshwater and Estuarine Studies
Scope and Methods

PAPUA LNG PROJECT

FRESHWATER AND ESTUARINE STUDIES SCOPE AND METHODS

Version	Details	Prepared	Endorsed	Approved	Date Issued
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v4	(Final report)	J. Visser / D. Richardson	C. Monahan / C. Coyne	Jeremy Roeygens / Catherine Edet	(11/07/16)

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1 – Freshwater and Estuarine Survey Team Credentials
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1. Project Overview

TOTAL Exploration and Production Papua New Guinea Limited (TEP PNG) is planning the development of the Elk-Antelope gas field in Papua New Guinea as part of the proposed Papua LNG Project (the Project).

The Elk-Antelope gas field is located within Petroleum Retention License 15 (PRL-15) in Baimuru District, Gulf Province, approximately 120 km inland from the township of Kerema and 360 km northwest of Port Moresby. The gas field is a highly significant gas discovery in Papua New Guinea and consists of a deep, high pressure, elevated temperature gas reservoir with several trillion cubic feet of gas reserves.

The Project development includes the following facilities:

- Wellpads and upstream gathering system.
- An upstream central processing facility (CPF) to separate and condition gas and condensate streams.
- Export gas and condensate pipeline system, comprising separate single gas and condensate export pipelines in the same route. The pipeline will traverse both onshore and offshore environments (approximately 60 km and 240 km, respectively).
- A liquefied natural gas (LNG) plant and support infrastructure, and associated coastal marine export facilities.
- An acid gas removal unit (AGRU) is proposed at the CPF rather than the LNG Plant as there is the potential for reinjection into a depleted well, thereby reducing the length of acid gas pipeline required.

This document describes the scope and methods for environmental baseline field surveys for the following components of the environmental and social impact assessment for the Project:

- Freshwater and estuarine surface water and sediment quality.
- Freshwater and estuarine biodiversity.

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2. Study Objectives

The objectives of the field studies relating to these components are described below.

2.1 Surface Water and Sediment Quality

- Characterise and describe spatial patterns in the physico-chemical properties of surface waters and sediments at sites encompassing the variety of aquatic ecosystem types within the study area (i.e., areas upstream, adjacent to, and downstream of project infrastructure), through:
  - Collection of in-situ measurements of water quality parameters through the water column using a portable multi-probe water quality instrument.
  - Collection of water samples for laboratory analysis of potential contaminants of concern (including trace metals/metalloids, hydrocarbons) and other parameters of interest (nutrients, suspended sediments, major ions, coliforms).
  - Collection of sediment samples for laboratory analysis of potential contaminants of concern (including trace metals/metalloids, hydrocarbons) and other parameters of interest (nutrients, sediment grain size, organic matter).
  - Maintenance of sample handling, transport and storage processes in accordance with relevant standards to ensure sample integrity and provision of high quality data.
  - Opportunistically supporting the assessment of project-related impacts on aquatic ecology and resources use (ecosystem services), such as drinking water quality and subsistence fisheries.

2.2 Freshwater and Estuarine Ecology

- Characterise and describe spatial patterns in the aquatic fauna and flora species, communities and ecosystems in the study area, through the following:
  - Ground truthing and validation of preliminary aquatic ecosystem maps, including the definition of different wetland types and key aquatic vegetation species in each ecosystem type.
  - Sampling of littoral habitats using standard AusRivAS netting procedures for subsequent laboratory analysis of aquatic macroinvertebrate assemblages (identification to lowest practical taxonomic level and enumeration).
  - Sampling of fish assemblages (including sharks and rays) using standard electrofishing, trapping and netting techniques to enable the identification and enumeration of fish species.
  - Assessing the presence of aquatic flora and fauna that are sensitive to increased turbidity and sediment loads and changes to natural flow regimes.
- On the basis of the above, together with analysis of existing data, identifying and mapping sensitive areas and critical habitat in accordance with IFC Performance Standard 6.

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- Opportunistically supporting the assessment of project-related impacts on aquatic biological resource uses (ecosystem services).

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3. Study Area and Project Areas

3.1 Study Area

The study area is based on the expected area of influence of the Project, collectively comprised of the following Project areas:

- Gasfield area within PRL-15 (well pads, upstream gathering system, CPF and associated infrastructure and support facilities, i.e., construction camp, laydown, wharf, airstrip, access roads).
- Onshore export pipeline corridor (export gas and condensate pipeline system of about 70 km in length from the CPF to the coast at Orokolo Bay, together with associated infrastructure and construction support facilities).
- Offshore export pipeline corridor (export gas and condensate pipeline system of approximately 260 km in length within the Gulf of Papua from Orokolo Bay to Caution Bay).
- Downstream LNG plant area, including coastal facilities and associated infrastructure and support facilities at Caution Bay.

These areas are shown in Figure 3.1.

West of the onshore export pipeline corridor, the Project area of influence includes potential barge transport routes along each of the Purari River's three main delta distributaries—the Purari, Ivo-Urika and Varoi rivers. These streams are also downstream of proposed Project facilities within PRL-15.

Streams within and downstream of PRL-15, the onshore export pipeline corridor, potential river transport corridors and the area of the LNG plant are all relevant to the scope of the freshwater and estuarine studies.

3.2 Project Area Descriptions

3.2.1 Gas/Condensate Field and Onshore Pipeline/River Transport Corridor

Gas/condensate field and onshore pipeline/river transport corridor project areas (hereafter referred to collectively as the Purari/Vailala area) are located in southern Papua New Guinea and encompass the following catchments (Figure 3.2):

- The Purari River basin, which includes the Ivo-Urika, Varoi and Purari rivers sub-branches.
- The Vailala River catchment, which abuts the Purari River basin to the east.

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Title:

Papua LNG Project Areas

Figure: **3.1**

Rev: **A**

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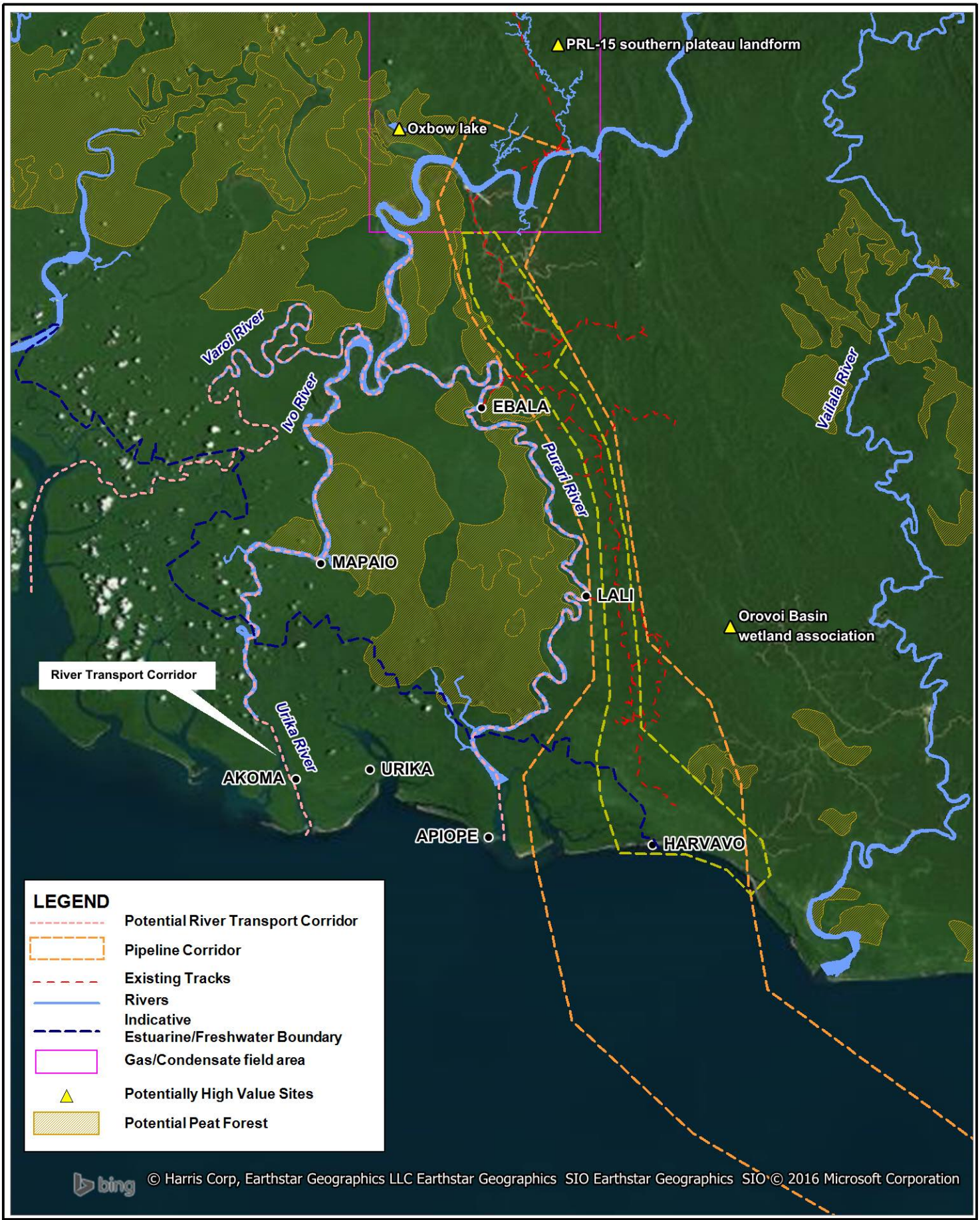
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Approx. Scale

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Title:

Purari/Vailala Area Catchments

Figure: 3.2

Rev: A

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0 10 20km

Approx. Scale

BMT WBM
www.bmtwbm.com.au

Filepath I:\B21414_I_GML_Elk_Antelope_EIA_JV\DRG\ECO_008_160129_Purari_River_Catchments.wor

All areas upstream of the junction between the Ivo-Urika, Varoi and Purari rivers are regarded as freshwater, noting that tidal influence through this area is largely dependent upon rainfall levels (i.e., high rainfall periods limit the tidal range to the immediate delta region). The areas downstream of this junction, including the waters of the three river systems and the delta, through to the coastline are considered estuarine. Similarly, the upper end of the Vailala River estuary is expected to be dependent upon meteorological conditions.

Of the three rivers in the Purari River basin, the Ivo-Urika River is the dominant watercourse, draining the highest percentage of flow from the basin, although the stretch of the Purari River through the delta is also a significant estuary (Pickup and Chewings, 1983). The Varoi River is the smallest river complex of the three (Pickup and Chewings, 1983).

The Purari/Vailala area is subject to two distinctive seasons: 'wet season' from December to March and 'dry season' from May to October, with April and November acting as changeover periods (Evesson, 1983). This seasonality is an important driver of hydrological, physico-chemical and aquatic ecosystem processes of the area (see Section 5).

The Purari/Vailala area falls within the Southwest New Guinea – Trans-Fly Lowland ecoregion (Ecoregion 815) of PNG, as defined by Abell et al. (2008) and Polhemus et al. (2004). Within this ecoregion, the Purari/Vailala area falls within the Trans-Fly Coastal Lowlands area (Area 27). This area is characterised by having a high degree of endemism clustered around tectonic plates (Abell et al., 2008). Nearly half of the freshwater fish through this ecoregion are expected to be endemic to the region, including the *Kiunga, Cochlefelis* and *Nedystoma* genera. Endemic aquatic invertebrates, including for aquatic insects, are also known to be endemic to the area (Polhemus et al., 2004). Freshwater fauna of this ecoregion have strong affinities with that of northern Australia, reflecting recent geological connection between these land masses (Allen, 1991; Abell et al., 2008).

Key aquatic ecosystems within the Purari/Vailala area are expected to consist of (following Haines, 1983):

- Freshwater zone of the river system – consisting of main channels, side branches and oxbow lakes. Adjacent plains support rainforest and swamp forest. Deposition banks support *Phragmites* sp. and *Saccharum* sp. Shallow backwaters tend to lack rooted aquatic vegetation.
- Upper estuary – uppermost part of the estuary where water is almost completely fresh but exhibits marked tidal fluctuations. *Pandanus* sp. interspersed with clumps of *Sonneratia* sp. grow along the deposition banks. Swamp forest extends away from the channels. A *Nypa* sp. zone usually forms a band between mangroves and swamp forest upstream.
- Lower estuary – consists of a series of low-lying, tidally inundated islands, covered with mangrove forest and interspersed with tidal creeks of varying width and depth. Salinity can vary considerably from almost full seawater to almost fresh. Where centres of large islands are above high tide level, mangrove forest merges into freshwater swamp forest.

Swartzendruber, in the Conservation Needs Assessment of PNG (1993), identified most of the Purari/Vailala area as part of the Purari Basin Biologically Important Area, noted as a 'very important' area for biodiversity in PNG.

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Particular aquatic areas of interest in the Purari/Vailala area, as determined during the Elk-Antelope Screening Study (ERIAS Group, 2015) and a review of the literature and satellite imagery, include:

- Wetland association within the Orovoi Basin[1].
- Oxbow lake off Purari River opposite Purari airstrip.
- Plateau landform approximately 5 km north of Herd Base.
- Plateau landform 10 km south-southeast of Hou Creek staging camp.
- Vaihua estuary at Caution Bay.
- Potential peat forest in the Purari River estuary.

The Orovoi Basin wetland association has been identified as having high environmental value as a wetland area, as well as cultural and social heritage values (GHD, 2012). The basin is a perennial feature, comprised of pandanus and palm swamps on poorly drained soils (GHD, 2012).

The oxbow lake opposite the Purari airstrip is connected to the Purari River by a tie-channel that is potentially ephemeral in nature. Where disconnected from main river channels for significant periods of time, off-river water bodies such as oxbow lakes have the potential to form a unique ecological feature that can host evolutionary processes for aquatic species.

In a similar way, the plateau north of Herd Base represents a geomorphological feature that may support permanent water bodies disconnected from the larger catchment area by waterfalls. Should this plateau support permanent water bodies that have been disconnected from other waterways over geological time-scales, it could contain local endemic species of fish and invertebrates. A similar plateau landform exists south of Hou Creek staging camp. This area is less likely to be disconnected from surrounding water but could present unique habitat types comparative to the surrounding study area.

Based on a review of the Forestry Inventory Management System (FIMS) data for the Purari River estuary, local vegetation communities consist of mangroves (M) and mixed swamp forest (Fsw) and swamp woodland (Wsw). Mixed swamp forest and swamp woodland have previously been treated as an analogue for peat forests (e.g., P'nyang Project terrestrial ecology studies), which have been suggested as occurring in the area (e.g., Paijmans, 1983). Peat forests often support perched lakes and acidic water environments which may be regionally significant.

3.2.2 Downstream LNG Plant

Caution Bay experiences a similar seasonality as the gas/condensate field and onshore pipeline/river transport corridor project areas, with dry season between May and October, monsoon season between December and March, and April and November as transition periods (CNS, 2009).

[1] Located equidistant between the Purari and Vailala Rivers, 15-20 km due north from the coastline; exact location is not available from current literature.

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The Vaihua River at Caution Bay is considered estuarine up to the edge of the saltflats, immediately south-east of the existing PNG LNG facility. The river experiences highest flows between December and March with only low or intermittent flows in May to October which leave isolated pools of standing water (CNS, 2009). Most of the tributary streams of the river are ephemeral. As a result, freshwater inputs during the dry season are negligible but quite high during the wet season, leading to a transition between a 'negative' and a 'positive' estuary, and creating areas of hypersaline wetland in intertidal and supratidal flats (CNS, 2009).

The PNG LNG EIS noted that the Vaihua estuary of Caution Bay supported a higher abundance and diversity of aquatic fauna than any other habitat type in the onshore Caution Bay area (CNS, 2009) and is of particular local importance.

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4. Study Approach

The study approach for both the surface water and sediment quality and the freshwater and estuarine ecology studies consists of a bibliographic study supplemented by a field survey to fill any gaps in data necessary to prepare the environmental impact assessment. The approach was guided by the following assessment and study criteria/standards:

- PNG Conservation and Environmental Protection Authority (CEPA) guideline GL-Env02/2004: Guideline for Conduct of Environmental Impact Assessment & Preparation of Environmental Impact Statement (CEPA, 2004).
- TOTAL general specification GS EP ENV 111: Environmental Baseline and Monitoring Studies: Onshore Sites (Total, 2012).
- TOTAL general specification GS EP ENV 112: Environmental Baseline and Monitoring Studies: Offshore and Nearshore Sites (Total, 2012).
- TOTAL general specification GS EP ENV 120: Environmental Impact Assessment of E & P Activities (Total, 2007).
- International Finance Corporation (IFC) Performance Standards (especially Performance Standards 1 and 6) and Guidance Notes.

4.1 Bibliographic Study

The bibliographic study consisted of a review of existing information to identify gaps that require collection of field data. Literature considered included:

- Societal and Environmental Screening Study Report for the Elk-Antelope Project Facilities, prepared for TOTAL by ERIAS Group, (ERIAS Group, 2015).
- Relevant chapters of Petr, T (ed.) (1983), The Purari – Tropical Environment of a High Rainfall River, Dr W Junk Publishers, The Hague.
- PNG LNG Environmental Impact Statement and appendices, prepared for ExxonMobil (CNS, 2009).
- Gulf LNG Project Environmental Impact Assessment and Water Quality Rapid Assessment, prepared for Liquid Niugini Gas Ltd (GHD, 2012).
- Environmental Management Plans (2015) and Water Quality Baseline Reports (2015) for Antelope South 1 and Antelope 4, 5 and 6, prepared for Interoil.
- Studies on broad-scale ecoregions and ecology of PNG, and regional studies for the Purari catchment and Trans-Fly area.
- PNG legislation and relevant international guidelines, policies and standards for the purposes of identifying key environmental areas and focus points for the EIS/ESHIA.

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4.2 Gap Analysis

Based on a review of the available literature, a number of gaps and information requirements were identified for the purposes of the freshwater field studies. These are described in Table 4.1.

Table 4.1 – Summary of Information Requirements Relevant to the Freshwater Field Studies

Study Element	Description of Gap	Proposed Field Study/Data Collection
Purari and Vailala River Catchments		
Aquatic flora and fauna, and aquatic ecosystems	♦ There is a large body of work from the 1970s collected for the Purari Hydropower Project. Taxonomic studies compiled by Polhemus and Allen (2006) also provide a preliminary basis for assessing levels of endemism ♦ Few contemporary systematic aquatic ecology studies in the area ♦ Insufficient existing data to characterise the baseline environment or conduct a robust impact assessment, particularly with respect to assessing IFC Standard 6 (Critical Habitats)	Collection of field data from representative survey locations during the 'wet' and 'dry' seasons that will characterise the following: ♦ Wetland/aquatic ecosystem mapping at and adjacent to project infrastructure and river transport route sites ♦ Site-specific information on aquatic plant communities ♦ Site-specific information on aquatic macroinvertebrate communities ♦ Site-specific information on fish and macrocrustaceans ♦ Potential threatened and/or endemic species in the study area, and location of IFC Critical Habitat.
	Records of at least three (possibly four) threatened elasmobranch (shark/ray) species in the Purari River catchment and surrounds, known to occur in estuarine and freshwater environments (Haines, 1979): ♦ Largetooth sawfish (*Pristis microdon*) ♦ Speartooth shark (*Glyphis glyphis*) ♦ Giant shovelnose ray (*Glaucostegus typus*) ♦ (possibly) New Guinea river shark (*Glyphis garricki*). Given that these species were last identified in the catchment in 1979, there is uncertainty as to their current presence in the study area, and whether suitable habitat occurs within potential areas of impact. The presence of threatened species may indicate an area is 'Critical Habitat' for the purposes of the EIS/ESHIA.	Netting within freshwater and estuarine tributaries of the Purari River (as part of the above).

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Table 4.1 – Summary of Information Requirements Relevant to the Freshwater Field Studies (cont'd)

Study Element	Description of Gap	Proposed Field Study/Data Collection
Aquatic flora and fauna, and aquatic ecosystems	Landforms identified in the study area may support unique evolutionary processes and/or endemic species where they are isolated (fully or partially) from other landscape features. This applies in particular to plateaus and oxbow lakes There is no data related to aquatic ecology of oxbow lakes or plateaus in the study area. This is of particular important in regards to: ♦ Oxbow lake opposite the Purari airstrip ♦ Plateau north of Herd Base NB – given the ephemeral nature of the Orovoi Basin, this area was not considered likely to represent a critical habitat feature for the purposes of endemism and/or evolutionary processes	Electrofishing, netting and trapping within oxbow lake opposite the Purari airstrip (as part of the above) Flyover of plateau north of Herd Base to identify whether: ♦ Permanent water bodies occur on the plateau ♦ Water bodies on the plateau are separated from other water bodies by fish barriers (e.g., waterfalls) If this is the case, electrofishing, netting and trapping is proposed to be undertaken as part of the second field trip (see below)
Surface water quality	Surface water quality has been collected at some of the wellpads in the study area. However, this data is limited for the purposes of characterising the baseline environment for the study area and conducting a robust impact assessment for the following reasons: ♦ Laboratory analysis was not conducted for all the parameters provided for in the Environment (Water Quality Criteria) Regulation 2002 or in GS EP ENV 111 ♦ Surface water samples previously collected will not be temporally consistent with samples collected in the remainder of the study area Therefore, while the existing data will contribute to the characterisation of the baseline environment, new baseline data will be required for the study area during both the 'wet' and 'dry' seasons	Collection of field data from representative survey locations during the 'wet' and 'dry' seasons that will characterise the following: ♦ Physico-chemical parameters of water quality ♦ Organics, metals, nutrients and other parameters of water quality described in GS EP ENV 111
In-stream sediment quality	No existing data has been identified from previous characterisations of riverine and estuarine sediment quality data in the study area	'Once off' collection of field data during the 'dry' season from representative survey locations that will characterise the following: ♦ Sediment physical parameters ♦ Organics, metals, nutrients and other chemical parameters of sediment quality described in GS EP ENV 111

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Table 4.1 – Summary of Information Requirements Relevant to the Freshwater Field Studies (cont'd)

Study Element	Description of Gap	Proposed Field Study/Data Collection
LNG Site and Estuarine Areas		
Surface water and sediment quality	Water and sediment quality sampling (including in-situ sampling) in the Vaihua estuary and upstream freshwater areas for the PNG LNG EIS did not test for the following parameters: ♦ Dissolved oxygen ♦ Total organic matter ♦ Dissolved metals/metalloids: Ba, Co, Sn, Sr, V ♦ Hydrocarbons ♦ Bacteriological parameters These parameters require testing under GS EP 111 While collecting samples to analyse just for these parameters is possible, the data would not be temporally aligned with existing data. In addition, there may be changes to the runoff into the Vaihua River as a result of the development of the PNG LNG facility hence new baseline data is required	Collection of field data from representative survey locations during the 'wet' season that will characterise the following: ♦ Physico-chemical parameters of water quality ♦ Organics, metals, nutrients and other parameters of water quality described in GS EP ENV 111 Existing PNG LNG data sufficiently supplements this study to justify a single survey. CNS (2009) also suggests that much of the freshwater areas of this site are dry during the 'dry' season Water sampling of the Vaihua estuary will be undertaken during the dry season marine survey
Aquatic flora and fauna and aquatic ecosystems	While aquatic ecology studies have been undertaken in the Vaihua River, including the estuary, the development of the PNG LNG facility at Caution Bay will have modified the baseline environment since this time. As a result, all aquatic ecosystems downstream of the new facility will have a modified baseline for the purposes of impact assessment for a new facility. Upstream, freshwater sites in the river, located within the eastern footprint of the proposed LNG facility, have never been characterised	Collection of field data from representative survey locations during the 'wet' season that will characterise the following: ♦ Wetland/aquatic ecosystem mapping at and adjacent to project infrastructure and river transport route sites ♦ Site-specific information on aquatic plant communities ♦ Site-specific information on aquatic macroinvertebrate communities ♦ Site-specific information on fish and macrocrustaceans ♦ Potential threatened and/or endemic species in the study area, and location of IFC Critical Habitat Existing PNG LNG data sufficiently supplements this study to justify a single survey. CNS (2009) also suggests that much of the freshwater areas of this site are dry during the 'dry' season Habitat assessment will also be undertaken while undertaking water sampling during the dry season marine survey. Fish sampling may also be undertaken during this survey, subject to consideration of local community concerns

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4.3 Information from Other ESBS Studies

4.3.1 High Conservation Value Habitats and Threatened/Migratory Species

Based on literature reviewed, the high conservation value habitats and threatened species potentially present in the freshwater and estuarine study area are expected to consist of mangroves, (which may include the presence of the critically endangered species *Bruguiera hainesii*), banded watersnake (*Cantoria annulata*) and the following sawfish and shark:

- Largetooth sawfish (*Pristis microdon*).
- Speartooth shark (*Glyphis glyphis*).
- Giant shovelnose ray (*Glaucostegus typus*).
- (possibly) New Guinea river shark (*Glyphis garricki*).

The Purari River tributaries and oxbox wetlands could also potentially provide habitat for freshwater turtle species including the pig-nosed turtle (*Carettochelys insculpta*) and striped New Guinea soft-shelled turtle (*Pelochelys bibroni*) (listed by the IUCN as Vulnerable).

Fishing will be undertaken using a variety of techniques during the freshwater and estuarine survey to identify the occurrence of potential threatened and endemic species. Observations will also be made of habitats within the area surveyed. Mangrove observations will be site-based only as part of the estuarine surveys, i.e., observations will be made of mangroves during vessel transit between the various estuarine/freshwater sampling sites. The intention of these observations is to ground-truth mangrove distribution (for the habitat map) and to identify any areas of *Bruguiera sp*p. Opportunistic observations of the presence of any megafauna (dolphins, dugongs, turtles, turtle nesting sites and waterbirds will also be made during the freshwater and estuarine surveys. The bibliographic studies will also provide information on critical habitats and threatened species likely to occur in the Project area.

Additional information will be obtained from other environmental and social baseline studies, as described below.

Terrestrial Biodiversity

- The terrestrial biodiversity survey will be a land-based survey with the pipeline corridor (in different areas to the estuarine survey) that will also record mangrove distribution and identify the presence of critically endangered species.
- Assessment of turtle nesting locations in Purari River tributaries and the oxbow wetland in the vicinity of the proposed CPF site will be undertaken by the herpetofauna specialist as part of the Terrestrial Biodiversity Study.
- Specific survey of waterbirds will be undertaken of mudflats and mangroves in estuarine areas by the avifauna specialist as part of the Terrestrial Biodiversity Study.

Social

- Information on the potential presence of threatened fish species, turtles and watersnakes will be obtained from community interviews and market surveys undertaken as part of the village

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surveys, with evidence for threatened species (such as specimens or photographs of specimens) verified by an expert.

- Information on the use of natural resources and processes of the local freshwater and estuarine environment to support local livelihoods (i.e., ecosystem services) will be obtained from community interviews and market surveys undertaken as part of the social study village surveys (see Section 4.3.2).

4.3.2 Ecosystem Services and Fisheries Resources

The freshwater and estuarine biodiversity survey will collect information on high-value habitats for aquatic resources (e.g., mangroves) as well as record any observations during the field survey of aquatic resource use. However, the primary collection of priority ecosystem services data will be through the social study surveys (village interviews, household questionnaires and market surveys). This includes obtaining information on aquatic resources utilised by local communities, including species targeted and consumed, key fishing areas and any areas used by turtles for nesting.

The bibliographic studies will also provide information on ecosystem services and fisheries resources in the project area.

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5. Survey Period

The entire study area is affected by seasonality (CNS, 2009; Evesson, 1983), however this varies with location. The seasons in Papua New Guinea (and rainfall patterns) are generally defined by the southeast trade winds that occur from May to October (dry season) and northwest monsoons winds that occur from December to March (wet season). April and November are doldrum periods in between these seasons. However in the Purari River area near PRL-15, there is reverse seasonality and the distinction between seasons is not major. Rainfall at the district station of Kikori has an annual average of 5,773 mm, peaking in May (750 mm) and is driest in December (301 mm) (McAlpine et al. 1983). Rainfall at Ihu to the east of the Purari River delta and at Baimuru to the west is fairly evenly distributed throughout the year, with an annual average of 3,098 mm at Ihu and 3,455 mm at Baimuru (Shearman, 2010).

Consistent with Guidance Note 9 of IFC Performance Standard 6 (Biodiversity Conservation and Sustainable Management of Living Natural Resources) and CEPA's GL-Env02/2004 (for surface water quality) in-field surveys over multiple seasons should be conducted for projects with the potential to cause significant impact to natural and critical habitats. On this basis, two surface water surveys will be conducted, with the first commencing in July 2016 in the middle of the dry season, and a second survey conducted in December 2016 within the wet season for the purposes of capturing this seasonality[2].

These surface water seasonal surveys will capture the riverine environment to a point approximately 35 km upstream of the Purari River mouth. Estuarine areas downstream of this point will be surveyed as part of the marine survey programs due to logistical considerations (such as the need to use marine survey vessel and tender in this area). These downstream estuarine surveys will also be conducted on a seasonal basis.

Due to landowner issues at the proposed LNG plant site, sampling can only be undertaken during the wet season under existing EIS/ESHIA timeframes. However CNS (2009) suggests that much of the freshwater areas of this site are dry during the dry season.

[2] An El Nino event was occurring at the time of survey planning, therefore survey commencement was delayed as late into 2016 as possible, while still meeting the EIS/ESHIA schedule.

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6. Survey Parameters

Parameters that will be measured as part of the freshwater field studies are listed in Table 6.1.

Table 6.1 – Parameters to be Measured during Freshwater and Estuarine Field Studies

Dataset	Description of Parameters	Justification
Surface water and sediment quality		
Site-based in-situ water quality data	Physico-chemical water quality parameters: ♦ Temperature ♦ pH, Eh ♦ Salinity ♦ Conductivity ♦ Dissolved oxygen (DO) ♦ Turbidity Observations of stream flow and conditions will also be noted, including smell, gas bubbles, algae, iridescence, bacterial aggregates and precipitates.	♦ Parameters as per GS EP ENV 111 ♦ Stream flow provides additional parameter for purpose of context
Continuous in-situ water quality data	Turbidity data collected continuously (i.e., from a continuously logging instrument) in the Purari River at Herd Base throughout the duration of each of the freshwater field studies	Opportunistic data gathering to assist model validation/calibration for riverine sediment transport assessment (as part of Hydrology and Meteorology study)
Water quality samples	Grab sampling for subsequent laboratory analysis. Parameters for analysis include: ♦ Total suspended sediments (TSS) ♦ Major cations and anions ♦ Alkalinity ♦ Total organic carbon (TOC) and dissolved organic carbon (DOC) ♦ Total nitrogen, total phosphorous, nitrate/nitrite, ammonia and orthophosphate ♦ Bacteriological analyses (coliforms) ♦ Total and dissolved metals/metalloids (Al, As, Ba, Cd, Co, Cr, Cu, Fe, Hg, Ni, Pb, Sn, V, Zn) ♦ Total petroleum hydrocarbons (TPHs), benzene, toluene, ethylbenzene and xylenes (BTEX) and polyaromatic hydrocarbons (PAHs)	Parameters as per GS EP ENV 111 Arsenic (As) was added to characterise water quality in the context of potential historical artisanal mining in the Purari River basin (As is associated with artisanal mining activities) Alkalinity and major cations and anions provide an indication of geochemical signature of waters and assists in impact assessment associated with interference of brown water interactions and waterway diversions DOC provides an additional parameter to assist in quantifying the impact of dissolved metals/metalloids as high DOC levels decreases bioavailability of dissolved metals/metalloids While nitrates/nitrites will be tested, these samples are expected to have breached holding times (~2 days) before reaching certified laboratory for analysis **NB** – all water quality criteria have been selected to meet the GS EP ENV 111 and to assess the existing environment against the ambient water quality criteria of the *Environment (Water Quality Criteria) Regulation 2002* that are considered relevant to project activities and potential discharges. BOD and COD analyses are not planned (holding times for samples would be breached before arriving at a NATA-accredited laboratory). TOC/DOC analyses will provide information on organic content and oxygen demand

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Table 6.1 – Parameters to be Measured during Freshwater and Estuarine Field Studies (cont'd)

Dataset	Description of Parameters	Justification
Sediment quality samples	Grab sampling for subsequent laboratory analysis. Parameters for laboratory analysis include: ♦ Particle size distribution (PSD) ♦ Moisture content ♦ Total organic matter (TOM) and TOC ♦ Total nitrogen and total phosphorous ♦ Total metals/metalloids (Al, As, Ba, Cd, Co, Cr, Cu, Fe, Hg, Ni, Pb, Sn, V, Zn) ♦ TPHs, BTEX and PAHs Observations will be recorded in the field regarding sediment colour, odour and texture (silt/clay/sand/gravel/cobble) and presence of organic matter/biota. Eh will also be measured	Parameters as per GS EP ENV 111 Additional metals/metalloid parameters were added (Al, Fe, V) for comparison with standard suite for sediment Arsenic added to characterise sediment quality in the context of potential historical artisanal mining in the Purari River basin PSDs provide data necessary for the purposes of characterising sediment transport within the Purari River
Freshwater and estuarine ecology		
Aquatic ecosystem mapping and characterisation	Based on modified version of Polhemus & Allen (2006) and IUCN (2015), which includes the following parameters: ♦ River channel morphology ♦ Lake/wetland morphology ♦ Substrate type ♦ Flow/wetting-drying regime type ♦ Dominant aquatic vegetation species	Necessary to describe key aquatic habitat areas in the study area, including potential special purpose areas (for GL-ENV02/2004) and natural habitat and critical habitat (for IFC Performance Standard 6)
Site-based aquatic vegetation and micro-habitat characterisation	Relative abundance of aquatic plant taxa Meso-habitat metrics including substrate type, depth, flow conditions, canopy cover	Description of plant species is consistent with GS EP ENV 111 Micro-habitat features provides further environmental context for site and potential for occurrence of particular species or species groups
Site-based aquatic macro-invertebrates	Relative abundance of macroinvertebrate taxa (littoral habitats) to: ♦ Calculate diversity metrics (diversity, abundance, richness) for different ecosystem types and sites, over time ♦ Quantify patterns in community similarity among ecosystem types and over time ♦ Identify occurrence of potential endemic species Relative abundance of benthic macroinvertebrates (estuarine habitats)	Key element of biodiversity in context of: ♦ Food source for fish ♦ Key ecosystem driver (food chain maintenance) ♦ Endemic species (as defined by Polhemus et al. (2004) – indicator for IFC Critical Habitat

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Table 6.1 – Parameters to be Measured during Freshwater and Estuarine Field Studies (cont'd)

Dataset	Description of Parameters	Justification
Site-based fish and macro-crustaceans	Relative abundance of fish species (catch per unit effort) at each site to: ♦ Calculate diversity metrics (diversity, abundance, richness) for different ecosystem types and sites, over time ♦ Quantify patterns in community similarity among ecosystem types and over time ♦ Identify occurrence of potential threatened and endemic species	Key element of biodiversity in context of: ♦ Food source for fish and humans ♦ Key ecosystem driver (food chain maintenance) ♦ Endemic species (as defined by Polhemus et al., 2004) – indicator for IFC Critical Habitat ♦ Threatened species – indicator for IFC Critical Habitat Description of these species is consistent with GS EP ENV 111
Site-based fish and macro-crustacean metal and hydrocarbon burden	Collection of tissue samples from fish and macro-crustaceans (prawns/shrimps) for the measurement of the following parameters: ♦ Moisture ♦ PAHs ♦ Trace metals (Al, As, Cd, Cr, Cu, Pb, Mn, Hg, Ni, Se, Ag, Zn)	LNG condensates include PAHs while drilling fluids and wastewaters may contain metals and metalloids. Aquatic organisms can bioaccumulate PAHs and metals/metalloids. This presents a risk to communities that eat potentially affected fish and/or macrocrustaceans. Collection of baseline data is necessary to characterise existing conditions

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7. Survey Methods

Two levels of survey activity will be undertaken for the freshwater and estuarine field studies:

- Helicopter-flyover and high level aquatic ecosystem mapping.
- Site-based sampling.

7.1 Helicopter Flyover

Vegetation mapping will be geo-rectified to a portable GPS or tablet device to enable aerial, low-altitude validation of wetland vegetation communities. Helicopter flyovers will confirm the presence and broad-scale distribution of these wetland communities. This will also allow refinement of potential freshwater and estuarine ecology sites and nearby landing areas.

If mapping from vegetation surveys undertaken by Booyong Forest Science is not available at the time of the survey, or is not suitable for these purposes, BMT WBM will source broadscale mapping (e.g., Hammermaster and Saunders (1995) – Forest Inventory Mapping System) and any available satellite imagery as part of the desktop analysis to aid in establishing differences in wetland communities.

This approach will allow for broad-scale identification of key aquatic ecosystem types to supplement site-based sampling and provide a regional understanding of aquatic ecosystems in the study area.

7.2 Site-based Sampling

The following survey activities will be undertaken at each survey site:

- In-situ water quality measurements.
- Continuous in-stream water quality measurements.
- Water sampling.
- In-stream sediment sampling.
- Assessment of structural habitat characteristics.
- Macroinvertebrate sampling.
- Fish and macrocrustacean sampling (with method used dependent upon stream type).

In addition, where fish and/or macrocrustaceans collected represent important local food fishes, tissue samples will be taken for laboratory analysis of metals and polyaromatic hydrocarbons (PAHs). Up to ten sites are proposed for taking of tissue samples for these analyses. In order to account for both freshwater and estuarine fish species and acknowledging the greater number of freshwater sites being sampled, tissue samples will be taken at up to four sites in estuarine waters and the remainder at freshwater sites.

For sites sampled on tributaries near the junction with the Purari River, sample locations will be split: water sampling and in-stream sediment sampling will be undertaken in the main channel of the Purari Rver while assessment of structural habitat characteristics and fish, macrocrustacean

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and macroinvertebrate sampling will be undertaken in the tributary stream. In situ water quality measurements will be taken at both locations, i.e., in the Purari River and the tributary stream.

It is not feasible to undertake fishing and macroinvertebrate sampling within the main channel of the Purari River due to fast flows and likely debris. In addition, more fish are expected to occur within the calmer (and probably less turbid) waters of the tributary where there are greater habitat and feeding opportunities. These fish species will be the same as would be found within the main channel. However, it is important to characterise the physico-chemical qualities of the water and sediment within the main channel of the river. It is for these reasons that these sites will be split.

Table 7.1 describes each of the survey activities and the relevant justification.

Table 7.1 – Description of Proposed Sampling Methodology

Sampling Activity	Description	Justification
In-situ water quality measurements	Reporting of observations and measuring of in-situ parameters using a calibrated YSI probe and calibrated McVan probe	Collects parameters as per requirements of GS EP ENV 111
Continuous in-stream water quality measurements	Attachment of YSI to fixed in-stream infrastructure at Herd Base (e.g., jetty) to collect continuous data for the duration of the field survey	As above for in-situ water quality measurements. Provision of a time-series will allow short term variability to be assessed, which can then be compared to water depth and rainfall data to assess potential drivers of change
Water sampling for subsequent laboratory analysis of relevant parameters	A sampling bottle appropriate to the parameters being tested for, as provided by the relevant laboratory, will be immersed in the water. The type of water shall be recorded (e.g. temporary, stagnant, permanent, spring) Water samples will be packed immediately in suitable containers, adapted to the parameters to be analysed, and numbered and stored. A photo of the sampling site and a water sample shall be taken at each site. The following basic information will also be gathered and recorded: data and time of sampling, sample coordinates, sampling depth, sampling method, precipitates, odour, bacterial aggregates, algae, gas bubbles and packing NB – all water quality samples will be collected before sediment quality sampling	Methodology as per GS EP ENV 111
In-stream sediment sampling	Sediments will be sampled at the same site where water quality samples have been taken using a 0.028m^2 gape Van Veen Grab and placed into a tray for placement into a sample jar. The sample will be packed immediately into a sampling jar appropriate to the parameters being analysed, as provided by the analytical laboratory Sediment samples will be labelled and stored. A photo of a sediment sample shall be undertaken at each site	Methodology as per GS EP ENV 111 and commonly undertaken for river bed sediments

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Table 7.1 – Description of Proposed Sampling Methodology (cont'd)

Sampling Activity	Description	Justification
Assessment of structural habitat characteristics	An assessment of structural habitat characteristics and aquatic/riparian vegetation will be conducted at all sites using a modified version of the AusRivAS sampling protocol (Parsons et al., 2002). Descriptive assessments of habitat conditions will be undertaken at all sites, which will include descriptions of the water body condition/integrity, adjacent land uses, habitat types present, evidence of pollution, assessment of aquatic macrophyte and large woody debris cover, and the longitudinal extent, percentage cover and composition of riparian vegetation. General information including photographs, GPS coordinates and altitude, site number, water body name, weather and recent rain conditions will also be collected. In addition, a sketch of the site is made, including landmarks such as villages/houses, helicopter landing facilities and riparian vegetation	AusRivAS protocol (Parsons et al., 2002) for habitat assessments has been successfully and widely used in PNG for monitoring and impact assessment reporting
Macroinvertebrate sampling	*Sweep and kick-netting (freshwater sites)* Sampling of freshwater littoral 'edge' habitat will be undertaken where possible following a modified version of the AusRivAS protocol (e.g., DNRM, 2001). Three samples will be collected by sweeping with a triangular dip-net (30x30x30 cm, 0.25 mm mesh) along the edge for standardised 10 m lengths Sampling of freshwater 'riffle' and/or waterbody 'pool' habitat following a modified version of the AusRivAS protocol (e.g., DNRM, 2001) will also be undertaken where possible. Three samples will be collected from either riffle or pool habitat areas, depending on habitat availability at each site. Where riffle habitat areas are present, this habitat will be sampled preferentially. Riffle habitat will be sampled by disturbing the substrate with the feet along a 10 m section of stream and collecting dislodged macroinvertebrates with the dip net held immediately downstream of the disturbance area. Pool samples will be collected using the dip net by disturbing sediments within a $1m^2$ quadrat. The suspended benthic animals are captured as the net sweeps through the cloud of suspended matter	AusRivAS protocol (e.g., DNRM (2001)) for macroinvertebrate sampling is the preferred sampling technique for freshwater environments adopted in Australia and has been successfully and widely used in PNG for impact assessment and monitoring purposes (e.g. Woodlark Gold Mine ESIA, P'nyang Gas Project ESIA, Wafi-Golpu Project ESIA, Hela Hydropower Project ESIA, environmental monitoring for Frieda River Project and Hidden Valley Mine)
Macroinvertebrate sampling	*Benthic grab sampling (estuarine sites)* In estuarine areas, three sediment samples will be collected using a $0.028m^2$ gape Van Veen Grab. Collected sediment will be run through a sieve and retained benthic infauna collected Macroinvertebrates are retained in preservative solution for the purposes of transport and subsequent identification. After analysis, samples will be disposed of in accordance with local regulation	Allows the quantitative sampling of macroinvertebrate assemblages Rapid and readily deployed from a small vessel Designed for sampling of muddy and sandy sediment, which are expected to be dominant substrate types in the estuary

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Table 7.1 – Description of Proposed Sampling Methodology (cont'd)

Sampling Activity	Description	Justification
Fish and macrocrustacean sampling	*Backpack electrofishing* Sampling will be undertaken at suitable sites within pools, runs and other suitable habitat types for 900 seconds of pulse time. Output power is standardised to conductivity to ensure that only enough power is used to temporarily stun fish. Pulsed DC current is fixed at a pulse rate of 60 Hz and a duty cycle of 25%. Backpack electrofishing is restricted to shallow areas (<1 m deep) due to safety issues associated with operating equipment in deeper waters and strong currents. Fish are collected using a dip net and are retained in temporary storage buckets until all electrofishing is completed to avoid potential recapture. Backpack electrofishing will form a principle sampling techniques for shallow water creeks and streams Fish collected are returned to the environment, except where they are retained for fish tissue analysis purposes	Allows the quantitative sampling of fish and macrocrustacean assemblages in freshwaters only Rapid, non-lethal technique Designed for sampling of wadeable streams, which are expected to be key waterway type in the upper catchment Potentially has higher catch rates than non-electrofishing methods (e.g., Vaux et al., 2000) Has been used successfully (and widely used) in PNG previously
	Baited box trapping Baited box traps (0.5 mm mesh) will be deployed at all sites to sample small-bodied fish and macrocrustaceans. Ten collapsible baitfish traps are deployed within the range of microhabitat types present within the site (i.e., littoral margin, among snags, open water) for a minimum period of one hour. Box traps will form a principle sampling technique for shallow water creeks and streams Fish collected are returned to the environment, except where they are retained for fish tissue analysis purposes	Allows the quantitative sampling of fish and macrocrustacean assemblages Rapid, non-lethal technique Designed for sampling of wadeable streams and deeper waterways Designed to target small-bodied cryptic species and macrocrustaceans that may evade other apparatus. Has been used successfully (and widely used) in PNG previously

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Table 7.1 – Description of Proposed Sampling Methodology (cont'd)

Sampling Activity	Description	Justification
Fish and macrocrustacean sampling (cont.)	*Gill netting* Three nets of varying mesh sizes (25 mm, 50 mm, 75 mm stretched mesh) will be set parallel to the shore for a soak time of two hours, checked half hourly. Gill nets will form a primary sampling method for deep (non-wadeable) environments but are only able to be placed at sites where waterway dimensions permit effective net use. Gill nets are the most effective fishing method for sampling of freshwater sharks and sawfish, which inhabit estuaries and freshwater rivers Fish collected are returned to the environment, except where they are retained for fish tissue analysis purposes **NB** – to avoid potential impacts to aquatic fauna, gill nets will be monitored through deployment and cleared immediately upon capturing any large fish, shark, sawfish etc	Allows the quantitative sampling of larger-bodied fish species. In particular, gill netting is the principle methodology available for catching freshwater sharks and sawfish in waters that are too deep for backpack electrofishing. Other netting methodologies for deep water areas are not viable for catching sharks. Gill netting is currently used by Murdoch University when targeting freshwater sharks in Western Australia (cf. Thorburn et al., 2004) Designed for sampling of deeper waterways Has been used successfully (and widely used) in PNG previously Sharks and sawfish need to be targeted for the purposes of establishing the presence of threatened species in the study area
	Fyke netting Dual wing fyke nets (12 mm mesh) may be deployed to target larger fish. Two traps may be set for a standard two hour period at sites with sufficient water depth (~0.5m) and no/low flow. Fyke nets will form a secondary sampling technique for shallow water creeks and streams and will be used at the discretion of field staff and where suitable conditions for deployment are present Fish collected are returned to the environment, except where they are retained for fish tissue analysis purposes	Allows the quantitative sampling of fish assemblages in freshwaters only (crocodile hazard in estuary) Non-lethal technique Designed for sampling of wadeable streams, which are expected to be key waterway type in the upper catchment Has been used successfully (and widely used) in PNG previously Used as a supplementary collection methodology where site conditions allow and where larger fish are expected to occur that would otherwise avoid electrofishing

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Table 7.1 – Description of Proposed Sampling Methodology (cont'd)

Sampling Activity	Description	Justification
Fish and macrocrustacean sampling (cont.)	*Seine netting* Small seine nets may be used where environmental conditions do not allow for effective use of backpack electrofishing unit (i.e., high conductivity and/or turbidity conditions). Seine nets which will be available for the study include a pole seine (0.5 mm mesh) and small push seine (3 m long, 2 m high, 5 mm stretched mesh). Seine nets will form a secondary sampling technique for shallow water creeks and streams and will only be used where conditions are unsuitable for backpack electrofishing Fish collected are returned to the environment, except where they are retained for fish tissue analysis purposes	As for fyke netting (plus it also samples macrocrustaceans)
	Cast netting Ten replicable casts will be thrown along channel banks in areas likely to be inhabited by small-bodied fish (such as beneath overhanging branches or in eddies and backwaters). Cast netting will form a secondary sampling technique for deep (non-wadeable) environments and will be utilised where suitable conditions permit effective use of this apparatus Fish collected are returned to the environment, except where they are retained for fish tissue analysis purposes	As for fyke netting
Fish tissue sampling	Samples will be collected at each site for tissue analysis, depending on the species present. Individual samples could include whole body (for small-bodied fish), hind body (for large freshwater prawns) or cephalothorax (for large freshwater prawns). It is preferable that whole samples be collected and submitted for analysis as this reduces the risk of cross-contamination and damage of tissue from field processing All samples will be assigned an identification label, weighed to the nearest gram and their total length measured. Samples will be frozen and transported to a laboratory for analysis Any material not taken for analysis (i.e., if fish is dissected) will be disposed of appropriately (e.g., returned to waterway, taking caution that this does not present a risk due to crocodile attack)	Methodology is consistent with commonly adopted processes for fish tissue sampling and analysis

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8. Personnel and Equipment

8.1 Technical Specialists

The survey team will include the following technical personnel:

- Brad Hiles – Senior Aquatic Ecologist.
- Daniel Moran – Specialist Aquatic Ecologist.
- Ninkama Yoba – Aquatic Ecologist and Field Assistant.
- Kobus Meulenbroeks – Field Assistant and Logistics Coordinator.

8.2 Survey Equipment

The following technical equipment will be used for the purpose of field sampling:

- Water and sediment quality sample bottles, as provided by laboratory for the particular parameters to be tested.
- 2 x calibrated YSI 6600 water quality instruments.
- 1 x calibrated McVan water quality instrument.
- 1 x 0.028m ^{2} gape Van Veen sediment grab.
- 500 µm sieve.
- Macroinvertebrate sample bottles.
- Sediment mixing tray and plastic trowel.
- 1 x triangular dip net.
- 1 x Smith-Root Inc. LR-24 backpack electrofisher and 1x dip net.
- 10 x baited box traps.
- 3 x gill nets of varying mesh (25 mm, 50 mm, 75 mm stretched mesh).
- 2 x dual wing fyke nets (12 mm mesh).
- 1 x pole seine (0.5 mm mesh) and 1x small push seine (3 m long, 2 m high, 5 mm stretched mesh).
- 1 x cast net.

In addition, the field team will also carry GPSs and cameras for the purpose of making in-field observations. The list of nets above includes spares for redundancy purposes. In addition, spare batteries for the electrofisher will be taken.

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9. Sampling Sites

Sites for sampling have been identified based on the following key parts of the study area:

- Freshwater environments within PRL-15.
- Freshwater and estuarine environments associated with the Purari River and upper estuary.
- Estuarine environments associated with the lower estuary and delta of the Purari River, including the Ivo-Urika River[3].
- Freshwater and estuarine environments in the upstream pipeline corridor (i.e., between the CPF and the coastline).
- Freshwater and estuarine environments at the LNG plant site at Caution Bay.

For each area, a number of days of effort have been nominated, based on the expected time required to undertake sampling adequate for the EIS/ESHIA. The number of sites identified depends upon this number of days and an expectation of how many sites can be sampled in a day. The locations of the proposed sites are shown in Figures 9.1, 9.2 and 9.3. Table 9.1 lists the sites along with a justification for selection of the site.

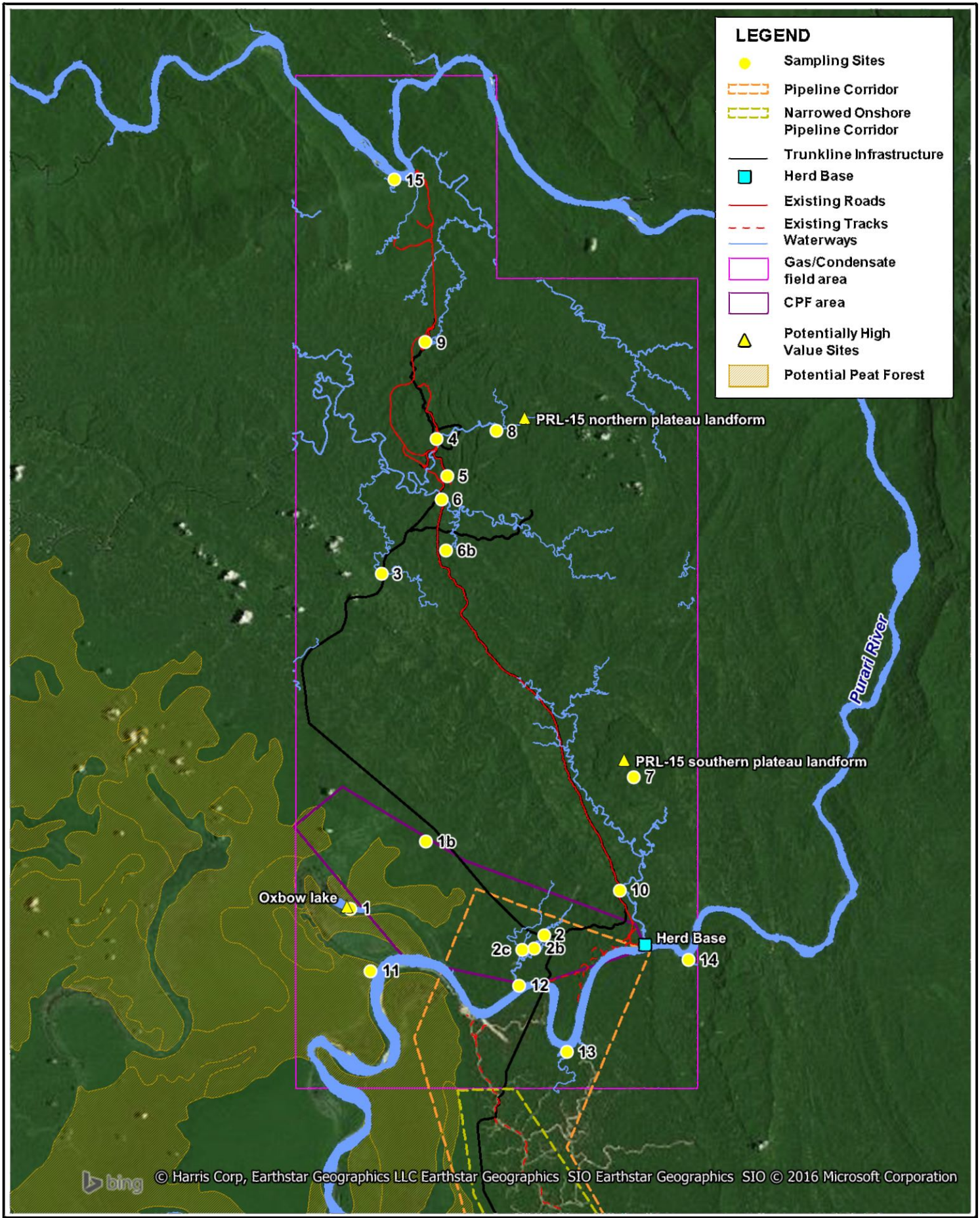
These sites may be varied depending on practicality of access to sites and further information that becomes available on project design and changes to areas that may be potentially impacted by project activities. Any such modifications would be made in consultation with TEP PNG.

A summary of the sampling program at each site during dry and wet seasons is provided in the following tables:

- Table 9.2 – Upstream freshwater sampling program.
- Table 9.3 – Downstream freshwater sampling program.
- Table 9.4 – Upstream and downstream estuarine sampling program.

[3] These represent the dominant watercourses in the Purari River delta and are most likely to be impacted through river traffic and upstream catchment runoff. No sampling is proposed in the Varoi River (which is a branch of the Purari River delta and a potential river transport route) however information obtained from the Purari and Ivo-Urika river branches will provide analogue information on this section of the delta.

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Title:

PRL-15 and Purari River Sampling Sites

Figure: 9.1

Rev: A

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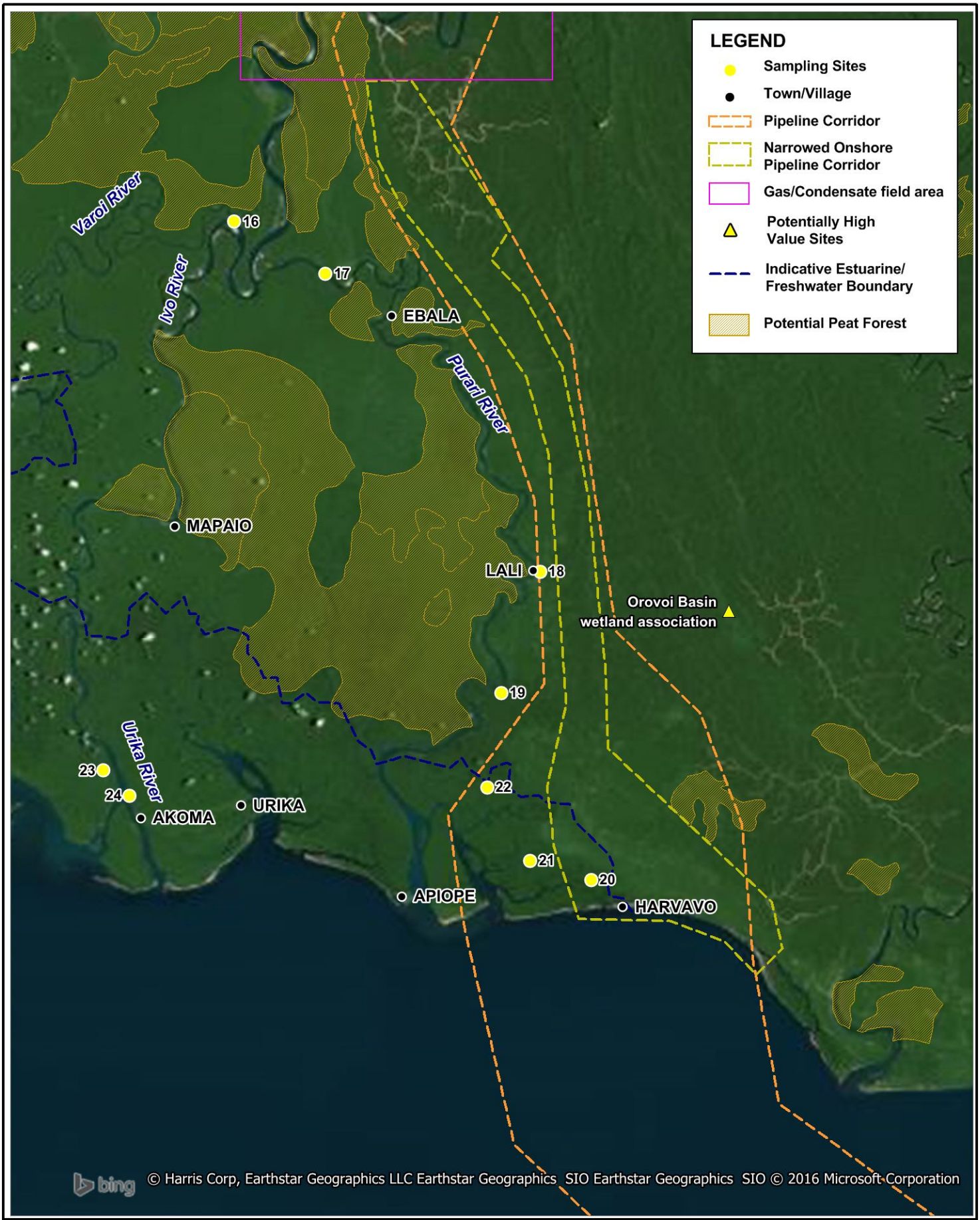
0 5 10km

Approx. Scale

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Title:

Purari River Delta Sampling Sites

Figure: 9.2

Rev: A

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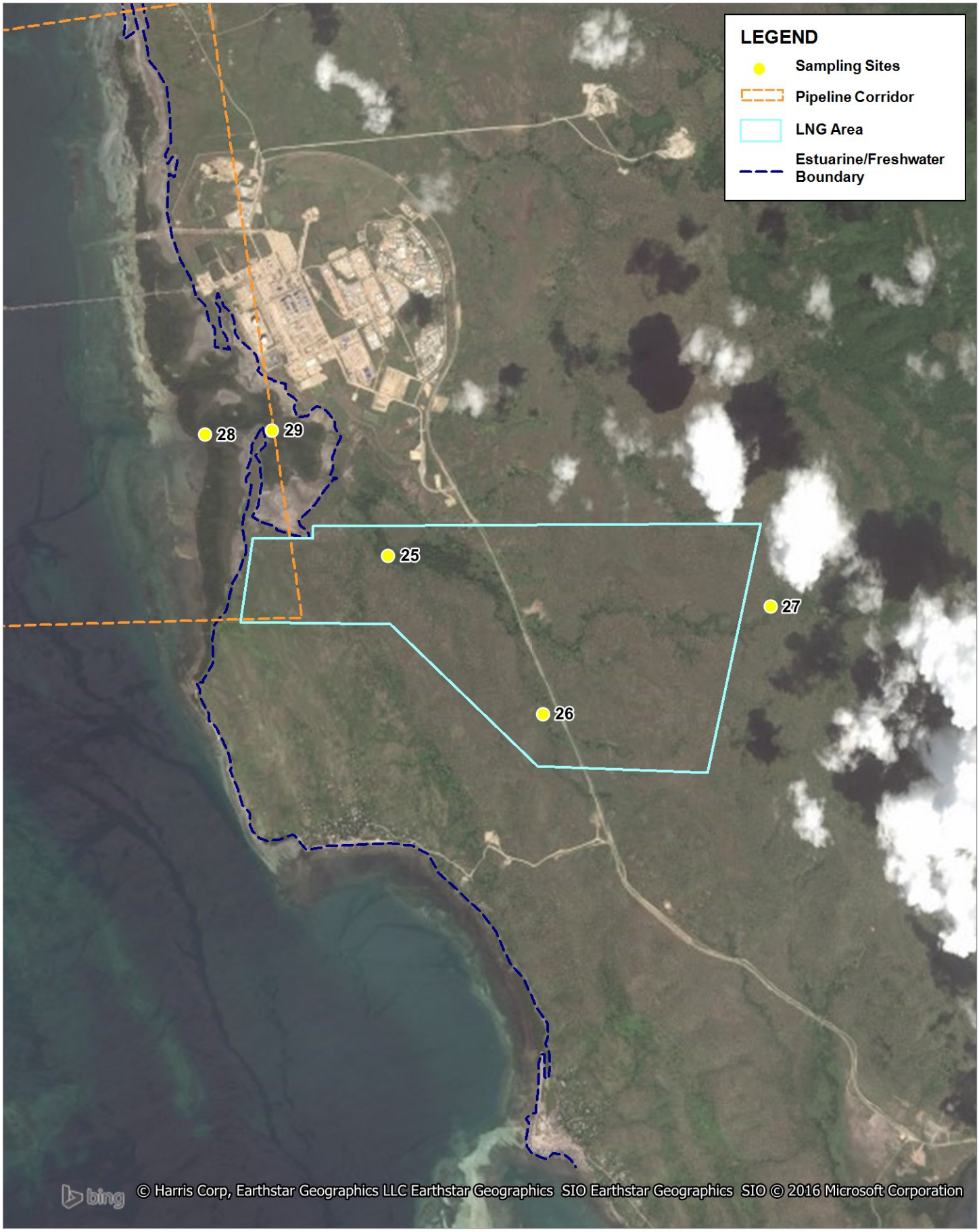
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Title:
Caution Bay Sampling Sites

Figure: **9.3**

Rev: **A**

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0 1 2km

Approx. Scale

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Filepath : I:\B21414_I_GML_Elk_Antelope_EIA_JV\DRG\ECO_002_160112_Caution_Bay_Sites.wor

Table 9.1 – Description of Study Sites

Site	Description	Justification
Herd Base	Wharf or similar in-stream structure at Herd Base for the purposes of deploying a continuously logging water quality instrument	Provides an in-stream reference point for sediment transport model calibration/validation
PRL-15		
1	Purari River oxbow opposite Purari airstrip (or alternative oxbow) -7.340532º, 145.106869º	HIGH PRIORITY SITE Significant oxbow lake identified in the study area which could potentially represent important habitat on the basis of refugia and/or evolutionary processes qualities This is important to survey as it may represent a special purpose area under CEPA's GL-Env02/2004 and/or critical habitat under IFC Performance Standard 6 It is ERIAS Group's understanding that this site may not be accessible for sampling, therefore the Precautionary Principle approach would be applied and the area considered as possible critical habitat for the purpose of impact assessment. This would include consideration of information obtained from the terrestrial biodiversity study and social study programs, including community interviews. Additionally, information on aquatic biodiversity will be obtained from sampling of Nea Creek (Site 11) which is a tie channel to the oxbow lake
1b	Tributary north of Purari River oxbow -7.312862º, 145.138048º	HIGH PRIORITY SITE In lieu of sampling at Site 1, water and sediment quality sampling would be conducted at a tributary north of the oxbow (located near Fly Camp B). This tributary should provide an indication of drainage flowing into the oxbow
2†	Fly Camp C (near CPF) -7.351415º, 145.187151º	HIGH PRIORITY SITE Under the current infrastructure arrangements, this area is likely to be most directly affected and therefore needs to be characterised for the purposes of assessing impacts in accordance with CEPA's GS EP ENV 120 and IFC Performance Standards 1 and 6 Sampling at this site will also allow data to be contextualised with terrestrial ecology sampling, where relevant, and to minimise logistics requirements (i.e., by reusing an existing helicopter pad)
3	Fly Camp A on tributary crossing along western trunkline route -7.202791º, 145.119768º	Site 3 is located on a potential pipeline route, leading from the gas/condensate well pads to the CPF. If this western pipeline route it is not selected, Site 3 will represent a control/reference site within the study area that is upstream of likely impacts from ground disturbance If the western pipeline route is selected, Site 3 will be important for characterising a site that will be directly impacted

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Table 9.1 – Description of Study Sites (cont'd)

Site	Description	Justification
4	Unnamed creek walking/driving distance to Antelope-3 Operations Camp -7.147307º, 145.142643º	Sites have been selected in order to achieve the following: ♦ Characterise the aquatic environment of tributaries in PRL-15, especially where closely associated with proposed infrastructure ♦ Minimise logistics requirements by using existing helicopter pads and/or sites accessible by existing roads Of sites 4-6, Site 5 may be connected to groundwater seepage from the adjoining plateau (near site 8). This groundwater seepage could create an area of refugia habitat during the dry season, where other surface water dries up. Where this is the case, Site 5 would be a distinctive habitat type that requires sampling NB – each of these sites are on different tributaries representing a different area of potential impact from project activities
5	Unnamed creek driving distance to Antelope-3 Operations Camp -7.162596º, 145.146963º	
6‡	Unnamed creek driving distance to Antelope-3 Operations Camp -7.172197º, 145.144579º	
7	Southern tabletop ***(helicopter flyover only)*** -7.286328º, 145.191930º	This site may represent an evolutionary significant location being host to endemic species. However, this cannot be confirmed until a helicopter flyover has been conducted to confirm a) there are permanent waterbodies on the plateau, and b) these waterbodies are disconnected in some way from the surrounding aquatic environments (e.g., by waterfalls) If the site is separated, it could represent critical habitat in accordance with IFC Performance Standard 6 It is ERIAS Group's understanding that this site is not accessible for sampling, therefore the Precautionary Principle approach would be applied and the area considered as possible critical habitat for the purpose of impact assessment NB – it is not the intention to sample at this site; rather, this site will be surveyed (by helicopter) in order to describe the local water resources and aquatic habitat
8	Northern tabletop ***(helicopter flyover only)*** -7.143959º, 145.167300º	As for Site 7, Site 8 may represent a unique geomorphological feature within the study area that could support species of regional significance. While sampling is not proposed for this area, aerial reconnaissance will be necessary to identify the geomorphological and habitat features of the site to assist in identifying if it meets critical habitat under IFC Performance Standard 6 or special purpose area (e.g., wetland area, etc) under CEPA GL-Env02/2004
9	Tributary to Hou Creek -7.107353º 145.137853º	Sites have been selected in order to achieve the following: ♦ Characterise the aquatic environment of tributaries in PRL-15, especially where closely associated with proposed infrastructure ♦ Minimise logistics requirements by using existing helicopter pads and/or sites accessible by existing roads ♦ Ensure a wide spatial variation of sites across PRL-15 ♦ Identify sensitivity of receptors in the aquatic environment likely to be affected, especially comparative to natural variation
10	Tributary north of Herd Base, TBC after helicopter flyover -7.332987º, 145.218569º	

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Table 9.1 – Description of Study Sites (cont'd)

Site	Description	Justification
Purari River within PRL-15		
11	Tributary at Purari River oxbow entrance (Nea Creek) -7.366268º, 145.116476º	Sites have been selected in order to achieve the following: ♦ Characterise the aquatic environment of the Purari River at tributary entrances, with particular focus on identifying presence of threatened freshwater sharks and sawfish ♦ Ensure a wide spatial variation of sites both up- and down-stream of the main impacting infrastructure (i.e., CPF and pipeline crossing) ♦ Identify sensitivity of receptors in the aquatic environment likely to be affected, especially comparative to natural variation Site 15 has been selected as an upstream control/reference site on the Purari River upstream of Hou Creek. Site 14 is also upstream of Herd Base and proposed CPF site and is a reference site As described in Section 7.2, water sampling and in-stream sediment sampling will be undertaken in the main channel of the Purari Rver while assessment of structural habitat characteristics and fish, macrocrustacean and macroinvertebrate sampling will be undertaken in the tributary stream. In situ water quality measurements will be taken at both locations, i.e., in the Purari River and the tributary stream
12	Purari River at CPF tributary entrance -7.372086º, 145.176788º	
13	Purari River at southern tributary entrance -7.399481º, 145.196520º	
14	Purari River at southern tributary entrance -7.361598º, 145.246974º	
15	Purari River at tributary upstream of Hou Creek -7.040567º, 145.124942º	
Pipeline Corridor/River Transport Route		
16	Ivo River at tributary entrance downstream of Purari/Ivo River junction -7.489445º, 145.080505º	To characterise aquatic environment along potential river transport route
17	Purari River immediately downstream of Ivo River junction -7.516970º, 145.129408º	To characterise aquatic environment along pipeline corridor and potential river transport routes (water and sediment quality sampling only)
Purari River Delta (including Ivo-Urika River) (sampled as part of the marine survey)		
18	Purari River at tributary entrance at Lali village -7.6748675º, 145.2439989º	Sites have been selected in order to achieve the following: ♦ Characterise the aquatic environments in areas downstream of the pipeline corridor ♦ Characterise aquatic environments along potential river transport routes ♦ Characterise sites that may be impacted by spills or other discharges from project infrastructure ♦ Identify sensitivity of receptors in the aquatic environment potentially exposed to project-related impacts
19	Purari River at tributary entrance approx. 10 km south of Lali Village -7.7388594º, 145.2232550º	
20	Tributary of Purari River estuary -7.837921º, 147.271344º	
21	Tributary of Purari River estuary -7.827696º, 145.238810º	
22	Tributary of Purari River estuary -7.791244°, 145.255296°	

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Table 9.1 – Description of Study Sites (cont'd)

Site	Description	Justification
23	Tributary of Ivo-Urika River estuary -7.78002º, 145.010788º	As described in Section 3, the Ivo-Urika River is a potential river traffic transport corridor for the project, during both construction and operation phases. The aquatic environment in these areas therefore requires characterisation to understand potential impacts to the aquatic environment from river traffic **NB.** No sampling is proposed for a possible alternative transport route on the Varoi River branch of the Purari River delta immediately to the west of the Ivo-Urika River. Information provided by sampling on the Purari and Ivo-Urika river branches of the Purari River delta is considered to provide suitable analogue information on the Varoi River for the purpose of the ESHIA
24	Tributary of Ivo-Urika River estuary -7.79638º, 145.008847º	
LNG Plant Site, Caution Bay		
25	Vaihua River west of highway -9.362684º, 147.026794º	Sites have been selected in order to achieve the following: ♦ Characterise the aquatic environment in the footprint of the LNG facility ♦ Update baseline characterisation subsequent to survey by PNG LNG EIS (applicable to sites 26 and 27) ♦ Maximise the opportunity to sample from permanent waterbodies noting that much of the site is subject to annual drying **NB** – Site 27 is upstream of the direct footprint of the proposed LNG facility but is expected to be characteristic of the area and provide a reference location. Sites 25 and 26 are downstream of the proposed LNG facility or within the project footprint
26	Vaihua River west of highway -9.378022º, 147.041995º	
27	Vaihua River east of highway 9.367618°, 147.064380°	
28	Vaihua River estuary -9.350952º, 147.008769º	HIGH PRIORITY SITES The Vaihua River estuary is expected to represent the highest value aquatic ecosystem in the vicinity of the Caution Bay facility. These sites were surveyed as part of the PNG LNG EIS but will need to be sampled in order to update the baseline subsequent to the construction of the PNG LNG facility
29	Vaihua River estuary -9.350532º, 147.015366º	

Note: While coordinates have been given for each site, certain sites have been identified as a preferred primary site with alternative locations indicated in the figures in the event that the primary site is not suitable. In addition, other sites may also require movement when in the field where they are not suitable based on local environmental features (e.g., no water) or access/logistics constraints.
† Alternate sites have been identified south of this site (sites 2b and 2c) that are expected to be representative of the same environmental conditions but may be preferable from an access perspective.
‡ An alternate site has been identified south of this site (Site 6b) which is expected to be representative of the same environmental conditions but may be preferable from an access perspective.

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Table 9.2 – Summary of Freshwater Sampling Program (Upstream)

Site	Surface Water Sampling				Sediment Sampling		Aquatic Biodiversity							
	Dry season Jun 2016		Wet season Dec 2016		Dry season Jun 2016	Wet season Dec 2016	Dry season Jun 2016				Wet season Dec 2016			
	Grab samples (chem)	In situ	Grab samples (chem)	In situ	Sampling (chem)	Sampling (chem)	Fishing & macro. sampling	Tissue Sampling	Habitat chara.	Helicopter mapping	Fishing & macro. sampling	Tissue sampling	Habitat char.	Helicopter mapping
PRL-15														
1*	-	-	-	-	-	-	-	Sites will be determined while in the field based on catch, species & village proximity	✓	✓	-	-	✓	-
1b	1	✓	1	✓	1	-	-		✓	✓	-	-	-	-
2†	1	✓	1	✓	1	-	✓		✓	✓	✓	-	✓	-
3	1	✓	1	✓	1	-	✓		✓	✓	✓	-	✓	-
4	1	✓	1	✓	1	-	✓		✓	✓	✓	-	✓	-
5	1	✓	1	✓	1	-	✓		✓	✓	✓	-	✓	-
6†	1	✓	1	✓	1	-	✓		✓	✓	✓	-	✓	-
7*	-	-	-	-	-	-	-		✓	✓	-	-	✓	-
8*	-	-	-	-	-	-	-		✓	✓	-	-	✓	-
9	1	✓	1	✓	1	-	✓		✓	✓	✓	-	✓	-
10	1	✓	1	✓	1	-	✓		✓	✓	✓	-	✓	-

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Table 9.2 – Summary of Freshwater Sampling Program (Upstream) (cont.)

	Surface Water Sampling				**Sediment Sampling**		**Aquatic Biodiversity**							
Site	Dry season Jun 2016		Wet season Dec 2016		Dry season Jun 2016	Wet season Dec 2016	Dry season Jun 2016				Wet season Dec 2016			
	Grab samples (chem)	In situ	Grab samples (chem)	In situ	Sampling (chem)	Sampling (chem)	Fishing & macro. sampling	Tissue Sampling	Habitat chara.	Helicopter mapping	Fishing & macro. sampling	Tissue sampling	Habitat char.	Helicopter mapping
Purari and Ivo-Urika Rivers/Tributaries[#]														
11	1	✓	1	✓	1	-	✓	Sites to be determined in the field	✓	✓	✓	-	✓	-
12	1	✓	1	✓	1	-	✓		✓	✓	✓	-	✓	-
13	1	✓	1	✓	1	-	✓		✓	✓	✓	-	✓	-
14	1	✓	1	✓	1	-	✓		✓	✓	✓	-	✓	-
15	1	✓	1	✓	1	-	✓		✓	✓	✓	-	✓	-
16	1	✓	1	✓	1	-	✓		✓	✓	✓	-	✓	-
17	1	✓	1	✓	1	-	**		✓	✓	✓	-	✓	-

* No site-based sampling will be undertaken at potential sensitive sites 1, 7 and 8 due to inaccessibility – rather these sites will be surveyed by helicopter.
Instead of sampling at Site 1 (oxbox lake), water and sediment sampling and habitat characterisation is proposed to be undertaken at a creek near terrestrial biodiversity Fly Camp D, which flows toward the oxbow (Site 1b) (refer to Table 9.1)

** No fishing or macroinvertebrate sampling is being undertaken at Site 17 since there is no nearby calm water tributary suitable for deploying nets

† Alternate sampling locations have been identified at this site that may be preferable from an access perspective (see Table 9.1).

As described in Table 9.1, water and sediment sampling at these sites will be undertaken in the main stream of the Purari River rather than at the tributary. Water quality in situ measurements will be undertaken in the main stem and the tributary stream. Fish and macroinvertebrate sampling will be undertaken within the tributary stream.

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Table 9.3 – Summary of Freshwater Sampling Program (Downstream)

Site	Surface Water Sampling				Sediment Sampling		Aquatic Biodiversity							
	Dry season Jun 2016		Wet Season Dec 2016		Dry season Jun 2016	Wet season Dec 2016	Dry season Jun 2016				Wet season Dec 2016			
	Grab samples (chem)	In situ	Grab samples (chem)	In situ	Sampling (chem)	Sampling (chem)	Fishing & macro. sampling	Tissue Sampling	Habitat chara.	Ecosystem mapping	Fishing & macro. sampling	Tissue Sampling	Habitat chara.	Ecosystem mapping
Caution Bay														
25	-	-	1	✓	-	1	-	-	-	-	✓	-	✓	✓
26	-	-	1	✓	-	1	-	-	-	-	✓	-	✓	✓
27	-	-	1	✓	-	1	-	-	-	-	✓	-	✓	✓

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Table 9.4 – Summary of Estuarine Sampling Program (Upstream and Downstream)

Site	Surface Water Sampling				Sediment Sampling				Aquatic Biodiversity		Fish Ecotox.
	Dry season Jun 2016		Wet season Jan 2017		Dry season Jun 2016		Wet season Jan 2017		Both seasons		
	Grab samples (chem)	In situ profiling	Grab samples (chem)	In situ profiling	Macro-invertebrates	Chemistry	Macro-invertebrates	Chemistry	Habitat chara.	Fish and macro-crustaceans*	Tissue samples
Purari Estuary											Sampling to occur at up to four estuarine sites (refer to Section 7.2)#
18	1	✓	1	✓	3	1	-	-	✓	✓	
19	1	✓	1	✓	3	1	-	-	✓	✓	
20	1	✓	1	✓	3	1	-	-	✓	✓	
21	1	✓	1	✓	3	1	-	-	✓	✓	
22	1	✓	1	✓	3	1	-	-	✓	✓	
Ivo-Urika Estuary											
23	1	✓	1	✓	3	1	-	-	✓	✓	
24	1	✓	1	✓	3	1	-	-	✓	✓	
Vaihua Estuary (Caution Bay)											
28	1	✓	1	✓	-	-	3	1	✓	✓**	
29	1	✓	1	✓	-	-	3	1	✓	✓**	

* Gill netting, supplemented by cast netting and baited box trapping

** Sampling for fish will consider community concerns regarding conduct of fishing at Caution Bay. Sampling for benthic macroinvertebrates will also consider risk due to potential presence of UXOs, i.e., is dependent upon the risk being considered acceptable

\# Sites to be determined in the field in consultation with TEP PNG based on catch availability, species and village proximity

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10. Collected Samples

10.1 Sample Storage

10.1.1 Biological Samples

Macroinvertebrate samples and reference specimens of fish will be placed into 600 mL screw top containers and preserved using a 10% buffered formalin solution. Field personnel will carry appropriate safety data sheets (SDSs) and personal protective equipment (PPE) and knowledge of handling of formalin. Samples will be sent to Dardanus Scientific (see below) for specimen identification, enumeration and disposal.

Fish tissue samples will be stored in appropriately labelled zip lock backs and double-bagged to ensure no cross-contamination will occurring during storage and transport. Samples will be frozen on site and transported frozen to the National Measurement Institute (NMI) at the end of field work under import permits held by BMT WBM and NMI.

10.1.2 Water and Sediment Samples

Water and sediment samples will be preserved as per recommendations provided by the primary analytical laboratory, Australian Laboratory Services (ALS) Brisbane. Sample containers are provided pre-dosed with appropriate volumes of preservatives where required. Samples will be transported to ALS under their import permits.

10.2 Sample Analyses

10.2.1 Biological Samples

All fish and macrocrustaceans caught during sampling works will be identified to species level, wherever possible, in the field by the field team aquatic ecologists. Identification will rely on Allen (1991) and any other relevant fish identification field guides. Where necessary, voucher specimens (i.e., specimens that cannot be identified in the field and require further analysis) would be collected for subsequent identification. These specimens will be stored frozen and placed on ice for transport to museums in Australia for species identification (Queensland Museum or Northern Territory Museum, depending upon species). Where possible, DNA samples will also be taken of freshwater sharks and sawfish and provided to Charles Darwin University (Northern Territory, Australia) to assist in ongoing research into these species in the Australia-Papua region.

Macroinvertebrates will be analysed by Stephen Cook of Dardanus Scientific in accordance with the AusRivAS methodology (e.g., DNRM 2001). This analysis will be undertaken to a morpho-species level for all samples. Stephen is former curator of invertebrates at Queensland Museum and holds AusRivAS accreditation for Module 3 – Laboratory. A copy of this accreditation certificate is provided in Appendix 2.

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10.2.2 Water and Sediment Samples

Water and sediment quality samples will be analysed by ALS Brisbane, while fish tissue samples will be analysed by the NMI. No laboratories are available in Papua New Guinea that are accredited to conduct the required analyses.

Table 10.1 lists the parameters to be tested with the associated analysis method and limits of reporting. These methods are consistent with or superior to indicative methods described in GS EP ENV 111 and provide suitable limits of detection for comparison with environmental quality criteria. Both laboratories are accredited under ISO 17025 for these analyses. Accreditation certificates are provided in Appendix 2.

Table 10.1 – Water, Sediment and Fish Tissue Analyses

Parameter	Analysis Method	Limits of Reporting
ALS (water)		
TSS	APHA 2540 D (gravimetric, dried at 103-105ºC)	1 mg/L
Major cations (Ca, Mg, Na, K)	APHA 3120 (inductively coupled plasma - atomic emission spectrometry (ICP/AES)) Hardness: APHA 2340 B (by calculation)	1 mg/L
Major anions (Cl, SO_4, alkalinity)	Various (turbidimetric, flow injection analysis, titration)	0.1-1.0 mg/L
TOC	APHA 5310 B (high temperature combustion)	1 mg/L
DOC	APHA 5310 B (high temperature combustion)	1 mg/L
TPH	Gas chromatography-flame ionisation detector (GC-FID)	20-100 µg/L
BTEX/PAH	Gas chromatography-mass spectrometry (GC-MS)	1-5 µg/L
Ammonia	APHA 4500 NH_3^- - H (flow injection analysis phenate method)	0.01 mg/L
Nitrite and Nitrate	APHA 4500-NO_2^- I/NO_3^- I (flow injection analysis)	
Total phosphorous	APHA 4500 P – H (manual digestion and flow injection analysis)	
Reactive phosphorous	APHA 4500 P – H (flow injection analysis)	
Total nitrogen	APHA 400 N_{org}/NO_3 (flow injection analysis)	0.1 mg/L
Dissolved metals: As, Cd, Cr, Cu, Ni, Pb, Zn	USEPA 6020 (inductively coupled plasma - mass spectrometry (ICP/MS))	Cd: 0.0001 mg/L Zn: 0.005 mg/L Others: 0.001 mg/L
Dissolved metals: Al, Ba, Co, Fe, Sn, Sr, V	USEPA 6020 (ICP/MS)	Ba, Co, Sr: 0.001 mg/L Fe: 0.05 mg/L Al: 0.01 mg/L V: 0.01 mg/L
Dissolved Hg	Cold vapour atomic absorption spectrometry (CV AAS)	0.0001 mg/L
Total metals: As, Cd, Cr, Cu, Ni, Pb, Zn	USEPA 6020 (ICP/MS)	Cd: 0.0001 mg/L Zn: 0.005 mg/L Others: 0.001 mg/L

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Table 10.1 – Water, Sediment and Fish Tissue Analyses (cont'd)

Parameter	Analysis Method	Limits of Reporting
Total metals: Al, Ba, Co, Fe, Sn, Sr, V	USEPA 6020 (ICP/MS)	Ba, Co, Sr: 0.001 mg/L Fe: 0.05 mg/L Al: 0.01 mg/L V: 0.01 mg/L
Total Hg	CVAAS	0.0001 mg/L
Coliforms enumeration	DTS method code 3-3-2-3	-
ALS (sediment)		
Moisture	AS 1289 3.6.3 (gravimetric)	1%
PSD	Sieving	1%
Total phosphorous as P	APHA 4500 P-H (flow injection analysis)	2 mg/kg
Total nitrogen as N	APHA 4500 N_{org}/NO_3 APHA 4500 $NO_2/_3$ (flow injection analysis)	TKN, NH_3, TN: 20 mg/kg NO_2: 0.1 mg/kg
TPH	USEPA 5030/8260 (GC/FID)	10-100 mg/kg
BTEX/PAH	USEPA 3640/827- (GC-MS)	0.2-1.0 / 0.5-2.0 mg/kg
TOC	AS 1289 3.6.3 (high temperature combustion)	0.5%
Total metals: Al, As, Ba, Fe, Sn, Sr	USEPA 200.2 (mod) (inductively coupled plasma - atomic emission spectrometry (ICP/AES))	Al, Fe: 50 mg/kg As: 1 mg/kg Sr: 2 mg/kg Cr, Cu: 0.1 mg/kg Ba: 10 mg/kg
Total metals: Cd, Co, Cr, Cu, Pb, Ni, V, Zn	USEPA 6020 (ICP/MS)	Zn: 0.5 mg/kg V: 1 mg/kg Others: 0.1 mg/kg
Total Hg	APHA 3112 Hg-B (CV AAS)	0.1 mg/kg
NMI (fish tissue)		
Moisture	Freeze drying	0.10%
PAHs	USEPA 8270 (GC-MS)	0.01 mg/kg
Trace metals: Al, As, Cd, Cr, Cu, Pb, Mn, Hg, Ni, Se, Ag, Zn	NT2.46 (ICP-MS/optical emission spectrometry (OES))	Al, As, Cr, Se: 0.05 mg/kg Ag: 0.02 mg/kg Others: 0.01 mg/kg

10.2.3 In Situ Measurements

Specifications for the YSI 6600 water quality sonde that will be used to take in situ measurements of water physicochemical parameters are provided in Table 10.2.

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Table 10.2 – YSI 6600 Water Quality Sonde Specifications

Parameter	Range	Resolution	Accuracy
Dissolved oxygen	0 to 500% 0 to 50 mg/L	0.1% 0.01 mg/L	±1% of reading
Conductivity	0 to 100 mS/cm	0.001 to 0.1 mS/cm	±0.5% of reading
Salinity	0 to 70 ppt	0.01 ppt	±1% of reading
pH	0 to 14 pH units	0.01 unit	±0.2 unit
Eh (ORP)	-999 to +999 mV	0.1 mV	±20 mV
Turbidity	0 to 1000 NTU	0.1 NTU	±2% of reading
Temperature	-5 to +50ºC	0.01 ºC	±0.15ºC

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11. Quality Control

11.1 Sample Collection, Handling, Storage and Transport

To ensure good quality data are collected during the field program, a number of quality assurance (QA) and quality control (QC) procedures are adhered to during all field work, as follows:

- Use and maintenance of appropriate sampling equipment, and implementation of appropriate calibration procedures (including use of controlled standard solutions supplied by ALS in Brisbane).
- Proper sampling techniques utilised in accordance with relevant water and sediment quality sampling guidelines and standards (e.g., AS/NZS 5667.1:1998 and AS/NZS 5667.12:1999).
- Sample containers clearly and accurately labelled and a log of collected samples maintained and updated.
- Chain of custody forms maintained and included with samples.
- Data validation including cross check by a second scientist after entry into the database.

Water sample preservation and handling procedures will be followed and samples supplied to the laboratory within nominated holding times where practicable.

11.2 Control Samples

A range of additional samples will be collected for QC purposes to assess the repeatability and precision of laboratory results, and will include the following:

- Intra-laboratory duplicates – water/sediment samples will be split into two duplicate sub-samples and tested as separate (blind) samples by the primary laboratory (ALS). Intra-laboratory duplicates are collected at 10% of monitoring sites.
- Inter-laboratory duplicates – water/sediment samples will be split into two duplicate sub-samples and tested as separate (blind) samples by the primary laboratory (ALS) and a second independent laboratory (NMI). Inter-laboratory duplicates are collected at 5% of monitoring sites.
- Field blanks – samples taken in the field using laboratory supplied deionised distilled water which is placed into sample containers the same way as normal samples (i.e., using sampling equipment such as the sample pole, syringes and filters). Field blanks are taken once per monitoring event, and are used to test for sample contamination from sampling personnel, equipment, or the atmosphere.
- Trip blank samples – pre-filled sample bottles (with deionised distilled water) supplied by ALS to test for contamination of volatile substances (such as hydrocarbons) during storage and transport of samples.

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11.3 Laboratory Quality Control Measures

ALS in Brisbane will be the primary laboratory used for water sample analyses. Inter-laboratory duplicates will be sent to NMI. Both these laboratories are NATA-accredited and as such have strict quality assurance and quality control procedures in place.

Routine laboratory control procedures at ALS include:

- Certified reference materials.
- Laboratory duplicates.
- Laboratory control spikes.
- Matrix spikes.
- Surrogates.
- Secondary and project standards.
- Inter-laboratory (proficiency) testing.
- Client and industry managed independent audits and accreditations.

Water samples are stored by the laboratory for two weeks after release of analysis results, whereas sediment samples are retained for 90 days (in case check analyses are required).

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12. Summary

This report provides a comprehensive description and rationale of the scope and methods that will be used to characterise freshwater and estuarine water and sediment quality and biodiversity, of the Papua LNG Project area. The approach consists of desktop bibliographic reviews supplemented by field surveys to fill any gaps in data necessary to describe baseline conditions and prepare the environmental impact assessment, including identification of potential critical habitat or other significant environmental features.

The study approach and design was guided by the following guidelines and specifications and developed based on the Project description provided by TOTAL at the time of preparation of this document:

- PNG Conservation and Environmental Protection Authority (CEPA) guideline GL-Env02/2004: Guideline for Conduct of Environmental Impact Assessment & Preparation of Environmental Impact Statement (CEPA, 2004).
- TOTAL general specification GS EP ENV 112: Environmental Baseline and Monitoring Studies: Offshore and Nearshore Sites TOTAL, 2012) and GS EP ENV 111: Environmental Baseline and Monitoring Studies: Onshore Sites (TOTAL, 2012).
- TOTAL general specification GS EP ENV 120: Environmental impact assessment of E&P activities (TOTAL, 2007).
- International Finance Corporation (IFC) Performance Standards (especially Performance Standards 1, 3 and 6) and Guidance Notes.

The scope and methods for the freshwater and estuarine studies are considered suitable to meet the requirements of these guidelines and TOTAL's general specifications.

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Appendix 1

Freshwater and Estuarine Survey Team Credentials

Appendix 1 – Freshwater and Estuarine Survey Team Credentials

The qualifications and experience of the marine field survey team are outlined in Table 1 below.

Table 1 – Marine Survey Team Specialist Qualifications and Experience

Personnel	Role	Credentials
Dr Conor Jones (BMT WBM)	Senior Marine Biologist	Bachelor of Science (Marine Biology) 1st Class Honours (Marine Parasitology/Marine Biology) Doctor of Philosophy (Marine Parasitology/Ecology) 16 years of experience
Brad Hiles (BMT WBM)	Senior Aquatic Ecologist	Bachelor of Applied Science Bachelor of Education 8 years of experience
Daniel Moran (BMT WBM)	Aquatic Ecologist	Bachelor of Marine Studies 1st Class Honours (Marine Ecology/Marine Evolutionary Ecology) 5 years of experience
Ninkama Yoba (Ninkama Yoba & Associates)	Community Liaison and Aquatic Ecologist/ Field Assistant	Bachelor of Science 13 years of experience
Kobus Meulenbroeks	Field Assistant and Logistics Coordinator	Master of Environmental Science Bachelor of Science 8 years of experience

Appendix 2

AUSRIVAS Accreditation Certificate

QLD AUSRIVAS ACCREDITATION ASSESSMENT RESULTS SUMMARY

This assessment sheet provides the mark attained by the AUSRIVAS course participant named below against the criteria and mark needed for AUSRIVAS accreditation purposes. AUSRIVAS accreditation requires trainees to achieve the standards specified by the relevant National River Health Program (NRHP) lead agency.

AUSRIVAS-course participant's name: **Stephen Cook**

AUSRIVAS ACCREDITATION COMPONENT	Participant's MARK (%)	PASS MARK REQUIRED FOR ACCREDITATION (%)
1 – PRE-FIELD AND SITE INFORMATION		
Exercise 1 (map work)	NA	≥80
2 – FIELD WORK		
Exercise 1 & 2 (Field data)	NA	≥80
Exercise 3 (Macroinvertebrate & water sample collection)	NA	≥80
Exercise 4 (Live-sorting)		
❑ % number of taxa, % common taxa, % Predicted taxa – Averaged for 2 habitats	NA	≥80
❑ Bray Curtis similarity - Averaged for 2 habitats	NA	≤0.30
❑ Samples sorted according to protocol	NA	
3 - LABORATORY		
Macroinvertebrate identification exercise 1 & 2:	95.45	≥95
4 – AUSRIVAS PREDICTIVE MODELS		
Data preparation & input	NA	≥80
Site assessment	NA	≥80
Interpreting AUSRIVAS results	NA	≥60

(NA = Not Assessed)

Organization conducting course: Institute for Applied Ecology, University of Canberra

Instructor's Signature:

Instructor's Name: Evan Harrison

Convener's Signature:

Course Convener: Susan Nichols

Date: February 13, 2012

NATA Accredited Laboratory

National Association of Testing Authorities, Australia
(ABN 59 004 379 748)

has accredited

ALS Laboratory Group
Brisbane Laboratory

following demonstration of its technical competence
to operate in accordance with

ISO/IEC 17025

This facility is accredited in the field of

Chemical Testing

for the tests shown on the *Scope of Accreditation* issued by NATA

Alan Patterson
Chief Executive

Date of accreditation: 10 April 1970
Accreditation number: 825
Corporate site number: 818

NATA
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ACCREDITATION

NATA is Australia's government-endorsed laboratory accreditor, and a leader in accreditation internationally. NATA is a signatory to the international mutual recognition arrangements of the International Laboratory Accreditation Cooperation (ILAC) and the Asia Pacific Laboratory Accreditation Cooperation (APLAC).

NATA Accredited Laboratory

National Association of Testing Authorities, Australia
(ABN 59 004 379 748)

has accredited

National Measurement Institute
NSW Laboratories (Chemical)

following demonstration of its technical competence
to operate in accordance with

ISO/IEC 17025

This facility is accredited in the field of

CHEMICAL TESTING

for the tests, calibrations and measurements shown on the
Scope of Accreditation issued by NATA

Jennifer Evans
Chief Executive Officer

Date of accreditation: 11 June 1956
Accreditation number: 198

NATA
WORLD RECOGNISED
ACCREDITATION

NATA is Australia's government-endorsed laboratory accreditor, and a leader in accreditation internationally. NATA is a signatory to the international mutual recognition arrangements of the International Laboratory Accreditation Cooperation (ILAC) and the Asia Pacific Laboratory Accreditation Cooperation (APLAC).

Part 23C
Addendum to Freshwater and Estuarine Studies Scope and Methods

PAPUA LNG PROJECT

ADDENDUM TO FRESHWATER AND ESTUARINE STUDIES SCOPE AND METHODS

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v2	Revised to client	B. Hiles, J. Visser	C. Monahan, C. Coyne	N/A	14/12/16
v3	Revised to client	B. Hiles, J. Visser	C. Monahan, C. Coyne	N/A	09/01/17
v4	Final report	B. Hiles, J. Visser	C. Monahan, C. Coyne	C. Edet	25/01/17
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1. Introduction

A Scope and Methods document (ERIAS Group report ref. 01215B_6-4_v4) was prepared in July 2016 by ERIAS Group and BMT WBM that described the rationale of survey methods and survey instruments to be used for the following studies:

- Surface water and sediment quality.
- Freshwater and estuarine biodiversity.

The study approach consisted of a bibliographic study of existing information supplemented by field surveys to fill any gaps in data necessary to prepare the environmental impact assessment.

As described in the Scope and Methods document, surveys are being undertaken in both the dry and wet seasons to capture the range in seasonal conditions. The dry season survey was completed in July 2016, and was largely undertaken as described in that document. However some changes were made based on logistical considerations and information obtained while in the field. Some changes to the Phase 2 'wet season' survey are also proposed considering information and results obtained from the July 2016 'dry season' survey.

This addendum document has been prepared to describe these changes to the scope and methods, and the rationale for them, prior to undertaking the Phase 2 'wet season' survey in January/February[1] 2017.

[1] Sampling of estuarine sites and some riverine sites will be undertaken during the marine survey in January 2017, whereas sampling of most riverine sites will be undertaken as a separate survey in February 2017.

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2. Changes to 'Wet Season' Survey Scope and Methods

2.1 Sampling Sites

These changes relate to modifications of the description provided in Section 9 of Freshwater and Estuarine Studies Scope and Methods.

The locations of the sites sampled during the July 2016 'dry season' survey were generally consistent with the descriptions provided in the Rationale, with the exception of the freshwater and estuarine sites described below (in sections 2.1.1 and 2.1.2, respectively). The proposed sites and location of sites actually sampled are shown in Figure 1.

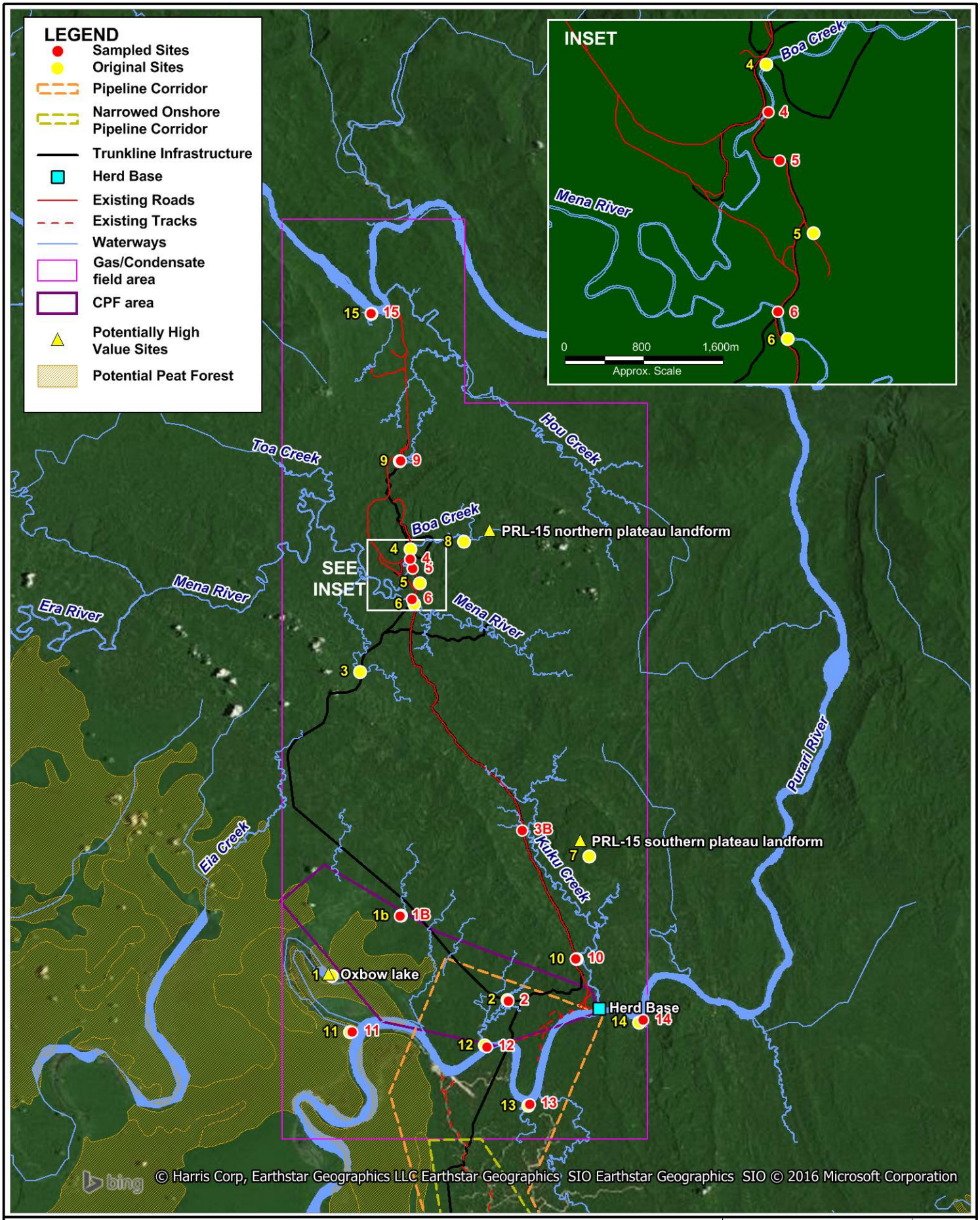
Sampling during the January/February 2017 Phase 2 'wet season' freshwater survey will be repeated at the same sites as sampled during the July 2016 'dry season' survey. The exception is Site 1b on an unnamed creek north of the Purari River oxbow lake. This site is not able to be sampled during the Phase 2 'wet season' survey due to new Total HSE requirements that preclude helicopter access to the site. All logistical means to access the site were investigated and none were considered acceptable. As described in Section 2.3, sampling at Site 1b was undertaken to provide an indication of water and sediment quality expected in the oxbow lake downgradient of the sampling site, since the oxbow lake is not accessible for sampling. However, based on results for the July 2016 survey, it is expected that other small freshwater streams sampled within PRL-15 will be characteristic of Site 1b. The 'Precautionary Principle' approach would also be applied when considering the oxbow lake, as described in Section 2.3. At this stage of Project design and pipeline route selection, it is also not known whether the unnamed stream or the oxbow lake will be impacted by the Project. If the environmental impact assessment finds that these areas may potentially be impacted, additional sampling can be undertaken post-EIS and prior to construction to provide baseline characterization of these locations.

2.1.1 Freshwater Sites

Modifications to the locations of freshwater sampling sites described in the Rationale are as follows:

- Site 3: This site could not be physically accessed during the survey as the helicopter pad and access tracks were overgrown. As a result, the site was moved to a tributary of Kuku Creek; Site 3b (145.1940765º E, -7.2743459º S). This new site, while in a different catchment, has similar habitat types to those present at Site 3. This does not present a significant limitation in characterising the environment in the Project area for the purpose of the EIS/ESHIA as Site 3b (and other sites) can form a 'surrogate' for Site 3.
- Site 4: This site on Boa Creek was moved downstream (145.1428833º E, -7.1515579º S) to coincide with an existing PRL-15 water quality monitoring station. It was also relocated since water was not wadeable at the proposed site, which is necessary to allow electrofishing.
- Site 5: This site on a tributary of Boa Creek was moved further downstream (145.1439209º E, -7.1559558º S), to provide more reliable access.
- Site 6: This site on the Mena River was moved further downstream (145.1437531º E, -7.1696801º S), to provide more reliable access.

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Title:

PRL-15 and Purari River Sampling Site Differences

Figure: 1

Rev: A

BMT WBM endeavours to ensure that the information provided in this map is correct at the time of publication. BMT WBM does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.

N

0 5 10km

Approx. Scale

BMT WBM

www.bmtwbm.com.au

Filepath : I:\B21414_I_GML_Elk_Antelope_EIA_JV\DRG\ECO_027_161209_PRL15_Sites_Sampled.wor

2.1.2 Estuarine Sites

Modifications to the locations of estuarine sampling sites described in the Rationale are as follows:

- Sites 20, 21 and 22 in the Purari River estuary were located in areas that were affected by low levels of dissolved oxygen. Fishing sites were therefore surveyed downstream of these areas, where water was better oxygenated, to provide a better indication of the fish communities present in the estuary. Similar assessment and site review will be undertaken during the 'wet season' survey.
- Sites 23 and 24: These sites, originally proposed in the Urika River estuary, were moved to the Wame River estuary (144.8919373º E, -7.584074497º S (Site 23); and 144.9483948º E, -7.595789433º S (Site 24)) as the Urika River could not be accessed during the survey (due to shallow water and sandbars at the mouth). No sampling was originally proposed in the Wame River (which is a branch of the Purari River delta and a potential river transport route). Information obtained from sampling of the Purari and Urika River branches was to be used to provide analogue information on this section of the delta. The information obtained from sampling of the Wame River will now be used to provide analogue information for the Urika River.

2.2 Plateau Landforms

This section describes information on plateau landforms obtained during the July 2016 'dry season' survey, and subsequent modifications to the assessment approach described in Section 9 of Freshwater and Estuarine Studies Scope and Methods.

The July 2016 'dry season' freshwater survey included low-level helicopter flyover of two plateau areas within PRL-15 (Site 7 (southern plateau landform)) and Site 8 (northern plateau landform)) to identify whether permanent water bodies occur on the plateau that are separated from other water bodies by fish barriers (e.g., waterfalls). Such landforms may support unique evolutionary processes and/or endemic species where they are isolated (fully or partially) from other landscape features, thereby possibly representing critical habitat in accordance with IFC Performance Standard 6. If this was the case, electrofishing, netting and trapping was to be considered as part of the 'wet season' field trip.

Based on observations made during these flyovers, it appears that both locations have significant barriers to fish passage. The nature of these barriers varies for each plateau. The northern plateau drainage and catchment area appears to be separated from downstream areas by a significant barrier in the form of a large waterfall located on the main drainage flowing off the plateau. Waterbody isolation (over geological timescales) can lead to speciation and endemism, and it is therefore possible that unique species or genetically distinct sub-populations may exist above the waterfall. The southern plateau differed from the northern plateau in that there are no obvious barriers to fish passage along the main drainages flowing from the plateau. The main drainages flowing from the plateau area are composed of moderate gradient streams confined within steep gorges. However at least one waterfall was observed on a tributary stream on the higher plateau of the catchment, and steep cliff faces where observed elsewhere in this area. These cliff faces and waterfall represent potential significant barriers within smaller drainages in the higher catchment areas. It is therefore possible that unique species or genetically distinct sub-

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populations may exist within these smaller streams on the upper catchment of the southern plateau.

It was established during the July 2016 'dry season' survey that the streams on these plateau landforms are not accessible for sampling. As described in the Freshwater and Estuarine Studies Scope and Methods, the 'Precautionary Principle' approach may be applied and the area considered as possible critical habitat for the purpose of impact assessment. It is to be noted that both plateau landforms are not in areas to be directly disturbed by Project activities, and are also located upstream of such areas.

2.3 Palustrine Wetlands

This section describes information on palustrine wetlands obtained during the July 2016 'dry season' survey, and subsequent modifications to the assessment approach described in Section 9 of Freshwater and Estuarine Studies Scope and Methods.

The Purari River oxbow is an important palustrine wetland habitat located within PRL-15. It represents the largest off-river water body in the area and could potentially provide refugia for endemic or conservation significant species (e.g., freshwater sawfish). It also could potentially be part of an area of peat wetlands, which are not well documented in Papua New Guinea. Peat wetlands can support unique species that are sensitive to changes in water quality. In addition, this site is known to have cultural significance and be an important aquatic resource for local landowners. This wetland habitat is hydraulically connected to both the Purari River and sub-catchments that drain potential infrastructure areas to the north. As a result, this oxbow lake could potentially be impacted both during project construction (by increased sedimentation related with clearing and construction activities) and by any spills from pipelines, the CPF site or river traffic.

The oxbow lake site (Site 1) is not accessible for water and sediment quality and biodiversity sampling, therefore the Precautionary Principle approach may be applied (as described in the Rationale) and the area considered as possible critical habitat for the purpose of impact assessment. This will include consideration of information obtained from the terrestrial biodiversity study and social study programs, including community interviews. Additionally, information on aquatic biodiversity will be obtained from sampling of Nea Creek (Site 11), which is a tie channel to the oxbow lake.

Low-level helicopter survey of the oxbow lake (Site 1) and associated swamp/wetland areas located in the south-west quadrant of PRL-15 and further downstream was conducted during the 'dry season' survey. Observations of water within the oxbow lake were consistent with that seen in Nea Creek (Site 11), which is connected to the oxbow lake and has tannin-stained water. Measurements in this creek show that water has low dissolved oxygen levels and lower pH than other streams. In lieu of sampling at Site 1, water and sediment quality and biodiversity sampling is also being conducted at a tributary north of the oxbow (Site 1b). Sampling of this tributary provides an indication of water quality characteristics of drainage flowing into the oxbow.

More broadly, the aerial survey undertaken during the 'dry season' survey indicated that mapping of swamp dominated areas within the study area from FIMS data is reasonably accurate, however does not show two tannin-stained lakes located to the southwest of PRL-15. Approximate locations of these wetlands are 145.050457º E, -7.393349º S, and 145.056092º E, -7.405384º S, No drainage into or out of these lakes could be identified from the aerial survey and further

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examination of connectivity with surface streams is recommended if these locations can be accessed.

Similar to the Purari River oxbow, there is the possibility that these wetlands are peat swamps. As these wetlands may be hydraulically linked to the Purari River (as well as to local groundwater systems), they potentially are at risk of impact from spills associated with river traffic. Characterization of these areas, including hydraulic linkages, would inform the potential risk to unique ecological values and allow for more informed management protocols within the EIS/ESHIA. Similar to the oxbow lake, a collaborative approach between various specialists is required to characterize this area.

As none of these sites can be accessed due to physical and logistical constraints, the 'Precautionary Principle' may be applied in undertaking assessments, in conjunction with other studies undertaken for terrestrial biodiversity and groundwater.

2.4 Purari River Turbidity Measurements

This section describes information on the turbidity of the Purari River obtained during the July 2016 'dry season' survey, and subsequent modifications to the assessment approach described in sections 6, 7 and 9 of Freshwater and Estuarine Studies Scope and Methods.

Turbidity measured at the upstream reference location on the Purari River (Site 15) during the July 2016 'dry season' survey was observed to be much lower than at downstream locations (Sites 11 to 14). This is likely attributable to sediment-laden runoff from a substantial rainfall event that occurred following sampling at Site 15 and prior to sampling at downstream locations. It is proposed to undertake additional turbidity measurements along the Purari River from Herd Base to Site 15, particularly upstream and downstream of Aure River, to provide further information on spatial trends along the Purari River and the influence of inflow from the Aure River.

It is also proposed that further information on temporal trends in turbidity in the Purari River is obtained by extended deployment of a water quality instrument (McVan) at Herd Base. Deployment of such an instrument was planned to occur for the duration of the July 2016 'dry season' survey. However, the deployment period has been longer since a rise in river level has prevented retrieval of the instrument to date. Assuming successful capture and recovery of data from the instrument, continuous measurements of turbidity are expected to have been obtained for a period of one to two months during the 'dry season' (depending on battery life and fouling on the instrument). It is recommended that a water quality instrument be again deployed during the February Phase 2 'wet season' survey, with instrument retrieval undertaken by TEP PNG site personnel after one to two months. Alternatively, the instrument can be retrieved by the survey team at the end of the 'wet season' survey.

2.5 Fish Netting

These changes relate to modifications of the description provided in Section 7.2 of Freshwater and Estuarine Studies Scope and Methods.

It is intended to increase net soak times at sites with deeper water pools (sites 4, 5, 6 and 10) by the deployment of fyke nets overnight. This will increase the chance of capturing larger-bodied and/or nocturnally active fishes that utilise these habitats. Whilst sites 4, 5 and 6 were not originally sampled with fyke nets, these sites have been identified (together with site 10) as likely to support larger-bodied fish because of the presence of deep-water pools.

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While retrieval of nets at sites 6 and 10 may be undertaken the next day without impact to the survey duration, retrieval from sites 4 and 5 is expected to require an additional day in the field.

2.6 Vaihua River (Caution Bay)

These changes relate to modifications of descriptions provided in sections 5 and 9 of Freshwater and Estuarine Studies Scope and Methods regarding sampling at sites 25, 26 and 27.

Due to site access issues at the proposed LNG plant site, it was identified that sampling of freshwater streams could only be undertaken during the wet season under existing EIS/ESHIA timeframes. Access issues remain at the site, and there is also considered to be an unacceptable risk from unexploded ordnances (UXOs) potentially present in the area. Sampling of surface water and sediment quality and freshwater biodiversity of the Vaihua River at sites 25, 26 and 27 is therefore not proposed to occur in conjunction with the upstream freshwater Phase 2 'wet season' survey in January/February 2017.

2.7 Vaihua Estuary Sediment Sampling

These changes relate to modifications of the description provided in Section 9 of Freshwater and Estuarine Studies Scope and Methods.

Sampling of the Vaihua Estuary (at sites 28 and 29) is being undertaken in conjunction with the marine surveys because of the use of a sea-going vessel to access sites. Sediment sampling was proposed to be undertaken in the estuary during the January 2017 Phase 2 marine 'wet season' survey, following addressing of risk due to UXOs. Due to this risk still remaining unacceptable, intrusive sampling of sediment is not proposed to occur during the wet season survey. However, given that sampling of the estuary requires use of the marine survey vessel, it is proposed that other sampling in the Vaihua Estuary at sites 28 and 29 described in Section 9 of Freshwater and Estuarine Studies Scope and Methods (i.e., surface water and aquatic biodiversity sampling) will be completed during the Phase 2 marine 'wet season' survey in January 2017.

2.8 River Traffic Observations

To provide supplementary information for the Marine and Riverine Traffic and Transport Study, it is proposed that opportunistic observations of boat movements by local communities and commercial vessels in the Purari River delta are recorded during the 'wet season' freshwater and estuarine surveys in January and February 2017. A log sheet, with guidance on how to classify and record the traffic and transport data, has been prepared by ERIAS Group and issued to Total prior to commencement of the surveys.

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Part 23D
Terrestrial Biodiversity Phase 1
Scope and Methods

PAPUA LNG PROJECT

TERRESTRIAL BIODIVERSITY SCOPE AND METHODS PHASE 1

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1. Project Overview

Total Exploration and Production Papua New Guinea Limited (TEP PNG) is planning the development of the Elk-Antelope gas field in Papua New Guinea as part of the proposed Papua LNG Project (the Project).

The Elk-Antelope gas field is located within Petroleum Retention License 15 (PRL15) in Baimuru District, Gulf Province, approximately 120 km inland from the township of Kerema and 360 km northwest of Port Moresby. The gas field is a highly significant gas discovery in Papua New Guinea and consists of a deep, high pressure, elevated temperature gas reservoir with several trillion cubic feet of gas reserves.

The Project development includes the following facilities:

- Wellpads and upstream gathering system.
- An upstream central processing facility (CPF) to separate and condition gas and condensate streams.
- Export gas and condensate pipeline system, comprising separate single gas and condensate export pipelines in the same route. The pipeline will traverse both onshore and offshore environments (approximately 60 km and 240 km, respectively).
- A Liquefied Natural Gas (LNG) Plant and supporting infrastructure; associated coastal marine export facilities.
- An Acid Gas Removal Unit (AGRU) will be located either upstream or at the LNG Plant due to inert components (CO_2, N_2 and H_2S) in the reservoir.

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2. Scope of Work

2.1 Study Objectives

The overall objective of the terrestrial biodiversity baseline study program is to describe the terrestrial biodiversity and related conservation features present in a 'Terrestrial Biodiversity Study Area' (as defined for the Project), such that key biodiversity values and sensitivities may be identified for subsequent impact assessment and monitoring of the efficacy of the Project's biodiversity program (including biodiversity action plan).

The specific aims of the terrestrial biodiversity baseline study are to:

- Collate and assess existing information relevant to biodiversity values present in the vicinity of the study area, building on the existing information reviewed for the bibliographic study ERIAS Group undertook for the Elk-Antelope Screening Study.
- Characterise biodiversity values present in the study area at varying levels of biological organisation, including ecosystem, species and (where applicable) subspecies/population scales.
- Map the distribution and condition of major vegetation types present within the study area.
- Determine the presence and (where practicable) status of species of conservation significance recorded or potentially present within the study area.
- Assess the presence and status of non-native species (e.g., weeds) present within the study area.
- Collect information on the importance of flora, fauna and ecosystems/habitats to locally resident Papua New Guineans suitable for use in ecosystem services studies.
- Plan and execute baseline studies to collect sufficient data to underpin assessment of potential project impacts to satisfy International Finance Corporation (IFC) (2012) environment and social performance standards and to meet Papua New Guinea (PNG) requirements under the *Environment Act 2000*. This includes data on priority biodiversity values suitable for use in impact assessment, including cumulative impacts, Critical Habitat assessment and monitoring programs.

2.2 Baseline Study Approach

Baseline information on terrestrial biodiversity values will draw on a combination of a review of existing data sources (bibliographical review/desktop analysis), field surveys, stakeholder consultation and expert opinion.

The collection and presentation of baseline information is tailored to align with the International Finance Corporation's Performance Standards (IFC PS) on Environmental and Social Sustainability, most specifically with Performance Standard 6 (PS6) Biodiversity Conservation and Sustainable Management of Living Natural Resources.

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A key component of IFC PS6 is the identification and description of existing 'biodiversity attributes' in the project 'area of influence'. An understanding of these attributes (hereafter 'biodiversity values') is required for:

- Assessing project-related risks and impacts to biodiversity.
- Assessing whether the project operates in areas of Critical Habitat.
- Designating appropriate biodiversity offsets.
- Testing client compliance throughout the life of the project by monitoring residual impacts.

2.3 Assessment Steps

2.3.1 Bibliographic Study

A bibliographical review will be undertaken of existing information on biodiversity and conservation values present in the vicinity of the study area. To the extent possible, prior available species data is to be used to inform the biodiversity study. Existing data sources and guidelines to be utilised include:

- Published scientific literature, such as peer-reviewed journals, books, and private sector, government and non-government organisation (NGO) reports.
- Unpublished scientific reports and data, including masters/doctoral theses, museum records and various NGO and private sector sources.
- National assessments and planning documents, including:
  - The Papua New Guinea Conservation Needs Assessment (Beehler, 1993a; Swartzendruber, 1992).
  - The Papua New Guinea Country Study on Biological Diversity (Sekhran and Miller, 1995).
  - The Papua New Guinea National Biodiversity Strategy and Action Plan (Government of Papua New Guinea 2007, 2010).
- Spatial data and landscape mapping assessments, including:
  - Topographic, hydrological and watershed mapping.
  - Vegetation type, land classification and land use mapping, including the Papua New Guinea Resources Information System (PNGRIS, Third Edition) (Bryan and Shearman, 2008) and the Papua New Guinea Forest Inventory Mapping System (FIMS) (Hammermaster and Saunders, 1995).
  - Ecosystem mapping, in the form of terrestrial ecoregions, biomes and bioregions (e.g., Wikramanayake et al., 2002).
  - Satellite and aerial imagery available for the study area.

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- Web-based data sources, such as:
  - The International Union for Conservation of Nature (IUCN) Red List of Threatened Species (IUCN, 2015).
  - The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).
  - The Integrated Biodiversity Assessment Tool (IBAT) and Proteus (United Nations Environment Programme World Conservation Monitoring Centre) will be checked also for applicability to the study area.
- Existing reports available through TEP PNG's data base including relevant technical baseline studies undertaken by TEP PNG's commercial partners for previous oil and gas development proposals in the study area.
- Information available from biodiversity studies conducted for Origin Energy's Purari Hydropower Project (PHP).
- Total General Specifications, including GS EP ENV 111: Environmental Baseline and Monitoring Studies: Onshore Sites.

2.3.2 Field Survey

2.3.2.1 Study Area

The biodiversity study area will be designed to accommodate the project's 'area of influence' (per IFC requirements). The study will encompass:

- All areas earmarked for potential development of project facilities and associated infrastructure.
- Adjacent/downstream areas within which biodiversity may measurably be influenced by project development.

Consideration is to be given to the potential geographic extent of project-related impacts, including those associated with direct, indirect and cumulative impact processes. The final study area boundary will be based on a combination of:

- A finalised and confirmed project design.
- The arrangement of physical landscape features such as landform, catchment boundaries, substrate and elevation.

Additional consideration will be given to the location of:

- Operational activities of 'associated facilities' (per IFC requirements).
- Centres of recruitment for local labour work force (where in-migration may indirectly impact on local biodiversity values).

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2.3.2.2 Field Survey Sites

The main survey program will involve sampling from a series of forest-based existing camps and fly camps located in areas earmarked for potential development of project infrastructure and in areas potentially indirectly affected by project development. Based on review of existing data, mapping analysis and aerial reconnaissance, fly camps are to be positioned to provide access to an array of habitats present in biologically poorly known areas, at sites distant from major settlements and associated hunting activity. Further information relating to site selection is provided in Section 3.2).

Additional field surveys outside of the project area of influence may be required to identify suitable biodiversity offset locations. The type and amount of biodiversity offsets required to meet project commitments will be determined during the ESHIA (Environmental, Social and Health Impact Assessment) process. At this stage the requirement for additional field survey is not confirmed. If offsets are required outside of the project study area, it is possible that prior surveys conducted for the Purari Hydropower Project may provide data sufficient to identify suitable offset locations.

2.3.2.3 Survey Parameters

Terrestrial biodiversity data collected during the baseline surveys will provide for characterisation of biodiversity values at the following scales of biological organisation:

- Ecosystem/community level values.
- Species level values.
- Genetic level values where applicable (per IFC).

Ecosystem/Community Level Values

These include the composition and conservation value of the study area and its component systems, including vegetation and habitats, protected areas, rare and/or threatened ecosystems, unusual/sensitive species assemblages, and habitats and local landscape features important to faunal communities, species of conservation significance and evolutionary processes.

Assessment at this scale will include a detailed vegetation mapping study of the study area. Vegetation mapping and habitat descriptions will be based on a combination of:

- Review of existing data (PNG Forest Inventory Mapping System (FIMS)).
- Vegetation mapping undertaken specifically for the study.
- Ground and aerial surveys.

The outcomes of the vegetation mapping study will be:

- Preparation of a vegetation map of the study area that improves on the existing (PNG Forest Inventory Mapping System) mapping and provides the basis for habitat mapping and biodiversity characterisation at a scale relevant to meet the objectives of IFCPS6 in Papua New Guinea.

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- Quantification of the mapped vegetation and habitat types including their condition, as well as land uses and all anthropogenic or natural disturbance areas within the study area.

Species Level Values

Species level values include the results of the flora and fauna technical studies conducted for the Project, with summaries for species of conservation significance, endemic and restricted range species, migratory and congregatory species and non-native species. Seven major taxonomic groups (shown in italic below) have been selected for focus at this level:

- *Vascular plants* (higher plants; Tracheophyta) – including ferns, gymnosperms (including conifers) and angiosperms (flowering plants).
- Mammals (Mammalia). For the purposes of this assessment mammals are divided into two groups:
  - *Non-volant (non-flying) mammals* – including monotremes (Prototheria), marsupials (Marsupialia) and all placental mammals (Placentalia) other than bats.
  - *Bats* (Chiroptera).
- *Birds* (Aves).
- Herpetofauna – including *reptiles* **(**Reptilia) and *amphibians* (Amphibia).
- *Odonates* (Odonata) – dragonflies and damselflies.

These taxonomic groups have been selected for a number of reasons: 1) there is an expectation from CEPA that terrestrial biodiversity surveys cover tetrapods (excluding fish), 2) the majority of these taxonomic groups have a high potential for the identification of new species and/or for limited range endemics (including restricted ranges species, which feeds into the Critical Habitat assessment), 3) some of the groups (e.g., flora, birds and odonates) are good indicator species, and 4) all include IUCN listed species higher than Least Concern and/or include Nationally Protected species.

All other terrestrial fauna taxa that are conservation listed, including IUCN and Nationally Protected species (e.g. butterflies) will be assessed at a desktop level based on information from available literature.

This taxonomic coverage is considered sufficiently broad so as to inform a set of avoidance, mitigation and management recommendations that are applicable to most terrestrial biota. This concept mirrors an expanded ‘focal species’ approach, in which a suite of taxa is selected whose management is expected to confer an ecosystem-wide conservation advantage (Lambeck, 1997; Nicholson et al., 2013).

Genetic Level Values

Includes information on subspecies/populations of conservation significance, where applicable (per IFC).

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2.3.2.4 Field Survey Methods

Field surveys are to follow a rapid assessment protocol, combining a number of techniques. This approach will maximise the completeness of species inventories and the likelihood of locating ecologically sensitive features, including rare and threatened taxa, in the time available at each site. Table 2.1 shows the sampling methods that will be applied to each of the major taxonomic groups under investigation.

CEPA is to review the scope of the terrestrial biodiversity surveys through review of the draft EIR and will be provided opportunities (as required and/or requested) to review the scope of, and provide their endorsement on, the proposed survey methods ahead of the start of the surveys. The terrestrial biodiversity team is also to liaise with, and seek feedback from, biodiversity NGOs on proposed survey methods as required by TEP PNG.

Table 2.1 – Biodiversity Survey Methods

Survey Method	Vascular Plants	Non-volant Mammals	Bats	Birds	Herpetofauna	Odonates
Visual searches	x	x	x	x	x	x
Audial detection		x	x	x	x	
Mist-nets			x	x		
Harp traps			x			
Camera traps		x		x		
Snap-traps		x				
Elliot traps		x				
Hand nets			x			x
Sound recording				x	x	
Sound playback				x		
Ultrasonic call recording			x			
Specimen collection	x	x	x	x	x	x
Informal interviews with local landowners		x	x	x	x	x

Surveys will generally involve six complete sampling days at each fly camp (excluding transfer between sites) to characterise resident communities of most major taxonomic groups for subsequent impact assessment. This survey effort has been optimised for the seven taxa so that each taxon is approaching the asymptote of encountering new species towards the end of each site survey; once this asymptote is reached, there are diminishing returns for survey effort.

The proposed field survey program will involve two survey phases conducted at different times of year to allow for seasonal variance-: January–February 2016, June–July 2016.

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2.3.2.5 Specimen Collection and Analysis

Multiple new-to-science and otherwise scientifically undescribed taxa are expected to occur within the study area.

Specimens of all taxa will be collected to varying degrees and installed in institutional collections to aid with subsequent taxonomic identification. The types of specimens collected include plant cuttings, voucher skins, whole animal vouchers and tissue samples. The number of specimens collected will vary among disciplines according to the degree to which their taxonomic framework is sufficiently well understood. While avian taxonomies are relatively well (though not fully) settled, poorer taxonomic frameworks prevail for other groups. Accordingly, collecting of plants, mammals, herpetofauna and odonates will be more extensive than for birds.

Specimens of various taxa are to be sent to the following institutions:

- Plants – Papua New Guinea National Herbarium, Lae.
- Mammals – Smithsonian Institution, Washington D.C., U.S.A.
- Birds (primarily blood samples) – Museum Victoria, Melbourne, Australia.
- Herpetofauna, odonates and any DNA samples (e.g., frogs and bats) for identification purposes – South Australian Museum, Adelaide, Australia.

All specimens will be added to existing collections at the nominated institutions. The PNG National Herbarium in Lae has been selected to receive plant specimens as it has the best existing collection of PNG plants. In addition, each taxon specialist is associated with one of the three other nominated institutions and, therefore, has access to the institution's collections (and other PNG specimens) for future reference. Access to these collections allows for specimen comparisons to aid taxonomic identification for the Project. The requirement for a memorandum of understanding between TEP PNG and the relevant institutions will be made on a case-by-case basis.

CEPA have encouraged the export of important specimens, in recognition of limited past and current capacity of local institutions to properly preserve them in good condition. However, should CEPA request that example specimens be deposited at the PNG National Museum and Art Gallery (NMAG), specimens will be returned as requested. The export of specimens will be undertaken in accordance with CEPA requirements, including the procurement of relevant permits. This process is aligned with the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization.

In addition, TEP PNG will be consulted regarding the feasibility of possible options for sharing unique sampling specimens/material with other international institutions that they may have alliances with in terrestrial biodiversity research, including Kew Gardens Herbarium and Missouri Botanical Garden. These investigations will require liaison with institutions like the Lae Herbarium and CEPA to ascertain any permit requirements or protocols for the exchange of material.

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2.3.3 Information Feedback Loop

The scope of the terrestrial biodiversity study will be subject to review throughout the impact assessment process, including refinement following the Phase 1 surveys. The review will occur through debriefs and ongoing communications between ERIAS Group, the biodiversity specialists, logistics personnel and TEP PNG, and will take into account:

- Updates to the Project description.
- Outcomes of the bibliographic review.
- Outcomes of the Phase 1 field program, including:
  - Community-based information.
  - Lessons learned in relation to logistics and execution of the field program.
  - Technical findings.
- Any changes relating to land access and assumptions of access to information.
- Any new information/requests from CEPA.

The outputs of the review process will feed into the design of the Phase 2 field surveys and the wider terrestrial biodiversity impact assessment study.

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3. Methods

The methods outlined in this section have been prepared by a collaborative team of specialists who will be undertaking the work. Their qualifications and relevant credentials are outlined in Appendix 1.

3.1 Biodiversity Setting and Existing Knowledge

New Guinea is one of the most biologically diverse and endemically rich regions on Earth (Mittermeier et al., 1997; Olson and Dinerstein, 1998; Brooks et al., 2006). Basic knowledge of the distribution, status and ecology of New Guinea's biota is limited (Beehler, 2007; Frodin, 2007).

As defined in 1993 under the PNG Conservation Needs Assessment (CNA) (Beehler, 1993; Swartzendruber, 1993), the northern half of PRL15 is located within Papua New Guinea's largest 'major terrestrial unknown' area; specifically, one of '16 major geographic areas…for which the present lack of scientific information is particularly serious' (Swartzendruber, 1993, p.10). Relevant research conducted in the years following the PNG CNA has been limited both taxonomically and geographically.

In 2008, Douglas Environmental Services (DES) acknowledged that '[t]here have been no detailed biological studies carried out within the project area' (DES 2008, p.30). Accordingly, a number of biological assessments were carried out in the project area by DES (2008, 2010, 2011), Worley Parsons (2009) and GHD (2012) as part of a series of environmental impact assessment studies and pre-construction surveys to support approvals for petroleum development proposals contemplated by the previous operator, InterOil.

A detailed analysis of existing data will be undertaken during a bibliographic study. This will build on a previous bibliographic review and facilities location screening study undertaken in January/February 2015 (ERIAS Group, 2015). A preliminary assessment of these studies shows that:

- Vegetation surveys were non-comprehensive, often utilised non-standardised terminologies and/or were mapped only using existing large-scale national mapping resources (e.g. PNGRIS: Bryan and Shearman, 2008).
- Flora and fauna surveys appear not to have been conducted by species specialists with local regional experience.
- Assessments of flora were largely 'qualitative', unvouchered and incomplete.
- Insects were not systematically sampled.
- Vertebrate inventories were far from complete and, where photos are available, included obvious errors in identification, causing doubt as to the veracity of unvouchered listings (e.g., without photographs).

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- Coverage of conservation-listed species (e.g. IUCN and nationally Protected) was incomplete and in some instances included errors in assignment of conservation status/category (excluding updates to IUCN listings).

The most recent, complete and reliable local datasets were collected in 2011–12 during a series of multidisciplinary terrestrial biodiversity surveys conducted for the Purari Hydropower Project (PHP). The PHP survey effort focussed largely on areas north of PRL15 with some sampling of habitats within the proposed pipeline corridor south of PRL15 (Figure 1). Relevant data from the PHP studies are held under confidentiality embargo, though inquiries are being pursued by TEP PNG to make the PHP data available for use by the current Project[1].

Further afield, relevant data are available:

- At comparable elevations >100 km west of the Project area in the Kikori catchment—numerous reports to WWF and the Kikori Integrated Conservation and Development Project (KICDP) (currently Kikori Basin Conservation Program).
- At comparable elevations >100 km to the east in the Lakekamu basin (e.g. Beehler et al., 1995; Mack, 1998).
- North of PRL15 in the Crater Mountain Wildlife Management Area (WMA)[2]—a good deal of biological research undertaken, though most of it above 800 m above sea level (asl) and therefore of limited relevance to the Project area (all below 500 m asl).

3.2 Survey Site Selection – Areas of Interest

Six (6) terrestrial biodiversity areas of interest (AOIs), shown in Figure 1, were selected for examination during an aerial reconnaissance undertaken over the upstream Project area in November 2015 (ERIAS Group, 2015a).

Aerial/satellite imagery provided by TEP PNG has been used to confirm the distribution of natural forest habitat in each AOI. This imagery was further used, along with topographic maps, digital elevation modelling (DEM) and aerial survey during the November 2015 reconnaissance, to pinpoint suitable fly camp locations within each AOI that maximise accessibility to specific microhabitat and local landscape features of interest to various species specialists.

It should be noted that:

- AOIs 1 to 4 shown in this document are sites to be surveyed during the Phase 1 survey period (January to February 2016).
- AOIs 5 and 6 and one or more additional AOIs are to be surveyed in Phase 2 (later in 2016). The areas shown for AOI 5 and 6 are candidate areas[3] only. Additional areas will be

[1] At the time of writing this document, TEP PNG had launched a process to have official access to the PHP data.

[2] While the Crater Mountain WMA overlaps with PRL15 in a small area north of the Purari River, all studies undertaken within the WMA were conducted north of this area.

[3] A candidate area is an area regarded as being suitable for consideration. These survey site options have features that align with the attributes identified in the site selection process.

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identified with sufficient lead time to facilitate discussion with TEP PNG regarding the optimum approach. Some candidate areas are here omitted to maximise seasonal coverage of comparable habitats during later surveys. The placement of other locations will further depend on (*inter alia*):

- Provision of Project layout GIS layers by TEP PNG.
- Potential changes to Project design.
- Findings of the November 2015 reconnaissance, for example in the southern (sub-) coastal limit of the export pipeline route.
- Vegetation and land use mapping results.
- Results of the bibliographic study.
- Finalisation of the area of influence[4] and broader study area (scheduled for bibliographic study).
- Access to data from the PHP biodiversity studies.

Based on knowledge of New Guinea biodiversity, including other large-landscape scale developments (e.g., ExxonMobil's PNG LNG Project) and the distribution of key species-level biodiversity values pertinent to Critical Habitat assessment criteria 1 and 2, all AOIs considered in this report potentially contain or comprise areas of Critical Habitat.

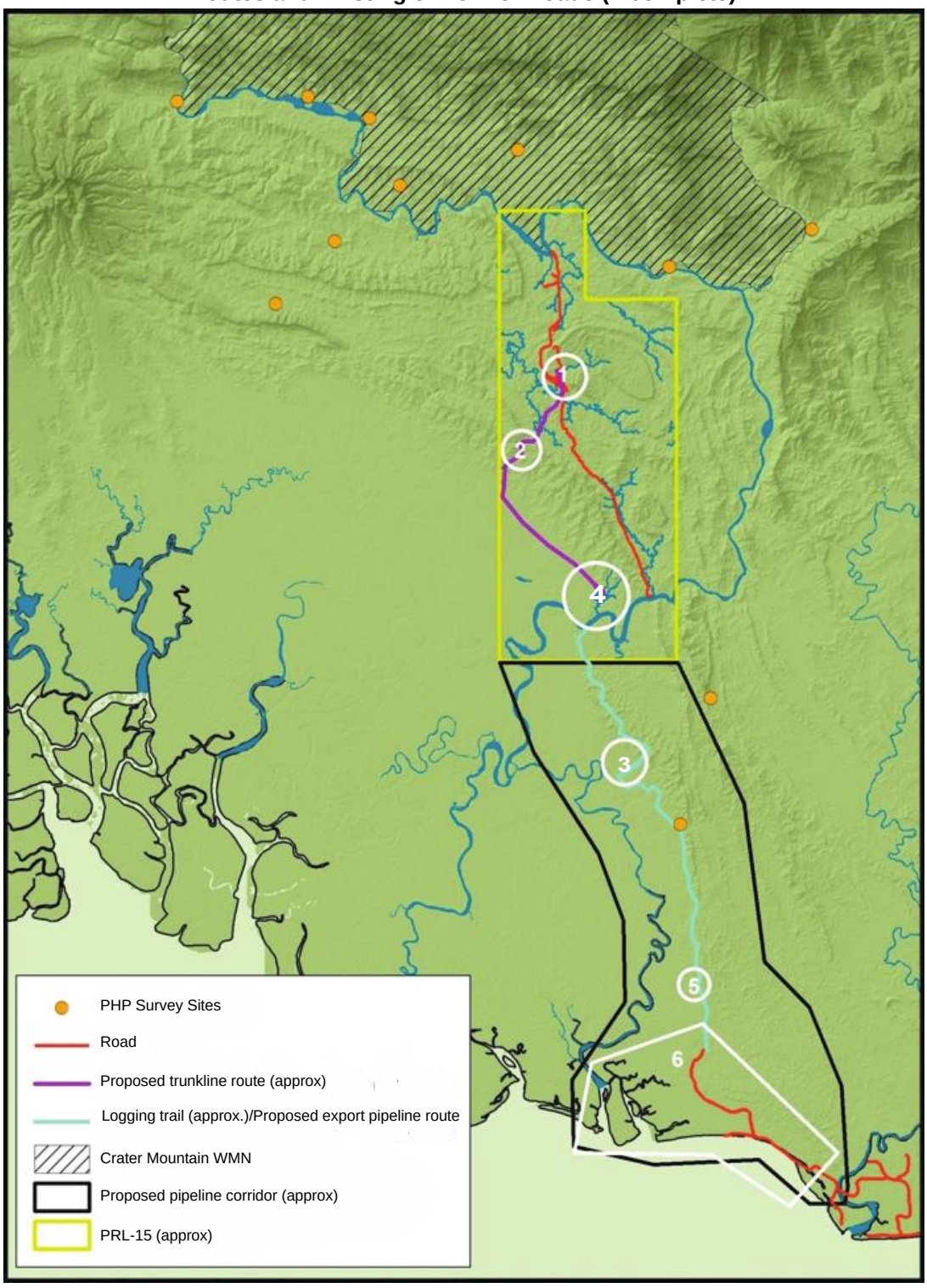
From an IFC perspective, less priority should be given to those faunal groups (e.g. birds), which are less likely to trigger Critical Habitat. From a CEPA and public perspective, the field surveys need to cover a broader range of habitats and taxa than is required to satisfy Critical Habitat protocols. The AOIs outlined below, and the methods that will be applied in each, represent an efficient means of satisfying both requirements.

Reasoning for the location of AOIs 1–5 and AOI 6 are outlined separately in the following sections.

[4] The area of influence includes the area within which the Project may potentially and measurably impact biodiversity through direct, indirect and/or cumulative impact processes.

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Figure 1 – Terrestrial Biodiversity AOIs (white circles/polygons), Proposed Infrastructure Routes and Existing or Former Roads (Incomplete)



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3.2.1 AOI 1 to 5

The five northernmost AOIs (AOI 1−5 in Figure 1) are intended to support the full multidisciplinary team of biologists, housed in existing operations camps or temporary fly camps. Each of these AOIs is located in a remote and biodiversity rich forested environment with a low resident human population and a paucity of existing environmental data. Key species level biodiversity values present in these environments include:

- Multiple species listed above Least Concern by the IUCN, including Threatened, Near Threatened and Data Deficient species (most groups surveyed, reptiles a potential exception away from major watercourses).
- Multiple species Protected under PNG law (mostly birds, potentially some mammals, and reptiles).
- Multiple restricted range species (most prevalent among plants, damselflies and some non-volant vertebrate groups such as herpetofauna and small non-volant mammals).
- Multiple congregatory and migratory species (relevant groups include bats, birds, freshwater and marine turtles).
- Multiple new and undescribed species.

Analysis of existing global and regional datasets is insufficient to predict the presence, status and distribution of these biodiversity values. Moreover, in tropical forest landscapes they may be expected to occur in any of a variety of vegetation types and microhabitats present both at the landscape scale across the Project area and at the local scale in areas accessible on foot from fly camps. Accordingly, survey methods at these sites will follow a rapid assessment approach with some quantitative sampling enhancements. This will:

- Maximise the opportunity to document key species level biodiversity values in a variety of major vegetation groups and microhabitats accessible from each fly camp. While complete species inventories are not a survey objective, extensive taxonomic coverage is facilitated by this approach and provides a useful indicator of survey coverage and the application of taxonomic expertise in an understudied and species rich landscape.
- Acquire quantitative baseline data for a selection of taxonomic groups that will be suitable for input to future impact monitoring programs. Some quantitative data will be collected for all faunal taxonomic groups, at least in the form of relative abundance estimates. In addition, groups will be selected for more detailed quantitative sampling based on (*inter alia*):
  - Ease/practicality of sampling within a rapid assessment timeframe.
  - Ability to monitor the efficacy of biodiversity management strategies covering a range of potential impact processes, based on previous project experience, including impact assessments and monitoring studies, undertaken by the specialists elsewhere in PNG.

It is worth noting that, while the area containing AOIs 3 and 5 along the export pipeline route has been subject to intensive logging (Woxvold, pers. com., 2015), very few studies have been

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conducted in logged forest in New Guinea and experience surveying this area has shown that it supports species rich communities that: (1) are notably different in composition to those surveyed to the north around PRL15, and; (2) include all of the key species level biodiversity values listed above.

The landscape-level strategy for locating AOIs 1−5 aims to:

- Focus on Project footprint areas as an early-stage sampling strategy.
- Provide maximum coverage of major landforms (sensu PNG Resource Information System: Bryan and Shearman, 2008) and major vegetation groups (from PNG Forest Inventory Mapping System (FIMS): Hammermaster and Saunders, 1995).
- Maximise the potential for seasonal sampling of similar vegetation types/local landforms by leaving select sites available for survey in mid-2016.

Assessing data from footprint areas is an IFC requirement. IFC Performance Standard 6, Guidance Note Paragraph 9 (PS6 GN9) states:

> Infield surveys/assessments should be recent and *data should be acquired for the actual site of the project's facilities*, including related and associated facilities, and the project's area of influence (I. Woxvold italics).

Relevant to maximising coverage of major landforms and vegetation types, PS6 GN68 states:

> Information should be gathered on species, habitats, ecosystems, evolutionary processes and ecological processes.

It is a basic ecological principle that different vegetation communities support different assemblages of flora and fauna. In the ERIAS Group team's experience, and consistent with the issues outlined above in relation to the Project's location in a biodiversity-rich and knowledge-poor landscape, greater coverage of vegetation types provides greater coverage of key biodiversity values at a variety of scales of biological organisation, including at both the species and ecosystem scales.

Vegetation types mapped for the study area under the PNG Forest Inventory Mapping System (FIMS) (Hammermaster and Saunders 1995), and their coverage under the early-stage AOIs, are listed in Table 3.1. More than half of the FIMS types and three of the four major vegetation groupings (hill, alluvial and swamp forest) are covered by the early-stage AOIs. Information on the applicability and limitations of the FIMS dataset is outlined in Appendix 2. Not all vegetation types included in the expanded AOI 6 will be covered by ground survey (see Section 3.2.2).

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Table 3.1 – FIMS Vegetation Types Present in PRL15 and the Pipeline Corridor, and Those Covered by Early-Stage AOIs and Prior Surveys of the PHP

Vegetation Type	FIMS Code	PRL15	Pipeline Corridor	AOI (#) & Prior (P) Coverage
Hill Forest				
Medium crowned hill forest	Hm	X	X	1–4, P
Small crowned hill forest	Hs		X	5, 6
Complex: medium crowned hill forest/scrub	Hm/Sc	X		2
Alluvial Forest				
Large crowned alluvial forest	Pl	X	X	6
Open alluvial forest	Po	X	X	4, 6, P
Complex: open alluvial forest/mixed swamp forest	Po/Fsw	X		4
Swamp Vegetation				
Mixed swamp forest	Fsw	X	X	
Herbaceous swamp	Hsw	X	X	
Swamp woodland	Wsw	X	X	4, 6
Complex: mixed swamp forest/swamp woodland	Fsw/Wsw		X	5, 6
Complex: mixed swamp forest/swamp grassland	Fsw/Gsw; Gsw/Fsw		X	5
Complex: swamp woodland/swamp grassland	Wsw/Gsw; Gsw/Wsw	X	X	
Marine & Coastal				
Mangroves	M		X	6
Non-Forest Areas				
Converted land; anthropogenic land use	O		X	6

Elevation exerts a marked influence on the structure of tropical floral and faunal communities (e.g., Whitmore, 1984; Kattan et al., 2006), including those in New Guinea (Diamond, 1972; Paijmans, 1976; Beehler, 1982; Flannery, 1995). Despite the large scale of the Project area, its elevational range is limited—all areas of PRL15 and the export pipeline corridor are below 450 m asl, with most infrastructure planned for development in areas below 250 m asl. In the ERIAS Group team's experience, elevational shifts of this order account for relatively little variation in species assemblages, the more important landscape-level factors being vegetation type, vegetation condition and geographic distance within vegetation type[5].

[5] For example, most non-coastal bird species restricted to the lowest elevational bands in southern New Guinea are reported from lowland foothill environments at least as high as 500 m asl (e.g. Southern Cassowary *Casuarius casuarius*, Southern Crowned Pigeon *Goura scheepmakeri*) and in many instances higher (e.g. Black-billed Brushturkey *Talegalla fuscirostris*). While some change in community assemblage can be expected with a change in elevation between 150 and 450 m asl within hill forest environments, these changes are thus expected to be minor, and even less so in areas below 250 m asl subject to Project development. A range of elevations will nevertheless be covered during the Terrestrial Biodiversity Study program.

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Within each AOI, and where an existing camp is not available, fly camps will be located to provide safe and reliable access to a variety of habitats and microhabitats supporting distinct flora and fauna communities. As described above, this will maximise the opportunity for characterising key biodiversity values present.

Locating fly camps close to footprint sites will provide access to habitats and flora/fauna populations subject to both direct and indirect impact processes—surveys typically cover areas up to 3 km from fly camp locations. Proximity to Project facilities is also reasonably expected to cover areas of perceived impact as interpreted by local communities and other stakeholders. Control sites for some species-level biodiversity values may also be covered at the local scale by survey in areas accessible on foot from fly camps and away from Project footprint sites (depending on the nature and location of the target values and the predicted impacts).

However, at the landscape scale it is acknowledged that control sites are not covered by these early-stage AOIs. Accordingly, PS6 GN64 states:

> A critical habitat assessment…must not solely focus on the project site. The client should be prepared to…conduct field surveys beyond the boundaries of the project site.

This is understood by the ERIAS Group team, and data from outside of Project footprint areas are considered a vital component of the Terrestrial Biodiversity Study. However, at this early stage of the study it is unclear where and to what degree such areas may need to be surveyed. Locating such sites is dependent on a variety of factors that will be determined as the ESHIA program develops, including (*inter alia*):

- Access to data from the PHP biodiversity studies.
- Finalisation of Project design.
- Characterisation of biodiversity values present in footprint areas.
- Determination of what, if any, biodiversity values require offsetting.

Areas relevant to acquire control datasets will therefore be considered for the Phase 2 survey program in mid 2016. If access to the PHP biodiversity data is obtained, then this would provide information from up to 10 suitable control sites.

The location and features of AOI 1 to 6 are described below.

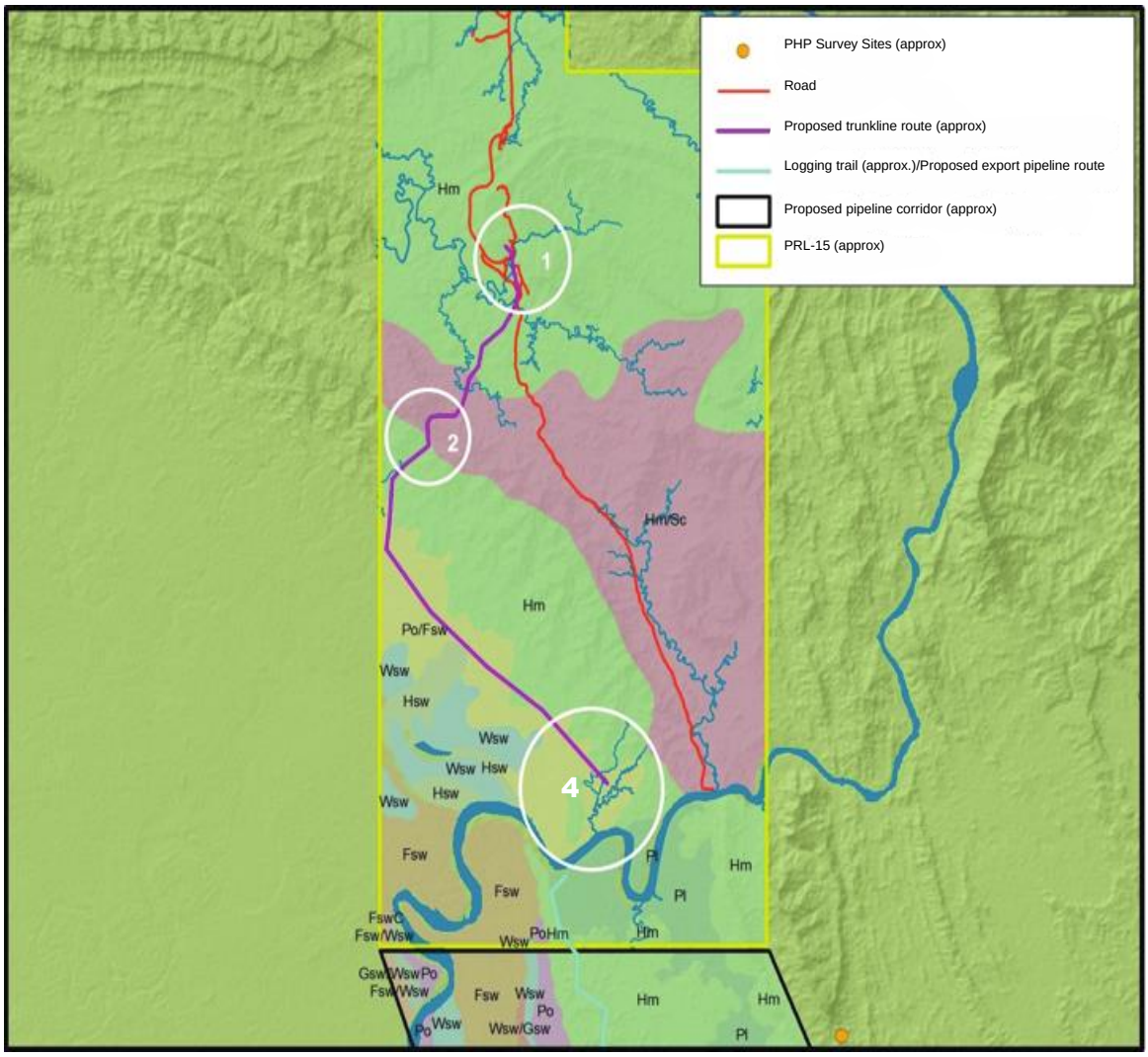
3.2.1.1 AOI 1 – Antelope-3 Area

AOI 1 has been chosen to ensure coverage of the wellpad area and the existing operations camp at the Antelope-3 wellpad in the northern half of PRL15 has been selected as a base for this survey. The site provides access to extensive areas of largely undisturbed (based on satellite imagery provided by TEP PNG) medium crowned hill forest (Hm) around the accommodation base, gathering station and multiple wellpads (Figure 2). Hill forest supports the highest diversity of tree species (Louman and Nicholls, 1995; Takeuchi, 2008) and the highest diversity faunal communities (Coates, 1985, 1990; Flannery, 1995; Menzies, 2006) of any forest type in New Guinea. Boo Creek, a broad, open canopy watercourse, flows past the site, and numerous tributaries drain the surrounding landscape beneath closed canopy forest; these will provide opportunity for sampling of key faunal values associated with these features such as freshwater

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turtles and an undescribed water rat (*Hydromys* sp.) known from nearby localities. An existing road network will provide access to extensive areas of forest not normally accessible in more remote fly camps (where trails need to be cut and normally restrict movement to within 3 km).

Figure 2 – FIMS Vegetation Types, Proposed Project Linear Infrastructure Routes and the PRL15 Early-Stage Biodiversity AOIs.



See Table 3.1 and Sections 3.2.1.1 to 3.2.1.3 for text labels of coded FIMS vegetation types. The pipeline routes, PRL boundary and pipeline corridor boundary have been approximately drawn in lieu of GIS data.

This area will be considered for enhanced quantitative sampling of some select faunal groups (dependent on approval by TEP PNG) – notably camera trapping of terrestrial birds and mammals and deployment of bioacoustic recorders to record frog calls along watercourses. If approved by TEP PNG, cameras would be left in the field for the period between survey missions. These faunal groups are susceptible to two distinct and high profile impact processes that will be

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considered as part of the impact assessment – hunting and water quality management issues. Existing facilities and roads provide an opportunity to gauge changes in relative abundances of target fauna at increasing distances from these features, potentially helping to predict Project-related impacts in other areas. Further detail relating to this enhanced quantitative sampling is provided in Section 3.3.1.6.

Four of the five nearest sites sampled under the PHP (at 15–30 km from Antelope-3) were surveyed during June to July 2012 (Woxvold, unpublished data). The Phase 1 survey at Boo Creek thus provides maximum cross-seasonal perspective against potentially available data.

3.2.1.2 AOI 2 – Western Trunkline Route

The AOI 2 fly camp will be located near the western edge of central PRL15 along the preferred western trunkline route, within a shallow pass which the trunkline will follow through a complex ridge system. The site provides access to two FIMS vegetation types—medium crowned hill forest (Hm) and scrub (in a complex with medium crowned hill forest: Hm/Sc) (see Figure 2). The fly camp will be located to provide access to naturally occurring areas of both of these vegetation types, and to watercourses flowing off the ridge system—topographic mapping (1:100,000) and satellite imagery (provided by TEP PNG) show that all of these features are present locally within the AOI.

3.2.1.3 AOI 3 – Northern Export Pipeline

This AOI is located along the northern sector of the proposed export pipeline route approximately 4 km northeast of Ebala village. The fly camp will provide access to:

- Both the foothill zone and the deltaic zone landforms (Bryan and Shearman 2008).
- At least two FIMS vegetation types—medium crowned hill forest (Hm) and open alluvial forest (Po) (Figure 3). Other potentially accessible vegetation types include swamp woodland (Wsw) and riparian habitats along the Purari River.
- Minor watercourses and potentially the Purari River.

Based on prior survey experience and the location of the logging road, this area has almost certainly been subject to extensive logging.

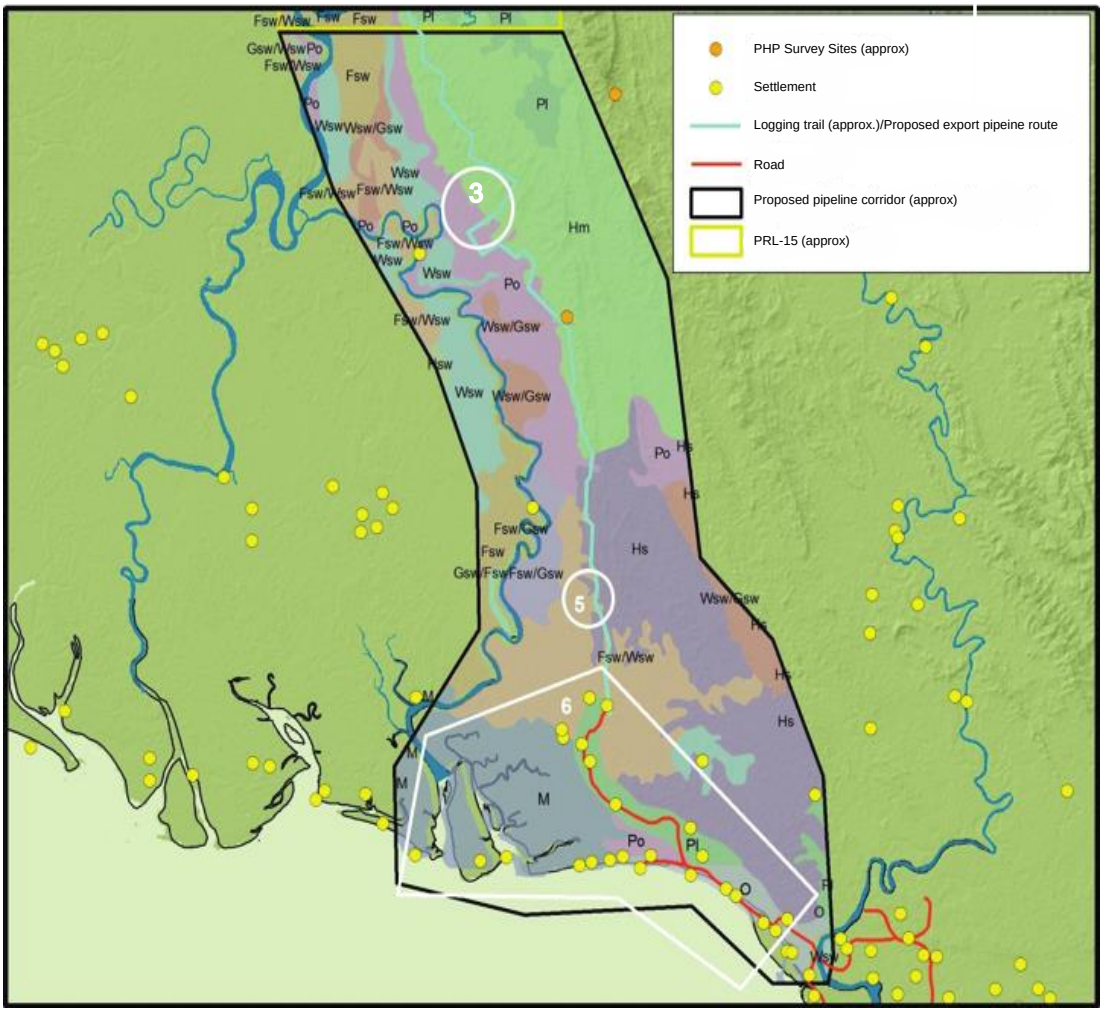
Approximately 8 km southeast of this AOI, in October 2011 the same FIMS types were surveyed along the proposed pipeline route/logging road as part of the PHP EIS (Environmental Impact Statement) studies (Woxvold, unpublished data). Survey timing at this AOI provides for coverage of similar habitat at a different location and with some seasonal perspective (3–4 months).

Significant impacts to biodiversity have been reported in other more heavily populated tropical countries when logging and road construction are followed by secondary logging and increased hunting pressure (Meijaard et al., 2005; Laurance et al., 2009). These secondary impacts appear not to have been a significant issue in this sparsely populated region, with many key species level biodiversity values still present (unpublished data). In addition to documenting these values, the status of weeds and other invasive species already present in these disturbed habitats, and the

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potential for them to spread to other sectors of the Project area, will be an important focus in this area.

Figure 3 – FIMS Vegetation Types, Proposed Project Linear Infrastructure Routes, Public Roads (as Mapped on Government Issue 1:100,000 Topographic Maps), Village Locations and the Export Pipeline Corridor Early-stage Biodiversity AOIs



See Table 3.1 and Sections 3.2.1.4 to 3.2.1.5 and 3.2.2 for text labels of coded FIMS vegetation types. The proposed export pipeline route and pipeline corridor boundary have been approximately drawn in lieu of GIS data.

3.2.1.4 AOI 4 – CPF and Purari Area

Survey within AOI 4 is planned for the Phase 1 survey as it sits within the proposed CPF Area. The fly camp will be located in the south of PRL15 in a minor tributary catchment north of the Purari River. This still forested area (based on satellite imagery provided by TEP PNG) has been proposed for development of a suite of major Project facilities. The site provides access to:

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- Two major landforms present within the Project area—the foothill zone and the deltaic zone (Bryan and Shearman, 2008).
- Two FIMS vegetation types—medium crowned hill forest (Hm) and open alluvial forest/mixed swamp forest (Po/Fsw)—representing three of the major vegetation groupings listed in Table 3.1—hill forest, alluvial forest and swamp vegetation (see Figure 2).
- A branching network of closed forest and open canopy watercourses, including lower reach tributaries and the northern banks of the Purari River (topographic maps and satellite imagery).
- Areas earmarked for development of a CPF, airstrip, logistics base and infrastructure.

A suitable fly camp location near the end of the approximate trunkline route is shown in Figure 2. This site is within 2 km of all natural and Project features listed above. Close attention has been paid to ground conditions and the nature of potential stream crossings when assessing the accessibility of target locations.

This area will be considered for enhanced quantitative sampling of select faunal groups (dependent on approval by TEP PNG), providing opportunity for collection of baseline data suitable for monitoring in an area earmarked for major infrastructure development.

3.2.1.5 AOI 5—Southern Export Pipeline Between Lali and Kilave

This AOI is located on the southern pipeline route approximately 16 km north of the coast between Lali and Kilave villages. The fly camp will be located to provide access to:

- Both the foothill zone and the deltaic zone landforms (Bryan and Shearman 2008).
- At least two FIMS vegetation types—small crowned hill forest (Hs) and mixed swamp forest/swamp woodland/swamp grassland (Fsw/Wsw) (see Figure 3). Neither of these vegetation types is accessible from other AOIs or has been surveyed previously under the PHP program. Other potentially accessible FIMS types include large mixed swamp forest/swamp grassland (Fsw/Gsw).
- Minor watercourses draining low hills east towards the Purari River.

The timing of this AOI provides for some seasonal perspective (3–4 months) from the nearest site surveyed under the PHP EIS studies.

3.2.2 AOI 6 – Southern Export Pipeline

AOI 6 has been chosen to ensure coverage of the southern and coastal section of the export pipeline. South of Kilave village the export pipeline route is yet to be determined. The export pipeline corridor widens to span approximately 30 km of coastline at the eastern end of the Gulf of Papua and includes a variety of coastal, sub-coastal and inland environments, including a large area of mangroves in its western half (see Figure 3), alluvial forest, hill forest and swamp forest vegetation types. The AOI here is expanded to cover most of this southern sector of the pipeline corridor in order to screen for habitat condition and potential sensitivities that may help to inform the optimal pipeline route.

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AOI 6 may comprise a complex of Natural, Modified and Critical Habitats *sensu* IFC. The mangrove vegetation in the west of this AOI is likely to qualify as Critical Habitat (TBC, 2015).

Being more heavily populated than areas north of Kilave village, parts of AOI 6 may also qualify as Modified Habitat. AOI 6 includes the only area mapped under FIMS as converted for anthropogenic land use (Non-forest FIMS class 'O'; see Figure 3). Among the FIMS mapping units present in the upstream Project area, this is the unit most defensibly classifiable as Modified Habitat *sensu* IFC, though confirmation may ultimately require ground-truthing to determine the proportion of natural vegetation components still present and the prevalence of non-native species[6]. Other areas may ultimately be mapped as Natural Habitat, in the absence (for example) of ESHIA studies locating the presence (confirmed or likely) of key species level biodiversity values pertinent to PS6 Critical Habitat criteria 1–3. Some sectors of Natural Habitat in AOI 6 are also likely to show some level of disturbance. For example, the large crowned alluvial forest (Pl) vegetation unit through which the public road was constructed is mapped under FIMS as having a disturbance class of '8' (=Pl8), equating to a 20% disturbance to canopy cover at the time of mapping (Hammermaster and Saunders, 1995).

The purpose of the November 2015 reconnaissance was to collect information on environmental conditions relevant to optimising pipeline route selection. Aerial survey was conducted during the November reconnaissance to check the status of roads (mapped or otherwise), the condition of vegetation along the existing road route and in areas mapped under FIMS as converted land (O), the distribution and condition of other areas mapped under FIMS as supporting natural vegetation types, and coastal zones for the presence of areas that may provide important habitat for migratory wading birds (Scolopacidae, Charadriidae) or beach nesting turtles. The condition of the mangroves was also examined.

In the ERIAS Group team's experience, the distribution of the various habitats/ecosystems present in AOI 6 and the presence of numerous settlements and high intensity land use areas, all have implications for the potential distribution of key biodiversity values potentially present in this area. Importantly, the key biodiversity values that would require assessment by field survey differ in different sectors of this AOI. A number of important species level values are potentially present, many of which are not expected to occur further north in the upstream Project area. They include (*inter alia*):

- The Critically Endangered (and recently rediscovered: Hughes et al., 2014) New Guinea Big-eared Bat (*Pharotis imogene*) (K. Armstrong & K. Aplin, pers. com.).
- The Critically Endangered mangrove tree *Bruguiera hainesii*.
- The Endangered Giant Bandicoot (*Peroryctes broadbenti*).

[6] By contrast, regenerating logged forest, such as that present along much of the proposed export pipeline route, is best considered Natural Habitat *sensu* IFC (IFC staff, pers. com. to Woxvold, without reference to current Project).

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- Turtle nesting sites. Two IUCN Endangered species potentially nest here—the Green (*Chelonia mydas*) and Hawksbill (*Eretmochelys imbricate*)—as might the IUCN Vulnerable Pig-nosed turtle (*Carettochelys insculpta*) (Eisemberg et al., 2015; S. Richards, pers. com.).
- Migratory wader (Scolopacidae, Charadriidae) feeding and roosting habitat. Aerial survey during the November 2015 reconnaissance showed that some migratory waders use the tidal flats along the coast within AOI 6. Nine potentially occurring migratory wader species are listed as Threatened or Near Threatened by the IUCN.
- Some IUCN listed marine mammals (Dugong *Dugong dugon* (Vulnerable), Australian Snub-fin Dolphin *Orcaella heinsohni* (Near Threatened)).

A complete list of the potential sensitivities is beyond the scope of this report, however, the sensitivities requiring field survey, and the location of any camp/accommodation required to undertake field survey, will vary depending on the route of the export pipeline. Interviewing local residents will be a key component of the assessment process, and the Terrestrial Biodiversity Study team will contribute to household questionnaires utilised by the social team in the first instance to provide important information on the potential presence and location of these sensitivities. Based on this initial information, a ground survey program will be designed to focus on likely important areas, at which time local residents will be questioned in more detail about relevant matters. Combining field survey with information provided by local resident informants is a key component of the survey methodology that is applied by our team in all areas of New Guinea and that will be applied in all sectors of the present Project area.

Both littoral and mangrove forest are relevant to the terrestrial biodiversity component of the ESHIA studies. If potentially occurring terrestrial biodiversity values require ground-truthing the appropriate survey activities would be proposed. The requirement for such surveys is to be determined. Relevant factors include the following:

- Mangrove forest is already likely to qualify as Critical Habitat (based on TBC screening study), survey for species level values may not, therefore, be required to ascertain this from the outset, though they may be useful for determining Tier 1 vs Tier 2 status in some instances.
- Routing of the export pipeline and associated facilities. This would determine the potential impacts on coastal forest types, including mangroves and littoral communities.
- Surveying mangroves is logistically challenging. Careful consideration should be given to what information collected on the ground would add to Critical Habitat assessment and the development of the Project's biodiversity management strategies. The marine and estuarine study will also execute surveys of mangroves by boat in the estuarine and riverine areas at the coast.

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3.3 Field Methods

3.3.1 Fauna

Each of the upstream survey areas are located in a remote and biodiversity rich forested environment with a low resident human population and a paucity of existing environmental data. At each of the survey sites, multiple key species-level biodiversity values (listed in Section 2.3.2.3) may be expected to occur for each of the taxonomic groups under investigation. Analysis of existing global and regional datasets is insufficient to predict the presence, status and distribution of these biodiversity values. Moreover, in tropical forest landscapes they may be expected to occur in any of a variety of vegetation types and microhabitats present both at the landscape scale across the Project area and at the local scale in areas accessible on foot from fly camps. Accordingly, survey methods applied at each site will follow a rapid assessment approach with some quantitative sampling enhancements.

Rapid assessment field survey methods are appropriate for maximising the detectability of rare, little known and previously unknown taxa. As an example relevant to Critical Habitat assessment, such groups typically include multiple restricted range species whose presence and distribution cannot be predicted based on existing datasets. Field techniques will be combined with bibliographic reviews, expert taxonomic knowledge and extensive information gathered from local resident informants (for example by working with them at fly camps, visiting relevant landowner villages and contributing to social team household questionnaires in particular those relating to provisioning ecosystem services) to provide proper context for Critical Habitat-qualifying values.

The various survey methods are described below for each of the major taxonomic groups under investigation. They will be applied:

- In forest environments, targeting the many forest-dwelling species for which suitable habitat is more or less continuously distributed.
- To discontinuously distributed terrain and microhabitat features, including (but not limited to) watercourses, standing water bodies, ridges/valleys and caves (if present), targeting taxa closely associated with these features.
- At existing project facility/infrastructure sites, to assess the presence of invasive species and the status of native taxa at these sites to provide context on their sensitivity to future project developments.

Accordingly, fly camps have been located to provide safe and reliable access to a variety of habitats and microhabitats supporting distinct flora and fauna communities.

The field survey methods outlined below have been developed by each taxonomic specialist to meet the aims described above and are based on extensive experience in Papua New Guinea environments. For all taxa the various methods combine to maximise the completeness of species inventories in the time available. It is acknowledged that a complete species inventory is not necessary to meet ESHIA or IFC PS6 requirements. However, the production of a near-complete and taxonomically up-to-date species inventory is a suitable indicator for the coverage

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of key biodiversity values in these biodiversity rich, knowledge poor and extensively forested landscapes (Woxvold, pers. com.).

Each taxonomic specialist will combine field data with their extensive and unpublished regional knowledge to refine the datasets with relevance to Project development.

3.3.1.1 Mammals

A variety of field methods will be used with the general goal of detecting the greatest number of mammal species. Variation in effort between localities will reflect judgement regarding the best use of available time at each site. The following factors will be taken into account:

- The degree of overlap with habitats sampled at other sites.
- The capture returns within a given habitat or using a particular method (e.g. high returns from mist-netting on the first night might encourage the setting of additional nets).
- Distance required for travel to particular habitats.
- Safety issues related to servicing of nets or trap lines, or daytime exploration and night patrolling.

Trapping for Non-volant Mammals

Three types of traps will be used for non-volant mammals:

- Elliott live-capture traps (Plate 1).
- Kill traps designed for domestic rat control (Snap-E Trap – rat).
- Kill traps designed for domestic mouse control (Snap-E Trap – mouse).

A variety of baits may be employed including pineapple, taro, sweet potato, rice mixed with tinned fish, rat meat, and peanut butter (usually smeared on taro or sweet potato). Traps will be set in positions thought to be a focus of small mammal activity rather than on a regular grid or spacing. This will involve searching for recent signs of small mammal activity, including active burrows or run ways, feeding stations and faecal piles, as well as potential food resources such as fallen fruit.

Traps will be set on the ground and up to 2 m above ground on low tree branches, fallen trees etc. Placing traps higher within the understorey or canopy poses an unacceptable safety risk.

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Plate 1 – Elliott Trap in Position



Camera Trapping

Up to 30 digital camera traps (Reconyx PC850/HC550, ScoutGuard SG565) will set by project ornithologist Iain Woxvold. Camera trap arrays will be set to target larger terrestrial mammal species not readily encountered by other survey techniques. Camera traps will be set on the ground along animal trails, beside forest floor pools or recent feeding debris, or along fallen trees that cross steep-sided gullies or streams. Depending on the purpose of survey at each site, camera traps will either be baited with cooked rice or sweet potato (rapid assessment protocol) or remain unbaited (quantitative baseline data collection). All camera traps will be deployed away from other survey activity centres and left in place for the duration of each survey.

Many of the mammals that might occur have two or more closely related species that cannot be distinguished reliably from an image. In these cases, the identification is made to genus level only. In a few cases, identification to species level is possible either because distinguishing features are visible in the image or because other species of the group can be discounted reliably on distributional grounds.

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Plate 2 – Camera Trap in Position



Mist Nets, Harp Traps and Scoop Nets for Bats

Between 12 and 24 mist nets will be deployed at each site – nylon nets used also for capturing birds (and kept open overnight), and monofilament nets set specifically for bats. Mist nets are expected to yield the greatest number of bat captures, predominantly involving small megachiropteran bats.

Two (2) harp traps will be deployed continuously at each site to catch microchiropteran bats.

Mist nets and harp traps will be placed in positions most likely to capture bats, including across streams, adjacent to rocky outcrop, along tracks, at cave entrances and at the edges of clearings. Most mist nets will be deployed near ground level or to a maximum basal height of 2 m. Mist nets are usually left in position for the duration of each camp, with effort put into erecting additional nets rather than moving nets. Harp traps are generally left in position for at least two nights. If unsuccessful over this period, they are usually moved to a new position.

Scoop nets will be used to attempt capture of bats flying at night through camp or along tracks. Although several bats may be captured this way the success rate is generally low.

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Plate 3 – Harp Trap in Position



Plate 4 – Mist Net Set Along a Trail



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Acoustic Recordings

Up to six (6) acoustic bat detectors will be deployed each night to make acoustic recordings of ultrasonic microchiropteran bat echolocation calls which can then be analysed to determine taxa present. The detectors will be employed as passive stationary recorders, being set in position at dusk and collected after dawn. Bat detectors will be placed in a variety of habitats including adjacent to streams, along tracks, on slopes facing into the forest canopy, and facing into both small and large clearings. The same position may be sampled on multiple nights to account for different conditions (e.g., heavy or light rain).

For each recording station a GPS position will be recorded and notes made regarding the habitat in front of the unit. This will be coded to produce a variety of habitat types, e.g.:

- FC – forest canopy, usually sampled by facing the microphone backwards on a steep slope.
- FS – rapidly flowing streams within forest cover.
- FT – well-defined tracks passing below forest cover.
- FU – understorey below forest cover.
- CL – large artificial clearings such as a helipad or major camp area.
- CR – open airspace above major river courses.
- CS – small clearings below forest cover.
- SS – slow flowing streams below forest cover.
- SW – densely cluttered swamp habitat.

Day and Night Patrol

Some hours per day will be spent walking forest habitats, either in the process of setting up, checking or retrieving traps and nets, or searching for caves and signs of mammal activity.

On most evenings three or more hours will be spent walking slowly in the forest, sometimes with the express purpose of sighting mammals but more often in course of visiting mist nets or assisting with the amphibian survey. This activity will be carried out under clear conditions and in light rain; however, heavy rain obscures vision and any aural contact and effort is usually abandoned under persistent heavy rain.

Cave Searches

Caves often contain roosting bats which can be captured in hand nets or by setting mist nets across entrances. Information that can be obtained from cave surveys includes:

- Records of species that otherwise evade capture in nets and harp traps.
- Valuable reference echolocation calls.
- An indication of species abundance within an area.
- Information on breeding activity at the time of the visit.

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- An indication of species vulnerability to cave disturbance.
- Discovery of important roosting sites that might be given special consideration during impact mitigation.

In addition, caves are sometimes used by predators such as owls, and these may produce accumulations of prey remains including the bones and teeth of mammals. Large accumulations of mammal bones are sometimes found in caves, and these provide an almost unparalleled source of information on the local small mammal community, including indications of relative abundance.

No karst terrain or other notable cave-forming geological features are mapped present for the project area. However, every effort will be made to locate caves if present.

Interviews and Inspection of Hunting Trophies

Prearranged interviews will be conducted at villages during the Phase 1 surveys. During interviews, if appropriate, people will be asked to exhibit collections of hunting trophies kept inside their houses.

Questioning will be used in conjunction with those of household interviews conducted by the social team to inform on biodiversity values present, including rare and threatened hunting sensitive taxa, and ecosystem services that may be impacted by project development.

Additional valuable material will be gathered during discussions with local residents employed to assist field scientists during the field surveys.

Vouchering and Identification Methods

With experience, most mammal captures can be identified to generic level in the field. For some groups of mammals, species determinations are also possible based on external characteristics. However, for many more groups, most notably among the rodents, smaller marsupials and bats, reliable species determinations require examination of the bones and teeth, and this can rarely be carried out on a live animal. Furthermore, the very incomplete state of knowledge of mammal taxonomy in New Guinea dictates that there is a high likelihood of encountering entirely new species of mammal, or that the newly collected material will facilitate clarification of known taxonomic problems and lead to the recognition of additional biological diversity.

Where necessary, specimens including vouchered animals and DNA samples will be taken. Further information on vouchering is presented in Section 3.3.1.5.

In addition, organ tissues will be collected from vouchered animals to provide baseline information on the prevalence of pathogens in native and non-native mammal species. Further information is provided in the document describing proposed quantitative baseline data collection methods.

Analysis of Acoustic Recordings

Two main sources of information will be used to make species level identifications from acoustic bat recordings: 1) reference calls in the published literature; and 2) reference calls collected

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during the survey. Comparison between reference and recorded calls will be made from a time-frequency display of echolocation sequences following Zero Crossings Analysis (ZCA).

There will be no attempt to identify calls on the basis of general correlations between physical characteristics (e.g. forearm length, body weight) and echolocation call frequency. Although this inferential method has merit in some circumstances, in the present context the specialist prefers to follow a more cautious, evidentiary approach that minimises the chance of calls being misidentified and action being taken on the basis of an incorrect determination.

The acoustic dataset can be used to characterise the ecological structure of the regional bat fauna, and make predictions about how it might change in response to project activities because variation in echolocation signal structure is closely related to bat ecology. Echolocation signal structure gives information about the types of habitats bats forage in, how they capture prey, and their diet. Knowing this, it is possible to infer the general composition and richness of an assemblage, and predict how these might change under impacts, without knowing the actual taxonomic identity of each species present.

3.3.1.2 Birds

Survey methods will include ‘active’ (transect) searches, call recording and playback, mist-netting, camera trapping and interviews with local hunters. These techniques will be combined to maximise completeness of the bird species inventory and the likelihood of locating rare and threatened taxa in the time available at each site.

Transect Surveys

Each morning and afternoon birds will be surveyed on foot along walking trails and identified visually and/or by their calls. Surveys will commence at or prior to dawn on most mornings (05h15–06h15) and regularly continue until after dusk to cover active periods of both diurnal and nocturnal birds. All survey trails will be GPS tracked and mapped.

Sound Recording and Playback

Bird calls will be routinely recorded while walking trails and during informal survey periods. Calls will be recorded digitally on a Sony PCM-D50 Linear PCM Recorder. Difficult or unfamiliar calls will be subsequently matched against an extensive database of New Guinea bird calls. Recordings of positively identified species will be added to the database for future reference. Selected calls will be played aloud using a portable speaker in an effort to elucidate a response from shy, cryptic, rare or threatened species that may be present.

Mist Nets

Mist nets ranging in size from 9 to 12 m (31 mm mesh) will be deployed at each survey site in a variety of habitats according to the method outlined above (‘Mist nets, harp traps and scoop nets for bats’ in Section 3.3.1.1). All nets will be checked regularly during daylight hours and some will be left open continuously both day and night. Captured birds will be brought back to camp and stored in the shade in calico bags for subsequent processing including photography, biometric measurement, blood sampling and plumage marking prior to release.

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Camera Traps

Digital camera traps will be deployed as described above ('Camera Trapping' in Section 3.3.1.1).

Community Knowledge

Direct observational data will be supplemented with information provided by local community advisors. Relevant data will be gathered during conversations with locals assigned to assist with the terrestrial biodiversity surveys, and with residents in local villages where visits are made. Discussions will focus on the distribution and status of recognisable species of conservation concern (e.g. cassowaries, crowned pigeons) and on local dialect ('*tok ples*') names of distinctive and commonly encountered bird species.

Information provided by local community advisors must be carefully interpreted, as verbal descriptions, photos and images from field guides often lead to misunderstandings over which species are being discussed and may result in false information. More reliable are those identifications based on (for example):

- Distinctive and commonly hunted species (e.g. cassowaries, megapodes, birds-of-paradise).
- Bird vocalisations heard together in the field for which the local informant can provide an accurate visual and/or behavioural description.
- Birds in the hand for which the local informant can provide an accurate vocal and/or behavioural description.

Information about birds collected during these surveys will be conservatively presented with these caveats in mind.

Vouchering

Most birds captured in mist nets are blood sampled, measured and released unharmed. Whole animal vouchering is kept to a minimum, and the number of birds collected is typically lower than those of other taxa, reflecting the generally more settled taxonomy of this group. Further information on vouchering is presented in Section 3.3.1.5.

Analysis

After field surveys, species accumulation curves will be generated for each site in MS Excel by matching accumulated species richness against survey time (hours). For most species relative abundance will be noted at each site by ranking frequency of encounter ('common', 'fairly common', 'occasional', etc.).

Survey sites will be clustered according to similarity in species composition by means of a hierarchical (agglomerative) cluster analysis using the SPSS version 20.0 statistical package. A dendrogram will be generated from presence/absence data using the average linkage (between groups) method and Jaccard's similarity index.

Trapping rates from mist nets and camera traps will be presented for each species. For select sites where camera trap arrays are deployed systematically to collect quantitative baseline data

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these results will be presented as relative abundance indices (RAIs) in a manner suitable for use in monitoring studies.

3.3.1.3 Herpetofauna

Transect Searches

At each site intensive searches for amphibians (frogs) and reptiles will be conducted along walking trails with special focus paid to water-bodies including seepages, small closed-canopy streams, larger streams and small forest pools. During the day searches will focus on heliothermic (basking) reptiles along trails through forest, clearings, and on stream banks. Small lizards will be collected by hand or stunned with a large rubber band. Large lizards and snakes will be collected by hand. Non-basking reptiles will be sampled by searching in deeply shaded forest, during rain, or at dusk. Nocturnal reptiles, including geckos, will be detected by walking along forest trails at night with a headlamp.

Frogs will be sampled at night by conducting visual-encounter and aural surveys along streams, and in and around small ponds. Because a large proportion of New Guinean frogs have life cycles that are independent of free-standing water, extensive visual and aural searches along trails in forest away from water will also be conducted.

Special attention will be directed at determining the status of regionally anticipated species with a 2015 IUCN Red List rating above Least Concern or a listing as *Protected in the PNG Fauna (Protection and Control) Act 1966*.

Sound Recording

Frog calls are an important diagnostic character that assists greatly with species identification. Whenever possible the advertisement calls of frogs will be recorded with a Marantz PMD-661 Solid-state Recorder and Sennheiser ME66 microphone.

Bioacoustic recorders (BARs) will be deployed to collect some quantitative baseline data in select localities near existing or proposed infrastructure sites. The resulting data will provide information on the impact of existing infrastructure to select taxa.

Freshwater Turtle Trapping

Turtles will be sampled using two live ‘funnel-style’ traps; the two traps have slightly different designs to allow sampling in deeper and shallower water. The first is a ‘Modified Crab Trap’ that is designed to sample in water less than 1 m deep and the other is a ‘Cathedral Trap’ that is designed to sample turtles in deeper water. Both traps are suspended from a branch or pole above the water with the top of the trap remaining above water so that turtles can reach the surface to breathe. Bait (dead fish, meat) is placed in a pocket inside the trap and turtles enter to access the bait where they become trapped. The traps will not sample large adult Pig-nosed or Striped New Guinea Softshell turtles but are sufficiently large to sample juveniles of these species and adults of all other taxa. Traps will be placed in order to sample representative examples of all available water bodies that are likely to provide habitat for turtles, including deeper pools in shallow streams, rivers (especially adjacent to submerged logs), lagoons, and large ponds or

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swamps. If investigation of mangrove habitats is required (to be decided based on export pipeline routing decisions), they will also be deployed in mangrove habitats to sample for juvenile Pig-nosed Turtles (known to aggregate in these habitats) and Banded Water Snakes. Traps will be checked at least twice daily.

Vouchering

Where necessary for taxonomic identification whole animal vouchers will be collected. The rationale for vouchering is described in Section 3.3.1.5. Most species will be photographed alive before preparation as voucher specimens. Euthanasing of frogs and reptiles follows standard and globally accepted protocols. For frogs this involves immersion in an aqueous solution of chloretone as recommended in the volume 'Measuring and Monitoring Biological Diversity: Standard methods for Amphibians' edited by W.R. Heyer et al, (Smithsonian Institution Press 1994) and for reptiles it involves injection of a saturated aqueous solution of chloretone as recommended in 'Reptile Biodiversity: Standard methods for inventory and monitoring' edited by R.W. McDiarmid et al. (University of California Press, 2012). Specimens will be fixed in 10%-formalin solution, and then stored in 70% ethanol. Samples of liver tissue for DNA analyses will be extracted from representative specimens of each species and stored in 95% ethanol.

3.3.1.4 Odonates

Odonates (dragonflies and damselflies) are useful indicators of environmental change because they have a complex life cycle that includes an aquatic larval and a terrestrial, flying adult stage. A number of recent studies have demonstrated that odonates are powerful indicators of forest disturbance in tropical forest habitats (e.g. Dolny et al., 2011, 2012; Oppel, 2006). In addition, New Guinea odonate fauna is highly endemic and contains numerous species with restricted known ranges, particularly among the Zygoptera (damselflies), making them a useful indicator for Critical Habitat. Odonates are also a conspicuous component of New Guinea's terrestrial/freshwater biota and are relatively easy to identify with existing resources.

Search Methods

Odonate activity patterns vary among species, with some taxa preferring to perch in early-morning sun patches in the forest, others defending territories along streams, and others flying in forest gaps predominantly at dusk and rarely perching. Intensive searches are therefore conducted for adult dragonflies and damselflies along and around all available water-bodies, during the morning, on sunny afternoons, and in the evenings. They are captured with long-handled insect nets, and larger species can be observed and identified with binoculars.

Water-bodies that should be examined included seepages, small closed-canopy streams, larger streams and rivers, and small forest pools. Additional surveys are conducted along forest trails and in clearings, especially helipads, where large dragonflies often hunt for small, flying insect prey. Samples are conducted by 2–3 (usually 2) persons and search effort (man-hours) for odonate sampling can be calculated for each habitat sampled to permit comparisons of relative abundance among habitats and between samples.

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Larval odonates are not targeted because the larvae of most New Guinean taxa remain unknown. Larvae are predaceous and providing sufficient prey to rear individuals to metamorphosis for identification in the field is labour intensive and, based on studies of other tropical species, development rates of most species encountered are too slow to permit successful rearing during the course of a survey. As a result identifications based on larval collections would be problematic at best for most species. However the presence of one species, the specialist tree-hole breeding damselfly *Podopteryx selysi*, can be confirmed from its distinctive larva alone.

Vouchering

In order to properly identify all species encountered, specimens of problematic species are preserved as museum vouchers. Representatives of most species are photographed alive, and vouchers are then fixed in acetone and stored in labelled glassine envelopes in boxes containing naphthalene to prevent mould and deterioration. Voucher specimens will be deposited in the South Australian Museum, Australia and in the Papua New Guinea National Museum, Port Moresby.

3.3.1.5 Vertebrate Vouchering Rationale

A number of vouchered animal specimens will be taken as part of the terrestrial biodiversity studies. The rationale for collection is based primarily on immediate contractual requirements for accurate taxonomic assessment of the potentially impacted fauna.

Our scopes of work specify tasks that require taxonomic assessments at a high level of competency and diligence. There is broad consensus amongst the international scientific community that the New Guinean vertebrate fauna is still far from fully documented. Many species are known to have restricted geographic and or elevational ranges and have evaded prior collection due to a lack of appropriate geographic focus or effort. Others have been collected but remain unrecognised due to a lack of appropriately detailed taxonomic work using modern methods including genetic analysis.

As a rule, the diversity within any particular group of vertebrates cannot be said to have been adequately documented until it has been subject to a detailed morphological and genetic (and in the case of frogs, acoustic) studies. More often than not, when such studies are carried out, the result is either the discovery of additional species (these are often called ‘cryptic species’ because they were formerly hidden to taxonomists) or the delineation of significant geographic units within species (these might be termed ‘subspecies’ and/or treated as distinct ‘management units’ for conservation purposes). Only a small number of New Guinean vertebrates have been subject to this level of scrutiny.

Before considering vouchering activities for any particular group of organisms, it is important to recognize that voucher specimens perform four different functions that underpin biodiversity assessment:

- They allow for detailed morphological comparisons with previously described species.
- They form the necessary basis for formal taxonomic description of new species.

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- They allow for independent verification of a taxonomic determination.
- They contribute to the corpus of study materials on which future taxonomic revisions will be based.

The first three of these are directly relevant to the EIS/ESHIA assessment. The fourth is also important to the longer-term future of resource development activities in New Guinea (see below).

Relevant issues for each of the major fauna groups under investigation are outlined below.

Mammals

The mammal fauna of New Guinea is similarly poorly known. Many areas remain almost entirely unsampled and detailed work in almost any locality has a high likelihood of encountering entirely new species of mammal. Furthermore, only a few groups have been subject to modern taxonomic assessment and any new regional voucher collection is likely to facilitate clarification of known taxonomic problems and lead to the recognition of additional biological diversity.

Mammals also pose more serious problems for field identification than most birds and many groups of frogs and reptiles. This is primarily due to the fact that mammals typically rely more on smell than either sight or audible calls (many bats use ultrasonic calls) for social interactions, so that different species often look very similar to our eye, at least externally. Moreover, the differences between them are very often found in the structure of the skull or teeth – features that cannot be examined on a live animal. For these reasons, field identifications that cannot be rechecked and verified through detailed study of voucher specimens are often intrinsically unreliable. The severity of these issues clearly depends on the intrinsic diversity of each group but the difficulties are profound for New Guinean rodents, for all groups of bats, and for many of the families of marsupials.

The South Australian Museum has a 3-year grant from the Herman Slade Foundation (HSF) for genetic analysis of PNG bats[7] and is making use of tissues collected at numerous sites in PNG and by many different people and projects since 1981. The work is being carried out at the museum, however, sequencing is done off site at commercial/semi-commercial facilities (e.g., Australian Genome Research Facility).

Resolution of taxonomic problems in PNG bats requires analysis of samples drawn from broad geographic coverage. Inclusion of samples from the Project's study area in these broader studies will clarify the taxonomic identity of local Purari bat populations and provide information on the level of gene flow between the local and surrounding populations. This information will be useful in the impact assessment, as it will provide a firm basis for determining the degree of taxonomic uniqueness of the Purari bat fauna and, therefore, the distribution of bat species across PNG.

Because of the extended time frame of the HSF funding, genetic information will not become available for all groups of bats within the time frame of the ESHIA. However, the existing prioritization of the bat groups is consistent with the major taxonomic uncertainties that are

[7] The grant is held by Kyle Armstrong, Stephen Donnellan and Ken Aplin and has two years of work remaining.

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identified from the first field season (i.e. the Purari populations of Nyctimene, Paranyctimene, Macroglossus, Murina, Nyctophilius are all taxonomically problematic and all of these genera are existing priorities within the plan of HSF work).

An additional consideration for mammals is that snap traps are preferred in the New Guinea context for small mammal survey on account of their cost effectiveness and efficiency (they are much lighter, quicker to set, and have a substantially higher capture rates than any form of live trap). The animals killed in snap traps are always vouchered rather than discarded so as to allow for accurate identification and to derive the maximum long-term scientific benefit. Snap traps will be used in combination with live animal traps to maximise efficiency of survey without over-vouchering.

Birds

Despite being the best known of all vertebrate taxa, uncertainty still exists regarding the taxonomic status of many New Guinea bird taxa. For example, a number of currently recognised species likely conceal cryptic taxa, various subspecies appear to warrant elevation to full species status, and new species are still occasionally discovered in New Guinea. Problematic groups include various honeyeaters, berrypeckers, scrubwrens, fairy-wrens, drongos and crowned pigeons, to name a few. Most birds captured in mist nets are blood sampled, measured and released unharmed. Voucher specimens are taken in the small proportion of cases where taxonomic uncertainties are present, and in those few cases where birds have perished during the mist netting or handling process. Vouchering is kept to a minimum, and the number of birds collected is typically lower than those of other taxa, reflecting the generally better settled taxonomy of this group.

Herpetofauna

The herpetofauna of New Guinea remains very poorly known. Many groups of frogs and reptiles are currently undergoing revision, and new techniques including DNA and acoustic analyses are revealing widespread species to be complexes of closely related but distinct taxa. Particularly problematic groups include forest dragons of the genus *Hypsilurus*, lizards of the genera *Emoia* and *Sphenomorphus*, and most microhylid frog genera but particularly *Hylophorbus* and *Oreophryne,* which both contain numerous undescribed species distinguished predominantly by call structure. In these and many other cases, whole animal vouchers as well as tissue collections are vital for accurate determination of identity at the species level. Variation among individuals within a species means that, where possible, a few individuals of each problematic or potentially new species should be collected where possible. Where a minimum number is acquired and additional individuals are obtained they are typically released unharmed.

In the event that species identification can only be determined by DNA analysis, the analysis will be conducted at the South Australian Museum, with costs being dependant on the extent of analyses required.

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3.3.1.6 Enhanced Quantitative Sampling

One of the specific aims of the terrestrial biodiversity study is to collect baseline data on priority biodiversity values suitable for use in impact assessment, Critical Habitat assessment and monitoring programs. Monitoring programs are also an explicit requirement of IFC PS6 (though the timing of their initiation is not). For example, IFC PS6 paragraph 7 states:

> [T]he client should adopt a practice of adaptive management in which the implementation of mitigation and management measures are responsive to changing conditions and the results of monitoring throughout the project's lifecycle.

And in IFC PS6 paragraph 17:

> In areas of Critical Habitat, the client will not implement any project activities unless…[a] robust, appropriately designed, and long-term biodiversity monitoring and evaluation program is integrated into the client's management program.

While the exact nature of requisite monitoring programs is appropriately informed by the results of the ESHIA process, it is nevertheless desirable to commence the collection of baseline data that are expected to be useful as the Project progresses. Accordingly, in addition to the survey protocols designed to inform Critical Habitat assessment, impact assessment and to conform to mitigation hierarchy principles, ERIAS Group intend to perform enhanced quantitative sampling procedures that will provide quantitative baseline data suitable for use in impact monitoring.

Many of the techniques applied in our broader survey methodologies readily yield quantitative data. The vegetation mapping study will provide critical information on baseline conditions across the study area as a whole. At the species level, quantitative data are collected as (for example) trapping rates of small non-volant mammals and mist netted birds and as call record rates from ultrasonic bat detectors. However, in many cases the equipment used to collect these data are not deployed in a structured way suitable for statistical analysis; rather, the equipment is deployed in a 'focal survey' approach (*sensu* Gullison et al., 2015) to target those microhabitats and local landscape features that maximise the ability to detect rare and sensitive species.

In addition to these 'focal survey' techniques, the fauna team will collect baseline data on a select group of species specifically intended for use in subsequent monitoring studies. Relevant techniques and target groups include:

- Camera trapping of terrestrial birds and mammals—to test for edge effects and to monitor population trends in taxa sensitive to hunting and/or habitat disturbance.
- Automated bioacoustic recording—to monitor frog population trends along watercourses potentially affected by Project development.
- Tissue collection of native and non-native rodents—to archive baseline information on pathogens present is local rodent populations.

Each of these methods is described briefly below.

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Camera Trapping

Rationale

Estimating population trends through time and space is one of the main goals of conservation research. Camera traps are increasingly used as an efficient and effective tool for monitoring animal populations (O'Connell et al., 2011). For example, camera trap studies have been used to examine the influence of roads or edge effects on animal behaviour and abundance (Srbek-Araujo and Chiarello, 2013), to compare use of different habitats (Pettorelli et al., 2010), to examine the impacts of hunting and disturbance (Datta et al., 2008; Jenks et al., 2011), to monitor feral animal populations (Bengsen et al., 2011a, b) and to test the effectiveness of wildlife corridors (Gregory et al., 2014) as well as to more generally monitor populations in natural and protected landscapes (Kays et al., 2009; Liu et al., 2013).

As a remotely operated, static sampling tool, camera traps bring a number of advantages to monitoring studies (Pettorelli et al., 2010; O'Connell et al., 2011; Srbek-Araujo and Chiarello, 2013):

- They can run continuously for long periods[8] without requiring human resource intervention.
- They are non-invasive and result in minimal environmental disturbance.
- They are particularly effective at sampling rare and elusive species.
- They provide quantitative data on a range of species suitable for use in statistical analysis.
- They provide a cost effective method for conducting long-term monitoring programs.

Extensive experience (>10 years) of the survey team with camera trapping in New Guinea has proven this to be the most effective technique for detecting larger terrestrial birds and mammals, most of which are shy and hunting-sensitive and many of which are listed as Threatened by the IUCN. .

Objectives and Target Species

Camera trap arrays will be used to:

1. Improve the understanding of bird and mammal diversity present in sampling areas.
2. Monitor population trends (increase/decrease) in select species over time and space, for example:
    a. In relation to proximity to existing project facilities/infrastructure.
    b. Before, during and after construction of project facilities/infrastructure.

One of the most important impact processes to be considered during impact assessment for any major development in PNG forest environments is an increase in hunting pressure. The species most at risk of increased hunting pressure include a number of Threatened and 'charismatic'

[8] Up to 3–4 months with the Reconyx cameras used by our team.

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fauna species. While many of these are large, they often occur at naturally low densities and/or are difficult to detect due to their avoidance of humans.

Target species include a suite of terrestrial birds and mammals that are known to occur in the Purari basin lowlands[9], that are hunting sensitive and whose sensitivity to disturbance and habitat degradation is poorly known. A variety of detectable species are listed in Table 3.2. Notable species of conservation value for which useful baseline data are reasonably expected to be collected are described below.

Table 3.2 – Species Known in the Project Area that will be Detectable on Camera Traps

Species	IUCN status	PNG status	Notes*
Mammals			
Eastern Long-beaked Echidna *Zaglossus bartoni*	CR	P	Hunting sensitive; could occur based on information from local landowners
Grey Dorcopsis *Dorcopsis luctuosa*	VU		Hunting sensitive (pct)
Dusky Pademelon *Thylogale brunii*	VU		Hunting sensitive; could occur
Lowland Tree Kangaroo *Dendrolagus spadix*	LC	P	Hunting sensitive; could occur based on information from local landowners
New Guinea Quoll *Dasyurus albopunctatus*	NT		Known present
Three-striped Dasyure *Dasyurus* sp.	DD		Taxon uncertain; could occur
Ground Cuscus *Phalanger gymnotis*	LC		(pct)
Bandicoots *Echymipera* spp.	LC		(pct)
All rodents, inlcuding *Uromys*, *Leptomys*, *Xenuromys*, *Hydromys*	Some DD		Some invasives (pct)
Birds			
Southern Cassowary *Casuarius casuarius*	VU		Hunting sensitive; keystone frugivore (pct)
Megapodes *Talegalla*, *Megapodius*	LC		Hunting sensitive (pct)
Southern Crowned Pigeon *Goura scheepmakeri*	VU	P	Hunting sensitive (pct)
Other terrestrial pigeons: *Chalcophaps*, *Trugon*, *Gallicolumba*, *Otidiphaps*, *Henicophaps*	LC		(pct)
Terrestrial insectivores: *Pitta*, *Ptilorrhoa*, *Craterosceli*s, *Ornorectes*, *Rallina*, *Gymnocrex*	LC		(pct)

* 'pct' = 'previously camera trapped' in the Purari basin lowlands (I. Woxvold, unpublished data).
IUCN status: CR—Critically Endangered; VU—Vulnerable; NT—Near Threatened; DD—Data Deficient; LC—Least Concern.
PNG status: P—Protected under the *Fauna (Protection and Control) Act 1966*.

Grey Dorcopsis (*Dorcopsis luctuosa*)—Though not mapped to occur in Gulf Province in the most recent authoritative text (Eldridge and Coulson, 2015) the species certainly occurs in the local area as it was camera trapped on multiple occasions during the Purari Hydropower surveys

9 Many of which were encountered during the Purari Hydropower Project EIS surveys.

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(unpublished data). This IUCN Vulnerable species is susceptible to habitat loss and degradation (e.g., through logging), and as a preferred bush-meat species it is now rare or locally extinct in the vicinity of many settled areas (Leary et al., 2008; Eldridge and Coulson, 2015).

Southern Cassowary (*Casuarius casuarius*)—This IUCN Vulnerable bird is a keystone frugivore vital to the dispersal of a large number of rainforest tree species, thus providing an important role in ecosystem functioning (Crome and Moore, 1990; Mack and Wright, 2005). Hunting poses a major threat to cassowary populations across New Guinea, and cassowaries are now rare or have been locally extirpated from the vicinity of many settled areas (Healey, 1986; Johnson et al., 2004). They are also sensitive to habitat loss and degradation (Pangau-Adam et al., 2015) and are subject to roadkill. Southern Cassowaries were regularly camera trapped during the Purari Hydropower surveys (unpublished data).

Southern Crowned Pigeon (*Goura scheepmakeri*)—this IUCN Threatened (Vulnerable) bird is the world's largest pigeon. It is a preferred bush-meat species and is now rare or has been hunted to extinction in the vicinity of human settlements (Coates, 1985; King and Nijboer 1994). Their sensitivity to habitat disturbance is not well known. Southern Crowned Pigeons were regularly camera trapped during the Purari Hydropower surveys (unpublished data).

Monitoring of these (and other) species will provide important information on the effectiveness of the Project's environmental strategies for management of some of the project area's most sensitive species.

Theory and Approach

Individual camera traps are fixed in position to a tree or post and capture images of passing warm-blooded animals (mammals and birds) as they trigger the infrared sensor. Rates of photo-capture will be used to generate 'relative abundance indices' (RAIs) for a variety of species.

In situations where individual animals cannot be reliably recognised by photograph[10], RAIs provide a reliable surrogate for direct estimates of population density provided a number of assumptions hold (Carbone et al., 2001; Rowcliffe et al., 2008; O'Brien, 2011). The critical factor linking a species' RAI with its actual population size is 'detection probability'. Detection probabilities are influenced by a variety of behavioural and environmental factors, including habitat, terrain, seasonal changes in behaviour and changing climatic conditions (O'Brien, 2011; Sollmann et al., 2013). The requisite assumptions are most readily violated where RAIs are used to compare population densities between species, between sites, in markedly different habitats and/or at different times of year (seasonality).

However, under a standardised sampling design, and where analysis is restricted to comparing RAIs within species and within a single study 'site', changes in RAI are considered to provide a reliable indication of the *direction of the change* (increase, decrease) in a species' local

[10] As is the case for all relevant species in the Purari basin lowlands, and in contrast to studies of boldly marked carnivores (e.g. Tiger *Panthera tigris*) conducted in other parts of the globe.

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population density (Oliveira-Santos et al., 2009; Harmsen et al., 2010; Bengsen et al., 2011b; O'Brien, 2011).

Changes in a species' RAI over time—for example before, during and after construction/operation of a project facility—or over space—for example or in relation to distance from project infrastructure—can thus provide valuable information on the influence of project development on local wildlife populations and on the effectiveness of project management strategies designed to mitigate those effects[11].

The sampling objective is to acquire RAIs for a variety of terrestrial birds and mammals for select sites in which facility/infrastructure components of interest will be developed and which includes adjacent areas of forest habitat. These RAIs can also be used as a representative sample of populations within the broader area of habitat as it occurs across the Project area (notwithstanding variation in variables such as landscape, habitat and disturbance features) that may influence population size or detectability across the landscape).

Sound inferences about population dynamics can be made from RAIs when variables potentially affecting detection probabilities are adequately controlled for with a suitable sampling design. Potentially confounding variables will be controlled for by (O'Brien, 2011; Sollmann et al., 2013):

- Repeat sampling at the same time of year to minimise seasonal effects.
- Extending sampling over a period of 60–90 days to control for within-season climatic/weather effects and to smooth over stochastic behavioural changes.
- Using moderately large camera arrays (beginning with 35+).
- Only comparing data within 'sites'.
- Only comparing data within species.
- Not baiting cameras (to prevent artificially inflated capture rates at individual cameras).
- Sampling at increasing distances from project infrastructure in similar forest type to control for habitat effects on detection probability.

Further, to control for variation in detection probability among camera positions within sampling 'sites', information will be collected on a range of potentially relevant variables, including:

- Elevation.
- Topographic position (ridge, slope, valley).
- Forest structure variables (e.g. canopy height and closure, understorey density class).

[11] Calibrating RAIs with actual population densities requires independent assessment of local population size through separate investigation (O'Brien 2011). These are typically expensive and time consuming studies, especially where rare, shy or cryptic species are involved. Nevertheless, if in the future there is a requirement for actual estimates of population size (for example to develop threshold triggers for adaptive management responses), then the opportunity would be there to conduct the requisite investigations and to retrospectively apply calibration factors to past RAIs for a select group of taxa.

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- Temperature.
- Distance from project infrastructure (an important variable of interest in these investigations).

The way in which a camera trap array is deployed in the landscape depends on the objective of the study (Kays et al. 2009). Twenty five (25) camera traps will be deployed along a series of 'transects' running parallel to and at increasing distances from the existing road. The design is similar to those used to test Project-related impacts in other tropical regions (T. Gregory and A. Alonso, unpublished data), including elsewhere in New Guinea (Woxvold, unpublished data), and has been developed in consultation with a biostatistician (without disclosing current project details).

Deploying these camera arrays is time consuming, and each array should be left out for periods of more than one month (and up to three months wherever possible) to ensure that suitable amounts of data are collected. Due to these restrictions, the full camera arrays will only be deployed at select sites and when the cameras will not be required for immediate use at a different locality. One site is initially proposed:

- The area west of Herd Base earmarked for development of multiple facilities including the CPF, logistics base, accommodation base and airstrip. This area will be the last site surveyed during the January–February 2016 surveys, thus providing opportunity for the full camera array to be left in the field for the full three months. This recent alluvial landform supports a different forest type, and accordingly different faunal community structures, to that occurring on the hills near Antelope-3. It is not yet developed, providing opportunity for important comparison of faunal communities before and after construction.

Bioacoustic Recording

Rationale

Bioacoustic Recorders (BARs) are increasingly being used to document and monitor populations and communities of species that vocalise. Their use is amenable to a variety of sampling designs, from focused surveys and monitoring of threatened taxa to documentation of the distribution and relative abundance of common species across a larger landscape. They permit documentation of species without the need for researchers to be present, and remove sampling bias in monitoring programs by offering standardised and quantitative recording protocols. BARs have been demonstrated to be more efficient than active searches for detecting and monitoring the presence of rare and difficult to detect vocalising species (e.g. Zwart et al., 2014) and are increasingly being used to document frog faunas; use of automatic recording devices has recently been recommended as a standard technique for documenting frogs during rapid biodiversity surveys (Catenazzi et al., in press).

Objectives

Natural freshwater environments, including watercourses and standing water wetlands, are sensitive to a suite of environmental changes that may be initiated by project development, including potential changes to water quality and the alteration of flooding or flow regimes.

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Protecting these environments is an important and distinct objective of a project's biodiversity management strategies, and one that is typically enacted by multiple management plans, including (but not limited to) those relating to water management, waste management, spill prevention and response, hazardous materials management and erosion and sediment control.

The aim of the BARs will be to provide quantitative information on calling activity by frogs along and around water-bodies that may experience impacts from infrastructure construction/operation or from riparian forest disturbance during project development. Information collected by the BARs will thus provide quantitative baseline data on the presence and status of species that are reliant on the project's water management strategies—a component of biodiversity management distinct from that associated with hunting and forest loss/degradation relevant to species targeted by the camera trapping program.

The BARs also have the potential to incidentally collect baseline data on a variety of large non-terrestrial bird species with easily recognised vocalisations that are hunting sensitive, nationally Protected and/or provide important ecological roles as keystone frugivores. Relevant taxa include as Blyth's Hornbill (*Rhyticeros plicatus*), the IUCN Vulnerable Pesquet's Parrot (*Psittrichas fulgidus*) and some birds-of-paradise (Paradisaeidae).

Protocol

BARs will be placed at different distances upstream and downstream of existing and proposed development sites such as road crossings/facility locations, and adjacent to other aquatic habitats such as ponds and wetlands.

To reduce the influence of weather on calling activity, BARs will be left in place at each survey point for two nights. Weather conditions (e.g., rainfall, temperature) will be recorded to control for variables that are known to influence frog calling activity. The BARs will record for 24 hrs/day and will be switched off only during re-location to the next recording point at which time batteries and flash cards will be replaced.

BARs will be deployed only during the biodiversity field survey period (cf. camera traps). Five units will be deployed for seven days of survey. With each unit remaining at one survey point for two nights, a total of 15 recording points will be utilised at each proposed site.

Analysis of recordings will involve automated 'searches' for vouchered call types using voice recognition software and/or visual searches of distinctive call signatures in data displays. Output data will be similar to the RAIs generated by the camera trapping program.

Pathogen Archiving

Rationale

The introduction of exotic animal species into a natural community can cause direct impacts linked to competition for resources and indirect impacts associated with the introduction of novel of parasites and microbes to which native species have no prior exposure and no natural immunity (MacPhee and Greenwood, 2013). Importantly, the two kinds of impact may also interact, for while the novel pathogens may not always lead to mortalities, they are likely to always

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reduce fitness and/or reproductive success, and thus inhibit the competitive capacity of native species. Examples of native mammal declines and extinctions following the introduction of exotic rodent species and their pathogens are found in the recent history of Christmas Island, where two native rodents decline rapidly to extinction following introduction of Black Rats (*Rattus rattus*) and an associated trypanosome parasite (Wyatt et al., 2008), and Madagascar, where an entire native rodent community has declined followed the arrival of plague carried by Black Rats (Tollenaere et al., 2010).

In the event that one or more native mammal species declines following the introduction of an exotic species, it is important to establish the proximate cause of the decline. If the decline is caused primarily by competition, it may be necessary to eradicate or permanently suppress the exotic species. If novel pathogens are involved, it may be necessary to do so only until such time as the native species develop resistance or immunity to the pathogen, after which their competitiveness may be re-established.

For these reasons, it is recommended that baseline samples are collected to allow for documentation of the existing microbial communities of both native and exotic mammal species at, or in proximity to, each of the study sites. If an exotic species spreads into a previously uninfected area, the baseline samples will allow for rigorous pre-invasion/post-invasion comparisons. The absence of pre-invasion samples is a major limitation for most wildlife disease investigations and for this reason, proactive collection of suitable samples is highly recommended.

Technologies are available today that allow for complete genomic characterisation of the parasite and microbial communities of the various exotic and native animals (Razzauti et al., 2015). However, as there is no need to process any samples in the short term, it is proposed that they are archived for future reference. Rapid advances are being made in both the technology and bioinformatic of genomic methods, and such analyses will soon be routine.

An additional reason to document the microbial community of the exotic mammal species is that a significant number of the known pathogenic agents are zoonotic, i.e. they are transferrable to humans and/or domestic stock including pigs. In the event of a zoonotic disease outbreak either among local people or their livestock, knowledge of the status of the pathogenic agents among exotic and native mammal communities is essential to understanding disease reservoirs and pathways of infection, and thus to the rapid development of effective management and control strategies.

Protocol

For captured individuals of invasive species (sample size to be advised):

1. Sacrifice captured individuals using approved, humane method.
2. Immediately after death, take 1 ml of blood via cardiac puncture. Fix 0.5 ml of whole blood in RNA Later, 0.5 ml in 95% Ethanol.
3. Bathe whole animal in insecticide to kill ectoparasites.

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4. For visible macroscopic parasites, fix first set in RNA Later (to fix RNA viruses) and duplicate set in 95% Ethanol (for DNA of hosts, bacteria and DNA viruses).
5. Pass remaining fluid paper. Cut into equal portions and fix 50% in each of RNA Later and 95% Ethanol.
6. Dissect out submaxillary gland, heart, lung, spleen, kidney, stomach, rectum.
7. From each of submaxillary gland, heart, lung, spleen, and kidney: remove two samples of approximately 5 mm^2 from each organ and fix one sample of each in RNA Later and 95% Ethanol.
8. Open stomach, remove lining and contents by scraping. Divide into two portions and fix one sample in each of RNA Later and 95% Ethanol.
9. Open rectum, remove lining and contents by scraping. Divide into two portions and fix one sample in each of RNA Later and 95% Ethanol.

For captured individuals of native species:

- In event of a trap-mortality, sample using the same procedure outlined above.

For live captures (samples sizes to be advised):

1. During handling of animal in calico bag, gently perform oral swab and rectal swab, using separate cotton buds for each. Fix the swab in separate tubes of RNA Later.
2. After completion of data collection, open trap and remove faeces.
3. Fix 50% of faeces in a tube of RNA Later and 50% in tube of 95% Ethanol.

3.3.2 Flora and Vegetation

3.3.2.1 Vegetation Assessment Levels

The vegetation assessment involves three levels of surveys. The surveys are designed to meet the range of vegetation study components and will be applied as needed to a particular site. Level 1 is a plot based description, Level 2 is a visual check on the Level 1 survey, which is used as the botany team traverses the survey sites, and Level 3 involves targeted searches. Where there is apparent variation in the FIMS type associated with landforms (e.g. dry ridge lines and wet gullies/riparian areas) Level 1 and Level 2 surveys may be used to characterise these differences. However, the plant taxonomist and the botany assistant will focus their time on the Level 3 survey effort to maximise the chance of identifying restricted range/threatened and undescribed species. Moreover, because there is a paucity of information on restricted range species for the project area, the plant taxonomist will be targeting searches for threatened and undescribed species. For undescribed species the focus will be on at least thirteen plant groups to maximise new plant discoveries. These plant groups include the following:

- Actinidiaceae – *Saurauia.*
- Apocynaceae – *Hoya.*

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- Lecythidaceae – *Barringtonia.*
- Begoniaceae – *Begonia.*
- Ericaceae – Dimorphanthera and Vaccinium.
- Fabaceae – *Archidendron.*
- Gesneriaceae – *Cyrtandra.*
- Lecythidaceae – *Barringtonia.*
- Lycopodiaceae – *Phlegmariurus.*
- Myrtaceae – *Syzygium.*
- Nepenthaceae – *Nepenthes.*
- Orchidaceae.
- Zingiberaceae.

Level 1– For each FIMS vegetation type encountered, unbounded plots (generally 400 to 500 m^2) will be used to record the plant species for the main plant life forms (e.g., trees, shrubs, palms, pandans, ferns, herbs, pitcher plants, grasses and sedges). For each plot, up to six physiognomic strata are recognised (ground layer, shrub layer, understorey, sub-canopy, canopy and emergent layer). For each stratum all the main vascular plants will be recorded for the main life forms. This survey method is used to rapidly characterise the vegetation communities but is not used to obtain a complete plant inventory. GPS coordinates are recorded for Level 1 survey only.

Level 2– Level 2 survey involves a rapid visual check of the vegetation that primarily focuses on the canopy species to determine similarity to the Level 1 survey records. The area assessed by the visual check will be of similar size to the unbounded plots. This provides a rapid method to verify the FIMS mapping and determine more detailed plant community and landform/drainage/disturbance relationships not evident in the mapping. Level 2 survey reflects the visual checking that occurs as the botany team traverses the survey sites. No GPS records are made of the Level 2 sites.

Level 3– At each change in major vegetation type the botany team will conduct searches for species listed under the IUCN Red List of threatened species, PNG protected species and taxa (genera) most likely to support species new to science/botanical novelties. The lead botanist has previous experience in the upper Purari to assist with targeting plant groups most likely to result in undescribed species. Searches for the IUCN-listed species will include species listed under the categories Critically Endangered (CR), Endangered (EN), Vulnerable (VU), Near Threatened (NT), Least Concern (LC) Data Deficient (DD) and Restricted Range (RR).

Moreover, potentially rare or sensitive vegetation communities will be recorded at all levels of survey if present.

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GPS tracks will be recorded throughout the survey but GPS points will be recorded at Level 1 survey locations only, and at locations to assist with the mapping of rare or sensitive vegetation communities from the imagery.

3.3.2.2 Unidentified Species

For species that cannot be identified in the field or from specimens, pragmatically there are no options to transplant and grow plant material until fertile material is present to facilitate identification, other than for orchids. It is possible to transplant orchids collected from lowland environments to a shade house at the University of Papua New Guinea in Port Moresby, where they can potentially be monitored until flowering occurs. No other facility is readily available for other plant groups.

3.3.2.3 Vegetation Condition/Quality

Vegetation condition and quality will be verified at all field sites and in relation to selected vegetation mapping sites where ground truthing or aerial verification is required. Aerial verification will occur after the vegetation and land use mapping is complete on a later phase of the field survey.

Vegetation condition refers to levels of anthropogenic disturbance, e.g. from logging, food gardens and settlements and infrastructure. This is initially assessed from the imagery with field verification of the disturbance type obtained as part of the vegetation Level 1 and Level 2 surveys and additional targeted verification. Condition is classified based on the FIMS disturbance classes: nil disturbance, slight disturbance 8-9, moderate disturbance (6-7), heavy disturbance (4-5), and very heavy disturbance (< 5). Each digit indicates the percentage of forest cover, e.g. 8-9 = 80 to 90% forest cover.

Where practicable, each site assessed will be assigned a forest quality[12] of high, medium or low. This is a qualitative assessment based on a visual assessment of key forest attributes, which comprise stand structural, plant species composition and functional components (Table 3.3). This provides an approximate assessment of the quality of forest (high, medium and low) in relation to the typical characteristics of primary rainforest. For example a site that has been logged typically has few large trees remaining, has a low canopy cover compared to undisturbed forest and may have weed infestations. Such a site would be classified as low quality. In contrast undisturbed forest is mostly classified as high quality since it typically supports most of the primary forest attributes.

[12] Forest quality reflects how well the typical structural and compositional components of the particular forest type are represented in relation to its FIMS description and relative comparisons across the study area.

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Table 3.3 – Vegetation Functions and Attributes

Function of the vegetation	Attributes that can act as indicators of functions typically found in primary rainforest
Structural Aspects	
Provision of reliable foraging resources for wildlife (e.g. nectar, fruit, leaves, seeds)	♦ Large trees ♦ Shrub cover ♦ Tree canopy cover and canopy health ♦ Epiphytes ♦ Fallen woody material ♦ Organic leaf litter ♦ Ground cover
Provision of reliable sheltering resources and or breeding sites for wildlife	♦ Large trees and/or hollow-bearing trees ♦ Fallen woody material ♦ Tree canopy cover and canopy health ♦ Shrub cover ♦ Organic litter
Functional Aspects	
Nutrient and water cycling	♦ Tree canopy cover and canopy health ♦ Organic litter cover ♦ Fallen woody material ♦ Bryophyte biomass
Maintenance of soil condition	♦ Organic litter cover ♦ Native perennial forbs and non-grass cover ♦ Native annual grass, forbs and non-grass cover ♦ Fallen woody material (acts as a nutrient trap and reduces overland flow)
Retention of plant propagules	♦ Organic litter ♦ Fallen woody material
Compositional Aspects	
Maintenance of plant species diversity	♦ Native plant species richness ♦ Recruitment of woody perennial species ♦ Exotic weed species cover (lack of)

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4. Impact Assessment and Reporting

The data and information obtained during the biodiversity baseline study will be used to prepare the biodiversity baseline study report that will input to the assessment of potential project impacts on biodiversity values in the Project area in order to satisfy International Finance Corporation (IFC) (2012) environment and social performance standards and to meet Papua New Guinea (PNG) requirements under the *Environment Act 2000*. The biodiversity baseline study will include a suite of supporting appendices describing in detail the findings of the field surveys for the seven major groups including vascular plants, mammals, birds, herpetofauna, and insectivores.

The environmental and social impact assessment is to be consistent with National requirements (CEPA) and TEP PNG's requirements described in the following general specifications:

- TEP PNG's GS EP ENV 120 —Environmental Impact Assessment for E&P Activities; and
- TEP PNG's GS EP SDV 102 – Social Impact Assessment for E&P Activities.

These specifications describe impact assessment approaches for the EIS and the ESHIA reports that will satisfy the biophysical, societal and health requirements of IFCPS1 (Assessment and Management of Environmental and Social Risks and Impacts). Inherent in the impact assessment process will also be the inclusion of requirements from the various technical performance standards from IFC PS2 through to IFC PS8.

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5. Conclusions

This report provides a comprehensive description and rationale of the scope and methods that will be used to undertake baseline rapid assessment surveys to characterise the biodiversity of the Papua LNG Project area. The scope and methods are considered robust and suitable to meet review and scrutiny of expert reviewers engaged by CEPA and project international lenders concerned with conformance against IFCPS6.

In summary, the objectives of the study as described in Section 2 are fulfilled by the scope and methods that will be implemented as follows:

- Collate & assess existing information and building on existing information:

  Baseline information will draw on an all-encompassing combination of existing data (bibliographic/desktop analysis), field survey, stakeholder consultation and expert opinion.

- Characterise biodiversity values:

  A specific aim of the terrestrial biodiversity study is to collect baseline data on priority biodiversity attributes for impact assessment and critical habitat assessment and monitoring programs (where possible). This baseline data will provide for characterisation of biodiversity values at the level of ecosystem/community, species level, genetic level where applicable.

- Map the distribution and condition of major vegetation types:

  Vegetation mapping will be based on a combination of review of existing data (FIMS), vegetation mapping and ground aerial surveys. Vegetation condition and quality will be verified at all field sites and the vegetation assessment involves a comprehensive technique with three levels of survey.

- Determine the presence and status of species of conservation significance:

  Vegetation surveys will concentrate on conducting surveys for species listed under the IUCN Red List of threatened species. Fauna under the IUCN Red List have been identified and will be targeted with an array of methods and techniques to comprehensively identify species.

- Assess presence and status of non-native species:

  Non-native species found in study areas will be recorded in order to assess their threat to native and endemic fauna.

- Collect data on priority biodiversity values: (See characterise biodiversity values above).

- Collect info on the importance of ecosystems/habitats to locally resident PNG's:

  Local residents will be interviewed to provide important information around biodiversity sensitivities. Based on this information, a ground survey program will be designed to focus on likely important areas including on related ecosystem services.

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Appendix 1

Terrestrial Biodiversity Specialist Credentials

Appendix 1 – Terrestrial Biodiversity Specialist Credentials

Lead Biodiversity Specialist: Dr Iain Woxvold

Dr Woxvold is a researcher and private consultant specialising in the diversity and conservation significance of bird communities in South East Asia and the Pacific. His expertise spans a broad range of topics pertaining to animal behaviour, community ecology, population biology and conservation, and he has published numerous peer-reviewed papers in Australian and international scientific journals. As a private consultant, Dr Woxvold provides specialist advice on the conservation significance and management of vertebrate communities to industry, government agencies, non-government organizations (NGOs) and private landholders. In this capacity he has completed a number of terrestrial biodiversity environmental impact assessments and compiled numerous reports on the structure of tropical vertebrate communities, their sensitivity to disturbances arising from planned developments and proposals for maintaining current levels of biodiversity within management areas.

Dr Woxvold has worked extensively in Papua New Guinea, Indonesia, Lao PDR and Australia on projects for the oil and gas industry, mineral mining companies and conservation non-government organisations. He is proficient with a wide range of survey techniques that combine to maximise the completeness of bird community inventories conducted in a short time frame, including activities designed to target high conservation value species. As well as providing specialist ornithological advice, Dr Woxvold has been involved in surveys of other vertebrate taxa in numerous parts of Australia, South East Asia and Papua New Guinea, and is familiar with most field survey techniques, including those developed for mammals and herpetofauna.

The specialist team supporting Dr Woxvold is comprised of highly skilled consultants, the majority of whom also have extensive experience in Papua New Guinea. The qualifications and relevant experience of the biodiversity team are outlined in Table 1 below.

Table 1 – Biodiversity Study Specialist Qualifications and Experience

Name/ Credentials	Area of Expertise/ Specialist Study	Years Experience in PNG (years)	Relevant Experience
Dr Iain Woxvold (PhD, BSc, BSc Hon, BA)	Biodiversity Lead; Avifauna	10	Over 10 years surveying birds and five years co-ordinating biodiversity and EIS surveys in Papua New Guinea and South East Asia
Dr Ken Aplin (PhD Zoology, BA)	Mammals (volant and non-volant)	33	Over 32 years of field experience in Papua New Guinea, Australia and South East Asia. An internationally recognised authority on the taxonomy, ecology and evolutionary history of Australasian mammals
Dr Kyle Armstrong (PhD Zoology, BSc)	Mammals (volant)	6	Over 18 years experience in research and as a consultant zoologist on mammals. Specialist on bats—diversity, taxonomy, acoustics and genetics across Australasia and South East Asia, including Papua New Guinea

Table 1 – Biodiversity Study Specialist Qualifications and Experience (cont'd)

Name/ Credentials	Area of Expertise/ Specialist Study	Years Experience in PNG (years)	Relevant Experience
Steve Richards (BA)	Herpetofauna and Odonates	24	Over 20 years of experience on more than 50 biodiversity surveys focusing on herpetofauna and odonates in New Guinea. 100+ peer reviewed scientific publications. Regional Chair (Melanesia) for the IUCN's Amphibian Specialist Group. Previous Papua New Guinea experience on ExxonMobil's projects
Fanie Venter (MSc, PhD)	Vegetation/ Flora	4	Over 30 years experience in botany/plant taxonomy, vegetation science and rehabilitation. Previous PNG experience on ExxonMobil projects, Purari Hydropower project and Massau & Manus Island biodiversity studies
Dr Howard Rogers[1] (PhD, BSc)	Ecosystem Services and Forestry	18	Over 18 years experience as an ecologist, forest scientist and technical forestry advisor with a focus on Papua New Guinea. Provision of plant and forestry surveys and reporting to Lihir Gold (1998 - 2006), the PNG Gas Project (2005) and PNG LNG Project (2008 – current)

Note 1. Assistance with identification will be provided by Dr. Andre Schuiteman from Kew, head of Orchid Research and a specialist on PNG orchids and Dr. Ed de Vogel from Hortus Botanicus in Leiden. Dr. Axel Dalberg Poulsen from Oslo Botanic Gardens, a specialist on gingers of the world will help with and verify identifications of all Alpinia and Riedelia species (Zingiberacea). Assistance with the identification of Gesneriaceae will be provided by the Gesneriaceae research group at Kew in London.

Appendix 2

PNG FIMS Dataset Applicability and Limitations

Appendix 2 – PNG FIMS Dataset Applicability and Limitations

The PNG Forest Inventory Mapping System (FIMS) provides broad-scale (1:250,000) mapping of vegetation types occurring across all provinces of PNG (Hammermaster and Saunders, 1995). Developed by Papua New Guinea's forest authorities for forest management and planning, it is based on interpretation of 1970s aerial photography with areas known to be subject to significant logging activity updated in 1996 using remote sensing imagery supported by rapid ground and air survey (Paijmans, 1976). In 2005 FIMS was endorsed by the National Forest Board of the PNG Forest Authority as the official National Forest Inventory. The FIMS data have provided a useful baseline for many environmental studies, including regular Global Forest Resources Assessments by the United Nations Food and Agriculture Organisation.

A number of factors restrict the applicability of FIMS to detailed biodiversity studies. For example, as it is primarily a tool for forest resource management, FIMS is focused on land-use capabilities rather than fine-scale floristic and structural variations, and it is therefore of limited use in predicting biotic (flora and fauna) community structure and composition at the local scale. In addition, most of the country has not been ground truthed to verify the assignation of vegetation classes, and ground surveys regularly reveal inaccuracies in broad-scale typing. Finally, with the last update more than 15 years old, recent forest clearance, degradation and regrowth mean that the quantification of habitat disturbance within vegetation types is often out dated.

Accepting these limitations, the FIMS dataset provides the most detailed Project area-wide vegetation assessment available prior to vegetation mapping that is to be undertaken for the ESHIA. Moreover, while ground-truthing regularly shows that individual FIMS mapping units often include multiple recognisable vegetation types at the local scale, real differences in community structure and composition are repeatedly evident at the landscape scale.

Part 23E
Terrestrial Biodiversity Phase 2
Scope and Methods

PAPUA LNG PROJECT

TERRESTRIAL BIODIVERSITY SCOPE AND METHODS PHASE 2

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1. Introduction and Document Purpose

The upstream terrestrial biodiversity field surveys for the Papua LNG Project's environmental and social impact assessment have been planned to occur over two survey phases within the two major climatic seasons occurring in New Guinea[1], to cover seasonal variance. These two main seasons are broadly affected by the major airstreams from which they are named, the northwesterlies, which occurs from December to March ('wet'), and the southeasterlies that occur from May to October ('dry'). Despite the recognition of these two main seasons, the climate and in particular rainfall of the Purari basin is dictated by the effect of topography and its alignment with respect to the two major air streams and the presence of the Southern Fold Mountains, which creates an overall rain shadow effect in the northern part of the catchment. The Wabo area is at the convergence of complex terrain features and air flow effects and receives an average of 8,000 mm per annum in reverse seasonality, with the highest monthly rainfall occurring between May and October (about 900 mm/month). Towards the coast, rainfall is lower and more evenly spread throughout the year (averaging around 300 mm/month) (Evesson, D.T., 1983).

The phases and dates of these surveys have been planned therefore, to overlap these major seasons as follows:

- Phase 1: January/February 2016 (northwest season, targeting dryer conditions in PRL-15 area and more humid conditions along the PER) – complete.
- Phase 2: June/July 2016 (southeast (tradewind) season. targeting wetter conditions in PRL-15 area and possibly dryer conditions along the PER especially towards the coast) – proposed.

Information collected during these surveys will contribute to the Terrestrial Biodiversity Environmental and Social Baseline Study (ESBS), and baseline data to support rehabilitation, deforestation and land use ESBS and ecosystem services.

The scope of work and methods for the overall terrestrial biodiversity field survey program for the upstream Project area, as well as detail relating to Phase 1 survey areas of interest and two proposed areas for the Phase 2 survey, have been described previously in a comprehensive scope and methods document (ERIAS Group, 2016, hereafter referred to as the Phase 1 scope and methods document). Specifically, the Phase 1 scope and methods document covers the following:

- Overview of the Project.
- Terrestrial biodiversity baseline study scope of works including the study objectives, study approach and tasks (bibliographic review and field survey).
- Survey methods including the biodiversity setting and existing knowledge, Phase 1 survey site selection and initial considerations for Phase 2 survey site selection, and detailed field methods for capture, identification and vouchering of fauna and flora/vegetation specimens.

[1] The terms wet and dry seasons do not apply in the study area. There is no low rainfall period for this part of New Guinea and while it is evident that higher seasonal variance is experienced at the coast versus the inland Purari areas near Herd Base and further north (e.g., Wabo), in this 'perhumid' environment, rainfall is consistently high in all seasons throughout the study area.

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- Impact assessment approach.
- Conclusions.

The purpose of this report is to build on the information presented in the Phase 1 scope and methods document by providing additional information relevant to the terrestrial biodiversity field program, including outcomes of a review of the terrestrial biodiversity program and details of the Phase 2 survey areas of interest. It is not intended to repeat the information previously provided, unless context is required.

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2. Terrestrial Biodiversity Upstream Project Area of Influence and Study Area

2.1 Terrestrial Biodiversity Upstream Project Area of Influence

The terrestrial biodiversity upstream Project Area of Influence (hereafter referred to as the upstream PAOI) includes the area within which the Project may potentially and measurably impact biodiversity through direct, indirect and/or cumulative impact processes (Figure 1), and is defined according to Project information provided by TEP PNG at the time of writing.

The upstream PAOI[2] is preliminary in that its boundary may change based on additions to or changes in relevant information provided by TEP PNG, including (but not limited to):

- The provision of additional information (including GIS datasets) on existing and proposed Project components and activities.
- Changes in Project design.
- The location and operational activities of 'associated facilities'[3].
- Affected landowner boundaries[4].
- The location of employment recruitment centres.

The upstream PAOI is delineated by a 5 km buffer around existing or proposed facilities sites and infrastructure routes. This includes Project roads, existing and future wellpads, pipelines upstream of the proposed Central Processing Facility (CPF) (e.g., injection, trunkline and flowlines), the 'CPF Area' (including the CPF, airstrip, logistics base, wharf and accommodation camp), and the export pipeline corridor. West of the export pipeline corridor, the upstream PAOI also includes potential barge transport routes along each of the Purari River's three main delta distributaries—the Purari, Ivo and Varoi rivers—and a 250 m buffer into surrounding vegetation (see Figure 1).

2.2 Regional Study Area

In accordance with recent good practice guidelines (Gullison et al., 2015) a study area is defined as an area that encompasses and expands on the upstream PAOI. Accordingly, the Terrestrial Biodiversity Study Area (hereafter referred to as the study area) incorporates the upstream PAOI and contains continuous extensions of those ecosystems and habitats present within it. It is also considered likely to support viable populations of most or all resident species whose distributions overlap with Project components.

The study area boundaries are based on the arrangement of physical landscape features that influence the composition and distribution of terrestrial biotic communities such as landform,

[2] This differs slightly to the wider Project Area of Influence submitted to TEP PNG in Technical Note TN004 on 21/03/2016. The upstream PAOI presented in this document is related directly to the terrestrial biodiversity study, which contributed to the definition of the wider Project Area of Influence outlined in TN004.
[3] Sensu International Finance Corporation (2012)—i.e. that were not constructed as part of the Project, but "that would not have been constructed or expanded if the project did not exist and without which the project would not be viable" (PS1, Paragraph 8).
[4] To be delineated under Social Mapping and Landowner Identification (SMLI) studies.

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substrate, elevation and watersheds. With this in mind, and based on a combination of objective ecological principles and subjective expert opinion, the study area is bounded:

- In the north by the 500 m elevation contour.
- In the west by (from north to south) the volcanic landforms of Mount Favenc (PNGRIS data), the Era and Pie rivers and Port Romilly.
- In the east by (from north to south) the Aure Scarp and the Vailala River.
- In the south by the Gulf Province coast, extended offshore to include intertidal habitats (e.g. mudflats) as determined by recent aerial and satellite imagery.

The study area is approximately 7,290 km^2 and is shown in Figure 1.

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250,000 300,000 350,000

9,250,000 9,200,000 9,150,000

Southern Highlands Province
Chimbu Province
Eastern Highlands Province
Morobe Province
Gulf Province

Mount Favenc
Aure Scarp

Purari River
Era River
Pie River
Wame River
Kuroi River
Purari River
Iyo River
Hou Creek
Kuru Creek
Vailala River

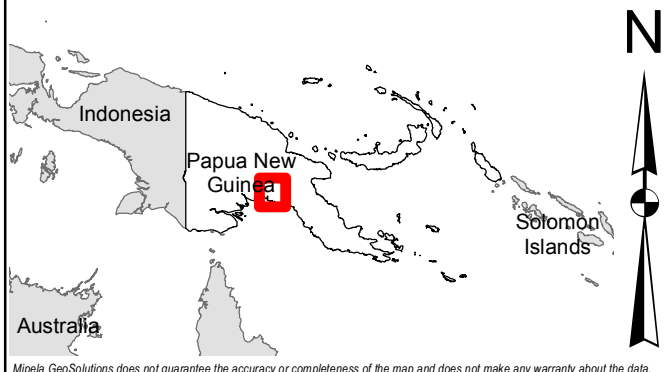
Upstream Area of Influence
Field Purari West Route
PRL-15
Field Purari Central Route

Port Roomily

Gulf of Papua

250,000 300,000 350,000

AREA OF DETAIL:



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LEGEND:

Pipeline Route

Trunklines

- Field Purari West Route
- Field Purari Central Route
- Province boundaries
- Waterways
- Waterbodies
- Study area - upstream
- Pipeline export route corridor
- PRL-15 License
- CPF, logistics base and airstrip area
- Terrestrial Biodiversity Upstream Project Area of Influence

PROJECT: Papua LNG Project

TITLE: Terrestrial Biodiversity Upstream Project Area of Influence and Study Area

SUBTITLE: Figure 1

DATE: 9/06/2016

DATA SOURCE:
Pipeline export route corridor, PRL-15, CPF, logistics base and airstrip area, waterbodies, waterways, supplied by Total and ERIAS (2016).
Study area, and areas of influence supplied by Iain Woxvold (2016).

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3. Field Survey Program

3.1 Program Review

To ensure the information requirements for the terrestrial biodiversity impact assessment are met, the field survey program has been, and continues to be, refined as per the review process described in Section 2.3.3 of the Phase 1 scope and methods document. Relevant outcomes of the review process that have directed the refinement of the upstream survey program are as follows:

- Updates to the Project description:
  - Two infrastructure routes (the western and central routes) may now be developed within PRL-15 to support a trunkline and a road. These two potential infrastructure routes traverse different biotic environments (separate catchments, landforms, vegetation types and ecological zones (as identified in the bibliographic review)).
  - The pipeline export corridor was narrowed and the updated information was subsequently provided to ERIAS Group in March 2016.
- Findings from the Phase 1 field surveys, specifically, a notable transitional difference in flora and fauna and habitats within the proposed CPF study site as the proposed facility footprint encroaches into swamp forest complex, indicating a need for greater examination of this habitat type considering the CPF footprint and western pipeline corridor occur predominantly within this habitat type.
- Additional information from local landowners during the Phase 1 surveys provided further detail on the importance of the oxbow wetland located immediately northwest of the CPF area, from a biodiversity, ecosystem services and cultural perspective.
- Landowner assistants in the biodiversity fly camps were not appropriately informed with local knowledge of flora and fauna (many were in-migrants) resulting in reduced information gathering during the Phase 1 surveys.
- Restricted access to some survey sites (e.g., the oxbow wetland, Subu village) during the Phase 1 survey due to lack of physical access or issues relating to transport.
- Advice from TEP PNG that access to the Purari Hydropower Project (PHP) data by the Project is uncertain. These are the only detailed and reliable pre-existing biodiversity datasets available for the study area. Consequently, the Phase 2 survey program has been reviewed and augmented to address any possible shortfall in terrestrial biodiversity and ecosystem services survey coverage that a lack of access to PHP data would have created.
- The occurrence of an ‘extreme’ El Niño climate event, the strongest in nearly 20 years, has occurred in the region with notable environmental effects in various parts of Papua New Guinea (NOAA/National Weather Service, 2015). This event has prompted comments by the Conservation and Environment Protection Authority (CEPA) to ensure that the potential effects of this climatic event on local biotic factors are accounted for in the survey program. The Phase 1 surveys were conducted during and towards the end of this El Niño event.

There were no lessons learned relating to survey methods from the Phase 1 surveys that have directed the Phase 2 program. This is due to the fact the biodiversity specialists in the team have

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conducted many similar forest-based surveys in Papua New Guinea (prior to the PLNG surveys), during which, they have all refined their approach over time. This refined approach has been implemented for the PLNG surveys.

3.2 Upstream Survey Program

A total of 12 survey areas of interest[5] (AOI) were initially considered as options for the location of the terrestrial biodiversity ESBS field survey sites and were representative of the Project design at the time (Figure 2). This total was then reduced to seven as Project design progressed to show that no components would be developed in those areas. Theseven AOIs selected were intended for survey over two survey phases; the selection for survey was based on a number of assumptions regarding, for example, Project layout, access to existing relevant data and the normality of climatic conditions. Six of these survey AOIs were presented in the Phase 1 scope and methods document, however, it noted that the candidate areas for AOIs 5 and 6 were to be surveyed during Phase 2 along with one or more additional AOIs.

As a result of the program review (see Section 3.1), an additional AOI has been selected for survey within PRL-15, bringing the total number to eight. These eight AOIs are shown in Figure 3.

In addition to the AOIs, wetland and riparian sites of interest have been identified for shorter duration day visits (i.e., not overnight) to assess particular sensitivities potentially present and/or to examine the location of proposed facilities.

The location of the eight AOIs and shorter-duration sites, and their order of survey (i.e., Phase 1 versus Phase 2) have been considered to:

- Maximise seasonal coverage of comparable habitats. The additional AOI in PRL-15 was selected specifically to enhance seasonal coverage of hill forest environments in light of the Phase 1 surveys being conducted during the 2015-16 El Niño. Rather than resampling the Phase 1 sites, seasonal sampling is undertaken in similar forest environments within the same ecological zones and general region. This increases efficiency in terms of combined site and ecosystem coverage, which is a priority requirement.
- Examine the various habitat types present in areas earmarked for development.
- Access habitats inhabited by species-level sensitivities predicted to occur in areas potentially subject to Project-related impacts.

While no field survey sites are located in the proposed transport route areas, any potential sensitivities present in these areas will be assessed by vegetation mapping and desktop study and potential impacts will be assessed during the impact assessment phase.

Vegetation types mapped for the study area under the PNG Forest Inventory Mapping System (FIMS) (Hammermaster and Saunders 1995) and their coverage under all eight AOIs and short duration survey areas (specifically, the oxbow wetlands) are listed in Table 3.1 and are shown in Figures 4 and 5. All but one FIMS type and all four major vegetation groupings (hill, alluvial and swamp forest and mangroves) are covered by the AOIs. Information on the applicability and

[5] Area of Interest is a term used for survey areas of interest, within which, the survey camps will be located. This term will be phased out and will not be used in the baseline report; new site numbers will be used, likely in chronological order of survey).

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limitations of the FIMS dataset is outlined in Appendix 2 of the Phase 1 scope and methods document.

Table 3.1 – FIMS Vegetation Types Present in PRL-15 and the Pipeline Corridor

Vegetation Type	FIMS Code	PRL-15	Pipeline Corridor	Phase 1 AOI	Phase 2 AOI *
Hill Forest					
Medium crowned hill forest	Hm	X	X	1, 3, 4	5, 7, R
Small crowned hill forest	Hs		X		5, 6
Complex: medium crowned hill forest/scrub	Hm/Sc	X		2	8, R
Alluvial Forest					
Large crowned alluvial forest	Pl	X	X		6
Open alluvial forest	Po	X	X		5, 6
Complex: open alluvial forest/mixed swamp forest	Po/Fsw	X		4	7
Swamp Vegetation					
Mixed swamp forest	Fsw	X	X		Ox
Herbaceous swamp	Hsw	X			7, Ox
Swamp woodland	Wsw	X	X		6, Ox
Complex: mixed swamp forest/swamp woodland	Fsw/Wsw		X		5, 6
Complex: mixed swamp forest/swamp grassland	Fsw/Gsw; Gsw/Fsw		X		5
Complex: swamp woodland/swamp grassland	Wsw/Gsw; Gsw/Wsw	X	X		
Marine and Coastal					
Mangroves	M		X		6
Non-Forest Areas					
Converted land; anthropogenic land use	O		X		6

* Oxbow wetlands (Ox); Ridgeline (R)

Swamp woodland/swamp grassland complexes will not be directly sampled due to access constraints. This is not considered to represent a gap in sampling since both of their component vegetation types (Wsw and Gsw) will be sampled in other locations, either as independent mapping units (e.g., Wsw) or in other 'complex' arrangements (e.g., Gsw/Fsw). Accordingly, the unsampled FIMS vegetation mapping units are not expected to support any species-level sensitivities that are not represented in other freshwater swamp vegetation environments that will be surveyed at other Phase 2 survey sites. Moreover, impacts on these unsampled units are expected to be low due to: (1) the very limited areal extent of these mapping units in both the proposed pipeline corridor and in PRL15, and; (2) the location within PRL15 of the unsampled mapping unit being more than 10 km from any currently proposed Project facility developments and more than 6 km from the proposed 'CPF, logistics base and airstrip area' boundary.

Further information relating to reasons for surveying a variety of Project footprints and vegetation types has been outlined in the Phase 1 scope and methods document.

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Surveys of AOIs 1 to 4 were completed during the Phase 1 fieldwork (January to February 2016) and are, therefore, not covered in further detail here. Information on these Phase 1 sites can be found in the Phase 1 scope and methods document.

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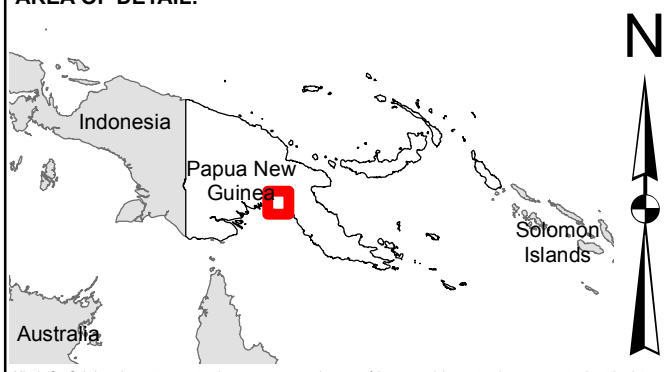
280,000 320,000 360,000

9,220,000 9,180,000 9,140,000

Purari River
Purari River
Hou Creek
Era River
PRL-15
Pie River
Kuku Creek
Purari River
Vailala River
Vailala River
Pie River
Varoi River
Wome River
Ivo River
Vailala River
Vailala River
Vailala River

280,000 320,000 360,000

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LEGEND:

- Waterways
- Waterbodies
- Pipeline export route corridor (February 2016)
- Pipeline export route corridor (December 2014)
- PRL-15 License
- Terrestrial Biodiversity Survey Areas of Interest

PROJECT: Papua LNG Project

TITLE: Terrestrial Biodiversity Upstream AOI Options

SUBTITLE: Figure 2

DATE: 10/06/2016

DATA SOURCE:
Pipeline export route corridors suppled by Total (2014 and 2016)
PRL-15, waterbodies, waterways, supplied by Total and ERIAS (2016).
Study area, and areas of interest supplied by Iain Woxvold (2016).

DOCUMENT NUMBER: R_047-73292

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C	ISSUED FOR REVIEW	REC	IN	JRB		13/04/16
B	ISSUED FOR REVIEW	REC	IN	SRF		12/04/16
A	ISSUED FOR REVIEW	REC	IN	SRF		31/03/16

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280,000 320,000

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Purari River
Era River
Hou Creek
Vailala River
Middle Purari Hills
PRL-15
Field Purari Central Route
Field Purari West Route
Kuku Creek
Ridgeline
Pie River
Oxbow Wetlands
Oxbow Lake
Delta Swamps and Plains
Wharf, Purari River and Tributaries
Varoi River
Wame River
Iyo River
Mangroves
Southeast Hills
Kilavi
Avavu
Hururu
South East Coast
1
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LEGEND:

- Phase 1 Fly
- Phase 2 Fly Camp

Towns and Villages - Upstream

- PER
- Ihu Rural
- Field Purari West
- Field Purari Central
- Tracks
- Waterways
- Waterbodies
- CPF, logistics base and airstrip
- Pipeline export route
- PRL-15 License

Terrestrial Biodiversity Survey Areas of Interest

- Phase 1
- Phase 2

Ecological

- Delta swamps and plains
- Mangroves
- Middle purari hills
- South east coast
- Southeast hills

PROJECT: Papua LNG Project

TITLE: Terrestrial Biodiversity AOIs 1 to 8

SUBTITLE: Figure 3

DATE: 20/06/2016

DATA SOURCE:
Pipeline export route corridor, PRL-15, waterbodies, waterways, supplied by Total and ERIAS (2016).
Study area, and areas of interest supplied by Iain Woxvold (2016).

DOCUMENT NUMBER: R_047-73448

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E	ISSUED FOR REVIEW	REC	KS	JRB		20/06/16
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C	ISSUED FOR REVIEW	REC	IN	JRB		13/04/16
B	ISSUED FOR REVIEW	REC	IN	SRF		12/04/16
A	ISSUED FOR REVIEW	REC	IN	SRF		31/03/16

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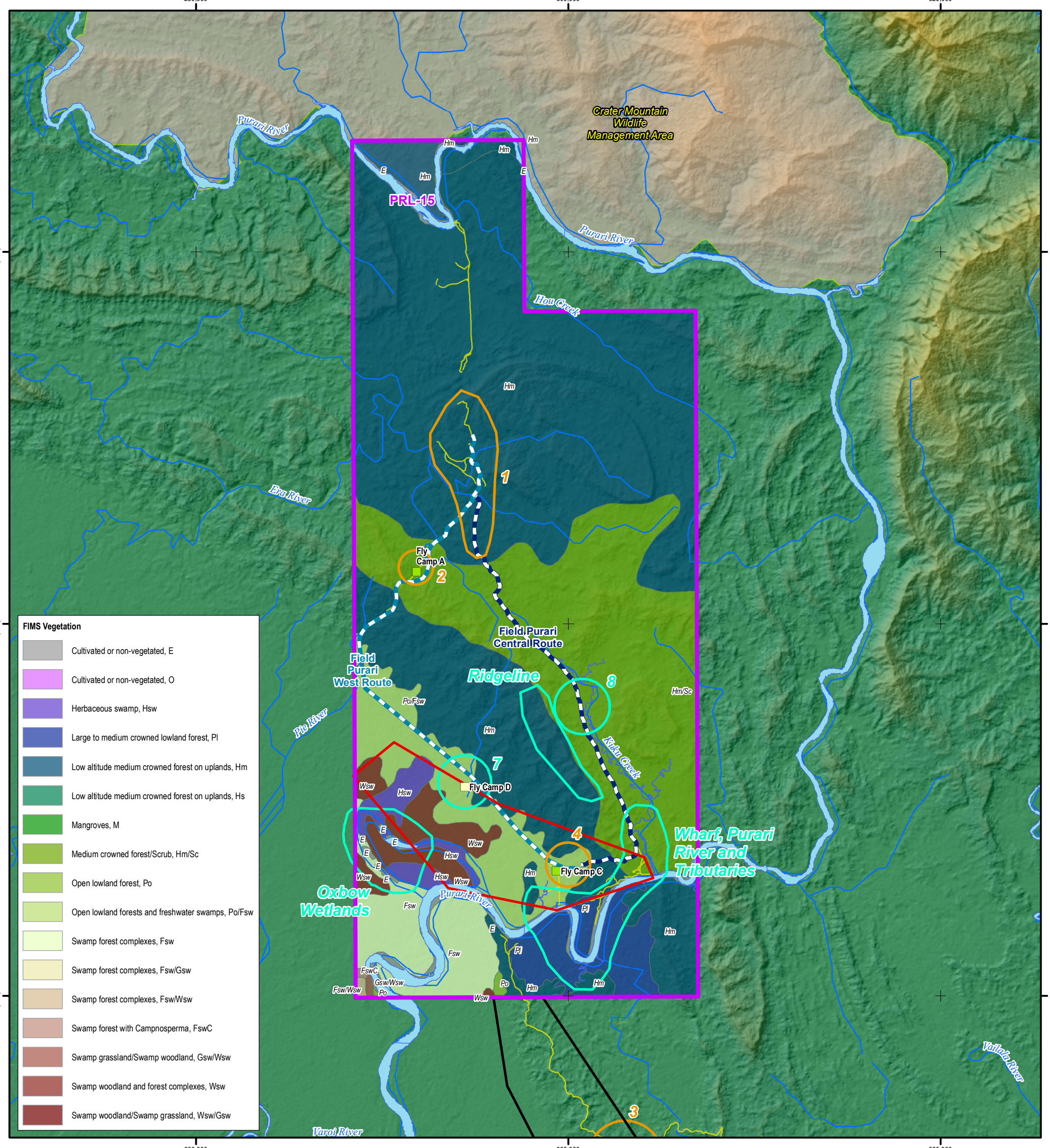
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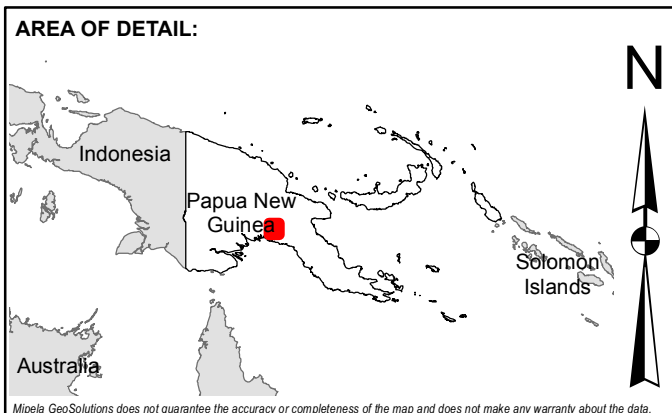
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LEGEND:

- Fly Camp, Phase 1
- Fly Camp, Phase 2
- Field Purari West Route
- Field Purari Central Route
- Tracks
- Waterways
- Waterbodies
- Crater Mountain Wildlife Management Area
- Pipeline export route corridor
- PRL-15 License
- CPF, logistics base and airstrip area

Terrestrial Biodiversity Survey Areas of Interest

- Phase 1
- Phase 2

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PROJECT: Papua LNG Project

TITLE: FIMS Vegetation Types of the Northern AOIs

SUBTITLE: Figure 4

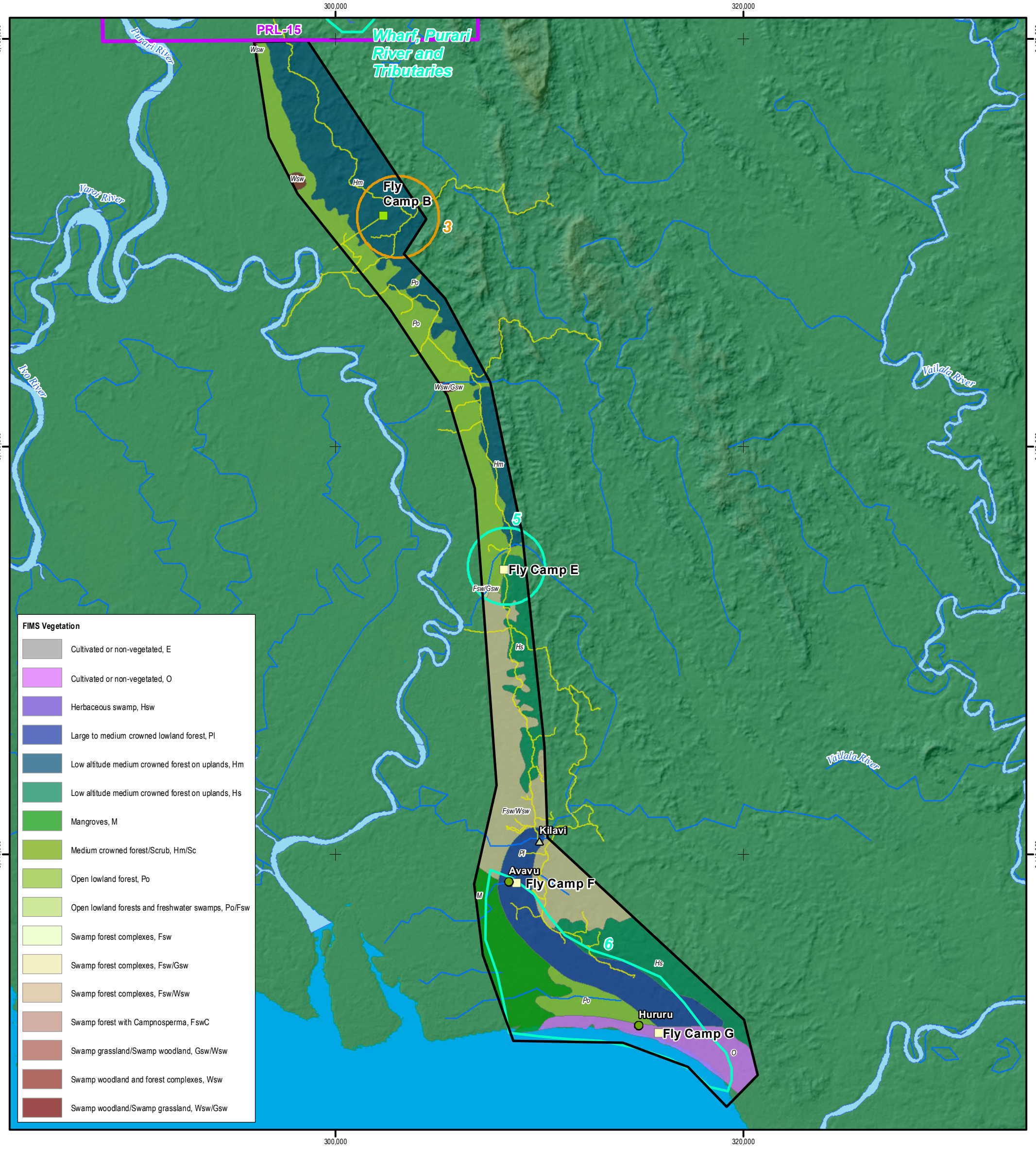
DATE: 10/06/2016

DATA SOURCE:
Pipeline export route corridor, CPF, logistics base and airstrip area, PRL-15, waterbodies, waterways, supplied by Total and ERIAS (2016).
Study area, and areas of interest supplied by Iain Woxvold (2016).

DOCUMENT NUMBER: R_047-73294

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C	ISSUED FOR REVIEW	REC	IN	JRB		13/04/16
B	ISSUED FOR REVIEW	REC	IN	KCS		13/04/16
A	ISSUED FOR REVIEW	REC	IN	SRF		31/03/16

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LEGEND:

- Phase 1 Fly Camp
- Phase 2 Fly Camp (Proposed)
- Pipeline export route corridor
- PRL-15 License

Towns and Villages - Upstream

- PER
- Ihu Rural
- Tracks
- Waterways
- Waterbodies

Terrestrial Biodiversity Survey Areas of Interest

- Phase 1
- Phase 2

PROJECT:	Papua LNG Project
TITLE:	FIMS Vegetation Types of the Southern AOIs
SUBTITLE:	Figure 5
DATE:	10/06/2016

DATA SOURCE:
Pipeline export route corridor, PRL-15, waterbodies, waterways, supplied by Total and ERIAS (2016).
Study area, and areas of interest supplied by Iain Woxvold (2016).

DOCUMENT NUMBER: R_047-73295

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B	ISSUED FOR REVIEW	REC	IN	KCS		13/04/16
A	ISSUED FOR REVIEW	REC	IN	SRF		31/03/16

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SCALE: 1:180,000 @ A3 PNG94 PNGMG94 Zone 55

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3.3 Phase 2 Survey Areas of Interest

Surveys of AOIs 5 to 8 are proposed for the Phase 2 field work planned for June to July 2016. Two of these AOIs (AOI 5 and 7) have been identified as sites requiring survey from forest-based fly camps, while AOI 8 will be surveyed whilst the team is accommodated at the camp at AOI 7. The fourth (AOI 6) will utilise existing social infrastructure with additional logistics support as required.

The landscape-level strategy for locating these AOIs for Phase 2 aimed to:

- Focus on Project footprint areas.
- Provide maximum coverage of major landforms (sensu PNG Resource Information System: Bryan and Shearman, 2008), ecological zones (as identified in the bibliographic review) and major vegetation groups (from PNG Forest Inventory Mapping System (FIMS): (Hammermaster and Saunders, 1995), especially in the absence of the PHP data.
- Maximise seasonal sampling of similar vegetation types surveyed during Phase 1 in early 2016.

Examination of the location of AOI 5 and 6 occurred during an aerial reconnaissance undertaken over the upstream Project area in November 2015 (ERIAS Group, 2015). Since that time, the pipeline corridor has been narrowed (March, 2016), thereby reducing the size of the AOI in the southern area (AOI 6). A reconnaissance to confirm the proposed fly camp locations for AOIs 7 and 8 (both within PRL-15) was undertaken on 26 May 2016.

3.3.1 Inland AOIs (AOI 5, 7 and 8)

The three inland AOIs (AOIs 5, 7 and 8) are located in a remote and biodiversity-rich forested environment with a low resident human population and a paucity of existing environmental data. Further information on the various factors used in selection of these AOIs (e.g., review of the Project description, existing knowledge, landforms and broad vegetation mapping (i.e., FIMS), aerial/satellite imagery and digital elevation models) is outlined in the Phase 1 scope and methods document.

3.3.1.1 AOI 5—Southern Export Pipeline Between Lali and Kilavi

AOI 5 is located on the southern pipeline route approximately 16 km north of the coast between La'li and Kilavi villages. A fly camp will be located to provide access to:

- Two major landforms (Bryan and Shearman 2008), recognised in the bibliographic review by the delineation of two separate ecological zones—the Southeast Hills and the Delta Swamps and Plains.
- At least two FIMS vegetation types—small crowned hill forest (Hs) and mixed swamp forest/swamp woodland (Fsw/Wsw) (see Figure 5). Neither of these vegetation types was surveyed during Phase 1. Other potentially accessible FIMS types include mixed swamp forest/swamp grassland (Fsw/Gsw).
- Minor watercourses draining low hills west towards the Purari River.

The timing of this AOI provides for seasonal perspective (4 months) from the nearest site (AOI 3) surveyed in the northern sector of the pipeline corridor during Phase 1.

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3.3.1.2 AOI 7—Trunkline Western Route

AOI 7 is located along the western trunkline route between AOIs 2 and 4 (surveyed during Phase 1) (see Figures 3 and 4). A fly camp at AOI 7 will be located to provide access to:

- Two major landforms (Bryan and Shearman, 2008), recognized in the bibliographic review by the delineation of two separate ecological zones—the Middle Purari Hills and the Delta Swamps and Plains.
- Three FIMS vegetation types—medium crowned hill forest (Hm), open alluvial forest/mixed swamp forest (Po/Fsw) and herbaceous swamp (Hsw) (see Figure 4). Hsw was not surveyed during Phase 1 and is not accessible from other AOIs.

Alluvial forest is a locally- and regionally-restricted forest type that is under pressure from industrial logging. Preliminary results from the Phase 1 surveys at AOI 4 (see Figure 4) indicate that local alluvial forests support flora and fauna communities that are distinct from those resident in the much more extensive (locally and regionally) areas of hill forest. These communities include a number of species newly discovered in alluvial forest during the Phase 1 survey and not yet encountered in other sites or habitats. Seasonal sampling requirements under IFC PS6, potentially enhanced by the 2015 El Niño (expressly referred to by CEPA), dictate that this forest type should be resampled during Phase 2.

The timing of this AOI further provides for seasonal perspective (4 months) from the alluvial and hill forest sites surveyed in PRL-15 during Phase 1.

3.3.1.3 AOI 8—Trunkline Central Route, Project Road Route and Kuku Creek

This AOI is located along the central trunkline route option, and along the existing road between Herd Base and the Elk-Antelope gas field proposed for upgrading and use by the Project, and alongside Kuku Creek (see Figures 3 and 4). This site provides access to:

- Medium crowned hill forest (Hm) and naturally occurring scrub (in a complex with hill forest: Hm/Sc).
- Kuku Creek, its tributaries and associated riparian habitats.

The timing of this AOI provides for seasonal perspective (4 months) from the hill forest sites surveyed in PRL-15 during Phase 1.

With a second infrastructure route under consideration, this site is considered necessary to survey habitats within the Kuku Creek catchment—the main hill zone Purari sub-catchment subject to development within PRL-15. All other facilities and infrastructure routes to be developed within PRL-15 (under current Project design) are located within the Era River or Pie River catchments, or are on alluvial landforms within a separate and smaller Purari sub-catchment (west and downstream of the Kuku Creek catchment).

Seasonal sampling requirements under IFC PS6, potentially enhanced by the 2015 El Niño (expressly referred to by CEPA), dictate that this forest type should be resampled during Phase 2.

Lack of survey in the Kuku Creek area could be considered a gap by reviewers.

3.3.2 Southern AOI (AOI 6)

South of Kilavi village multiple potential pipeline routes to the coast are currently under consideration. The resultant export pipeline corridor widens from 3 km to span approximately 10

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km of coastline at the eastern end of the Gulf of Papua and includes a variety of coastal, sub-coastal and inland environments, including mangroves in its western half (see Figures 3 and 5), alluvial forest, hill forest, swamp forest and remnant littoral forest vegetation types.

The AOI here is expanded to cover most of this southern sector of the pipeline corridor and the range of habitats present.

AOI 6 may comprise a complex of Natural, Modified and Critical Habitats *sensu* IFC. The mangrove vegetation in the west of this AOI is likely to qualify as Critical Habitat (TBC, 2015) and survey of this mangrove forest is necessitated by the path of one potential pipeline route option through this habitat.

Being more heavily populated than areas north of Kilavi village, parts of AOI 6 may also qualify as Modified Habitat. AOI 6 includes the only area mapped under FIMS as converted for anthropogenic land use (Non-forest FIMS class 'O'; see Figure 5). Among the FIMS mapping units present in the upstream Project area, this is the unit most defensibly classifiable as Modified Habitat *sensu* IFC, though confirmation may ultimately require ground-truthing to determine the proportion of natural vegetation components still present and the prevalence of non-native species[6]. Other areas may ultimately be mapped as Natural Habitat, in the absence (for example) of ESHIA studies locating the confirmed or likely presence (i.e., confirmed or likely) of key species-level biodiversity values pertinent to PS6 Critical Habitat criteria 1–3. Some sectors of Natural Habitat in AOI 6 are also likely to show some level of disturbance. For example, the large crowned alluvial forest (Pl) vegetation unit through which the road south of Kilavi village was constructed is mapped under FIMS as having a disturbance class of '8' (=Pl8), equating to a 20% disturbance to canopy cover at the time of mapping (Hammermaster and Saunders, 1995).

The purpose of the November 2015 reconnaissance was to collect information on environmental conditions relevant to optimising pipeline route selection. An aerial survey was conducted, although limited in the level of detail possible to be acquired from this survey type, to check the status of roads (mapped or otherwise), the condition of vegetation along the existing road route and in areas mapped under FIMS as converted land (O), the general distribution and condition of other areas mapped under FIMS as supporting natural vegetation types, and coastal zones for the presence of areas that may provide important habitat for migratory wading birds (Scolopacidae, Charadriidae) or beach nesting turtles. The general condition of the mangroves was also examined.

In the ERIAS Group biodiversity team's experience, the distribution of the various habitats/ecosystems present in AOI 6 and the presence of numerous settlements and high intensity land use areas, all have implications for the distribution of key biodiversity values potentially present in this area. Importantly, the key biodiversity values that would require assessment by field survey differ in different sectors of this AOI. A number of important species-level values are potentially present, many of which are not expected to occur further north in the upstream Project area, including aquatic (marine and estuarine) species. They include (*inter alia*), but are not limited to:

- The Critically Endangered (and recently rediscovered: Hughes et al., 2014) New Guinea big-eared bat (*Pharotis imogene*) (K. Armstrong & K. Aplin, pers. com.).

[6] By contrast, regenerating logged forest, such as that present along much of the proposed export pipeline route, is best considered Natural Habitat *sensu* IFC (IFC staff, pers. com. to Woxvold, without reference to current Project).

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- The Critically Endangered mangrove tree *Bruguiera hainesii*.
- The Endangered giant bandicoot (*Peroryctes broadbenti*).
- Turtle nesting sites. Two species listed as Endangered by the International Union for the Conservation of Nature (IUCN) potentially nest here—the green (*Chelonia mydas*) and hawksbill (*Eretmochelys imbricate*)—as might the IUCN Vulnerable pig-nosed turtle (*Carettochelys insculpta*) (Eisemberg et al., 2015; S. Richards, pers. com.).
- Migratory wader (Scolopacidae, Charadriidae) feeding and roosting habitat. Aerial survey during the November 2015 reconnaissance showed that some migratory waders use the tidal flats along the coast within AOI 6. Nine potentially occurring migratory wader species are listed as Threatened or Near Threatened by the IUCN.
- Some IUCN listed marine mammals (dugong *Dugong dugon* (Vulnerable), Australian snub-fin dolphin *Orcaella heinsohni* (Near Threatened)).

A complete list of the potential sensitivities is beyond the scope of this report. However, with different pipeline routing options under consideration in this coastal region, a wide variety of habitats will be targeted during this survey including, but not limited to, hill forest, alluvial forest and mangrove vegetation types, coastal beaches and intertidal flats, relict dune systems and inter-dune swales and drainage systems. To access this variety of component ecosystems and habitats, biodiversity team members will need to be based at two fly camps within the AOI and will access areas on foot, via boat and potentially via helicopter.

3.3.3 Shorter Duration Surveys

3.3.3.1 Oxbow Wetland

The oxbow wetland proposed for survey during Phase 2 is located within PRL-15 to the southwest of the proposed CPF area (see Figures 3 and 4). The oxbow wetland is considered to be an area of potential high environmental sensitivity as it is a regionally rare example (only one other similar lake system identified in the Purari delta) of an isolated open water lake ecosystem with no major disturbance. It potentially provides important habitat for migratory and resident breeding waterbirds, and the presence of pig-nose turtle (*Carettochelys insculpta*) and striped New Guinea soft-shelled turtle (*Pelochelys bibroni*) (listed by the IUCN as Vulnerable), and crocodile breeding sites, has been reported.

During the Phase 1 surveys, the terrestrial biodiversity team were informed by a Poroi villager and former Interoil Village Liaison Officer that the lake is also an area of cultural sensitivity (spiritual) (Pers. Comm. Simon Poari, 2016).

The oxbow wetland is situated within the catchment of the western trunkline route option and the proposed airstrip, and within the western part of the proposed CPF area. It is therefore susceptible to indirect impacts from these developments, including:

- Changes to hydrology (water regimes) affecting wetland biota.
- Temporary and potentially long-term impacts to water quality during operations.
- Potential impacts from operational spills (e.g., from condensate storage, jet fuel).
- Invasive flora and fauna, especially aquatic weeds.

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This area is likely to be identified as a 'priority ecosystem' in the terrestrial biodiversity ESBS report, and concern may be raised by CEPA and the IFC if studies of this site are not conducted.

3.3.3.2 Logistics Base and Wharf Area, and Potential Turtle Nesting sites

The area proposed for construction of a new logistics base and wharf on the northern bank of the Purari River in the south of the proposed CPF area was not able to be surveyed from Fly Camp C (AOI 4, see Figures 3 and 4) during the Phase 1 surveys (due to the revised fly camp location, trail cutting and radio communications issues). CEPA is considered likely to expect coverage of this site located in riparian forest along one of the country's major waterways.

Based on recent research conducted in the nearby Kikori River system (Eisemberg et al., 2015), Purari River tributaries in the south of PRL-15, including Kuku Creek and the tributary system draining the proposed CPF area and associated facility sites, potentially provide nesting habitat for IUCN Vulnerable freshwater turtle species including the pig-nosed turtle (*Carettochelys insculpta*). Any turtle nesting sites present should be identified prior to Project construction to provide opportunity for monitoring activities. The potential location of turtle nesting sites will be identified with a local guide and based on information provided by local landowner informants during upcoming social surveys.

3.3.3.3 Ridgeline North-northwest of Herd Base

An area to the north-northwest of Herd Base, between the western trunkline route option and the Project road, is currently under consideration for development of an alternative infrastructure route and has been proposed for survey during Phase 2 (see Figures 3 and 4). The survey area spans a ridgeline that runs in a northwest to southeast direction and provides access to:

- Medium crowned hill forest (Hm) south of the ridge
- Complex: medium crowned hill forest/scrub (Hm/Sc) to the north of the ridge

The aim of the survey is to cover part of the alternative route option corridor and to assess the vegetation types present for similarity with or differences from (structure, floristics) the same FIMS vegetation types sampled in adjacent areas during Phase 1 and 2.

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3.4 Nominal Camp Locations

The co-ordinates of the proposed fly camps for the Phase 2 surveys are listed in Table 3.2. These locations are nominal only and will be confirmed following an aerial reconnaissance.

Table 3.2 – Proposed Phase 2 Field Camp Locations

Area of Interest	Location Description	Camp Name (Type)	Coordinates*
AOI 5	Southern Export Pipeline Route between Lali and Kilavi (outside PRL-15)	Fly Camp E (standard forest-based fly camp)	UTM: 308260 / 9153975 Lat/Long: S7° 39' 01.1" / E145° 15' 42.4"
AOI 6	Southern export pipeline corridor between Kilavi and the coast (outside PRL-15) - at Avavu village	Fly Camp F (standard fly camp in already-cleared area)	UTM: 308863 / 9138605 Lat/Long: S7° 47' 21" / E145° 16' 00"
	Southern export pipeline corridor between Kilavi and the coast (outside PRL-15) - at Hururu village	Fly Camp G (standard fly camp in already-cleared area)	UTM: 315830 / 9131229 Lat/Long: S7° 51' 22" / E145° 19' 46"
AOI 7	Trunkline Western Route (inside PRL-15)	Fly Camp D (standard forest-based fly camp)	UTM: 294463 / 9191201 Lat/Long: S7º 18' 47.57" / E145º 08' 17.38"
AOI 8	Trunkline Central Route, Project Road Route and Kuku Creek (inside PRL-15)	Fly Camp D	As above
Shorter-duration site	Logistics base and wharf area, potential turtle nesting sites on the Purari River and tributaries (locations to be determined in the field)		
Shorter-duration site	Oxbow wetlands, west of the CPF area (within PRL-15)		
Shorter-duration site	Elevated terrain and ridgeline (located between Site 5 and Site 6a).		

* UTM coordinates are in PNG94 Zone 55S.

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4. Survey Methods

4.1 Flora and Fauna Surveys

At each survey site, the effort expended on individual sampling methods and in various habitats and microhabitats will be adjusted according to the expected distribution of known species-level sensitivities as identified during the bibliographic review, Phase 1 surveys and during community-based interviews.

Given the high rate of discovery of new-to-science species in Papua New Guinea (supported by the findings of the Phase 1 surveys), the full range of sampling techniques will be deployed in a variety of microhabitats at the three northernmost AOIs (AOIs 5, 7 and 8), which are remote forest sites in poorly documented areas. These AOIs will support the full multidisciplinary team of biologists (flora and fauna) housed in temporary fly camps constructed to support the studies. Methods for undertaking these surveys will be as per the methods described previously for AOIs 1 to 4 in the Phase 1 scope and methods document. Valuable information will also be gathered during discussions with local landowners employed to assist field scientists during these field surveys. For this reason, it is important that the landowners selected reside in the landowner village and are actively involved in hunting and fishing in the forests and waterways of the study area.

Shorter visits will be made to particular sites/ecosystems of interest that preclude the construction of fly camps for logistic reasons and/or that are expected to support a narrower range of sensitivities based on findings from the bibliographic review (including the shorter-durations sites outlined in Section 3.3.3); examples of these sites/ecosystems include (but are not limited to) freshwater swamps and wetlands, mangroves, and coastal sites with relatively high human population. Access to these sites will be on foot, via boat and potentially via helicopter.

As per the Phase 1 surveys, prearranged interviews will also be conducted at villages, during which (if appropriate), local landowners will be asked to exhibit collections of hunting trophies kept inside their houses. Questioning will be used in conjunction with information gathered by the social team to provide information on biodiversity values present, including rare and threatened hunting sensitive taxa, and ecosystem services that may be impacted by Project development. In addition, the biodiversity team will speak with people in communities at the coast and in selected inland villages for the purpose of collecting information on turtle nesting sites and ecosystem services (especially in relation to terrestrial and aquatic fauna and plant resources). In the coastal communities, the biodiversity team will also gather information on marine and estuarine species of interest.

In the coastal area (AOI 6, see Figures 3 and 5) where there are higher levels of disturbance and hunting as a result of higher human populations, the team will use the survey methods described for the remote forest sites, however, the methods will be deployed more strategically in areas of remnant/relatively undisturbed habitat and/or in areas where local informants have indicated that one or more target species may be present. The team will also place increased reliance on community-based information through interviews and opportunistic information gathering during walking surveys to supplement the more patchy nature of the habitat in the area.

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4.2 Vegetation Mapping

Vegetation mapping will be undertaken as part of the terrestrial biodiversity study and habitat descriptions will be based on a review of existing data (i.e., PNG Forest Inventory Mapping System (FIMS)), imagery and LiDAR contours, and ground and aerial surveys.

The desktop assessment focuses on assessing the corridor vegetation and land use and includes the use of LiDAR-generated contours to determine the boundary between hill forest and alluvial forest. The FIMS mapping is typically subject to numerous errors in both vegetation type boundaries and vegetation type. These errors have the potential to significantly alter the area mapped as critical habitat and/or vegetation types particularly sensitive to disturbance. As a result, the boundary between hill forest and alluvial forest is often inaccurately defined due to errors associated with the scale of the original FIMS mapping. The vegetation mapping is, therefore, reliant on the LiDAR data to assist with determining this boundary.

Following the desktop-based review of existing data, aerial survey and ground truthing will be undertaken, where access is available, to:

- Verify the boundary of the hill forest and alluvial forest.
- Verify the FIMS mapping units.
- Identify FIMS types/land use not identifiable in the imagery, typically due to cloud cover, poor quality imagery or areas that are simply difficult to interpret (potential anomalies).

4.3 Survey Team

The senior scientists conducting the Phase 2 surveys remain the same as for Phase 1. Their credentials can be found in Appendix 1 of the Phase 1 scope and methods document.

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5. Conclusion

Following a review of the terrestrial biodiversity field survey program, eight AOIs in the upstream area have been identified for the terrestrial biodiversity study. The Phase 2 field work will involve the survey of four of these AOIs as well as some shorter duration surveys to assess sensitivities potentially present and/or to examine the location of proposed facilities.

Implementation of a range of flora and fauna sampling techniques as well as information gathering from local landowners will occur in all survey areas. Combining these survey techniques is a key component of the survey methodology, which is also applied by the biodiversity team in other areas of New Guinea.

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Part 23F
Marine Studies Scope and Methods

PAPUA LNG PROJECT

MARINE STUDIES
SCOPE AND METHODS

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1. Project Overview

Total Exploration and Production Papua New Guinea Limited (TEP PNG) is planning the development of the Elk-Antelope gas field in Papua New Guinea (PNG) as part of the proposed Papua LNG Project (the Project).

The Elk-Antelope gas field is located within Petroleum Retention License 15 (PRL-15) in Baimuru District, Gulf Province, approximately 120 km inland from the township of Kerema and 360 km northwest of Port Moresby. The gas field is a highly significant gas discovery in Papua New Guinea and consists of a deep, high pressure, elevated temperature gas reservoir with several trillion cubic feet of gas reserves.

The Project development includes the following facilities:

- Wellpads and upstream gathering system.
- An upstream central processing facility (CPF) to separate and condition gas and condensate streams.
- Export gas and condensate pipeline system, comprising separate single gas and condensate export pipelines in the same route. The pipeline will traverse both onshore and offshore environments (approximately 60 km and 240 km, respectively).
- A liquefied natural gas (LNG) plant and support infrastructure, and associated coastal marine export facilities.
- An acid gas removal unit (AGRU) is proposed at the CPF rather than the LNG Plant as there is the potential for reinjection into a depleted well, thereby reducing the length of acid gas pipeline required.

This document describes the scope and methods for environmental baseline field surveys for the following components of the environmental and social impact assessment (ESIA) for the Project:

- Marine water and sediment quality.
- Marine biodiversity.
- Coastal geomorphology.

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2. Study Objectives

The objectives of the field studies relating to these components are described below.

2.1 Marine Water and Sediment Quality

- Characterise existing marine water and sediment quality of areas identified as at risk from project-related impacts, and contribute to development of a baseline dataset.
- Inform development of hydrodynamic and water quality models.
- Support marine biodiversity and marine resource uses (ecosystem services) assessments.

2.2 Marine Biodiversity

- Map intertidal and subtidal habitats in the study area, and identify sensitive areas and critical habitat in accordance with International Finance Corporation (IFC) Performance Standard 6.
- Characterise epibenthic communities in the study area.
- Describe marine fauna and flora species that inhabit the study area.
- Determine the presence and (where practicable) status of species of conservation significance potentially present within the study area.
- Collect information on priority biodiversity values suitable for use in impact and critical habitat assessment, development of mitigation and management measures, and monitoring programs.
- Collate information on marine biodiversity and provide support in assessing potential impacts on marine biological resource use (ecosystem services).

2.3 Seabed and Coastal Geomorphology

- Characterise seabed and coastal morphology and processes in the study area.
- Inform the mapping of marine habitat types in the study area.
- Characterise potential sensitivities of coastal processes (e.g., subsea sand movements, beach/dune erosional processes) at the pipeline landfall site and LNG plant site.
- Inform development of sediment transport conceptual and numerical models to a level suitable for impact assessment.
- Collect information on seabed mapping of marine habitat types to inform the marine biodiversity and resource studies and provide support in assessing potential impacts on seabed benthic and coral reef resource uses (ecosystem services).

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3. Study Area and Project Areas

3.1 Study Area

The study area is based on the expected area of influence of the Project, collectively comprised of the following Project areas:

- Gasfield area within PRL-15 (well pads, upstream gathering system, CPF and associated infrastructure and support facilities, i.e., construction camp, laydown, wharf, airstrip, access roads).
- Onshore export pipeline corridor (export gas and condensate pipeline system of about 70 km in length from the CPF to the coast at Orokolo Bay, together with associated infrastructure and construction support facilities).
- Offshore export pipeline corridor (export gas and condensate pipeline system of approximately 260 km in length within the Gulf of Papua from Orokolo Bay to Caution Bay).
- Downstream LNG plant area, including coastal facilities and associated infrastructure and support facilities at Caution Bay.

These areas are shown in Figure 1.

West of the onshore export pipeline corridor, the Project area of influence includes potential barge transport routes along each of the Purari River's three main delta distributaries—the Purari, Ivo-Urika and Varoi-Warne rivers. These streams are also downstream of proposed Project facilities within PRL-15.

The area of the offshore export pipeline corridor, landfall sites (shoreline crossings), LNG plant coastal facilities at Caution Bay and marine transport routes are all relevant to the scope of the marine studies. Further illustration and description of the study areas and sampling locations is provided in Section 9.

3.2 Offshore Pipeline Project Area Descriptions

3.2.1 Upstream Landfall Site (Orokolo Bay)

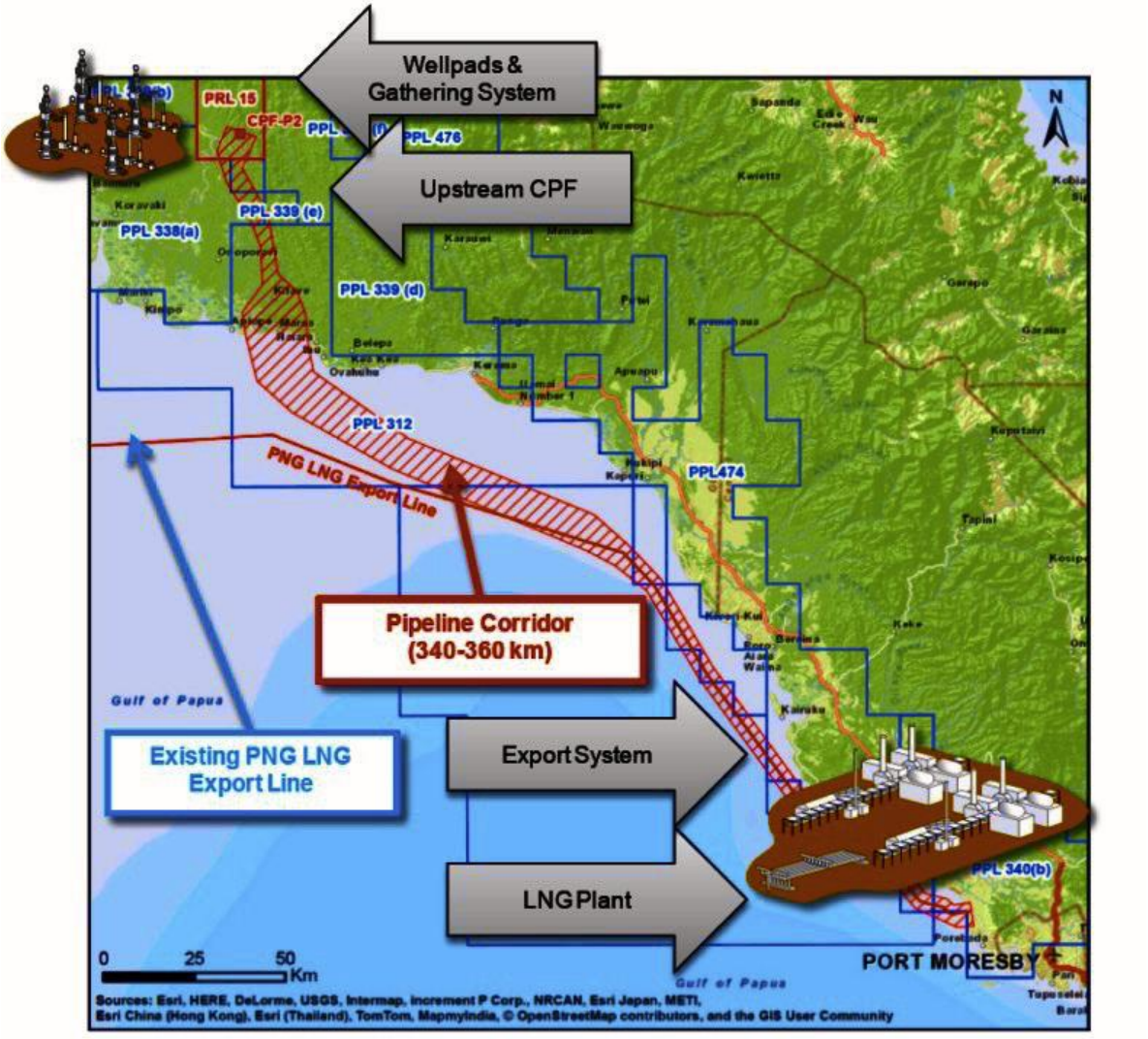
Orokolo Bay is subject to two distinctive seasons experiencing north to north-west monsoon winds from December to March (wet season) and south-east trade winds from May to October (dry season), with April and November acting as changeover periods (Evesson, 1983). In the wet season, winds tend to be calmer and wind vectors are frequently from the west to north-west (Saint-cast & Condie, 2006). These winds have a small fetch. This results in late January and February months experiencing the most quiescent wave climate. Wind strength gradually increases throughout the year to a peak with the dry season trade winds in July, and then progressively decreases with the return of the wet season. Dry season trade winds are generally strong from the south-east and cover a significant fetch across the Coral Sea, setting up seasonally averaged significant wave heights[1] in Orokolo Bay of 1.5 m (Hemer et al., 2004).

[1] Average of the highest one third of waves (measured from trough to crest) that occur in a given period.

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Significant wave heights are much larger in deeper waters, but attenuate as waters become shallower.

Figure 1 – Papua LNG Project Areas



Source: TOTAL (2015).

Tides are semi-diurnal within the Gulf of Papua and tidal range highest in the north-west gulf, near the mouth of the Wawoi River at over 5 m. Tidal range then attenuates heading eastwards, to the point where tidal range in the vicinity of Orokolo Bay is approximately 3 m, and 2.9 m at Caution Bay.

Resuspension of sediments in the Gulf of Papua is driven primarily by waves, with waves and currents mobilising about ten times more sediment than currents alone (Saint-cast & Condie, 2006). Therefore, wind and wave driven resuspension is likely to be highest during the dry season, while turbidity generated by fluvial delivery of terrigenous sediment is highest during the wet season.

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The Hiri Current is a gyre spinning clockwise around the Gulf of Papua. The strength of the Hiri Current is unlikely to be significantly altered by El Nino given a lack of response observed in the Coral Sea Current, which is thought to drive the Hiri Current (Saint-cast & Condie, 2006). Sediment released from the mouth of Fly and Purari rivers generally moves in an eastward direction through the wet season, and with the onset of the strong south-east trades, a westward shoreline current develops (Keen *et al*., 2006) pushing sediments westwards back towards the Fly River and into the northern part of Torres Strait.

Seasonal changes and broad-scale ocean processes are critical to understanding the types of marine biological communities that may be present within the Project area, and how their ambient environment (natural stressors) changes through time. Strong winds and waves during the dry season will result in greater potential for resuspended sediment, but freshwater plumes and entrained sediment from the Gulf rivers are likely to be more extensive, and move farther eastwards during the wet season. Sedimentation, turbidity, and salinity are three key factors affecting the presence or distribution of sensitive habitats such as coral reefs and seagrass meadows. Although there are several modelled simulations of salinity and turbidity in the Gulf of Papua, actual water quality data specific to the Orokolo Bay area are not available.

While no detailed marine habitat surveys have been conducted in Orokolo Bay, coral assemblages have previously been identified in the nearshore areas in Kerema Bay, adjoining to the west of Orokolo Bay (GHD, 2012). The location of significant bathymetric rises identified in Orokolo Bay from navigation charts may be an indicator of similar reef communities in the study area. If reefs occur here, ahermatypic and/or hermatypic coral communities may be present. Ahermatypic communities consist of non-reef forming coral and sponge communities that often occur in deep or highly turbid waters. Hermatypic coral communities are reef forming coral and algae communities that rely on light for nutrition, as can occur in offshore reefs and clear inshore waters.

In addition, while no significant seagrass beds have been identified previously in Orokolo Bay or Kerema Bay, the Endangered[2] green (*Chelonia mydas*) and Vulnerable olive Ridley (*Lepidochelys olivacea*) turtles are known to occur in low densities, with green turtles occasionally nesting along beaches in Kerema Bay (GHD, 2012). Anecdotal evidence also suggests the occurrence of the Vulnerable dugong (*Dugong dugon*) infrequently in the area (GHD (2012) and WorleyParsons (2009)). A number of dolphin species are known to occur in the broader region, including the Data Deficient Indo-Pacific bottlenose dolphin (*Tursiops aduncus*), Least Concern common dolphin (*Delphinus delphis*), Near Threatened Indo-Pacific humpback dolphin (*Sousa chinensis*), Vulnerable Irrawaddy dolphin (*Orcaella brevirostris*) and Near Threatened Australian snubfin dolphin (*O. heinsohni*) (CNS (2008), GHD (2012) and WorleyParsons (2009)). The nearshore waters of the Gulf also represent part of the annual migration route of the Least Concern ornate rock lobster (*Panulirus ornatus*) (WorleyParsons, 2009).

In addition, the Data Deficient banded watersnake (*Cantoria annulata*) is known to be endemic to New Guinea. It is currently only known from a few localities in the Trans-Fly region and may occur in nearshore waters and mangrove habitats of the Purari River (IUCN, 2015).

[2] All listings are based on the International Union for the Conservation of Nature (IUCN) Red List.

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3.2.2 Offshore Export Pipeline (Gulf of Papua)

The majority of seafloor substrate along the offshore pipeline corridor reportedly consists of sandy material with interbedded silt and clay layers and occasional rock outcrops (CNS, 2008). No seagrass or coral communities have been recorded through this area.

Significant species known or likely to occur in this area include sea snakes, marine turtles (especially green and olive Ridley turtles) and cetaceans (CNS, 2008). Cetaceans include various dolphin species (e.g., Indo-Pacific bottlenose dolphin, common dolphin, Indo-Pacific humpback dolphin, Irrawaddy dolphin, Australian snubfin dolphin), as well as Bryde's whale (*Balaeonoptera edeni*), sperm whale (*Physeter catodon*), minke whale (*Balaenoptera acutorostrata*) and humpback whale (*Megaptera novaeangliae*), though whales are only infrequent visitors to the Gulf. Offshore waters of the Gulf are also important fisheries areas, especially for prawn trawling between 10 and 40 m water depth (CNS, 2008). Other locally important fisheries include the ornate rock lobster (*Panulirus ornatus*).

3.2.3 LNG Plant Coastal Facilities and Pipeline Landfall Site (Caution Bay)

Caution Bay is subject to the same distinct seasonality as Orokolo Bay, with a period dominated by northwest monsoons from December to March, and by southeast trade winds from May to December (GEMS, 2008). As much of the bay is sheltered by a barrier reef (CNS, 2009), the effect of waves is mitigated to some extent, with a mean wave height of 0.42 m (CNS, 2009). A metocean deployment campaign for the PNG LNG Project EIS identified wave height in the area as exceeding 1 m only 10% of the time, with a maximum wave height of 1.9 m recorded over this time (GEMS, 2008).

Unlike at Orokolo Bay, sedimentation rates at Caution Bay appear to be higher during the wet season. Studies conducted for the PNG LNG Project EIS indicated a significantly higher (approximately four times higher) suspended sediment level during the wet season than the dry season (CNS, 2009).

Caution Bay supports significant hermatypic coral reef communities as well as dense seagrass meadows (CNS, 2009). While fringing coral reefs in the nearshore environment have been noted as being in poor condition, likely as a result of fishing pressures (including dynamite fishing), higher value coral reefs occur in offshore waters, especially associated with some small islands within the embayment (CNS, 2009). Within the fringing coral reef communities, the dominant hard coral species were *Porites* spp. with lower levels of *Acropora* spp. also occurring (CNS, 2009).

Seagrass communities occur between the fringing reef and the intertidal mangrove communities. These communities form dense meadows of *Enhalus acoroides*, *Syringodium isoetifolium* and *Cymodocea* spp. (CNS, 2009). Seagrass meadows were not recorded further offshore as part of the PNG LNG Project environmental studies.

These coral and seagrass communities support a number of small fish species as well as marine megafauna. Anecdotal evidence from local villagers indicated the presence of green and hawksbill (*Eretmochelys imbricata*) turtles in Caution Bay, as well as infrequent occurrence of whale sharks beyond the fringing reef (*Rhincodon typus*) (CNS, 2009). Reef sharks (*Carcharhinus* spp.) may also occur in small numbers but would also be subject to fishing

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pressures (CNS, 2009). Dolphin species are known to occur, and are likely to include all the species noted as occurring in the northern Gulf region (CNS, 2009). No dugong feeding tracks were noted in seagrass beds in Caution Bay during the PNG LNG Project EIS environmental studies.

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4. Study Approach

The study approach for the marine water and sediment quality, marine biodiversity, seabed and coastal geomorphology, and physical oceanography studies consists of a desktop bibliographic review supplemented by a field survey to fill any gaps in data necessary to prepare the environmental impact assessment. The marine impact assessment will also include characterisation of existing conditions and prediction of project-related impacts through the use of numerical modelling. The study approach was guided by the following assessment and study criteria/standards:

- PNG Conservation and Environmental Protection Authority (CEPA) guideline GL-Env02/2004: Guideline for Conduct of Environmental Impact Assessment & Preparation of Environmental Impact Statement (CEPA, 2004).
- TOTAL General Specification GS EP ENV 112: Environmental Baseline and Monitoring Studies: Offshore and Nearshore Sites (TOTAL, 2012) and GS EP ENV 111: Environmental Baseline and Monitoring Studies: Onshore Sites (TOTAL, 2012).
- TOTAL General Specification GS EP ENV 120: Environmental impact assessment of E&P activities (TOTAL, 2007).
- TOTAL General Specification GS EP GEO 504: Comprehensive Evaluation of Metocean Conditions (TOTAL, 2013).
- International Finance Corporation (IFC) Performance Standards (especially Performance Standards 1, 3 and 6) and Guidance Notes.

4.1 Bibliographic Study

The bibliographic study consisted of a review of existing information to identify gaps that require collection of field data. Literature considered included:

- ERIAS Group (2015), Societal and Environmental Screening Study Report: Elk-Antelope Project Facilities, prepared for TOTAL, ERIAS Group, Melbourne.
- Relevant chapters of Petr, T (ed.) (1983), The Purari – Tropical Environment of a High Rainfall River, Dr W Junk Publishers, The Hague.
- PNG LNG Project Environmental Impact Statement (CNS, 2009) and appendices, prepared by Coffey Natural Systems for ExxonMobil.
- Gulf LNG Project Environmental Impact Assessment (2012), Marine Ecology Assessment (2012) and Dredge and Spoil Management Plan (2012), all prepared by GHD Pty Ltd for Liquid Niugini Gas Ltd.
- Liquid Niugini Gas Marine Ecology Study (2009), prepared by WorleyParsons for Liquid Niugini Gas Ltd.

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- Metocean, meteorological and sediment transport reports and assessments for the Gulf of Papua (e.g., Hermer et al., 2004; Keen et al., 2006 and Saint-Cast & Condie, 2006).
- Papua New Guinean legislation and relevant international guidelines, policies and standards for the purposes of identifying key environmental areas and focus points for the EIS/ESHIA.

Global habitat layers (such as USGS mangroves and UNEP-WCMC coral reefs) will also be used to support validation and distribution mapping of coral and mangrove habitats.

4.2 Numerical Modelling

Numerical modelling is proposed as part of the physical oceanography and seabed coastal geomorphology studies, and will also be used to inform the marine water quality and ecology impact assessments. For example, trenching to lay the pipeline in the nearshore area of the upstream landfall (or any dredging required for shipping access) will generate suspended sediment, which may impact sensitive receptors (such as coral and seagrass), if present. Modelling provides a prediction of the level, duration and extent of turbidity that may be expected to occur due to trenching, and allows assessment of impacts to sensitive receptors.

The numerical modelling system will consist of a bathymetric digital elevation model (DEM), 3D hydrodynamic model, 3D advection-dispersion (i.e., water quality) model, wave model and sediment transport model. This modelling suite is based on the typical numerical modelling activities undertaken for environmental impact assessments in tropical waters. In addition, the modelling suite has been chosen to assist completion of a quantitative impact and risk assessment in accordance with TOTAL's General Specification GS EP ENV 120 and IFC Performance Standards 1 and 3.

The numerical models developed to support the impact assessment will be used to assess 1) hydrodynamic changes, 2) changes in littoral sediment transport, 3) water quality impacts (turbidity and sedimentation) from marine dredging/trenching, and 4) far-field water quality impacts associated with point source discharges (e.g., brine discharge, hydrotest water discharge) (in accordance with requirements of GS EP ENV 120). This modelling will focus on the nearshore areas and will not include any spill modelling or high-end/near-field modelling of point source discharges.

At present there are sufficient publically available data (including global models) for the development of the proposed metocean numerical models. However, insufficient data are currently available for the purpose of calibrating and validating the numerical models for impact assessment. This includes seasonal metocean and water quality data.

Quantitative prediction and assessment of metocean and sediment transport impacts can be undertaken using uncalibrated/unvalidated models. This approach, however, is not consistent with national or international best practice and is unlikely to be accepted without subsequent data collection for calibration and validation purposes.

Data collection for the purposes of calibration/validation of models will require deployment of co-located metocean and water quality instruments at infrastructure and potential impact sites to establish ambient conditions in wet and dry seasons. The minimum length of such deployments would be three months to capture the change in seasonal conditions.

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It is the understanding of ERIAS Group that oceanographic equipment deployment will not occur as part of the initial EIS/ESHIA studies but rather that TOTAL will obtain data in conjunction with TOTAL's Front End Engineering Design (FEED) studies at a later date. It is envisaged that once this data is provided by TOTAL, numerical models would be calibrated and validated. Any uncertainties and limitations regarding the modelling outputs and data provided for model calibration would be described in the modelling report.

4.3 Gap Analysis

Based on a review of the available reports and associated data, a number of gaps and information requirements were identified for the purposes of the marine field studies. These are described in Table 4.1. The previous EIS studies referred to in this table are described in Section 4.1.

Table 4.1 – Summary of Information Requirements Relevant to the Marine Field Studies

Study Element	Description of Gap	Proposed Field Study/Data Collection
Orokolo Bay		
Aquatic flora and fauna of marine ecosystems	Lack of recent systematic marine biodiversity studies of Orokolo Bay and environs Existing information and data regarding habitat types, mangrove and coral assemblages, fish communities, aquatic plant communities, macroinvertebrate communities, threatened species and species of conservation value are not sufficient to characterise the marine biodiversity or conduct a robust impact assessment, especially for areas that may be affected by project activities	'Once-off' (wet season) collection of field data from representative survey locations that will characterise the following: ♦ Marine plant communities (mangroves, seagrass and algae) ♦ Site-specific benthic macroinvertebrate community data ♦ Incidental records of threatened and/or endemic species in the study area See also below for 'reefs and subtidal habitat mapping' Opportunistic observations of marine megafauna (e.g., dolphins, sea turtles, whales), including observations of turtle tracks on beach and suitability of beach for turtle nesting

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Table 4.1 – Summary of Information Requirements Relevant to the Marine Field Studies (cont'd)

Study Element	Description of Gap	Proposed Field Study/Data Collection
Aquatic flora and fauna, and aquatic ecosystems (reefs and subtidal habitat mapping)	Bathymetry charts identify raised seabed near the pipeline shore crossings; such features may represent reefs (to be confirmed). Reefs do not appear to be a common habitat type in the wider area The biodiversity values provided by reefs depend on the physical structural diversity of habitats and the types of reef-associated flora and fauna communities present. Nearshore turbid water reefs can support species of conservation significance (particularly turtles) and represent important fisheries habitats There are no quantitative data describing the structure and values of reef communities in the area. Rocky shore communities near The Bluff, 15 km west of Kerema, are qualitatively described by GHD (2012), and WorleyParsons (2009) undertook grab sampling at reefs further offshore from Kerema. In both cases visibility was poor and drop cameras could not be used	'Once-off' (wet season) acoustic habitat mapping with side scan sonar and/or single beam backscatter collection to map reefs and seafloor sediments in the vicinity of the pipeline crossing. Ground-truthing of acoustic habitat classes, and mapping of seagrass beds, will be undertaken based on: ♦ Drop camera, if visibility permits ♦ Benthic grabs over hard substrates where visibility prevents the use of drop camera ♦ Small benthic sled trawls over soft sediment habitats where visibility prevents the use of drop camera Visual assessments will rely on calm sea conditions; otherwise benthic grabs and sled trawls (which are less effective and more destructive) will be used It is also proposed to undertake some side scan survey during the dry season survey (this technique is less susceptible to adverse sea conditions) to provide information on benthic habitat and substrate types to inform pipeline route selection prior to the wet season survey. Drop cameras will also be deployed if water visibility permits. **NB** – benthic grabs over coral or sponge communities will cause impact to individuals within the area of the grab. However, the frequency of impact is expected to be low as a) works will be conducted wherever possible in high visibility situations (i.e., during the wet season), negating the need for grabs, and b) for areas where visibility is low even during the wet season, the likelihood of occurrence of corals and sponges is low
Sediment quality	Seafloor sediment quality data has not been collected along the pipeline alignment at the proposed shore crossing area	'Once-off' (any season) collection of sediment samples for the laboratory analysis of the following: ♦ Particle size distribution of sediments ♦ Suite of chemical parameters

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Table 4.1 – Summary of Information Requirements Relevant to the Marine Field Studies (cont'd)

Study Element	Description of Gap	Proposed Field Study/Data Collection
Water quality	Surface water quality spot measurements have been collected either side of Orokolo Bay as a part of past EIS studies (2009 Liquid Niugini Gas Project and 2012 Gulf LNG Project). However, this data is limited for the purposes of characterising the baseline environment for the study area and conducting a robust impact assessment for the following reasons: ♦ Laboratory analysis was not conducted against all the parameters provided for in the *Environment (Water Quality Criteria) Regulation 2002* or in TOTAL GS EP ENV 112 ♦ It shows no information on seasonality and will not be useful to develop thresholds for impact assessment ♦ Surface measurements do not show vertical stratification, which is likely to be significant given the large freshwater inflows from the nearby Gulf rivers ♦ It is not be able to be directly compared with any new data collected in Orokolo Bay since it was not collected at the same time (and therefore may be different due to seasonal/climatic conditions) Therefore, while this data will be a minor contribution to the characterisation of the baseline environment, new data will be required for all of the study area	Collection of: ♦ Physico-chemical parameters of water quality in vertical profiles to determine stratification and mixing (measured in situ using a water quality meter in wet and dry season) ♦ Grab samples (collected using a Niskin® bottle) from the surface, mid-water column and near the seafloor (depending on the depth of the water column) for laboratory analysis of a suite of chemical parameters (in wet and dry season) ♦ Water quality instrument deployments (see Section 7.3) at reefs in Orokolo Bay to establish ambient water quality conditions to determine the assimilative capacity/resilience (i.e., impact thresholds) of sensitive receptors (e.g., coral reefs, seagrass meadows) in relation to proposed water quality impacts
Caution Bay		
Aquatic flora and fauna of marine ecosystems	There is a large body of historical information describing habitat types, mangrove and coral assemblages, fish communities, marine plant communities, macroinvertebrate communities, threatened species etc Post PNG LNG Project EIS port development and natural temporal variability is however likely to have resulted in a shift in baseline conditions. Furthermore, there is a lack of site-specific information on marine communities and biodiversity values within the Project footprint. Such information is required to characterise the existing environment and inform the impact assessment	'Once-off' (wet season) collection of field data from representative survey locations that will characterise: ♦ Marine plant communities (mangroves, seagrass beds and algae), including mapping of distribution ♦ Site-specific benthic macroinvertebrate community data ♦ Incidental records of threatened and/or endemic species in the study area
	Bathymetric undulations within the 25 m depth contour in Caution Bay may represent reefs that were not surveyed as part of the PNG LNG Project EIS. Studies in the wider Caution Bay area suggest that reefs can support extensive coral and algal communities, and provide potential habitat for turtles and species of high fisheries significance	'Once-off' (wet season) acoustic habitat mapping with side scan and single beam sonar to characterise benthic habitat in the vicinity of the Caution Bay pipeline crossing Assessment of benthic community structure will also be made on reefs in the pipeline corridor using drop camera, during the wet season and dry season surveys

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Table 4.1 – Summary of Information Requirements Relevant to the Marine Field Studies (cont'd)

Study Element	Description of Gap	Proposed Field Study/Data Collection
Sediment quality	Sediment characterisation was undertaken in Caution Bay for the PNG LNG Project but has not been collected along the Papua LNG Project pipeline alignment at Caution Bay. All previous data collected at Caution Bay for the PNG LNG Project facilities were pre-construction; therefore, more recent post-PNG LNG Project construction data are required to provide a robust baseline dataset for the Papua LNG Project	'Once-off' (wet season) collection of sediment samples for the laboratory analysis of the following: ♦ Particle size distribution of sediments ♦ Suite of chemical parameters
Water quality	Surface water quality spot measurements have been collected as a part of past EIS studies. However, this data is limited for the purposes of characterising the baseline environment for the study area and conducting a robust impact assessment for the following reasons: ♦ Laboratory analysis was not conducted against all the parameters provided for in TOTAL GS EP ENV 112 ♦ Surface water samples already collected will not be temporally consistent with samples collected in the remainder of the study area. Therefore, new baseline data will be required for all of the study area	Collection of: ♦ In situ measurements of the physico-chemical properties of waters in vertical profiles to determine stratification and mixing (in wet and dry season) ♦ Grab samples (using a Niskin® bottle) from the surface, mid-column and near the seafloor (depending on the depth of the water column) for laboratory analysis of a suite of chemical parameters (in wet and dry season)
Offshore Pipeline		
Aquatic flora and fauna	Benthic infauna sediment sampling undertaken for the PNG LNG Project found infauna to be similar along the offshore pipeline route, with uniform substrate type and no unusual habitats. No video footage was obtained during this survey due to equipment failure	Field survey will involve: ♦ Wet and dry season survey along the Papua LNG offshore pipeline corridor using drop camera ♦ 'Once off' sediment sampling at selected sites to obtain site-specific benthic macroinvertebrate community data
Sediment quality	Seafloor sediment quality data was collected along the PNG LNG Project offshore pipeline corridor. However, laboratory analysis was not conducted for all the parameters in TOTAL GS EP ENV 112 Therefore, new baseline data will be required for the study area	'Once off' collection of seafloor sediment samples at selected sites along the Papua LNG offshore pipeline route for the laboratory analysis of the following: ♦ Particle size distribution of sediments ♦ Suite of chemical parameters

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Table 4.1 – Summary of Information Requirements Relevant to the Marine Field Studies (cont'd)

Study Element	Description of Gap	Proposed Field Study/Data Collection
Water quality	Water quality measurements have been collected in previous EIS studies. However, this data is limited for the purposes of characterising the baseline environment for the study area and conducting a robust impact assessment for the following reasons: ♦ Laboratory analysis was not conducted against all the parameters provided for in TOTAL GS EP ENV 112 ♦ Surface water samples already collected will not be temporally consistent with samples collected in the remainder of the study area Therefore, new baseline data will be required for the study area	Collection of ♦ In situ measurements of the physico-chemical properties of waters in vertical profiles to determine stratification and mixing (in wet and dry season) ♦ Grab samples at selected sites from the surface, mid-water column and near the seafloor for laboratory analysis of a suite of chemical parameters (in wet and dry season)

4.4 Information from Other ESBS Studies

4.4.1 Critical Habitats and Threatened/Migratory Species

Based on literature reviewed, the critical habitat and threatened species potentially present in the marine study area are expected to consist of mangroves, (which may include the presence of the critically endangered species *Bruguiera hainesii*), banded watersnake (*Cantoria annulata*) and marine turtle nesting locations.

The marine survey will record observations of any critical habitats (reefs, seagrass, mangroves,) and threatened species within the area surveyed. Mangrove observations will be site-based only as part of the estuarine surveys, i.e., observations will be made of mangroves during vessel transit between the various estuarine/freshwater sampling sites. The intention of these observations is to ground-truth mangrove distribution (for the habitat map) and to identify any areas of *Bruguiera sp*p. Opportunistic observations of the presence of any megafauna (whales, dolphins, dugongs, sea turtles) will also be made during the marine surveys along the offshore pipeline route. Opportunistic observations of any turtle nesting locations and waterbirds will also be made during the marine and estuarine surveys.

The bibliographic studies will also provide information on critical habitats and threatened species likely to occur in the Project area.

Additional information will be obtained from other environmental and social baseline studies, as described below.

Terrestrial Biodiversity

- The terrestrial biodiversity survey will be a land-based survey with the pipeline corridor (in different areas to the estuarine survey) that will also record mangrove distribution and identify the presence of critically endangered species.
- Assessment of turtle nesting locations on coastal beaches at Orokolo Bay will be undertaken by the herpetofauna specialist as part of the Terrestrial Biodiversity Study, based on

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information obtained from coastal village interviews. Cue cards will be used to assist species identification.

- Specific survey of waterbirds will be undertaken of beaches, mudflats and mangroves by the avifauna specialist as part of the Terrestrial Biodiversity Study.

Social

- Information on the potential presence of threatened fish species, sea turtles and watersnakes will be obtained from community interviews and market surveys undertaken as part of the social study village surveys.
- Information on the use of natural resources and processes of the local marine environment to support local livelihoods (i.e., ecosystem services) will be obtained from community interviews and market surveys undertaken as part of the social study village surveys (see Section 4.4.2).

Marine Fisheries and Resources Study

- The desktop 'Marine Fisheries and Resources Study' will obtain information from the National Fisheries Authority (NFA) on commercial fisheries and by-catch in the Gulf of Papua. Information on species present in by-catch will contribute to the identification of the presence of threatened species in the study area, such as the banded watersnake (*Cantoria annulata*).

4.4.2 Ecosystem Services and Fisheries Resources

The marine biodiversity survey will collect information on high-value habitats for aquatic resources (e.g., reefs and seagrass) as well as record any observations during the field survey of aquatic resource use. However, the primary collection of priority ecosystem services data will be through the social study surveys (village interviews, household questionnaires and market surveys). This includes obtaining information on marine resources utilised by local communities, including species targeted and consumed, key fishing areas and any beaches used by turtles for nesting.

The terrestrial biodiversity survey will also assess coastal beaches for sea turtle nesting sites. Observations for marine megafauna will also be made from the vessel during the dry season and wet season marine sampling campaigns.

Information on fisheries resources will be provided by the desktop 'Marine Fisheries and Resources Study' which will obtain information from the NFA on commercial fisheries and by-catch in the Gulf of Papua.

The bibliographic studies will also provide information on ecosystem services and fisheries resources in the project area.

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5. Survey Period

5.1 Seasonality

The study area is affected by distinct seasonality (CNS, 2008, 2009; GEMS, 2008 and GHD, 2012). Consistent with Guidance Note 9 of IFC Performance Standard 6 (Biodiversity Conservation and Sustainable Management of Living Natural Resources), in-field surveys over multiple seasons should be conducted for projects with the potential to cause significant impact to natural and critical habitats. Within the marine environment, water quality is one of the most important environmental processes subject to seasonal changes. In particular, suspended sediment concentrations, water temperature and salinity show distinct seasonality and are key drivers of the ecological character of marine environments in the study area.

On this basis, short-term marine water quality sampling campaigns will be conducted during both the dry and the wet season (i.e., two survey campaigns). The marine biodiversity, sediment sampling and geomorphology data collection will occur on one occasion only. The marine biodiversity surveys are designed primarily to focus on marine habitats (e.g., physical reef substrate, seagrass beds, benthic substrate) rather than capture of aquatic species. As these aspects are not subject to significant seasonal change, wet and dry season surveys will not be required. Similarly, changes in sediment quality and geomorphology are not expected to occur on a seasonal basis.

Note: All survey activities would be undertaken during the day; no nocturnal surveys are considered necessary.

5.2 Dry Season Survey Campaign

Historical climate data indicate that strongest winds and higher waves (and therefore higher bed re-suspension and turbidity) typically occur during the dry season (May to October) (see Section 3.1.1). This period is therefore unlikely to be suitable for video and acoustic data collection (side scan and single beam sonar) to be undertaken as part of the marine biodiversity study. It is therefore planned that this marine biodiversity data collection is undertaken during the wet season survey. However, given the request by TEP PNG to provide information on benthic habitat and substrate types to inform pipeline route selection prior to the wet season survey, it is proposed to undertake some side scan survey during the dry season survey (this technique is less susceptible to adverse sea conditions). The dry season survey, to be undertaken in June 2016, will therefore involve:

- Side scan sonar (acoustic transects) along potential offshore pipeline routes in Orokolo Bay, and opportunistic drop-camera survey if conditions are suitable (however more extensive ground-truthing of acoustic transects will be undertaken during the wet season marine biodiversity survey).
- Water column profiling and water and sediment quality sampling (for chemical analysis) at sites within Orokolo Bay.

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- Water column profiling, water sampling (for chemical analysis), sediment sampling (for chemical and macroinvertebrate analysis) and drop-camera surveys along the offshore pipeline route between Orokolo Bay and Caution Bay.
- Water column profiling, water sampling (for chemical analysis) and drop camera surveys at sites within Caution Bay.

This program is summarised in Table 5.1.

The dry season survey will also aim to collect continuous water quality data (using a logger water quality instrument) at Orokolo Bay in order to better understand short term changes in salinity and turbidity associated with climatic and oceanographic conditions at this time of the year (see Section 7.3).

Due to logistical considerations, the estuarine surveys in the lower estuary of the Purari and Ivo-Urika rivers will also be conducted in conjunction with the marine survey. The estuarine sampling program is further described in the Freshwater and Estuarine Study Rationale.

5.3 Wet Season Survey Campaign

The wet season survey, to be undertaken in January 2017, is summarised in Table 5.1 and will involve:

- Single beam and side scan sonar (acoustic transects) at Orokolo Bay.
- Water column profiling, water sampling (for chemical analysis), sediment sampling (for macroinvertebrate analysis) at Orokolo Bay.
- Water column profiling, water sampling (for chemical analysis), and drop-camera surveys along the offshore pipeline route between Orokolo Bay and Caution Bay.
- Single beam and side scan sonar (acoustic transects) at Caution Bay.
- Benthic sediment grabs and drop-camera work to ground-truth acoustic transects at Caution Bay.
- Water column profiling, water sampling (for chemical analysis) and sediment sampling (for chemical and macroinvertebrate analysis) at Caution Bay.

The wet season survey will also collect continuous water quality data (using a logger water quality instrument) at Orokolo Bay in order to better understand short term changes in salinity and turbidity associated with climatic and oceanographic conditions at this time of the year (see Section 7.3).

The estuarine wet season survey in the lower estuary of the Purari and Ivo-Urika rivers will also be conducted in conjunction with the marine survey.

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Table 5.1 – Summary of Marine Sampling Program

Site	Water Sampling				Sediment Sampling				Marine Habitat			
	Dry season Jun 2016		Wet Season Jan 2017		Dry season Jun 2016		Wet Season Jan 2017		Dry season Jun 2016		Wet Season Jan 2017	
Orokolo Bay	No. of water samples (depths)	In situ profiling	No. of water samples (depths)	In situ profiling	Macro-invertebrates	Chemistry	Macro-invertebrates	Chemistry	Acoustic surveys	Drop camera	Acoustic surveys	Drop camera/ ground truthing
M1	2	✓	2	✓	-	1	3	-	Side	✓	Side	✓
M2	2	✓	2	✓	-	1	3	-	scan	✓	scan	✓
M3	3	✓	3	✓	-	1	3	-	sonar	✓	+	✓
M4	3	✓	3	✓	-	1	3	-		✓	single	✓
M5	2	✓	2	✓	-	1	3	-		✓	beam	✓
M6	2	✓	2	✓	-	1	3	-		✓	sonar	✓
M7	2	✓	2	✓	-	1	3	-		✓		✓
M8	2	✓	2	✓	-	1	3	-		✓		✓
M9	3	✓	3	✓	-	1	3	-		✓		✓
M10	**2**	✓	2	✓	-	1	3	-		✓		✓
M11	3	✓	3	✓	-	1	3	-		✓		✓
M12	3	✓	3	✓	-	1	3	-		✓		✓

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Table 5.1 – Summary of Marine Sampling Program (cont.)

Site	Water Sampling				Sediment Sampling				Marine Habitat			
	Dry season Jun 2016		Wet Season Jan 2017		Dry season Jun 2016		Wet Season Jan 2017		Dry season Jun 2016		Wet Season Jan 2017	
Caution Bay*	No. of water samples (depths)	In situ profiling	No. of water samples (depths)	In situ profiling	Macro-invertebrates	Chemistry	Macro-invertebrates	Chemistry	Acoustic surveys	Drop camera	Acoustic surveys	Drop camera/ ground truthing
M13	3	✓	3	✓	-	-	-	-	-	✓	Side	✓
M14	-	-	-	-	-	-	-	-	-	✓	scan	✓
M15	-	-	3	✓	-	-	-	-	-	✓	+	✓
M16	-	-	3	✓	-	-	3	1	-	✓	single	✓
M17	2	✓	2	✓	-	-	-	-	-	✓	beam	✓
M18	-	-	-	-	-	-	3	1	-	✓	sonar	✓
M19	2	✓	2	✓	-	-	3	1	-	✓		✓
M20	-	-	2	✓	-	-	3	1	-	✓		✓
M21	2	✓	2	✓	-	-	3	1	-	✓		✓
M22	2	✓	2	✓	-	-	3	1	-	✓		✓
M23	-	-	2	✓	-	-	3	1	-	✓		✓
M24	-	-	3	✓	-	-	3	1	-	✓		✓

* Water sampling and in situ profiling also to be undertaken at 2 sites in the Vaihua estuary (sites 28 and 29) in June 2016 (and the full estuarine program of sampling will be undertaken in the Vaihua estuary in the wet season)

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Table 5.1 – Summary of Marine Sampling Program (cont.)

Site	Water Sampling				Sediment Sampling				Marine Habitat			
	Dry season Jun 2016		Wet Season Jan 2017		Dry season Jun 2016		Wet Season Jan 2017		Dry season Jun 2016		Wet Season Jan 2017	
Offshore pipeline	No. water samples	In situ profiling	No. water samples	In situ profiling	Macro-invertebrates	Chemistry	Macro-invertebrates	Chemistry	Acoustic surveys	Drop camera	Acoustic surveys	Drop camera
M25	3	✓	3	✓	3	1	-	-	-	✓	-	✓
M26	-	✓	-	✓	-	-	-	-	-	✓	-	✓
M27	-	✓	-	✓	-	-	-	-	-	✓	-	✓
M28	-	✓	-	✓	-	-	-	-	-	✓	-	✓
M29	-	✓	-	✓	-	-	-	-	-	✓	-	✓
M30	-	✓	-	✓	-	-	-	-	-	✓	-	✓
M31	3	✓	3	✓	3	1	-	-	-	✓	-	✓
M32	-	✓	-	✓	-	-	-	-	-	✓	-	✓
M33	-	✓	-	✓	-	-	-	-	-	✓	-	✓
M34	-	✓	-	✓	-	-	-	-	-	✓	-	✓
M35	-	✓	-	✓	-	-	-	-	-	✓	-	✓
M36	-	✓	-	✓	-	-	-	-	-	✓	-	✓
M37	3	✓	3	✓	3	1	-	-	-	✓	-	✓
M38	-	✓	-	✓	-	-	-	-	-	✓	-	✓
M39	-	✓	-	✓	-	-	-	-	-	✓	-	✓
M40	-	✓	-	✓	-	-	-	-	-	✓	-	✓
M41	-	✓	-	✓	-	-	-	-	-	✓	-	✓
M42	-	✓	-	✓	-	-	-	-	-	✓	-	✓
M43	3	✓	3	✓	3	1	-	-	-	✓	-	✓
M44	-	✓	-	✓	-	-	-	-	-	✓	-	✓

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6. Survey Parameters

The key parameters that will be measured as part of the marine field studies are listed in Table 6.1.

Table 6.1 – Parameters to be Measured during Marine Field Studies

Dataset	Description of Parameters	Justification
Marine Water and Sediment Quality		
Site-based in-situ water quality[3] data	Physico-chemical water quality profiling of the following parameters: ♦ Temperature ♦ pH ♦ Salinity ♦ Conductivity ♦ Dissolved oxygen (DO) ♦ Turbidity. Observations of surface conditions will also be noted, including colour, smell, algae, iridescence, bacterial aggregates, rubbish, and precipitates	Parameters as per GS EP ENV 112
Continuous in-situ water quality data	Turbidity, conductivity, temperature and depth data to be collected continuously (i.e., from a continuously logging instrument) throughout the duration of each of the dry and wet season marine field studies at Orokolo Bay	Data gathering for the purpose of determining impact thresholds for sensitive receptors that may exist near the pipeline alignment at Orokolo Bay‡ NB – no data will be required for Caution Bay as generic literature values for impact thresholds will be adopted based on previous PNG LNG EIS studies
Water quality samples from surface, mid-water and near the sea floor (depending on the depth of the water column, i.e., less samples will be collected in shallow waters)	Sampling for subsequent laboratory analysis of the following parameters: ♦ Total suspended sediments (TSS) ♦ Total nitrogen, total phosphorous, nitrate/nitrite, ammonia and orthophosphate ♦ Chlorophyll a ♦ Total and dissolved metals/metalloids (Al, As, Ba, Cd, Co, Cr, Cu, Fe, Hg, Ni, Pb, Sn, Sr, V, Zn) ♦ Total petroleum hydrocarbons (TPH), benzene, toluene, ethylbenzene and xylenes (BTEX) and polyaromatic hydrocarbons (PAH)	Parameters as per TOTAL's GS EP ENV 112 Metals/metalloids based on suite used for surface water quality sampling (see Freshwater and Estuarine Study Rationale) for comparison across aquatic environments in study area NB – while nitrates/nitrites will be tested, these samples are expected to have breached holding times (~2 days) before reaching certified laboratory

[3] In-situ data is that measured in the field. This is distinguished from data obtained by laboratory analysis of samples taken from the field.

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Table 6.1 – Parameters to be Measured during Marine Field Studies (cont'd)

Dataset	Description of Parameters	Justification
Sediment quality samples	Measurement of redox potential will be undertaken in the field immediately upon sample retrieval and observations made of odour, homogeneity, bioturbation, colour, texture, stratification, presence of biota and any extraneous objects Sampling will be undertaken for subsequent laboratory analysis of the following parameters: ♦ Particle size distribution (PSD) (down to 1 µm) ♦ Moisture content ♦ Total organic matter (TOM) and total organic carbon (TOC) ♦ Total nitrogen and total phosphorus ♦ Total metals/metalloids (Ag, Al, As, Ba, Be, Cd, Co, Cr, Cu, Fe, Hg, Mn, Mo, Ni, Pb, Sb, Sn, Tl, V, Zn ♦ TPH, BTEX and PAH	Parameters as per TOTAL's GS EP ENV 112
Marine Biodiversity		
Coastal mangrove habitat characterisation	Description of mangrove community and percentage cover by species at survey sites	Description of plant species is consistent with TOTAL's GS EP ENV 111. This will include photographs as necessary for the purpose of subsequent IDs, and completion of a tailored pro-forma Necessary to describe key aquatic habitat areas in the study area, including potential special purpose areas (for CEPA's GL-Env02/2004) and natural habitat and critical habitat (for IFC Performance Standard 6)
Marine habitat types and extents	Description of habitat type extents using acoustic imagery and aerial photos Broad-scale mapping of seafloor sediment types via classification by single beam backscatter data Determination of relative abundance of dominant species (percent cover)	Description of habitat types will assist in identifying potential special purpose areas (for CEPA's GL-Env02/2004) as well as critical habitat (for IFC Performance Standard 6) Mapping of seafloor sediment and benthic habitat types is consistent with TOTAL's GS EP ENV 112 Diversity and relative abundance of dominant species is important to characterise the benthic ecology and the potential occurrence of sensitive receptors and species

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Table 6.1 – Parameters to be Measured during Marine Field Studies (cont'd)

Dataset	Description of Parameters	Justification
Benthic macroinvertebrates	Collection of macroinvertebrates in sediments (three replicates per site) for the purpose of defining community structure metrics such as abundance, richness and diversity (with taxonomic identification undertaken to morpho-species level) Community metrics that will be calculated are species richness, species diversity (Shannon H), evenness (Pielous), total abundance, and taxonomic distinctness. Total abundance will also be tabulated for the dominant species. Patterns in community structure will be explored using multi-variate techniques (n-MDS/cluster analysis)	Key element of biodiversity in context of: ♦ Food resource for fish ♦ Ecosystem drivers (e.g., food web maintenance)
Seabed and Coastal Geomorphology		
Seabed geomorphology	Description of habitat type extents and mapping of sediment types – as per marine biodiversity	Provides description of seafloor substrate type and identification of any significant geomorphological formations that may be impacted. This is consistent with CEPA's GL-Env02/2004
Coastal geomorphology	Description of coastal geomorphology along areas of potential pipeline impact PSDs of sediment in intertidal zone Photographs of coastal zone	Allows for identification of any significant geomorphological formations or sensitive coastal processes that may be impacted by possible altered coastal hydrodynamics due to project infrastructure. This is consistent with CEPA's GL-Env02/2004 Provides description of sediment types in intertidal zone. Together with PSDs from seabed sediment (see above), this helps understand potential impacts associated with mobilisation of sediments from project infrastructure in the nearshore and marine environment

‡ This data will be used to assist verification of results from models developed as part of the physical oceanography study.

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7. Survey Methods

7.1 Intertidal/Coastal Mapping and Observations

Intertidal/coastal mapping and observations will consist of the following activities:

- Ground-truthing of intertidal habitat types at pipeline landfall locations based on low-level aerial photography (or other available aerial imagery).
- Visual assessment of mangrove communities based on a tailored pro-forma.
- Photographs of coastal zone at pipeline landfall locations.
- Description of coastal geomorphological features at pipeline landfall locations, including evidence of coastal processes. This would be focused upon key features as identified from satellite imagery and aerial photography (where available).
- Analysis of particle size of sediment in intertidal area.

7.2 Subtidal Habitat Mapping and Ground-truthing

Two forms of subtidal habitat mapping and ground-truthing will be undertaken:

- Acoustic habitat mapping using a single beam sonar and a compressed high-intensity radar pulse (CHIRP) side scan sonar (SSS), with ground-truthing by drop-camera and benthic grab sampling to confirm seafloor habitat types.
- Drop-camera and benthic grab ground-truthing to compare against known or expected benthic habitat features in the area, based on maps utilising data from the PNG LNG Project EIS. This ground-truthing will be qualitative only (i.e., visual characterisation of substrate type, particle size, presence of seagrass or coral fragments, etc). Results from site-based sediment testing (see Section 7.4) will be used to supplement this ground-truthing where appropriate.

7.3 Water Quality Instrument Deployment

YSI 6600 and McVan turbidity and CTD (conductivity-temperature-depth) probes will be installed at selected sites at Orokolo Bay for the purpose of collecting continuous turbidity, conductivity, temperature and water depth data (i.e., to capture changes in tides, sediment resuspension, temperature and conductivity). McVan and CTD instruments will be deployed as part of the dry season survey and left in place until retrieval during the wet season survey. YSI 6600 instruments will only be deployed for part of the duration of the wet season surveys in order to supplement long-term data from the McVan and CTD probes.

The instruments will be fixed to the seafloor using weights and frames and a guywire to prevent loss from trawling or other fishing activities. Depth of placement will depend upon the exact nature of sensitive receptors at the sites and local conditions. These instruments will be retrieved by hooking the frame guywire or the frame itself (located by reference to differential GPS[4] points).

[4] Differential GPS (dGPS) has sub-metre accuracy.

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The deployment period will depend on whether reefs are present supporting coral, seagrass, sponges or other sensitive receptors or not. In this regard, if:

- Sensitive receptors are not present – the loggers will be left in the water for the duration of each survey campaign (i.e., nominally seven days in the Orokolo Bay area). This data will be useful for describing short-term changes in water quality and likely drivers of impacts. YSI 6600 water quality instruments will be used for these deployments.
- Sensitive receptors are present – a more robust data-set (longer-term) data set would be collected for this scenario. In this instance, it is proposed to deploy the instruments in the first (dry season) campaign and retrieve the instruments in the second (wet season) campaign. The duration of measurement period will depend upon the time during which the instruments remain in calibration (i.e., instrument will cease to collect accurate data after a period of time). In tropical waters this is expected to be eight to twelve weeks for turbidity probes, depending upon the rate of biofouling upon the instrument. It is proposed to deploy McVan turbidity probes for these longer-term deployments because of their lesser susceptibility to biofouling or sedimentation build-up.

7.4 In Situ Profiling and Grab Sampling

The following sampling activities will be undertaken at the various survey sites:

- In situ water quality profiles:
  - 12 sites at Orokolo Bay in wet and dry season
  - Up to 20 sites along the offshore pipeline route in wet and dry season
  - 10 sites at Caution Bay in wet season and 5 sites during dry season.
- Grab water sampling at surface, mid-water column and near the seafloor depending upon water depth:[5]
  - 12 sites at Orokolo Bay in wet and dry season
  - 4 sites along the offshore pipeline route in wet and dry season
  - 10 sites at Caution Bay in wet season and 5 sites during dry season.
- 'Once off' seafloor sediment sampling for laboratory chemical analysis:[6]
  - 12 sites at Orokolo Bay
  - 4 sites along the offshore pipeline route from Orokolo Bay to Caution Bay
  - 8 sites at Caution Bay.
- 'Once off' benthic macroinvertebrate sampling (three replicates per site):
  - 12 sites at Orokolo Bay

[5] Grab samples would not be collected mid-water column in shallow waters (i.e., less than 20 m depth).
[6] Sampling for macroinvertebrate and chemical analysis will be depth-dependent based on the draft of a vessel equipped with a winch. Sampling in shallower nearshore areas (e.g., less than 3 m depth) will not be undertaken; however, these environments are not expected to be substantially different from deeper nearshore areas with regards to providing an understanding of the characteristics of the nearshore environment for the purpose of the EIS.

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– 4 sites along the offshore pipeline route from Orokolo Bay to Caution Bay

– 8 sites at Caution Bay.

Table 7.1 describes each of these methods and the relevant justification.

Table 7.1 – Description of Proposed Sampling Methodology

Sampling Activity	Description	Justification
Ground-truthing of intertidal habitat types	Intertidal communities and habitat types will be ground-truthed using maps produced from low-level aerial photography (or other available aerial photography). This will include describing existing communities (e.g., mangroves and saltmarsh) using a rapid assessment of cover and identification of dominant structure-forming vegetation	Rapid assessment deemed acceptable for the purposes of identifying dominant intertidal habitat types
Description of coastal geomorphology features	Visual observations and descriptions of coastal geomorphology features will be made, including location of beaches and dune systems, rocky outcrops, and evidence of coastal processes	Rapid assessment deemed acceptable for identifying key geomorphological features
Analysis of PSD in intertidal area	Samples will be collected from surface material at points within the intertidal zone of the pipeline corridor that represent distinct sediment types. Sediment grain size (PSD) of these samples will be assessed	PSD provides the clearest indication of sediment types within the intertidal area NB – A 0.028 m^2 grab sampler may be used to collect these sediment samples for PSD assessment. This is because such samples may need to be collected in shallow waters from the tender vessel, which does not have mechanical lifting mechanisms This sampling is additional to sediment sampling requirements described in GS EP ENV 112
Acoustic habitat mapping and ground-truthing	A 450 kHz CHIRP side scan sonar (SSS) will be used to record surface textures to determine reef areas from soft sediment areas Types of soft sediment habitat will be discriminated by analysis of single-beam 200 kHz backscatter data, using QTC IMPACT software. Single beam data will be collected concurrently with SSS data by running the SSS towfish behind the vessel 200 kHz sounder. Preliminary spatial analysis at the end of the sonar acquisition will then allow ground-truthing of the acoustically defined habitats during the same survey Ground-truthing will occur by lowering a high definition drop-camera over the habitat and recording the duration and distance of drift, and the types of communities observed within each habitat	Lateral sweep sonar for assessing seabed and benthic morphology is described in TOTAL's GS EP ENV 112. SSS has been accepted as a suitable acoustic technique for seabed classification by Geoscience Australia (2015b; see also Penrose et al. 2005) and has been used successfully in environmental studies in Australia Use of QTC IMPACT for sediment classification has also been endorsed by Geoscience Australia (2015a) and used successfully in conjunction with SSS

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Table 7.1 – Description of Proposed Sampling Methodology (cont.)

Sampling Activity	Description	Justification
Acoustic habitat mapping and ground-truthing (cont'd)	In reefal areas where visibility is limited, benthic grabs (0.1 m^2 and 0.028 m^2) will be used to assess the sediment and epibenthic community composition. In soft sediment areas where visibility is limited, benthic sleds will also be used to investigate epibenthic communities Additional PSD samples will also be taken to validate the sediment maps derived by the analysis of 200kHz backscatter **Note:** Ground-truthing is a qualitative assessment undertaken to verify the results of acoustic habitat mapping. No quantitative analyses will be undertaken of samples collected during ground-truthing. This is distinct from benthic invertebrate and sediment sampling	Proposed ground-truthing and validation techniques are commonly used for these purposes and specifically target the same data as collected by acoustic habitat mapping
Other subtidal habitat mapping	Maps will be developed of potential benthic habitat types based on the results of PNG LNG EIS surveys. Ground-truthing activities will then be undertaken at these sites using a high definition drop-camera or benthic grabs (depending upon visibility)	Proposed ground-truthing and validation techniques are commonly used for these purposes and specifically target the same data as collected by previous studies NB – A 0.028 m^2 grab sampler may be used to collect qualitative sediment samples for the purpose of ground-truthing (rather than a larger 0.1 m^2 grab sampler used to obtain samples for laboratory analysis). This is because such samples may need to be collected in shallow waters from the tender vessel, which does not have mechanical lifting mechanisms. This sampling is additional to sediment sampling requirements described in GS EP ENV 112
Water quality instrument deployment	Two YSI 6600 or McVan water quality instruments will be deployed at Orokolo Bay. These instruments will be calibrated to record continuous turbidity data Where sensitive receptor sites (e.g., coral, seagrass) are identified at Orokolo Bay, instruments will be deployed close to these receptors and retrieved during the second marine survey Where sensitive receptor sites are not present, instruments will be deployed only for the duration of Orokolo Bay surveys	IFC PS 3 requires impacts associated with discharges into water environments to consider the ambient water quality conditions for the purposes of determining impact thresholds. In the context of the Project this relates to sedimentation impacts from 'ploughing' of the pipeline As ambient water quality conditions in marine environments are subject to both tidal and seasonal conditions, longer-term data sets are required to appropriately characterise these conditions NB – Data collection at Caution Bay is not considered necessary given the high level of data already available from previous studies

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Table 7.1 – Description of Proposed Sampling Methodology (cont'd)

Sampling Activity	Description	Justification
In situ water quality measurements	Logging observations measuring in situ physical water quality parameters from surface to seafloor using a calibrated YSI probe	Collects parameters as per requirements of TOTAL's GS EP ENV 112
Water sampling	A 5 litre water sampler (Niskin®) will be used to collect water samples at surface, mid-water and near bottom depth horizons (dependent on water depth of sampling location) Water samples will be packed immediately in suitable containers, appropriate for the parameters to be analysed, and numbered and stored cool The following basic information will also be gathered and recorded: sample coordinates, sampling depth, sampling method, precipitates, odour, bacterial aggregates, algae, gas bubbles and packing	Methodology as per TOTAL's GS EP ENV112
Sediment sampling	Seafloor sediments will be sampled at the same site where water quality samples have been taken using a Van Veen grab and placed into a tray for filling into a sample container. The sample will be packed into a sampling bottle appropriate to the parameters being tested for, as provided by the relevant laboratory Sediment samples will be packed immediately in suitable containers, adapted to the parameters to be analysed, and numbered and stored cool. One photo shall be taken for each freshly collected sample	Methodology as per TOTAL's GS EP ENV 112
Macroinvertebrate sampling	At each location three seafloor sediment samples will be collected using a Van Veen grab sampler. Collected sediment will be run through a 1 mm sieve and retained benthic infauna collected and preserved in 10% formalin in seawater	Methodology as per TOTAL's GS EP ENV 112

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8. Survey Personnel and Equipment

8.1 Technical Specialists

The survey team for the marine studies will include the following technical personnel:

- Conor Jones – Senior Marine Biologist (BTM WBM).
- Brad Hiles – Senior Aquatic Ecologist or Daniel Moran – Aquatic Ecologist (BTM WBM).
- Ninkama Yoba – Community Liaison and Aquatic Ecologist (Ninkama Yoba and Associates).
- Harry Hughes – Marine Scientist (ERIAS Group).

The credentials of the field team are provided in Appendix 1.

8.2 Survey Equipment

8.2.1 Acoustic Survey

The acoustic survey equipment described below is commonly used for seafloor habitat mapping. Studies have shown that the sounds emitted by these instruments are well below levels that cause physical injury to fish and marine mammals.[7]

No permit is required from the PNG Conservation and Environment Protection Authority to operate these acoustic survey instruments.

Single Beam Echo Sounder

A dual beam 200kHz and 50kHz Hondex Model 7300 echo sounder interfaced to the Quester Tangent Corporation (QTC) View Series 5.5 will be used to collect the single-beam backscatter data. The system consists of hydrographic survey hardware and software components tailored to acoustic seabed discrimination based upon the shape of acoustic sonar returns from the seabed (Plate 1).

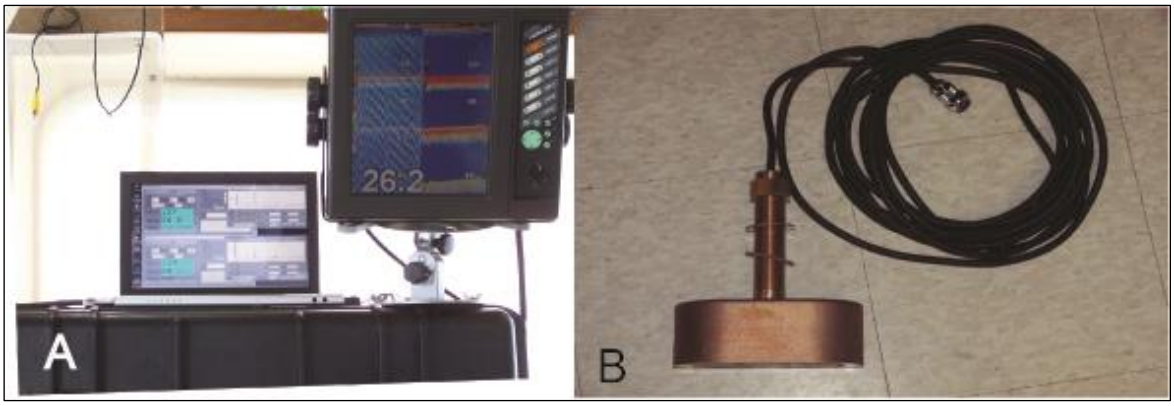
The system records the characteristics of the reflected acoustic waveforms to generate habitat classifications, based upon the diversity of scattering and penetration of the acoustic signal from varying types of seabed. The process involves collection of acoustic data which are time stamped and geo-referenced using dGPS. The raw acoustic data are stored in real-time on a laptop computer running the QTC View Series 5.5 software.

The 200 kHz frequency has consistently provided reliable surface seabed habitat descriptions in studies by BMT WBM and others. However, the 50 kHz frequency can also provide classification of sediments up to 10 cm deep in coarse calcareous sands (and deeper in muddy substrates), but has less resolution to discern differences in the sediment surface type, such as bedforms and sand ripples.

[7] See https://journals.plos/plosone/article?id=10.1371/journal.pone.0095315

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Plate 1 – Acoustic Seabed Classification Equipment



Side Scan Sonar

Side scan sonar (SSS) images of surface textures will be collected using a portable SSS which uses advanced digital CHIRP acoustic techniques to provide better range resolution compared to conventional, fixed-frequency side scan sonars. The beam width will be set to 50 to 100 m either side of the vessel depending on sea conditions, tow-speed and tow-depth, to optimise pixel resolution and swath width. The total swath width will vary between 100 and 200 m.

8.2.2 Ground-truthing and Sediment Sampling

Photography

Drop camera underwater footage will utilise a wide-angle, high-definition camera (GoPro Hero4 Silver) with live feed to surface to record imagery of the seafloor and epibenthic communities. Additional 1800 lumen lights can be mounted for deeper or low-light deployments. The system is capable of operating to 50 m depth under low-current speeds using a live-to-surface feed cable. A 'blind' feed cable also allows operation to 100 m depth. A back-up camera will be provided.

A high-definition digital camera (Panasonic Lumix FT4) will be used for other photography. The camera is waterproof to 12 m depth, and includes a compass and GPS tagging. A back-up camera will be provided.

Sediment Sampling

A 0.1 m^2 gape Van Veen grab (Plate 2) will be used for sampling of sediment for quantitative laboratory analysis of sediment chemistry and benthic infauna. A smaller (0.028 m^2 gape) Van Veen grab may be used for qualitative ground-truthing as part of acoustic habitat mapping, since the larger Van Veen grab cannot be used in shallow water from a tender as it requires lifting mechanisms (e.g., davit and winches) to enable safe operation.

Epibenthos Sampling

A benthic beam trawl (Plate 3) fitted with 20 mm mesh (bottom) and 2 mm mesh (top and sides) will be used to collect epibenthos overlying soft seafloor sediments in the event that turbidity is too high to use visual methods.

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Plate 2 – Van Veen Grab Sampler



Plate 3 – Benthic Beam Trawl



8.2.3 Water Quality Sampling

Five litre Niskin® water samplers will be used to obtain grab samples of water from the surface, middle and bottom of the water column.

In situ profile measurements of water quality properties (turbidity, conductivity, temperature and depth) will be undertaken using a YSI 6600 multi-probes, with data throughout the water column continuously logged and stored on a handset.

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Temporal measurements of water quality (turbidity, conductivity and temperature) will be undertaken in Orokolo Bay using a YSI 6600 or McVan turbidity sensor and CTDs deployed on hoop frames, as shown in Plate 4.

A spare YSI 6600 sonde, McVan turbidity sensor and CTD will be taken for the first survey (in the dry season), and a spare YSI 6600 sonde will be taken on the second survey (in the wet season) in case of equipment failure.

Plate 4 – Water Quality Instrument Deployment Set-up



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9. Sampling Sites

Sites for sampling have been identified based on the following key parts of the study area:

- Orokolo Bay.
- Offshore pipeline corridor within the Gulf of Papua, between Orokolo Bay and Caution Bay.
- Caution Bay.

Table 9.1 lists the sites to be sampled along with a justification for selection of the site. The locations of proposed sites are shown in Figure 2, Figure 3 and Figure 4. All sites have been selected by reference to existing satellite and aerial imagery, but are currently indicative as the exact location of activities may change depending upon the habitat types identified in the area by acoustic habitat mapping. Actual locations will be recorded in the field using GPS to an accuracy of ±4 m.

In addition, Table 9.1 describes the proposed acoustic transects and the sites for placement of water quality instruments for continuous water quality data collection. These sites are shown in Figure 2. Coordinates are provided in Appendix 2.

Table 9.1 – Description of Study Sites

Site	Justification
Orokolo Bay (see Figure 2)	
M1–M12	Indicative points have been identified at present within the context of the acoustic survey lines and depth contours. Sites will be selected in the field on the basis of the results from acoustic habitat mapping as this will identify the variety of habitat types in Orokolo Bay. It is intended that sites will be sampled across all the relevant depth contours in the pipeline corridor Note**:** These sites are spread across multiple potential pipeline routes such that, when a final route has been selected, a number of sites will serve as reference sites
Acoustic transects	*Dry season transects*: These transects have been set out to capture the likely pipeline route for each of the potential onshore crossing locations, in order to identify any potential sensitive receptor or high environmental values areas. It is understood that this information would then be considered by TOTAL (together with other factors) to identify a single pipeline route *Wet season transects:* Transects have been laid out across Orokolo Bay to capture all potential sensitive receptor features. Particular attention has been provided to geomorphological features identified from bathymetric charts (i.e., rises), which may support corals and sponges or otherwise form important habitat for marine species Note: These transect lines may be subject to change if a defined pipeline route is adopted prior to the commencement of the wet season survey
Ground-truthing	Ground-truthing (drop camera/benthic grab sampling) will be undertaken at additional locations to sites selected for sediment sampling and laboratory analysis to provide additional information on seafloor habitat An additional ground-truthing site has been identified in the Purari River delta in Alele Passage to supplement works being conducted as part of the estuarine ecology surveys

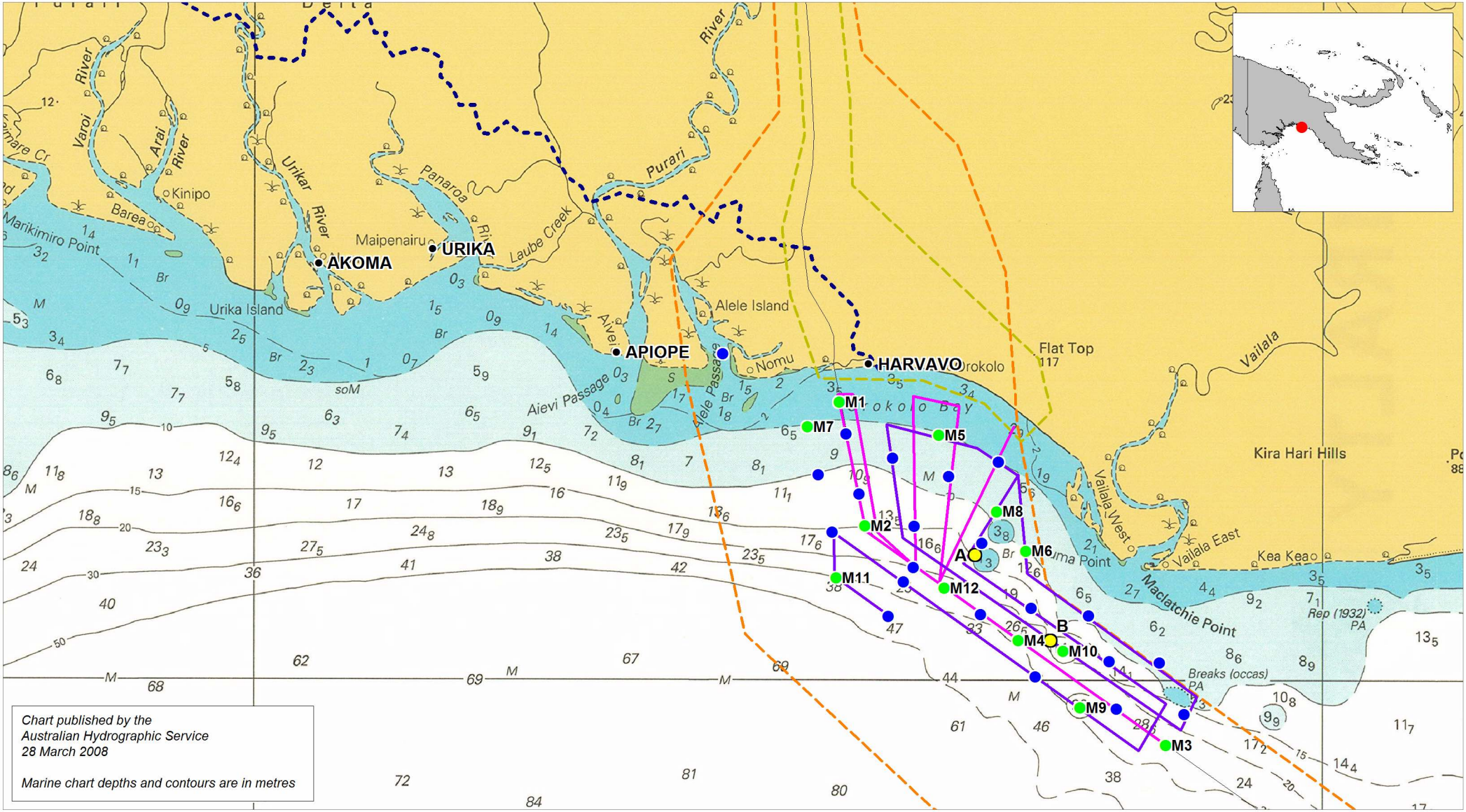
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Table 9.1 – Description of Study Sites (cont.)

Site	Justification
Instrument Deployment Sites (see Figure 2)	
Note: These two sites have been selected as the sites most likely to host sensitive receptors (e.g., coral)	
A	Aus378 (AHS 1992) shows a rise in seafloor bathymetry from 15 m deep to 1 m deep southwest of Vailala West. This feature is expected to be a reef formation and thus could potentially provide habitat for hermatypic coral and sponge assemblages and/or for other marine flora and fauna These features may therefore be sensitive receptors in the potential impact area. Collection of water quality data adjacent to these receptors will provide an indication of natural tolerance thresholds for the purpose of impact assessment
B	Aus378 (AHS 1992) shows a rise in seafloor bathymetry from 20 m deep to 14 m deep south of the Vailala River mouth. This feature is expected to be a reef formation and thus could potentially provide habitat for ahermatypic coral and sponge assemblages and/or other marine flora and fauna. This site contrasts from site A in that it is deeper and thus less likely to be impacted by surface level freshwater flows Ecological features potentially associated with the rise may represent sensitive receptors in the potential impact area. Collection of water quality data adjacent to these receptors will allow for an indication of natural tolerance thresholds for the purpose of impact assessment
Offshore Pipeline Corridor (see Figure 3)	
M25-M44	20 sites spaced along the offshore pipeline corridor. Sites are spaced evenly to the greatest extent possible
Caution Bay (see Figure 4)	
M13	*Reference site*. Site selected within the likely pipeline corridor to provide an indication of water quality and benthic ecology in deeper water areas
M14-M20	Indicative points have been identified at present within the context of the acoustic survey lines and depth contours. Sites will be selected in the field on the basis of the results from acoustic habitat mapping, as this will identify key habitat areas and geomorphological features in the context of the pipeline corridor
M21	Nearshore site selected within the vicinity of the existing PNG LNG Project pipeline to provide context for the existing impacted environment. The site has been co-located with an expected coral reef assemblage
M22	*Reference site*[#]. Site located south of pipeline corridor to provide broader environmental context
M23	*Reference site*[#]. Site located north of pipeline corridor to provide broader environmental context
M24	*Reference site*. Site located south of pipeline corridor to provide broader environmental context. Site has been co-located with an expected coral reef assemblage
Acoustic survey transects	Transects laid out in the nearshore pipeline corridor route. It is anticipated that transects will cover the entire pipeline corridor. This will allow for an indication of all the habitat types occurring within pipeline infrastructure area
Ground truthing sites	Ground truthing (drop camera/benthic grab) will be undertaken along the acoustic transects at additional locations to the grab sampling sites Additional ground truthing sites have been identified in conjunction with known coral and seagrass community areas based on studies conducted for the PNG LNG Project. This will assist in providing an updated baseline for the broader region

These sites are characterised as 'reference sites' as they are unlikely to be impacted by the Papua LNG Project. While there is the potential the PNG LNG project has caused some change in conditions at these sites comparative to the initial baseline, for the purposes of the Papua LNG project these sites constitute the *present* baseline and are therefore suitable as reference sites.

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LEGEND

- Town/Village
- Water, Sediment and Invertebrate Sites[1]
- Ground-truthing Sites
- Instrument Sites

1. Sites M1, M2, M5, M6, M7, M8 and M10 will be sampled for water quality at surface and seafloor only

- Acoustic Survey Lines (Dry Season)
- Acoustic Survey Lines (Wet Season)
- Indicative Estuarine/ Freshwater Boundary
- Pipeline Corridor
- Narrowed Onshore Pipeline Corridor

Title:

Location of Proposed Study Sites in Orokolo Bay

Figure: 2

Rev: B

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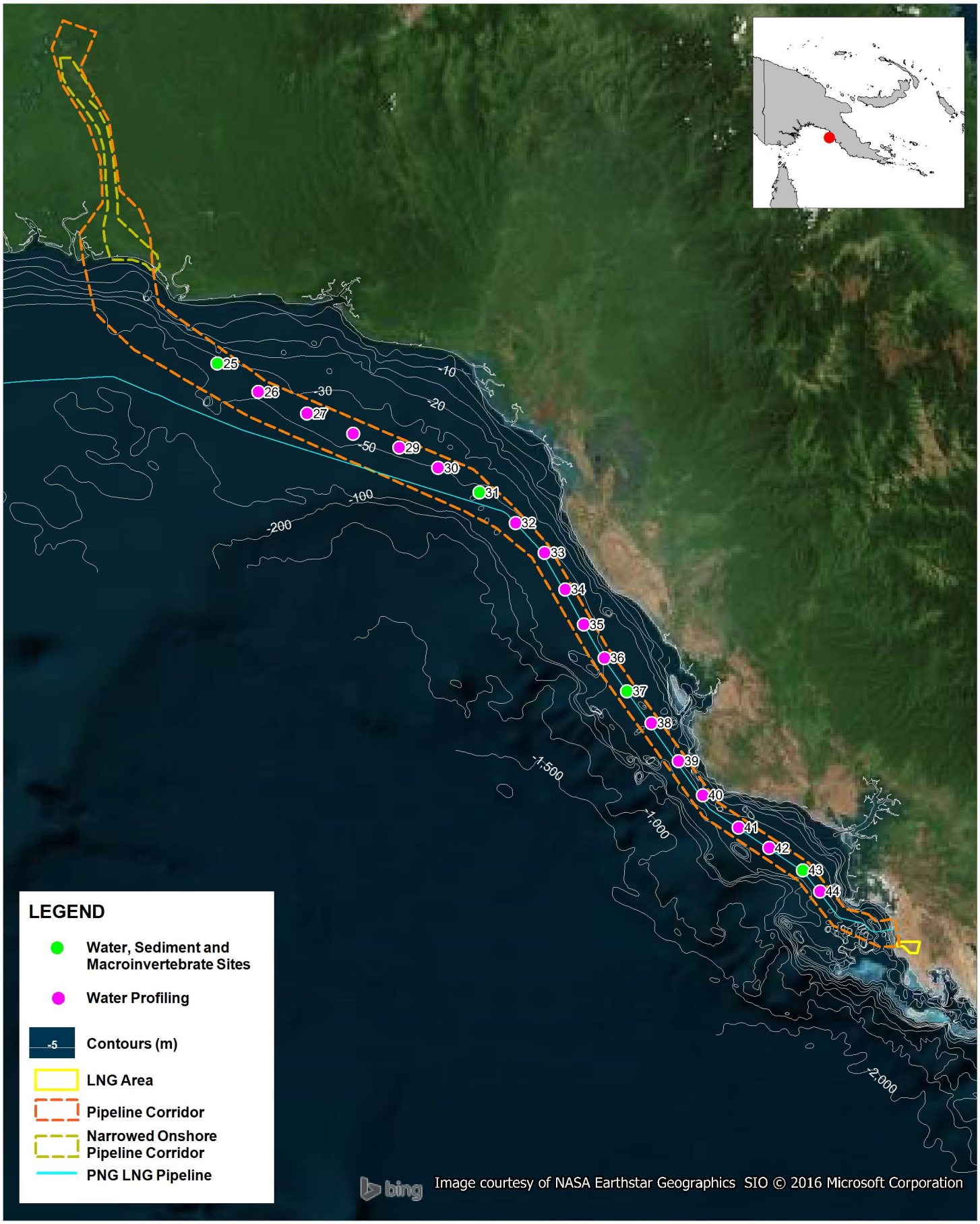
N

0km 5 10

Approx. Scale

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Title:

Location of Proposed Study Sites in Offshore Pipeline Corridor

Figure: 3

Rev: B

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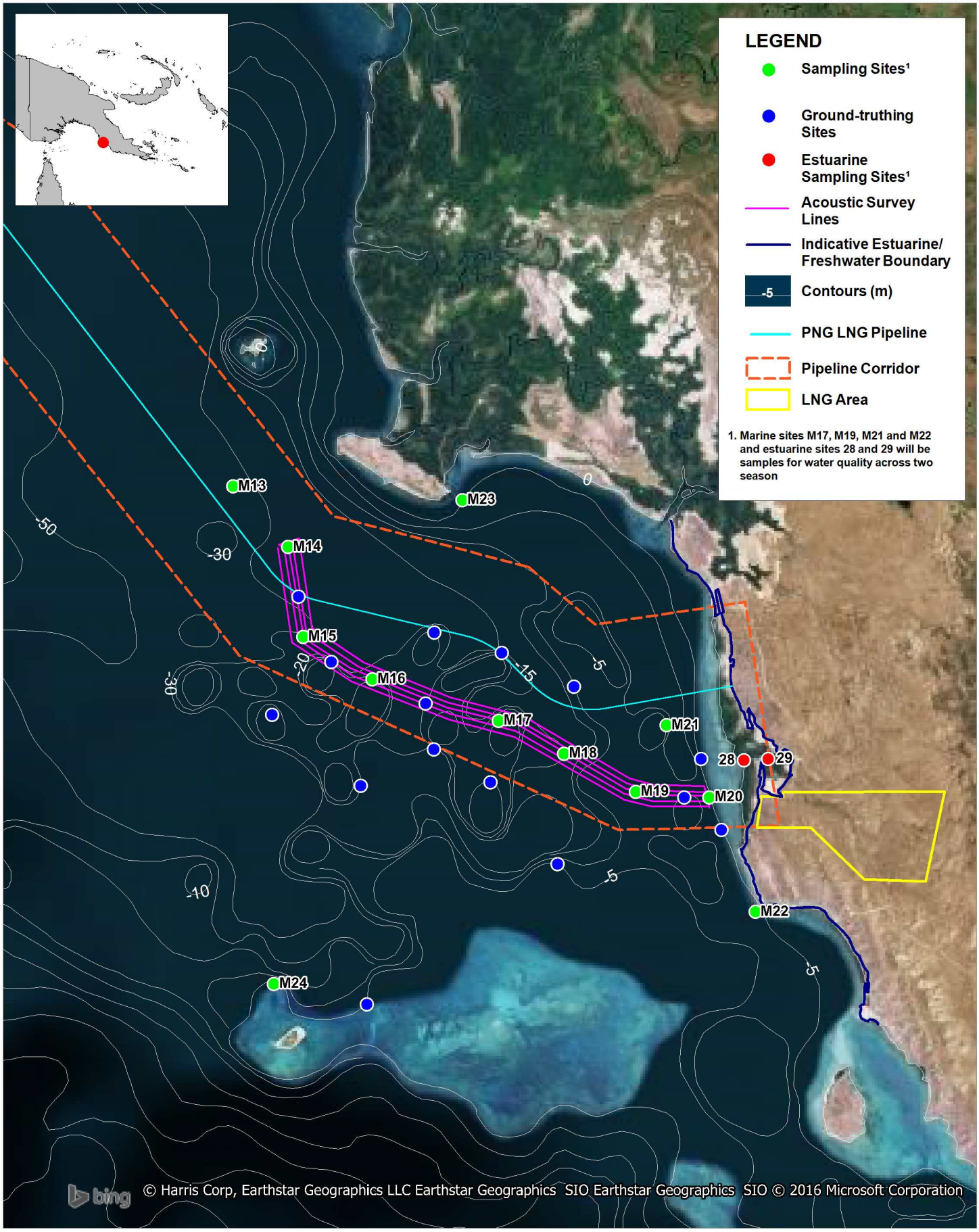
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Approx. Scale

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Title:

Location of Proposed Study Sites at Caution Bay

Figure: 4

Rev: B

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10. Collected Samples

10.1 Sample Storage

10.1.1 Biological Samples

Benthic macroinvertebrate and infauna samples will be placed into 600 mL screw top containers and preserved using a 10% buffered formalin solution. Field personnel will carry the appropriate formaldehyde safety data sheets (SDSs) and personal protective equipment (PPE) and knowledge of handling formalin. Samples will be sent to Dardanus Scientific (see below) for specimen identification and enumeration.

10.1.2 Water and Sediment Samples

Water and sediment samples will be preserved as per recommendations provided by the primary NATA-accredited analytical laboratory, Australian Laboratory Services (ALS) Brisbane. Sample containers are provided pre-dosed with appropriate volumes of preservatives where required. Samples will be transported to ALS under their import permits.

10.2 Sample Analyses

10.2.1 Biological Samples

Macroinvertebrates will be analysed by Stephen Cook of Dardanus Scientific. This analysis will be undertaken to a morpho-species level for all samples. Stephen is former curator of invertebrates at Queensland Museum and holds AusRivAS accreditation for Module 3 – Laboratory. A copy of this accreditation certificate is provided in Appendix 3.

10.2.2 Water and Sediment Samples

Water and sediment quality samples will be analysed by ALS Brisbane, with the Australian Government National Measurement Institute (NMI) used as a secondary laboratory for quality assurance purposes. No laboratories are available in Papua New Guinea that are accredited to conduct the required analyses. Table 10.1 lists the parameters to be tested with the associated analysis method and limits of reporting. ALS Brisbane is accredited under ISO 17025 for these analyses. A copy of the accreditation certificate is provided in Appendix 3.

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Table 10.1 – Water and Sediment Analyses

Parameter	Analysis Method	Limits of Reporting
ALS (Water)		
TSS	APHA 2540 D (gravimetric, dried at 103-105ºC)	5 mg/L
BTEX/PAH	Gas chromatography-mass spectrometry (GC/MS)	1-5 µg/L
TPH	Gas chromatography-flame ionisation detector (GC-FID)	20-100 µg/L
Chlorophyll a	APHA 10200 H	1 mg/m^3
Ammonia	APHA 4500 NH_3^- - H (flow injection analysis phenate method)	0.01 mg/L
Nitrite	APHA 4500-NO_2^- I (flow injection analysis)	0.01 mg/L
Nitrate	APHA 4500-NO_2^- I (flow injection analysis)	0.01 mg/L
Nitrite and Nitrate	APHA 4500-NO_2^- I/NO_3^- I (flow injection analysis)	0.01 mg/L
Total phosphorous	APHA 4500 P – H (manual digestion and flow injection analysis)	0.01 mg/L
Reactive phosphorous	APHA 4500 P – F (flow injection analysis)	0.01 mg/L
Total nitrogen	APHA 4500 N_{org}/NO_3 (flow injection analysis)	0.01 mg/L
Total metals (Al, As, Ba, Cd, Co, Cr, Cu, Fe, Ni, Pb, Sr, V, Zn)	APHA 3125B ORC/ICP/MS (octapole reaction cell/inductively coupled plasma - mass spectrometry (ORP/ICP-MS))	Cu, Ba: 1 µg/L Cd, Co, Pb: 0.2 µg/L As, Cr, Ni, V: 0.5 µg/L Al, Zn: 5 µg/L Sr, 10 µg/L
Hg	Cold vapour atomic absorption spectrometry (CV AAS)	0.0001 mg/L
ALS (Sediment)		
Moisture	In-house (gravimetric)	1%
PSD	AS1289 3.6.3 (sieving and hydrometer)	1%
Total phosphorous	APHA 4500 P – H (flow injection analysis)	2 mg/kg
Total nitrogen	APHA 4500 N_{or}/NO_3 APHA 4500 $NO_2/_3$ (flow injection analysis)	TKN, NH_4, TN: 20 mg/kg, NO_2
BTEX/PAH	USEPA 3640/827- (GC-MS)	0.2-1.0 / 0.5-2.0 mg/kg
TPH	USEPA 5030/8260 (GC/FID)	10-100 mg/kg
Organic matter and TOC	AS 1289.4.1.1 – 1997/NEPM (high temperature combustion)	0.5%
Total metals (Al, As, Ba, Fe, Sr)	USEPA 200.2 (mod) (inductively coupled plasma - atomic emission spectrometry (ICP/AES))	Al, Fe: 50 mg/kg As: 1 mg/kg Sr: 2 mg/kg Cr, Cu: 0.1 mg/kg Ba: 10 mg/kg
Total metals (Cd, Co, Cr, Cu, Pb, Ni, V, Zn)	USEPA 6020 ICP/MS	Zn: 0.5 mg/kg V: 1 mg/kg Others: 0.1 mg/kg
Total Hg	APHA 3112 Hg-B (CV AAS)	0.1 mg/kg

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11. Quality Control

11.1 Sample Collection, Handling, Storage and Transport

To ensure good quality data are collected during the field program, a number of quality assurance (QA) and quality control (QC) procedures are adhered to during all field work, as follows:

- Use and maintenance of appropriate sampling equipment, and implementation of appropriate calibration procedures (including use of controlled standard solutions provided by ALS in Brisbane).
- Proper sampling techniques utilised in accordance with relevant water and sediment quality sampling guidelines and standards (e.g., AS/NZS 5667.1:1998 and AS/NZS 5667.12:1999).
- Sample containers clearly and accurately labelled and a log of collected samples maintained and updated.
- Chain of custody forms maintained and included with samples.
- Data validation including cross-checking by a second scientist after entry into the database.

Water sample preservation and handling procedures will be followed and samples supplied to the laboratory within nominated holding times where practicable.

11.2 Control Samples

A range of additional samples will be collected for QC purposes to assess the repeatability and precision of laboratory results, and will include the following:

- Intra-laboratory duplicates – water/sediment samples will be split into two duplicate sub-samples and tested as separate (blind) samples by the primary laboratory (ALS). Intra-laboratory duplicates are collected at 10% of monitoring sites.
- Inter-laboratory duplicates – water/sediment samples will be split into two duplicate sub-samples and tested as separate (blind) samples by the primary laboratory (ALS) and a second independent laboratory (NMI). Inter-laboratory duplicates are collected at 5% of monitoring sites.
- Field blanks – samples taken in the field using laboratory supplied deionised distilled water which is placed into sample containers the same way as normal samples (i.e., using sampling equipment). Field blanks are taken once per monitoring event, and are used to test for sample contamination from sampling personnel, equipment, or the atmosphere.
- Trip blank samples – pre-filled sample bottles (with deionised distilled water) supplied by ALS to test for contamination of volatile substances (such as hydrocarbons) during storage and transport of samples.

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11.3 Laboratory Quality Control Measures

ALS in Brisbane will be the primary laboratory used for water sample analyses. Inter-laboratory duplicates will be sent to NMI. Both these laboratories are NATA-accredited and as such have strict quality assurance and quality control procedures in place.

Routine laboratory control procedures at ALS include:

- Certified reference materials.
- Laboratory duplicates.
- Laboratory control spikes.
- Matrix spikes.
- Surrogates.
- Secondary and project standards.
- Inter-laboratory (proficiency) testing.
- Client and industry managed independent audits and accreditations.

Water samples are stored by the laboratory for two weeks after release of analysis results, whereas sediment samples are retained for 90 days (in case check analyses are required).

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12. Summary

This report provides a comprehensive description and rationale of the scope and methods that will be used to characterise marine water and sediment quality, marine biodiversity, physical oceanography and seabed and coastal geomorphology of the Papua LNG Project area. The approach consists of desktop bibliographic reviews supplemented by field surveys and numerical modelling to fill any gaps in data necessary to describe baseline conditions and prepare the environmental impact assessment, including identification of potential critical habitat or other significant environmental features.

The study approach and design was guided by the following guidelines and specifications and developed based on the Project description provided by TOTAL at the time of preparation of this document:

- PNG Conservation and Environmental Protection Authority (CEPA) guideline GL-Env02/2004: Guideline for Conduct of Environmental Impact Assessment & Preparation of Environmental Impact Statement (CEPA, 2004).
- TOTAL General Specification GS EP ENV 112: Environmental Baseline and Monitoring Studies: Offshore and Nearshore Sites (TOTAL, 2012) and GS EP ENV 111: Environmental Baseline and Monitoring Studies: Onshore Sites (TOTAL, 2012).
- TOTAL General Specification GS EP ENV 120: Environmental impact assessment of E&P activities (Total, 2007).
- TOTAL General Specification GS EP GEO 504: Comprehensive Evaluation of Metocean Conditions (TOTAL, 2013).
- International Finance Corporation (IFC) Performance Standards (especially Performance Standards 1, 3 and 6) and Guidance Notes.

The study design has been developed in consultation with TOTAL. The scope and methods for the marine studies are considered suitable to meet the requirements of the above guidelines and TOTAL's General Specifications.

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Appendix 1

Marine Survey Team Credentials

Appendix 1 – Marine Survey Team Credentials

The qualifications and experience of the marine field survey team are outlined in Table 1 below.

Table 1 – Marine Survey Team Specialist Qualifications and Experience

Personnel	Role	Credentials
Dr Conor Jones (BMT WBM)	Senior Marine Biologist	Bachelor of Science (Marine Biology) 1st Class Honours (Marine Parasitology/Marine Biology) Doctor of Philosophy (Marine Parasitology/Ecology) 16 years of experience
Brad Hiles (BMT WBM)	Senior Aquatic Ecologist	Bachelor of Applied Science Bachelor of Education 8 years of experience
Daniel Moran (BMT WBM)	Aquatic Ecologist	Bachelor of Marine Studies 1st Class Honours (Marine Ecology/Marine Evolutionary Ecology) 5 years of experience
Ninkama Yoba (Ninkama Yoba & Associates)	Community Liaison and Aquatic Ecologist	Bachelor of Science 13 years of experience
Harry Hughes (ERIAS Group)	Marine Scientist	Bachelor of Science (Honours) Marine Biology and Ecological Management 5 years of experience

Appendix 2

Coordinates of Sampling Sites

Study Area	Site	Longitude	Latitude
		(WGS84)	
Marine sites			
Orokolo Bay	M1	145.27448	-7.870057
	M2	145.286573	-7.927804
	M3	145.427321	-8.030354
	M4	145.358308	-7.981364
	M5	145.321091	-7.885546
	M6	145.361872	-7.939611
	M7	145.259665	-7.881584
	M8	145.348191	-7.921208
	M9	145.387214	-8.012703
	M10	145.379265	-7.986407
	M11	145.273035	-7.952096
	M12	145.32362	-7.956869
Caution Bay	M13	146.869846	-9.277466
	M14	146.884815	-9.293712
	M15	146.888878	-9.317768
	M16	146.907774	-9.329183
	M17	146.942079	-9.340335
	M18	146.959855	-9.349162
	M19	146.979414	-9.359326
	M20	146.999434	-9.360864
	M21	146.987715	-9.341523
	M22	147.011961	-9.391556
	M23	146.932183	-9.281133
	M24	146.880965	-9.410869
Offshore Pipeline	M25	145.501914	-8.084702
	M26	145.592558	-8.147329
	M27	145.701121	-8.195253
	M28	145.803743	-8.240063
	M29	145.906365	-8.269933
	M30	145.99314	-8.314733
	M31	146.084444	-8.368488
	M32	146.165183	-8.43567
	M33	146.230075	-8.501348
	M34	146.27535	-8.581938
	M35	146.316514	-8.659201
	M36	146.36288	-8.732625
	M37	146.412682	-8.805708
	M38	146.467011	-8.875795
	M39	146.528131	-8.959286
	M40	146.581707	-9.033815
	M41	146.660935	-9.105348
	M42	146.729602	-9.150049
	M43	146.804434	-9.198948
	M44	146.842235	-9.244915
Estuarine Sites			
Purari	18	145.2439989	-7.6748675
	19	145.223255	-7.7388594
	20	145.271344	-7.837921
	21	145.23881	-7.827696
	22	145.255296	-7.791244
Urika	23	145.010788	-7.78002
	24	145.008847	-7.79638
Vaihua	28	147.008769	-9.350952
	29	147.015366	-9.350532

Appendix 3

Laboratory Accreditation Certificates

QLD AUSRIVAS ACCREDITATION ASSESSMENT RESULTS SUMMARY

This assessment sheet provides the mark attained by the AUSRIVAS course participant named below against the criteria and mark needed for AUSRIVAS accreditation purposes. AUSRIVAS accreditation requires trainees to achieve the standards specified by the relevant National River Health Program (NRHP) lead agency.

AUSRIVAS-course participant's name: **Stephen Cook**

AUSRIVAS ACCREDITATION COMPONENT	Participant's MARK (%)	PASS MARK REQUIRED FOR ACCREDITATION (%)
1 – PRE-FIELD AND SITE INFORMATION		
Exercise 1 (map work)	NA	≥80
2 – FIELD WORK		
Exercise 1 & 2 (Field data)	NA	≥80
Exercise 3 (Macroinvertebrate & water sample collection)	NA	≥80
Exercise 4 (Live-sorting)		
❑ % number of taxa, % common taxa, % Predicted taxa – Averaged for 2 habitats	NA	≥80
❑ Bray Curtis similarity - Averaged for 2 habitats	NA	≤0.30
❑ Samples sorted according to protocol	NA	
3 - LABORATORY		
Macroinvertebrate identification exercise 1 & 2:	95.45	≥95
4 – AUSRIVAS PREDICTIVE MODELS		
Data preparation & input	NA	≥80
Site assessment	NA	≥80
Interpreting AUSRIVAS results	NA	≥60

(NA = Not Assessed)

Organization conducting course: Institute for Applied Ecology, University of Canberra

Instructor's Signature:

Instructor's Name: Evan Harrison

Convener's Signature:

Course Convener: Susan Nichols

Date: February 13, 2012

NATA Accredited Laboratory

National Association of Testing Authorities, Australia
(ABN 59 004 379 748)

has accredited

ALS Laboratory Group
Brisbane Laboratory

following demonstration of its technical competence
to operate in accordance with

ISO/IEC 17025

This facility is accredited in the field of

Chemical Testing

for the tests shown on the *Scope of Accreditation* issued by NATA

Alan Patterson
Chief Executive

Date of accreditation: 10 April 1970
Accreditation number: 825
Corporate site number: 818

NATA
WORLD RECOGNISED
ACCREDITATION

NATA is Australia's government-endorsed laboratory accreditor, and a leader in accreditation internationally. NATA is a signatory to the international mutual recognition arrangements of the International Laboratory Accreditation Cooperation (ILAC) and the Asia Pacific Laboratory Accreditation Cooperation (APLAC).

Part 23G
Addendum to Marine Studies Scope and Methods

PAPUA LNG PROJECT

ADDENDUM TO MARINE STUDIES SCOPE AND METHODS

Version	Details	Prepared	Endorsed	Approved	Date Issued
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v2	Revised to client	C. Jones, J. Visser	C. Monahan, C. Coyne	N/A	14/12/16
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1. Introduction

A Scope and Methods document (ERIAS Group report ref. 01215B_6-5_v5) was prepared in June 2016 by ERIAS Group and BMT WBM that described the rationale of survey methods and survey instruments to be used for the following studies:

- Marine water and sediment quality.
- Marine biodiversity.
- Seabed and coastal geomorphology.

The study approach consisted of a bibliographic study of existing information supplemented by field surveys to fill any gaps in data necessary to prepare the environmental impact assessment.

As described in the Scope and Methods document, surveys are being undertaken in both the dry and wet seasons to capture the range in seasonal conditions. The 'dry season' survey was completed in June/July 2016, and was largely undertaken as described in that document. However some changes were made based on logistical considerations and information obtained while in the field. Some changes to the sampling in the January 2017 'wet season' (Phase 2) survey are also proposed considering information and results obtained from the June/July 2016 'dry season' survey.

This addendum document has been prepared to describe the proposed changes to the scope and methods for the Phase 2 'wet season' survey, to be conducted in January 2017.

Changes to the freshwater and estuarine component of the program are described in a separate document (Addendum to Freshwater and Estuarine Studies Scope and Methods – Report 01215B_6-13).

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2. Changes to 'Wet Season' Survey Scope and Methods

2.1 Sampling Site Locations

2.1.1 Site-based Sampling

The 'dry season' survey in June/July 2016 was undertaken at the locations proposed in the Scope and Methods document (ERIAS Group report ref. 01215B_6-5_v5) with the following exceptions:

- Site M6 at Orokolo Bay: the original location of this site was situated on a potential area of 'reef', as indicated on the nautical chart. However, site inspections undertaken in June/July 2016 did not identify any reefs at or adjacent to this location. This site was therefore moved (12.5 km southeast to 145.455618E; -8.011039S) in order to sample an actual reef structure in the study area.
- Site M21 at Caution Bay: This site was moved (to 146.987706E; -9.341529S) as the original coordinates were within a 500 m radius exclusion zone at the western end of the PNG LNG jetty.

These relocated sites will also be sampled in the 'wet season' survey in January 2017.

An additional two sites are also proposed to be sampled either side of the Purari River mouth (sites M45 and M46) during the January 2017 'wet season' survey. These sites are shown in Figure 2.1. In situ water profile measurements will be undertaken of the water column, and water and sediment samples will be collected for laboratory physico-chemical analysis. Sediment samples will also be collected for identification and enumeration of benthic macroinvertebrates. This will provide data on the existing environment at the Purari River mouth and inform the impact assessment, particularly in the event that dredging is proposed at the mouth to assist river navigability for barges.

2.1.2 Fixed instrument Deployments

The locations of the two instrument deployment sites at possible reef locations in Orokolo Bay (Sites A and B) were altered from the positions described in the Scope and Methods document. In this regard:

- Site A was relocated to a local 'mound' structure which was the highest value structure in the immediate vicinity, although not considered of high value generally. It is proposed that the instrument deployed at this site be deployed at an alternate site in the vicinity of the mouth of the Purari River (Site C). Deployment at Site C will provide data on background turbidity directly opposite the mouth of the Purari River in order to describe existing conditions and inform impact assessment. The proposed site is shown in Figure 2.1, however the final position will be decided in the field, considering actual observations of water depth and potential risks from river traffic.
- Site B was relocated to an actual reef environment located near site M6 (see Section 2.1.1). This reef was subject to highly turbid waters and did not support photosynthetic benthic organisms. The reef transitions to mud almost immediately, indicating that the reef is unlikely to support reef building corals, and communities would need to be tolerant of highly turbid

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conditions. It is proposed to again deploy an instrument at Site B during the 'wet season' survey in January 2017.

2.2 Acoustic Habitat Mapping

'Once-off' seabed habitat mapping surveys using side scan sonar and single beam backscatter collection was proposed to occur in the vicinity of the pipeline crossing in Orokolo Bay and Caution Bay. As described in the Scope and Methods document, these once-off surveys (and associated ground-truthing) were proposed to occur during the January 2017 wet season survey, to take advantage of the generally calmer sea conditions during the wet season. However calm conditions encountered during the dry season survey allowed completion of the once-off seabed habitat survey at Orokolo Bay. Seabed habitat mapping surveys and ground-truthing therefore do not need to be undertaken in Orokolo Bay during the January 2017 Phase 2 'wet season' survey.

Seabed habitat mapping remains to be completed in Caution Bay during the Phase 2 'wet season' survey, in accordance with the timing set out in the Scope and Methods document. However, the location of acoustic survey transect lines has been amended from that originally proposed in the Scope and Methods document. The transect lines originally proposed followed an expected pipeline alignment, subject to amendment following finalisation of the alignment. Given that the final alignment has not been decided, it is proposed to distribute the transect lines further apart noting that this gives less coverage in a particular spot but greater overall coverage. The proposed transect lines are shown in Figure 2.2. There would also be alterations to the locations of some of the ground-truthing sites (see Section 2.3).

NOTE: This amendment will provide for the characterisation of a broader area but will require interpolation of habitat types between transect lines based on expert opinion. However, this is considered appropriate for the purposes of the EIS/ESHIA and will enable production of habitat distribution maps for Caution Bay, verifying and updating habitat maps produced for the PNG LNG Project EIS.

2.3 Ground-truthing

The Scope and Methods document identified a number of proposed 'ground-truthing' sites, intended to be locations where a remotely deployed underwater video camera ('drop camera') would be used to validate data from acoustic habitat mapping. In order to maximise data collection opportunities, additional ground-truthing sites to those described in the Scope and Methods document will be investigated in Caution Bay, if time permits. The intention of these additional sites will be to validate previous sampling campaigns at Caution Bay (i.e., those undertaken when preparing the PNG LNG Project EIS). Investigation of these sites will provide an indication of the scale of impact and/or recovery to Caution Bay as a result of development of the PNG LNG Project.

Figure 2-2 shows indicative ground-truthing sites. These sites will be subject to refinement in the field based on findings of the acoustic transect surveys.

As described in Section 2.2, ground-truthing in Orokolo Bay was undertaken in conjunction with the acoustic habitat mapping completed in June/July 2016, and therefore is not required to occur during the January 2017 Phase 2 'wet season' survey. Notwithstanding, additional observations will be opportunistically undertaken during the survey, including at the reef habitat site (Site B/M6).

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All video footage obtained from drop camera will be downloaded on a daily basis in order to avoid data loss.

2.4 Caution Bay Sediment Sampling

Sampling of sediment in Caution Bay was proposed to occur during the Phase 2 'wet season' survey. However the potential risk from unexploded ordnances (UXOs) in Caution Bay remains unacceptable (no further investigation of their presence has been undertaken to date), hence intrusive sediment sampling is not to be undertaken during the survey.

2.5 Caution Bay Underwater Video

The habitat and reef community mapping described above will provide information on the nature of benthic (bottom-dwelling) flora and fauna. It does not provide information on types, diversity and abundance of fish that occur on reef habitats. As a value-add, it is proposed to deploy Baited Remote Underwater Video (BRUV) devices to survey reef fish communities at selected sites in Caution Bay. BRUVs provide a continuous video recording of fish and shark species drawn to the location by the use of camera-mounted bait (i.e., remains of oily fish, cat food, etc.). Based on a review of collected footage undertaken on return to the office, it is possible to undertake standardised counts of different fish species and therefore provide quantitative data on fish communities at different sites. Video footage obtained from the BRUV will be downloaded to a computer and back-up drive on a daily basis in order to prevent loss.

The use of a BRUV device differs from the use of drop-camera in regards to both the length/location of deployment and the use of bait. Also, rather than providing a close-up image of the bottom substrate, a BRUV captures an image horizontally through the water column and is therefore more limited by water visibility.

Indicative sites for BRUV deployment are shown in Figure 2-1, with coordinates for these locations as follows:

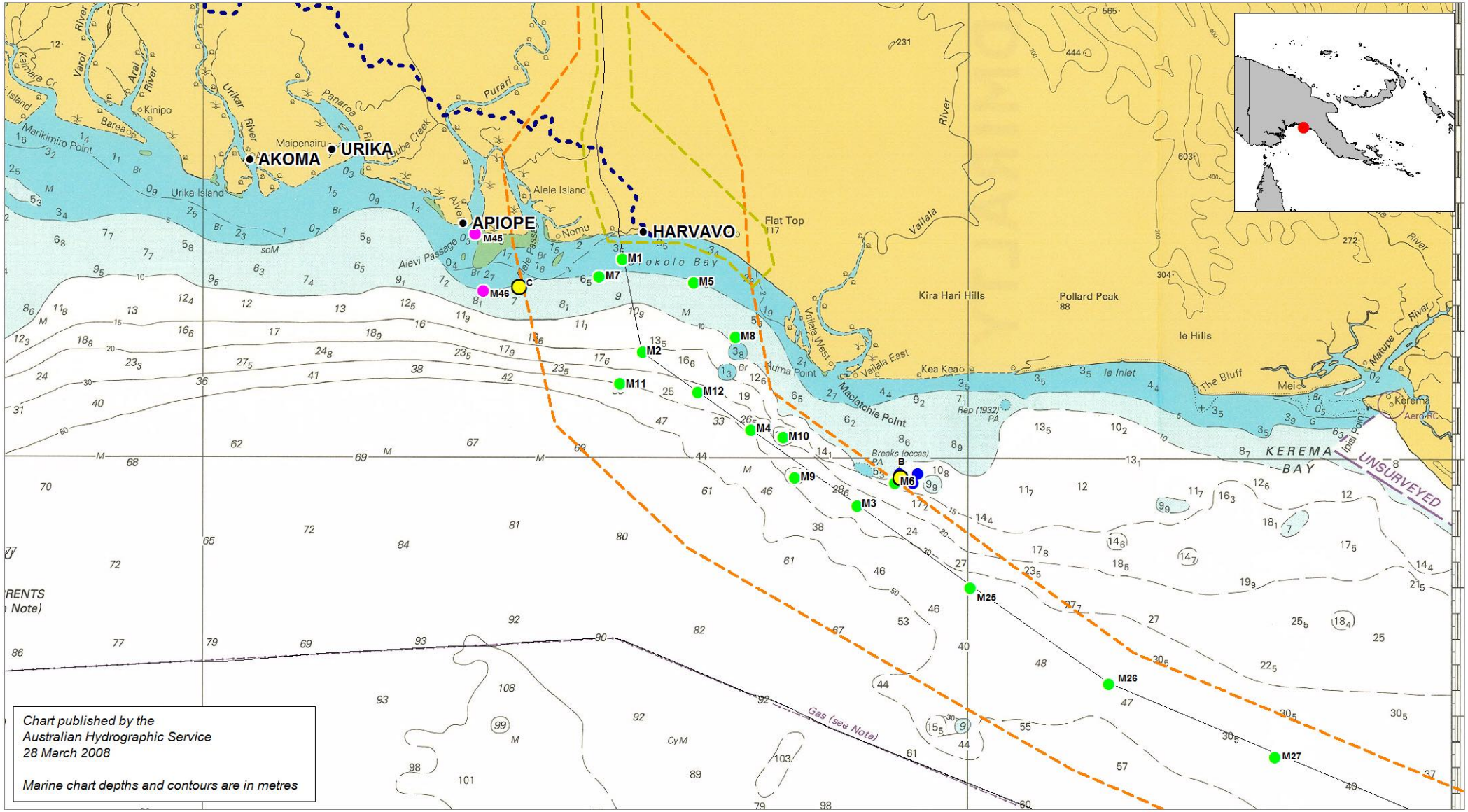
- B1: 146.994894 E; -9.360875 S.
- B2: 146.939719 E; -9.339447 S.
- B3: 146.885924 E; -9.413770 S.

The BRUV instruments would be deployed for the duration of sampling activities in the local area, usually for 30 minutes. BRUVs will be deployed using surface buoys which will be kept within visual range at all times during deployment.

Plate 2.1 shows the BRUV device while Plate 2-2 shows an example of footage obtained using the device.

NOTE: BRUVs are proposed for Caution Bay only. Reef and seagrass communities in this area represent significant habitat features that promote congregation of fish species that can be observed using BRUVs. These are considered to be important for characterisation due to the potential for significant impact/loss of these features. It is not proposed to deploy BRUVs at Orokolo Bay, which has lower habitat values due to the absence of reef and seagrass. High suspended sediment levels and associated turbidity also limit the effectiveness of BRUVs in this area. Fish catch information (from NFA data and community surveys) is considered more useful and relevant for the purpose of fish characterisation in this area.

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LEGEND

- Town/Village
- Water, Sediment and Invertebrate Sites[1]
- Ground-truthing Sites
- Instrument Sites
- Proposed Additional Water, Sediment and Invertebrate Sites
- Indicative Estuarine/ Freshwater Boundary
- Pipeline Corridor
- Narrowed Onshore Pipeline Corridor

1. Sites M1, M2, M5, M6, M7, M8 and M10 will be sampled for water quality at surface and seafloor only

Title:

Location of Proposed Study Sites in Orokolo Bay

Figure: 2-1

Rev: B

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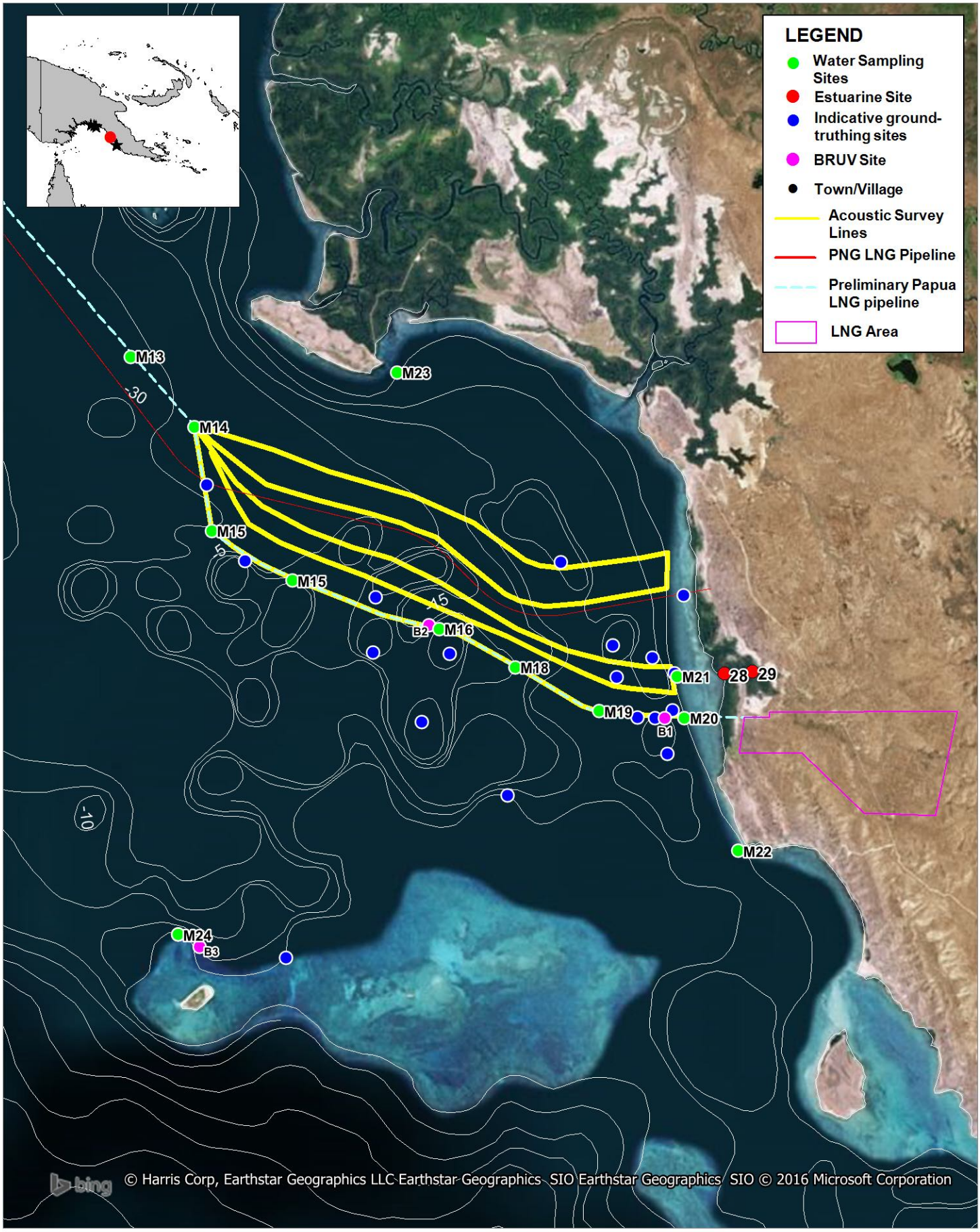
N

0km 5 10

Approx. Scale

BMT WBM
www.bmtwbm.com.au

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Title:

Location of Proposed Study Sites at Caution Bay

Figure: **2-2**

Rev: **A**

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N

0 2.5 5 km

Approx. Scale

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Filepath : I:\B21414_I_GML_Elk_Antelope_EIA_JV\DRG\ECO_005c_161125_Caution_Bay_Marine.wor

Plate 2.1 – Example of Deployed BRUV

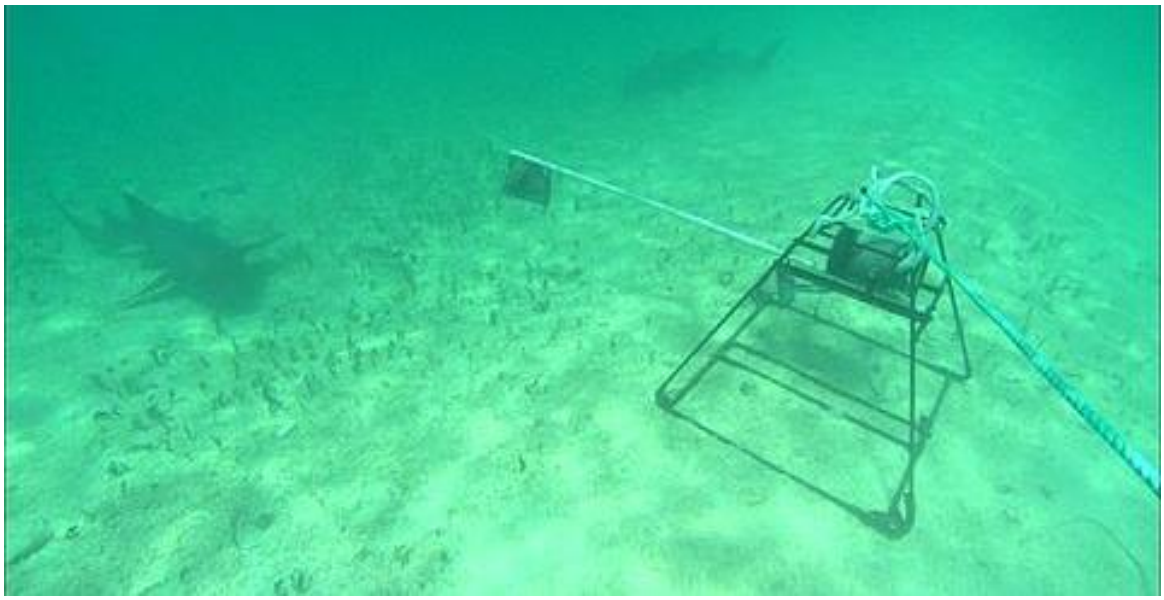
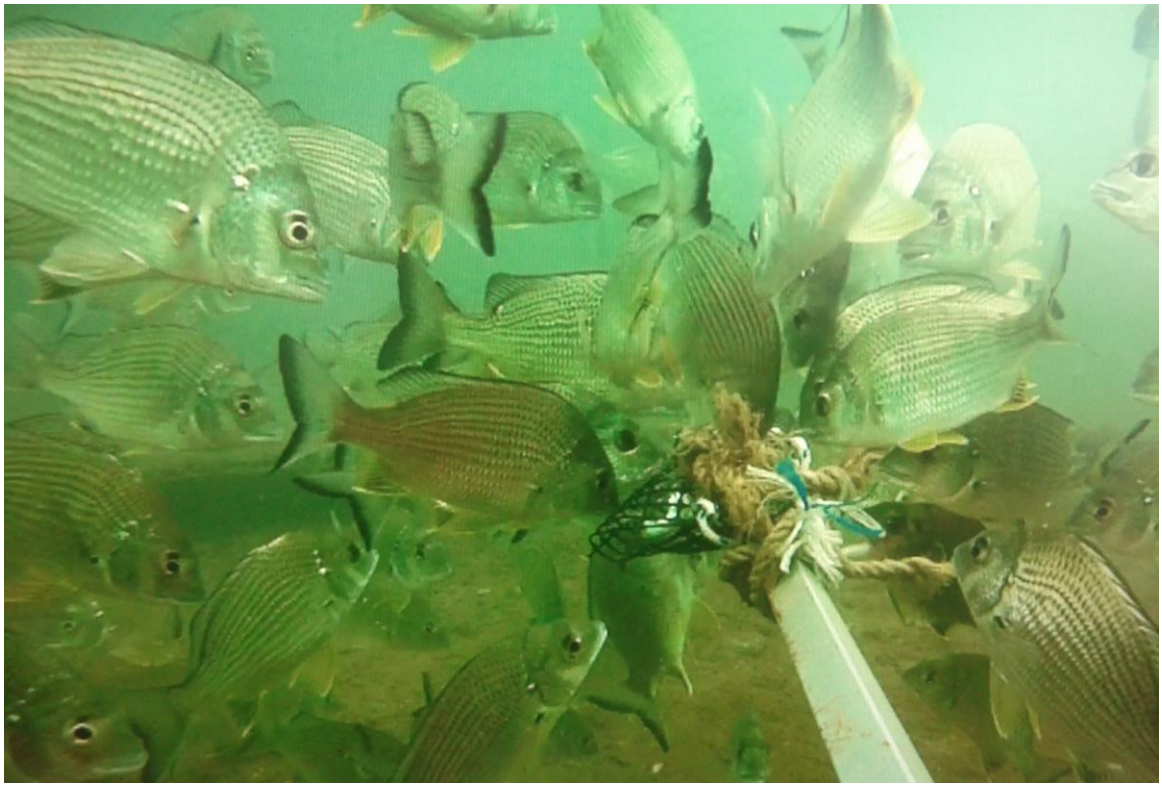


Plate 2-2 – Example of Footage from BRUV



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Part 23H
Household Level Social Survey Scope and Methods

PAPUA LNG PROJECT

UPSTREAM HOUSEHOLD LEVEL SOCIAL SURVEY SCOPE AND METHODS

Version	Details	Prepared (ERIAS Group)	Endorsed (ERIAS Group)	Approved (TEP PNG)	Date Issued
v1	Issued for review	K. Munro/D. Martin	A. Reeman/C. Coyne	J. Roeygens/C. Edet	18/7/2016
v2	Revised to client	K. Munro/D. Martin	A. Reeman/C. Coyne	J. Roeygens/C. Edet	4/8/2016
v3	Final report	K. Munro/D. Martin	A. Reeman/C. Coyne	J. Roeygens/C. Edet	15/8/2016

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IDENTIFICATION PAGE

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Issuer	ERIAS Group Pty Ltd
For Entity	TEP PNG/CA/E&S
Location	Melbourne
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Attachment 1 – Household Survey Instrument

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Abbreviations

AP	Affected Persons
CPF	Central Processing Facility
EIS/ESHIA	Environmental impact Statement/Environmental Social Health Impact Assessment
FGD	Focus Group Discussion
IFC	International Finance Cooperation
KII	Key Informant Interview
LLG	Local Level Government
LNG	Liquefied Natural Gas
PAC	Project Affected Community
PAOI	Project Area of Influence
PER	Pipeline Export Route
POM	Port Moresby
PRL	Petroleum Retention License
SBS	Social baseline study
SMLI	Social Mapping and Landowner Identification
TEP PNG	Total Exploration & Production Papua New Guinea Limited
QA/QC	Quality Assurance/Quality Control

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1. Introduction

1.1 Project Overview

Joint venture partners, Total Exploration & Production Papua New Guinea Limited (TEP PNG) (40.1%), InterOil (36.5%) and Oil Search (22.8%) are currently planning the development of the Elk-Antelope gas field, which is located in the Gulf Province, Papua New Guinea. TEP PNG, a wholly owned subsidiary of TOTAL, has a majority interest in the Elk-Antelope gas field and will be the Project proponent and operator of the Papua LNG Project (the Project) on behalf of the other joint venture partners.

The Elk-Antelope formation is a significant gas discovery in Papua New Guinea consisting of a deep, high pressure, elevated temperature gas reservoir with several trillion cubic feet of gas reserves located approximately 120 km inland from the township of Kerema, and 340 km northwest of Port Moresby.

The Project will comprise upstream production well development and associated infrastructure at the gas production field within petroleum retention license (PRL-15), construction of an upstream central processing facility (CPF), onshore and offshore gas and condensation export pipelines and a new Liquefied Natural Gas (LNG) Plant at Caution Bay, 20 km northwest of Port Moresby. The LNG product will be shipped to international markets.

The Project area comprises the physical footprint of the various Project components and associated infrastructure. The main components of the Project are:

- Upstream (within PRL-15):
  - Wellpads, the gathering system (including trunk pipeline).
  - Central processing facility (CPF) incorporating an acid gas removal unit.
  - Initial section of the onshore export pipeline corridor.
- Upstream (outside PRL-15):
  - Remainder of the onshore export pipeline corridor to landfall on the Gulf coast.
  - Offshore section of the export pipeline corridor to the Liquefied Natural Gas (LNG) Plant site.
- Downstream:
  - LNG Plant site at Caution Bay.

1.2 This Document

This document describes the scope and methods for the household level data collection survey that is part of the social baseline surveys (SBS) for the upstream component of the Project only. This document also provides scope and methods for some additional community level data collection that was identified as necessary for inclusion during the community level social baseline survey conducted in May 2016.

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The scope and methods reports for the downstream component of the Project will be presented in separate documents one month prior to the commencement of those fieldwork components of the SBS.

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2. Study Objectives

The key objective of the social baseline studies (SBS) is to identify, describe and, where possible, map social values in the study area that require consideration in the development of the Project.

In the context of the overall SBS, the social field surveys aim to meet the requirements of national legislation and international guidelines, including the relevant aspects of the International Finance Corporation's (IFC) Performance Standards 1 – Assessment and Management of Environmental and Social Risks and Impacts (including aspects related to stakeholder engagement) and TEP PNG Sustainable Development Specifications (GS EP SDV101 Social Baseline Study).

In order to achieve this, the social field surveys will obtain socio-economic data that will help characterize the socio-economic context of the study area and thereby inform the prediction of potential impacts and development of management and mitigation measures, as part of the Environmental Impact Statement (EIS)/Environment, Social, Health Impact Assessment (ESHIA) process.

The household level survey aims to collect information representative of potentially affected persons (APs) within the Project Area of Influence (PAOI). Specifically it will collect quantifiable information on:

- Household composition.
- Education.
- Livelihoods and income.
- Subsistence activities.
- Household assets.
- Infrastructure and services.
- Health and nutrition.

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3. Study Area

The upstream, household level study area has been informed by the preliminary Project area of influence (PAOI[1]) (Figures 3.1 and 3.2).

The study area has been updated since the community level social baseline survey in May 2016 to include five additional communities (Aiere, Mariki, Maipenaru, Ikinu and Kakarravi). These communities were identified as being either a) potentially directly affected by barges travelling to and from PRL-15 (in the case of Aiere, Ikinu and Kakarravi), or b) an important focal point for other communities within the language groups included in the PAOI. Community level surveys will be undertaken in four of these communities (Mariki, Maipenaru, Ikinu and Kakarravi) alongside the household survey campaign. TEP PNG have advised that the village of Aiere, which has been identified as a potentially directly affected village, is not accessible and thus it will not be surveyed at this time.

It must be noted that as the Project design is further defined, additional communities may be identified as needing to be included or excluded in the study area and/or PAOI, and that this is an iterative process until all components of the Projects are locked down.

[1] Note that the PER corridor remains broad, particularly at the southern end towards the coast, to enable TEP PNG to consider five pipeline route and shore crossing options, as such the PER currently encompasses a large number of communities south of Ere/Kilavi that may not necessarily be impacted by the Project. Once TEP PNG has selected the pipeline route, the PER corridor will be narrowed south of Ere/Kilavi and PAOI will be revised.

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280,000 320,000

9,220,000 9,180,000

KARIMUI RURAL LLG

OKAPA RURAL LLG

YELIA RURAL LLG

BAIMURU RURAL LLG

IHU RURAL LLG

Songhe

Uraru

Crater Mountain Wildlife Management Area

Wabo

Wabo Station

Ura

Subu 2

Subu

Antelope-3 Operations Camp

PRL-15

Field Purari West Route

Field Purari Central Route

Poroi 3

Poroi 2

Herd Base

Mapaio Fish Camp

Poroi 1

Purari Airstrip

Purari River

Ipigo

Ampoke

Kemei

Pakemba

Bekoro

Kaevaria

Evara

Paku

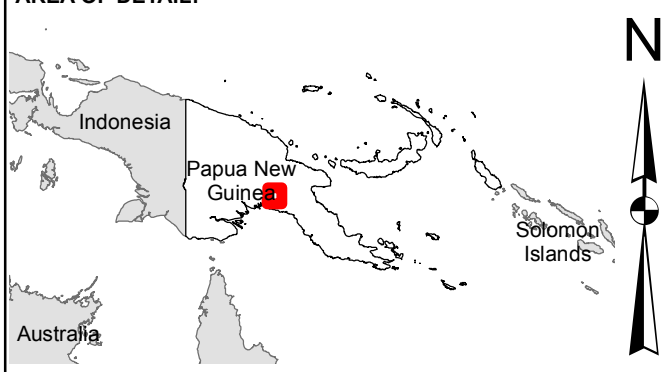
Vailala Logging Camp / Airstrip

Korovake

Beara

280,000 320,000

AREA OF DETAIL:



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LEGEND:

- Existing airstrip
- Base Camp

Project Affected Communities

- PRL15
- Riverways

Host LLG Communities

- Baimuru Rural
- Ihu Rural
- Proposed well pad
- Tracks
- Trunkline route options
- Rivers
- Local level government boundaries
- Project areas of influence
- Pipeline export route
- PRL-15 License
- Notional development area of CPF
- Crater Mountain Wildlife Management Area

PROJECT:	Papua LNG Project
TITLE:	Social Baseline Study Upstream Study Area
SUBTITLE:	PRL-15
DATE:	18/07/2016

DATA SOURCE:
Facilities, CPF area, pipeline routes, villages, rivers, wellpads, tracks, PRL15, hillshade supplied by ERIAS and TOTAL (2015-2016). PAOI supplied by ERIAS (2016).
LLG Boundaries from HDX and then spatially adjusted to align with background and coastal boundaries removed.

DOCUMENT NUMBER: R_041-74026

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H	ISSUED FOR REVIEW	REC	KM	SRF		23/05/16
G	ISSUED FOR REVIEW	REC	KM	SRF		09/05/16
F	ISSUED FOR REVIEW	REC	KM	SRF		07/04/16
E	ISSUED FOR REVIEW	REC	IN	DHC		21/03/16

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SCALE: 1:275,000 @ A3 PNG94 PNGMG94 Zone 55

0 10 20

Kilometres

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Australia

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275,000
300,000
9,175,000
9,150,000
9,125,000

Mapaio Fish Camp
PRL-15
Poroi 1
Purari Airstrip
EAST KIKORI RURAL LLG
Ipigo
Ampoke
Kemei
Pakemba
Bekoro
Kararua
Baimuru
Kaevaria
Evara
Korovake
Beara
Kapuna
Kairimai
Ara'ava
BAIMURU RURAL LLG
Kaiaravi
Mapaio
Purari River
Ravikivau
Kairiravi
Iari
Ravikaupara
Aikavaravi
Aivai
IHU RURAL LLG
Aiere
Upaia
Mira
Kaimari
Kauravi
Mariki
Koiravi
Kinipo
Ikinu
Kairu'u
Akoma
Kakarravi
Maipenaru
Kapai Number 2
Apiapi
Kapai
Aivei
Apiope
Aumu
Hepere
Avavu
Kilavi
Ere
Muro Mission
Huruta
Arehava 2
Paevera
Aroaro
Kaivukavu
Marea
Harevavo
Iuku
Mareke
Hururu
Miha Kavava
Lariau
Herakela
Miae
Haiara
Oru
Kavava
Larihairu
Mirimurua
Hororo
Haeari
Miai Miai Number 2
Ihu
Ihu Airstrip
Auma
Haruape
Vailala
Kukipi

AREA OF DETAIL:



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LEGEND:

- Existing airstrip
- **Project Affected Communities**
  - PRL-15
  - PER
  - Riverways
- **Host LLG Communities**
  - Baimuru Rural
  - Ihu Rural
- Tracks
- Rivers
- Local level government boundaries
- Project areas of influence
- Pipeline export route
- PRL-15 License
- Notional development area of CPF

PROJECT: Papua LNG Project

TITLE: Social Baseline Study Upstream Study Area

SUBTITLE: Pipeline Export Route and Riverways

DATE: 18/07/2016

DATA SOURCE:

Facilities, CPF area, pipeline routes, villages, rivers, wellpads, tracks, PRL15, hillshade supplied by ERIAS and TOTAL (2015-2016). PAOI supplied by ERIAS (2016).
LLG Boundaries from HDX and then spatially adjusted to align with background and coastal boundaries removed.

DOCUMENT NUMBER: R_041-74024

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G	ISSUED FOR REVIEW	REC	KM	SRF		09/05/16
F	ISSUED FOR REVIEW	REC	KM	SRF		07/04/16
E	ISSUED FOR REVIEW	REC	IN	JRB		18/03/16

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SCALE:

1:250,000 @ A3 PNG94 PNGMG94 Zone 55

0 10 20
Kilometres

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4. Relevant Legal and Other Requirements

The SBS has been designed to comply with the requirements of, and address issues identified within, the following national legislation, national and international standards and operational guidelines:

- Environment Act 2000.
- Oil and Gas Act 1998.
- PNG Conservation and Environmental Protection Authority (CEPA) guideline GL-Env02/2004: Guideline for Conduct of Environmental Impact Assessment & Preparation of Environmental Impact Statement (CEPA, 2004).
- CEPA (formerly DEC): Social Impact Assessment Guideline (Draft).
- Total Charter of Principles and Guidelines Regarding Indigenous and Tribal Peoples (CH-GR-SBS-001).
- Total General Specification, Sustainable Development, Social Baseline Study (GS EP SDV101).
- Total General Specification, Sustainable Development, Social Impact Assessment (GS EP SDV 102).
- International Finance Corporation's (IFC) Performance Standards on Social and Environmental Sustainability (2012). In particular:
  - PS 1: Assessment and Management of Environmental and Social Risks and Impacts.
  - PS 2: Labour and Working Conditions.
  - PS 4: Community Health, Safety and Security.
  - PS 5: Land Acquisition and Involuntary Resettlement.
  - PS 7: Indigenous Peoples.
  - PS 8: Cultural Heritage.

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5. Stakeholder Engagement

TEP PNG will undertake stakeholder engagement in the form of a pre-awareness campaign in the four additional riverway communities where community level surveys are planned (Mariki, Maipenaru, Ikinu and Kakarravi). This pre-awareness campaign will advise communities about the Project (including but not limited to what it is, where it is located, and the development schedule), the forthcoming studies (community and household level data collection and other studies that are part of the EIS/ESHIA program), the purpose of those studies and what community members can expect when survey teams visit (at a minimum), and seek approval for survey teams to visit and conduct said studies.

Communities involved in the household survey were recently visited by both TEP PNG's community affairs team and the social baseline study team during the community level survey. At this time the communities were advised that a household level survey would follow in August-September 2016. In addition, it is expected that TEP PNG's community affairs team will notify community representatives in the villages to be included in the household survey of the sampling approach (i.e., in 30% of households to be surveyed in larger communities and 100% of households to be surveyed in communities with less than 14 households) and the proposed date of the team's attendance.

It is also anticipated that communities within the Project area of influence (PAOI) that are not to be visited during the household level survey be visited or notified by TEP PNG's community affairs team during or closely following the household level survey to ensure they understand the justification for undertaking household surveys in some but not all communities within the PAOI.

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6. Study Approach

6.1 Overview of Study Approach

The SBS has been designed to identify social values and parameters within the study area using four primary means, summarised below:

- Bibliographic review – a desktop exercise reviewing existing literature.
- Community level data collection – involving focus group discussions (FGDs), key informant interviews (KIIs) and mapping.
- Household level data collection – involving the detailed surveying of individual households.
- National, Provincial, District and Local Level Government (LLG) interviews – involving discussions with key Government agencies and authorities to obtain current information and secondary data (such as annual and statistical reports).

Within the SBS structure, data collection occurs at different levels:

- Focus Group Discussions (FGD) – a range of topics are explored at a generalized level. FGDs formed part of the community level survey in May 2016.
- Key Informant Interview (KIIs) – key topics are explored in greater detail with participants who are particularly informed on those topics. KIIs formed part of the community level survey in May 2016.
- Household surveys – detailed quantitative data on key indicators is collected from a sample of individual households. This is the focus of this document and will be conducted across the upstream PAOI in August-September 2016.
- Interviews with National, Provincial, District and LLG agencies and authorities. Interviews have commenced and will be conducted opportunistically over the course of the SBS field programs.

6.2 Bibliographic Review

This occurred ahead of the field surveys and involved a review of existing information relevant to the Project area, including previous studies related to the demographic makeup of the area, its economy and land and natural resource use. There was a range of recent and publicly available literature relevant to the Gulf and Central provinces, Districts and LLGs that the Project spans. Relevant literature that has been reviewed includes (but is not limited to):

- Societal and Environmental Screening Study Report for the Elk-Antelope Project Facilities, prepared for Total by ERIAS Group, (ERIAS Group, 2015).
- PNG LNG Environmental Impact Statement and appendices, prepared for ExxonMobil (CNS, 2009).
- Gulf LNG Project Full Scale Social Mapping & Landowner Identification (Pipeline License) (Kameata, 2012).

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- Liquid Niugini Gas Ltd Gulf LNG Project Environmental Impact Statement (GHD, 2012).
- Full-Scale Social Mapping and Landowner Identification Study for the Elk-Antelope PRL-15 Gas Field Development Project (Sagir, 2015).
- Broader studies of PNG relating to demographics, economics, health, and land and natural resource use, and regional studies for the Gulf and Central provinces.
- PNG legislation and relevant international guidelines, policies and standards for the purposes of characterizing areas of significance in terms of demographics, economics and natural resource use and focus points for the EIS/ESHIA.

The bibliographic review also included:

- Previous scientific and scholarly studies undertaken in the study area.
- Secondary data (such as annual and statistical reports) provided by National, Provincial, District and LLG agencies and authorities.
- Existing knowledge held by TEP PNG and their other joint venture partners of the Project and past resource development projects in the Project area.

Data gaps identified during the bibliographic review are addressed the SBS field surveys and discussions with National, Provincial, District and LLG agencies and authorities (and their provision of statistics and reports).

The findings of the bibliographic review:

- Were used to prepare the National, Provincial, District and LLG components of the SBS.
- Informed field data collection.
- Will be summarised and referenced in the resulting baseline technical reports.

6.3 Findings from the Community Level Surveys

Community level data collection, as described in Section 6.1 Overview of Study Approach, was conducted at 37 communities (villages and hamlets) in the PAOI in May 2016.

Findings from the community level survey have been used to determine the approach to the household survey. The community level survey allowed ERIAS Group to:

- properly locate, name and identify the language group of each village
- conduct a population count of residents and map the households in each village
- identify cultural affiliations of those communities with others
- understand settlement history, historical migration, cultural beliefs and cultural practices of each village
- map and describe villages' access to and use of health and education facilities and services, as well as markets
- understand the environmental context in which villages are set, the ecological zone in which each occurs and how each generally uses their land and natural resources.

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This information has informed the survey design and logistics plan, including the identification of four additional villages to be included in community level surveying and the cluster approach to household surveying (see Section 6.4 Additional Community Level Surveys).

6.4 Additional Community Level Surveys

6.4.1 Community Level Surveys

Community level data will be collected to form a qualitative picture of social functioning (i.e., community profile) from four additional communities (Mariki, Maipenaru, Ikinu and Kakarravi). These communities were identified as being either a) potentially directly affected by barges travelling to and from PRL-15 (in the case of Ikinu and Kakarravi), or b) an important focal point for other communities within the language groups included in the PAOI. The direct PAOI boundary has been amended to include Ikinu and Kakarravi, as these villages are located on the banks of the Purari River tributaries that are likely to be used by barging by the Project (thus they may be directly impacted). Mariki and Maipenaru are not likely to be directly impacted, thus are not included in the PAOI boundary. However, they are important focal points within their language group and thus are considered important to include in surveying in order to properly understand the social context of those language groups and as a result of which have the potential to be indirectly impacted.

Therefore, community level surveys will be undertaken in these four communities alongside the household survey campaign.

The same approach and instruments described in 'Upstream Social Baseline Studies Scope and Methods' (01215B_6-7_v2) will be applied in this survey to collect information on the social services, infrastructure and organisation of each village. Because of the small number of additional villages to be included, and with only one village per day to be surveyed, a smaller survey team will complete this work. It is anticipated that all survey instruments will be completed, however, if surveying is constrained at all, the team will prioritise collection of information that is necessary to understand individual villages, and will relying on previously-collected information to inform language group and regional understanding. The community level survey team is outlined in Section 8.

6.4.2 Interviews with National, Provincial, District and LLG Agencies and Authorities

Delays during the community level baseline survey resulted in gaps in the collection of data from government agencies and health facilities. It is therefore planned that this consultation is undertaken during the household level survey campaign. The following consultation is planned:

- Health interviews at Kerema (Marci Balge):
  - Ben Bal (Provincial Health Director).
  - Catholic Health Services.
  - United Church Health Services.
  - Kerema area medical store.

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  - Médecins Sans Frontières Tuberculosis Treatment Centre.
- Health interview at Kapuna Health Centre (Marci Balge)[2]
- Government interviews in Kerema and Port Moresby (Mike Finlayson):
  - Gulf Provincial Management Team (Kerema).
  - Mineral Resource Development Corporation (Port Moresby).
  - Department of Works (Port Moresby).
  - InterOil (Port Moresby).
  - Oil Search (Port Moresby).
  - National Fisheries Authority (Port Moresby).
  - PNG Forestry Authority (Port Moresby).

The schedule incorporates a visit to Kerema ahead of the commencement of the household survey and additional community level data collection (16/08/2016 to 17/08/2016), and to Kapuna on 19/08/2016.

6.5 Household Level Data Collection

The household level survey approach has been designed to ensure the data collected is representative of all the potentially Affected Persons (APs) in the PAOI. It does not aim to achieve a statistically representative sample but aims to produce a result that enables reliable generalisation about the larger group and fulfil the IFC PS1 requirements to provide information 'at an appropriate level of detail' and which 'enables the determination of the potential impacts and risks of the project'.

The household level survey will survey 30% of households from clusters of villages within the PAOI that are homogeneous (i.e., reflect the attributes of the broader PAOI population).

Within villages with less than 14 total households, 100% of households will be surveyed.

The clusters of villages have been selected by stratifying the villages by language group and ecological zone (Figures 6.1 and 6.2). Language groups have the same history, cultural beliefs and traditional practices and ecological zones have the same natural resources and patterns of resource use. Combined, it means that within each cluster, people have similar daily activities and lifestyles. Importantly, the clusters comprise villages with little variability between each. A brief description of each cluster is provided in Section 6.5.1.

[2] It is noted that Marci Balge has already visited Kapuna Health Centre (during community level surveying in May 2016). However, ERIAS Group recommends that in order to maximize the value of her return visit for the purposes of attending Kerema, she return to Kapuna to explore the centre's capacity to potentially provide additional diagnostic data to Total in the future (i.e., clinical data on malaria and TB).

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Table 6.1 – Village Clusters Selected for Household Level Survey

Cluster	Project Area	Villages Selected for Household Survey (population)	Ecological Zone	Language Group
1	PRL-15	Subu (11) Subu 2 (13) Ura & Wabo Station (64) Wabo (71) Poroi (62) Poroi 1 (Rainbow) (10) Poroi 3 (Suarido) (8)	Middle Purari hills Delta swamps & plains	Pawaia
2	Riverways	Upaia (41) Mariki (58)	Mangroves	Kaimare
3		Kairimai (19) Akoma & Kairu'u (68)	Delta swamps & plains mangroves	Koriki
4		Mapaio Fish Camp (4) Kaevaria (18) Aivai (13) Maipenaru (65)	Delta swamps & plains Mangroves	Iare
5		Apiope (45) Kapai 2 (12)	Mangroves	Maipua
6		Evara (70)	Delta swamps & plains	Ahia
7	PER	Avavu (42) Paevera (48)	Southeast coast	Orokolo-Popo Inland
8		Harevavo (30) Iuku (24) Herekela (36)	Mangroves Southeast coast	Orokolo-Coastal

6.5.1 Clusters

Cluster 1 – PRL-15/Pawaians

With the exception of Poroi 1 (locally known as 'Rainbow', a hamlet of Poroi), all of these villages are located upstream of Herd Base, they are all Pawaian speaking, are significantly dependent on the Purari River (for subsistence activities and transport). Sago is the primary staple food. Health care is accessed at Kapuna Health Centre. They are all located on, or near to, the banks of the Purari River, surrounded by undulating, lowland forest

Cluster 2 – Wame/Vario Purari River Mouth/Kaimares

Upaia is Kaimare speaking and located on the banks of the Aria and Wame Rivers surrounded by mangroves, extensive tidal nipa palm swamps and small patches of forest within the nipa palm swamps. Sago is the primary staple food. The Kaimare tribe originated from Pairi'umu (old village) but moved to Mariki because of population pressures, before spreading to the various present-day Kaimare villages in the region. Mariki was reported as an important central location

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for Kaimare people to access health and education and to trade and maintain relations with their kin.

Cluster 3 – Urika-Vario Purari River/Korikis

Sharing tribal affiliation (Koriki), Kairimai in the north and Akoma & Kairu'u in the south represent the geographical diversity of this language group. Both reported to share a common history and migration patterns with other Koriki villages. Despite the geographical differences, both villages relied on sago as their main staple food, and relied heavily on the river system for subsistence activities and transport. Surrounded by lowland swamp forest in the north and mangroves and extensive tidal nipa palm swamps in the south

Cluster 4 – Small Purari (Aivei) River/Iares

The Iare people have a common ancestral story and language, and are significantly dependent on the Purari River (for subsistence activities and transport). Sago is the main staple food, and health and education services are accessed at Kapuna (to the northwest), Mapaio (central) and Maipenaru to the south. Maipenaru was reported as a central location for trade. Surrounded by lowland swamp forest.

Cluster 5 – Small Purari Mouth/Maipuas

Apiope and Kapai 2 are Maipua speaking but closely affiliated with the Iare and Koriki tribes (a result of historical migration). Located on the mouth of the Small Purari, Apiope people reported to have come from further north, settling in the present locations (Apiope, Kerea and Kapai 2). Surrounded by beach dunes, mangroves and extensive tidal nipa palm and sago swamps. The main staple food was sago, dependence on the Small Purari was high (for subsistence and transport) and health, education and trade were accessed at Apiope (aid post) and Maipenaru.

Cluster 6 – Evara

Not a cluster as such but Evara has been included in the household survey as the only Ahia community within the PAOI. The Evaras may be potentially landowning within the PAOI. Other Ahia communities are understood to exist to the east of Evara.

Cluster 7 – Orokolo Popo Inland/Orokolos

The Orokolo Popo Inland people are Orokolo speaking and see themselves as inland Popo following the migration history of their ancestors who migrated from upper Purari in Poroi and Wabo. This distinction, they feel, is needed in order to distinguish between themselves from their kin who migrated southward to settle on the coast. Land resources include, sago swamps, alluvial forest and hill forests. Betel nut is a significant cash crop in this area. These villages are connected to several other villages by walking tracks including Ere-Kilavi, Avavu, Muro Station, Huruta, Arehava 2, Paevera and Mareke on the coast. Education and health services are accessed at Muro and Orokolo.

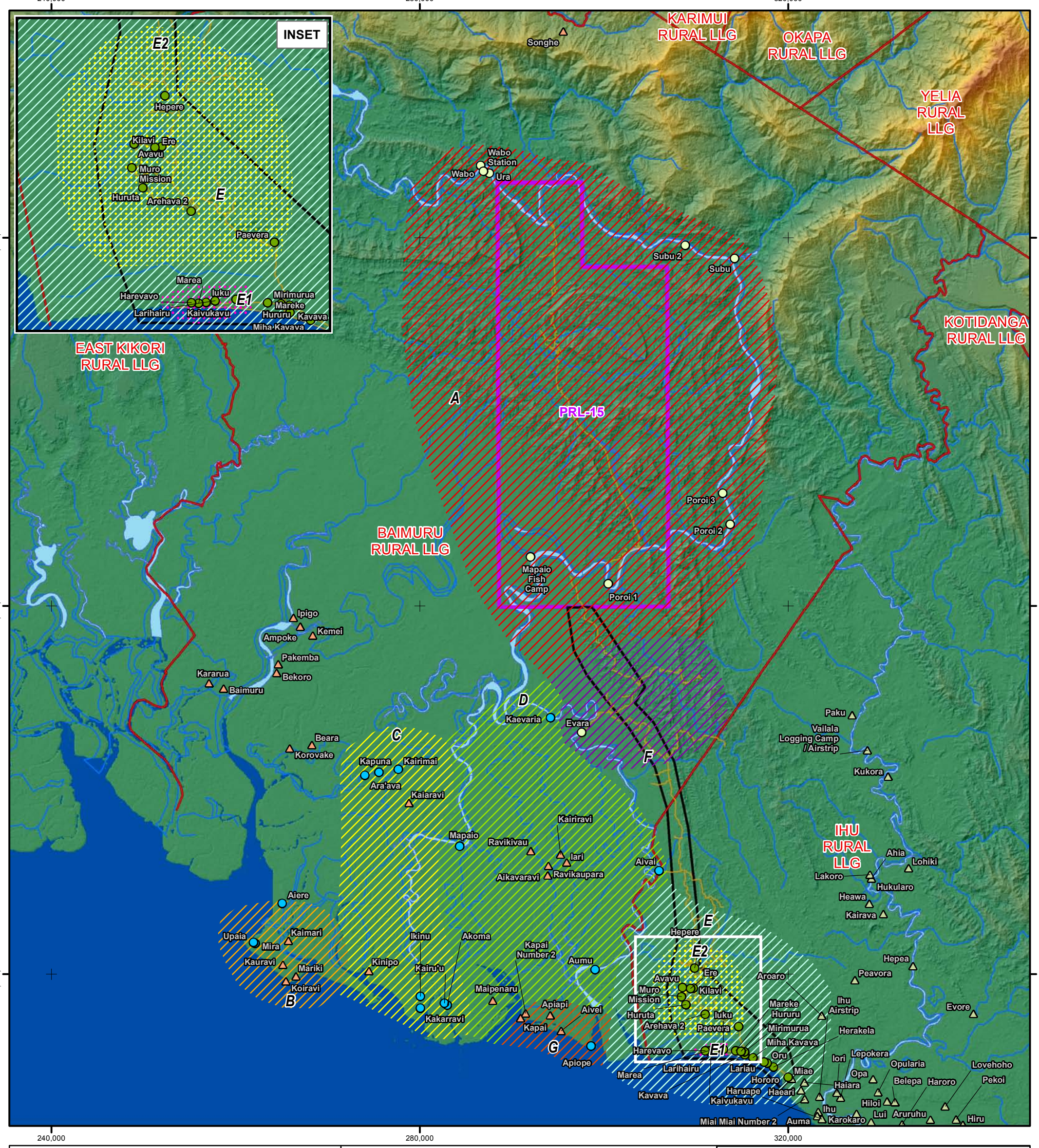
Cluster 8 – Orokolo Coast/Orokolos

Like cluster 7, the Orokolo Coast people are Orokolo speaking and believe to have migrated from inland areas in a series of migrations undertaken by their ancestors. Land resources include, mangroves, nipa palm swamps, beach vegetation, alluvial forest and hill forests. Sago is the

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primary staple food. Betel nut, food crops and seafood products generate income for Orokolo Coastal people. Health and education facilities are accessed at Orokolo and Oru/Lariau respectively.

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LEGEND:

Project Affected Communities
- PRL15
- PER
- Riverways

Host LLG Communities
- Baimuru Rural
- Ihu Rural
- Tracks
- Local level government boundaries
- Waterways
- Waterbodies
- PRL-15 License
- Pipeline export route corridor

Language Groups
- A - Pawaian
- B - Kaimare
- C - Koriki
- D - Iare
- E - Orokolo
- E1 - Coastal Popo
- E2 - Inland Popo
- F - Ahia
- G - Maipua

PROJECT: Papua LNG Project

TITLE: Upstream Language Groups

SUBTITLE:

DATE: 21/07/2016

DATA SOURCE:
Language Groups, villages, rivers, tracks, PRL15, hillshade supplied by ERIAS and TOTAL (2015-2016)
LLG Boundaries from HDX and then spatially adjusted to align with background and coastal boundaries removed.

DOCUMENT NUMBER: R_060-74116

Revision	Description	Drawn	Checked	QC	Approved	Date
C	ISSUED FOR REVIEW	REC	KM	SRF		21/07/16
B	ISSUED FOR REVIEW	REC	KM	SRF		31/05/16
A	ISSUED FOR REVIEW	REC	KM	JRB		30/05/16

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SCALE: 1:400,000 @ A3 PNG94 PNGMG94 Zone 55

0 10 20 30

Kilometres

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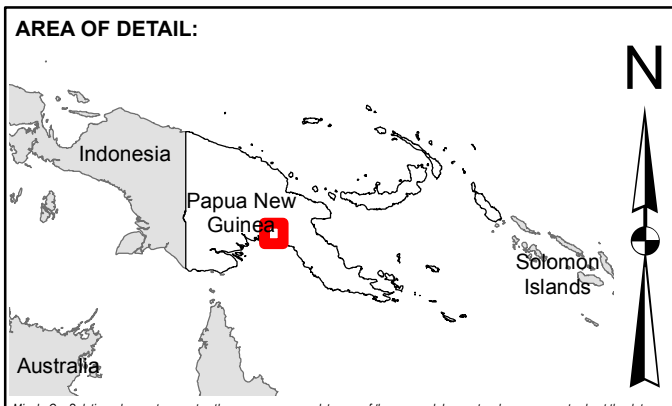
T:\Projects\ER\002 Elk Antelope LNG Project EIS-ESHIA\Work Request\R_060 - Upstream Language Groups Map\ER\002-R_060-74116_Upstream_Language_Groups_RevC.mxd - 21 Jul 2016 - rchoucroun

280,000 320,000

9,220,000 9,180,000 9,140,000

Wabo
Ura
Wabo Station
Purari River
Subu 2
Subu
Hou Creek
Vailala River
Era River
Middle Purari Hills
PRL-15
Kuku Creek
Pie River
Poroi (Suarido)
Poroi
Field Purari Central Route
Oxbow Lake
Mapaio Fish Camp
Field Purari West Route
Purari River
Poroi 1 (Rainbow)
Delta Swamps and Plains
Ipigo
Ampoke
Kemei
Pakemba
Bekoro
Kararua
Baimuru
Varoi River
Kaevaria
Evara
Paku
Vailala Logging Camp / Airstrip
Korovake
Beara
Kapuna
Kairimai
Ara'ava
Wame River
Kukora
Southeast Hills
Kaiaravi
Ivo River
Mapaio
Old Iare
Aikavaravi
Aivai
Lakoro
Lohiki
Ahia
Heawa
Hukularo
Kairava
Aiere
Upaia
Kaimari
Kauravi
Koiravi
Mariki
Mangroves
Kinipo
Ikinu
Akoma
Maipenaru
Kapai Number 2
Aumu
Hepere
Ere
Avavu
Kilavi
Paevera
Peavora
Hepea
Mirimurua
Miha Kavava
Apiapi
Muro Mission
Huruta
Lariau
Aroaro
Evore
Aivei
Arehava 2
South East Coast
Oru
Herakela
Ihu Airstrip
Kakarravi
Kairu'u
Kapai
Apiope
Kaivukavu
Hororo
Opa
Miae
Iori
Opularia
Haiara
Harevavo
Marea
Kavava
Hiloi
Belepa
Larihairu
Hururu
Lovehoho
Iuku
Mareke
Haeari
Miai Miai Number 2
Lepokera

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LEGEND:

Towns and Villages - Upstream
- PRL15
- PER
- Riverways
- Baimuru Rural
- Ihu Rural
- Field Purari West Route
- Field Purari Central Route
- Tracks
- Waterways
- Waterbodies

- CPF, logistics base and airstrip area
- Pipeline export route corridor
- PRL-15 License
- Project areas of influence

Ecological Zones
- Delta swamps and plains
- Mangroves
- Middle purari hills
- South east coast
- Southeast hills

PROJECT: Papua LNG Project

TITLE: Ecological Zones

SUBTITLE:

DATE: 2/08/2016

DATA SOURCE:
Pipeline export route corridor, PRL-15, Towns and Villages, PAOI, waterbodies, waterways, supplied by Total and ERIAS (2016).
Study area, and areas of interest supplied by Iain Woxvold (2016).

DOCUMENT NUMBER: R_071-74370

Revision	Description	Drawn	Checked	QC	Approved	Date
A	ISSUED FOR REVIEW	JRB	KM	REC		02/08/16

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SCALE: 1:350,000 @ A3 PNG94 PNGMG94 Zone 55

0 5 10 20 30

Kilometres

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7. Study Methods

7.1 Community Level Survey

The study methods for the community level survey are described in 'Upstream Social Baseline Studies Scope and Methods' (01215B_6-7_v2). In each location the team will:

1. Participate in an introductory tok save (speech).
2. Conduct three focus group discussions (FGDs) - leaders, women, youth.
3. Conduct a range of key informant interviews (KIIs) - social organisation, education, health.
4. Map households and community infrastructure.

7.2 Household Level Survey

The Household Survey instrument is provided in Attachment A. The instrument is broken down into five parts as detailed below.

A. Household composition (name, sex, age, relationship, marital status and language).

B. Education (school attending, highest education attained and literacy).

C. Livelihoods and income (occupation, wage, employer, subsistence activities, income and expenditure, household assets).

D. Infrastructure, services and household utilities (access to electricity, water etc.).

E. Health (traditional medicine, disability, child health and immunisation, food consumption).

It is anticipated that the administration of the household survey will take approximately 90 minutes per survey (including introduction, questions and time spent walking from household to household). This means that each member of the team can complete approximately three surveys per day.

7.2.1 Sampling Methodology

A clustering approach for household surveying will involve:

- a target of 30% households from clusters of villages that are considered homogenous (thus reflect the attributes of the broader PAOI population). Clusters are presented herein.
- 30% of households from each and every village located within (or owning land within, to the best of current understanding) PRL-15.
- 100% of households within villages that have less than 14 total households (such as Aivai, Subu and Subu 2).

Villages selected for surveying within the identified clusters were selected by stratifying the villages by language group and ecological zone. Language groups have the same history, cultural beliefs and traditional practices and ecological zones have the same natural resources and patterns of resource use. Combined, it means that within each cluster people have similar daily

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activities and lifestyles. Importantly, the clusters comprise villages with little variability between each.

Households within those villages will be purposefully selected using GPS points and population data collected at community level stage.

7.3 Recording Procedures

All data collection surveys will be recorded within an instrument template, using standardized coding. Some coding has been included in the instruments provided herein as an example. The instruments require the facilitator to document their name as the person responsible for the completion of the exercise, as well as the date, village name, primary spokesperson, location and photo reference, and where relevant, GPS location. The facilitator is also required to complete a Completion Checklist at the end of each instrument as a reminder to review that the instrument has been comprehensively completed.

Each household surveyed will be photographed and their locations recorded using handheld GPS devices standardized to the WGS84 datum and UTM Zone 55S projection.

Householders will be advised that the individual personal information they provide during the field surveys will not be presented publically but will be used for the following purposes:

- EIS/ESHIA: characterization of the nature of social values and the existing socio-economic environment that may be impacted by the Project. This is required so that the proponent can identify impacts and mitigate and manage those to acceptable levels in collaboration with affected communities. The communities will be advised that the EIS/ESHIA will be public documents, and that information concerning their socio-economic context will be described in these documents.
- It is the intention of TEP PNG to explore the opportunity to share socio-economic information with relevant and appropriate parties in support of country development. Personal data will be de-identified in this instance.

7.4 Completion and Quality Check

At the conclusion of each of the aforementioned exercises, and prior to moving to the next location or ceasing for the day, a completion and quality check will be performed by the Technical Lead to ensure instruments have been comprehensively completed. Should the completion and quality check identify missing data (and scheduling/logistics allow it), these may be filled prior to departing the community; alternatively, a data make-up strategy will be developed and agreed with TEP PNG. The Technical Lead will take custody of completed instruments prior to moving on from the village (to prevent any data being misplaced).

The household level data collection survey will be conducted over approximately 25 days during which data will be collected for 22 villages in the study area. The 25-day schedule includes three Quality Assurance/Quality Control (QA/QC) days at Herd Base. In the event the team is delayed, additional days may need to be added to the end of the proposed schedule (a decision that will be taken in consultation with TEP PNG).

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At the completion of the household level survey, the Technical Lead will present a 'debrief' to TEP PNG prior to demobilising back to place of origin.

An upstream household level field survey report will be provided in the agreed timeframe after completion of the survey.

7.5 Chain of Custody – Survey Instruments

It is the responsibility of the Technical Lead to store the hard copy completed instruments in such a manner that they cannot be damaged by environmental or human factors. Completed hard copy instruments will be stored in waterproof plastic pockets until they can be scanned and stored digitally (either at Herd Base, Total's office in Port Moresby or in one of ERIAS Groups' offices in Australia). They will remain in the possession of the Technical Lead whilst in the field.

All data collection (completed instruments) will remain in the custody of ERIAS Group until they arrive at ERIAS Group's head office in Melbourne where the data will be:

- Scanned and digitally stored.
- Provided digitally to TEP PNG for storage.
- Entered into a Microsoft Office Excel spreadsheet for analysis and reporting.

Hard copies of completed instruments will be retained until the EIS and ESHIA are approved, after which they can be destroyed (subject to confirmation that all documents are digitally stored and backed up).

7.6 Survey Data

Raw data (including raw GIS data) from the community survey instruments will be provided to TEP PNG as per TOTAL General Specification.

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8. Survey Period and Team

8.1 Field Program

The field program is scheduled for 15 August to 15 September 2016. Three contingency days have been allowed for at the end of the field program in the anticipation that there will be some 'bad weather' days during the survey period. A debriefing is scheduled for Thursday 15th September 2016 (to be confirmed).

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Table 8.1 – Field Program

Date 2016	Location – Kerema/Kapuna/Health (MF and MB[3] only)	Location – Community Level survey	Location – Household Level Survey	Total Households in Village	30% of Households[4]	Supervision
Monday 15th August	Transit by vehicle to Kerema (o'night)	-	-	-	-	-
Tuesday 16th August	Kerema (o'night)	-	POM – First Aid Training			DM
Wednesday 17th August	Kerema – Herd Base	-	POM – Herd Base			DM
Thursday 18th August	Herd Base – HHS training	-	Herd Base - Training			MF/DM
Friday 19th August	MB Kapuna MF Poroi 1 & Mapaio Fish Camp	Members[5] of CL survey team mobilise from POM to Herd Base	Poroi 1 (Rainbow) & Mapaio Fish Camp – Testing			MF/DM
Saturday 20th August	MB Kapuna (if 2nd day req'd)	Herakela	Herakela[6]	36	10.8	MF/DM
Sunday 21st August	MB Herd Base	Kakarravi	Kapai	12	12 (100%)	MF/DM
Monday 22nd August	MB demobilize to POM	Mariki	Mariki	58	17.4	MF/DM
Tuesday 23rd August	MB POM	Maipenaru	Maipenaru	65	19.5	MF/DM
Wednesday 24th August	MB POM	Ikinu	Akoma & Kairu'u	68	20.4	MF/DM
Thursday 25th August	MB demobilize to USA	Harevavo	Harevavo	100	30	MF/DM
Friday 26th August	MF joins HHS team	Demobilisation	Apiope	45	13.5	MF/DM

Table 8.1 – Field Program (cont'd)

[3] MF – Mike Finlayson, MB – Marci Balge, DM – Danielle Martin, YH – Yvonne Hani, BP – Brett Perry, CC – Carmel Coyne
[4] ERIAS Group proposes that the minimum number of households surveyed at any one village will be 14 to increase confidence in representativeness of results. For villages with a total number of households less than 14 (such as Aivai, Subu and Subu 2), 100% of households will be surveyed.
[5] This refers to Amos Ona and John Sepe. Other members of the CL survey team – Mike Finlayson and Yvonne Hani and a student mapper – will already be at site.
[6] Herekela now replaces Aiere which is thought to be inaccessible in this campaign, based on advice from Jeremy Roeygens 05/08/2016.

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Date 2016	Location – Kerema/Kapuna/Health (MF and MB[7] only)	Location – Community Level survey	Location – Household Level Survey	Total Households in Village	30% of Households[8]	Supervision
Saturday 27th August	MF joins HHS team		Evara	70	21	MF/DM
Sunday 28th August	MF to Poroi 3		Herd Base – QA/QC/Data entry	N/a	N/a	MF/DM
Monday 29th August	MF demobilize to POM		Iuku	80	24	DM MF demob
Tuesday 30th August			Kairimai	62	18.6	DM
Wednesday 31st August			Upaia	41	12.3	DM
Thursday 1st September			Kaevaria	18	5.4	DM
			Aivai	13	13 (100%)	
Friday 2nd September			Ere/Kilavi	114	23 (20%[9])	DM
Saturday 3rd September			Paevera	48	14.4	DM
Sunday 4th September			Herd Base – QA/QC/Data entry	N/a	N/a	DM
Monday 5th September			Wabo	71	21.3	DM CC mobilise
Tuesday 6th September			Ura & Wabo Station	64	19.2	CC/YH/BP DM demob

Table 8.1 – Field Program (cont'd)

[7] MF – Mike Finlayson, MB – Marci Balge, DM – Danielle Martin, YH – Yvonne Hani, BP – Brett Perry, CC – Carmel Coyne
[8] ERIAS Group proposes that the minimum number of households surveyed at any one village will be 14 to increase confidence in representativeness of results. For villages with a total number of households less than 14 (such as Aivai, Subu and Subu 2), 100% of households will be surveyed.
[9] A 20% sample size was agreed with Jeremy Roeygens 05/08/2016 at his request to replace Avavu with Ere/Kilavi (which is a significantly larger village).

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Date 2016	Location – Kerema/Kapuna/Health (MF and MB[10] only)	Location – Community Level survey	Location – Household Level Survey	Total Households in Village	30% of Households[11]	Supervision
Wednesday 7th September			Poroi	44	13.2	CC/YH/BP
			Poroi 3	8	8 (100%)	
Thursday 8th September			Subu	11	11 (100%)	CC/YH/BP
			Subu 2	13	13 (100%)	
Friday 9th September			Herd Base – QA/QC/Data entry	N/a	N/a	CC/YH/BP
Saturday 10th September			Demobilization or contingency	-	-	-
Sunday 11th September			Demobilization or contingency	-	-	-
Monday 12th September			Demobilization or contingency	-	-	-
Thursday 15th September (TBC)			Debrief (TBC)	-	-	-

[10] MF – Mike Finlayson, MB – Marci Balge, DM – Danielle Martin, YH – Yvonne Hani, BP – Brett Perry, CC – Carmel Coyne

[11] ERIAS Group proposes that the minimum number of households surveyed at any one village will be 14 to increase confidence in representativeness of results. For villages with a total number of households less than 14 (such as Aivai, Subu and Subu 2), 100% of households will be surveyed.

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8.2 Survey Team

8.2.1 Community Level Survey

This more rationalised approach to surveying outlined in Section 6.2.1 will allow a smaller survey team to undertake the community level surveys than what was required during the community level survey campaign. The community level survey team consists of:

- Mike Finlayson (Technical Lead and Village Leaders FGD).
- Yvonne Hani (Women's FGD and Education and Health KII).
- John Sepe (Cultural Heritage and Social Organisation and Settlement KII).
- Amos Ona (Land and Natural Resource Use including mapping).
- Mapper[12] (Mapping of key infrastructure and households).

8.2.2 Household Level Survey

The core household level survey team comprises of the following specialists:

- Technical Lead – Mike Finlayson/Danielle Martin/Carmel Coyne.
- Team Lead – Yvonne Hani.
- 8 x enumerators from University of PNG (candidates validated by Total on 28/07/2016).

The Technical Lead role will be performed by Mike Finlayson, Danielle Martin and Carmel Coyne ensuring full oversight for the duration of the program, supported by ERIAS Group In-country Manager Brett Perry/Kobus Meulenbroeks (both whom have a great deal of experience managing surveys in PNG). Yvonne Hani will act as Team Lead for the student enumerators, ensuring they are technically and personally supported.

8.2.3 Interviews with National, Provincial, District and LLG Agencies and Authorities

Interviews with National, Provincial and LLG Agencies and Authorities will be conducted by:

- Mike Finlayson (for data required for compilation of the community and demographics; governance and economics; and land and natural resources (contribution) technical baseline reports).
- Marci Balge (for data collection relating to health technical baseline report).

It is envisaged that Total will provide letters of introduction to those agencies on

8.2.4 Logistics and Support

ERIAS Group In-country Manager Brett Perry/Kobus Meulenbroeks will manage the logistics and health and safety aspects of the survey in conjunction with the Technical Leads.

[12] The schedule has been arranged such that smaller villages will be household surveyed while the community level survey is underway, enabling an enumerator from the HHS team to conduct mapping for the community level team at those four villages, and avoiding the need for an additional resource to be added to the teams.

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9. Quality Control

To ensure good quality data are collected during the SBS field program, a number of QA/QC procedures are adhered to:

- Use of TEP PNG approved survey instruments that have been optimised for clarity, ease of recording and data entry and consistent data analysis.
- Use of experienced and trained field surveyors.
- Training of team members – over a two day period prior to commencement of field surveys, team members will be trained in how to complete the household survey tool (in an agreed standard manner) and use handheld GPS devices and cameras (including logging waypoints and photograph reference numbers), as well as HSSE matters.
- Standard procedure for daily activities, recording of data (using the instruments) and completion tasks.
- Use of GPS devices that are calibrated and standardized to the WGS84 datum and UTM Zone 55S projection.
- Storage of completed surveys in waterproof plastic pockets, in-field scan uploaded to cloud or company server, if possible and a scan taken at the earliest opportunity following demobilisation from the field (either at Herd Base or in Port Moresby).
- Technical Lead/Team Lead responsible for oversight of daily activities and reviewing quality and completeness of instruments at end of each day.
- Data validation by triangulation of community level data with existing literature and national and international information.
- Quality control checks of data entry (sample of hard copies against database).
- Review and peer review of the resulting reports.

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Attachment 1
SBS Instruments

Household Survey

HH ID	
Consent obtained *(initial)*	

Recorder:	
Date of survey: (day/month/year)	/ /2016
Village Name	
Household GPS location	
Household Photo Reference(s) ID#	
First name of Respondent:	
Surname of Respondent:	
Clan of household head:	

Respondent if not HHH:

Entered into database by:	

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A Household Composition List all household members

ID #	A1 First name (Head of HH first)	A2 Surname	A3 Sex (M/F)	A4 Age (years)	A5 R'ship to HH head (code)	A6 Marital status (code)	A7 Location at birth (code)	A8 Most common language spoken at home (code)	A9 Other languages spoken (code)	A10 Physical or mental disability (code)
1					01					
2										
3										
4										
5										
6										
7										
8										
9										
10										
12										
13										
14										
15										

A5 -Relationship to head of household

01	*Head of Household*	*07*	*Parent in-law*
02	*Spouse*	*08*	*Brother/Sister*
03	*Son/Daughter*	*09*	*Aunt/Uncle*
04	*Son/Daughter in-law*	*10*	*Other relative*
05	*Grandparent*	*11*	*Adopted/foster/stepchild*
06	*Parent*	*12*	*Not related*

A6 - Marital status

01	*Never married*
02	*Married*
03	*Divorced*
04	*Separated*
05	*Widowed*

A7 - Location at birth

01	*Same village*
02	*Other village in this LLG area*
03	*Other village in this province*
04	*Village in a different province (specify)*

A8/A9 - Languages

01	*Pawaia*	*07*	*Orokolo*
02	*Kaimare*	*08*	*Pidgin*
03	*Koriki*	*09*	*Motu*
04	*Maipua*	*10*	*English*
05	*Iare*	*11*	*Other*
06	*Ahia*		

A10 - Disability

01	*None*
02	*Sight*
03	*Hearing*
04	*Amputee*
05	*Mobility impaired*
06	*Mental illness*
07	*Other (specify)*

B Education *(all household members aged 6 and above)*

C Employment *(all household members aged 15 and above)*

ID#	B1 Attending school now? (code)	B2 Highest education complete (code)	B3 If no at B1 and aged 6-18 yrs, why no longer attending? (code)	B4 Literacy (code)	C1 Current job (code) If 01 or 02, go to C4	C2 Current employer (code)	C3 Location of employment (code)	C4 Previous occupation (code)
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								

B1 - Attending school now

00 No
01 Elementary (Prep - Gr 2)
02 Primary (Gr 3-8)
03 Secondary (Gr 9-12)
04 Vocational (specify course)
05 Technical (specify course)
06 University (specify course)

B2 - Highest education attained

00 None
01 E Gr 1
02 E Gr 2
03 P Gr 3
04 P Gr 4
05 P Gr 5
06 P Gr 6
07 P Gr 7
08 P Gr 8
09 S Gr 9
10 S Gr 10
11 S Gr 11
12 S Gr 12
13 Vocational certificate
14 Technical cert
15 University dip
16 University deg
17 University post-graduate/other
18 Elementary prep

B3 - No longer attending

01 No school/higher grades accessible
02 Not affordable
03 Commenced working
04 School closed
05 Not interested
06 Helping parents at home
07 Other

B4 - Literacy

01 Read and write
02 Read only
03 Cannot read or write

C1/C4 - Current & previous occupation

01 Unemployed, looking for work
02 Subsistence
03 Labourer
04 Pastor
05 Policeman
06 Magistrate/ counsel.
07 Logging/milling
08 Commercial fishing
09 Driver
10 Carpenter
11 Mechanic
12 Electrician
13 Welder
14 Pipefitter
15 Scaffolder
16 Stevedore
17 Supervisor
18 O&M technician
19 Administration
20 Cook
21 Security
22 Cleaner
23 Teacher
24 Health worker
25 Retired/old
26 Disabled/can't
27 Attending school
28 Own business, specify
29 Other

C2 - Current

01 PNG LNG
02 Logging company
03 InterOil
04 Total
05 Church group
06 Government
07 Other employer (specify)

C3 - Location

01 In village
02 Other location within LLG
03 Outside of LLG,
04 Outside of province

D Subsistence Activities

D1 What activities do male and female household members perform and how frequently?

(Indicate whether activities were performed yesterday or during the past two weeks, for male and female members of the household) ***Tick and cross***

Activity		Male		Female	
		Yesterday	***Past 2 weeks***	***Yesterday***	***Past 2 weeks***
A	Clearing or planting new garden				
B	Garden maintenance				
C	Harvesting garden produce *(anything from garden)*				
D	Harvesting fruit or nuts *(from the bush)*				
E	Making sago				
F	Collecting edible/medicinal plants foods from forest				
G	Collecting building/craft materials from forest				
H	Hunting with dogs/bow and arrow *(not gun)*				
I	Setting/checking traps *(on land not water)*				
J	Fishing with hook from canoe/outrigger or river bank or beach				
K	Fishing (incl. prawns) with scoop net/Y-net				
L	Fishing with gill net from canoe/outrigger or river bank or beach				
M	Fishing with poison vine / bow and arrow / spear / spear gun				
N	Collecting crabs or shellfish from beach/river				
O	Harvesting of eggs (scrub fowl/turtle/croc)				
P	Collecting other animal foods from forest (honey/grubs /reptiles/ frogs / birds)				
Q	Making canoe				
R	Repairing/building the house				
S	Community work (work bung)				

D2 How many livestock/animals do household members own? *(insert number or strike through if none)*

Livestock			Number
a	Pigs		
b	Chickens / ducks		
c	Cassowary		
d	Crocodiles		
e	Hunting dogs		
f	Cats		
g	Other	(specify)	
h	Other	(specify)	

D3 Which of the following food items have been consumed by household members in the past two weeks or in the past year? ***Tick and cross***

	Food item	**Past 2 weeks**	**Past year**
A	Domestic pig		
B	Wild pig		
C	Cassowary		
D	Wallaby		
E	Kapul/bandicoot		
F	Flying fox		
G	Turtle – meat or eggs		
H	Crocodile – meat or eggs		
I	Dugong/dolphin		
J	Bush fowl – meat or eggs		
K	Sago grubs		
L	Moran snake		
M	Kundu lizard		
N	Barramundi		
O	Shark		
P	Mud crabs		
Q	Shellfish		
R	Prawns		
S	Honey		

D4 Which of the following items are important for your family as a seasonal food resource and when? *(Indicate months when used)*

	Product	**Indicate month** *(Write Jan-Feb, etc. If NOT important, strike through)*
A	Turtle	
B	Crocodile	
C	Turtle eggs	
D	Crocodile eggs	
E	Flying foxes	
F	Bush fowl eggs	
G	Possum	
H	Crabs (ocean)	
I	Mud crab (river)	
J	Shellfish	
K	Shark	
L	Barramundi	
M	Salmon	
N	Kaukau	
O	Wild yams	
P	Terminalia / small okari nut	

E Income and Expenditure

E1	In the past year, what were the **TOP THREE** sources from which household members earn income and how much did they earn from it? *Code: 01=wages, 02=betel nut, 03=sago, 04=garden produce, 05=fish, 06=trade store, 07=other business activity, 08=remittances, 09=other (specify)*	
	Income source	**How much? (Kina per year)**
1.		K
2.		K
3.		K

E2	In the past two weeks, approximately how much income have all household members earned from the following sources? *(if nothing, strike out. If don't know, write, unsure)*:	
	Income source	**Kina**
a	Wages	K
b	Betel nut	K
c	Copra	K
d	Sago	K
e	Brus - bush tobacco	K
f	Garden produce (banana, kumu, etc)	K
g	Other cash crops	K
h	Fish	K
i	Crabs	K
j	Prawns	K
k	Other food from the river or sea	K
l	Chickens/ducks	K
m	Pigs	K
n	Other livestock	K
o	Abus (bushmeat)	K
p	Other forest products (kumu/timber)	K
q	Home brew/marijuana	K
r	Rental of boat/canoe	K
s	Rental of property (guest house)	K
t	Business income (i.e., trade-store)(specify)	K
u	Royalties (e.g. from logging)	K
v	Customary payments	K
w	Gifts/remittances	K
x	Other (specify)	K

Business Activity

E3	Do any household members run a business? If YES, what is the annual income and annual expenditure? *(if no, strike through)*	**Annual income (kina)**	**Annual costs (kina)**
a	Trade store	K	K
b	Fuel seller	K	K
c	Black market	K	K
d	Guesthouse	K	K
e	Canoe hire	K	K
f	Dinghy hire	K	K
g	Crocodile products	K	K
h	Other *(specify)*	K	K

Savings and Borrowings

E4	Do any household members have: *(circle)*		
A	Bank account	YES	NO
B	Access to savings *(not necessarily bank savings)*	YES	NO

E5 If you need money, for example, to pay for a new house, where would you get money? *(list up to 3 options)(code)*

Code: 01=Use savings from bank account, 02=Use other cash savings, 03=Borrow from friends/relatives, 04=Sell products, 05=Seek employment, 06=Other (specify)

1.	2.	3.

Spending

E6 What did your household spend in the previous two weeks on: *(if nothing, strike out)*:

	Item	**Kina**
A	Food from trade store (tinned fish, rice, biscuits, etc)	K
B	Local food from market	K
C	Fuel	K
D	Kerosene	K
E	Batteries	K
F	Transport (PMV, etc)	K
G	Mobile phones (credit/charging)	K
H	Medicine, health care	K
I	Clothes/shoes	K
J	Household items (pots, kapa)	K
K	Cigarettes, spia, brus	K
L	Alcohol	K
M	Any other store products (soap, matches, etc)	K
N	Church donations	K
O	Business costs (e.g. buying/transporting store goods)	K
P	Customary payments	K
Q	Gifts/remittances	K
R	Other (Specify)	K

Household Assets

E7 Does your household have the following assets in **working order**: *(Indicate number or strike through for none)*

	Assets	Number
a	Refrigerator / freezer	
b	Television	
c	Mobile phone	
d	Radio	
e	Sewing machine	
f	Motor vehicle	
g	Motor bike	
h	Computer/ipad	
i	Canoe	
j	Dinghy	
k	Outboard motors	
l	Gun or rifle	
m	Chainsaw	

F Infrastructure, Services & Household Utilities

F1	Does your household have regular access to: *(circle)*				
a	Electricity from a generator			YES	NO
b	Electricity from solar panels			YES	NO
F2	Has anyone in the household used EFTPOS in any stores before			YES	NO
F3	Has anyone in the household used the internet before			YES	NO
	a. If YES, do they use it to access social media?			YES	NO
	b. How often do they access the internet?	DAILY	ONCE A WEEK	ONCE A MONTH	LESS THAN MONTHLY

F4 What are the main and secondary sources of drinking water in this house? Use code:

Code: 01=piped into house/yard, 02=piped into village, 03=well in yard, 04=well in village, 05=spring, 06=river/creek, 07=pond/lake/dam, 08=communal tank, 09=rain water,10= other (specify) *<<well in bush>>*

Main:	Secondary:

F5	What are the household's main and secondary sources of lighting: *(select one for main and one for secondary, if no secondary strike through)*	*Code: 01 -main, 02 - secondary*	**F6**	What are the household's main and secondary fuels used for cooking: *(select one for main and one for secondary, if no secondary strike through)*	*Code: 01 -main, 02 - secondary*
A	Fire		a	Firewood	
B	Kero lamp		b	Kero stove	
C	Gas lamp (pressure lamp)		c	Gas stove	
D	Battery lamp		d	Electric stove	
E	Generator		e	Other	
F	Solar				
G	Torch				
H	Other				

G Health, Nutrition and Sanitation

Ask an adult female to answer this question. If possible, questions G1, G2 and G3 to be asked by a female.

G1	How old are you? *(number)*				
G2	Have you ever given birth?	YES	NO	If yes, number of births:	
G3	Have any of your children died? *(Indicate gender of child and when they died?)*	**During child birth/within first month**	**Within first year (2-12 mths)**	**With five years**	**After five year**
a	Child 1, gender:				
b	Child 2, gender:				
c	Child 3, gender:				
d	Child 4, gender:				

G4 Deleted question about deaths.

G5 When was the last time members of your household visited *(tick timeframe and use codes for reason and treatment received)*: REPLACED WITH G5 AT END.

		Past week	**Past month**	**Past year**	**More than a year ago**	**Never**	**Reason for visit** *Use reason for visit code, may be multiple*	**Treatment received** *Use treatment code*
a	Traditional doctor / medicine person							
b	Aid post							
c	Health centre							
d	Hospital							
e	Other *(specify) This might be an exploration camp, logging camp or medical staff on patrol, for example.* _____							

Reason for visit code:

01 – antenatal care (pregnancy)
02 – delivery
03 – Postnatal care (after birth)
04 – fever (lying in sun, sleeping by fire)
05 – accident/injury/trauma
06 – skin disease or ulcer
07 – pain in joints or back
08 – pain in stomach or abdomen
09 – diarrhoea
10 – vomiting
11 – follow up to previous visit
12 – cough
13 – snake/spider/insect bite
14 – other (specify reason)

Treatment code:

01 – none
02 – antibiotics (pill/syrup)
03 – injection
04 – anti-malarial (pills/syrup
05 – tuberculosis treatment
06 – cough syrup
07 – Other pill/syrup
08 – Unknown pill/syrup
09 – Home remedy/herb
10 – Other (specify)

Bed Net Use and Treatment

G6 How many mosquito nets does this household have? *(number)*	How many: *(number)*	
G7 If NO, why not? *Use code.* *Code: 01=too costly, 02=not available in this area, 03=have flywire in house, 04=use insecticides/coils/sprays, 05= other (specify)*		
G8 Who in your household uses the mosquito net(s) to sleep in? *Use as many as apply.* *Code: 01=everyone in house, 02=females only, 03=males only, 04=mother and children only, 05=children only, 06=pregnant women/mother only, 07=father and mother only, 08=other (specify), 09=no one.*		
G9 How often does your household use mosquito net(s)? *Use as many as apply.* *Code: 01=every night, 02=some nights only, 03=every night except when it is hot, 04=seasonal (during mosquito season only), 05=never used at all, 06=other (specify).*		
G10 Who slept under the net/s last night? *Use codes from G8*		
G11 When was the net/s soaked or dipped into chemicals? *(date)*	Date:	UNSURE

Sanitation

G12 Do people in this house usually wash hands before cooking food, eating, after going to the toilet? *(circle)*	ALL	SOME	NONE	UNSURE
G13 Do most people use soap to wash their hands? *(circle)*	ALL	SOME	NONE	UNSURE
G14 What type of toilet facility does this household mainly use? *Use code.* *Code: 01=traditional pit latrine, 02=improved latrine, 03=bucket system, 04=closet over sea/river, 05=bush (no facility), 06= sea/river (no facility), 07=other (specify)*				
G15 Is the toilet for use only by this household or shared with others? *(circle)*		OWN		SHARED

Respiratory

G16 Has anyone in your household had these problems in the past fortnight?

Tick the symptom for each person in the household who has had these symptoms.

Person	Age	Unexplained weight loss	Loss of appetite	Night sweats *(sweating at night)*	Fever *(lying in sun, sleeping by fire)*	Fatigue *(tiredness)*	Coughing for more than three weeks	Coughing up blood	Chest pain
1									
2									
3									
4									
5									
6									
7									

Child Health and Immunisation

G17 Only complete for children under 5 years of age (if mother is present).

		Child 1	Child 2	Child 3	Child 4	Child 5	Child 6
a	Where was the child born? *Code: 1=hospital, 2=health centre, 3=aid post, 4=village, 5=bush, 6=other*						
b	If born in the village, who supervised delivery? *Code: 1=APO, 2=trained VBA, 3=traditional VBA, 4=delivered alone, 5=other (specify)*						
c	If born in the bush, who supervised delivery? *Code: 1=APO, 2=trained VBA, 3=traditional VBA, 4=delivered alone, 5=other (specify)*						
d	Did the mother attend an ante-natal clinic during pregnancy? *Code: 1=Yes, 2=No, 3=Not sure*						
e	Was the mother vaccinated for tetanus during pregnancy? *Code: 1=Yes, 2=No, 3=Not sure*						
f	Has the child been immunised? Y/N. *If yes, baby book, then first number = age in months/years, second number = number of immunisations.*						

Food Consumption and Nutrition

Ask one individual to answer this question. Record if male or female: *(circle)* M / F and HH ID# _____

G18 Yesterday, what foods did you eat?

Tick all that apply. Prompt what foods were eaten in morning, during day, in afternoon, at night, in the garden or visiting other people.

Sago	
Rice	
Biscuits	
Noodles	
Flour, bread, scones	
Store snack foods	
Coke, soft drinks	
Marita	
Peanuts	
Other nuts	
Betel nut	
Brus, cigarettes	
Alcohol	

Kau kau	
Taro	
Yam	
Pumpkin	
Cooking banana	
Corn	
Cassava	
Other garden kumu	
Forest kumu	
Kapiak (breadfruit)	
Pineapple	
Banana	
Sugar cane	
Water melon	
Pit pit	
Mango	
Coconut	
Kulau	
Paw paw	
Other fruits	

Tinned fish/meat	
Abus (bushmeat)	
Pig meat (pork)	
Chicken meat	
Beef/lamb	
Small birds	
Cassowary	
Bush turkey	
Possum	
Rat	
Lizard/snake	
Wallaby	
Bandicoot	
Crocodile	
Fresh fish	
Prawns	
Crabs	
Turtle meat	
Shellfish	
Shark	
Eggs	
Other (specify)	
Other (specify)	

G19	How many meals did this household take yesterday? *(Number)*			
G20	How many meals did the children take yesterday? *(Number)*			
G21	Did this family regularly go a whole day without eating anything? *(That is, wake up in the morning and go to sleep in the night without eating anything) (circle)*	YES	NO	UNSURE
G22	Do children in this family regularly go a whole day (as above) without eating anything? *(circle)*	YES	NO	UNSURE
G23	Do women in this family regularly go a whole day (as above) without eating anything? *(circle)*	YES	NO	UNSURE

Thank each person who participated in the survey.

COMPLETION CHECKLIST: **initials**

All questions complete / filled in	
Checked and ready for data entry	

REPLACEMENT QUESTION FOR G5

G5a		P1	P2	P3	P4	P5	P6	P7
How many people in family have been ill with a fever in the last two weeks?								
If YES:		**P1**	**P2**	**P3**	**P4**	**P5**	**P6**	**P7**
G5b	**Where did you seek advice or treatment for the fever?** *(Include location)*							
1	Your home							
2	Other home							
3	Hospital							
4	Aid Post							
5	Health Centre							
6	Other							
7	If Other, specify							

G5c		P1	P2	P3	P4	P5	P6	P7
How many people in family have been ill with a cough in the last two weeks?								
If YES:		**P1**	**P2**	**P3**	**P4**	**P5**	**P6**	**P7**
G5d	**Where did you seek advice or treatment for the fever?** *(Include location)*							
1	Your home							
2	Other home							
3	Hospital							
4	Aid Post							
5	Health Centre							
6	Other							
7	If Other, specify							

G5e		P1	P2	P3	P4	P5	P6	P7
How many people in family have been ill with diarrhoea in the last two weeks?								
If YES:		**P1**	**P2**	**P3**	**P4**	**P5**	**P6**	**P7**
G5f	**Where did you seek advice or treatment for the fever?** *(Include location)*							
1	Your home							
2	Other home							
3	Hospital							
4	Aid Post							
5	Health Centre							
6	Other							
7	If Other, specify							

Part 23l
Upstream Social Baseline Studies Scope and Methods

PAPUA LNG PROJECT

UPSTREAM SOCIAL BASELINE STUDIES SCOPE AND METHODS

Version	Details	Prepared (ERIAS Group)	Endorsed (ERIAS Group)	Approved (TEP PNG)	Date Issued
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Abbreviations

CEPA	Conservation and Environment Protection Authority
CPF	Central Processing Facility
DEC	Department of Environment and Conservation
EIS/ESHIA	Environmental impact Statement/Environmental Social Health Impact Assessment
FGD	Focus Group Discussion
IFC	International Finance Cooperation
KII	Key Informant Interview
LLG	Local Level Government
LNG	Liquefied Natural Gas
PAC	Project Affected Community
PAOI	Project Area of Influence
PER	Pipeline Export Route
POM	Port Moresby
PRL	petroleum retention license
SBS	Social baseline study
SMLI	Social Mapping and Landowner Identification
TEP PNG	Total Exploration & Production Papua New Guinea Limited

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1. Introduction

1.1 Project Overview

Joint venture partners, Total Exploration & Production Papua New Guinea Limited (TEP PNG) (40.1%), InterOil (36.5%) and Oil Search (22.8%) are currently planning the development of the Elk-Antelope gas field, which is located in the Gulf Province, Papua New Guinea. TEP PNG, a wholly owned subsidiary of TOTAL, has a majority interest in the Elk-Antelope gas field and will be the Project proponent and operator of the Papua LNG Project (the Project) on behalf of the other joint venture partners.

The Elk-Antelope formation is a significant gas discovery in Papua New Guinea consisting of a deep, high pressure, elevated temperature gas reservoir with several trillion cubic feet of gas reserves located approximately 120 km inland from the township of Kerema, and 340 km northwest of Port Moresby.

The Project will comprise upstream production well development and associated infrastructure at the gas production field within petroleum retention license (PRL) 15, construction of an upstream central processing facility (CPF), onshore and offshore gas and condensation export pipelines and a new Liquefied Natural Gas (LNG) Plant at Caution Bay, 20 km northwest of Port Moresby. The LNG product will be shipped to international markets.

The Project area comprises the physical footprint of the various Project components and associated infrastructure. The main components of the Project are:

- Upstream (within PRL15):
  - Wellpads, the gathering system (including trunk pipeline).
  - Central processing facility (CPF) incorporating an acid gas removal unit.
  - Initial section of the onshore export pipeline corridor.
- Upstream (outside PRL15):
  - Remainder of the onshore export pipeline corridor to landfall on the Gulf coast.
  - Offshore section of the export pipeline corridor to the Liquefied Natural Gas (LNG) Plant site.
- Downstream:
  - LNG Plant site at Caution Bay.

Initially, the Project will focus on exploiting the Elk-Antelope reservoirs via the ANT-2, ANT-3, ANT-5 and Elk-1 wellpads. Gas will be transported to the LNG Plant located on the southern coast of Papua New Guinea. Most of the LNG will be exported to the nearby Asian market. While still to be formally agreed, possibilities may also exist to provide gas tie-in points at the LNG Plant boundary to permit domestic gas take-off.

The estimated Project development costs are 20 to 30 billion PNG Kina.

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1.2 This Document

This document describes the scope and methods for the community level data collection survey that is part of the social baseline surveys (SBS) for the upstream component of the Project only. It excludes cultural heritage baseline field surveys which are addressed as part of a separate document [01215B_6-6]). The scope and methods reports for the community level data collection for the downstream component of the Project and the household level data collection for the entire study area will be presented in separate documents one month prior to the commencement of those fieldwork components of the SBS.

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2. Study Objectives

The key objective of the social baseline studies (SBS) is to identify, describe and, where possible, map social values in the study area that require consideration in the development of the Project.

Specifically, and in the context of the overall SBS, the social field surveys aims to meet the requirements of national legislation and international regulations, including the relevant aspects of the International Finance Corporation's (IFC) Performance Standards 1, – Assessment and Management of Environmental and Social Risks and Impacts (including aspects related to stakeholder engagement) and TEP PNG Sustainable Development Specifications (GS EP SDV101 Social Baseline Study).

In order to achieve this, the social field surveys will obtain socio-economic data that will help characterize the socio-economic context of the study area and thereby inform the prediction of potential impacts and development of management and mitigation measures, as part of the Environmental Impact Statement (EIS)/Environment, Social, Health Impact Assessment (ESHIA) process.

Characterization of the socio-economic context of the study area will involve:

- Describing the social and cultural anthropology of the Project area.
- Describing the social services and infrastructure (health, education, governance, communication) that exist in the study area and communities' use of and access to them.
- Identifying and describing the historical and existing social values of potentially affected communities (PACs) in order that those values are recognised and appropriately considered in the development of the Project.

An additional objective of the social field surveys is to contribute to the level of awareness of the Project amongst local communities, local government and other relevant stakeholders.

The scope of SBS fieldwork involves collection of qualitative and quantitative data and information for the following key thematic areas:

- Community and demographics[1].
- Community health and safety.
- Governance and economics[2].
- Land and natural resource use[3].
- Cultural heritage[4].

[1] This includes social organisation and settlement, infrastructure and services, education, markets, and others.
[2] This includes local and household economics as well as benefits distribution.
[3] This includes ecosystem services.
[4] The scope and methodology for the cultural heritage surveys are addressed in a separate rationale document (see 01215B_6-6).

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Also to be collected, is data to complete spatial mapping and to inform the labour and industrial relations study (Lot 3), project induced-in-migration study (Lot 4), ecosystem services study (Lot 10), and cultural heritage management (Lot 14).

The specific objectives of each study outlined above are provided at Attachment 1.

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3. Study Area

The SBS upstream study area has been informed by the preliminary Project area of influence (PAOI) (see Figure 1 and Technical Note 04 Project Area of Influence). The local study area includes land and communities anticipated to be directly affected by Project infrastructure, facilities and associated activities within PRL15, the pipeline export route (PER) and the Purari tributary riverways (Riverways). The regional study area includes the relevant Provincial, District and Local Level Governments (LLGs), which for the SBS upstream study area includes:

- Gulf Province.
- Kikori District.
- Baimuru Rural and Ihu Rural LLGs.

The SBS upstream study area excludes potentially affected communities in the downstream Project area (Caution Bay).

Table 1 and Figures 1 and 2 show the potential PACs that have been identified within the upstream local study area.

Table 1 – Local Study Area Communities – Upstream

Category (Community)		Project Area
1	Wabo	PRL15
2	Ura	
3	Subu (1 and 2)	
4	Poroi	
5	Old Poroi	
6	Nea Creek settlement (name unknown) (TBC)	
7	Evara	Pipeline Export Route
8	Ere/Kilavi	
9	Huruta	
10	Arehava 2	
11	Avavu	
12	Harevavo	
13	Hepere	
14	Herekera	
15	Luku	
16	Kanukabu	
17	Lariau	
18	Larihairu	
19	Maiva	
20	Marea	

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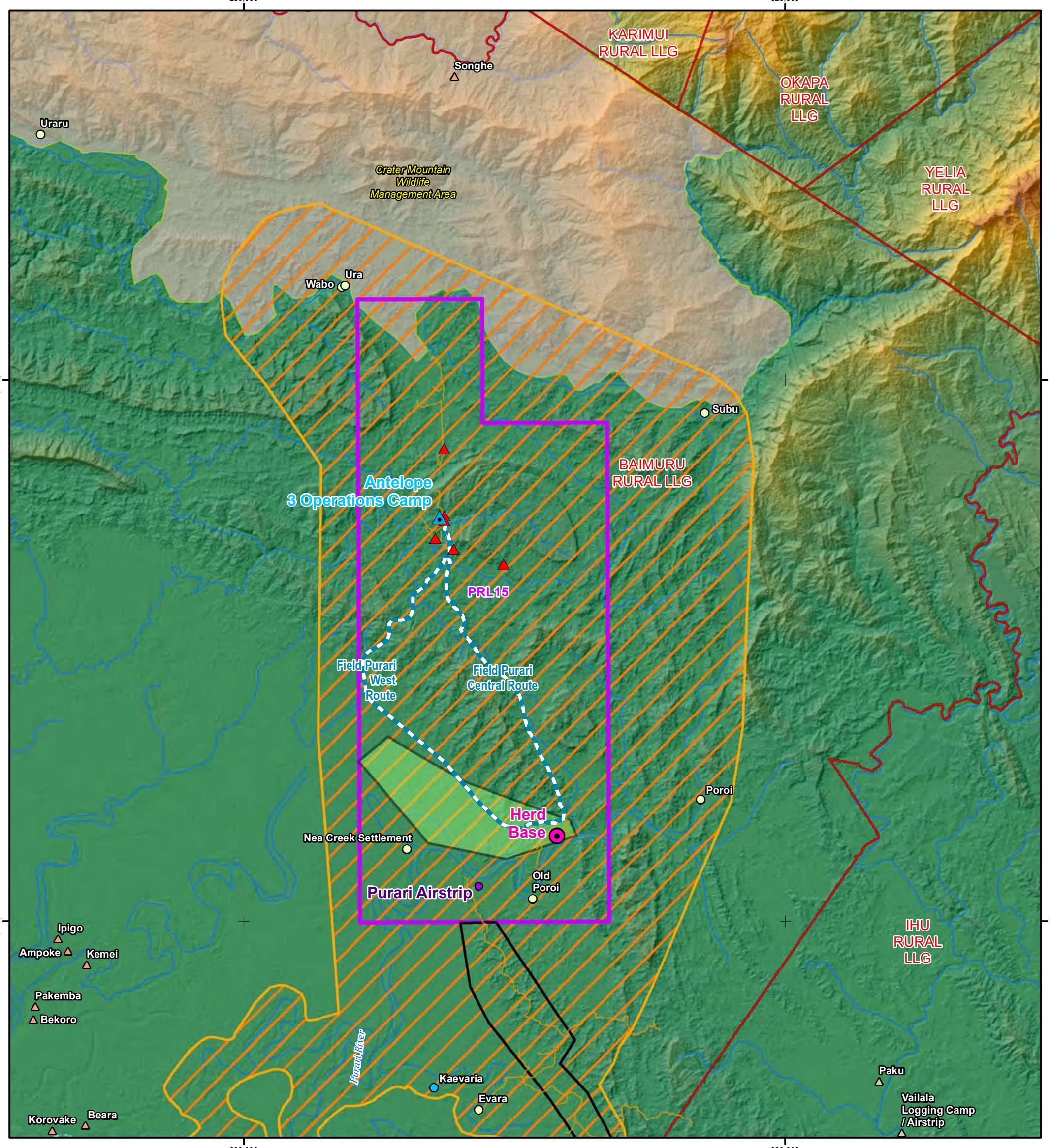
Table 1 – Local Study Area Communities – Upstream (cont'd)

Category (Community)		Project Area
21	Mareke	
22	Paevara	
23	Apiope	Riverways
24	Aumu	
25	Aivaikoki	
26	Kaevaria	
27	Akoma	
28	Kairu'u	
29	Mapaio	
30	Upaia	
31	Ara'ava	
32	Kapuna	
33	Kairmai	
34	Mira	

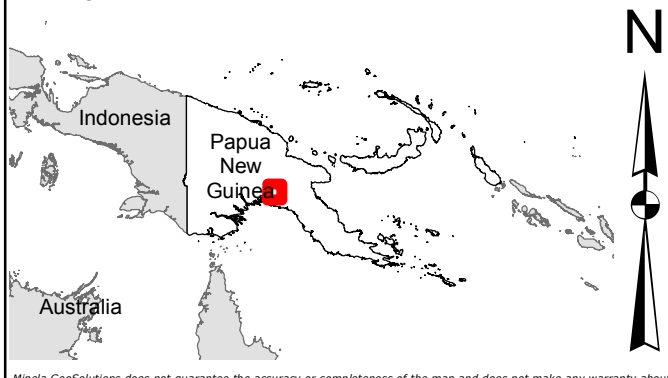
Note that the PER corridor remains broad, particularly at the southern end towards the coast, to enable TEP PNG to consider five pipeline route and shore crossing options, as such the PER currently encompasses a large number of communities south of Kilavi that may not necessarily be impacted by the Project. Once TEP PNG has selected the pipeline route, the PER corridor will be narrowed south of Kilavi and the number of PACs would be expected to reduce. Conversely, the community level data collection survey may identify communities that are not currently, but should be, identified within the PAOI and thus the number of PACs may potentially increase.

Further note that the study area is based on the preliminary PAOI and that a Social Mapping and Landowner Identification (SMLI) study has not yet been completed for the upstream Project area, with the exception of PRL 15. It is recommended that ahead of mobilisation, ERIAS and TEP PNG reconcile, to the best of each party's knowledge, each party's data concerning the precise location of communities. As a result of a) that reconciliation process, b) the conduct of the community level survey and c) further definition of the Project description, it is possible that additional potential PACs may be identified (see Section 6).

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LEGEND:

- Existing airstrip
- Proposed well pad

Project Affected Communities

- PRL15
- Riverways
- Tracks
- Trunkline route options
- Rivers

Host LLG Communities

- Baimuru Rural
- Ihu Rural
- Local level government boundaries
- Project areas of influence

Facilities

- Active base
- Proposed base
- Pipeline export route
- PRL 15 License
- Notional development area of CPF
- Crater Mountain Wildlife Management Area

PROJECT: Papua LNG Project

TITLE: Social Baseline Study Upstream Study Area'

SUBTITLE: PRL15

DATE: 21/03/2016

DATA SOURCE:
Facilities, CPF area, pipeline routes, villages, rivers, wellpads, tracks, PRL15, hillshade supplied by ERIAS and TOTAL (2015-2016)
LLG Boundaries from HDX and then spatially adjusted to align with background and coastal boundaries removed.

DOCUMENT NUMBER: R_041-71582

Revision	Description	Drawn	Checked	QC	Approved	Date
E	ISSUED FOR REVIEW	REC	IN	DHC		21/03/16
D	ISSUED FOR REVIEW	REC	IN	JRB		18/03/16
C	ISSUED FOR REVIEW	SRF	KM	REC		26/02/16
B	ISSUED FOR REVIEW	SRF	KM	REC		25/02/16
A	ISSUED FOR REVIEW	REC	KM	SRF		22/02/16

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SCALE: 1:275,000 @ A3 PNG94 PNGMG94 Zone 55

0 10 20

Kilometres

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275,000 300,000

9,175,000 9,150,000 9,125,000

EAST KIKORI RURAL LLG

BAIMURU RURAL LLG

IHU RURAL LLG

PRL15

Purari Airstrip

Nea Creek Settlement

Old Poroi

Purari River

Ipigo
Ampoke
Kemei
Pakemba
Bekoro
Kararua
Baimuru
Korovake
Beara
Ara'ava
Kapuna
Kairimai
Kaiaravi
Mapaio
Ravikivau
Kairiravi
Ravikaupara
Iari
Aikavaravi
Aivaivikoki
Upaia
Mira
Kaimari
Kauravi
Koiravi
Mariki
Kinipo
Ikinu
Kakarravi
Akoma & Kairu'u
Maipenaru
Kapai Number 2
Kapai
Apiapi
Aivei
Apiope
Aumu
Kaevaria
Evara
Hepere
Ere
Kilavi
Maiva
Avavu
Muro
Mission
Huruta
Arehava Number 2
Aroaro
Paevera
Marea
Larihairu
Iuku
Mareke
Harevavo
Kanukabu
Lariau
Herekera
Pakovavu
Haiara
Hohoro
Miai Miai Number 2
Ihu
Auma
Vailala
Kukipi

275,000 300,000

AREA OF DETAIL:



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LEGEND:

- Existing airstrip
- **Project Affected Communities**
  - PRL15
  - PER
  - Riverways
- **Host LLG Communities**
  - Baimuru Rural
  - Ihu Rural
- Tracks
- Rivers
- Local level government boundaries
- Project areas of influence
- Pipeline export route
- PRL 15 License
- Notional development area of CPF

PROJECT:	Papua LNG Project
TITLE:	Social Baseline Study Upstream Study Area'
SUBTITLE:	Pipeline Export Route and Riverways
DATE:	21/03/2016

DATA SOURCE:
Facilities, CPF area, pipeline routes, villages, rivers, wellpads, tracks, PRL15, hillshade supplied by ERIAS and TOTAL (2015-2016)
LLG Boundaries from HDX and then spatially adjusted to align with background and coastal boundaries removed.

DOCUMENT NUMBER: R_041-71583

Revision	Description	Drawn	Checked	QC	Approved	Date
E	ISSUED FOR REVIEW	REC	IN	DHC		21/03/16
D	ISSUED FOR REVIEW	REC	IN	JRB		18/03/16
C	ISSUED FOR REVIEW	SRF	KM	REC		26/02/16
B	ISSUED FOR REVIEW	SRF	KM	REC		25/02/16
A	ISSUED FOR REVIEW	REC	KM	SRF		22/02/16

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SCALE: 1:250,000 @ A3 PNG94 PNGMG94 Zone 55

0 10 20

Kilometres

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4. Relevant Legal and Other Requirements

The SBS has been designed to comply with the requirements of, and address issues identified within, the following national legislation, national and international standards and operational guidelines:

- Environment Act 2000.
- Oil and Gas Act 1998.
- PNG Conservation and Environmental Protection Authority (CEPA) guideline GL-Env02/2004: Guideline for Conduct of Environmental Impact Assessment & Preparation of Environmental Impact Statement (CEPA, 2004).
- CEPA (formerly DEC): Social Impact Assessment Guideline (Draft).
- Total Charter of Principles and Guidelines Regarding Indigenous and Tribal Peoples (CH-GR-SBS-001).
- Total General Specification, Sustainable Development, Social Baseline Study (GS EP SDV101).
- Total General Specification, Sustainable Development, Social Impact Assessment (GS EP SDV 102).
- International Finance Corporation's (IFC) Performance Standards on Social and Environmental Sustainability (2012). In particular:
  - PS 1: Assessment and Management of Environmental and Social Risks and Impacts.
  - PS 2: Labour and Working Conditions.
  - PS 4: Community Health, Safety and Security.
  - PS 5: Land Acquisition and Involuntary Resettlement.
  - PS 7: Indigenous Peoples.
  - PS 8: Cultural Heritage.

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5. Stakeholder Engagement

The SBS approach assumes that TEP PNG will undertake stakeholder engagement with PACs in the form of a pre-awareness campaign in all communities identified in Table 1 prior to the commencement of the community survey. In addition, it is recommended that TEP PNG also visit with CEPA and DPE as well as officials in Kerema, Baimuru and Ihu prior to the community survey as a courtesy to inform them about the upcoming social (and terrestrial biodiversity) surveys. This is good practice and an important step in the SBS process.

The criticality of sound and effective pre-awareness cannot be overstated and may likely be one of the pivotal factors in the SBS program's success. The pre-awareness campaign that TEP PNG will undertake ahead of the commencement of the community survey will advise communities about the Project (including but not limited to what it is, where it is located, and the development schedule), the forthcoming studies (community level data collection and other studies that are part of the EIS/ESHIA program), the purpose of those studies and what community members can expect when survey teams visit (at a minimum), and seek approval for survey teams to visit and conduct said studies.

It is suggested that planning for the pre-awareness occur in the period 1 – 13 April 2016 and that implementation occur in the period 14 – 30 April 2016.

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6. Study Approach

The SBS has been designed to identify social values and parameters within the study area using four primary means, summarised below:

1. Bibliographic review – a desktop exercise reviewing existing literature.
2. Community level data collection (the focus of this document) – involving focus group discussions (FGDs), key informant interviews (KIIs) and mapping.
3. Household level data collection (the focus of a separate, future document) – involving the detailed surveying of individual households.
4. National, Provincial, District and Local Level Government (LLG) interviews – involving discussions with key Government agencies and authorities to obtain current information and secondary data (such as annual and statistical reports).

The approach adopted has been to collect community level information from 34 villages currently identified as potentially impacted, and using this information, to subsequently collect more detailed household level data, later in a separate exercise. The reasoning for this approach to SBS fieldwork is provided in Attachment 2 (previously provided memo, 012515B_M001_20160307_v1). Should additional PACs be identified during this initial community level survey, community level data, as well as household level data could be collected from these villages, if deemed necessary, during the household survey campaign (August/September 2016) or during a separate exercise. This would be discussed with TEP PNG as appropriate after this initial SBS fieldwork.

Within the SBS structure, data collection occurs at different levels:

- FGDs – a range of topics are explored at a generalized level.
- KIIs – key topics are explored in greater detail with participants who are particularly informed on those topics.
- Household surveys – detailed quantitative data on key indicators is collected from a sample of individual households.
- Interviews with National, Provincial, District and LLG agencies and authorities.

The household survey is discussed here because it is important context for the community level survey process.

Table 2 outlines the parameters that will be identified during the collective SBS (bibliographic review, FDGs and KIIs).

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Table 2 – Parameters to be Identified During SBS Field Surveys

Dataset	Description of Parameters
Community and demographics	♦ Name, structure and social dynamics of village/community/town ♦ Population size, density, distribution ♦ Age ♦ Gender ♦ Origin, settlement history, migration patterns ♦ Clan and/or religious association ♦ Access to services and infrastructure (education [primary, secondary, tertiary], potable water, sanitation, electricity, energy sources, etc.) ♦ Education (attainment, literacy) and language ♦ Type of housing
Community health and safety	♦ Housing and respiratory issues ♦ Vector related diseases ♦ Sexually transmitted infections (STIs) including HIV/AIDS ♦ Soil, water, sanitation and waste ♦ Food and nutrition ♦ Accidents/ injuries ♦ Exposure to hazardous materials ♦ Other social determinants of health (such as income, education, employment) ♦ Cultural health practices ♦ Health services infrastructure and capacity ♦ Non-communicable diseases ♦ Zoonotic diseases ♦ Morbidity and mortality
Land and natural resource use	♦ Identification and quantification of actual land use/land cover units, including farmland, grazing land, forest lands, residential land, institutional land, social infrastructure (schools, markets, aid posts, etc.) and any other formal or informal land use (e.g., squatting/hawking) ♦ Mapping of other land features and natural resources (ecosystem services) used by communities (e.g., water bodies, roads, foot tracks) ♦ Identification and quantification of community use of natural resources (ecosystem services) including forest products, fishing/fish resources, medicinal plants, wildlife for hunting ♦ Land tenure systems (e.g., customary, lease, freehold) and distribution patterns ♦ Women's and any other vulnerable groups' land rights ♦ Previous or current land or land related disputes and speculation ♦ Natural resource challenges and pressures
Governance and economics	♦ Formal administrative structure of host local level governments (LLGs), districts and provinces ♦ Customary governance functions and processes ♦ Customary dispute resolution methods and land/ownership disputes ♦ Law and order (crime, conflict and security) context at the village, LLG and regional level with specific focus on common disputes and resolution mechanisms, as well as inter-tribal conflicts ♦ Gross domestic product (GDP), average earnings, unemployment, inflation rate and economic risk

Table 2 – Parameters to be Identified During SBS Field Surveys (cont'd)

Dataset	Description of Parameters

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Governance and economics (cont'd)	♦ Existence of landowner associations, incorporate landowner groups, chambers of commerce, chambers of private trades, associations of business owners, professional associations ♦ Labor market information by sector: employment rate, distribution by gender, age or region, fast-growing sectors that are providing jobs, employment law (salaries, diversity, hiring and contract practices, personnel management, unions, forced labor and child labor) ♦ Local businesses – spheres of activity, development capacity, local hiring potential, health, safety, environment and quality standards, commitments to purchase from local communities ♦ Existence of support structures and programs for small-medium enterprises. ♦ Formal economic activity in the area by sector (industry, agriculture, fishing, forestry, transport, commerce and markets, small and medium enterprises). ♦ Informal economy (including illegal activity): representativeness, sectors, distribution, and efficiency ♦ Former or current oil and gas projects. ♦ Ongoing and previous development projects (operator – non-governmental organizations [NGOs], development agencies – legitimacy, pertinence and results, challenges overcome) ♦ Industrial or public sector projects being financed by international lenders and institutions

6.1 Bibliographic Review

This will occur ahead of the field surveys and involves a review of existing information relevant to the Project area, including any previous studies related to the demographic makeup of the area, its economy and land and natural resource use. There is a range of recent and publicly available literature relevant to the Gulf and Central provinces, Districts and LLGs that the Project spans. Relevant literature to be reviewed will include (but is not limited to):

- Societal and Environmental Screening Study Report for the Elk-Antelope Project Facilities, prepared for Total by ERIAS Group, (ERIAS Group, 2015).
- PNG LNG Environmental Impact Statement and appendices, prepared for ExxonMobil (CNS, 2009).
- Gulf LNG Project Full Scale Social Mapping & Landowner Identification (Pipeline License) (Kameata, 2012).
- Liquid Niugini Gas Ltd Gulf LNG Project Environmental Impact Statement (GHD, 2012).
- Full-Scale Social Mapping and Landowner Identification Study for the Elk-Antelope PRL15 Gas Field Development Project (Sagir, 2015).
- Broader studies of PNG relating to demographics, economics, health, and land and natural resource use, and regional studies for the Gulf and Central provinces.
- PNG legislation and relevant international guidelines, policies and standards for the purposes of characterizing areas of significance in terms of demographics, economics and natural resource use and focus points for the EIS/ESHIA.

The bibliographic review will also include:

- Previous scientific and scholarly studies undertaken in the study area.

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- Secondary data (such as annual and statistical reports) provided by National, Provincial, District and LLG agencies and authorities.
- Existing knowledge held by TEP PNG and their other joint venture partners of the Project and past resource development projects in the Project area.

Any data gaps identified during the bibliographic review will be addressed the SBS field surveys and discussions with National, Provincial, District and LLG agencies and authorities (and their provision of statistics and reports).

The findings of the bibliographic review will:

- Be used to prepare the National, Provincial, District and LLG components of the SBS.
- Inform field data collection.
- Be summarised and referenced in the resulting baseline technical reports.

6.2 Community Level Surveys

Community level data will be collected to form a qualitative picture of social functioning (i.e., community profile). Community level data identifies where there may be sensitive areas such as land and natural resources used for subsistence purposes, community access routes and areas of social or cultural significance. Qualitative as well as some quantitative data will be collected through consultation with PACs via FGDs and KIIs overseen by a Technical Lead. Surveys will also be conducted at local markets and with village store owners. Community level data will be supported by GPS mapping and photographs. The methods to be used for community level data collection are described in detail in Section 7, Study Methods.

6.3 Household Level Data Collection

Household level data collection will be conducted after community level data collection and will form the topic of a future Scope and Methods report, to be submitted to TEP PNG one month prior to the commencement of that fieldwork.

Household level data generally provides quantification of issues explored in greater detail in community level data collection and is particularly important to collect for Affected Persons (APs), as opposed to PACs. Household level surveys will be conducted by a specially trained team of enumerators, overseen by the Technical Lead. A 20-30% sample of households in each PAC will be recorded.

6.4 National/Provincial/District/Local Level Government Data Collection

Official records, statistics, annual reports and development plans will be sought from relevant Government agencies and authorities to complete the socio-economic picture of the study area.

Ahead of mobilisation of the field component of the community survey, Technical Lead/s accompanied by TEP PNG personnel will visit CEPA and DPE to advise them of the study and seek advice on areas of particular interest to them that may be explored during the study. Other National Government agencies and authorities, listed in Table 3, will be met with immediately on demobilisation of the field component of the community survey.

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During community level data collection surveying, Technical Lead, Mike Finlayson, and Health Lead, Marci Balge, will visit Provincial, District and LLG locations where there are Government agencies/authorities (Kerema, Baimuru and Ihu[5]) to meet with Government representatives listed in Table 3. The purpose of the meetings is to discuss key areas of interest and to gather available secondary information (such as statistical and annual reports and development plans). The visits also extend the courtesy to those Government agencies and authorities of hearing about the studies being undertaken in the Province/District/LLGs.

The ERIAS Technical Lead will meet with CEPA and DPE for a high-level debrief following completion of the upstream field surveys. A more detailed debrief will follow at a later date (to be agreed with TEP PNG).

Table 3 – National, Provincial and LLG Data Collection

Agency/Authority	Information Sought	Level	Location
CEPA	♦ Particular focus areas/issues of concern	National	POM
DPE	♦ Particular focus areas/issues of concern ♦ Process to determine and distribute development grants/seed money for Landowner companies	National	POM
Gulf Provincial Administration	♦ Particular focus area/issues of concern ♦ Economic infrastructure ♦ Development assistance ♦ Development plans/priorities ♦ Process to determine and distribute development grants/seed money for Landowner companies	Provincial	Kerema/POM
Central Provincial Administration	♦ Particular focus area/issues of concern ♦ Economic infrastructure ♦ Development assistance ♦ Development plans/priorities ♦ Process to determine and distribute development grants/seed money for Landowner companies	Provincial	POM

[5] The presence of relevant Government representatives in Ihu will be confirmed prior to mobilisation. If none are present in Ihu, attempts will be made to visit them in Kerema.

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Table 3 – National, Provincial and LLG Data Collection (cont'd)

Agency/Authority	Information Sought	Level	Location
Kikori District Administration	♦ Particular focus area/issues of concern ♦ Economic infrastructure ♦ Development assistance ♦ Development plans/priorities	District	Kerema
Kerema District Administration	♦ Particular focus area/issues of concern ♦ Economic infrastructure ♦ Development assistance ♦ Development plans/priorities	District	Kerema
Department of Education	♦ Statistics on state of education ♦ Annual sector review ♦ External support for education in area in recent years ♦ Relevant development plans and priorities for sector in Province	National, Provincial and District	POM, Kerema and Baimuru
Department of Health	♦ Statistics on state of health ♦ Annual sector review ♦ External support for health in area in recent years ♦ Relevant development plans and priorities for sector in Province	National and Provincial	POM and Kerema
Department of Planning and Monitoring	♦ Status, update of development priorities and plan for the region including the Petroleum Resource Area economic corridor	National and Provincial	POM and Kerema
Minerals Resources Development Commission	♦ Landowner and Provincial Government equity in resources projects	National	POM
Department of Trade, Commerce and Industry	♦ Relevant plans and priorities for the sector	National	POM
Department of Works	♦ Plans for Hiritano Highway and proposed Kerema Southern Highlands Road – status, update, conceptual map, timeframe	National	POM
National Fisheries Authority	♦ Statistics on fishing in province ♦ Number of trawlers and catch in province ♦ Relevant development plans and priorities for sector in Province	National and Provincial	POM and Kerema
PNG Forest Authority	♦ Logging concessions map/s ♦ Annual allowable cut ♦ Production ♦ Employment	National	POM
Provincial Police Commander	♦ Law and order statistics ♦ External support for law and order in area in recent years ♦ Relevant development plans and priorities for sector in Province	Provincial	Kerema and POM

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Table 3 – National, Provincial and LLG Data Collection (cont'd)

Agency/Authority	Information Sought	Level	Location
Royal PNG Constabulary	♦ Statistics on state of law and order ♦ Annual sector review ♦ External support for law and order in area in recent years ♦ Relevant development plans and priorities for sector	National	POM

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7. Study Methods

Data collection at the community level will focus on qualitative data but will also collect some quantitative data). Furthermore, qualitative data collected at a community level will be 'quantified' by using consistent instruments during community surveys. In this way, a range of responses collected from communities can be compared and quantified, e.g., X out of Y communities hunt for subsistence livelihood purposes or similar.

A data map was developed to facilitate preparation of the instruments. This is in a Microsoft Office Excel file and is provided separately to TEP PNG with this document. The data map is useful to show the full range of data parameters that been identified and how they will be collected.

The technical specialists involved in the SBS have reviewed and inputted to each relevant survey instrument.

Note that the contents of instruments may be adjusted following both the initial testing to be conducted during the survey team training session (see Table 6) and at Avavu. The Technical Lead may approve adjustment of the instruments if any questions/themes are not soliciting the required data, as a result of the testing. The instruments provided in Attachments 4-6 should therefore not be treated as final. Household level data collection is not described further in this document. The instrument is provided at Attachment 7 for indicative purposes only.

Table 4 below summarises the proposed survey methods to be implemented for each dataset.

Table 4 – Proposed Survey Methods

Dataset	Method
Community and demographics	♦ GPS mapping and photos ♦ Population count ♦ FGD – Village leaders ♦ FGD – Women ♦ FGD – Youth ♦ KII – Education ♦ KII – Social organisation and settlement
Community health and safety	♦ FGD – Village leaders ♦ FGD – Women ♦ FGD – Youth ♦ KII – Health ♦ GPS mapping and photos
Cultural heritage	♦ FGD – Village leaders ♦ FGD – Women ♦ KII – Cultural heritage (refer separate rationale document 01215B_6-6) ♦ GPS mapping and photos (refer separate rationale document 01215B_6-6)

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Table 4 – Proposed Survey Methods (cont'd)

Dataset	Method
Land and natural resource use	♦ Land use/features and units mapping ♦ FGD – Village leaders ♦ FGD – Women ♦ KII – Land and natural resources
Governance and economics	♦ FGD – Village leaders ♦ Market survey ♦ Store survey

The community survey across the upstream study area will involve a team of social scientists and assistants who will move systematically across the study area collecting socio-economic data with which to characterize the Project area. The community survey team structure is provided at Figure 3.

In each location identified in the study schedule (see Table 6), the team will:

1. Participate in an introductory tok save (speech).
2. Conduct two focus group discussions (FGDs).
3. Conduct a range of key informant interviews (KIIs).
4. Map households and community infrastructure.

In specific locations (where there are relevant government agencies/authorities and health facilities), as described in refer Section 7.5, the Technical Lead and Health Lead will:

1. Conduct semi-structured discussions with Government representatives.
2. Obtain official records, reports and plans (where available).

7.1 Introduction

The introductory speech will be conducted during a general community meeting following the arrival of the survey team in each village and will serve to reiterate the purpose of the study and confirm communities' acceptance to proceed. This speech will follow on from the important pre-awareness campaign that TEP PNG will undertake ahead of the commencement of community level data collection. As described in Section 5, Stakeholder Engagement, TEP PNG's pre-awareness will advise communities of the Project itself (including but not limited to what it is, where it is located, and the development schedule), the forthcoming studies (community level data collection and others that are part of the EIS/ESHIA program), the purpose of those studies and what community members can expect when study teams visit (at a minimum), and seek approval for the study team to visit and conduct said studies.

The introductory speech conducted at the arrival of the survey team will state clearly that participation is voluntary and optional, and confirm communities' willingness to participate.

7.2 Focus Group Discussions (FGDs)

FGDs are used to gather together potential PACs to participate in a mediated discussion on a range of pre-determined topics of interest to a project. FGDs are a particularly useful tool in terms

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of allowing participants, e.g., vulnerable groups such as women, to express opinions in an appropriate forum that might otherwise not be expressed in other forums such as a public meeting or a household survey.

Two FGDs will be conducted for each village in the study area – one with village leaders and the other with women. Participants will be invited to convene with the facilitator (who, for the women's FGD, will be female) to work through the approved instrument. The location of the women's FGD in the village will be selected in consultation with the participating women to ensure it is neutral and 'safe' thereby maximizing their participation. It will also be scheduled at the same time as the leader's FGD.

The village leaders' FGD will explore topics such as:

- Village origin and structure.
- Livelihoods and income.
- Governance, law and order e.g., structure and processes of formal and customary governance functions, prevalent crime issues, common disputes, etc.
- Infrastructure and service access in the village.
- Water and energy access and usage.
- Land and natural resource use for subsistence, livelihood or cultural activities.
- Local enterprise.
- Community health.
- Tangible and intangible cultural heritage.
- Project perceptions.

The women's FGD will explore topics such as:

- Role of women in the village.
- Women's livelihoods and income.
- Governance, law and order e.g., prevalent crime issues, drug and alcohol consumption, perceptions of safety and security, etc.
- Infrastructure and services (with emphasis on health access).
- Water and energy access and usage.
- Land and natural resource use by women.
- Community health including food and nutrition.
- Tangible and intangible cultural heritage particularly related to women.
- Project perceptions.

In addition to the women's and village leader's FGD a youth FGD will be convened in communities where a formal or informal youth group exist. The FGDs will be comprehensively

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recorded on the instruments and will contribute both qualitative and quantitative data. The instruments for FGDs are provided at Attachment 4.

Some refreshments (e.g., tea) may be provided by TEP PNG during the FGDs.

7.3 Key Informant Interviews (KIIs)

Key informant interviews (KIIs) are used to gather further detailed qualitative and quantitative information to expand on specific topics discussed in the FGDs. Key informants are selected based on their first-hand knowledge of the topic in question and their expertise within their community.

Depending on the specific social situation in each village, up to six KIIs will be conducted to cover, in greater detail than the FGDs, key thematic areas of community health, safety and security; education; land and natural resource use (ecosystems services); cultural heritage; social organisation and settlement, and economics (markets and stores). KIIs will collect data on community status, services and facilities (for example, in the area of health, the KIIs will collect data that represents the status of community members' health; the availability and quality of health services available in the local area; and the state of health facilities in the local area). TEP PNG's Community Liaison Officers shall visit each identified village the day prior to SBS surveys taking place in order to assist in identification of key informants. On the day of the surveys, facilitators of the KIIs may also identify more appropriate/additional key informants on the advice of members of communities (in the case of health, this will be the health professional (such as the health extension officer) responsible for administering health services and maintaining facilities (where they exist).

Table 5 details the topics to be explored by the KIIs. The KII instruments are provided at Attachment 5.

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Table 5 – KII Objectives and Topics

KII	Facilitator	Objectives	Topics
KII – Education	Yvonne Hani/Sally Jerome	Gather community level data pertaining to education levels and functionality of education infrastructure and service.	♦ Enrolment (by school grade and gender) ♦ Attendance ♦ Staffing and resources ♦ Cost of education ♦ Functionality of education infrastructure and service
KII – Health	Marci Balge/Sue Phuanukoonon	Gather community level health data pertaining to PACs, including accessibility and functionality of health infrastructure and service.	♦ Prevalent diseases/illnesses/injuries ♦ Food and nutrition ♦ Health services ♦ Health professionals ♦ Functionality of health infrastructure and service
KII – Land & natural resource use (including land use mapping)	Howard Rogers	Gather community level data related to land use and natural resource use (ecosystem services) and dependencies amongst PACs. Map land use features, types and units for each PAC.	♦ Land use types/units ♦ Agricultural and livestock practices ♦ Natural water/forest/marine resource use for subsistence, livelihood or cultural activities ♦ Forest listings/logging activities
KII – Cultural heritage	John Sepe and Rob Skelly	Gather community level data pertaining to tangible and intangible cultural heritage.	♦ Sites of archaeological significance/tangible cultural heritage and proximity to village ♦ Intangible cultural heritage practices ♦ Marine cultural heritage
KII – Social organization and settlement	Bill Sagir	Gather community level data pertaining to clan and kinship as well as the history of settlements within the study area.	♦ Social structure (clan and kin groups) ♦ Settlement history ♦ Land ownership and user rights ♦ Land disputes (inter and intra village/clan) and dispute resolution mechanisms

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Table 5 – KII Objectives and Topics (cont'd)

KII	Facilitator	Objectives	Topics
KII – Social organization and settlement (cont'd)			♦ Representation (active Incorporated land group/landowner company/landowner associations) ♦ Clan relationships
KII – Economics (markets and stores)	Yvonne Hani/Sally Jerome	Assess items sold and prices of items sold in markets and stores in within the study area.	♦ Market goods and prices ♦ Store goods and prices

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7.4 Mapping

The final component of the community level data collection is a mapping component and population count. This is in addition to the land and natural resources mapping that forms part of the land and natural resource use KII (refer Attachment 5). Mappers will:

- Collect a GPS location and household population count (total, male and female) for each house in all villages in the study area, where possible.
- Collect a GPS location, photograph and short description of all village infrastructure (such as aid post, school, church, sporting facilities, water sources).

The instrument for mapping is provided at Attachment 6.

7.5 National/Provincial/District/Local Level Government Interviews

National, Provincial, District and Local Level Government interviews are described in Section 6.4.

Depending on the information sought and the information available from each Government agency/authority, the availability of representatives and the level of knowledge of the representatives, these interviews will be conducted in a semi-structured manner by the Technical Lead and Health Lead. They will explore key issues, as identified in Table 3, and seek to obtain records available from those agencies/authorities.

All interviews will be recorded in detailed notes taken by the interviewer and summarised – along with any secondary data obtained – in the relevant technical report.

The study schedule (Table 6) identifies when the Technical Lead and Health Lead purpose to undertake Provincial, District and Local Level Government interviews. Because health facilities and health workers have been identified as present in only a small number of the communities to be visited by the survey team, and that in the main, health data will be obtained from Provincial, District and Local Level Government interviews and secondary data collection, the health specialists will complete their work program and demobilise sooner than the remainder of the team. However, community health data will be collected from all communities as part of the FGDs (and later as part of the household survey).

7.6 Recording Procedures

All data collection surveys will be recorded within an instrument template, using standardized coding where appropriate and free text elsewhere. Some coding has been included in the instruments provided herein as an example. The remainder of the coding will be completed once the instruments have received in-principle approval from TEP PNG (as coding requires a significant input of time/effort as is best done on finalization of instruments). The instruments require the facilitator to document their name as the person responsible for the completion of the exercise, as well as the date, village name, primary spokesperson, location and photo reference, and where relevant, GPS location. The facilitator is also required to complete a Completion Checklist at the end of each instrument as a reminder to review that the instrument has been comprehensively completed.

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Sites of social value (community infrastructure, important land and natural resources values) sites will be photographed and their locations recorded using handheld GPS devices standardized to the WGS84 datum and UTM Zone 55S projection.

Local communities will be advised that the individual personal information they provide during the field surveys will not be presented publically but will be used for the following purposes:

- EIS/ESHIA: characterization of the nature of social values and the existing socio-economic environment that may be impacted by the Project. This is required so that the proponent can identify impacts and mitigate and manage those to acceptable levels in collaboration with affected communities. The communities will be advised that the EIS/ESHIA will be public documents, and that information concerning their socio-economic context will be described in these documents.
- It is the intention of TEP PNG to explore the opportunity to share socio-economic information with relevant and appropriate parties in support of country development. Personal data will be de-identified in this instance.

7.7 Completion and Quality Check

At the conclusion of each of the aforementioned exercises, and prior to moving to the next location or ceasing for the day, a completion and quality check will be performed by the Technical Lead to ensure instruments have been comprehensively completed. Should the completion and quality check identify missing data (and scheduling/logistics allow it), these may be filled prior to departing the community; alternatively, a data make-up strategy will be developed and agreed with TEP PNG. The Technical Lead will take custody of completed instruments prior to moving on from the village (to prevent any data being misplaced).

The community level data collection survey will be conducted over approximately 24 days during which data will be collected for all 34 villages in the study area (refer to proposed schedule in Table 5). To achieve this degree of efficiency, where proximity and transport arrangements allow, the team will survey up to two communities in one day. Where proximity and transport arrangements do not allow, only one community per day will be surveyed. The 24-day schedule does not include contingency days for delays, e.g., caused by bad weather, transport constraints and/or communities refusing access to the survey team (the risk of this would increase if there is an incomplete pre-awareness campaigns, see Section 5). In the event the team is delayed, additional days may need to be added to the end of the proposed schedule (a decision that will be taken in consultation with TEP PNG).

At the completion of the community level data collection survey, the Technical Lead will present a ‘debrief’ to TEP PNG prior to demobilising back to place of origin.

An upstream SBS field survey report will be provided in the agreed timeframe after completion of the survey.

7.8 Chain of Custody – Survey Instruments

It is the responsibility of the Technical Lead to store the hard copy completed instruments in such a manner that they cannot be damaged by environmental or human factors. Completed hard copy instruments will be stored in waterproof plastic pockets until they can be scanned and stored

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digitally (either at Herd Base, Total's office in Port Moresby or in one of ERIAS Groups' offices in Australia). They will remain in the possession of the Technical Lead whilst in the field.

All data collection (completed instruments) will remain in the custody of the Technical Lead until they arrive at ERIAS Group's head office in Melbourne where the data will be:

- Scanned and digitally stored.
- Provided digitally to TEP PNG for storage.
- Entered into a Microsoft Office Excel spreadsheet for analysis and reporting.

Hard copies of completed instruments will be retained until the EIS and ESHIA are approved, after which they can be destroyed (subject to confirmation that all documents are digitally stored and backed up).

7.9 Survey Data

Raw data (including raw GIS data) from the community survey instruments will be provided to TEP PNG as per TOTAL General Specification.

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8. Survey Period and Team

The upstream community level data collection field program (including training) will take place between 4 – 31 May 2016 (including mobilisation and demobilisation, and debriefing).

Table 6 outlines the preliminary schedule for upstream community level data collection.

The upstream SBS **community level data collection** survey team comprises of the following specialists:

- Technical Lead – Mike Finlayson and Danielle Martin.
- Team Liaison – David Kombako.
- Focus group discussion – Village leaders – Bill Sagir/Mike Finlayson (interchanged).
- Focus group discussion – Women – Yvonne Hani/Sally Jerome (interchanged).
- Key informant interview – Health – Marci Balge and/or Sue Phuanukoonon.
- Key informant interview – Land and natural resource use –Howard Rogers.
- Key informant interview – Social organisation and settlement – David Kombako.
- Key informant interview – Education, Markets and Stores – Yvonne Hani/Sally Jerome (interchanged).
- Key informant interview – Cultural heritage – John Sepe and Rob Skelly.
- Mapping – x 2 [to be confirmed].
- Logistics and support – Brett Perry/Kobus Meulenbroeks.

The composition of the SBS upstream community level data collection team is shown in Figure 3. The structure of the household level data collection team is included for reference, but will be reviewed at a later date prior to commencement of the household surveys.

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Table 6 – Preliminary Schedule for Upstream Community Level Data Collection

Activity	Day/Date	SBS Location	2011 Population (Households)[6]
Preparation			
Key stakeholder briefings	3 May	CEPA and DPE	N/A
Mobilization to POM	4 May	POM – Herd Base	
Team training	5-6 May[7]	Herd Base	
PER			
Base at Muro Mission walk to villages	7 May	Avavu (including instrument testing)	187 (42)
	8 May	Maiva	Unknown
	9 May[8]	Hepere, Ere/Kilavi	293 (53) & 263 (49)
	10 May[9]	Huruta & Arehava Number 2	201 (39) & 75 (15)
Base at Iuku walk to villages	11 May	Lariau & Herekera	287 (65) & unknown (28)
	12 May[10]	Mareke	645 (127)
	13 May	Paevera & Iuku	112 (26) & 382 (82)
	14 May	Larihairu	372 (80)
	15 May	Marea	312 (68)
	16 May	Kanukabu	558 (122)
	17 May	Harevavo	593 (137)

[6] While there has been extensive liaison with villages it the vicinity of PRL15 in recent years, there has been limited interaction with and knowledge of villages along the PER and Riverways. Maps showing villages in the PER and Riverways are not up-to-date and some available population census data is incomplete, which means there is some uncertainty in regard to the actual number of potentially impacted villages and populations that will only be resolved as a result of the community level data collection survey.
[7] Newfields representative to attend Wabo Health Centre on this day (refer Sections 6.4 and 7.5).
[8] Technical Lead and Health Lead to attend Kerema on this day (refer Sections 6.4 and 7.5).
[9] Health Lead to attend Kapuna Rural health centre, Technical Lead to attend Baimuru (refer Sections 6.4 and 7.5).
[10] Newfields team demobilises (refer Sections 7.5).

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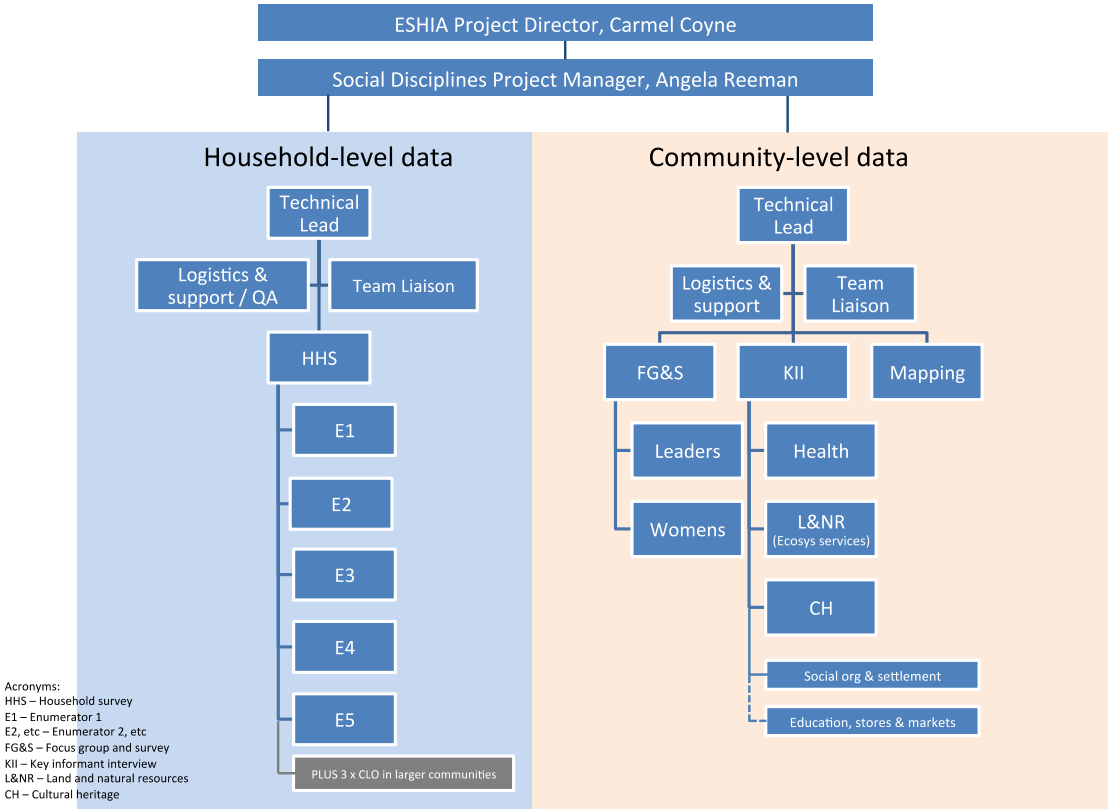
Table 6 – Preliminary Schedule for Upstream Community Level Data Collection (cont'd)

Riverways			
Overnight on board boat at Aumu with Bullet support to Apiope and Aivaivikoki	18 May	Apiope & Aumu	231 (47) & 188 (37)
	19 May	Aivaivikoki	389 (71)
Overnight on board boat at Akoma	20 May	Akoma & Kairu'u	417 (81)
Overnight on board boat at Upaia	21 May	Upaia & Mira	115 (26) & Unknown
Overnight on board boat at Kapuna with Bullet support to villages	22 May	Kapuna	200 (45)
	23 May	Ara'ava	590 (130)
	24 May	Mapaio	383 (81)
	25 May	Kairmai	214 (48)
Overnight on board boat at Evara	26 May	Evara	723 (81)
Overnight at Herd Base.	27 May	Kaevaria	250 (30)
PRL15			
Overnight at Herd Base	28 May	Poroi	430 (59)
Overnight at Wabo	29 May	Subu & Ura	Unknown & 304 (62)
Demobilize from Wabo	30 May	Wabo & demobilization	459 (82)
POM	31 May[11]	Debrief with Total in POM	

[11] Technical Lead/s meet with remaining National Government agencies/authorities (potentially also 1 June 2016) (refer Sections 6.4 and 7.5).

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Figure 3 – Proposed Team Composition



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9. Quality Control

To ensure good quality data are collected during the SBS field program, a number of quality assurance (QA) and quality control (QC) procedures are adhered to:

- Use of TEP PNG approved survey instruments that have been optimised for clarity, ease of recording and data entry and consistent data analysis.
- Use of experienced and trained field surveyors.
- Training of team members – over a two day period prior to commencement of field surveys, team members will be trained in how to complete the survey tools (in an agreed standard manner) and use handheld GPS devices and cameras (including logging waypoints and photograph reference numbers), as well as HSSE matters.
- Standard procedure for daily activities, recording of data (using the instruments) and completion tasks.
- Use of GPS devices that are calibrated and standardized to the WGS84 datum and UTM Zone 55S projection.
- Storage of completed surveys in waterproof plastic pockets, in-field scan uploaded to cloud or company server, if possible and a scan taken at the earliest opportunity following demobilisation from the field (either at Herd Base or in Port Moresby).
- Technical Lead responsible for oversight of daily activities and reviewing quality and completeness of instruments at end of each day.
- Data validation by triangulation of community level data with existing literature and national and international information.
- The presence of at least two senior specialists in the field who can confer and cross check with each other.
- Quality control checks of data entry (sample of hard copies against database).
- Review and peer review of the resulting reports.

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Attachment 1

SBS Study Objectives

SBS Study Objectives

Specific Objectives of Social Baseline Studies

Community and Demographics

The objectives of the community and demographics baseline characterization are to:

- Establish the demographic and community structure, including identification of vulnerable groups, of communities in the study area.
- Map and understand the geographical distribution of potentially affected individuals and communities and any other sensitive receptors in the study area.
- Characterize the ethnographic landscape of the study area using secondary sources as well as primary quantitative and qualitative data collection methods where required.
- Provide a comparative local, district, provincial and national analysis as appropriate and where data is available.
- Understand the education system and barriers for student participation.

Community Health and Safety

The purpose of the community health and safety baseline characterization is to:

- Establish baseline data on the health status of the people in the study area.
- Establish the presence of local and regional health facilities, emergency facilities, health practitioners, local and national health awareness and promotion programs in the Project area, and the capacity and degree of functioning of each (adequacy of staffing, stock of equipment and supplies).
- Assess major disease burdens as perceived by communities and the effect of health services provided on the health of communities.
- Describe the community-based prevalence of symptoms of common communicable and non-communicable diseases.
- Provide a comparative local, district, provincial and national analysis as appropriate and where data is available.
- Meet the requirements of national legislation and international regulations, including relevant aspects of the International Finance Corporation's (IFC) Performance Standard 4 – Community Health, Safety and Security.

Land and Natural Resource Use

The purpose of the land and natural resource use baseline characterization is to:

- Establish land and natural resource use (ecosystem services) within the study area.
- Characterize land use units and village/community boundaries to the extent feasible.

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- Understand village-level land use and ownership, as well as agricultural activities and other subsistence livelihoods, hunting and species, fishing, frequency of foraging, significant bush medicines, building materials and food security.
- Identify and describe potentially affected sensitive natural resources (ecosystem services) within and/or in the vicinity of the study area, including any pertinent to identified vulnerable groups and indigenous populations.
- Provide a comparative local, district, provincial and national analysis as appropriate and where data is available.
- Meet the requirements of national legislation and international regulations, including relevant aspects of the International Finance Corporation's (IFC) Performance Standard 6 – Biodiversity Conservation and Sustainable Management of Living Resources.

Governance and Economics

The purpose of the economic baseline characterization is to:

- Establish the economic context, including assessment of resources and activities, availability of and access to public and private infrastructure, and access to funding, of communities in the study area.
- Identify existing livelihoods and income-generating opportunities available to potentially affected communities, with particular focus on vulnerable groups and indigenous peoples.
- Understand the labor market and the types and level of skill amongst the working population.
- Describe traditional and contemporary governance structures in the study area, including representation.
- Provide a comparative local, district, provincial and national analysis as appropriate and where data is available.
- Understand the influence of any migrant populations on the local and regional economy.

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Attachment 2

SBS Approach Memo

Memo

Contractor Ref N° : **Revision N°:**

To	Catherine Edet and Jeremy Roeygens TEP PNG
Copy to	Carmel Coyne ERIAS PTY Ltd
From	Angela Reeman and Danielle Martin ERIAS PTY Ltd
Purchase Order #	TEP PNG 46000-0093
Date	07/03/2016
Memo #	01215B_M001_20160307_v1
Subject	Social Baseline Studies – Data Collection and Survey Process (UPSTREAM)

Social Baseline Studies (SBS) Data Collection and Survey Process

This memo outlines ERIAS Group's proposed approach to Social Baseline Studies (SBS) in the upstream area of the Papua LNG Project. It explains the proposed approach in terms of the technical and logistics arrangements required for an optimal data collection and survey process.

Context

The scope of SBS fieldwork involves collection of qualitative and quantitative data and information for the following key thematic areas:

- Community and demographics[1];
- Community health and safety;
- Economics[2];
- Land and natural resource use[3]; and
- Cultural heritage.

Also to be collected is data to complete spatial mapping and to inform the labour and industrial relations study, project induced-in-migration study and traffic and transport studies.

Given the vast amount of information and data to be collected several specialist teams are required and will comprise experienced persons and enumerators from PNG and international specialists.

[1] This includes social organisation and settlement, infrastructure and services, education, markets, and others.
[2] This includes local and household economics as well as benefits distribution.
[3] This includes ecosystem services.

Key Considerations

Planning for SBS fieldwork has been ongoing over a number of months by ERIAS Group with a range of specialists culminating in an internal SBS planning workshop was held between 8-10 February 2016 and the development of an optimal implementation approach to conducting the SBS field work, outlined herein.

Following these preliminary planning activities, preparation by ERIAS Group of a preliminary definition of the Project area of influence (PAOI), and the review of the current project description, the following key considerations or constraints for the SBS fieldwork have been identified:

- The Pipeline Export Route (PER) corridor will remain broad, particularly at the southern end in Gulf Province, to enable the GEDI to consider five pipeline route and shore crossing options. Within the broad PER corridor there are approximately 17 villages (contributing to approximately 37 villages across the entire PAOI). A review of a memo provided by Total on 04/03/2016 confirms that the number of villages that remain in the PER corridor are as stated herein. Only a portion of those 17 villages currently in the PER would be expected to be considered as directly affected communities once a pipeline route and shore crossing are determined.
- Two types of social baseline data collection are required:
  - Household (HH) level data collection – this involves surveying a sample of 20-30% of all households in all villages within the direct PAOI to collect information about the household structure, economics, livelihoods, behavior, etc. HH level data generally provides quantification of issues explored in greater detail in community level data collection and is particularly important to collect for Affected Persons (APs), as opposed to Project Affected Communities (PACs).
  - Community level data collection – this involves conducting focus group discussions, key informant interviews and mapping to understand the social context of communities. Community level data is used to form a qualitative picture of social functioning (i.e., community profile). Of the two data collection exercises, community level data collection will be most useful in informing Project design (such as the selection of the preferred pipeline route and shore crossing). Community level data identifies where there may be sensitive or 'no go' areas e.g., important cultural heritage sites, land and natural resources used for subsistence purposes, community access routes, etc. It is important to note that the mapping component of community level data collection will collect GPS waypoints for all households in each village (unless prevented by time or logistical constraints) as well as number of residents in each house as this is the only way to collect accurate population data.
- Conducting HH surveys at the same time as community level data collection will involve a team of approximately 20 persons (not including security, medic or TEP PNG CA team members). This number of team members is considered too onerous on small communities and for logistics management (potentially impacting the quality of data collection).
- It would also mean that HH surveys would potentially occur at a number of villages that, in the near future, will no longer be within the direct PAOI. That is, once a pipeline corridor and shore crossing are selected, the number of villages potentially affected by the Project will reduce from 17 to potentially significantly less. Consideration must be given to the impact of unnecessary household level data collection on:
  - Expectation management of households in those communities;
  - Dilution of relevant data (from legitimate participants); and
  - Improved quality of data collection that results from a more focussed program.

Approach

To manage the above constraints and maximise the efficiency of the SBS field survey program, ERIAS Group proposes the following process:

1. Firstly, to gather community level data (via focus group discussions, key informant interviews and village mapping); and

2. To then proceed to household level data collection (via a dedicated HH survey as part of a separate field visit), ideally once a pipeline route and shore crossing have been selected to ensure household level data collection occurs only with APs.

This approach is advantageous in that it will:

- Provide TEP PNG with the information necessary to influence Project design, specifically in selecting the most appropriate PER and shore-crossing location, via community level data collection, without unnecessarily raising expectations amongst households that will not be part of the Project going forward;
- Enable a more efficient community level data collection program because the team can move more quickly across the direct PAOI than a HH survey team would be able to move (particularly if required to collect HH survey data from all 37 villages);
- Enable a more focused HH survey program, once the PER is narrowed, that will be more time efficient (both in data collection, data entry and analysis) and likely higher quality (i.e., avoiding enumerator fatigue and data dilution). Incorporating the findings of the community level data collection into the design of the HH survey will also ensure the data set collected is most suitable to the social context of communities and that we do not collect data we already have at a community level if not needed at HH level;
- Enable the HH survey to also act as an infill exercise in the event additional information is identified after the community level survey data analysis has been conducted; and
- Reduce the duration of field surveys and the size of survey teams and thus any logistical issues. This is also particularly important in terms of ensuring that we do not send large teams into small communities. Since the SBS survey teams are supposed to be accommodated in villages then this is even more important.

An indicative SBS fieldwork team structure is provided in Figure 1. Please note, names are nominal only but included to show how, in some cases, one person would fill two roles to limit team size.

Methodology

Phase 1: Community level data collection

It is proposed that community level data collection takes place in the period April to May 2016, prior to the commencement of the EIR roadshows[4].

Data collection at the community level will primarily focus on qualitative data relating to: livelihoods, land and natural resource use, crime, conflict and security, traditional governance, health, transport and education infrastructure, local enterprise, cultural heritage, and Project perceptions. Some quantitative data can also be collected at community level from focus groups and by requesting information and data from KIIs with community leaders and others (e.g., population figures, gender ratio, number of students in school etc.). GPS waypoints for all households and number of residents will be collected.

Given the anticipated similarities between different communities, ERIAS Group proposes to appropriately group villages to conduct community level data collection. This would enable a field program of approximately 22-24 locations (as opposed to 37 that would be required by the HH survey at this time). Groupings would occur amongst villages that are geographically close to each other and that share kinship relations and/or are culturally synonymous. At a common location, focus group discussions and key informant interviews will collect data for each community. Mapping will be covered by a two-person team to ensure that all PACs are appropriately mapped (and GPS waypoints and population count completed).

It is also noted that the Social Mapping and Landowner Identification (SMLI) process is not proposed in the upstream area by TEP PNG until later in 2016. The community level survey for the SBS fieldwork will collect a

[4] ERIAS Group understands that TEP PNG propose to submit the draft EIR around the end of April or in early May. Ideally, data collection would occur following EIR submission and completion of the EIR roadshows; however, ERIAS recognizes this may not be possible. TEP do not want the SBS to overlap with the EIR roadshows. This is acceptable to ERIAS as long as there is sufficient pre-awareness by the TEP PNG CA team and appropriate 'Tok Save's' at the beginning of survey work in all communities.

range of information including on social organisation, settlement and language that will directly inform the SMLI process, therefore, allowing the SMLI to focus only on landowner identification and mapping landowner boundaries and preparing lists of landowner groups. This should minimise or prevent there from being overlap between the data collected for the SBS and the SMLI. It is noted that ideally, the SMLI would have occurred prior to commencement of the SBS. However, the fact that this will not occur until after SBS field work is not considered a constraint to the SBS studies but there may need to be infill SBS field work conducted in the future if new communities are identified to be within the PAOI as a result of the SMLI (and this would generate a change order).

The community level data collection team will comprise of approximately 12 people.

Phase 2: Household level data collection

Data collected during Phase 1 will then be used to inform the HH survey program, including refining the questionnaire as appropriate to only collect data needed. Household level data is useful for future monitoring and evaluation of change on APs (and communities) but only when it is collected from relevant households.

It is proposed that household level data will be collected via a dedicated HH survey between July-August 2016. This indicative timing has been proposed to allow for the community survey team to complete their fieldwork and some of the early results (particularly mapping) to be considered by ERIAS and TEP PNG to both inform the route selection for the PER and to finalise the HH survey instruments.

As discussed previously with TEP PNG, a full (100%) HH survey of all PACs is neither necessary nor feasible. Instead, it is proposed that a 20-30% sample is taken across PACs, ideally after the selection of a pipeline route and shore crossing and with the benefit of analysis of community-level information.

If, as outlined in the approach above, TEP PNG selects the PER/shore crossing and the PAOI is then contracted, the HH survey will only need to administer to those communities affected by the Project (rather than all the communities in the existing broad corridor).

The HH survey team will comprise approximately 6-8 people.

Budget

The approach is not expected to negatively impact the budget allocated for SBS[5].

[5] However, the final number of communities to be surveyed as part of the SBS fieldwork will still need to be compared with the original budget allocated (e.g., original estimate of no more than 30 communities).

Attachment 3

Sample Letter

Manager, Baimuru Rural LLG
Baimuru, Gulf Province
Manager, Ihu Rural LLG (separate)
Ihu, Gulf Province

4 April 2016

Dear <<Insert Name>>,

Global, integrated energy producer and provider, Total, is currently preparing an Environmental Impact Statement (EIS) for the Papua LNG Project. You may be aware, the current Project plan is to extract and compress gas from the Elk-Antelope field in Gulf Province, pipe the gas to Caution Bay, adjacent to the PNG LNG processing facility, and construct a facility to process and export LNG.

Total has engaged ERIAS to prepare the EIS. ERIAS is an Australian company that specialises in environmental and social impact assessment and has substantial experience with major resource projects in Papua New Guinea.

The EIS will include a Social Baseline and Social Impact Assessment. ERIAS would welcome the opportunity to brief you on the EIS process, particularly the collection of social data and community consultation.

At the same time, ERIAS would like an opportunity meet with you to discuss:

- The LLG's development plan and priorities;
- Details on economic infrastructure in the project area, including airstrips and wharves; and
- Any other major development activities in the project area in recent years.

The meeting would also provide an opportunity for you to provide initial comments on the Project, although we also envisage additional meetings in Baimuru (Kerema) to update you on progress and seek your input to the EIS.

We would like to propose that ERIAS' representative <<insert name>> meets you in your office in Baimuru on __ May 2016, at 10am, if that suits you. Please advise if this date and estimated time is suitable.

We look forward to your response. Please contact us on ……

Yours sincerely

Total

Attached – Map of the project area

Attachment 4

Focus Group Discussion Instruments

Focus Group Discussion and Survey - Village Leaders

Facilitator	
Date of FGD (Day/month/year)	/ /2016
Village Name	
Ward name	
Name of Ward Councillor	
LLG name	
Photo reference	

A Infrastructure & Services

A1) Does this village have the following:

Does this village have the following Circle . .			**If YES, is it operating/ functioning?** *Code:* ***Y****= Yes,* ***N*** *= No,* ***S****=Sometimes*	**If NO or not operating:** **Where is the nearest?**	**Usual method of travel** *Code:* ***1****=walk* ***2****=canoe* ***3****=other (specify)*	**Travel time** (minutes, one way)
Ward Councillor	YES	NO				
Village court magistrate	YES	NO				
Land mediator	YES	NO				
Police	YES	NO				
Auxiliary police (voluntary)	YES	NO				
Ward Development Committee	YES	NO				
Mobile phone coverage	YES	NO				
Electricity system	YES	NO				

Does this village have the following Circle . .			**If YES, is it operating/ functioning?** *Code:* ***Y****= Yes,* ***N*** *= No,* ***S****=Sometimes*	**If NO or not operating:** **Where is the nearest?**	**Usual method of travel** *Code:* ***1****=walk* ***2****=canoe* ***3****=other (specify)*	**Travel time** (minutes, one way)
Bank	YES	NO				
Airstrip	YES	NO				
Reticulated water system	YES	NO				

A2) Has there been a water project(s) in the village before?	YES	NO
If YES, what year was it installed? (circle)		
How was it funded?		
Is it still working? (circle)	YES	NO
If No, why not?		
Who is responsible for maintenance/repair? ***Code:*** ***1****=individual,* ***2****=village* ***3****=whoever built it,* ***4****=other*		

A3) If the village has a Ward Development Committee, does it have a ward development plan or list of development projects? If yes, provide details

1)

2)

3)

4)

A4) Has the village received any support (money/goods/services) from member/ government/ anyone else (specify) in the last decade?

Project	Source of support (for funding/goods/services) ***Code**: **1**=Member of Parliament, **2**=Government, **3**=Private sector, **4**=NGO/donor, **5**=other (specify)*	Year	Is it still operational? ***Code**: **Y**=Yes, **N**=No, **P**=Partly*
1)			
2)			
3)			

Transport

For **Purari villages** only:

A5)	**How many barges travel past this village each week?**	None	1-10	More than 10	Other (specify)
A6)	**Are there days when the barges are more frequent? If so, which days.**				
A7)	**What is their purpose?** *Code: **1**=carrying logs, **2**=carrying fuel and/or supplies, **3**=other (specify), **4**=don't know*				
A8)	**What are the effects of barges travelling past this village? Describe.**				
A9)	**How many dinghies/canoes (from other villages) travel past this village each day?**	None	1-10	More than 10	

B Livelihoods and Income

B1)	**What are the main responsibilities of men in this village? (most important role)?** *Code: For **importance** use 1 – 5 where **1** is not important and **5** is very important. For **frequency**, use code **1** = every day, **2** = most days, **3** = sometimes and **4** = rarely.*	**Importance (code)**	**Frequency (code)**
a	Caring for women and children		
b	Making gardens		
c	Tending gardens		
d	Raising livestock		
e	Hunting		
f	Fishing		
g	Collecting seafood		
h	Collecting edible plants		
i	Collecting water		
j	Collecting firewood		
k	Building house		
l	Earning income		
m	Other (specify)		

B2)	**What are main sources of income for most families in the village?**	
	List in order of importance *Code:* ***1** = betel nut, **2** = paid employment, **3** = logging royalties, **4** = sale of fish/seafood products, **5** = sale of food crops, **6** = sale of sago, **7** = other (specify)*	**Best times of year for earning income** *Code: Months **1** [January] - **12** [December], **13** = Year round, **14** = No particular time*
	1)	
	2)	
	3)	
	4)	
	5)	
	6)	
	7) Other *(specify)*	

B3)	**Where the following are identified as an income source, where are those items generally sold?**		
	Crops *Code: **1**=to families in the village, **2**=in the market in the village, **3**=in a market located elsewhere, **4**= to a buyer who comes to the village, **5**= other (specify)*	**Fish/seafood/other marine products** *Code: **1**=to families in the village, **2**=in the market in the village, **3**=in a market located elsewhere, **4**= to a buyer who comes to the village, **5**= other (specify)*	
B4)	**Do buyers come to the village?** (circle)	YES	NO
	If yes, what do they come to buy? 1) 2) 3)		
B5)	**Where are other local markets where crops/garden produce/fish are sold:**		
	Where are markets held:	How often are markets held: *Code: **1**=daily, **2**=week days, **3**=weekends, **4**= only during special events) **5**=other (specify)*	
	1)		
	2)		
	3)		
	4)		
B6)	**What are the most common/top five agricultural products grown in the village?**		
	Name *Code:* ***1** = kaukau, **2** = taro, **3** = cooking banana, **4** = sago, **5** = peanuts, **6** = other (specify)*	Grown when (indicate months) *(Code: Months **1** [January] - **12** [December],* ***13** = Year round, **14** = No particular time*	
	1)		
	2)		
	3)		
	4)		
	5)		

<table>
<tr><td rowspan="3">B7)</td><td colspan="2">Do all families in your community have gardens (e.g., where they can grow some vegetable/crop) (circle)?</td><td>YES</td><td>NO</td></tr>
<tr><td>If NO (write %):</td><td>% with garden</td><td colspan="2">% without garden</td></tr>
<tr><td>OR if unsure (circle):</td><td>More than half</td><td colspan="2">Less than half</td></tr>
<tr><td rowspan="8">B8)</td><td colspan="2">Where do families generally buy:
Code 1=Kerema, 2=Baimuru, 3=POM, 4=elsewhere (specify)</td><td colspan="2">How much does it cost (Kina / Litres of fuel) to get there?</td></tr>
<tr><td>1) Building materials</td><td></td><td colspan="2"></td></tr>
<tr><td>2) Agricultural inputs</td><td></td><td colspan="2"></td></tr>
<tr><td>3) Store goods (wholesale)</td><td></td><td colspan="2"></td></tr>
<tr><td>4) Clothes</td><td></td><td colspan="2"></td></tr>
<tr><td>5) Mobile phones</td><td></td><td colspan="2"></td></tr>
<tr><td>6) Radios</td><td></td><td colspan="2"></td></tr>
<tr><td>7) Kitchen utensils</td><td></td><td colspan="2"></td></tr>
<tr><td rowspan="6">B9)</td><td colspan="2">Are there people in the village that lend money to others? (circle)</td><td>YES</td><td>NO</td></tr>
<tr><td colspan="4">If YES, what is the main purpose (then list in order):
Code 1=medical emergency, 2=education costs, 3=funerals, 4=bride price, 5=build a house, 6=buy food, 7=other (specify):</td></tr>
<tr><td colspan="4">1)</td></tr>
<tr><td colspan="4">2)</td></tr>
<tr><td colspan="4">3)</td></tr>
<tr><td colspan="4">4)</td></tr>
<tr><td colspan="4">Additional details, such as how many people might typically lend money, are they businessmen, how is the money repaid, etc.:</td></tr>
</table>

B10)	**Are there individuals, families or groups within the village who are worse off (vulnerable) than most people** (circle)**?**			YES	NO
	If Yes, describe them: **If Yes**, describe them: *Code: **1**=women-headed HH, **2**=elderly headed HH, **3**=single-mothers, **4**=disabled, or **5**=long-term/seriously ill HH members, **6**=other (specify)*	How many?			Do they get support from anyone? *Code: **1**=immediately family, **2**=extended family/other relatives, **3**=community members, **4**=church, **5**=government, **6**=other (specify)*
1)		NONE	SOME	MANY	
2)		NONE	SOME	MANY	
3)		NONE	SOME	MANY	
4)		NONE	SOME	MANY	
5)		NONE	SOME	MANY	
6)		NONE	SOME	MANY	

C Governance, Law and Order

C1)	**What are the most prevalent law and order issues in the village?** *Code **1**=stealing, **2**=fighting, **3**=domestic violence/sexual violence, **4**=alcohol abuse, **5**=marijuana, **6**=land disputes, **7**=other (specify)*	**How are they dealt with/resolved and by whom?** Describe.
	1)	
	2)	
	3)	
	4)	
	5)	

C2)	**Do residents:** (circle)	**Men**			**Women**		
	Consume alcohol?	MOST	SOME	NONE	MOST	SOME	NONE
	Use marijuana?	MOST	SOME	NONE	MOST	SOME	NONE
	Use other / harder drugs, such as *(specify)*	MOST	SOME	NONE	MOST	SOME	NONE
	Gamble for money?	MOST	SOME	NONE	MOST	SOME	NONE
	Pay money for sex (i.e., use prostitutes)?	MOST	SOME	NONE	MOST	SOME	NONE
	Partake in other illicit activities? (specify)	MOST	SOME	NONE	MOST	SOME	NONE
C3)	**Do you (participants) generally feel safe and secure in this community** (circle)**?**	YES			NO		
	If NO, why not?						
	Do you (participants) feel like your safety and security has … (circle) (ie, Has the general feeling of safety and security changed over time?	INCREASED OVER TIME		DECREASED OVER TIME		STAYED THE SAME	
	Describe why.						
C4)	**How many households would have a working rifle or gun?**	NONE		SOME		MANY	

D Local Enterprise / Industry

D1. How many of the following businesses are <u>currently</u> operating in the village?	
Type of business	**Number**
Trade stores	
Fuel sellers	
Chicken projects	
Crocodiles	
Canoe hire	
Guest house	
Other business	

D2. Describe other local / nearby industries and their importance to this village (e.g. logging)			
Type of industry *Code: **1**=Logging, **2**=Copra, **3**=Oil & Gas exploration, **4**=Mining exploration, **5**=Other (specify)*	*Location*	*Number of employees from village*	*Any benefits/ royalties*

D3. Are many families from this village included in CLUAs?				
***Who are the agreements with**: Describe* *1.*	***How many people are included?** Circle*			
	Less than half	*About half*	*More than half*	*Everyone*
2.	*Less than half*	*About half*	*More than half*	*Everyone*
3.	*Less than half*	*About half*	*More than half*	*Everyone*

E Community Health

E1)	**What generally is the main reason for poor health in the village?** *Code: **1**=malaria, **2**= diarrhoea, **3**=respiratory infection, **4**=skin infection **5**=fever, **6**=cough, **7** = other (specify)*			1) 2) 3)
E2)	**When men have a serious illness who do they seek health advice from** (circle)**?**	TRADITIONAL DOCTOR	MEDICAL WORKER	NEITHER
E3)	**What is the perceived prevalence of and understanding of STDs?**	**Prevalence:** *Code: **1**=None, **2**=1 or 2 cases only, **3**=several cases, **4**=many cases **5**=not sure*		
		Understanding of how transmitted: *Code: **1**=Everyone knows, **2**=most people know, **3**= some people know, **4**=few people know, **5**=not sure*		
		Understanding of how treated: *Code: **1**=Everyone knows, **2**=most people know, **3**= some people know, **4**=few people know, **5**=not sure*		

F Population/ Migration

F1)	**How many families are currently living in the village that have moved here from other villages in the past 5 years?** (indicate)	Government/church workers	
		Others (count or indicate more than 20)	

F2)	**If families from other villages are living here (excluding government/church workers), <u>where</u> are they from?**	**<u>How long</u> have they lived here?**	**Why did they move here?** Code: **1**=to get married, **2**=to live with their relatives, **3**=to be nearer to services/infrastructure, **4**=work opportunities, **5**=other (specify)			
	1.					
	2.					
	3.					
	4.					
	5.					
F3)	**Would other people living elsewhere be allowed to relocate here permanently?** (circle)			YES	NO	UNSURE
F4)	**How many people from the village currently live in Port Moresby or other locations?** *(circle)*	None		Less than 20	20-100	More than 100

G Project Perceptions

G1)	**Have you (participants) heard of Total and the Papua LNG Project before today?**			
	Total	YES	NO	UNSURE
	Papua LNG Project	YES	NO	UNSURE
G2)	**At this point in time, how do you feel about the Papua LNG Project?**			

G3)	**How do you (participants) think the village might be affected by the project?**
G4)	**What are the village's priorities for the future?** *(seek out development needs only if no information from C6)* *1.* *2.* *3.* *4.*

FGD Spokespeople

Name	**Gender**		**Contact details**
1)	M	F	
2)	M	F	
3)	M	F	
4)	M	F	
5)	M	F	
6)	M	F	
7)	M	F	
8)	M	F	

Add others as needed on back.

COMPLETION CHECKLIST:

All questions complete / filled in:	
Photo record taken:	
Spokesperson/s recorded:	

QA COMPLETED:

_____
SIGNATURE of Technical Lead or authorised delegate

Print name: _____

Date: _____

Focus Group Discussion and Survey - Women

Facilitator	
Date of FGD (day/month/year)	/ /2016
Village Name	
Photo reference	

A Role of Women

A1)	**What are the main responsibilities of women in this village? (most important role)?** *Code: For **importance** use 1 – 5 where **1** is not important and **5** is very important. For **frequency**, use code **1** = every day, **2** = most days, **3** = sometimes and **4** = rarely.*	**Importance (code)**	**Frequency (code)**
a	Caring for children		
b	Tending gardens		
c	Making sago		
d	Raising livestock		
e	Fishing		
f	Collecting seafood		
g	Collecting edible plants		
h	Cleaning house		
i	Collecting water		
j	Collecting firewood		
k	Other (specify)		

B Livelihoods and Income

B1)	**Do women in this village earn income for the household?** *(circle)*	MOST	SOME	NONE	UNSURE
B2)	**Do women in this village have their own money to spend or save?** *(circle)*	MOST	SOME	NONE	UNSURE
B3)	**Do women in this village contribute to deciding how the household money is spent?** *(circle)*	MOST	SOME	NONE	UNSURE

B4)	**Are women in this village able to borrow money? (e.g. to start a business)** *(circle)*	MOST	SOME	NONE	UNSURE
B5)	**If yes, provide details:** From who (e.g. bank, private individuals, businessmen, village groups, etc)				
B6)	- Purpose (if a cooperative, indicate number of women involved)				
B7)	**What are the main food staples grown in gardens by women in this village?** *Code **1**=banana, **2**=taro, **3**=kaukau, **4**=cassava, **5**=sago, **6**=other (specify)*	*1)*			
		2)			
		3)			
		4)			
B8)	**What are the other main food sources in this village?** *Code **1**=fish, **2**=sago, **3**=wild animals, **4**=forest plants, **5**=other (specify)*	*1)*			
		2)			
		3)			
		4)			
B9)	**What are the main agricultural products sold by women in the village?** *Code **1**=betel nut, **2**=sago, **3**=fish, **4**=banana, **5**=other (specify)*	*1)*			
		2)			
		3)			
		4)			
B10)	**What are the main items harvested by women from the bush?** *Code **1**=food, **2**=medicinal, **3**=firewood, **4**=building materials. **5**=other (specify)*	*1)*			
		2)			
		3)			
		4)			

B11)	**How important is sago as a food source?** (circle)				
	Staple, very important	*Seasonal staple*	*Only in times of food shortage*	*Not Important*	*Other*

C Governance, Law and Order

C1)	**What are the most prevalent law and order *issues in the village?*** *Code **1**=stealing, **2**=fighting, **3**=domestic violence/sexual violence, **4**=alcohol abuse, **5**=marijuana, **6**=land disputes, **7**=other (specify)*	**How are they dealt with?**
	1)	
	2)	
	3)	
	4)	
	5)	

C2)	**Do residents:** (indicate)	**Men**			**Women**		
	Consume alcohol?	*Most*	*Some*	*None*	*Most*	*Some*	*None*
	Use marijuana?	*Most*	*Some*	*None*	*Most*	*Some*	*None*
	Use harder drugs?, such as *(specify)*	*Most*	*Some*	*None*	*Most*	*Some*	*None*
	Gamble for money?	*Most*	*Some*	*None*	*Most*	*Some*	*None*
	Pay money for sex (i.e., use prostitutes)?	*Most*	*Some*	*None*	*Most*	*Some*	*None*

C3)	**Do women generally feel safe and secure in this community** (circle)**?**		YES		NO	
	If NO, why not?					
	Do women feel like your safety and security has … (circle) (ie, Has the general feeling of safety and security changed over time?		Increased over time	Decreased over time	Stayed the same	
	Describe why.					
C4)	**Do women in this village have problems with domestic violence/sexual assault?** (Circle all that apply)	Domestic violence from husband	Domestic violence from other family members	Sexual assault from husband	Sexual assault from family members	Sexual assault from outsiders
C5)	**If yes, how are these problems dealt with?**					
C6)	**When was the last time a woman in this village was involved in an incident in which she was assaulted?** (Circle)		Last two weeks	Less than one year	More than one year	
C7)	**How was the incident dealt with?**					

D Infrastructure & Services

Water and Energy

D1) What is the main source of drinking water in this village? *Code: **1**=pipeline, **2**=well, **3**=river/creek, **4**=pond, **5**=tank, **6**=other (specify)*				
D2) Are you satisfied with the water quality? (circle)	YES	NO	UNSURE	
D3) If NO, why not? *Code: **1**=taste is poor, **2**=thought to contain contaminants, **3**=other (specify)*				
D4) How far away is it (approx. time to walk, minutes, one way)				
D5) Who collects most of the water? *Code: **1**=women, **2**=men, **3**=children, **4**=all*				
D6) Is there any seasonal influence to the quantity or quality of water for drinking and general domestic use? (circle)	YES	NO	UNSURE	
***D7)* If Yes, in what months is quality or quantity affected?** *Code: Months **1** [January] - **12** [December], **13** = Year round, **14** = No particular time*	Quantity:			
	Quality:			
D8) What is the secondary (back-up) source of drinking water *Code: **1**=pipeline, **2**=well, **3**=river/creek, **4**=pond, **5**=tank, **6**=other (specify)*				
D9) How far away is it (approx. time to walk, minutes, one way)				
D10) What is the main source of water for washing or other domestic use *Code: **1**=pipeline, **2**=well, **3**=river/creek, **4**=pond, **5**=tank, **6**=other (specify)*				
D11) Where do women usually wash? (describe)				
D12) Do people generally wash hands before cooking food, before eating, after going to the toilet? (circle)	ALL	SOME	NONE	UNSURE
D13) Do most people use soap to wash their hands? (circle)	ALL	SOME	NONE	UNSURE
D14) How many houses in the village have rainwater tanks?	ALL	SOME	NONE	UNSURE
D15) Does the school have rainwater tanks?	YES	NO	UNSURE	
D16) Does the school have somewhere for students to drink?	YES	NO	SOMETIMES	

Fuel

D17)	What do most households use as the primary fuel for:		Code *F = firewood* *G = gas* *D = diesel* *K = kerosene lamp* *P = pressure lamp* *C = candle* *E = mains electricity* *X= generator* *S = solar electricity* *B = battery* *Other - specify*
a	*Cooking*		
b	*Lighting*		
c	*Power (i.e., to charge mobile phone)*		

E Land and Natural Resource Use

E1)	**Are women allocated land for their exclusive use (independently of their husbands)?** (circle)	OFTEN	SOME TIMES	RARELY	NEVER
E2)	**Are women responsible for decision-making about planting gardens?** (circle)	OFTEN	SOME TIMES	RARELY	NEVER
E3)	**Are women responsible for decision-making about when to leave gardens fallow?** (circle)	OFTEN	SOME TIMES	RARELY	NEVER
E4)	**How many years do you keep a garden before abandoning it (leaving it fallow)?**	Indicate years			OR NOT SURE
E5)	**How many years do you let the ground rest before you might replant a garden?**	Indicate years			OR NOT SURE

E6) Describe how women are involved in managing natural resources shortages:

Flood and Drought

E7)	**In the last year, has the village been affected by a flood?** (circle)	YES		NO		
	If YES, did flood water: - Cover land inside the village	YES	NO	If YES, does this happen every year?	YES	NO
	- Enter any houses	YES	NO	If YES, does this happen every year?	YES	NO
	- Damage any houses	YES	NO	If YES, does this happen every year?	YES	NO

E8)	**When did this last flood occur?** (Date or estimate)		
E9)	**What are the main issues that arise from flooding?**		
E10)	**How does the village cope during floods?**		
E11)	**Is the village currently affected by drought?** (circle)	YES	NO
E12)	**When was the last time you were affected by drought?** (date or estimate)		
E13)	**What are the main issues that arise from drought?**		
E14)	**How does the village cope in times of drought?**		
E15)	**Has the village ever received assistance following flooding or periods of drought from government (national, provincial) or private companies, NGOs or other civil society organisations operating in the area? Describe.**		

F Food Consumption / Security

F1) Did/Do:

a	Families in this village experience food shortages in the last year? (circle)	YES	NO	SOME	UNSURE
b	Families in this village regularly go a day without eating anything? (circle)	YES	NO	SOME	UNSURE
c	Children in this village regularly go without eating anything? (circle)	YES	NO	SOME	UNSURE
d	Children in this village consume three meals or more per day? (circle)	YES	NO	SOME	UNSURE

F2) Do most household cook inside or outside? (circle)

Inside	Outside

F3) How do families cope with food shortages?

*Code **1**=eat more sago, **2**=eat more fish/seafood products, **3**=hunt more, **4**=eat more forest plants, **5**=eat more store food, **6**=other (specify):*

1.

2.

3.

G Health

G1)	**Have there been illnesses that have affected people in the village in the past year?**		
What *Code: **1**=malaria, **2**=diarrhoea, **3**=respiratory infection, **4**=skin infection **5**=fever, **6**=cough, **7** = other (specify)*	***When*** *Code: **1**=last two weeks, **2**=last 12 months, **3**=last two years*	***How many people affected*** *Code: **1**=a few, **2**=many, **3**=all*	***Treatment/ response***
1.			
2.			
3.			
4.			

G2)	**Which health facility do people generally go to?**	
G3)	**What generally is the main reason for poor health of women in the village?** *Code **1**=lack of medicine, **2**=lack of health workers, **3**=poor diet, **4**=poor hygiene, **5**=workload, **6**=climatic factors, **7**=other (specify)*	*1.* *2.* *3.*

G4)	**What generally is the main reason for poor health of children in the village?** *Code **1**=lack of medicine, **2**=lack of health workers, **3**=poor diet, **4**=poor hygiene, **5**=workload, **6**=climatic factors, **7**=other (specify)* *(Record at least 3 if possible)*	*1.* *2.* *3.*	
G5)	**What is the perceived prevalence of and understanding of STDs?**	**Prevalence:** *Code: **1**=None, **2**=1 or 2 cases only, **3**=several cases, **4**=many cases **5**=not sure*	
		Understanding of how transmitted: *Code: **1**=Everyone knows, **2**=most people know, **3**= some people know, **4**=few people know, **5**=not sure*	
		Understanding of how treated: *Code: **1**=Everyone knows, **2**=most people know, **3**= some people know, **4**=few people know, **5**=not sure*	
G6)	**How many women in the village would use some kind of family planning?** *Code: **1**=Everyone, **2**=most people, **3**= some people, **4**=few people, **5**=none*		
G7)	**How many women in the village have understanding of different contraceptive methods?** *Code: **1**=Everyone knows, **2**=most people know, **3**= some people know, **4**=few people know, **5**=not sure*		
G8)	**How many women have understanding of where to access contraceptives?** *Code: **1**=Everyone knows, **2**=most people know, **3**= some people know, **4**=few people know, **5**=not sure*		
G9)	**Do women make this decision on their own, or do men? or is it a shared decision?** *Code: **1**=Women, **2**=Men, **3**=Shared decision, **4**=Varies from family to family*		

No.	Item	*By Who*	*When (month/year)*
G10)	**When was the last health clinic conducted in this village?**		
G11)	**When was the last malaria patrol?**		
G12)	**When was the last immunisation program?**		
G13)	**When was any other health program (and on what)?**		

G14)	**At what age range do women usually get married?**	From	To
G15)	**Does the village have a trained village birth attendant?** (circle)	YES	NO
G16)	**Does the village have a traditional village birth attendant?** (circle)	YES	NO
G17)	**What proportion of babies are born in the village (as opposed to a nearby health facility)?**	_____% or estimate _____ of _____ born in last 12 mths	
G18)	**If women travel to give birth:**		
	Where?		
	How do they travel there?		
	How long does it take?		

G19)	**When women have a serious illness who do they seek health advice from?** (circle)	TRADITIONAL DOCTOR	MEDICAL WORKER	NEITHER
G20)	**When children have a serious illness who do you seek health advice from?**	TRADITIONAL DOCTOR	MEDICAL WORKER	NEITHER

G21)	How many deaths have there been in the community in the past 12 months?	
	Male:	Female:

G22)	**What type of toilet facility do most households have?** *Code: **1**=private pit, **2**=pit shared pit, **3**=flush toilet, **4**=bush, **5**=sea/river, **6**=other - specify)*			
G23)	**How do most households dispose of:** *Code: **1**=burn, **2**=bury, **3**=bush, **4**= sea/river, **5**=other - specify)*			
	tin cans/batteries	**paper/plastics**	**food scraps**	
G24)	**Is rubbish thrown in an agreed location for the village?** (circle)		YES	NO

H Infrastructure: Health and Education

H1) Does the village have the following?

	If YES, Is it operating/	**If NO or not operating**

			functioning? Code: **Y**= =Yes **N**= no **S**= sometimes	**Where is the nearest?**	**Usual method of travel?** *Code:* ***1****=walk* ***2****=canoe* ***4****=other (specify)*	**Travel time** (minutes, one way)
Aid Post	YES	NO				
Health Centre	YES	NO				
Hospital	YES	NO				
Traditional healer	YES	NO				
Elementary School (Prep-Grade 2)	YES	NO				
Primary school (G3-8)	YES	NO				
Secondary school (G9-12)	YES	NO				
Vocational technical or tertiary training facilities vocational facilities	YES	NO				

H2) How many school aged children (6-15 years of age) attend school: *Code **1**=None, **2**=Only a few, **3**=About half, **4**= Most, **5**=All*	*Boys*	*Girls*
H3) What are the main issues affecting education? *Code **1**=Distance to school, **2**=Schools not operating, **3**=Poor quality of infrastructure, **4**=High cost, **5**=Poor teachers, **6**=Safety issues, **7**=other (specify)*	1)	
	2)	
	3)	
	4)	
H4) In 2015, how often was the nearest school open? *Code: **1**=all year, **2**=most of the year, **3**=less than half of the year, **4**=not at all*	Elementary:	
	Primary:	

***H5)* If closed at any time, why?** *Code **1**=Poor student attendance, **2**=No teacher appointed, **3**=Absent teacher, **4**=lack of facilities, **5**=other (specify)*	
Elementary	**Primary**

I Social / Cultural

Describe the following:

I1)	**Describe any special traditional ceremonies involving women observed in this village.** (provide dates, frequency, other specific details wherever possible)
I2)	**Describe any special customs related to food/drinks involving women in this village?** (provide dates, frequency, other specific details wherever possible)

I3)	**Describe any other customs or taboos specific to women in this village.**

I4)	**Are any of the following active in the village (provide name[s]):**	*Name*			*Main function*	
	Non-governmental organizations					
	Youth groups					
	Women's groups					
	Church groups					
	Other (specify)					
I6)	**Are there individuals, families or groups within the village who are worse off (vulnerable) than most people** (circle)**?**				YES	NO
	If Yes, describe them: *Code: **1**=women-headed HH, **2**=elderly headed HH, **3**=single-mothers, **4**=disabled, or **5**=long-term/seriously ill HH members, **6**=other (specify)*	How many?			Do they get support from anyone? *Code: **1**=immediately family, **2**=extended family/other relatives, **3**=community members, **4**=church, **5**=government, **6**=other (specify)*	
1)		NONE	SOME	MANY		
2)		NONE	SOME	MANY		
3)		NONE	SOME	MANY		
4)		NONE	SOME	MANY		

5)		NONE	SOME	MANY	

J Project Perceptions

J1)	**Have you (participants) heard of Total and the Papua LNG Project before today?**			
	Total	YES	NO	UNSURE
	Papua LNG Project	YES	NO	UNSURE
J2)	**At this point in time, how do you feel about the Papua LNG Project?**			
J3)	**How do you (participants) think the village might be affected by the project?**			
J4)	**What are the village's priorities for the future?** *(seek out development needs only if no information from C6)* *1.* *2.* *3.* *4.*			

FGD Spokespeople

Name	**Gender**		**Contact details**
1)	M	F	
2)	M	F	
3)	M	F	

Name	Gender		Contact details
4)	M	F	
5)	M	F	
6)	M	F	
7)	M	F	
8)	M	F	

Add others as needed

COMPLETION CHECKLIST:

All questions complete / filled in:	
Photo record taken:	
Spokesperson/s recorded:	

QA COMPLETED:

SIGNATURE of Technical Lead or authorised delegate

PRINT NAME

DATE

Focus Group Discussion and Survey - Youths

Facilitator	
Date of FGD (Day/month/year)	/ /2016
Village Name	
Photo reference	

A Organisation

A1) Name of youth group *(if not a group, GO TO A4)*		
A2) Formal/informal organisation Does the group have an appointed leader, hold regular meetings?		
How many of members does the group have?		
Age range of members?	From: To:	
How many members are:	Male	Female
Any specific requirements to become a member?		
A3) What is the role of the youth group in the community? Describe activities undertaken by youth group		

A4) Describe any youth projects that have been implemented in this village in the past 2 years.	

B Activities

B1)	**What are your (participants) main activities in this village? (most important role)?** *Code: For **importance** use 1 – 5 where **1** is not important and **5** is very important. For **frequency**, use code **1** = every day, **2** = most days, **3** = sometimes and **4** = rarely.*	**Importance (code)**	**Frequency (code)**
a)	Attending school		
b)	Caring for family members		
c)	Making gardens		
d)	Tending gardens		
e)	Raising livestock		
f)	Hunting		
g)	Fishing		
h)	Collecting seafood		
i)	Collecting edible plants		
j)	Collecting water		
k)	Collecting firewood		
l)	Building/maintaining house and physical assets (e.g fences)		
m)	Earning income (to contribute to household)		
n)	Other (specify)		

B2)	**If members earn income: What are their main income sources/types of employment? (List in order of importance: 1 being most important).** *__1__ = betel nut, __2__ = paid employment, __3__ = logging companies, __4__ = sale of fish/seafood products, __5__ = sale of food crops, __6__ = sale of sago, __7__ = other (specify)*	1.
		2.
		3.
		4.
		5.

C Recreation

F1)	**What do you (participants) do in your spare time for recreation?** *__1__ = sport, __2__ = relax, __3__ = hang with friends, __4__ = craft, __5__ = surf net, __6__ = read, __7__ = other (specify)*	1.
		2.
		3.
		4.
		5.

D Law and Order

D1)	**What are the most prevalent law and order *issues in the village?*** *Code __1__=stealing, __2__=fighting, __3__=domestic violence/sexual violence, __4__=alcohol abuse, __5__=marijuana, __6__=land disputes, __7__=other (specify)*	**How are they dealt with?**
	1)	
	2)	
	3)	
	4)	
	5)	

D2)	**Do you:** (indicate)	**Boys**			**Girls**		
	Consume alcohol?	*Most*	*Some*	*None*	*Most*	*Some*	*None*
	Use marijuana?	*Most*	*Some*	*None*	*Most*	*Some*	*None*
	Use harder drugs?, such as *(specify)*	*Most*	*Some*	*None*	*Most*	*Some*	*None*
	Gamble for money?	*Most*	*Some*	*None*	*Most*	*Some*	*None*

E Health

E1)	**When you have a serious illness who do you seek health advice from?** (circle)	TRADITIONAL DOCTOR	MEDICAL WORKER	NEITHER
E2)	**What generally is the main reason for poor health in the village?** *Code **1**=lack of medicine, **2**=lack of health workers, **3**=poor diet, **4**=poor hygiene, **5**=workload, **6**=climatic factors, **7**=other (specify)* *(Record at least 3 if possible)*	*1.* *2.* *3.*		
E3)	**What is the perceived prevalence of and understanding of STDs?**	**Prevalence:** *Code: **1**=None, **2**=1 or 2 cases only, **3**=several cases, **4**=many cases **5**=not sure*		
		Understanding of how transmitted: *Code: **1**=Everyone knows, **2**=most people know, **3**= some people know, **4**=few people know, **5**=not sure*		
		Understanding of how treated: *Code: **1**=Everyone knows, **2**=most people know, **3**= some people know, **4**=few people know, **5**=not sure*		

F Youth Concerns/Issues

F2)	**What concerns or issues worry youth (participants) in this village?** ***1** = lack of job opportunity, **2** = lack of income/money, **3** = lack of education opportunity, **4** = lack of access to modernity, **5** = health, **6** = other (specify)*	1.
		2.
		3.
		4.
		5.

G Project Perceptions

G1)	**Have you (participants) heard of Total and the Papua LNG Project before today?**			
	Total (circle)	YES	NO	UNSURE
	Papua LNG Project (circle)	YES	NO	UNSURE

G2)	**At this point in time, how do you feel about the Papua LNG Project?**
G3)	**How do you (participants) think youths might be affected by the project?**
G4)	**What are your (participants) priorities for the future?**
	1.
	2.
	3.
	4.
	5.

FGD Spokespeople

Name	Gender		Age	Contact details
1)	M	F		
2)	M	F		
3)	M	F		
4)	M	F		
5)	M	F		

COMPLETION CHECKLIST:

All questions complete / filled in:	
Photo record taken:	
Spokesperson/s recorded:	

QA COMPLETED:

_____
SIGNATURE of Technical Lead or authorised delegate

Print name: _____

Date: _____

Attachment 5

Key Informant Interview Instruments

A Site Recording Form

Site #: _____ **PNG National Museum Site #**: _____ **Site name**: _____
Other site name(s): _____ _____
Language area: _____ **Clan**: _____
Recorded by: _____ **People present**: _____ **Date**: ____ / May / 2016
GPS location – Grid reference: _____/_____ WGS84
Elevation ASL: _____ m **Locational accuracy**: _____m

	Site Landscape																	
Site Vegetation	**Ecotone**	Hill Top	Hill Slope	Base of Hill	Cliff	Rocky Outcrop	Sinkhole	Lakeside	Lake/Waterhole	Spring	River/Creek	Freshwater Swamp	Mangrove/Salt water Swamp	Fresh water Swamp	Floodplain	River Levee	Beach	Beach ridges and swales	Degraded beach plains
Vine-Thicket																			
Grassland																			
Open Woodland																			
Mangrove																			
Garden																			
Other																			

Surface sediment type at site:
☐ Clay ☐ Silt ☐ Sand ☐ Loam ☐ Gravel ☐ Rock ☐ Freshwater ☐ Saltwater ☐ Other:_____
Ground surface visibility at site: **Bedrock**: ☐ Exposed ☐ Not exposed
☐ 0% ☐ 1-25% ☐ 25-50% ☐ 50-75% ☐ 75-100%

Site type:
☐ Open Shell Midden
☐ Rock-shelter
☐ Charcoal/Ash
☐ Stone Arrangement
☐ Shell Arrangement
☐ Isolated Shell
☐ Grinding Stone
☐ Isolated Stone/Ceramic
☐ Cultural Materials Scatter
☐ Quarry
☐ Rock-art
☐ Burial/Ossuary
☐ Garden
☐ Temporary Encampment
☐ Village
☐ Mound
☐ Ritual/Spirit/'Sacred' Site
☐ Fishing/Hunting Site
☐ Tree
☐ Other: _____

Cultural materials present:
☐ Ochre
☐ Hearth/earth oven
☐ 'European'/Asian Contact Materials
  ☐ Bottle Glass
  ☐ Metal Items
  ☐ Ceramic
  ☐ Other: _____
☐ Stone Artefacts
  ☐ Quartz ☐ 1-10 ☐ 11-50 ☐ 50+
  ☐ Volcanic ☐ 1-10 ☐ 11-50 ☐ 50+
  ☐ Metamorphic ☐ 1-10 ☐ 11-50 ☐ 50+
  ☐ Sedimentary ☐ 1-10 ☐ 11-50 ☐ 50+
☐ Shell MNI: ☐ 1-10 ☐ 11-50 ☐ 50+
☐ Melanesian Ceramics ☐ 1-10 ☐ 11-50 ☐ 50+
☐ Animal Bone ☐ 1-10 ☐ 11-50 ☐ 50+
☐ Human Bone
☐ Wooden Structures/Posts/Post-Holes

Stratification:
☐ Surface Site
☐ Stratified/Buried Site
☐ Site Exposed by Disturbance
☐ Unknown

Shells: ☐ *Anadara* sp. ☐ *Polymesoda* sp. ☐ *Syrinx* sp. ☐ *Cypraea* sp. ☐ *Oliva* sp. ☐ *Conus* sp. ☐ *Melo* sp. ☐ Other Bivalve _____ ☐ Other Gastropod _____

Vertebrate remains: ☐ Bird ☐ Fish ☐ Turtle ☐ Pig ☐ Other Mammal ☐ Other: _____

Modified Shells: _____ ☐ 1 ☐ 2-5 ☐ 5-10 ☐ 11+

Maximum density of cultural materials on site surface: _____ /m^2

Distance to nearest freshwater source:

Closest Permanent Water: _____ m ☐ Swamp ☐ River ☐ Creek ☐ Waterhole/Lake ☐ Other

Closest Temporary Water: _____ m ☐ Swamp ☐ Creek ☐ Waterhole/Lake ☐ Other: _____

Distance to High Water Mark: _____ m **Site area**: _____ m^2

Site length (max): _____ m Site Width (max): _____ m

Ceramic artefact description: ☐body sherds ☐ rim sherds ☐ decorated sherds

_____
_____
_____
_____

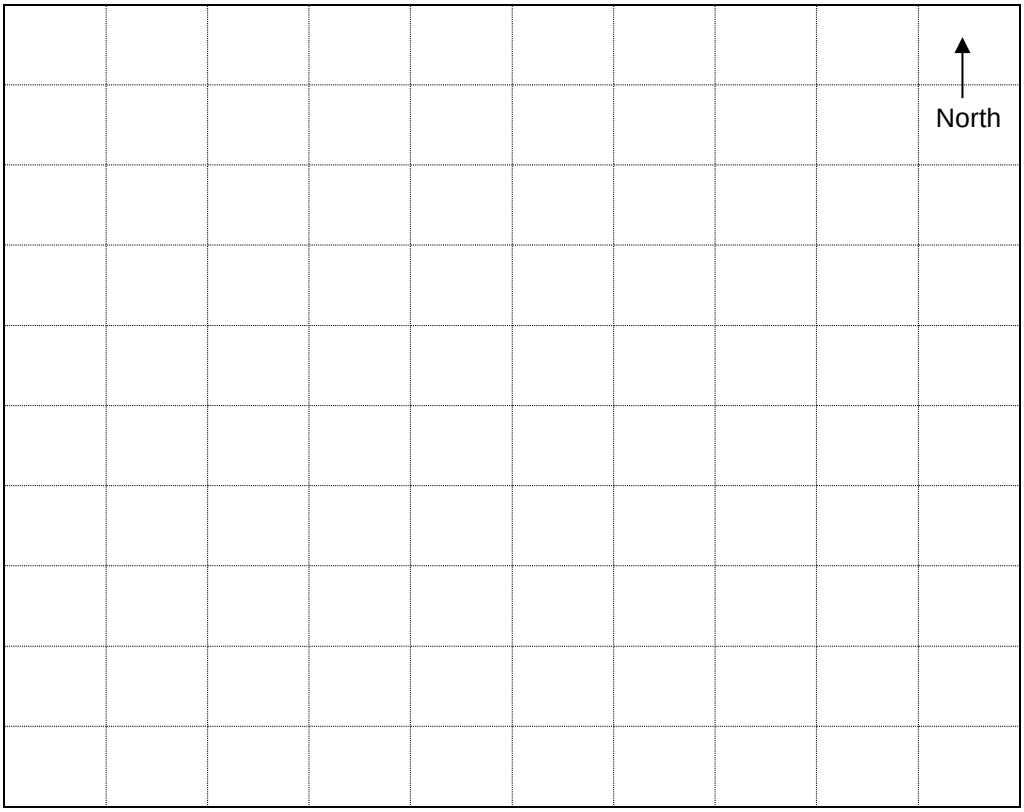
Environnemental description:

_____
_____
_____
_____

Site description:

_____
_____
_____

[Complete Site Map on next page]



Site Map…….Scale – one square =

☐ Large Site (>1000m^2) ☐ Medium Site (26-1000m^2) ☐ Small Site (<26m^2)

B Site Significance

Site Significance

☐ High ☐ Medium ☐ Low

ONLY ASK THE FOLLOWING IF FACILITATOR DETERMINES THAT SITE IS OF HIGH SIGNIFICANCE AND/OR HIGHLY LIKELY TO BE AFFECTED BY PROJECT ACTIVITIES.

B1 If the Project had to damage or destroy this place, what would the community's reaction be? Would the community require any specific responses from the Project in order for the damage/destruction to be permitted? (USE CODE)

Site #	Community Reaction	Project Response

Community Reaction

01 Not allow site to be harmed in any way
02 Allow site to be harmed but with conditions
03 Allow site to be unconditionally harmed
04 Other (specify)

Project Response

01 Ceremony prior to works commencing
02 Exhumation and relocation of human remains
03 Archaeological investigation/excavation of the site
04 Other (specify)

Key Informant Interview - Cultural Heritage

Facilitator	
Date of KII (Day/month/year)	/ /2016
Names of people interviewed and their clan affiliations and village of residence	Name: _____ M / F Clan: _____ Village of Residence: _____ Name: _____ M / F Clan: _____ Village of Residence: _____ Name: _____ M / F Clan: _____ Village of Residence: _____ Name: _____ M / F Clan: _____ Village of Residence: _____ Name: _____ M / F Clan: _____ Village of Residence: _____ Name: _____ M / F Clan: _____ Village of Residence: _____
Location / name of facility	
Photo reference	

A Site Recording Form

Site #: _____ **PNG National Museum Site #**: _____ **Site name**: _____
Other site name(s): _____ _____
Language area: _____ **Clan**: _____
Recorded by: _____ **People present**: _____ **Date**: ____ / May / 2016
GPS location – Grid reference: _____/_____ WGS84
Elevation ASL: _____ m **Locational accuracy**: _____m

	Site Landscape																	
Site Vegetation	**Ecotone**	Hill Top	Hill Slope	Base of Hill	Cliff	Rocky Outcrop	Sinkhole	Lakeside	Lake/Waterhole	Spring	River/Creek	Freshwater Swamp	Mangrove/Salt water Swamp	Fresh water Swamp	Floodplain	River Levee	Beach	Beach ridges and swales	Degraded beach plains
Vine-Thicket																			
Grassland																			
Open Woodland																			
Mangrove																			
Garden																			
Other																			

Surface sediment type at site:
☐ Clay ☐ Silt ☐ Sand ☐ Loam ☐ Gravel ☐ Rock ☐ Freshwater ☐ Saltwater ☐ Other:_____
Ground surface visibility at site: **Bedrock**: ☐ Exposed ☐ Not exposed
☐ 0% ☐ 1-25% ☐ 25-50% ☐ 50-75% ☐ 75-100%

Site type:
☐ Open Shell Midden
☐ Rock-shelter
☐ Charcoal/Ash
☐ Stone Arrangement
☐ Shell Arrangement
☐ Isolated Shell
☐ Grinding Stone
☐ Isolated Stone/Ceramic
☐ Cultural Materials Scatter
☐ Quarry
☐ Rock-art
☐ Burial/Ossuary
☐ Garden
☐ Temporary Encampment
☐ Village
☐ Mound
☐ Ritual/Spirit/'Sacred' Site
☐ Fishing/Hunting Site
☐ Tree
☐ Other: _____

Cultural materials present:
☐ Ochre
☐ Hearth/earth oven
☐ 'European'/Asian Contact Materials
  ☐ Bottle Glass
  ☐ Metal Items
  ☐ Ceramic
  ☐ Other: _____
☐ Stone Artefacts
  ☐ Quartz ☐ 1-10 ☐ 11-50 ☐ 50+
  ☐ Volcanic ☐ 1-10 ☐ 11-50 ☐ 50+
  ☐ Metamorphic ☐ 1-10 ☐ 11-50 ☐ 50+
  ☐ Sedimentary ☐ 1-10 ☐ 11-50 ☐ 50+
☐ Shell MNI: ☐ 1-10 ☐ 11-50 ☐ 50+
☐ Melanesian Ceramics ☐ 1-10 ☐ 11-50 ☐ 50+
☐ Animal Bone ☐ 1-10 ☐ 11-50 ☐ 50+
☐ Human Bone
☐ Wooden Structures/Posts/Post-Holes

Stratification:
☐ Surface Site
☐ Stratified/Buried Site
☐ Site Exposed by Disturbance
☐ Unknown

Shells: ☐ *Anadara* sp. ☐ *Polymesoda* sp. ☐ *Syrinx* sp. ☐ *Cypraea* sp. ☐ *Oliva* sp. ☐ *Conus* sp. ☐ *Melo* sp. ☐ Other Bivalve _____ ☐ Other Gastropod _____

Vertebrate remains: ☐ Bird ☐ Fish ☐ Turtle ☐ Pig ☐ Other Mammal ☐ Other: _____

Modified Shells: _____ ☐ 1 ☐ 2-5 ☐ 5-10 ☐ 11+

Maximum density of cultural materials on site surface: _____ /m^2

Distance to nearest freshwater source:

Closest Permanent Water: _____ m ☐ Swamp ☐ River ☐ Creek ☐ Waterhole/Lake ☐ Other

Closest Temporary Water: _____ m ☐ Swamp ☐ Creek ☐ Waterhole/Lake ☐ Other: _____

Distance to High Water Mark: _____ m **Site area**: _____ m^2

Site length (max): _____ m Site Width (max): _____ m

Ceramic artefact description: ☐body sherds ☐ rim sherds ☐ decorated sherds

_____
_____
_____
_____

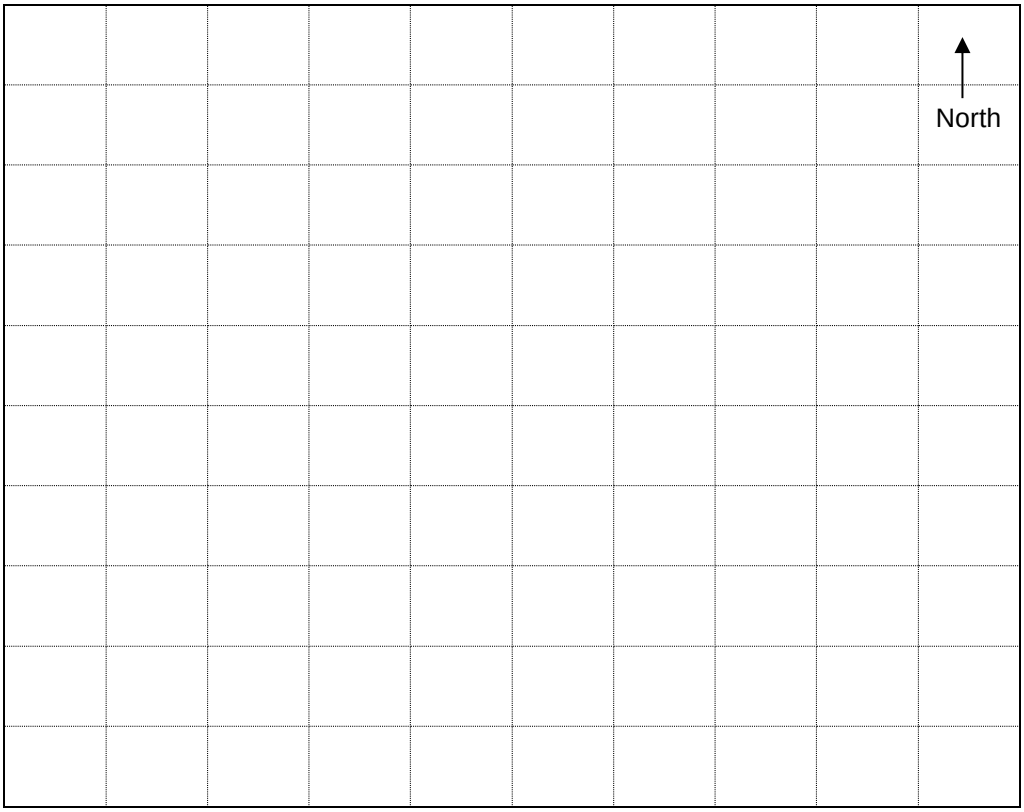
Environnemental description:

_____
_____
_____
_____

Site description:

_____
_____
_____

[Complete Site Map on next page]



Site Map…….Scale – one square =

☐ Large Site (>1000m^2) ☐ Medium Site (26-1000m^2) ☐ Small Site (<26m^2)

B Site Significance

Site Significance

☐ High ☐ Medium ☐ Low

ONLY ASK THE FOLLOWING IF FACILITATOR DETERMINES THAT SITE IS OF HIGH SIGNIFICANCE AND/OR HIGHLY LIKELY TO BE AFFECTED BY PROJECT ACTIVITIES.

B1 If the Project had to damage or destroy this place, what would the community's reaction be? Would the community require any specific responses from the Project in order for the damage/destruction to be permitted? (USE CODE)

Site #	Community Reaction	Project Response

Community Reaction

01 Not allow site to be harmed in any way
02 Allow site to be harmed but with conditions
03 Allow site to be unconditionally harmed
04 Other (specify)

Project Response

01 Ceremony prior to works commencing
02 Exhumation and relocation of human remains
03 Archaeological investigation/excavation of the site
04 Other (specify)

C Summary of Cultural Sites

Site #	Site Type (code)	Traditional Name	Clan Owners	1:100,000 mapsheet	Easting	Northing	Description (e.g. number of individuals, names, grave markers)	Significance Rating

Site Type

01 Open Shell Midden
02 Rock-shelter
03 Charcoal/Ash
04 Stone Arrangement
05 Shell Arrangement
06 Isolated Shell
07 Grinding Stone
08 Isolated Stone/Ceramic
09 Cultural Materials Scatter
10 Quarry
11 Rock-art
12 Burial/Ossuary
13 Garden
14 Temporary Encampment
15 Village
16 Mound
17 Ritual/Spirit/'Sacred' Site
18 Fishing/Hunting site
19 Tree
20 Other

Significance

01 Low
02 Medium
03 High

D Intangible Cultural Heritage

D1) Are there any aspects of your community's culture that do not exist physically but which is knowledge that is either shared by everyone or known only to sections of the community (e.g. song, dance, language, histories, rituals, ceremonies) that you are concerned might be affected by the Project?

ID#	Type of Knowledge	Practiced By	Description	Project Impact
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				

Type of Knowledge

01 Song
02 Dance
03 Language
04 History
05 Ritual/Ceremony
06 Other (specify)

Additional comments if any

COMPLETION CHECKLIST:

All questions complete / filled in:	
GPS waypoints taken:	
Photo records taken:	

QA COMPLETED

SIGNATURE of Technical Lead or authorised delegate

PRINT NAME

DATE

Key Informant Interview - Education

Facilitator			
Date of KII (Day/month/year)	/ /2016		
Name of person interviewed			
Gender (circle)	MALE	FEMALE	
Position of person			
Village			
Name of School			
Ownership of School (circle)	GOVERNMENT	CHURCH	Other (specify)
Photo reference			

A Students

A1) Current enrolment by school grade and gender

	Grade	Boys	Girls	Total
a)	Prep			
b)	Grade 1			
c)	Grade 2			
d)	Grade 3			
e)	Grade 4			
f)	Grade 5			
g)	Grade 6			
h)	Grade 7			
i)	Grade 8			
j)	Grade 9			

k)	Grade 10			
l)	Grade 11			
m)	Grade 12			
n)	Vocational facility *(specify types of courses and enrolments)*			

B Attendance

B1)	**How many local children attend school on a regular basis** *(circle)*	All	Most	No so many	Few
B2)	**If there is poor attendance, what are the main reasons?** *Code: **1**=unaffordable fees, **2**=too far to travel, **3**=absent teacher, **4**=poor conditions, **5**=needed for gardens/work, **5**=other (specify)*	1.			
		2.			
		3.			
		4.			
B3)	**How many of the students are boarders?**	Male		Female	
B4)	**Where do boarding students come from?**				

C Staff

C1)	**Number of teaching staff**	
C2)	**Number of vacant teaching positions**	
C3)	**Number of other staff (non-teaching)**	

C4)	**Main difficulties facing teachers** *Code: **1**=Remote location of school, **2**=payment of wages, **3**=poor conditions, **4**=unsupportive parents, **5**=unsupportive community, **6**=other (specify)*	1.
		2.
		3.

D Resources

D1) How is the School in terms of:

a)	School buildings (classrooms and others)	ADEQUATE	OK	POOR	UNSATISFACTORY
b)	Teacher/student ratio	ADEQUATE	OK	POOR	UNSATISFACTORY
c)	Books/other teaching materials	ADEQUATE	OK	POOR	UNSATISFACTORY
d)	Water supply	ADEQUATE	OK	POOR	UNSATISFACTORY
e)	Toilets/ sanitation	ADEQUATE	OK	POOR	UNSATISFACTORY
f)	Teachers housing	ADEQUATE	OK	POOR	UNSATISFACTORY

D2)	**In 2015, how often was the school open?**	ALL YEAR	MOST OF THE YEAR	LESS THAN HALF OF THE YEAR	HARDLY AT ALL
D3)	**If not all year, why?** *Code: **1**=Teacher absent, **2**=Repair of buildings, **3**=Lack of students, **5**=Trouble in community, **6**=other (specify)*				
D4)	**Does the school have a School Board?**	YES		NO	
D5)	**If yes, does the School Board meet regularly?**	YES		NO	
D6)	**When was the last time the school inspector visited this school?**				

D7)	Please describe any development support the school has received recent years from:		
	Who ***Code**: **1**=Member of Parliament, **2**=Government, **3**=Private sector, **4**=NGO/donor, **5**=other (specify)*	**What**	**When**
a)			
b)			
c)			
d)			

D8)	What are the main priorities to improve education in the local area?	
		1.
		2.
		3.
		4.

E Cost of education

E1)	**Describe the fee structure** *(include project fees)***:**

Other comments / observations:

COMPLETION CHECKLIST:

All questions complete / filled in:	
Photo record taken:	
Spokesperson/s recorded:	

QA COMPLETED

SIGNATURE of Technical Lead or authorised delegate

PRINT NAME

DATE

Key Informant Interview - Health

Interviewer		
Date of KII	/ /2016	
Name of person interviewed		
Gender	MALE	FEMALE
Position		
Village		
Photo reference		

A Community Health Issues

A1)	**Tell me about the main issues affecting health in this village / area.**

A2)	**Tell me about your main concerns about health in this village (illnesses, service provision, etc)**

B Attendance

B1)	**Discuss attendance at this facility (frequency, primary reasons, primary treatments, patient patterns, etc)**	
B2)	**Review and capture (photograph) monthly / annual records:**	**Complete**
	2015	
	2016	

B3)	**Discuss barriers to attendance, what are the main reasons?** *Code: **1**=unaffordable, **2**=too far to travel, **3**=poor conditions, **4**=other (specify)*	1.
		2.
		3.

C Staff

C1)	**Number of staff**	
C2)	**List positions**	
	1.	4.
	2.	5.
	3.	6.
C3)	**Number of vacant positions**	
C4)	**Number of other staff (non-medical)**	
C5)	**Main difficulties facing staff at this facility:** *Code: **1**=Remote location of facility, **2**=payment of wages, **3**=poor conditions, **4**=unsupportive community, **5**=other (specify)*	1.
		2.
		3.

D Resources

D1)	How is the facility in terms of:				
a	Building/s	ADEQUATE	OK	POOR	UNSATISFACTORY
b	Trained health staff/patient ratio	ADEQUATE	OK	POOR	UNSATISFACTORY
c	Medicine - stock	ADEQUATE	OK	POOR	UNSATISFACTORY
d	Medicine - range	ADEQUATE	OK	POOR	UNSATISFACTORY
e	Medicine – currency	ADEQUATE	OK	POOR	UNSATISFACTORY
f	Consumable materials (i.e., bandages) - stock	ADEQUATE	OK	POOR	UNSATISFACTORY
g	Consumable materials - range	ADEQUATE	OK	POOR	UNSATISFACTORY
i	Equipment	ADEQUATE	OK	POOR	UNSATISFACTORY
j	Water supply	ADEQUATE	OK	POOR	UNSATISFACTORY
k	Toilets/ sanitation	ADEQUATE	OK	POOR	UNSATISFACTORY

D2)	In 2015, how often was the facility open?	All year	Most of the year	Less than half of the year	Hardly at all
D3)	If not all year, why?				
D4)	In which year was the last time you received a supervisory visit?				

D5)	Please describe any development support the facility has received in recent years from:	What	When
a	Provincial Government		
b	District Government		

c	Local level Government		
d	Others		
D6)	What are the main priorities to improve health in the local area?	1.	
		2.	
		3.	
		4.	

Larger Facilities

D7)	**Number of beds:**	
D8)	**List of services provided:**	
	1.	
	2.	
	3.	
	4.	
	5.	
	6.	
	7.	
	8.	

D9)	**Is this facility a training facility?**	YES	NO
	If Yes, number of students attending?	MALE	FEMALE
	Describe training provided.		

E Cost of Health Services

E1)	**Cost of health services (list services and costs)**	
1.		**kina**
2.		**kina**
3.		
4.		
5.		

F Health Referrals

F1)	**If patients require referral, where are they referred?** **Location**	**Type of illness/injury**		
1.				
2.				
3.				
F2)	**Who covers the cost of referral treatment and associated travel etc?**	**Patient**	**Government**	**Other**
	Describe			

F3)	Does the cost of referral treatment prevent patients from receiving treatment?	Rarely	Often	Almost always
	Describe			

G Review of Health Facilities Records

A review of a sample of health facility records will be conducted at each aid post/clinic/hospital/facility visited.

This is designed to help obtain data on the most common causes of morbidity and mortality and the prevalence of communicable and non-communicable diseases in the local and regional study areas.

H Other

Additional comments if any

COMPLETION CHECKLIST:

All questions complete / filled in:	
Photo record taken:	
Spokesperson/s recorded:	

QA COMPLETED:

SIGNATURE of Technical Lead or authorised delegate

PRINT NAME

DATE

Key Informant Interview - Land & Natural Resource Use

Facilitator	
Date of KII (day/month/year)	/ /2016
Village Name	
Photo reference	

A Land – Gardening (Crops, sago, other productive assets)

No.	1	2	3	4	5
What garden resource? (Type/Species) *Try to list at least top 3.*					
A1) Where? Can location be identified on map? Note distance travelled from primary residence in pursuit of activity?	*Map* ***Distance***	*Map* ***Distance***	*Map* ***Distance***	*Map* ***Distance***	*Map* ***Distance***
A2) Who grows resource? Code: **1**=men, **2**=women, **3**=children, **4**=all					
A3) When is the resource grown? *Code: Months **1** [January] - **12** [December],* ***13** = Year round, **14** = No particular time*					
A4) Who collects the resource? Code: **1**=men, **2**=women, **3**=children, **4**=All					
A5) How abundant, generally, is the resource? How much do you generally grow? *Code: **1**=Not enough for family, **2**=Enough for family, **3**=More than family needs (excess is sold/given away), **4** =Other (specify)*					

No.	1	2	3	4	5
A6) Are there ever shortages of resource? Why? *Code: **1**=Under-planting, **2**=Overharvesting, **3**=Drought, **4**=Flood, **5**=Disease/pest/weeds, **6** =Other (specify)*					
A7) How do you cope with shortages? *Code: **1**=Supplement with other garden product, **2**=Supplement with bush plants, **3**=Supplement with hunting/catch, **4**=Supplement with store food, **5**=do nothing, **6**=Other (specify)*					
A8) Why do you grow this resource? **1**=Income, **2**=Consumption, **3**=Medicinal, **4**=Cultural (bilas).					
A9) Do you actively manage this resource? Describe. *Code: **1**=Fallow land, **2**=Fertilise land, **3**=Improve conditions, **4**=Burn land, **5** =Other (specify)*					

B Land – Collecting (Forest food, building materials, firewood, medicine, cultural, etc.)

No.	1	2	3	4	5
What resource? (Type/Species) *Try to list at least top 3.*					
B1) Where? Can location be identified on map? Note distance travelled from primary residence in pursuit of activity?	*Map* ***Distance***	*Map* ***Distance***	*Map* ***Distance***	*Map* ***Distance***	*Map* ***Distance***
B2) Who collects resource? *Code: **1**=men, **2**=women, **3**=children, **4**=All*					
B3) When is the resource collected? *Code: Months **1** [January] - **12** [December], **13** = Year round, **14** = No particular time*					
B4) How abundant, generally, is the resource? How much do you generally collect? *Code: **1**=Not enough for family, **2**=Enough for family, **3**=More than family needs (excess is sold/given away), **4** =Other (specify)*					
B5) Are there ever shortages of resource? Why? *Code: **1**=Overharvesting,*					

No.	1	2	3	4	5
***2**=Drought, **3**=Flood, **4**=Disease/pest/weeds, **5** =Other (specify)*					
B6) How do you cope with shortages? *Code: **1**=Supplement with garden produce, **2**=Supplement with other bush resource, **3**=Supplement with hunting/catch, **4**=Supplement with store-brought item, **5**=Do nothing, **6**=Other (specify)*					
B7) Why do you collect this resource? *Code: 1=Income, 2=Consumption, 3=Medicinal, 4=Cultural (bilas).*					
B8) Do you actively manage this resource? Describe. *Code: **1**=Allow to replenish, **2**=Improve land, **3**=improve conditions, **4**=Burn land, **5** =Other (specify)*					

C Land – Hunting (Wild animals, e.g., pig, flying foxes, possums etc.)

		1	2	3	4	5
C1)	**What resource?** (Type/Species)					
C2)	**Where?** Can location be identified on map? Note distance travelled from primary residence in pursuit of activity?	*Map* ***Distance***	*Map* ***Distance***	*Map* ***Distance***	*Map* ***Distance***	*Map* ***Distance***
C3)	**Who hunts resource?** *Code: **1**=men, **2**=women, **3**=children, **4**=All*					
C4)	**When is the resource hunted?** *Code: Months **1** [January] - **12** [December], **13** = Year round, **14** = No particular time*					
C5)	**How abundant, generally, is the resource?** How much do you generally hunt? *Code: **1**=Not enough for family, **2**=Enough for family, **3**=More than family needs (excess is sold/given away), **4** =Other (specify)*					

C6)	**Are there ever shortages of resource? Why?** *Code: **1**=Overhunting, **2**=Drought, **3**=Flood, **4**=Disease/pest/ weeds, **5** =Other (specify)*					
C7)	**How do you cope with shortages?** *Code: **1**=Supplement with garden produce, **2**=Supplement with bush plants, **3**=Supplement with other hunting/catch, **4**=Supplement with store food, **5**=Do nothing, **6**=Other (specify)*					
C8)	**Why do you hunt this resource?** *Code**: 1**=Income, **2**=Consumption, **3**=Medicinal, **4**=Cultural (bilas).*					
C9)	**Do you actively manage this resource? Describe.** *Code: **1**=Avoid impacted area, **2**=Avoid impacted species, **3**=Avoid type of impacted species (ie, young) **4** =Other (specify)*					

D Rivers – Fishing

		1	2	3	4	5
D1)	**What resource?** (Type/Species)					
D2)	**Where?** Can location be identified on map? Note distance travelled from primary residence in pursuit of activity?	*Map* ***Distance***	*Map* ***Distance***	*Map* ***Distance***	*Map* ***Distance***	*Map* ***Distance***
D3)	**Who fishes for the resource?** *Code: **1**=men, **2**=women, **3**=children, **4**=All*					
D4)	**When is the resource fished?** *Code: Months **1** [January] - **12** [December],* ***13** = Year round, **14** = No particular time*					
D5)	**How abundant, generally, is the resource?** How much do you generally collect? *Code: **1**=Not enough for family, **2**=Enough for family, **3**=More than family needs (excess is sold/given away), **4** =Other (specify)*					

D6)	**Are there ever shortages of resource? Why?** *Code: **1**=Overharvesting, **3**=Drought, **4**=Flood, **5**=Disease/pest/ weeds, **5** =Other (specify)*					
D7)	**How do you cope with shortages?** *Code: **1**=Supplement with other garden item, **2**=Supplement with bush plants, **3**=Supplement with hunting/catch, **4**=Supplement with store food, **5**=Do nothing, **6**=Other (specify)*					
D8)	**Why do you fish for this resource?** *Code**: 1**=Income, **2**=Consumption, **3**=Medicinal, **4**=Cultural (bilas).*					
D9)	**Do you actively manage this resource? Describe.** *Code: **1**=Avoid impacted area, **2**=Avoid impacted species, **3**=Avoid type of impacted species (ie, young) **4** =Other (specify)*					

E Rivers – Collecting (River plants, eggs, etc.)

		1	2	3	4	5
E1)	**What resource?** (Type/Species)					
E2)	**Where?** Can location be identified on map? Note distance travelled from primary residence in pursuit of activity?	*Map* ***Distance***	*Map* ***Distance***	*Map* ***Distance***	*Map* ***Distance***	*Map* ***Distance***
E3)	**Who collects resource?** *Code: **1**=men, **2**=women, **3**=children, **4**=All*					
E4)	**When is the resource collected?** *Code: Months **1** [January] - **12** [December], **13** = Year round, **14** = No particular time*					
E5)	**How abundant, generally, is the resource?** How much do you generally collect? *Code: **1**=Not enough for family, **2**=Enough for family, **3**=More than family needs (excess is sold/given away), **4** =Other (specify)*					

E6)	**Are there ever shortages of resource? Why?** ***1****=Overharvesting,* ***3****=Drought,* ***4****=Flood,* ***5****=Disease/pest/ word,* ***5*** *=Other (specify)*					
E7)	**How do you cope with shortages?** *Code:* ***1****=Supplement with garden produce,* ***2****=Supplement with bush plants,* ***3****=Supplement with hunting/catch,* ***4****=Supplement with other collecting,* ***5****=Supplement with store food,* ***6****=Do nothing,* ***7****=Other (specify)*					
E8)	**Why do you collect this resource?** *Code:* ***1****=Income,* ***2****=Consumption,* ***3****=Medicinal,* ***4****=Cultural (bilas).*					
E9)	**Do you actively manage this resource? Describe.** *Code:* ***1****=Avoid impacted area,* ***2****=Avoid impacted item/species,* ***3****=Avoid type of impacted item/species (ie, young)* ***4*** *=Other (specify)*					

F Rivers – Hunting (Crocodiles, turtles, etc.)

		1	2	3	4	5
F1)	**What resource?** (Type/Species)					
F2)	**Where?** Can location be identified on map? Note distance travelled from primary residence in pursuit of activity?	*Map* ***Distance***	*Map* ***Distance***	*Map* ***Distance***	*Map* ***Distance***	*Map* ***Distance***
F3)	**Who hunts the resource?** **M**=men, **W**=women, **C**=children, **A**=All					
F4)	**When is the resource hunted?** *Code: Months **1** [January] - **12** [December], **13** = Year round, **14** = No particular time*					
F5)	**How abundant, generally, is the resource?** How much do you generally collect? *Code: **1**=Not enough for family, **2**=Enough for family, **3**=More than family needs (excess is sold/given away), **4** =Other (specify)*					

F6)	**Are there ever shortages of resource? Why?** *Code: **1**=Overhunting, **3**=Drought, **4**=Flood, **5**=Disease/pest/ weeds, **5** =Other (specify)*					
F7)	**How do you cope with shortages?** *Code: **1**=Supplement with garden produce, **2**=Supplement with bush plants, **3**=Supplement with other hunting/catch, **4**=Supplement with store food, **5**=Do nothing, **6**=Other (specify)*					
F8)	**Why do you hunt this resource?** I=Income, C=Consumption, M=Medicinal, C=Cultural (bilas).					
F9)	**Do you actively manage this resource? Describe.** *Code: **1**=Avoid impacted area, **2**=Avoid impacted species, **3**=Avoid type of impacted species (ie, young) **4** =Other (specify)*					

G Ocean (including estuarine habitats (e.g. mangroves) – Fishing

		1	2	3	4	5
G1)	**What resource?** (Type/Species)					
G2)	**Where?** Can location be identified on map? Note distance travelled from primary residence in pursuit of activity?	*Map* ***Distance***	*Map* ***Distance***	*Map* ***Distance***	*Map* ***Distance***	*Map* ***Distance***
G3)	**Who fishes for the resource?** *Code: **1**=men, **2**=women, **3**=children, **4**=All*					
G4)	**When is the resource fished?** *Code: Months **1** [January] - **12** [December], **13** = Year round, **14** = No particular time*					
G5)	**How abundant, generally, is the resource?** How much do you generally collect? *Code: **1**=Not enough for family, **2**=Enough for family, **3**=More than family needs (excess is sold/given away), **4** =Other (specify)*					

G6)	**Are there ever shortages of resource? Why?** *Code: **1**=Overharvesting, **3**=Drought, **4**=Flood, **5**=Disease/pest /weeds, **5** =Other (specify)*					
G7)	**How do you cope with shortages?** *Code: **1**=Supplement with garden produce, **2**=Supplement with bush plants, **3**=Supplement with hunting/other catch, **4**=Supplement with store food, **5**=Do nothing, **6**=Other (specify)*					
G8)	**Why do you fish for this resource?** *Code**: 1**=Income, **2**=Consumption, **3**=Medicinal, **4**=Cultural (bilas).*					
G9)	**Do you actively manage this resource? Describe.** *Code: **1**=Avoid impacted area, **2**=Avoid impacted species, **3**=Avoid type of impacted species (ie, young) **4** =Other (specify)*					

H Ocean – Collecting (Shells, crabs, seaweed, etc.)

		1	2	3	4	5
H1)	**What resource?** (Type/Species)					
H2)	**Where?** Can location be identified on map? Note distance travelled from primary residence in pursuit of activity?	*Map* ***Distance***	*Map* ***Distance***	*Map* ***Distance***	*Map* ***Distance***	*Map* ***Distance***
H3)	**Who collects resource?** *Code: **1**=men, **2**=women, **3**=children, **4**=All*					
H4)	**When is the resource collected?** *Code: Months **1** [January] - **12** [December], **13** = Year round, **14** = No particular time*					
H5)	**How abundant, generally, is the resource?** How much do you generally collect? *Code: **1**=Not enough for family, **2**=Enough for family, **3**=More than family needs (excess is sold/given away), **4** =Other (specify)*					

H6)	**Are there ever shortages of resource? Why?** *Code: **1**=Overharvesting, **3**=Drought, **4**=Flood, **5**=Disease/pest / weeds, **5** =Other (specify)*					
H7)	**How do you cope with shortages?** *Code: **1**=Supplement with garden produce, **2**=Supplement with bush plants, **3**=Supplement with hunting/catch, **4**=Supplement with store food, **5**=Do nothing, **6**=Other (specify)*					
H8)	**Why do you collect this resource?** *Code: **1**=Income, **2**=Consumption, **3**=Medicinal, **4**=Cultural (bilas).*					
H9)	**Do you actively manage this resource? Describe.** *Code: **1**=Avoid impacted area, **2**=Avoid impacted item/species, **3**=Avoid type of impacted item/species (ie, young) **4** =Other (specify)*					

I Ocean – Hunting (Turtles, crocodiles, dugongs, sharks, etc.)

		1	2	3	4	5
I1)	**What resource?** (Type/Species)					
I2)	**Where?** Can location be identified on map? Note distance travelled from primary residence in pursuit of activity?	*Map* ***Distance***	*Map* ***Distance***	*Map* ***Distance***	*Map* ***Distance***	*Map* ***Distance***
I3)	**Who hunts the resource?** **M**=men, **W**=women, **C**=children, **A**=All					
I4)	**When is the resource hunted?** *Code: Months **1** [January] - **12** [December], **13** = Year round, **14** = No particular time*					
I5)	**How abundant, generally, is the resource?** How much do you generally collect? *Code: **1**=Not enough for family, **2**=Enough for family, **3**=More than family needs (excess is sold/given away), **4** =Other (specify)*					

I6)	**Are there ever shortages of resource? Why?** *Code: **1**=Overhunting, **3**=Drought, **4**=Flood, **5**=Disease/pest /weed, **5** =Other (specify)*					
I7)	**How do you cope with shortages?** *Code: **1**=Supplement with garden produce, **2**=Supplement with bush plants, **3**=Supplement with other hunting/catch, **4**=Supplement with store food, **5**=Do nothing, **6**=Other (specify)*					
I8)	**Why do you hunt this resource?** I=Income, C=Consumption, M=Medicinal, C=Cultural (bilas).					
I9)	**Do you actively manage this resource? Describe.** *Code: **1**=Avoid impacted area, **2**=Avoid impacted species, **3**=Avoid type of impacted species (ie, young) **4** =Other (specify)*					

J Cultural Uses

J1) Any there any restricted resources or forbidden areas? Describe. Plot on map, if possible.	
J2) Knowledge of nationally / internationally protected species? Describe.	

K Food: Fauna and Flora Consumption

Frequency of wild flora and fauna consumption (indicate only for yes)

		YES
K1)	Freshwater fish	
K2)	Prawns	
K3)	Crocodile	
K4)	Crocodile eggs	
K5)	Turtle	
K6)	Turtle eggs	
K7)	Dugong	
K8)	Frogs/small reptiles	
K9)	Marine fish	
K10)	Crabs (mangroves)	

K11)	Crabs (saltwater)	
K12)	Lobster	
K13)	Sea urchins	
K14)	Shellfish	
K15)	Beche-de-mer (sea cucumbers)	
K16)	Trochus	
K17)	Green snails	
K18)	Squid/octopus	
K19)	Seaweed	
K20)	Wild pig	
K21)	Sago grubs	
K22)	Other binatang	
K23)	Flying foxes	
K24)	Bandicoots	
K25)	Kapul (possums)	
K26)	Rats	
K27)	Wallabies	
K28)	Muruk (Cassowaries)	
K29)	Pisin (small birds)	
K30)	Brush-turkey eggs	
K31)	Honey	
K32)	Beetle larvae	
K33)	Land crabs	
K34)	Sago	
K35)	Fungi	
K36)	Marita	
K37)	Wild nuts (karuka)	

L Migration and Mobility

Land

L1) Primary land transport route/s. Describe. Mark on map if possible.
L2) Is land travel seasonally affected? Describe.
If YES, How do you cope with seasonal effects?

Rivers

L3) Primary river transport route. Describe. Mark on map if possible.
L4) Is river travel seasonally affected? Describe.
If YES, How do you cope with seasonal effects?

Ocean

L5) Primary ocean transport route/s. Describe Mark on map if possible.
L6) Is ocean travel seasonally affected? Describe.
If YES, How do you cope with seasonal effects?

Spokespeople

Name	Gender		Contact details
1)	M	F	
2)	M	F	
3)	M	F	
4)	M	F	
5)	M	F	
6)	M	F	
7)	M	F	
8)	M	F	

COMPLETION CHECKLIST:

All questions complete / filled in:	
Photo record taken:	
Spokesperson/s recorded:	

QA COMPLETED:

SIGNATURE of Technical Lead or authorised delegate

PRINT NAME

DATE

Key Informant Interview – Social organisation and settlement

Facilitator	
Date of KII (day/month/year)	/ /2016
Village	
Photo reference	

A Village history

A1)	**What is the meaning of the village name?**	
A2)	**Is the village known by other names?**	
A3)	**What year was the village established in this location?**	

A4)	**What is the origin of the village - place and story. Describe, include dates if possible.**
A5)	**Places of residence to now. Describe. Include reasons for moving.**

B Social / Cultural

Describe the following:

B1)	**Do you know of any places where the physical remains of your ancestors and their activities are still present (e.g. old villages or inhabited rock shelters, burials, stone or clay raw materials sources)?**
B2)	**Any places where important historical events occurred, or places inhabited by ancestral sprits?**

B3)	**Describe any special traditional ceremonies observed in this village.**
B4)	**Describe any special customs related to food/drinks in this village?**

B5)	**Describe any other customs or taboos specific to this village.**
B6)	**Describe any traditional enemies this village has/previous conflicts?**

C Social structure

Clans and kin groups

C1)	**What ethnicity/ies do people in this village identify with?** Code: **1**=Pawaian, **2**=Kaura, **3**=Ahia, **4**=Keuru, **5**=Meii, **6**=Opao, **7**=Namau, **8**=Orokolo, **9**=Elema, **10**=Ipiko, **11**=Koriki, **12**=Iari, **13**=Laimari, **14**=Baroi, **15**=other (specify)	
C2)	**Primary language spoken** *Code: **1**=Pawaian, **2**=Pidgin, **3**=Motu, **4**=Orokolo, **5**=Kauru, **6**=Elema, **7**=English, **8**=Other (specify)*	
C3)	**Other languages commonly spoken** *Code: **1**=Pawaian, **2**=Pidgin, **3**=Motu, **4**=Orokolo, **5**=Kauru, **6**=Elema, **7**=English, **8**=Other (specify)*	1.
		2.
		3.

C4)	Names of clans resident in this village	Other villages where members of this clan reside?
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		
11.		
12.		

13.		
14.		
15.		

D Land

D1)	**Describe the ownership of land.** Describe clan / family / individual ownership and user rights. Include communal land.
D2)	**Describe land ownership for men and women (ie. who inherits land, what happens in marriages.**

D3)	**Are the women allocated land for their exclusive use (independent of their husband)? Describe.**			
D4)	**Do clan boundaries extend:**			**How far?**
	1. Across rivers?	**YES**	**NO**	
	2. Across the beach?	**YES**	**NO**	
	3. Out to sea?	**YES**	**NO**	
D5)	**Describe any land disputes <u>within</u> the village in the past 10 years.**			

D6)	**Describe any land disputes between this and another village in the past 10 years.**
D7)	**Describe mechanisms for land dispute resolution.**

E Representation

F1)	**Describe the membership and activities of any active Incorporated land group (ILG) / landowner company / landowner association**				
1.	**Type:**	ILG	Landco	Landowners Ass	SABL/Other
2.	**Name:**				
3.	**Purpose:**				
4.	**Leader: (name)**				
5.	**Member Clans:**				**Total number of individual members:**
	1.				
	2.				
	3.				**Number of individual members from this village:**
	4.				
	5.				
6.	**Are any member clans from other villages? List villages:**				
	1.				
	2.				
	3.				
	4.				

F2)	**Describe the membership and activities of any active Incorporated land group (ILG) / landowner company / landowner association**				
1.	**Type:**	ILG	Landco	Landowners Ass	SABL/Other
2.	**Name:**				
3.	**Purpose:**				
4.	**Leader: (name)**				
5.	**Member Clans:**				**Total number of individual members:**
	1.				
	2.				
	3.				**Number of individual**

	4.	**members from this village:**
	5.	
6.	**Are any member clans from other villages? List villages:**	
	1.	
	2.	
	3.	
	4.	

F3)	**Describe the membership and activities of any active Incorporated land group (ILG) / landowner company / landowner association**				
1.	**Type:**	ILG	Landco	Landowners Ass	SABL/Other
2.	**Name:**				
3.	**Purpose:**				
4.	**Leader: (name)**				
5.	**Member Clans:**				**Total number of individual members:**
	1.				
	2.				
	3.				**Number of individual members from this village:**
	4.				
	5.				
6.	**Are any member clans from other villages? List villages:**				
	1.				
	2.				
	3.				
	4.				

F4)	**Does the village have church leaders?**	**YES**	**NO**
F5)	**If YES,** what role do they play in the village?		

	List churches present in the village	**Describe the services / activities provided**
1.		
2.		
3.		
4.		

F6)	**Does the village have traditional leaders?**

	Name	**Traditional position or role/responsibility**
1.		
2.		
3.		
4.		

F Relationships

F1)	**Describe any traditional or trade links with neighbouring villages.** **Traditional:** **Trade:**

F2)	**Describe how marriages are established (ie, pattern of marriage between clans)** - Where do men and women generally find partners (within village, from other villages, where?) - If people marry someone from another village, where do they settle?

KII Spokespeople

Name	**Gender**		**Contact details**
1)	M	F	
2)	M	F	
3)	M	F	
4)	M	F	
5)	M	F	
6)	M	F	
7)	M	F	
8)	M	F	

COMPLETION CHECKLIST:

All questions complete / filled in:	
Photo record taken:	
Spokesperson/s recorded:	

QA COMPLETED:

_____
SIGNATURE of Technical Lead or authorised delegate

Print name: _____

Date: _____

Attachment 6

Mapping Instruments

QA COMPLETED	
SIGNATURE of Technical Lead or authorised delegate	
PRINT NAME	
DATE	

Mapping – Houses

Recorder	
Date:	/ /2016
Village Name	

A Houses

No.	Longitude	Latitude	**Housing style** T= traditional M = modern (tin roof, sawn timber floors & walls) S = semi-improved (tin roof, traditional materials for walls/floors)	**Floor type** D= dirt R = raised (i.e., timber floor) O = other (define)	Last name of Head of Household	First name of Head of Household	**Ownership** O = owner R = renting S = staying with friends/family	Number of occupants	# males	# females
1										
2										
3										
4										
5										
6										

No.	Longitude	Latitude	Housing style T= traditional M = modern (tin roof, sawn timber floors & walls) S = semi-improved (tin roof, traditional materials for walls/floors)	Floor type D= dirt R = raised (i.e., timber floor) O = other (define)	Last name of Head of Household	First name of Head of Household	Ownership O = owner R = renting S = staying with friends/family	Number of occupants	# males	# females
7										
8										
9										
10										
11										
12										
13										
14										
15										
16										
17										
18										
19										
20										

No.	Longitude	Latitude	Housing style T= traditional M = modern (tin roof, sawn timber floors & walls) S = semi-improved (tin roof, traditional materials for walls/floors)	Floor type D= dirt R = raised (i.e., timber floor) O = other (define)	Last name of Head of Household	First name of Head of Household	Ownership O = owner R = renting S = staying with friends/family	Number of occupants	# males	# females
21										
22										
23										
24										
25										
26										
27										
28										
29										
30										
31										
32										
33										
34										

No.	Longitude	Latitude	Housing style T= traditional M = modern (tin roof, sawn timber floors & walls) S = semi-improved (tin roof, traditional materials for walls/floors)	Floor type D= dirt R = raised (i.e., timber floor) O = other (define)	Last name of Head of Household	First name of Head of Household	Ownership O = owner R = renting S = staying with friends/family	Number of occupants	# males	# females
35										
36										
37										
38										
39										
40										
41										
42										
43										
44										
45										
46										
47										
48										

No.	Longitude	Latitude	Housing style T= traditional M = modern (tin roof, sawn timber floors & walls) S = semi-improved (tin roof, traditional materials for walls/floors)	Floor type D= dirt R = raised (i.e., timber floor) O = other (define)	Last name of Head of Household	First name of Head of Household	Ownership O = owner R = renting S = staying with friends/family	Number of occupants	# males	# females
49										
50										
51										
52										
53										
54										
55										
56										
57										
58										
59										
60										
61										
62										

No.	Longitude	Latitude	Housing style T= traditional M = modern (tin roof, sawn timber floors & walls) S = semi-improved (tin roof, traditional materials for walls/floors)	Floor type D= dirt R = raised (i.e., timber floor) O = other (define)	Last name of Head of Household	First name of Head of Household	Ownership O = owner R = renting S = staying with friends/family	Number of occupants	# males	# females
63										
64										
65										
66										
67										
68										
69										
70										
71										
72										
73										
74										
75										
76										

No.	Longitude	Latitude	Housing style T= traditional M = modern (tin roof, sawn timber floors & walls) S = semi-improved (tin roof, traditional materials for walls/floors)	Floor type D= dirt R = raised (i.e., timber floor) O = other (define)	Last name of Head of Household	First name of Head of Household	Ownership O = owner R = renting S = staying with friends/family	Number of occupants	# males	# females
77										
78										
79										
80										
81										
82										
83										
84										
85										
86										
87										
88										
89										
90										

No.	Longitude	Latitude	Housing style T= traditional M = modern (tin roof, sawn timber floors & walls) S = semi-improved (tin roof, traditional materials for walls/floors)	Floor type D= dirt R = raised (i.e., timber floor) O = other (define)	Last name of Head of Household	First name of Head of Household	Ownership O = owner R = renting S = staying with friends/family	Number of occupants	# males	# females
91										
92										
93										
94										
95										
96										
97										
98										
99										
100										
101										
102										
103										
104										

No.	Longitude	Latitude	Housing style T= traditional M = modern (tin roof, sawn timber floors & walls) S = semi-improved (tin roof, traditional materials for walls/floors)	Floor type D= dirt R = raised (i.e., timber floor) O = other (define)	Last name of Head of Household	First name of Head of Household	Ownership O = owner R = renting S = staying with friends/family	Number of occupants	# males	# females
105										
106										
107										
108										
109										
110										
111										
112										
113										
114										
115										
116										
117										
118										

No.	Longitude	Latitude	Housing style T= traditional M = modern (tin roof, sawn timber floors & walls) S = semi-improved (tin roof, traditional materials for walls/floors)	Floor type D= dirt R = raised (i.e., timber floor) O = other (define)	Last name of Head of Household	First name of Head of Household	Ownership O = owner R = renting S = staying with friends/family	Number of occupants	# males	# females
119										
120										
121										
122										
123										
124										
125										
126										
127										
128										
129										
130										
131										
132										

No.	Longitude	Latitude	Housing style T= traditional M = modern (tin roof, sawn timber floors & walls) S = semi-improved (tin roof, traditional materials for walls/floors)	Floor type D= dirt R = raised (i.e., timber floor) O = other (define)	Last name of Head of Household	First name of Head of Household	Ownership O = owner R = renting S = staying with friends/family	Number of occupants	# males	# females
133										
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137										
138										
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143										
144										
145										
146										

No.	Longitude	Latitude	Housing style T= traditional M = modern (tin roof, sawn timber floors & walls) S = semi-improved (tin roof, traditional materials for walls/floors)	Floor type D= dirt R = raised (i.e., timber floor) O = other (define)	Last name of Head of Household	First name of Head of Household	Ownership O = owner R = renting S = staying with friends/family	Number of occupants	# males	# females
147										
148										
149										
150										
151										
152										
153										
154										
155										
156										

QA COMPLETED	
SIGNATURE of Technical Lead or authorised delegate	
PRINT NAME	
DATE	

Mapping – Infrastructure

Recorder	
Date	/ /2016
Village Name	

A Infrastructure

	Longitude	Latitude	Infrastructure type	Photo reference	Additional comments/ observations
1			Health facility		
2			Education facility		
3			Church		
4			Church		
5			Church		
6			Jetty		
7			Sporting field		
8			Sporting field		
9			Community hall		
10			Operating trade store		
11			Operating trade store		

12			Operating trade store		
13			Operating business		
14			Operating business		
15			Operating business		
16			Water source – drinking		
17			Water source – drinking		
18			Water source - drinking		
19			Water source - washing		
20			Water source – washing		
21			Water source - washing		
22			Burial sites / cemetery		
23			Burial sites/ cemetery		
24			Burial sites/ cemetery		
25			Copra dryer		
26			Copra dryer		
27			Copra dryer		
28			Telephone tower		
29			Logging yard		
30			Logging yard		
31					

32					
33					
34					
35					
36					
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43					
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48					
49					

Part 23J
Upstream Cultural Heritage Scope and Methods

PAPUA LNG PROJECT

UPSTREAM CULTURAL HERITAGE SCOPE AND METHODS

Version	Details	Prepared (ERIAS Group)	Endorsed (ERIAS Group)	Approved (TEP PNG)	Date Issued
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v3	Revised to client	K. Munro	C. Coyne	J. Roeygens/C. Edet	20/04/16
v4	Revised to client	J. Cundy	C. Coyne	J. Roeygens/C. Edet	27/04/16

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Appendices

Appendix 1 – Cultural Heritage Context of Study Area.
Appendix 2 – Example Oral Tradition Recording Form.
Appendix 3 – Example Cultural Heritage Site Recording Form.

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1. Project Overview

Joint venture partners, Total Exploration & Production Papua New Guinea Limited (TEP PNG) (40.1%), InterOil (36.5%) and Oil Search (22.8%) are currently planning the development of the Elk-Antelope gas field, which is located in the Gulf Province, Papua New Guinea. TEP PNG, a wholly owned subsidiary of TOTAL S.A., has a majority interest in the Elk-Antelope gas field and will be the Project proponent and operator of the Papua LNG Project (the Project) on behalf of the other joint venture partners.

The Elk-Antelope formation is a significant gas discovery in Papua New Guinea consisting of a deep, high pressure, elevated temperature gas reservoir with several trillion cubic feet of gas reserves located approximately 120 km inland from the township of Kerema, and 340 km northwest of Port Moresby.

The Project will comprise upstream production well development and associated infrastructure at the gas production field within petroleum retention license (PRL) 15, construction of an upstream central processing facility (CPF), onshore and offshore gas and condensation export pipelines and a new Liquefied Natural Gas (LNG) Plant at Caution Bay, 20 km northwest of Port Moresby. The LNG product will be shipped to international markets.

The Project area comprises the physical footprint of the various Project components and associated infrastructure. The main components of the Project are:

- Upstream (within PRL15):
  - Wellpads, the gathering system (including trunk pipeline).
  - Central processing facility (CPF) incorporating an acid gas removal unit (AGRU).
  - Initial section of the onshore export pipeline corridor.
- Upstream (outside PRL15):
  - Remainder of the onshore export pipeline corridor to landfall on the Gulf coast.
  - Offshore section of the export pipeline corridor to the Liquefied Natural Gas (LNG) Plant site.
- Downstream:
  - LNG Plant site at Caution Bay.

This document describes the scope and methods for cultural heritage baseline field surveys for the upstream component of the Project only. The scope and methods report for the downstream component of the Project will be presented in a separate report one month prior to the commencement of that fieldwork.

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2. Study Objectives

The key study objective is to identify, describe and, where possible, map cultural heritage values[1] in the study area.

Specifically the study aims to:

- Characterise the ethnographic[2] and cultural heritage landscape of the study area.
- Identify and describe cultural heritage values in the study area.
- Identify and describe any cultural resources in the study area such as natural areas with aesthetic value and sacred sites.
- Describe the cultural heritage significance of values identified in terms of local, regional, national and international significance (verified at each level with the relevant stakeholders).
- Identify any areas within the study area that should be avoided, and to the extent possible the boundary of/area to be avoided.
- Where it is determined that areas within the study area cannot be avoided through Project redesign, recommend management / mitigation measures to reduce the impact to the greatest extent possible.
- Meet the requirements of national legislation and international regulations, including International Finance Corporation (IFC) Performance Standard 8 - Cultural Heritage and TOTAL Sustainable Development Specifications (GS EP SDV101 Social Baseline Study).

[1] For the purpose of this study, cultural heritage values include archaeological sites, other cultural sites and resources, oral traditions sites or artefacts and any other relevant tangible and intangible heritage.
[2] Brief ethnographic information only will be included in this study in so far as it relates to use and occurrence of culture heritage resources in the study areas.

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3. Study Area

The study area is based on the preliminary Project area of influence (PAOI) (Figure 1) and includes the land and communities anticipated to be directly affected by Project infrastructure, facilities and associated activities within PRL15, the pipeline export route (PER) and on the Purari tributary riverways (Riverways).

No sites of high cultural heritage significance are known to have been identified within PRL15 to date; however, it should be noted that cultural heritage and archaeological surveys in this area have been limited.

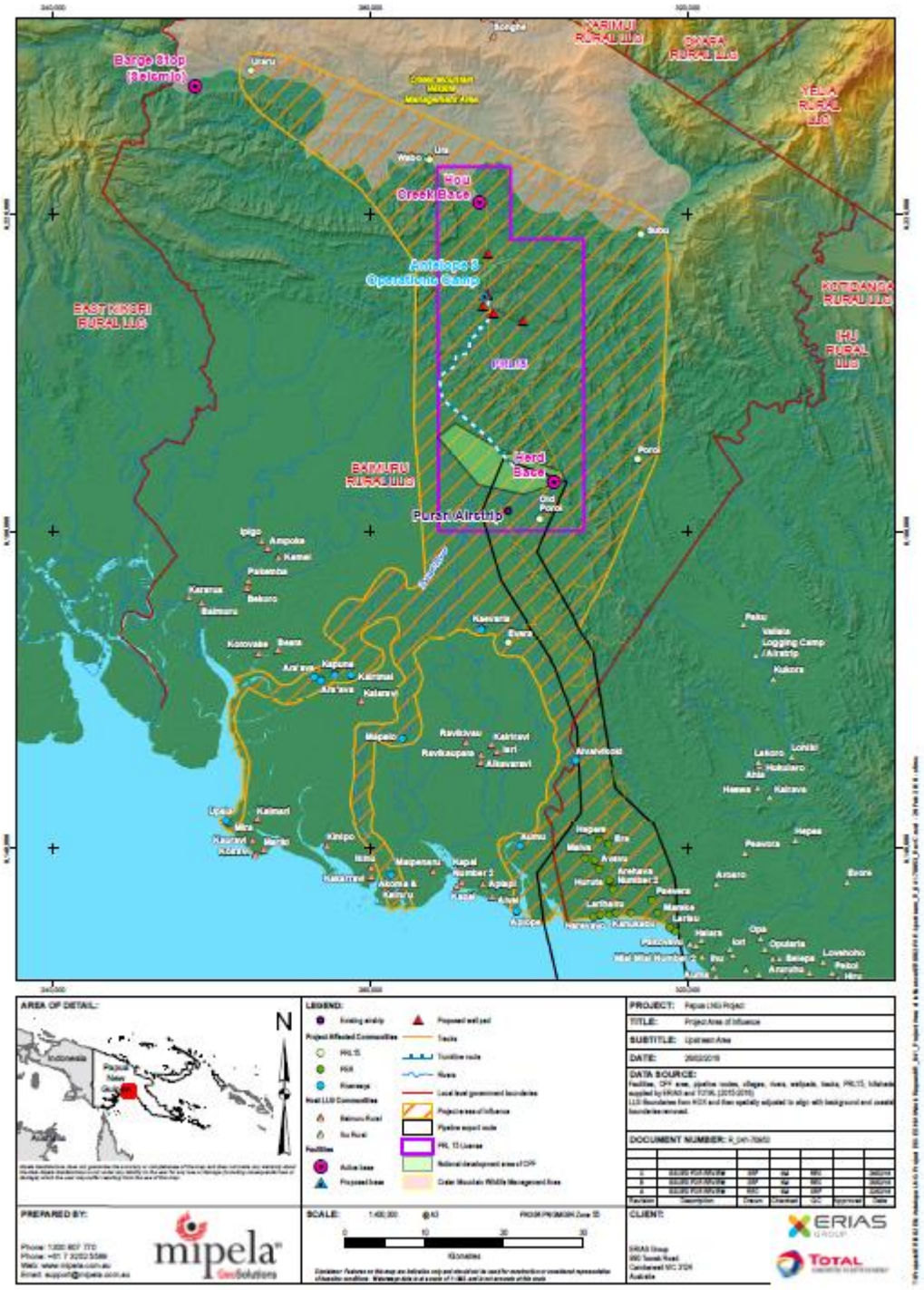
The area of the pipeline export route between PRL15 and the coastal zone is entirely unknown in terms of archaeological finds.

The coastal zone across the full extent of the pipeline corridor is potentially rich in sites of at least three different kinds: internationally significant Lapita sites; nationally significant *Hiri t*rading sites; and locally significant ancestral settlement and cultural (ritual, burial and sacred) sites.

Further background and cultural heritage context for the study area is provided in Appendix 1. This provides additional information on known and potential cultural resources in the study area and the known clans present nearby to PRL15 and the PER that will influence cultural heritage survey outcomes.

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Figure 1 – Upstream Project Area of Influence



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4. Relevant Legal and Other Requirements

This cultural heritage baseline study has been designed to comply with the requirements of, and address issues identified within, the following national and international standards and operational guidelines:

- Requirements of NMAG including those enshrined in the *National Cultural Property (Preservation) Act 1965*.
- *National Cultural Property (Preservation) Regulation 1965*.
- PNG Conservation and Environmental Protection Authority (CEPA) guideline GL-Env02/2004: Guideline for Conduct of Environmental Impact Assessment & Preparation of Environmental Impact Statement (CEPA, 2004).
- TOTAL General Specification GS EP SDV101: Social Baseline Study (Total, 2012).
- International Finance Corporation (IFC) Performance Standard 8: Cultural Heritage and guidance notes (IFC, 2012).
- UNESCO Conventions relating to cultural heritage including: UNESCO Convention Concerning the Protection of the World Cultural and Natural Heritage (1972); UNESCO Convention for the Safeguarding of the Intangible Cultural Heritage (2003); Operational Guidelines for the Implementation of the World Heritage Convention (2012).

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5. Study Approach

The cultural heritage study has been designed to identify and assess both the tangible and intangible cultural heritage values within the study area.

Cultural heritage is often considered in terms of both the tangible and intangible ways that people create, express and preserve that heritage. As would be expected, tangible and intangible heritage varies from culture to culture. Tangible heritage includes moveable or immovable objects, property, sites, structures or groups of structures, which have archaeological, paleontological, historical, cultural, artistic or religious values. Tangible heritage also includes unique natural features or tangible objects that embody cultural values, such as lakes, ponds, outcrops, rocks and waterfalls. Intangible forms of culture heritage include (but are not limited to) knowledge, innovations, religious ceremonies, values, beliefs, and the continuing practice of traditional lifestyles.

Previous studies investigating the potential for extractive industry projects to impact on cultural heritage in PNG typically distinguish between two classes of tangible cultural heritage: oral tradition sites and archaeological sites.

Oral tradition sites are places of intrinsic contemporary cultural significance or are associated with specific forms of contemporary cultural knowledge (this aspect being tangible). They are identified primarily on the basis that people alive today possess knowledge of these places (including their location, the stories behind them and the reasons why they are considered to be of cultural importance), and that the places exist as physical entities in the landscape.

While some of these places may contain physical (i.e. tangible) evidence of the human behaviours that relate to them, it is not an essential requirement in order for the place to be identified as a cultural heritage site – the fact that people have an extant oral tradition that identifies the place as being associated with a cultural activity or belief (i.e. intangible heritage) is sufficient. In PNG, these may include (but are not limited to) the following:

- Places associated with ceremonial or ritual activities.
- Places where spirits dwell, both ancestral (*tumbuna*) and spirit (*masalai*).
- Hunting camps, former settlements and clan origin places.
- Burials and cemeteries.
- Sites associated with warfare.
- Places where people lived or undertook important social or economic activities.

An archaeological site is a place (or group of physical sites) in which evidence of prehistoric, historic or contemporary human activity is preserved, and which has been, or may be, investigated using the discipline of archaeology. Archaeological sites may range from those with few or no remains visible above ground, to buildings and other structures still in use. In PNG, many archaeological sites typically include a range of manufactured materials such as pottery and stone or wooden artefacts, or evidence for human intervention in the landscape (e.g.

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fortifications, drainage ditches or mounded gardens). Archaeological site types in PNG include (but are not limited to):

- Artefact scatters.
- Occupation sites, including open settlement sites and caves or rockshelters.
- Economic sites, including stone quarries, former gardens and sago processing sites.
- Ossuary sites and marked graves and cemeteries.

Some archaeological sites still have significance for local people. For example, a rockshelter or cave used as an ossuary will usually have continuing cultural significance to members of the clans which used them, or in rare cases continue to visit them. Simultaneously, these sites are of archaeological interest in terms of understanding traditional mortuary practices, as well as contemporary conceptions of those places and practices.

In other instances, ancient archaeological sites may be encountered that have no contemporary cultural significance for local people, i.e. a cave or open site that bears evidence of past human occupation but which has no associated contemporary oral tradition. Following discovery, the site may acquire a new cultural significance to local communities because it now needs a place within their worldview. For example, a site with evidence of thousands of years of human occupation may become a source of pride for local people.

The broad goal of these surveys and interviews is to provide an overview of the cultural landscapes, past and present, contained within the upstream area. Cultural landscapes identified by living populations integrate tangible and intangible elements, including stories, natural features and material remains in the form of sites and artefacts, and relate them directly to living populations. In this way, local understandings of and vocabularies for the landscape are used as the primary lens through which to map potential impacts to the landscape. Archaeological landscapes understand sites and artefacts as the products of cultural landscapes, even where access to the level of detail for living cultural landscapes is not available.

Information for the cultural heritage study will derive from the following main sources:

- **Oral traditions/histories and related sites:** These are the cultural stories and related places that members of communities within the PAOI tell about their past and present cultural practices, cultural events and cultural or sacred sites.
- **Historical records:** A range of historical records will be reviewed to inform the cultural heritage studies, including early colonial and later observations of local inhabitants that have been recorded in reports, written texts, maps, charts, photos and other historical records.
- **Anthropological and linguistic information:** The writings of anthropologists and linguists will be reviewed for information about cultural heritage sites and practices based on professional observations.
- **Archaeological evidence:** Artefacts/material remains of past human activity observed and recorded during archaeological investigation (e.g., burials stone artefacts, pottery shards or shells).

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The proposed upstream facilities are located in Gulf Province and span two Local Level Government (LLG) areas, Baimuru Rural and Ihu Rural (Figure 1). There is limited literature that is publically available on known cultural heritage studies in the Gulf Province area. A bibliographic study consisting of a review of existing information is required in order to identify gaps in existing information that will require the collection of field data. Relevant literature will include:

- Societal and Environmental Screening Study Report for the Elk-Antelope Project Facilities, prepared for Total by ERIAS Group, (ERIAS Group, 2015).
- PNG LNG Environmental Impact Statement and appendices, prepared for ExxonMobil (CNS, 2009).
- Gulf LNG Project Full Scale Social Mapping & Landowner Identification (Pipeline License) (Kameata, 2012).
- Liquid Niugini Gas Ltd Gulf LNG Project Environmental Impact Statement (GHD, 2012).
- Full-Scale Social Mapping and Landowner Identification Study for the Elk=Antelope PRL15 Gas Field Development Project (Sagir, 2015).
- Broader studies on the cultural heritage of PNG, and regional studies for the Gulf and Central provinces.
- PNG legislation and relevant international guidelines, policies and standards for the purposes of identifying key cultural heritage areas and focus points for the EIS/ESHIA

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6. Study Methods

The cultural heritage study will consist of:

- **A review of existing information** (literature review) based on meetings with staff in the Prehistory Department at the National Museum and Art Gallery of PNG (NMAG), a review of NMAG's National Site File (NSF) and a review of previous studies relevant to the study (further to and completing the bibliographic study referenced above).
- **Consultation with local communities** in order to obtain **oral histories** and information on cultural traditions.
- **Inspections** of sites of cultural heritage value (if potentially significant) and field surveys in highly prospective areas (particularly the coastal zone).

Each method is described in detail below.

6.1 Literature Review

Building on the literature review in the 2015 Screening Report for Elk-Antelope (ERIAS 2015), a more focused review of sources directly relevant to the upstream area will include:

- NMAG's National Site File and report files.
- Previous scientific and scholarly studies undertaken in the PAOI.
- Historical records[3] including texts, maps, charts and photographs, held in libraries and archives in Australia and Papua New Guinea.
- Existing knowledge held by TEP PNG and their other joint venture partners of the Project and past resource development projects in the Project area.

The findings of the literature review will:

- Inform field data collection.
- Be summarised and referenced in the resulting baseline technical report.

6.2 Consultation with communities (oral traditions)

Oral histories will be collected at the start of consultation with selected communities and will typically include:

- Interviews with community elders.
- Interviews with selected key informants, e.g., senior community members, women, fishermen in the Orokolo Bay area.
- Information obtained through the women's and village leaders focus group discussions.

[3] All post-war patrol reports for Gulf Province (and Central Province) have recently been released online and can be consulted as a desktop activity.

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- Interviews with selected researchers and government officers who may have detailed knowledge of the study area (typically these will be conducted in Australia, Port Moresby or at other regional locations as relevant).

Archaeologists John Sepe and Robert Skelly will conduct community consultations to identify past and present cultural practices, events and sites.

An example of a questionnaire/focus group discussion guide for cultural heritage studies is provided in Appendix 2.

Cultural heritage sites or other significant sites identified within the study area (if accessible) will be visited and recorded by either John Sepe and/or Robert Skelly.

A preliminary culturally appropriate classification of oral tradition sites (by type) and important cultural heritage practices will be developed prior to the survey. It will be refined during initial consultations and adopted and used as a template during the main survey activities.

6.3 Site inspections (archaeological survey)

The method used to select areas within the broader study area for archaeological survey is based on a number of factors including risk of disturbance, accessibility, visibility and areas previously identified as having the potential to contain archaeological sites.

As no known archaeological sites occur in PRL15 and the inland section of the PER, and accessibility and visibility is very poor, it was determined that formal archaeological surveys will not be undertaken in these areas, except where interviews with local communities identify accessible oral tradition sites situated close to current villages that have a potential to retain archaeological materials. These might include ossuaries and occupation sites in caves and rockshelters, and former villages, which may exist as open sites with a potential to retain human burials and evidence of prior occupation.

Where it is considered necessary to do so to maintain the robustness of the survey methodology and based on information that will be gained through community consultations, inspection of non-accessible areas will be requested by helicopter as part of the social baseline survey fieldwork. Aerial surveillance of these areas will help to assess broader cultural landscape values and is an essential component of the survey methodology. The need for aerial surveillance of potential archaeological sites will be recommended by the cultural heritage field team during the survey and the request for helicopter support made as far in advance as possible with the logistics team.

The area of highest cultural heritage potential in the study area is considered to be where the PER crosses the hinterland and approaches the coast at Orokolo Bay. Robert Skelly and John Sepe will undertake a focused field survey of this zone, based on transects that will follow the PER optional alignments identified in the Project layout at the time of the survey. With the help of local community field assistants, the transect surveys will endeavor to comprehensively investigate a 50-m-wide corridor centered on the PER alignment, but the success of this approach will be heavily dependent upon accessible terrain and good ground surface visibility at the time of the survey.

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6.4 Recording Procedures

Cultural heritage sites will be photographed and their locations recorded using handheld GPS devices standardized to the WGS84 datum and UTM Zone 55S projection. Formal cultural heritage survey tracks will be recorded using handheld Garmin GPS devices.

All cultural heritage sites will be individually recorded using a standard site recording form (Appendix 3), which will include all of the information required by the NMAG National Site File form as well as additional information on environmental and social context. Field notes and a field diary will be recorded separately. Site recording will include information regarding site size and contents, the environmental and social context, a general description of the site, relevant oral traditions, and preliminary observations regarding potential management recommendations. Where relevant and feasible the clans/landowners connected to particular sites will be recorded.

Key interviews may be recorded using a digital voice recorder and provided to NMAG for their records. Digital recordings can also assist with any translation issues the field team have during the survey, however it is anticipated that younger clan representatives will translate for any elders in the village that do not speak Tok Pisin.

Local communities will be advised that the cultural heritage information they provide during the field surveys and community consultation program will be treated confidentially, and will only be used for the following purposes:

- EIS/ESHIA: high-level characterization of the nature and general location of cultural heritage values that may be impacted by the Project. This is required so that the proponent can identify and protect (to the greatest extent possible) important cultural heritage values identified by the communities. The communities will be advised that the EIS/ESHIA will be public documents, and that information concerning the precise location of cultural heritage sites or details regarding any relevant oral traditions will not be presented in these documents.
- Cultural Heritage Management Plan and Site Catalogue: precise information regarding the location and extent of recorded cultural heritage sites will be included in the cultural heritage management plan (CHMP) and associated Site Catalogue. This information will only be available to the proponent and its contractors, and is required in order to deliver the site management and impact mitigation measures contained within the EIS/ESHIA.
- National Site File, NMAG: it is a requirement under the provisions of the *National Cultural Property (Preservation) Act 1965* that all cultural heritage discoveries are reported to the National Cultural Commission. The NMAG is also required to maintain a register of all cultural heritage sites found in PNG; this register is called the National Site File (NSF), and all cultural heritage site recording forms completed during the course of the project will be forwarded to the NSF.

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7. Survey Period and Team

The cultural heritage study team consists of:

- Dr. Christopher Ballard (ANU Enterprise) – Strategic advice and peer review.
- John Muke (Social Research Institute) – In-country strategic adviser.
- John Sepe (Social Research Institute) – Lead archaeologist (fieldwork).
- Dr. Robert Skelly (ERIAS Group) – Senior archaeologist (fieldwork).

The **fieldwork component** of the cultural heritage survey is planned to be **conducted over 27 days** commencing in May 2016, in conjunction with the broader social baseline study fieldwork.

Dr. Christopher Ballard and John Muke will provide strategic advice and peer review across both the field studies, cultural heritage baseline characterization and cultural heritage elements of the EIS/ESHIA.

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8. Consultation Locations

Robert Skelly and John Sepe will conduct key informant interviews and focus groups in villages potentially directly affected by activities within PRL15, on riverways and a sample of communities within the PER. Strategically placed focus groups in the more densely populated coastal area of Orokolo Bay will be broadly advertised so that people from smaller, surrounding villages have the opportunity to attend and participate in the consultation.

Table 8.1 – Description of Study Sites

Category (Community)		Project Area
1	Wabo	PRL15
2	Ura	
3	Subu (1 and 2)	
4	Poroi	
5	Old Poroi	
6	Nea Creek settlement (name unknown)(TBC)	
7	Evara	Pipeline Export Route
8	Ere/Kilavi	
9	Huruta	
10	Arehava 2	
11	Avavu	
12	Harevavo	
13	Hepere	
14	Herekera	
15	Luku	
16	Kanukabu	
17	Lariau	
18	Larihairu	
19	Maiva	
20	Marea	
21	Mareke	
22	Paevara	
23	Apiope	Riverways
24	Aumu	
25	Aivaikoki	
26	Kaevaria	
27	Akoma	
28	Kairu'u	
29	Mapaio	
30	Upaia	

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Table 8.1 – Description of Study Sites (cont'd)

Category (Community)		Project Area
31	Ara'ava	Riverways (cont')
32	Kapuna	
33	Kairmai	
34	Mira	

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9. Significance and Compliance

9.1 Significance

The assessment of cultural heritage significance is a fundamental component of the heritage management process, in that it assists in determining which items, sites, places, landscapes and possibly environments are of sufficient cultural importance that they require preservation, and if not, appropriate management measures that will mitigate impacts to them. As such, the significance assessment process underpins many statutory frameworks for heritage site protection, by establishing a structure within which various types (assessment criteria) and levels (significance ratings) of heritage value can be identified and ascribed. A statement of the significance of the cultural heritage is an essential step in the process of developing appropriate cultural heritage management recommendations.

It is important to note that while all known cultural heritage may have levels of 'cultural heritage significance', the preservation of all cultural heritage may not be possible. In this context, *management* is not necessarily synonymous with *preservation*, and may involve sanctioned disturbance or destruction, or partial disturbance through controlled above-ground, ground surface and subsurface salvage investigations where archaeological material is present. Any sites identified during fieldwork that are clearly highly significant, and will require preservation, will be reported to TEP PNG immediately to allow for design modifications if necessary.

A process for establishing cultural significance is provided in the *Australia ICOMOS Charter for Places of Cultural Significance 2013*, otherwise known as 'The Burra Charter' (Australia ICOMOS 2013; Marquis-Kyle & Walker 2004). Article 1.2 of the Burra Charter (as at 26 November 1999) states that:

- *Cultural significance* means aesthetic, historic, scientific, social or spiritual value for past, present or future generations.
- Cultural significance is embodied in the place itself, its *fabric, setting, use, associations, meanings, records, related places* and *related objects*.
- Places may have a range of values for different individuals or groups.

A standardised process for significance assessment will be developed, in consultation with TEP PNG and NMAG, prior to the impact assessment phase of the EIS/ESHIA. The model for assessing significance will consider local community, national and international perspectives on the aesthetic, historic, scientific, social and spiritual values associated with all cultural heritage sites identified during the cultural heritage study. These considerations will result in significance ratings for each site. However, in the event there are likely to be any locally significant sites directly affected by the Project, TEP PNG with the assistance of the ESHIA team will need to conduct a collaborative significance assessment with local communities. This cannot be predetermined before the cultural heritage survey has been completed and it is known what cultural resources/sites are present. The significance ratings will then be used to inform the impact assessment and the mitigation and management measures proposed. The outcomes of

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the significance assessment will be communicated back to TEP PNG and key stakeholders (NMAG and participating communities).

9.2 Compliance

The study will employ internationally recognized practices for the field-based study and documentation of cultural heritage and comply with applicable law on the protection of cultural heritage, including national law implementing Papua New Guinea's obligations under the Convention Concerning the Protection of the World Cultural and Natural Heritage. No items of cultural heritage will be removed during the field study. If a site of high national importance is identified during the survey, the site will be recorded using the site recording form (Appendix 3) and highlighted to NMAG at the completion of the survey.

All findings and the results of the cultural heritage study will be provided to NMAG for inclusion in the National Site File. Field notes and diaries will be stored in an archive.

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10. Quality Control

To ensure good quality data are collected during the field program, a number of quality assurance (QA) and quality control (QC) procedures are adhered to:

- Use of standard site recording forms that include information required by the NMAG National Site File form as well as additional information on environmental context.
- Standard practice use of field notes and field diary.
- Use of GPS devices that are calibrated and standardized to the WGS84 datum and UTM Zone 55S projection.
- Data validation by triangulation of community-level data with existing literature and national and international information.
- The presence of at least two scientists in the field who can confer and cross check with each other.
- Review and peer review of the resulting report by ANU Enterprise.

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Appendix 1

Cultural Heritage Context of Study Area

Appendix 1 – Cultural Heritage Context of Study Area

The cultural group asserting landownership of PRL15 are Pawaia speakers. Pawaia is a member of the Trans-New Guinea Phylum of non-Austronesian languages, although Ross (2005: 24) identifies Pawaia as a stock-level isolate and questions its inclusion in the Trans New Guinea phylum. Pawaia-speakers are situated between the coastal tribes of the lower Purari River to their south, and the Highlanders to their north. Their homeland is in the middle Purari River, where they share their borders with the Daribi in the north, the Kewa in the northwest, the Kamea (Anggan tribes) in the north-east, the Ipiko and Iare in the south, the Kaura in the south-east and east, the Masi to the south-west, and the Polopa to the west.

The Pawaia have been described as semi-nomadic (Trefery 1969, cited in Warrillow, 1978: 3; Egloff and Kaiku 1978, 1983; Toft 1980: 7; Nancy Sullivan and Associates 2012: 17), living in *kombatis* (or bush camps) along the Purari River and moving frequently from camp to camp during the course of the year into territorially defined areas of rainforest for hunting, gathering or processing sago.

Pawaian subsistence activities include (Kinkin and Kewibu 2010: 23):

- Sago (*Metroxylon sp.*) cultivation and production.
- Swidden gardening.
- Cultivation of yielding trees and palms.
- Pig husbandry.
- Hunting and trapping of wild animals and birds.
- Fishing in rivers, creeks and small lakes.

The lack of an elaborate social hierarchy has resulted in traditional Pawaian communities being mostly comprised of scatted settlements organised by clan and sub-clans, which are made up of one or more descent groups (Kinkin and Kewibu 2010: 25). The clan is the most important social unit, and is responsible for communal activities such as the construction of long houses and the preparation of large feasts, as well as the guardianship of clan traditions. Social mapping studies carried out on behalf of the Elk-Antelope Project over the last 10 years have identified 11 Pawaian clans residing in Uraru, Wabo, Ura, Subu and Poroi villages along the Purari River as the principal landowners of PRL15 (Kinkin and Kewibu 2010; Larry 2010; Sagir 2015).

Kinkin and Kewibu (2010: 31) note that inheritance of landownership follows a patrilineal system. Some of the resources vested under transferred rights include sago stands, gardens and gardening land, hunting grounds, special purpose trees, and riverine resources. While clans hold residual rights, the primary rights to land are vested in individuals.

Areas of land and/or geographical features such as cliffs, caves, rocky summits, waterfalls, lakes, and swamps that have particular culturally significant associations are owned by clans or groups of clans residing within the area (Kinkin and Kewibu 2010: 31). In most instances only clan members are allowed to venture into these places, and outsiders are forbidden from entering unless they are accompanied by nominated clan custodians.

Limestone karst features containing caves and rockshelters have previously been identified at numerous locations across PNG as actual and potential sources of archaeological deposits. However, investigations by Egloff and Kaiku (1978, 1983) at three caves and rockshelters

20km to the north of Antelope-7, in relative proximity to the Purari River and its tributaries, did not identify any potential for archaeological deposits to have accumulated at these locations. Furthermore, the 2011 cultural heritage survey conducted by GHD (2016) within PRL 15 did not identify any limestone outcrops during either ground or helicopter surveys.

The combination of a semi-nomadic lifestyle in conjunction with a low-density human footprint on the landscape would have resulted in a limited potential for significant archaeological deposits to accumulate as open sites within the rainforest environment which characterises most of PRL15.

Kinkin and Kewibu (2010) noted that areas of land and/or geographical features such as cliffs, caves, rocky summits, waterfalls, lakes, and swamps may have culturally significant associations for Pawaian clans, in the form of oral traditions. Eight oral tradition sites were recorded by GHD during their 2011 survey of PRL15. GHD noted (2016: 16) that all of these sites are situated either as elevated locations on ridgelines (EA002, EA004, EA005, EA006, EA007 and EA008), or on waterways (EA001 and EA003.

The anthropologist FE Williams travelled extensively along the coast of PNG during the 1920s and 1930s. His work with Orokolo-speakers west of the Vailala River provides the most comprehensive description of customary life available for eastern parts of the Gulf of Papua. Williams (1941: 29) described village groups in Orokolo Bay as comprised of 'contiguous villages, called *karigara*'. The *karigara* is a fundamental unit of community organisation pertaining to land ownership and ceremonial matters. The *karigara* is made up of one or more *bira'ipi*, which Williams (1941: 37-38) describes as patrilineal descent groups (*bira* = male, husband, man) determined by residential location (*ipi* = base or origin). Quite separate from a person's *bira'ipi*, a person also belongs to an *aualari* with *aualari* membership determined by that person's patrilineal descent only. *Aualari* are spread among all coastal groups, and *aualari* membership remains immutable for life, whereas a person's *bira'ipi* based on descent and residence could change through marriage or residential relocation.

Each *karigara* had its own *eravo*; *karigara* are thus described as '*eravo*-communities' (Williams 1941: 31). An *eravo* was an impressive structure typically measuring around 30 m long by 15-20 m high that, by its presence, affirmed *karigara* residence and ownership (Williams 1941: 5, 35-38). Today in Orokolo Bay, the past positioning of *eravo* structures is remembered in oral traditions. The places where *eravo* once stood connect Orokolo people to their ancestral pasts and legitimise their rights of access to land. Places where *eravo* once stood are highly significant oral tradition sites that as the centre of village life will likely also have significant archaeological manifestations.

The site of Popo is one such ancestral village site which is described in the ethnographic literature as an ancestral village located on an old beach ridge in Orokolo Bay 2.5 km inland from the coast (Williams 1941). Although the dimensions of Popo are yet to be determined, it appears that Popo is probably an oral tradition and archaeological site complex that continues for a few kilometres on an old beach dune parallel to today's coastline.

Archaeologist Jim Rhoads visited Popo in 1974 when he made a surface collection of stone artefacts and pottery sherds. Assessing the site to be of high archaeological significance, he returned in 1976 and completed three excavations. The three excavation squares, widely-spaced across Popo (500 m apart), share comparable stratigraphic sequences, each consisting of three stratigraphic horizons (Horizons I, II and III). A single radiocarbon determination for Popo from 35 cm depth returned a date of 410±80 BP (ANU 2181). Being from the uppermost layer (Horizon I), Rhoads (1994: 55) suggested that 'a more ancient date for Popo's initial habitation seems probable'. Rhoads found that Popo contained a rich

ceramic assemblage and a Port Moresby provenance for the ceramics is supported by Proton-Induced X-ray Emission (PIXE) analyses which showed that the clay used to make the Popo ceramics is likely to have come from sources near Port Moresby. Thus, concluding that the Popo ceramics originated from manufacturing centres near Port Moresby, Rhoads (1994: 66) proposed that the Popo assemblage represents early evidence of Motu *hiri* trade into the Gulf of Papua *c*. 400 years ago.

To the east, Orokolo Bay is bordered by the Vailala River; areas east of the Vailala River are known locally as Kouri and are occupied by Keuru speakers who also trace their ancestral origins to a place called Popo which they describe as an inland area near Purari (Orokolo Bay). 'Popo' may therefore be a generic term referring to ancestral places inland from the coast across the region.

Recent archaeological investigations in the Kouri area have demonstrated that coastal villages there have maintained relationships with Austronesian-speaking maritime traders and ceramicists coming from the east at various times over the past *c*. 2600 years (Skelly *et al*. 2014). Archaeological excavations at sites in the Kouri area recovered ceramics with decorations stylistically comparable to those found on Lapita ceramics as well as obsidian originating from Fergusson Island, indicating that mid-regions of the Gulf of Papua participated in networks of social interaction over a distance of 900 km to the southeast by sea.

The discovery of Lapita ceramics in the Gulf of Papua is of both national and international significance and has stimulated debate about the actual meaning of the iconic 'Lapita Cultural Complex'. Orokolo Bay is geographically similar to the Kouri and in both areas the coastline has been prograding southward during recent millennia. At the time that Lapita ceramicists were tracking westward along the south coast of PNG, Orokolo Bay and the Kouri formed sheltered bays fringed by sandy beaches. It is very likely that Lapita settlements like those on the Kouri coastline were also established on the ancient beaches of Orokolo Bay. The important point to consider here is that the coastline in Orokolo Bay has been rapidly prograding as a consequence of the heavy sediment load of the Purari River, and in some places beach-fronting dunes of 2000-3000 years ago are today 4-7 km inland from the coast. If people in the past preferred to live in beach-fronting locations as they do today, then we can expect that they relocated villages following the prograding coastline. Thus, in the case of Orokolo Bay, as has been shown east of the Vailala River there is likely to be a chronological succession of occupational sites that become progressively older the further one moves inland from the coast, with the oldest archaeological sites likely to be found on deflated dunes along the southern margins of inland hills.

Appendix 2

Example Oral Tradition Recording Form

Appendix 2 – Example Oral Tradition Recording Form

Oral Tradition Community Interview Recording Form

Recorder: **Date:**

Location of Interview:

Informant's Name:

Informant's Clan:

Informant's Village of Residence:

Places Identified During Interview:

-
-
-
-

Actions Arising from Interview"

1.

2.

3.

Interview Notes

Appendix 3

Example Cultural Heritage Site Recording Form

Appendix 3 – Example Cultural Heritage Site Recording Form

[Example only – to be revised with TEP PNG and NMAG after initial consultations].

Cultural Heritage Site Recording Form

Field Site #_____ **PNG National Museum Site Code**_____ **Recorder**_____ **Date**_____

Field Site Name_____ **Traditional Name**_____

Language Area_____ **Clan**_____

Site Owners_____

GPS Location – Easting_____ **Northing**_____ ☐ AGD66 ☐ WGS84 **Elevation ASL**_____m

GPS Make/Model_____ **Locational Accuracy**_____m

1:100,000 Mapsheet Name_____ **Easting**_____ **Northing**_____

	Site Landscape															
Site Vegetation	Hill Top	Hill Slope	Base of Hill	Cliff	Rocky Outcrop	Sinkhole	Lakeside	Lake/Waterhole	Spring	River/Creek	Freshwater Swamp	Mangrove/Saltwater Swamp	Plain	Floodplain	River Levee	Beach	Other
Vine Thicket																	
Grassland																	
Open Woodland																	
Forest																	
Rainforest																	
Mangrove																	
Garden																	
Other																	

Other_____

Surface Sediment Type at Site

☐ Clay ☐ Silt ☐ Sand ☐ Loam ☐ Gravel ☐ Rock ☐ Freshwater ☐ Saltwater ☐ Other_____

Ground Surface Visibility at Site

☐ 0% ☐ 1-24% ☐ 25-49% ☐ 50-74% ☐ 75-100%

Bedrock ☐ Exposed ☐ Not Exposed

☐ Limestone ☐ Other_____

Site Type

- ☐ Open Shell Midden
- ☐ Rock Shelter
- ☐ Cave
- ☐ Stone Arrangement
- ☐ Shell Arrangement
- ☐ Isolated Shell
- ☐ Grinding Stone
- ☐ Isolated Stone/Ceramic
- ☐ Cultural Materials Scatter
- ☐ Quarry
- ☐ Rock Art
- ☐ Burial/Ossuary
- ☐ Garden
- ☐ Temporary Encampment
- ☐ Village
- ☐ Mound
- ☐ Ritual/Spirit/Sacred Site
- ☐ Fishing/Hunting Site
- ☐ Sago Processing Site
- ☐ Tree
- ☐ Other

Cultural Materials Present

- ☐ Ochre
- ☐ Hearth/Earth Oven
- ☐ Charcoal/Ash
- ☐ European/Asian Contact materials
  - ☐ Bottle Glass
  - ☐ Metal Items
  - ☐ Ceramics
  - ☐ Other_____
- ☐ Stone Artefacts
  - ☐ Quartz ☐ 1-10 ☐ 11-50 ☐ 50+
  - ☐ Volcanic ☐ 1-10 ☐ 11-50 ☐ 50+
  - ☐ Metamorphic ☐ 1-10 ☐ 11-50 ☐ 50+
  - ☐ Sedimentary ☐ 1-10 ☐ 11-50 ☐ 50+
- ☐ Shell MNI ☐ 1-10 ☐ 11-50 ☐ 50+
- ☐ Melanesian Ceramics ☐ 1-10 ☐ 11-50 ☐ 50+
- ☐ Animal Bone MNI ☐ 1-10 ☐ 11-50 ☐ 50+
- ☐ Human Bone
- ☐ Wooden Structures/Posts/Post Holes
- ☐ Macrobotanical Remains_____
- ☐ Other_____

Stratification

- ☐ Surface Site
- ☐ Stratified/Buried Deposit
- ☐ Site Exposed by Disturbance_____
- ☐ Unknown

Human Skeletal Remains

Skulls	MNI	☐ 1-10	☐ 11-50	☐ 50+
Mandibles	MNI	☐ 1-10	☐ 11-50	☐ 50+
Postcranial Bones	N	☐ 1-10	☐ 11-50	☐ 50+
	MNI	☐ 1-10	☐ 11-50	☐ 50+

Rock Art

☐ Paintings	☐ 1-10	☐ 11-50	☐ 50+
☐ Drawings	☐ 1-10	☐ 11-50	☐ 50+
☐ Stencils	☐ 1-10	☐ 11-50	☐ 50+
☐ Prints	☐ 1-10	☐ 11-50	☐ 50+
☐ Engravings	☐ 1-10	☐ 11-50	☐ 50+

☐ Other_____

Shells

☐ *Anadara* sp ☐ *Polymesoda* sp ☐ *Synnx* sp ☐ *Cypraea* sp ☐ *Oliva* sp ☐ *Conus* sp ☐ *Melo* sp

☐ Other Bivalve_____

☐ Other Gastropod_____

Modified Shells

_____ ☐ 1 ☐ 2-4 ☐ 5-10 ☐ 11+

Distance to Nearest Freshwater

Closest permanent water_____m ☐ Swamp ☐ River ☐ Creek ☐ Water Hole/Lake

☐ Other_____

Closest temporary water_____m ☐ Swamp ☐ Creek ☐ Water Hole/Lake

☐ Other_____

Distance to High Water Mark_____m

Vertebrate Remains

☐ Bird
☐ Fish
☐ Turtle
☐ Dugong
☐ Pig
☐ Other Mammal_____

Site Dimensions

Max Length_____m Max Width_____ Max Area_____m^2

Max Height (Rockshelters/Caves) _____m

Site Description

Environmental Description (include information on vegetation assemblage, landforms, slope, topography and drainage)

Oral Histories Relevant to the Site

Informant_____

History_____

Photo Numbers_____

Drawings?_____

Audio?_____

Management Recommendations

☐ Large Site (>1000m^2) ☐ Medium Site (25-1000m^2) ☐ Small Site (<25m^2)

☐ Protect ☐ Salvage ☐ Further Mapping Required ☐ Other_____

Comments_____

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Part 23K
Noise Study Scope and Methods

PAPUA LNG PROJECT

NOISE STUDY SCOPE AND METHODS

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Appendices

Appendix A – Acoustic Specialist Team Credentials

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1. Project Overview

TOTAL E&P PNG Limited (TEP PNG) is planning the development of the Elk-Antelope gas field in Papua New Guinea as part of the proposed Papua LNG Project (the Project).

The Elk-Antelope gas field is located within Petroleum Retention License 15 (PRL-15) in Kikori District, Gulf Province, approximately 120 km inland from the township of Kerema and 360 km northwest of Port Moresby. The gas field is a highly significant gas discovery in Papua New Guinea and consists of a deep, high pressure, elevated temperature gas reservoir with several trillion cubic feet of gas reserves.

The Project development includes the following facilities:

- Wellpads and upstream gathering system.
- An upstream central processing facility (CPF) to separate and condition gas and condensate streams.
- Export gas and condensate pipeline system, comprising separate single gas and condensate export pipelines in the same route. The pipeline will traverse both onshore and offshore environments (approximately 70 km and 255 km, respectively).
- A liquefied natural gas (LNG) plant and support infrastructure, and associated coastal marine export facilities.

This document describes the scope and methods for baseline noise study required as part of the environmental and social impact assessment for the Project.

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2. Study Objectives

The objectives of the baseline noise study are to:

- Identify and quantify existing ambient background noise levels at sensitive receptor areas surrounding critical infrastructure which may be impacted by noise from the Project. These receptors include existing non-project related receptors (such as established settlements and villages), areas where possible future in-migration may occur, and sensitive biodiversity habitats.
- Identify any existing significant noise sources near the various receptor areas which may have a bearing on future potential noise impacts.
- Undertake a site investigation to assist with the noise modeling component required as part of the operational noise impact assessment.
- Determine applicable noise limits based on measured background noise levels and applicable criteria.

The study objectives apply to upstream and downstream facilities. However, as the upstream field survey will be undertaken prior to downstream, any lessons from the execution of the upstream survey that are relevant to the overall baseline study objectives will be detailed in future versions of this document.

Ambient vibration levels across the study site will be minimal due to the lack of existing infrastructure in the area. It is not considered necessary to conduct baseline vibration measurements in the upstream project area. This will be considered as part of the downstream methods, focused on underwater noise and vibration effects on marine aquatic species (e.g., cetaceans).

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3. Study Area and Project Areas

The general study area is based on the expected area of influence of the Project, collectively comprised of the following Project areas:

- Gasfield area within PRL-15 (well pads, upstream gathering system, CPF and associated infrastructure and support facilities, i.e., construction camp, laydown area, wharf, airstrip, access roads).
- Onshore export pipeline corridor (export gas and condensate pipeline system from the CPF to the coast at Orokolo Bay, together with associated infrastructure and construction support facilities).
- Offshore export pipeline corridor (export gas and condensate pipeline system within the Gulf of Papua from Orokolo Bay to Caution Bay).
- Downstream LNG plant area, including coastal facilities and associated infrastructure and support facilities at Caution Bay.

West of the onshore export pipeline corridor, the Project area of influence includes potential barge transport routes along each of the Purari River's three main delta distributaries—the Purari, Ivo-Urika and Varoi-Warne rivers. These streams are also downstream of proposed Project facilities within PRL-15.

The proposed works covered in this field execution plan are restricted to the upstream area of the project. A subsequent and separate downstream baseline noise survey for the LNG site will be completed at a later date once the project description is finalised.

The upstream noise survey will be focussed on gathering baseline noise information at key locations such as existing villages, potential in-migration and fauna sensitive areas that will potentially be impacted by noise from the Project during both construction and operations. These locations will include the CPF and nearby logistics base, airstrip, adjacent Oxbow wetland complex, wellpads, pipeline route and where the pipeline makes landfall.

During the survey, reference attended noise measurements will be taken from an existing appraisal well drilling operation for inclusion in the noise model for the impact assessment

It should be recognised that while most of the areas within PRL-15 and the pipeline corridor are sparsely inhabited, there is a possibility for future in-migration to the area during the various construction and operational phases. These areas are likely to be restricted to those regions surrounding the logistics base, airport and nearby CPF.

Further illustration and description of the study areas and survey locations are provided in Section 9.

As previously mentioned baseline noise data will be collected from sites at the LNG Plant site at Caution Bay in a separate downstream survey. The details will be confirmed once the location of the LNG Plant is known and planning advances. Details of the proposed monitoring locations will be presented in separate documentation, hence the LNG Plant site is not considered further in this document.

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4. Study Approach

The approach for the noise study consists of a desktop bibliographic review supplemented by a field survey to measure and quantify existing background noise levels at potentially affected sensitive receptor areas surrounding critical Project infrastructure. The approach was guided by the following assessment and study criteria/standards:

- Independent State of Papua New Guinea No 64 of 2000 *"Environment Act 2000"* (PNG, 2000) and the Guideline for Conduct of Environmental Impact Assessment and Preparation of Environmental Impact Statement (DEC, GL-Env/02/2004).
- World Health Organization *"Guidelines for Community Noise"* (WHO, 1999).
- International Finance Corporation (IFC) World Bank Group *"Environmental, Health and Safety (EHS) Guidelines"*, Section 1.7 Noise (IFC, 2007).
- Total general specification GS EP ENV 001 *"Environmental requirements for project design and E&P activities*". Section 5.9. Noise level[1] (Total, 2015).
- TOTAL general specification GS EP ENV 111: Environmental Baseline and Monitoring Studies: Onshore Sites (Total, 2012).
- International Standard ISO 1996-1: 2016 *"Acoustics – Description, measurement and assessment of environmental noise – Part 1: Basic quantities and assessment procedures"* (ISO, 2016).
- International Standard ISO 1996-2: 2007 *"Acoustics – Description, measurement and assessment of environmental noise – Part 2: Determination of environmental noise levels"* (ISO, 2007).
- Australian Standard AS 1055.1: 1997 *"Acoustics – Description and measurement of environmental noise – Part 1: General procedures"* (Standards Australia, 1997).
- Australian Standard AS 1055.2: 1997 *"Acoustics – Description and measurement of environmental noise – Part 2: Application to specific situations"* (Standards Australia, 1997).

[1] The nominated project noise criteria are based on the IFC guidelines. It is noted that in addition to the day and night time noise criteria for residential and commercial/industrial areas, the guidelines also allow for background based noise limits.

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4.1 Bibliographic Study

The bibliographic study consisted of a review of existing information to identify gaps that require collection of field data. Literature considered included:

- PNG LNG Environmental Impact Statement and appendices, prepared for ExxonMobil (CNS, 2009).
- Elk/Antelope Gasfield Project Environmental Impact Statement (Elk/Antelope Gasfield Project EIS), prepared for InterOil (Douglas Environmental Services, 2008).
- PNG legislation and relevant international guidelines, policies and standards for the purposes of identifying key environmental area and focus points for the EIS/ESHIA.
- Trends in Ecology and Evolution Paper, 25(3), 180-189 *"The costs of chronic noise exposure for terrestrial organisms"* (Barber, J.R. et al., 2010).
- Landscape Ecology Research Article, 16:1297-1309, 180-189 *"An assessment of noise audibility and sound levels in U.S. National Parks"* (Lynch, E. et al., 2011).

4.2 Gap Analysis

Based on a review of the available literature, a number of gaps and information requirements were identified for the purposes of the baseline noise study.

Table 4.1 – Summary of Information Requirements Relevant to the Noise Study

Study Element	Description of Gap	Proposed Field Study/Data Collection
Baseline noise data	♦ Background noise levels in critical areas surrounding the Project are not known. As noise impacts during the construction works will predominantly occur during the day period and be of generally short duration, the upstream noise study will primarily focus on areas exposed to both construction and operational noise from the Project. Other areas where particular sensitivities have been highlighted (i.e. the high density coastal area and Oxbow wetlands area – see below) will also be considered in the study. It is noted that these receptors correlate with those examples provided in the IFC which include *'permanent or seasonal residences… and parks and campgrounds'* ♦ As background noise levels can have an impact on applicable noise criteria used to assess noise from the Project, the results can have implications on mitigation/noise control requirements for plant and equipment on the Project	♦ Collection of background noise data from representative measurement locations. Measurement locations will include existing villages and areas where future community in-migration/faunal impacts may occur ♦ As the dominant construction and operational noise impacts will be within PRL-15, the field study will be based from Herd Base near the CPF ♦ The only region where baseline noise monitoring will be conducted along the pipeline ROW is the highly populated coastal area. Due to the relative short-term and linear nature of noise impacts associated with the pipeline construction works, baseline monitoring is not proposed along the rest of the pipeline corridor. For these areas it is considered acceptable to use reference/empirical data from a representative location to assess noise impacts from these works

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Study Element	Description of Gap	Proposed Field Study/Data Collection
Fauna impact	♦ Section 4.4 of The Elk/Antelope Gasfield Project EIS (Douglas Environmental Services, 2008) highlighted the project area to be an occasional hunting ground for the local community. Construction and operational noise from the CPF is likely to cause local wildlife to move further away from the site which will have additional follow-on effects to local communities' livelihood activities ♦ The Elk/Antelope Gasfield Project EIS indicates that noise from exploration activities has already had an impact on local animals in the Purari Mangrove Forest 'Conservation Needs Assessment' (CNA) area as locals *"now hunt in pairs of 2-3 men because animals had gone further"*	♦ Quantify and measure existing (pre-Project) ambient background noise levels in the sensitive Oxbow wetland west of the CPF. It is understood that due to the flooded nature of this area access will not be possible during the survey period. Consequently, representative measurements will be taken from alternate locations which will be used to gain an understanding of the local acoustic environment ♦ The measurement results will allow for future comparison to assist in assessing potential noise impacts to these areas
Noise modelling assessment	♦ While most of the critical information to facilitate the noise modelling of the operational CPF is available, additional site data (such as local terrain/tree coverage, shielding/absorption parameters, existing noise sources) can significantly assist with the preparation of the noise model used to assess noise from the facility	♦ During the noise study, a site investigation will be undertaken near the CPF to identify parameters that can have an impact on modelling results

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5. Survey Period

As background noise levels can be significantly affected by local weather and seasonality the noise survey should ideally be undertaken during the dry season. It is common practice to undertake environmental noise surveys during periods of calm dry weather to avoid the effects of sustained wind or rainfall induced noise on the microphone which can artificially affect the measurement results.

The IFC guidelines for community noise do not provide any requirements with respect to seasonal monitoring.

The seasons in Papua New Guinea (and rainfall patterns) are generally defined by the southeast trade winds that occur from May to October (dry season) and northwest monsoons winds that occur from December to March (wet season). April and November are doldrum periods in between these seasons. However, in the Purari River area near PRL-15, there is reverse seasonality to the remainder of Papua New Guinea, with more rain from June to September and dry, hot weather from October to March.

Considering the above, the early November survey period is likely to have drier weather more suitable for the measurement of noise.

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6. Survey Parameters

Equipment requirements and parameters that will be measured during the baseline noise field study are listed in Table 6.1.

Table 6.1 – Equipment to be used and Parameters measured during Baseline Noise Study

Equipment/Dataset	Description of Equipment/Parameters	Justification
Noise measurement equipment	Noise surveys and monitoring will be completed using a sound level meter (SLM), noise loggers and calibrated audio recordings. Measurement equipment will be calibration checked before and after each survey using an acoustic calibrator. All equipment will have current National Australian Testing Authority (NATA) certification and comply with applicable calibration requirements All details of the equipment used, e.g., type/model and Serial # is to be recorded	Equipment to conform with: - Australian Standard AS IEC 61672.1:2004 - *Electroacoustics— Sound level meters, Part 1: Specifications* - Australian Standard IEC 60942:2004 *Electroacoustics – Sound calibrators*
Site information	For each survey the following observations shall be noted: ♦ Date and time of measurement ♦ Details of measurement position and location including GPS coordinates, digital photographs and a descriptive characterisation of the surrounding local environment including surrounding land-use, acoustic shielding, obstacles etc. ♦ Weather conditions during the survey (wind direction, speed, humidity, temperature) ♦ Instrumentation used and analysis made ♦ Description of the noise being investigated/ background noise environment, including noise due to other sources and any notable characteristics ♦ Levels and duration of normal and possibly unusual noises	Measurement observations as per: Section 7 of AS 1055-2:1997 Noise measurements/monitoring equipment to be conducted/ deployed in accordance with ISO 1996-1:2016 Note: Australian Standards referenced as they include additional information not covered by the International Standards.

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Table 6.1 – Equipment to be used and Parameters measured during Baseline Noise Study (cont'd)

Equipment/Dataset	Description of Equipment/Parameters	Justification
Noise measurement results	Noise levels will be measured in dBA, whereby the A-weighting is the frequency weighting used to approximate the response of the human ear. Measurement parameters used to quantify ambient background noise levels will include: ♦ L_{eq} – the equivalent continuous noise level. It is defined as the steady sound level that contains the same amount of acoustical energy as the corresponding time-varying sound over the same measurement interval ♦ L_{max} – the maximum noise level associated with a noise measurement interval ♦ L_{10} – the noise level exceeded 10% of a given measurement interval and is utilised normally to characterise average maximum noise levels ♦ L_{90} – the noise level exceeded for 90% of the sample period. The L_{90} is typically used to describe the average minimum sound level over the measurement period (in the absence of the source under consideration). Often used to describe the 'background' noise level	Measurement parameters as per: - ISO 1996-2:2007 - AS 1055-1:1997, and; - AS 1055-2:1997 Note: Australian Standards referenced as they include additional information not covered in the ISO standard.

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7. Survey Methods

Two levels of survey activity will be undertaken at each location:

- Unattended background noise monitoring.
- Attended noise survey.

7.1 Unattended Noise Monitoring

Unattended noise monitoring equipment (a noise logger) will be deployed in a secure location at each identified sensitive receptor. The noise logger will continuously measure ambient background noise levels (10 samples/second) over a minimum two day (48 hour +) monitoring period to quantify the day time and night time background noise levels in the area to be used for determination of applicable noise criteria.

Noise monitoring locations will be sited, and required parameters measured/recorded as per ISO 1996-1:2016, ISO 1996-2:2007, AS 1055-1:1997, and AS 1055-2:1997.

Noise monitoring results will be used to determine day and night background noise levels which can influence applicable noise limits as per the GS EP ENV 001 Project Requirements as based on the IFC Guidelines.

Each noise logger comes in a weatherproof enclosure which will be chained to a nearby tree or fixed structure for the monitoring period. A photograph of the monitoring equipment as used on a similar noise survey is provided in Figure 7.1

Figure 7.1 – Unattended Noise Monitoring Equipment for Min. 48hr Survey



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7.2 Attended Noise Survey

Attended noise measurements will also be taken at each location using a hand held sound level meter (SLM). During the measurements ambient noise sources will be quantified and characterized, with any surrounding noise sources with the potential to affect the detailed noise impact assessment identified. A photograph of the Brüel&Kjær 2260 SLM to be used on the noise survey is provided in Figure 7.2.

Figure 7.2 – Noise Measurement Equipment for Attended Noise Surveys



Each survey will be conducted in accordance with appropriate methodology, and the required parameters measured / recorded as per ISO 1996-1:2016, ISO 1996-2:2007, AS 1055-1:1997, and AS 10555-2:1997.

During the attended noise survey, site personnel will take the opportunity to investigate the surrounding area (particularly around the CPF) to identify any surrounding localised shielding (such as that provided by terrain) that can have an impact on future noise emissions across the site.

The surveys will also be used to familiarise SLR personnel with the site and to verify inputs for the noise modelling component of the assessment (such as potential ground and terrain absorption).

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8. Personnel and Equipment

8.1 Technical Specialists

The survey team will include the following technical personnel (Appendix A):

- Ima Fricker – Acoustics specialist.
- David Woodcock – Acoustics specialist.
- Kobus Meulenbroeks – ERIAS Group Logistics Coordinator.

8.2 Survey Equipment

The following technical equipment will be used for the purpose of the field survey:

- Acoustic calibrator



- Brüel&Kjær 2260 Type-1 Sound Level Meter (powered by 6 x C cell batteries)



.

- 5 x Acoustic Research Laboratories (ARL) Ngara Type-1 noise loggers (powered by 12 V battery)

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- Calibrated audio recording equipment (note Ngara noise logger has in-built audio recording capability – see above photo)
- Portable weather station



In addition to the above, the field team will also carry a GPS, digital camera, and range finder for the purpose of taking site observations.

A copy of all documents acquired during the survey, pictures, maps, electronic data acquisition (raw noise measurement data, GPS data) will be provided to TEP PNG on the last day of the campaign prior to demobilization.

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9. Sampling Sites

The study area includes areas surrounding the Project which may potentially be impacted by noise such as existing villages, sensitive fauna areas, and areas where possible future in-migration may occur. Noise measurement results will also be used to inform potential noise impacts to local communities and wildlife.

Areas where in situ noise monitoring and/or attended noise surveys will be undertaken are shown in Table 9.1

Table 9.1 – Description and Coordinates of Study Sites

Site	Description
1	Poroi Village: Closest existing major cluster of sensitive receptors to CPF. Village is located on north bank of the Purari River. Unattended noise monitoring will be conducted from this site along with an attended noise survey during the day period. -7°23’33.756”S, 145°11’31.636”E
2	Mapaio Fish Camp: Monitoring location at second closest established village to CPF. Unattended noise monitoring will be conducted from this site along with an attended noise survey during the day period. -7°21’57.631”S, 145°6’57.04”E
3	Purari Airstrip Garden Hut: Location representative of existing sensitive receptor near airstrip as well as possible community in-migration area at future logistics base. Unattended noise monitoring will be conducted from this site along with an attended noise survey during the day period. -7°23'16.25"S, 145° 9'45.57"E
4	Fly Camp C: Location representative of acoustic environment near perimeter fence to CPF. Unattended noise monitoring will be conducted from this site. If possible, a brief attended noise survey will also be conducted from this location during deployment / collection of logger. -7°21'14.78"S. 145°10'56.44" E
5	Fly Camp E*: Location representative of acoustic environment along the pipeline alignment. -7°39’01.1S”,145°15’ 42.4” E
6	Herd Base: Survey location representative of occupied, operational facility. Unattended noise monitoring will be conducted from this site during the day and night periods. -7°21’22.508”S, 145°13’26.893”E
7	ANT-7 operational wellpad: Collection of data from existing appraisal well drilling operation for inclusion in the noise model for the impact assessment. Unattended noise monitoring has been deemed not necessary for this location due its remote nature and minimal risk of future community in-migration. -7°9'46.62"S, 145° 7'21.92"E
8	Indicative coastal village (e.g. Marea, Iuki, Herekera, Hururu etc.) where pipeline ROW will make landfall. Location included due to high population density of area. However, it should be noted that potential noise impacts will only occur during the construction works. TEP PNG community affairs team recommend Hururu village (due to established relationships to secure equipment). Unattended noise monitoring will be conducted from this site along with an attended noise survey during the day period. -7°51'7.94"S, 145°18'25.10"E
9	ANT-3 future wellpad : location representative of acoustic environment within the gas wellpads -7°08'35.98"S,145°08'26.86”E

General Note: The provided coordinates only indicate the general location of each survey area. Due to site-specific considerations such as security, proximity to existing noise sources, exact monitoring locations will have be determined on site during the survey.

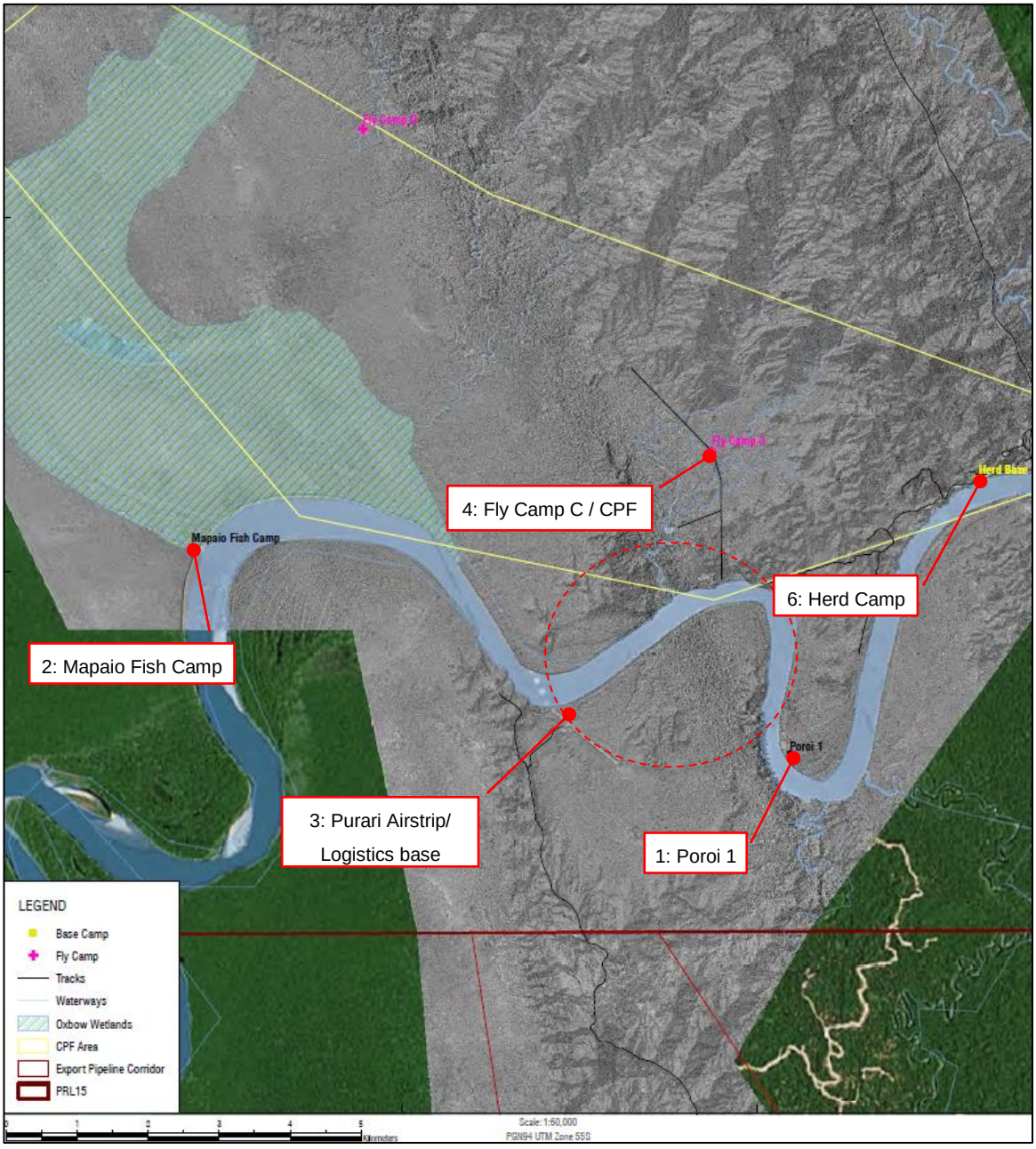
These areas are all accessible from Herd Base located on the north bank of the Purari River.

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The monitoring locations are shown in Figures 9.1, to 9.4.

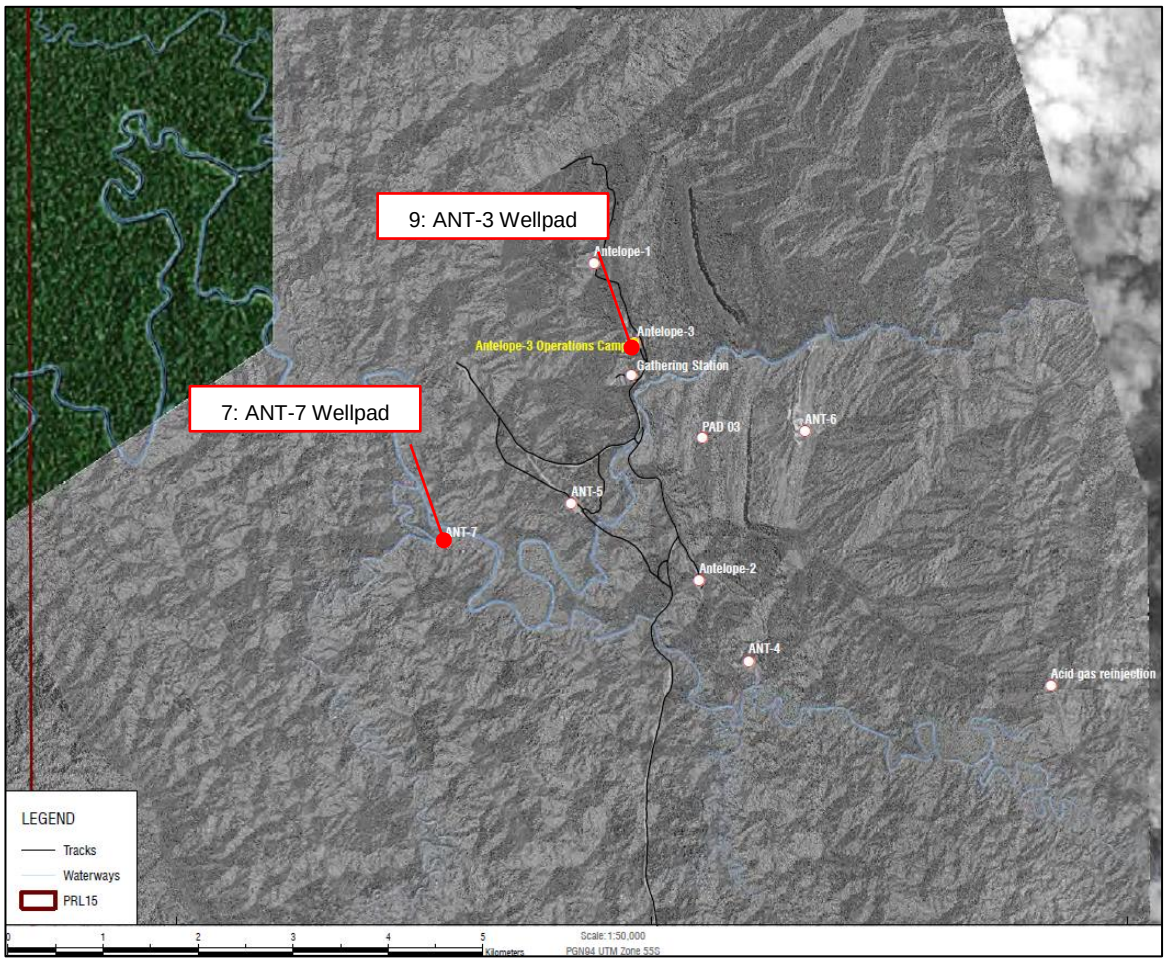
Where specified the unattended noise monitoring equipment will be deployed at each location for a minimum duration of 48 hours as per IFC requirements.

Figure 9.1 – Noise Survey Locations (Purari River)



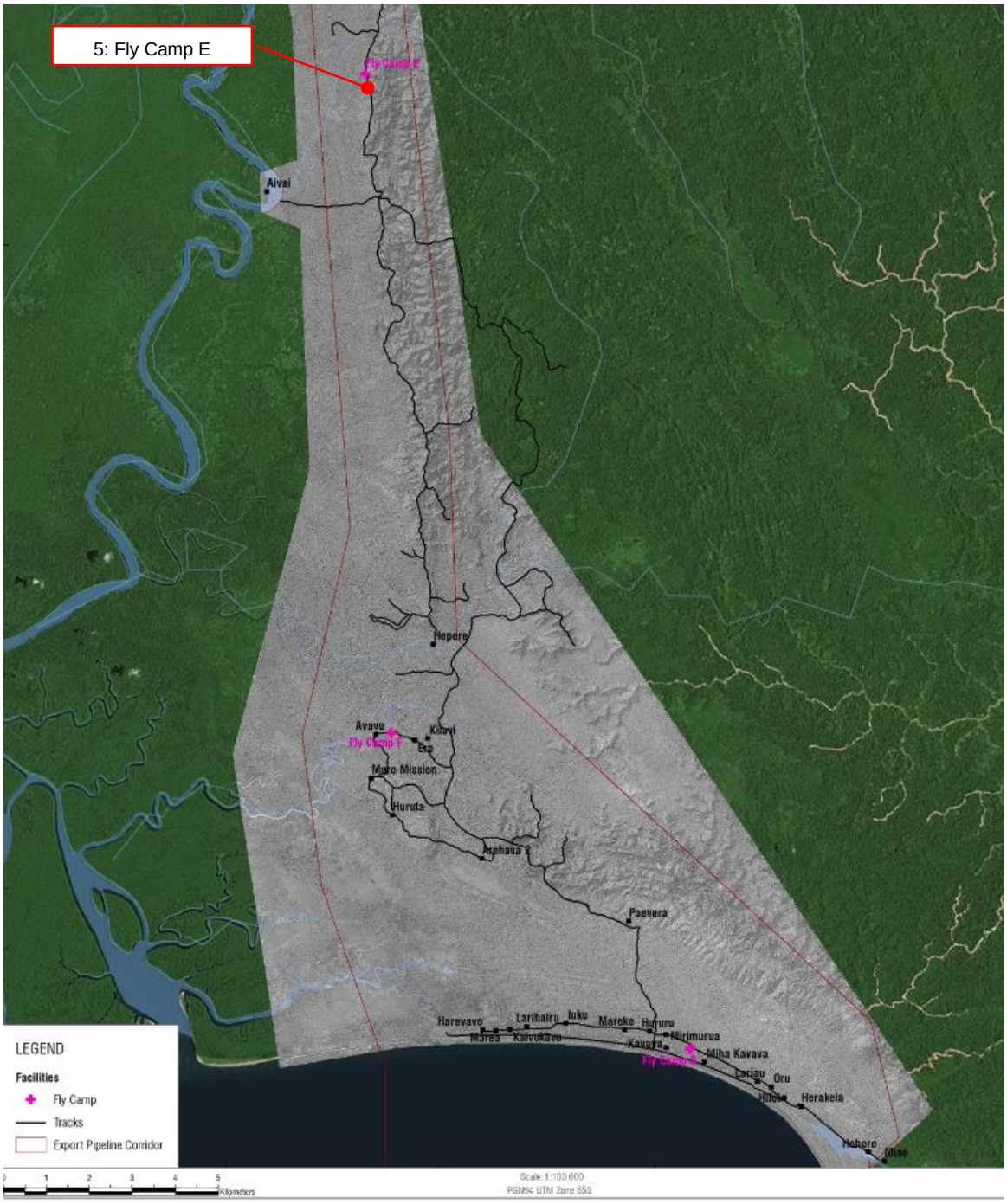
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Figure 9.2 – Noise Survey Locations (Wellpads)



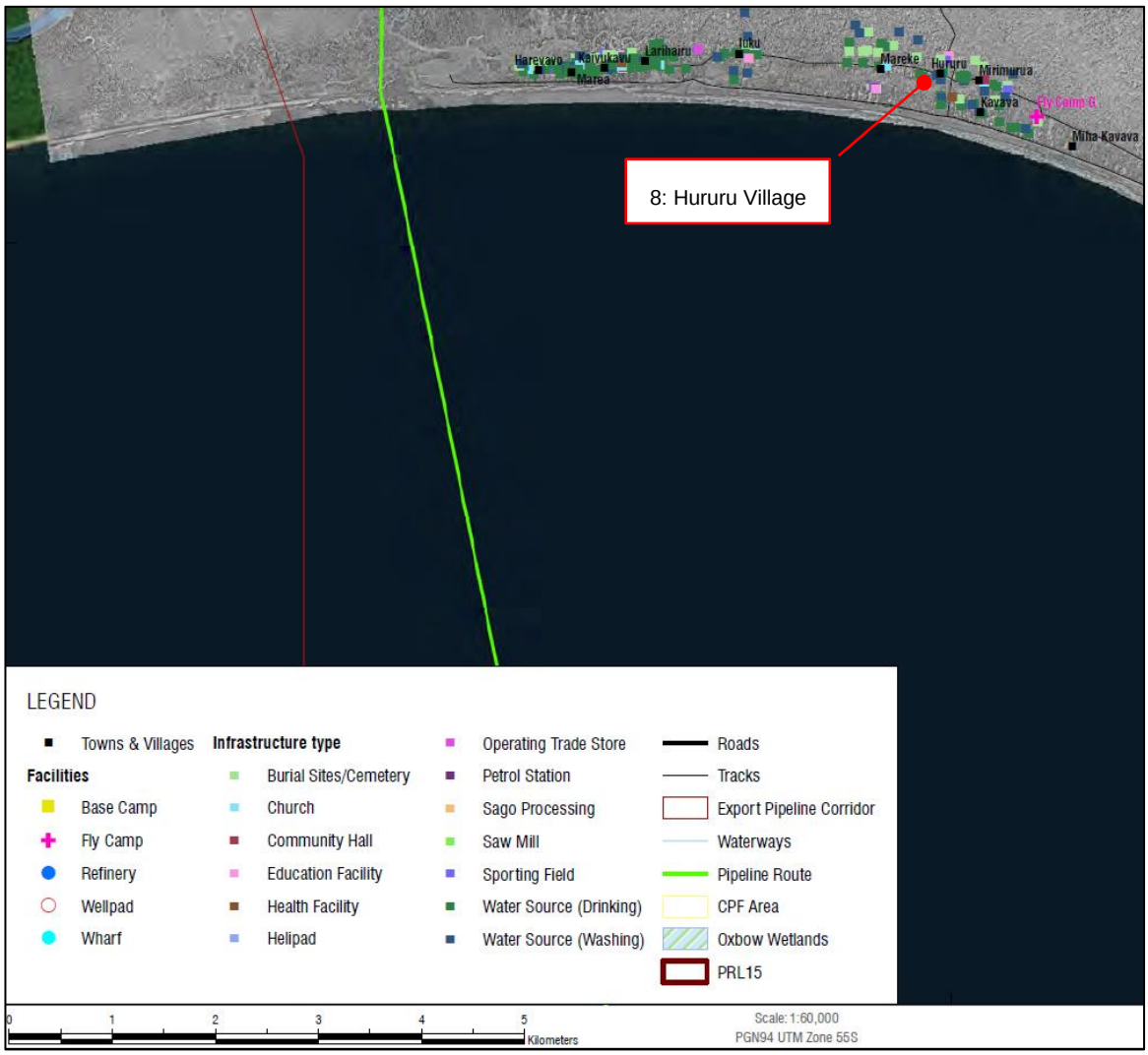
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Figure 9.3 – Noise Survey Locations (Pipeline)



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Figure 9.4 – Noise Survey Locations (Coastal Region)



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10. Sampling and Storage

All noise measurements will be taken on site using the equipment identified in Section 8.2 in accordance with the general procedures in ISO 1996-2:2007, and AS 1055:1997.

At the end of each survey, all measurement results will be backed up onto a separate hard drive to be summarised in a written baseline technical report.

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11. Sample Analyses

11.1 Unattended (48+hr) Noise Monitoring

The Ngara noise monitoring system used for the bulk of the noise monitoring campaign continuously logs data (instantaneous SPL and L_{eq} at 10 samples/second and recorded audio at 12 kHz) over the monitoring period which is then post analysed using the ARL Ngara Remote Host software package.

Unattended noise monitoring results are then processed using in-house SLR analysis software (Microsoft excel macros) to allow for data review/exclusions to then calculate the ambient background noise levels for each receptor area. Noise logging results will be provided graphically of the time trace (short-term 20 second L_{eq}) and in a tabulated format which will include all relevant hourly statistical indices.

The unattended monitoring equipment will also have the capability for audio recording to assist with the identification of extraneous noise and data exclusions (if necessary).

After any data exclusions (for extraneous noise) the resultant 'day' and 'night' time background noise levels will be determined.

11.2 Attended Noise Surveys

The short-term attended noise surveys will be used to identify any relevant existing noise sources (i.e. noise from the operational wellpad or other relevant noise sources such as those at Herd Base); if necessary a frequency spectrum will also be provided.

Due to the nature of the survey no external laboratory analysis will be required. All post measurement data analysis will be performed by SLR and reported in the Noise Environmental and Social Baseline Technical Report.

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12. Quality Control

12.1 Sample Collection, Handling, Storage and Transport

To ensure good quality data are collected during the field program, a number of quality assurance (QA) and quality control (QC) procedures are adhered to during all field work, as follows:

- Ensure all measurement equipment complies with relevant National Australian Testing Authority (NATA) standards as required.
- Conduct a field calibration check immediately before and after each noise survey to ensure the measurement equipment is operating within acceptable parameters.
- All noise measurements will be conducted in accordance with International Standard ISO 1996-2:2007, and Australian Standard AS 1055:1997.
- Data validation including a review by experienced site personnel to ensure the measured noise levels are representative for the measurement location.

12.2 Control Samples

Due to the nature of the survey, control samples are not necessary.

12.3 Laboratory Quality Control Measures

All measurement equipment used by SLR conforms to relevant calibration requirements. No external laboratories will be used.

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13. References

Barber, J.R, Crooks, C.R, Fristrup, K.M, 2010. The costs of chronic noise exposure for terrestrial organisms, *Trends in Ecology and Evolution Paper, 25(3)*: 180-189

Coffey Natural Systems. 2009. Receiving onshore environment: LNG facility. Chapter 12 in PNG LNG Environmental Impact Statement. Report prepared for ExxonMobil

Douglas Environmental Services, 2008. Elk/Antelope Gasfield Project – Environmental Impact Statement, Section 4.4, Section 7.1.7, and 7.2.1.2. Report prepared for InterOil.

Independent State of Papua New Guinea No 64 of 2000 *"Environment Act 2000"* (PNG, 2000) and the Guideline for Conduct of Environmental Impact Assessment and Preparation of Environmental Impact Statement (DEC, GL-Env/02/2004).

Lynch, E., Joyce, D., & Fristrup, K. 2011. An assessment of noise audibility and sound levels in U. S. National Parks. Landscape Ecology.

Total. 2015. Total general specification GS EP ENV 001: Environmental requirements for project design and E&P activities. Section 5.9. Noise level. Total S. A.

TOTAL general specification GS EP ENV 111: Environmental Baseline and Monitoring Studies: Onshore Sites (Total, 2012).

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Appendix A: Acoustic Specialist Team Credentials

IMA FRICKER

Senior Project Consultant

Curriculum Vitae

QUALIFICATIONS

BE Mechanical (Hons) - Monash University 2007

MEMBERSHIP

Member of Australian Acoustical Society

Member of the Institution of Engineers Australia (MIEAust) Mechanical College

CONSULTING BACKGROUND

Ima has almost 10 years of experience in project management and acoustics, noise and vibration consulting roles.

Over this period, Ima has been involved in a number of high profile projects, developing specific experience in building and architectural acoustics, computer noise modeling, occupational noise exposure, and the assessment and control of noise and vibration (N&V) from construction, industry, and road & rail traffic.

SPECIAL EXPERTISE

- Road / rail traffic noise measurement, predictive modelling, assessment and design of mitigation solutions
- Industrial and extractive industry noise measurement, prediction, assessment and control
- Investigations of occupational noise exposure
- Sound power measurement, sound and impact insulation testing, FFT analysis
- 3-D computer noise modelling
- Environmental management plans and impact assessments
- Vibration management, assessment and control
- Data management and analysis
- Field operations
- Project Management

SELECTED PROJECT EXPERIENCE

Occupational Noise

Occupational Health & Safety (OH&S) noise surveys as required for:

- Bulla Dairy
- Lotus Folding Walls & Doors
- Peerless Foods

Transportation & Infrastructure Projects

Webb Dock Port Capacity Project – Noise modelling & assessment of operational and construction noise impacts from Automotive Facility and Roads & Services (R&S) packages. Vibration monitoring & control advice was also provided on the Victorian International Container Terminal (VICT) and R&S packages.

M102 North Essendon to Tottenham Pipeline & Essendon Airport Main Works Projects – Vibration impact assessment & out-of-hours works (OOHW) construction noise impact assessments

EastLink tunnel – Noise control advice and review of noise from tunnel exhaust fans

City of Boroondara - Road traffic noise and air quality monitoring

VicRoads - Traffic noise monitoring at extensive sites throughout metro and regional Victoria

Architectural Acoustics & Mechanical Services

149 Hansworth St, Mulgrave – Noise modelling / assessment and building construction advice to mitigate road traffic noise to development

DB Schenker Office Fitout - Green Star Assessment

MFB Burnley Headquarters - Office environment assessment and remediation advice

Mining Projects

Hidden Valley Goldmine, Morobe Province, PNG – Detailed site noise measurements, provide training to environmental team, environmental modelling & assessment and preparation of project noise management plan

Costin's Pit Quarry - Industrial noise and vibration modelling and assessment of proposed future operations

Morningstar Goldmine - Predictive noise modelling and assessment of proposed operations

Oil and Gas Projects

PNG LNG Project – Baseline noise surveys at upstream construction work camps. Following construction, detailed noise measurements were conducted of operational facilities and a calibrated noise model prepared. Acoustics measurement & training was also provided to site environmental personnel

APLNG – Attended noise measurements during Bleed Off Line operations and preparation of noise model for upstream facilities

Santos Gas Field Development Project – Predictive modelling and assessment of construction related traffic noise

DAVID WOODCOCK

Project Consultant

Curriculum Vitae

QUALIFICATIONS

BEng (Electrical/Electronics)(Hons) RMIT

MEMBERSHIP

Member of Australian Acoustical Society
AAS (Grad level 1)

Audio Engineering Society (Post Grad)

BACKGROUND

Dave joined SLR's acoustics team in 2014 and has gained experience in a broad range of projects across road, building, environmental and vibration sectors.

Dave has a total of approximately 2 years' experience as an acoustic consultant which involved measurement, prediction and analysis of noise and vibration emissions from commercial and industrial premises as well as from road vehicles. He has also prepared SoundPLAN noise models for key infrastructure projects and land use developments.

Dave is competent in the use of a range of noise and vibration monitoring equipment and has worked on Hardware research and development projects in the company.

Dave has worked on studio recordings and many audio video projects using digital audio workstations. He also has skills in code writing and digital signal processing, network engineering and more hands on tasks such as wood and metal work, PCB component soldering.

SPECIAL EXPERTISE

- Environmental Noise Monitoring
- Road Traffic Noise Measurement
- Building Acoustics Measurement
- Vibration Monitoring
- Research and Development
- Coding and Data Processing

SELECTED PROJECT EXPERIENCE

Wind Farm Noise Projects

Silverton Wind Farm – unattended noise measurements, data processing, SoundPLAN Noise modelling

Sapphire Wind Farm – SoundPLAN Noise modelling

Crookwell 2&3 Wind Farm – SoundPLAN Noise modelling

Road & Rail Traffic Noise Projects

CityLink Tullamarine Widening – Bridge reflection analysis, unattended noise measurements data processing and summaries.

53 Hartington St Glenroy development – Rail noise measurements and recommendations.

East West Link – unattended noise measurements data processing and summaries.

Keilor Park Drive Storage World – road traffic noise and SoundPLAN modelling.

114 Rix Road, housing development road and rail – noise and vibration monitoring.

Vibration Monitoring

Webb Dock PCP VICT – monitoring and analysis on a weekly basis

Bombardier Tram Vibration – technical measurements

Richmond Bridge Vibration monitoring –DASYLAB software management control

Reid St Fitzroy monitoring – monitoring and analysis

CityLink Tullamarine Widening Project – Accelerometer setup and measurements at toll gantry point and camera stability testing

Minimate remote access / webhosting Research and Development project.

Building Acoustic Projects

77 Riversdale Road – apartment BCA wall, floor and door testing

Melbourne One Apartments – compliance measurements and data processing

106 Warrigal Road Camberwell – apartment wall tests



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